

Impacts of Land Use and Land Cover Change on Water Quality in the Big Sioux River Basin: 2007-2015



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Advisor: Dr. Darrell Napton**

A Story

▶ Right or Wrong?

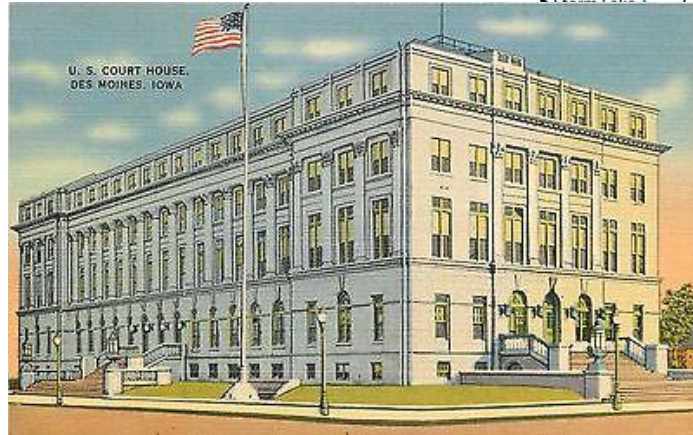
▶ Moral:

You have right to your *rights* but not over my *rights*.

▶ Dinesh Shrestha



Another story...

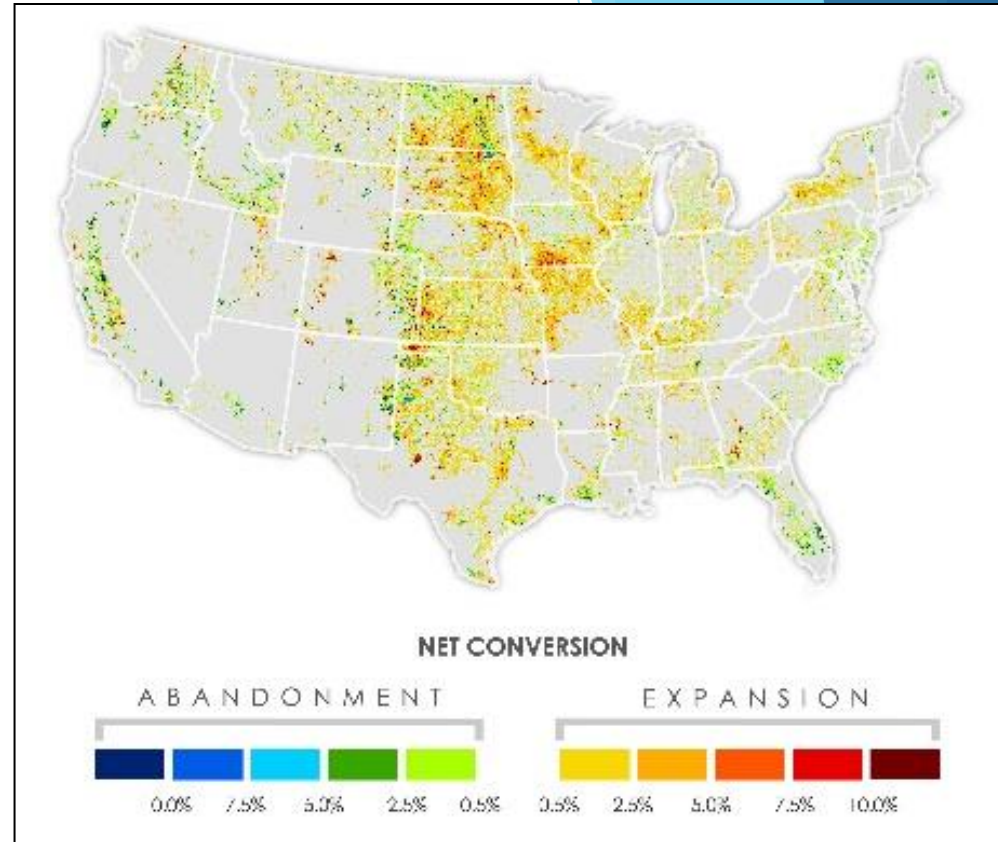


Raccoon River Watershed (Jha et al, 2007)

Stories behind My Story

- ▶ Western Corn Belt Plains Ecoregion
 - More grassland was lost to corn or soybeans.
 - The majority of changes is happening along the western edge of the ecoregion.
 - Net decline in grass-dominated land cover totaling nearly 530,000 ha in the WCB

(Wright and Wimberly 2013)

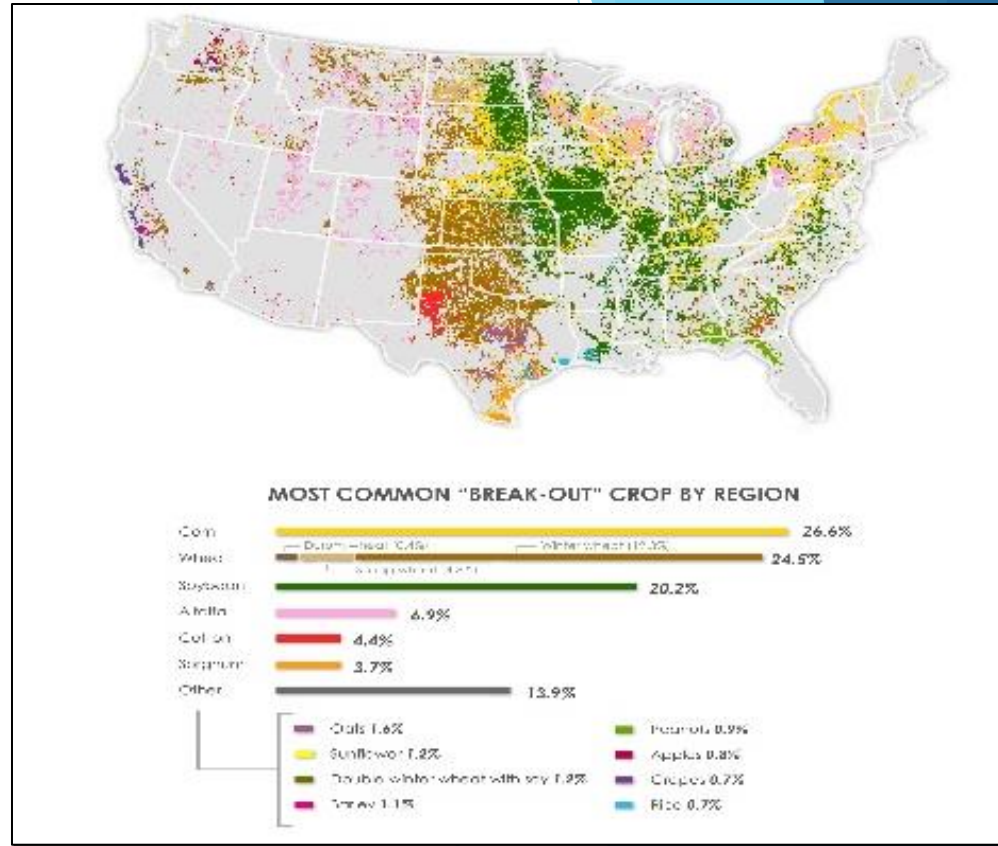


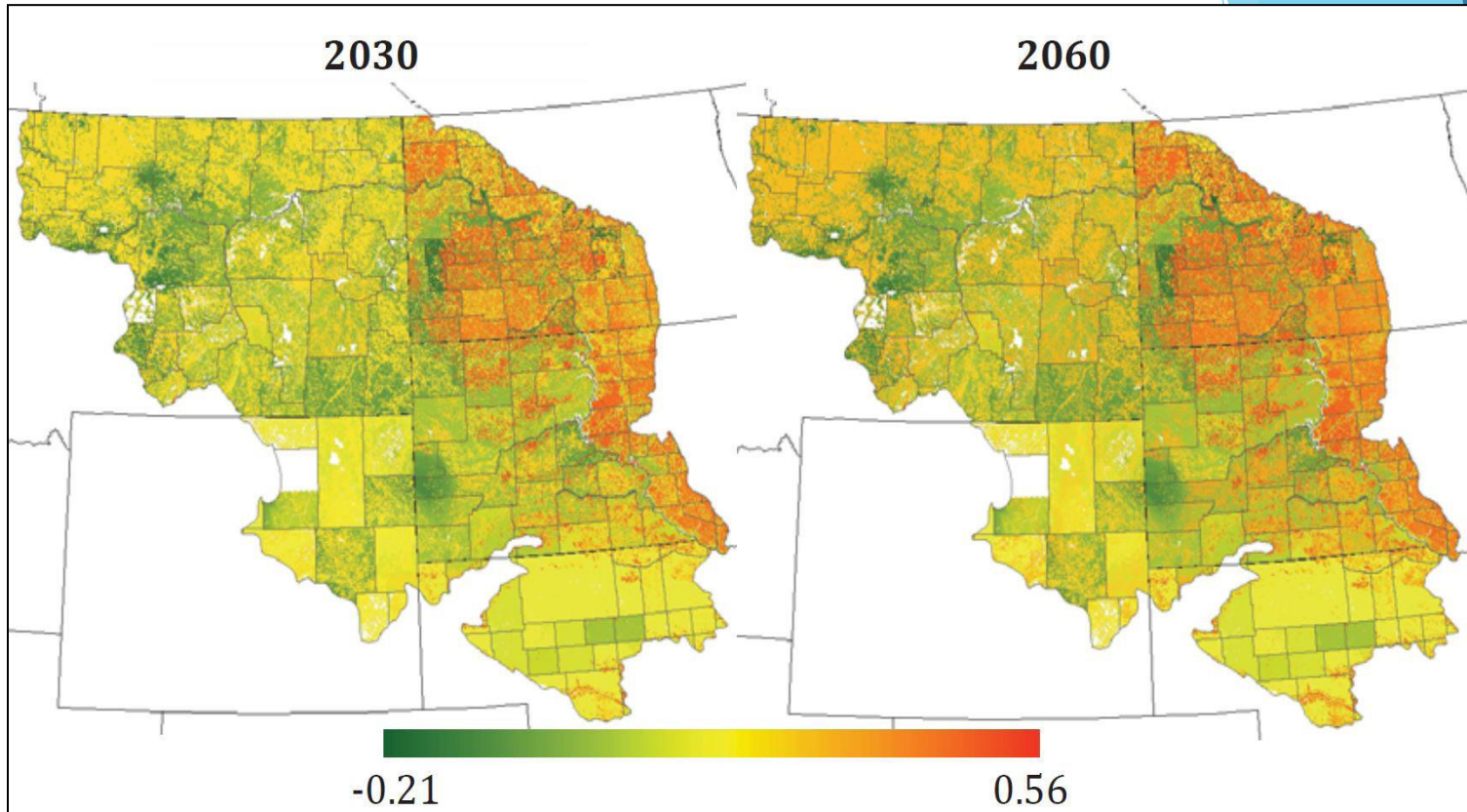
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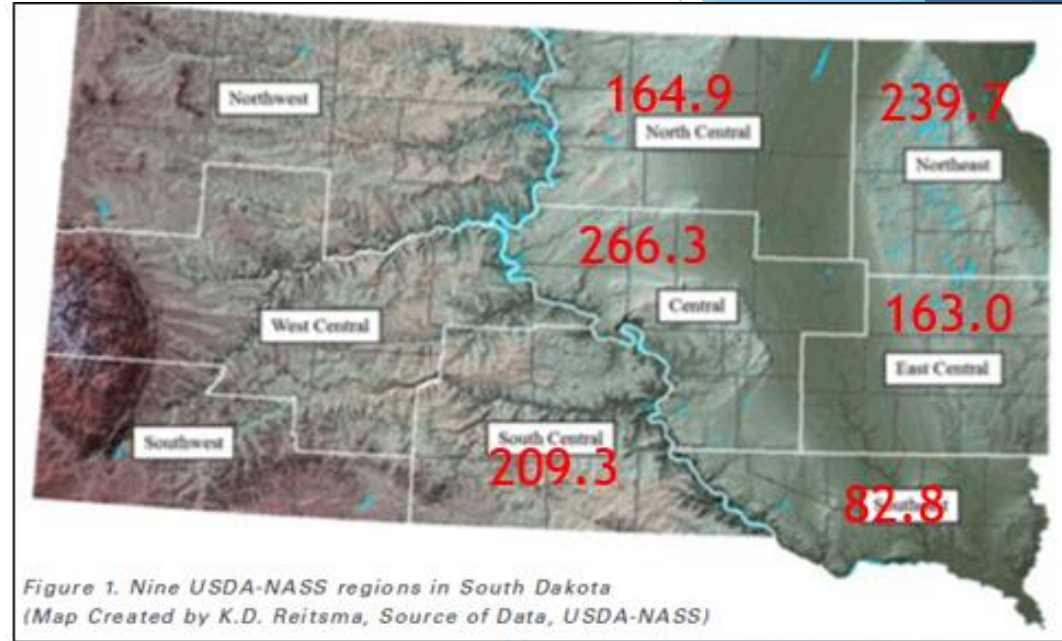




According to Rashford et. Al (2013), an additional 700,000 acres (more than total area of Rhode Island State) of grassland may be lost in North and South Dakota by 2060.

Framing the story

- Conversion of 1.8 million acres of grassland to cropland, in South Dakota, between 2006 to 2012 (Reitsma et.al 2014, 1).
- Most of the conversion took place in the eastern and central SD.

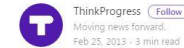
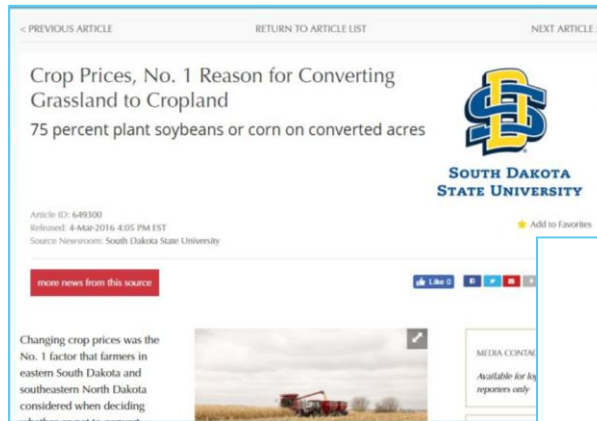


- Changes in the agricultural pattern and use of fertilizer for increasing the productivity have led to an increased quantity of nitrates in the soil.

Framing the story

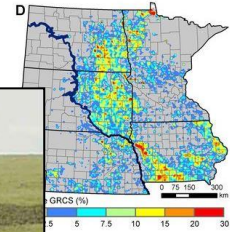
Driving forces...

- Biofuel demands
- High corn and soybean prices
- Grain (corn) demand
- Government payments
 - Crop insurance subsidies
 - Disaster payments



Biofuels Policy Helping Destroy U.S. Grasslands At Fastest Rate Since 1930s, Boosting Threat of Dust-Bowlification

By Jeff Spross




duction has thus far been a major misfire in the
e. By driving up the price of corn and other biofuel
in the United States and Europe requiring a certain

This happened..

BREAKING

Federal judge rules against revised travel ban

South Dakota's Big Sioux among dirtiest rivers in nation

The Associated Press May 7, 2012  2



SIOUX FALLS — The Big Sioux River snakes 420 miles down eastern South Dakota.

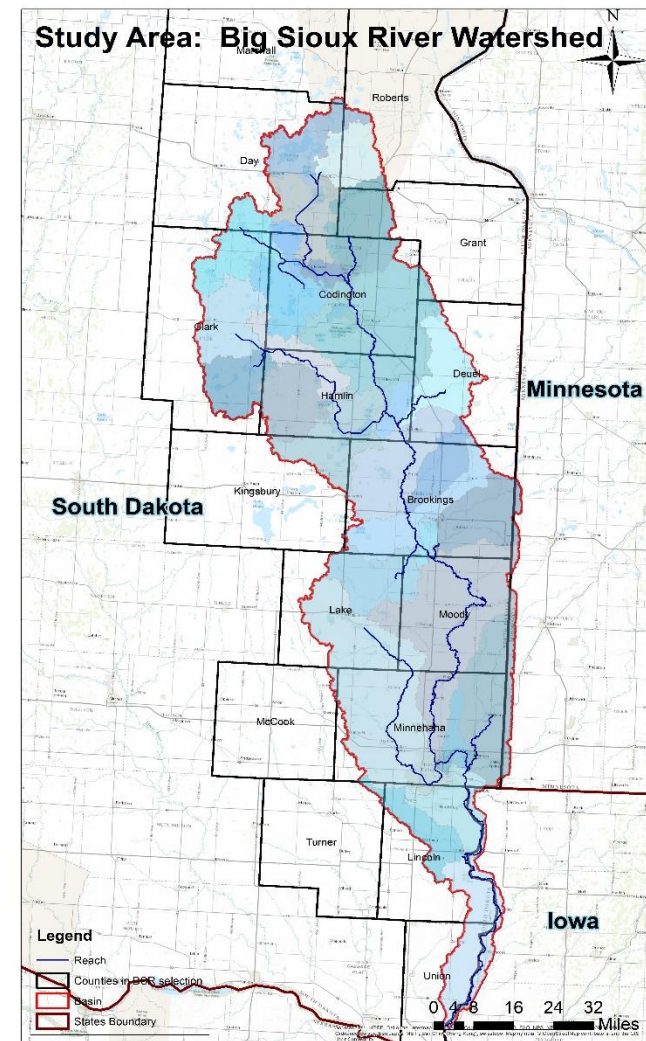
Latest

Man charged in Ra
pleads guilty

A story of the Big Sioux River

▶ The Big Sioux River Watershed

- ▶ Area: 5799 sq. miles lies in Eastern SD
- ▶ 420 miles long river that begins in Robert County, SD and flows south to Missouri River in Sioux City, Iowa
- ▶ Historically agricultural state; cattle, corn, soybeans, wheat, and hogs (Reitsma et al. 2015, 2363).



A story of the Big Sioux River

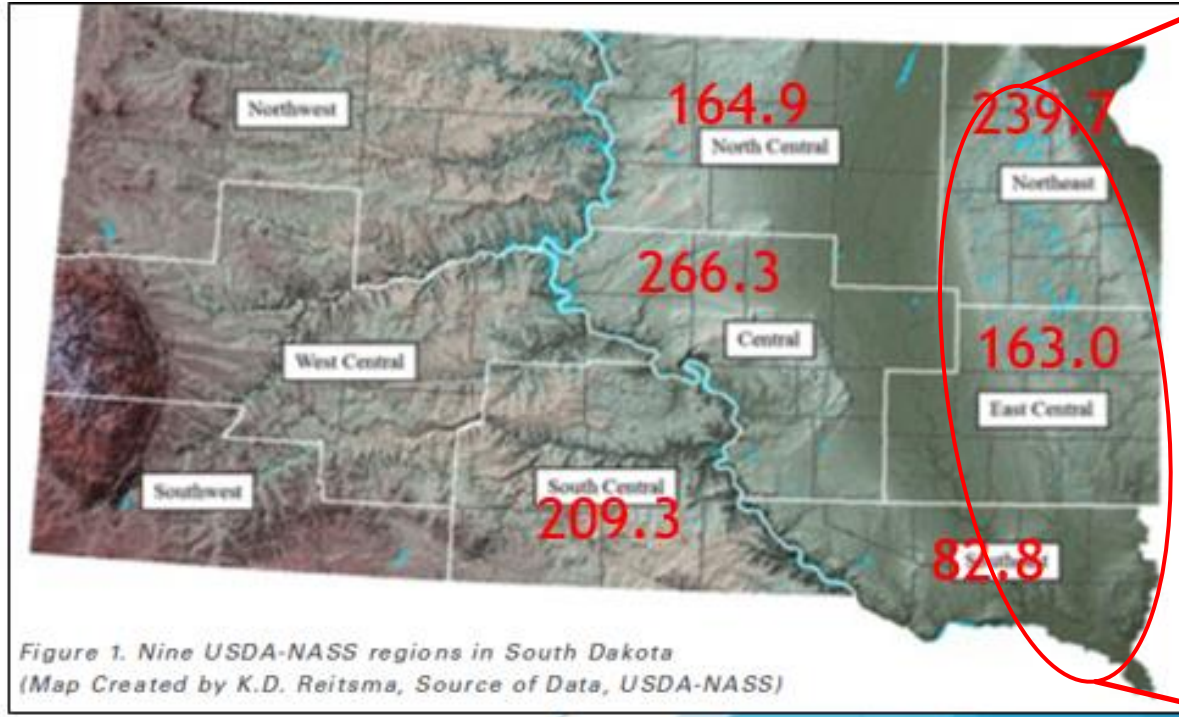
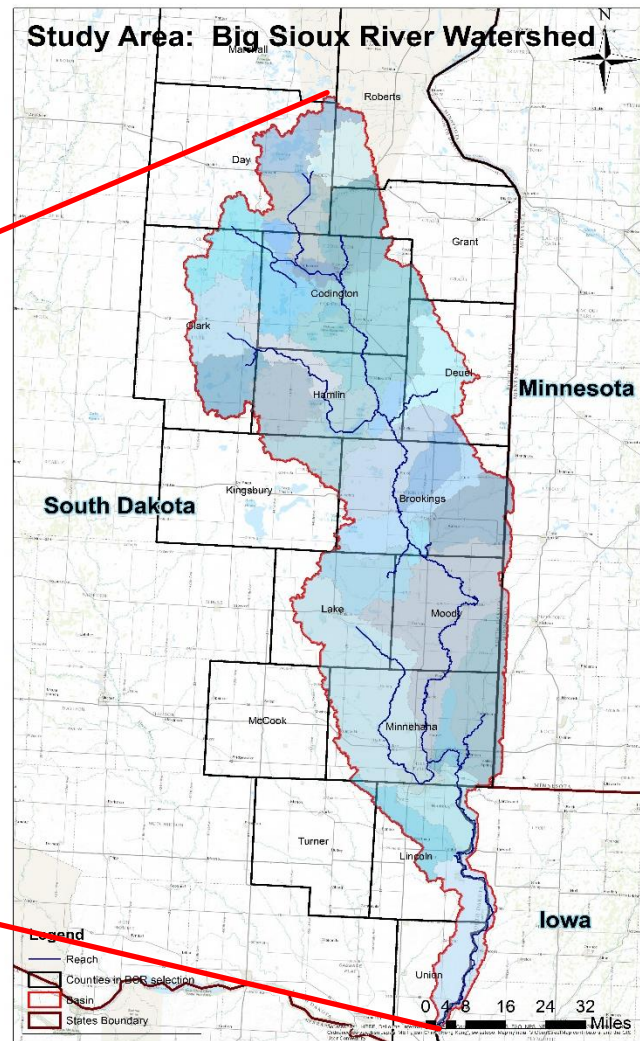
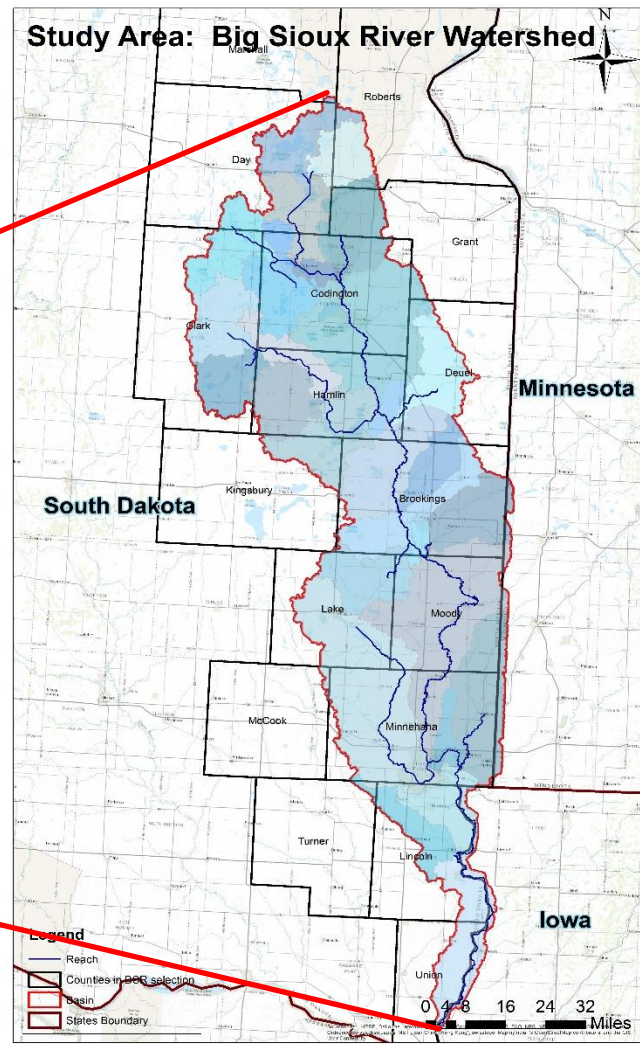
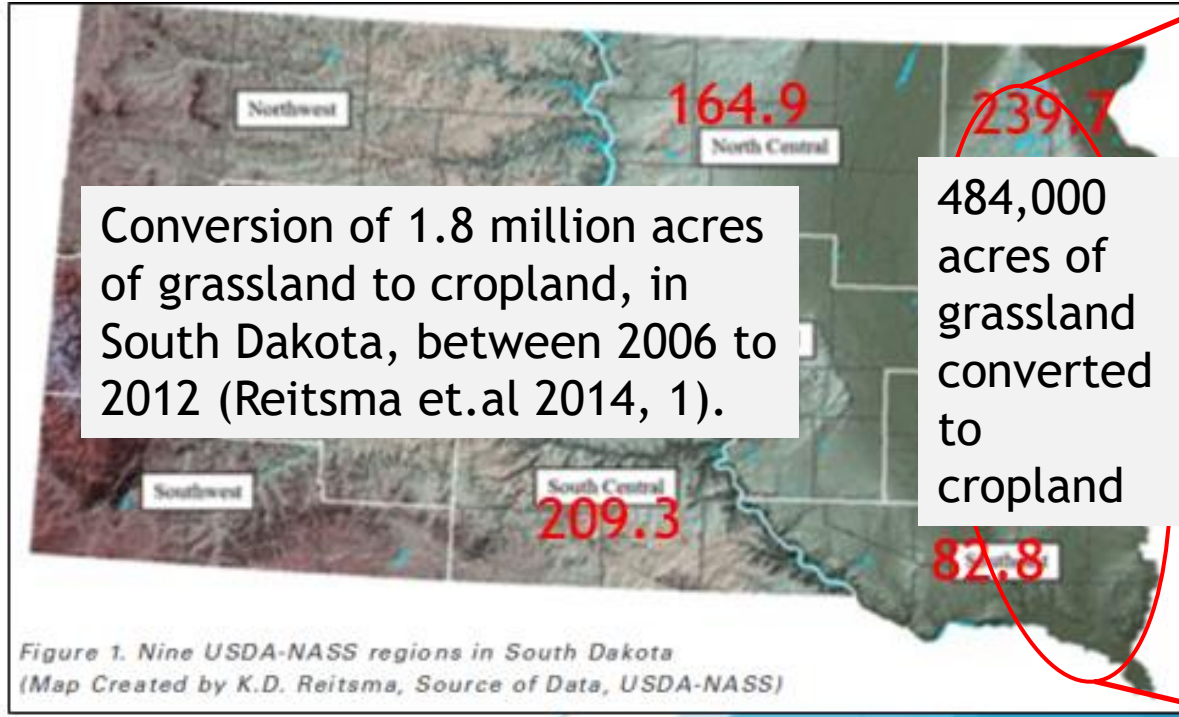


Figure 1. Nine USDA-NASS regions in South Dakota
(Map Created by K.D. Reitsma, Source of Data, USDA-NASS)

Study Area: Big Sioux River Watershed



A story of the Big Sioux River



Purpose of my story

Headline:

Impacts of Land Use and Land Cover Change on Water Quality in the Big Sioux River Basin: 2007-2015

The purposes of my story (research) are to determine

- ▶ **(1) Land Use and Land Cover (LULC) change in the Big Sioux River (BSR) watershed,**
- ▶ **(2) spatial and temporal trends of nitrogen levels in the BSR, and**
- ▶ **(3) determine whether there is a correlation between LULC change and changes in nitrogen levels in the river.**

Methods and Materials

Data Collection

- **Land Use Land Cover Change**
 - National Agricultural Statistics Service (NASS) CropScape-Cropland Data Layer: 2007-2015
- **SWAT Analysis**
 - Arc Grid representing a DEM for the Big Sioux River (Quad 1:24,000, topographic map sheet 30m x 30m cell size; heights in meters),
 - NLCD
 - Soil Data Set – Geospatial Data Gateway
 - Precipitation, Temperature and Weather Datasets

Methods and Materials

Land Use Land Cover Change

- Reclassification
- Trend of LULC change
- Change Matrix

SWAT Analysis

- Watershed Delineation
- HRU Definition
- Weather Definition
- SWAT Model run

Methods and Materials

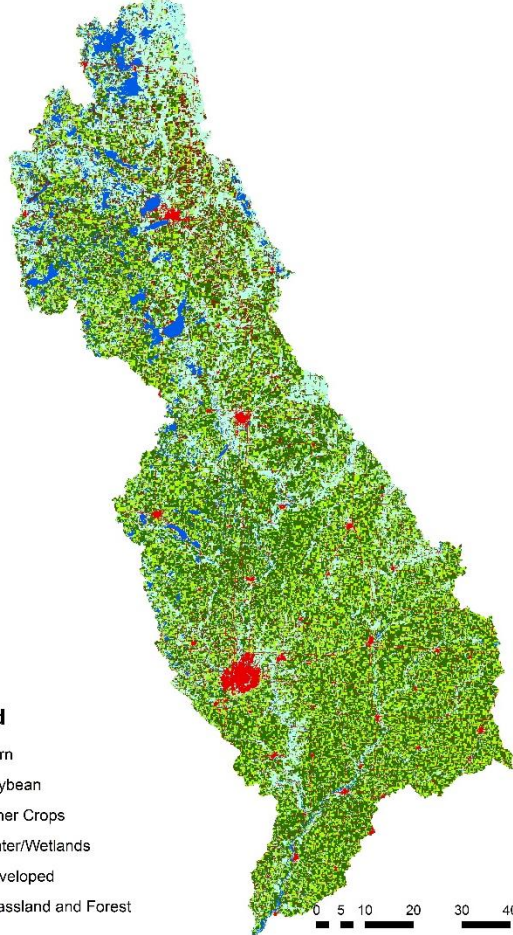
Land Use Land Cover Change

- **Reclassification**
- Trend of LULC change
- Change Matrix



Table 1: Reclassification table

Classes	Categories
Corn	Corn, Sweet Corn
Soybean	Soybeans
Other Crops	Wheat, Alfalfa, Cotton, Sorghum, Rice, Potato, Peas, Millet, Pumpkin, Mustard, and other crops.
Water /Wetland	Water, Perennial Ice/Snow, and Wetlands
Developed	Developed (low, medium and high density)
Grassland and Forest	Forest, Fruit Trees, Shrub land, Barren, and others

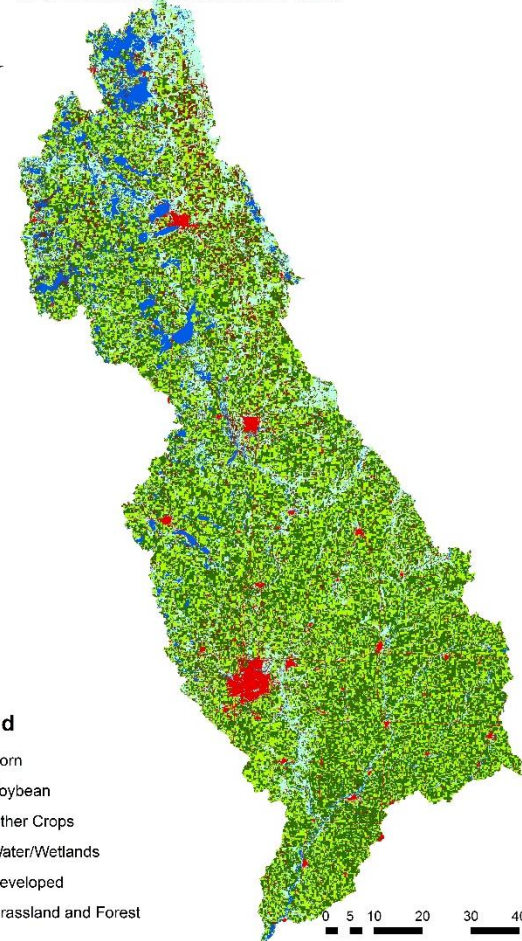
CDL Reclassification 2007








Legend

-  Corn
-  Soybean
-  Other Crops
-  Water/Wetlands
-  Developed
-  Grassland and Forest

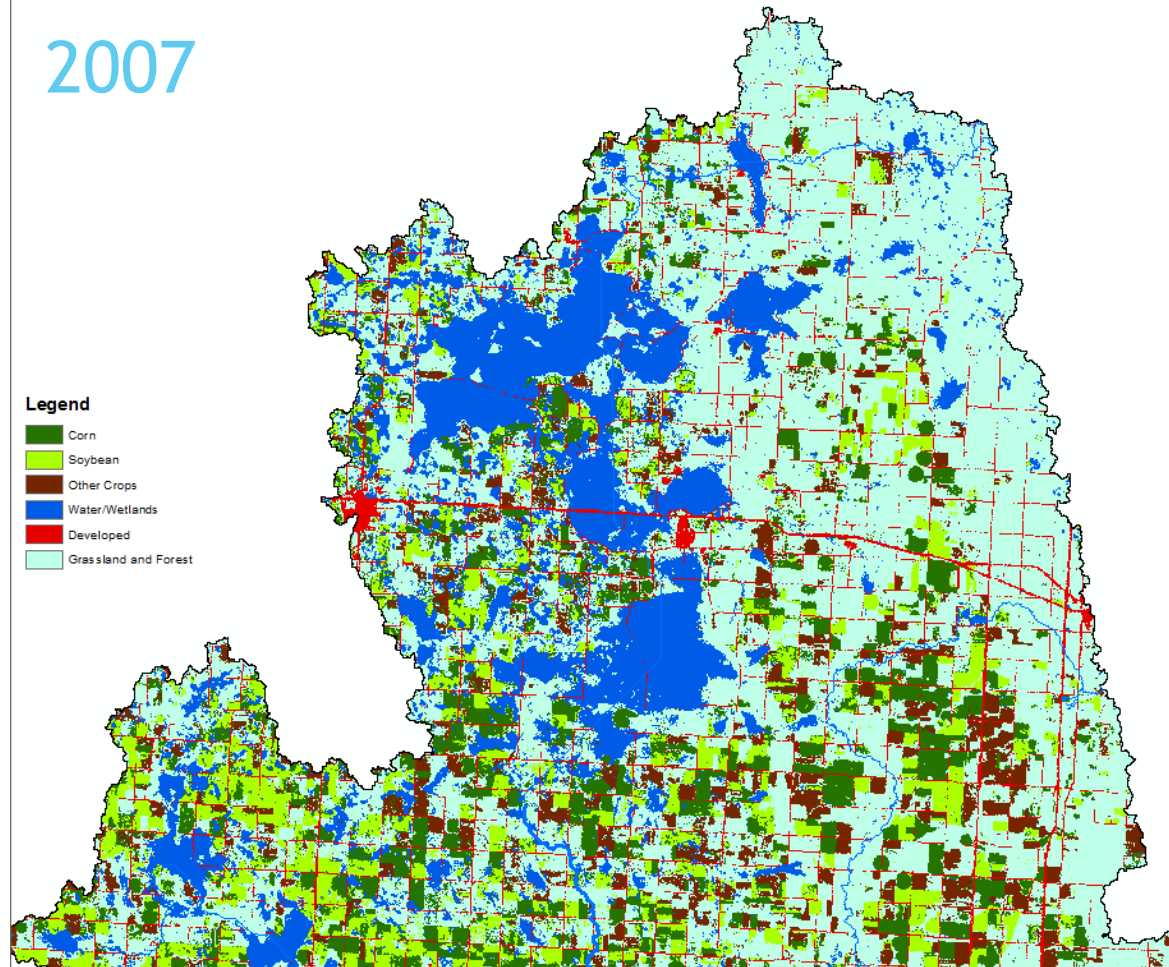
CDL Reclassification 2015



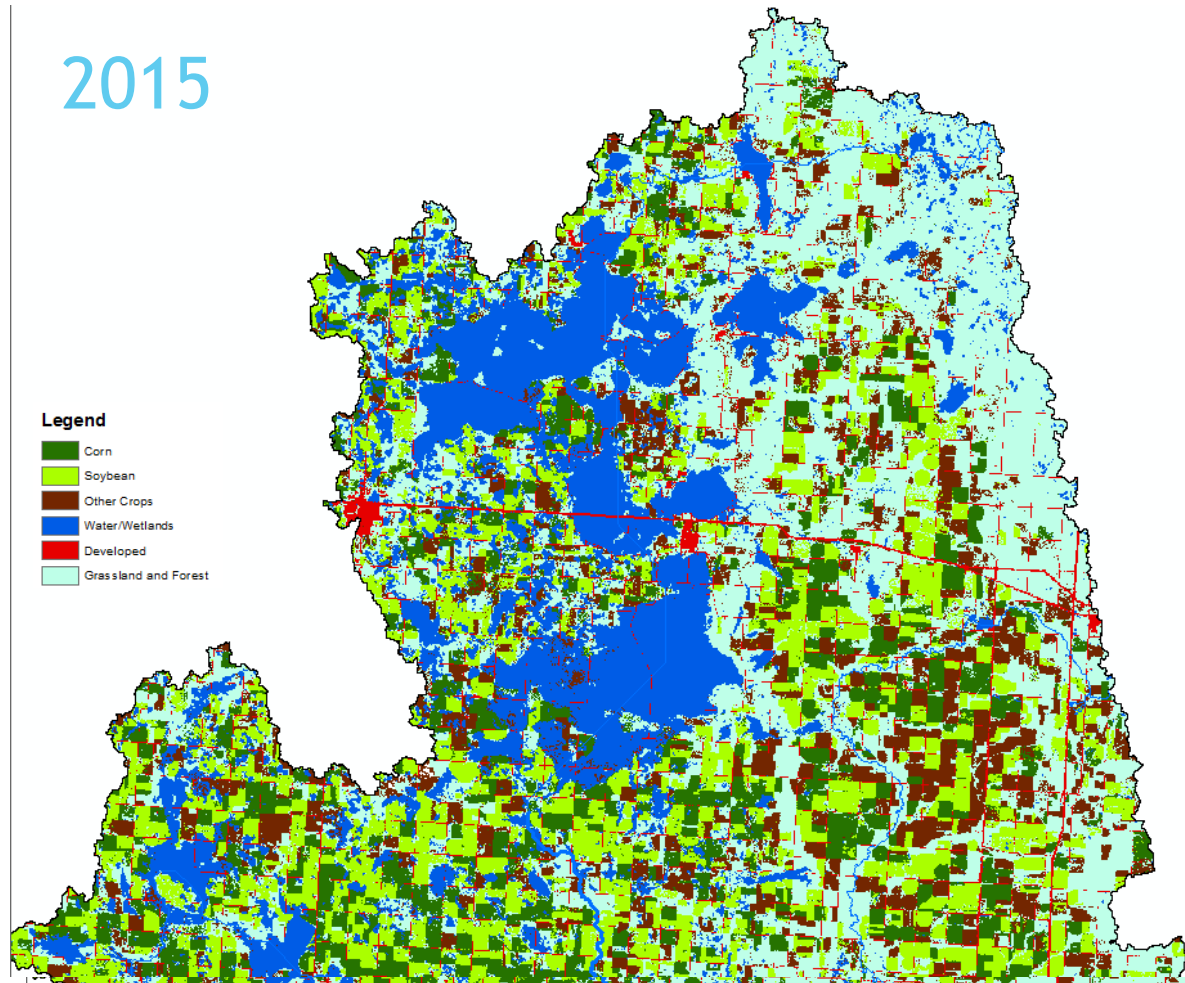
Legend

-  Corn
-  Soybean
-  Other Crops
-  Water/Wetlands
-  Developed
-  Grassland and Forest

2007

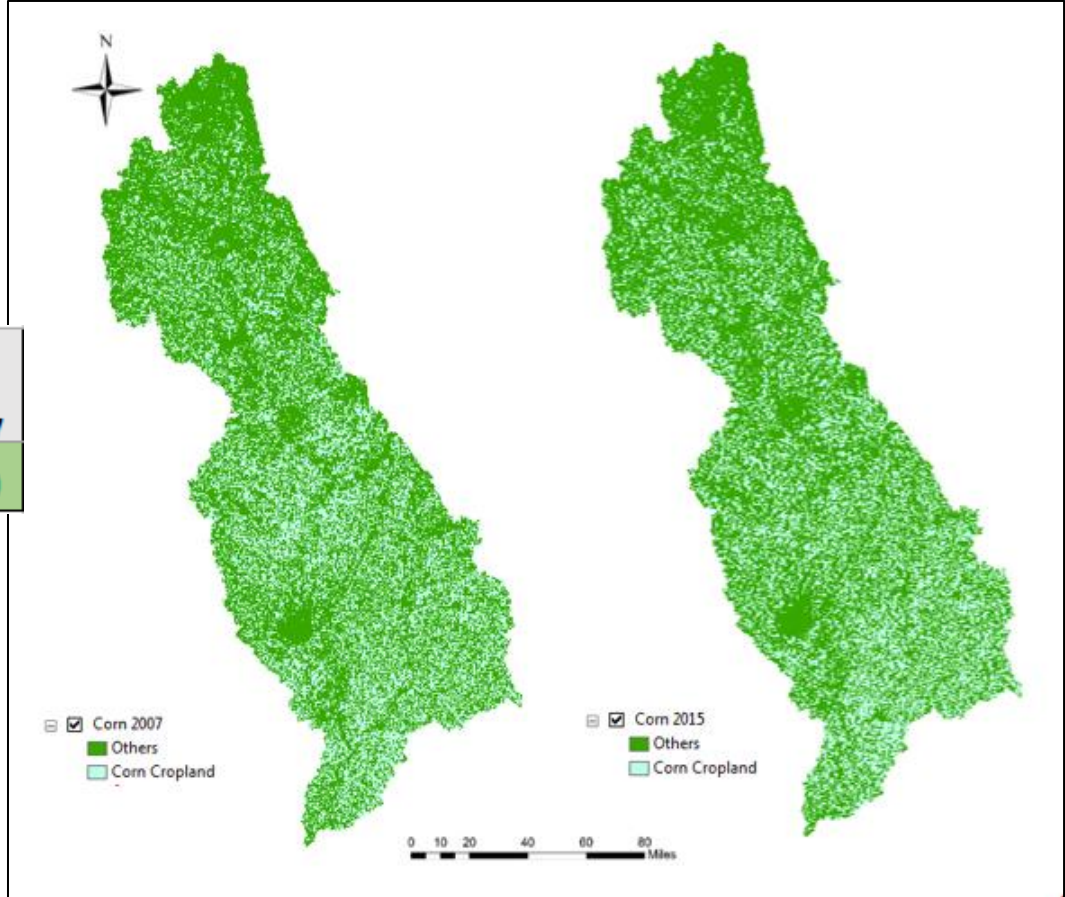


2015



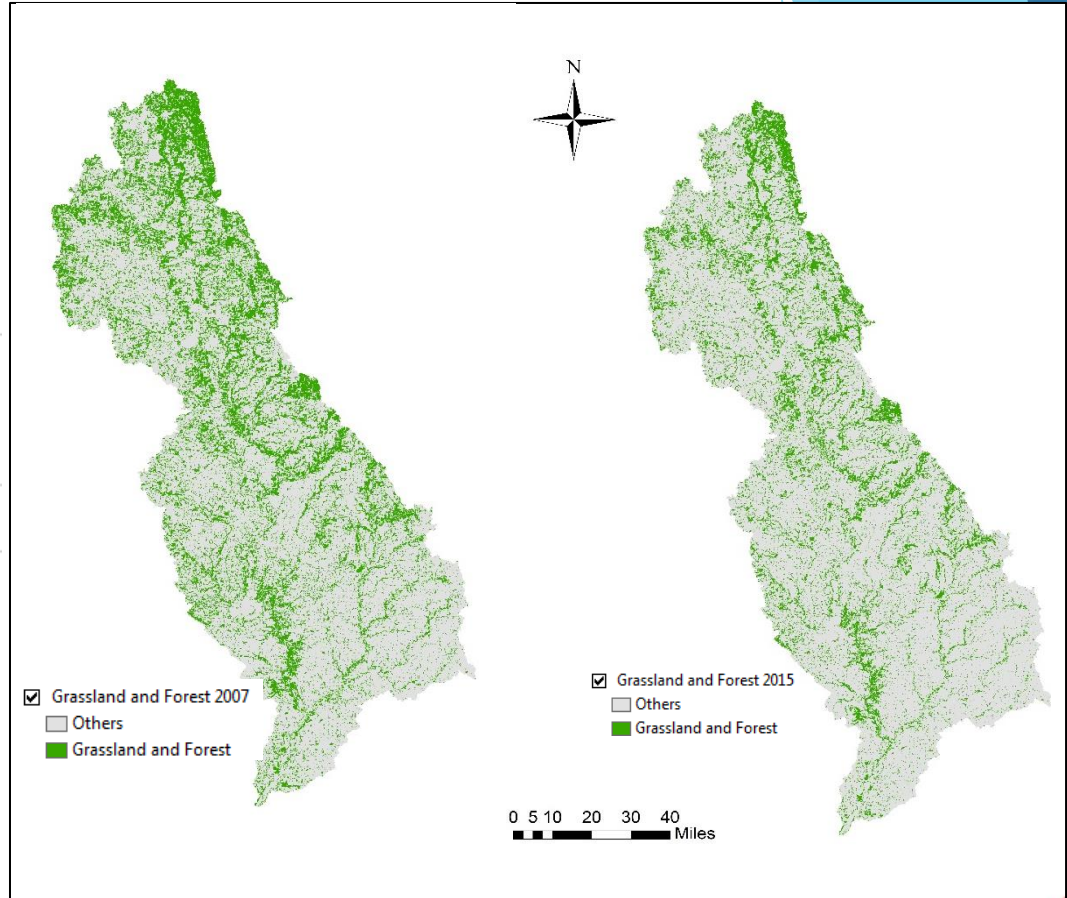
Corn Cropland

Corn Acreage in 2007	Corn Acreage in 2015	Acreage increased by
1,786,580	1,765,020	21,560



Grassland and Forest

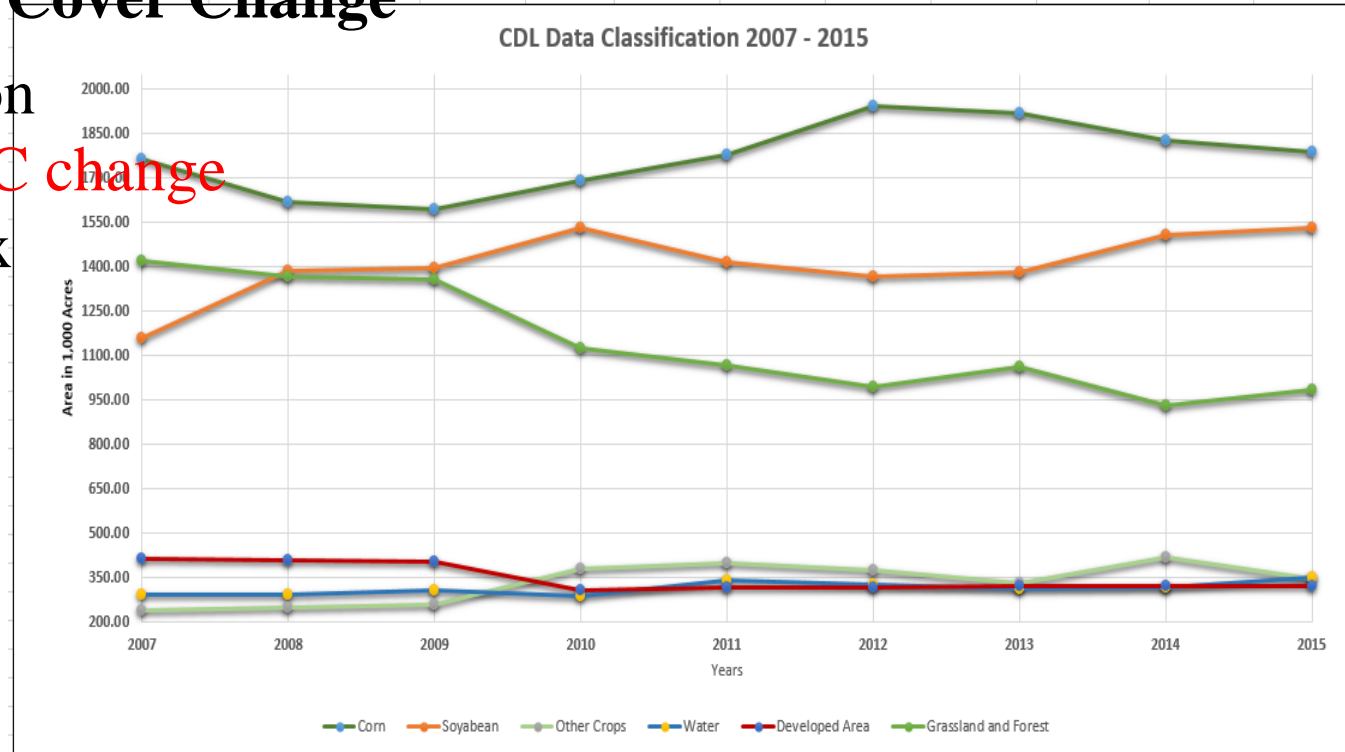
Grassland and Forest Acreage in 2007	Grassland and Forest Acreage in 2015	Acreage decreased by
1,420,040	982,977	(437,063)



Methods and Materials

Land Use Land Cover Change

- Reclassification
- Trend of LULC change
- Change Matrix

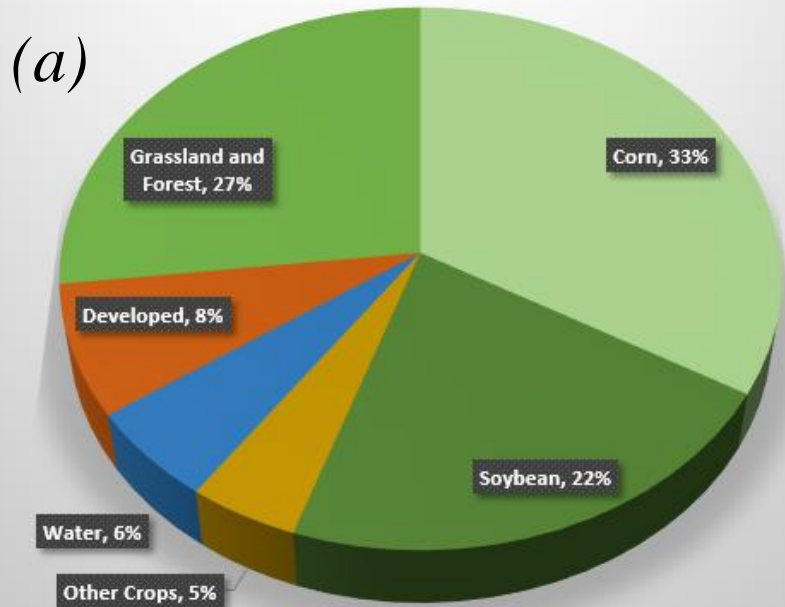


Methods and Materials

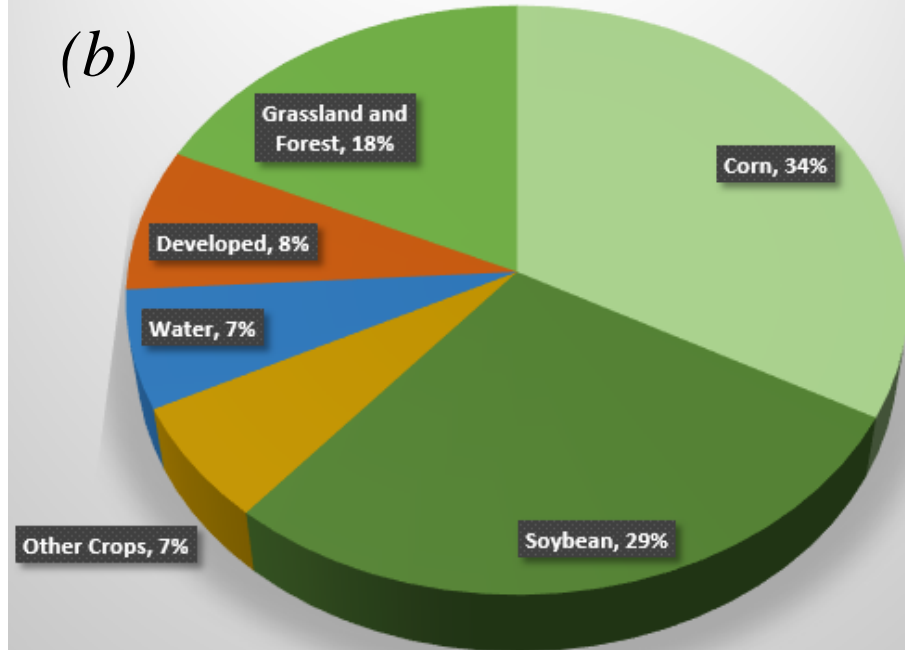
Land Use Land Cover Change

- Reclassification
- Trend of LULC change
- Change Matrix

Land Use Land Cover in the Big Sioux River, 2007



Land Use Land Cover in the Big Sioux River, 2015



Pie charts showing the percentage of land use and land cover in the Big Sioux River in (a) 2007, and (b) 2015.

Methods and Materials

Land Use Land Cover Change

- Reclassification
- Trend of LULC
- **Change Matrix**

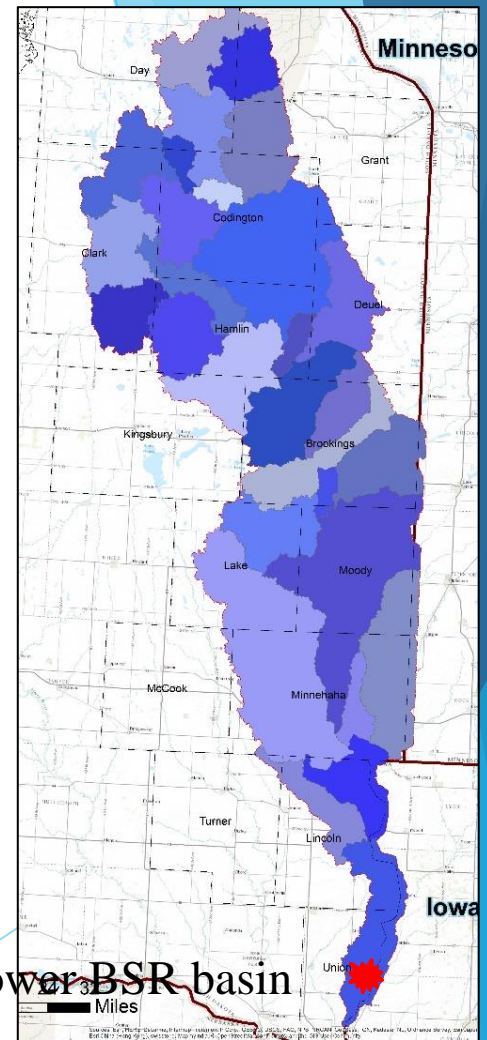
Table: CDL Data Reclassification into 6 major class types, area in 1,000 of acres, from 2007 to 2015.

		2015	2015	2015	2015	2015	2015	
		Corn	Soybean	Other Crops	Water/ Wetlands	Developed	Grassland and Forest	Total
2007	Corn	21.55	8.80	1.78	0.28	0.29	0.64	33.34
2007	Soybean	5.78	14.19	1.13	0.12	0.23	0.43	21.87
2007	Other Crops	1.51	1.65	1.05	0.06	0.04	0.22	4.53
2007	Water/ Wetlands	0.33	0.15	0.28	4.29	0.05	0.48	5.58
2007	Developed	0.84	0.75	0.18	0.19	4.90	0.98	7.84
2007	Grassland and Forest	3.64	3.32	2.13	1.62	0.59	15.53	26.83
	Total	33.65	28.87	6.54	6.56	6.10	18.29	100.00

Story to be continued...

SWAT Analysis

- Watershed Delineation
- HRU Definition
- Weather Definition
- SWAT Model run



Station WQM32 at lower BSR basin

Summary

Objective 1: LULC change in the BSR

- Increase in corn and soybeans and decrease in grassland and forest.
- Grasslands are mostly converted to corn and soybeans from 2007-2015.

Objective 2: trends of nitrogen levels in the BSR

- Increasing? Or Decreasing? Or No change?

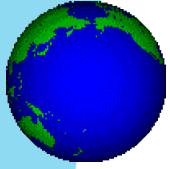
Objective 3: determine whether there is a correlation between LULC change and changes in nitrogen levels in the basin.

Unanswered questions

- How did the changes in LULC result in increased concentrations of nitrates in the river water?
- What are the impacts of LULC change in water quality?
- Does the LULC change have a correlation with changes in nitrogen levels in the river?
- What about BSR's contribution to hypoxia in the Gulf of Mexico?

References

- ▶ Kalcic, Margaret M., Indrajeet Chaubey, and Jane Frankenberger. Defining Soil and Water Assessment Tool (SWAT) hydrologic response units (HRUs) by field boundaries. *International Journal of Agricultural and Biological Engineering* 8, no. 3 (2015): 69-80
- ▶ Reitsma, K. D., B. H. Dunn, U. Mishra, S. A. Clay, T. DeSutter, and D. E. Clay. 2015. Land-use change impact on soil sustainability in a climate and vegetation transition zone. *Agronomy Journal* 107 (6): 2263-2372.
- ▶ Wright, Christopher K., and Michael C. Wimberly. 2013. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *Proceedings of the National Academy of Sciences* 110 (10): 4134-4139.



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Thank You

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