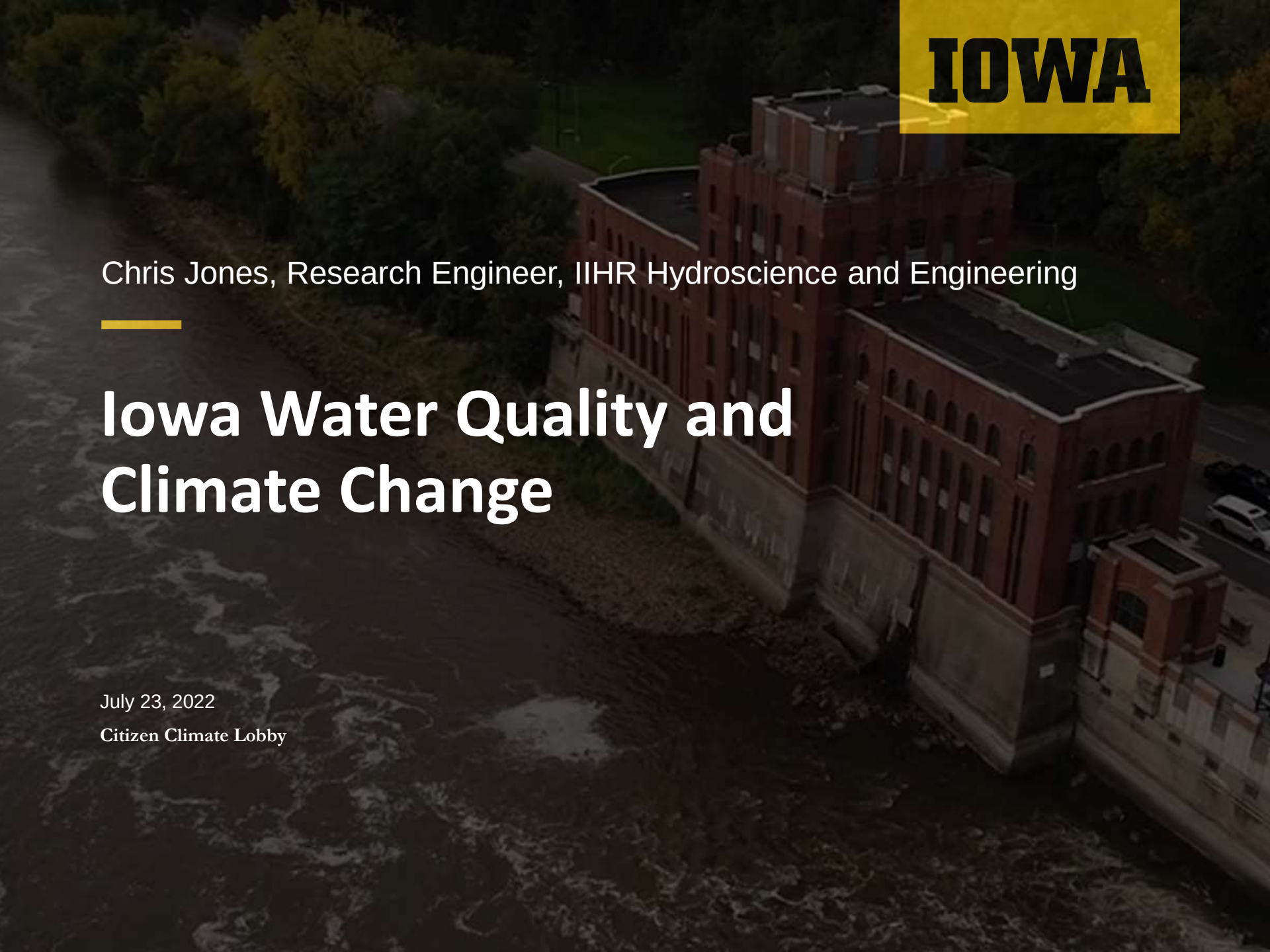


Chris Jones, Research Engineer, IIHR Hydroscience and Engineering

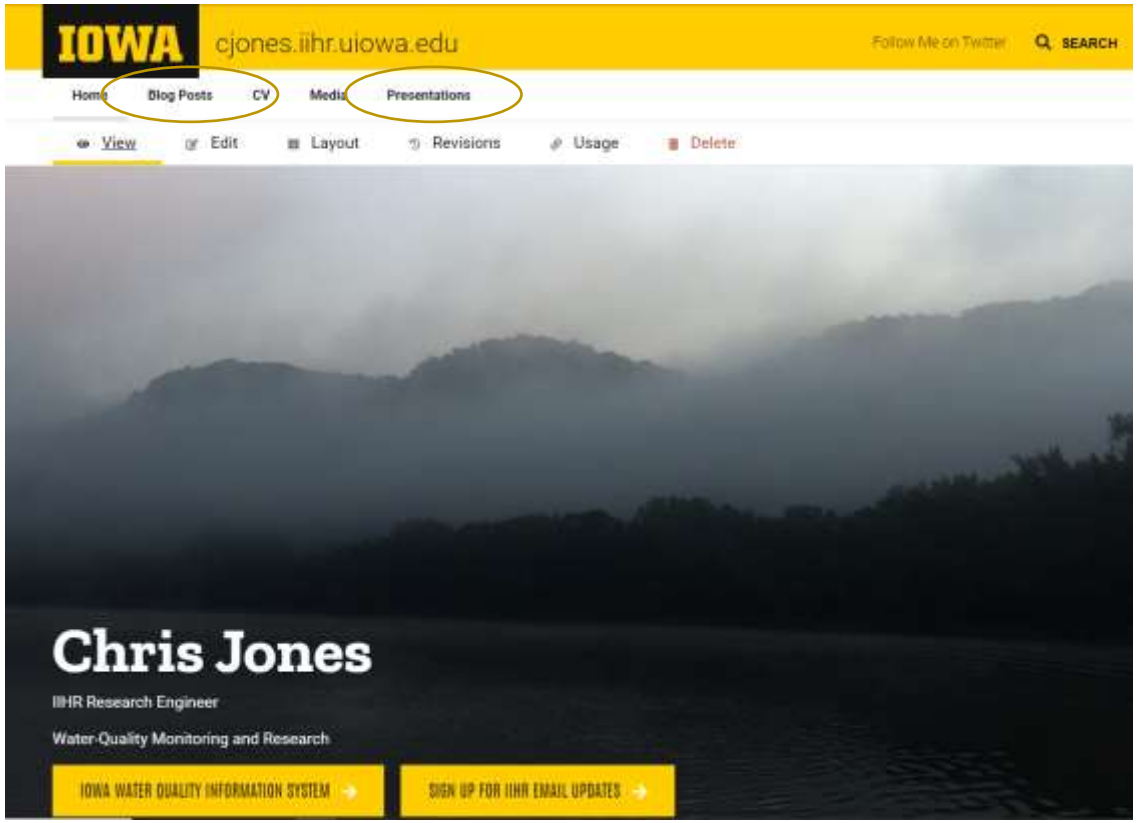
Iowa Water Quality and Climate Change

July 23, 2022

Citizen Climate Lobby

Slides Available at:

https://cjones.iihr.uiowa.edu/



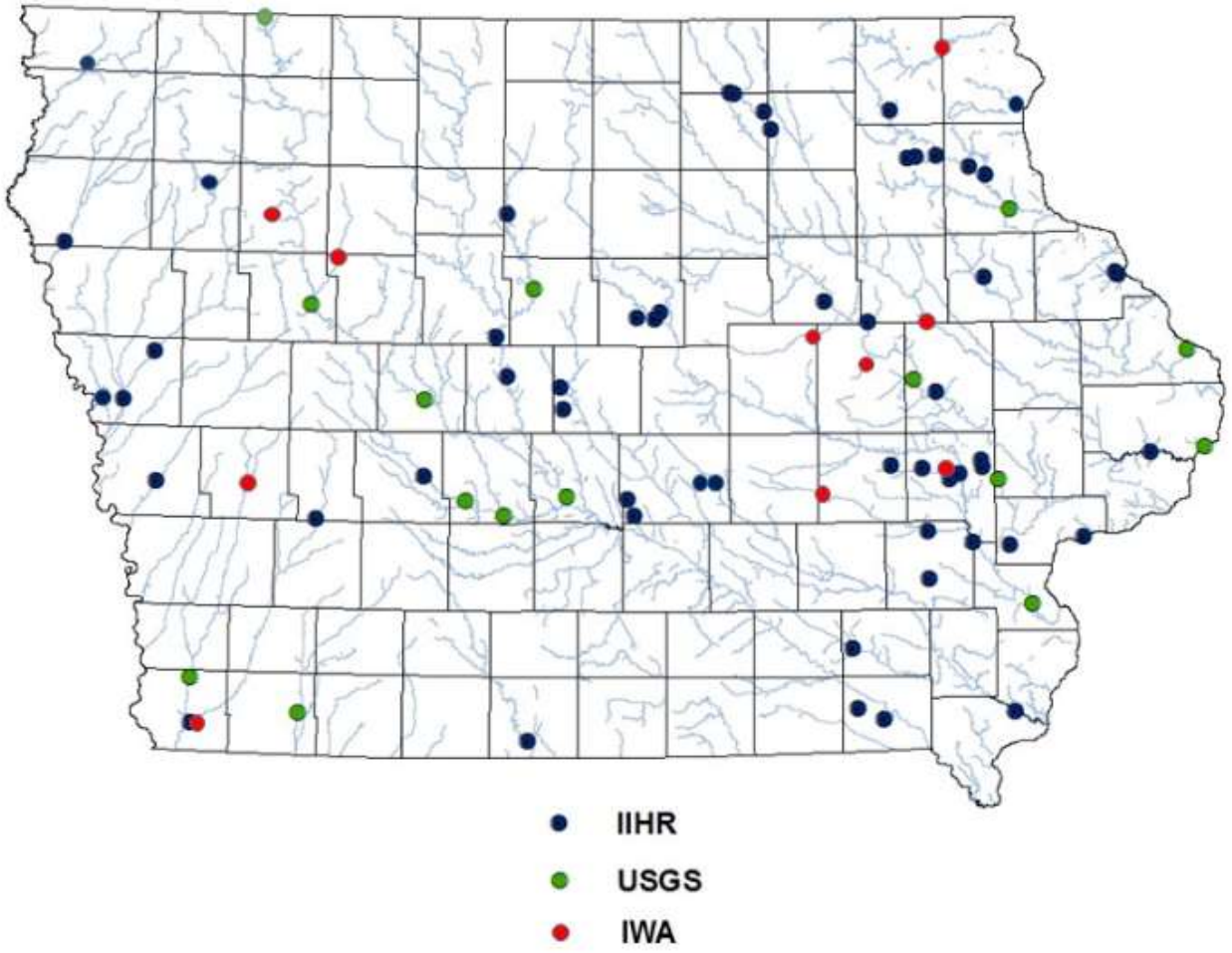
IIHR Water Quality Sensor Network

Sites

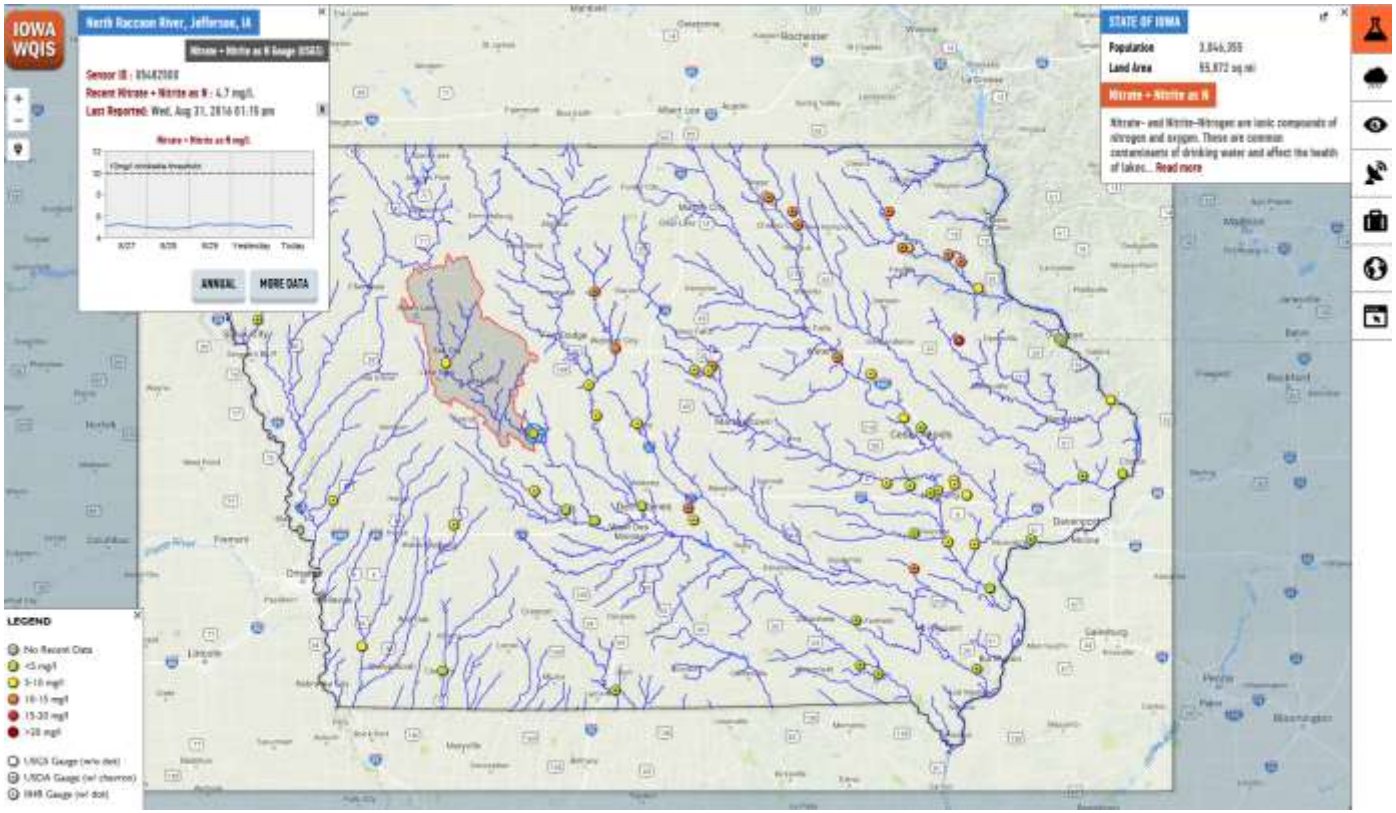
70+ sites
Nitrate-N

20-25 sites

- **Temperature**
- **pH**
- **SC**
- **DO**
- **Turbidity**



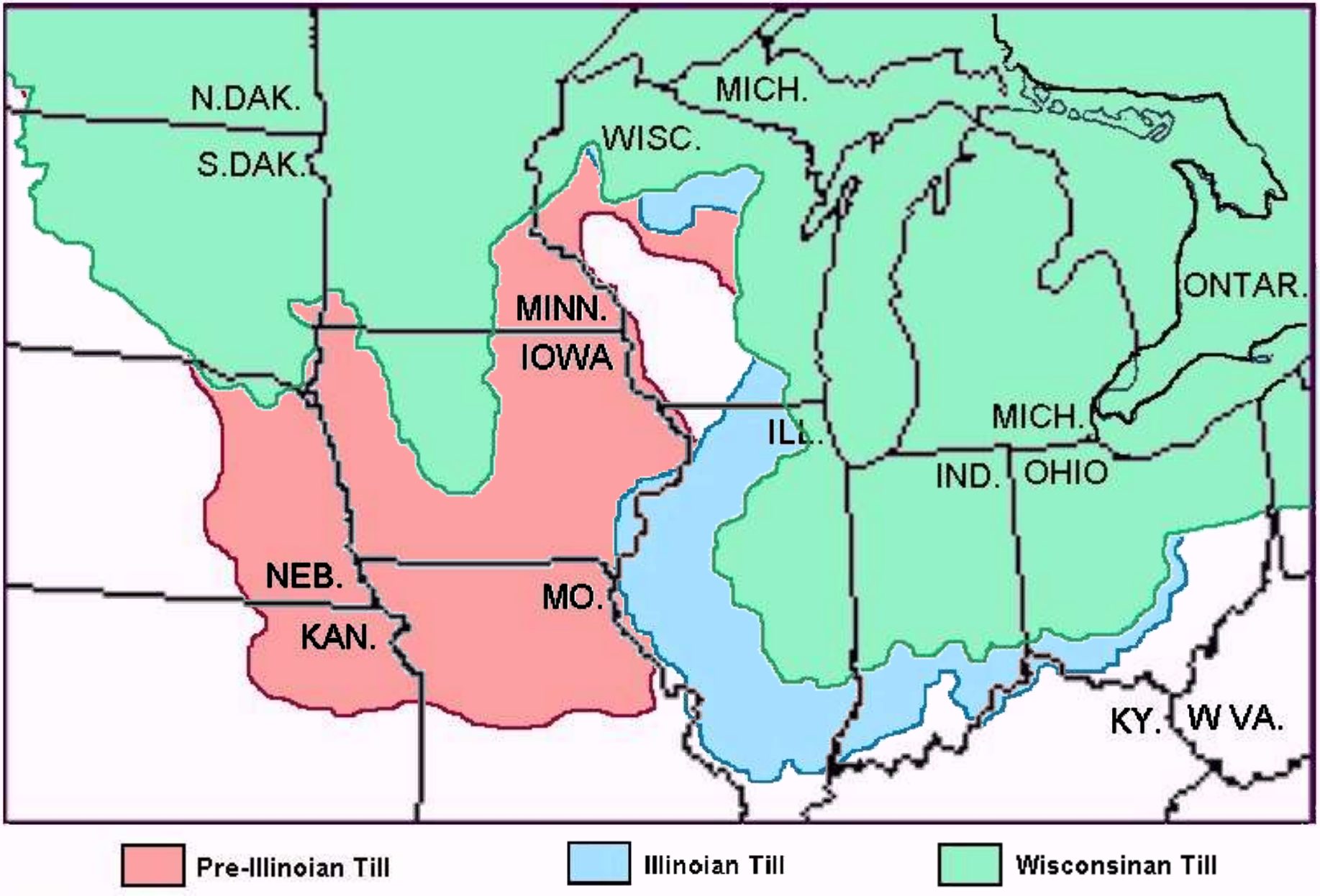
Iowa Water Quality Information System

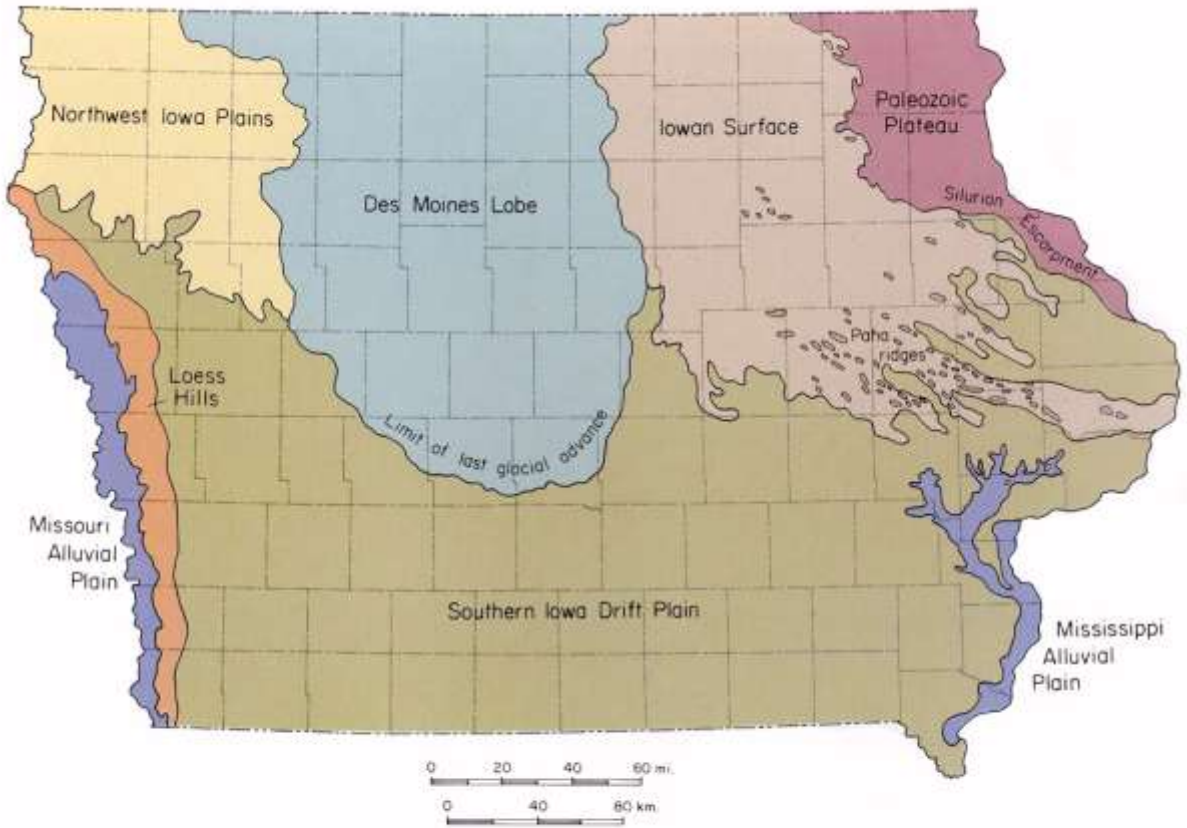


iwqis.iowawis.org/

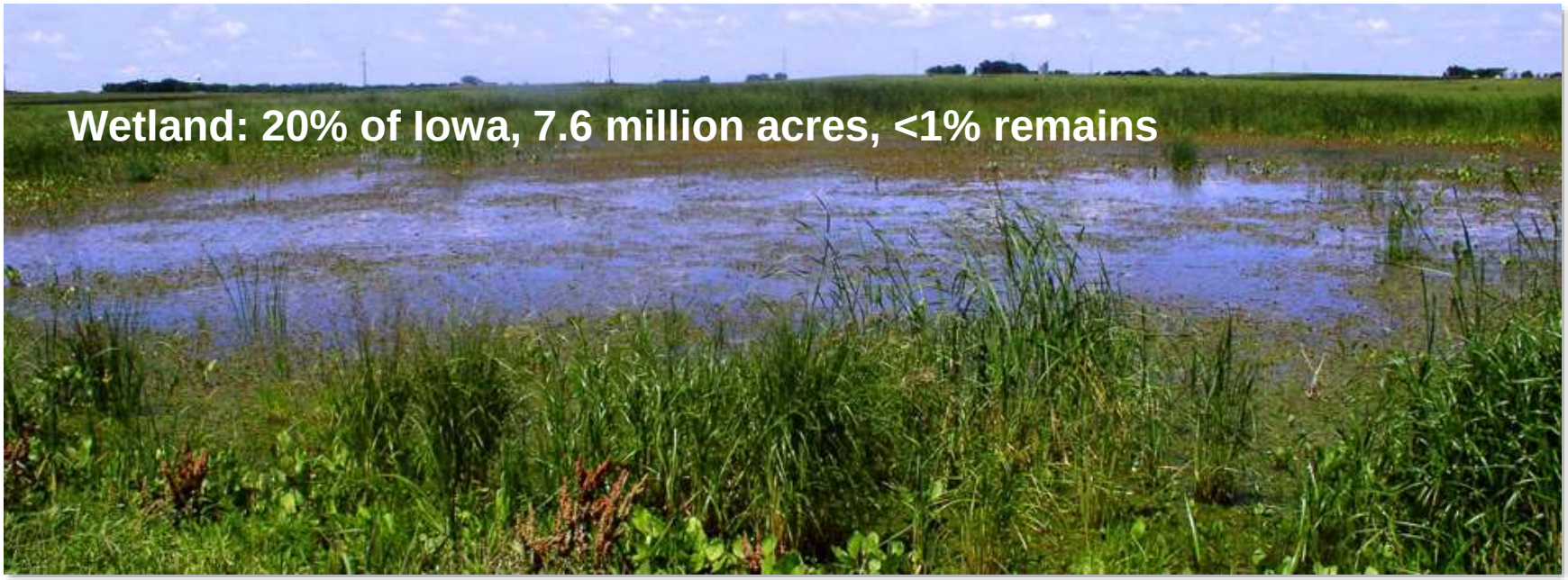
http://iwqis.iowawis.org/app/?datetime=2017-06-06T13:00

30,000 – 10,500 years





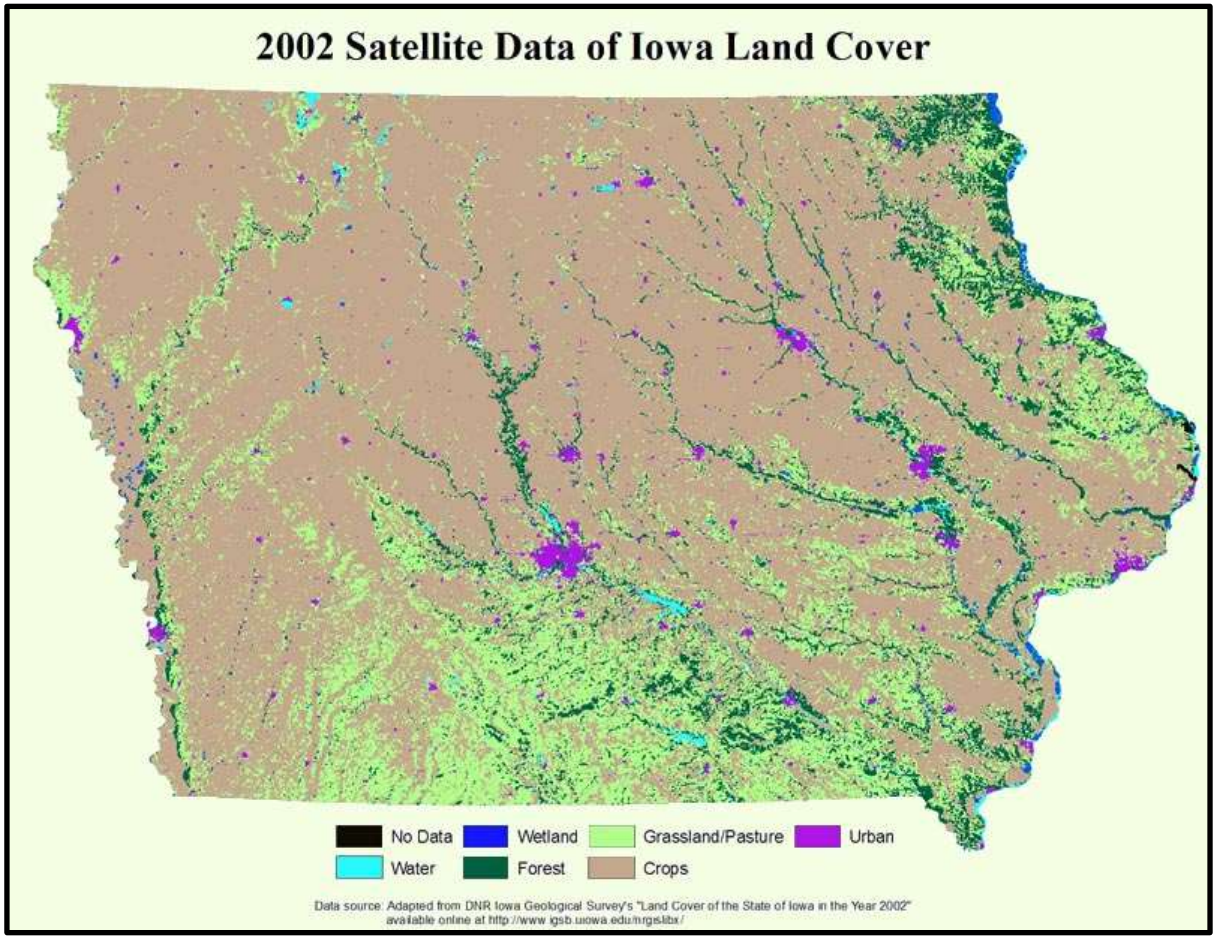
Landform Regions of Iowa


Wetland: 20% of Iowa, 7.6 million acres, <1% remains

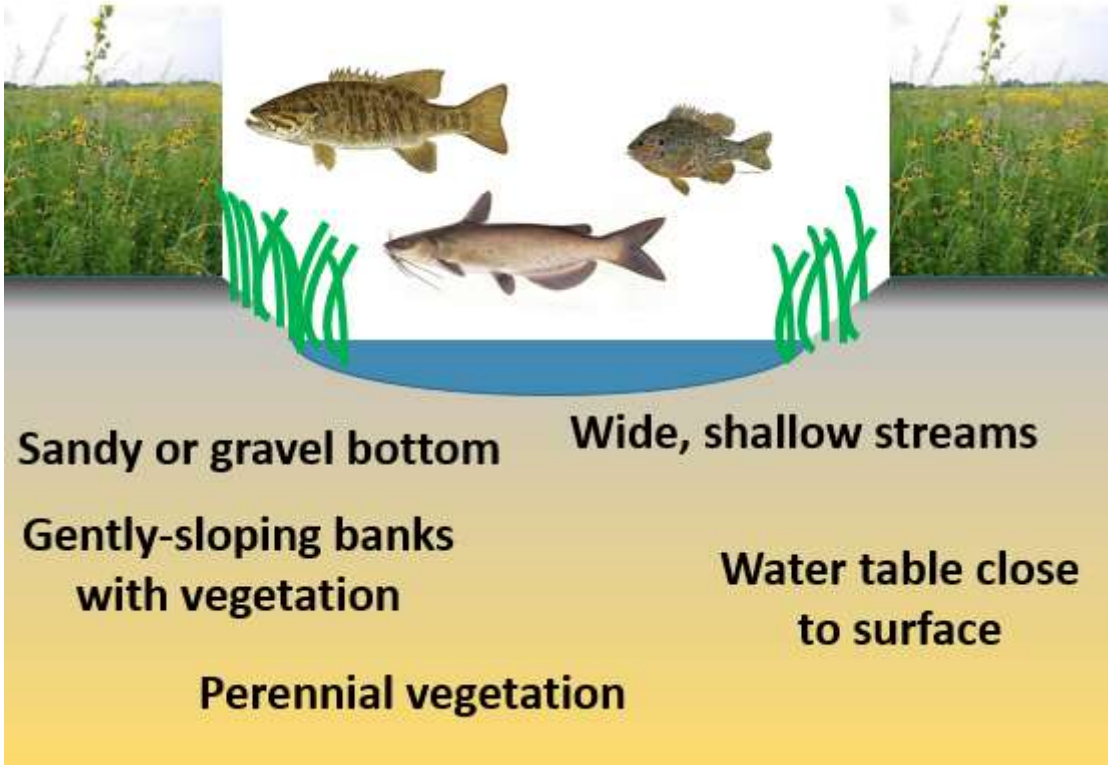

Oak Savannah: ~5%, < 1% remains


Prairie: 70%, 0.1% Remains

Iowa Land Cover



Pre-European Settlement Streams



Breaking the prairie

Photo courtesy of Deere and Company

Hydrological Modification: 1860s-1910s

Excavating a large ditch using steam power, circa 1910.

Hand digging tile, Boone Co. IA. ca 1914
Source: 'An Iowa album: a photographic history, 1860-1920' by M. J. Bennet, University of Iowa Press, Iowa City, Iowa

Tiling field now

Source of the Iowa River

Stream Straightening, 1930-1975

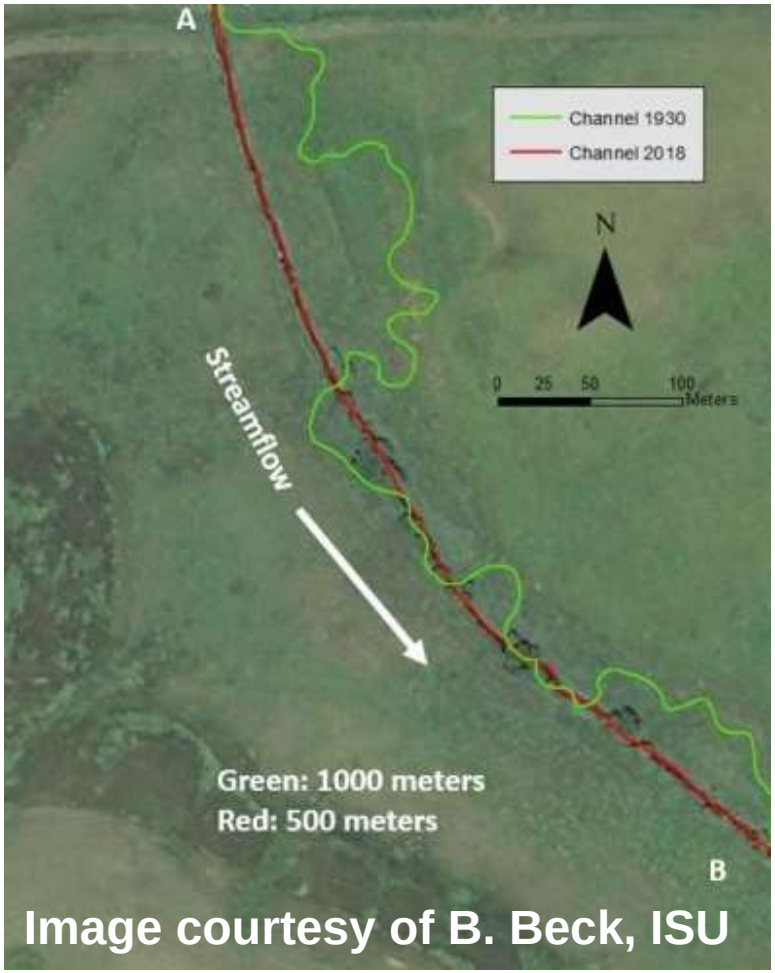
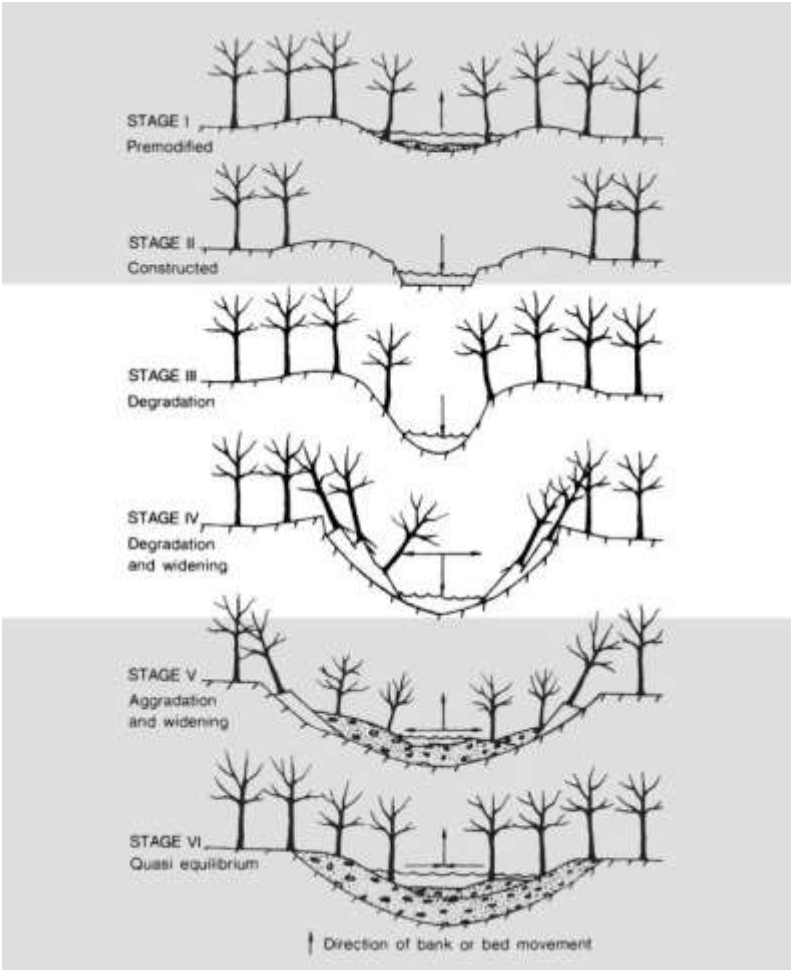
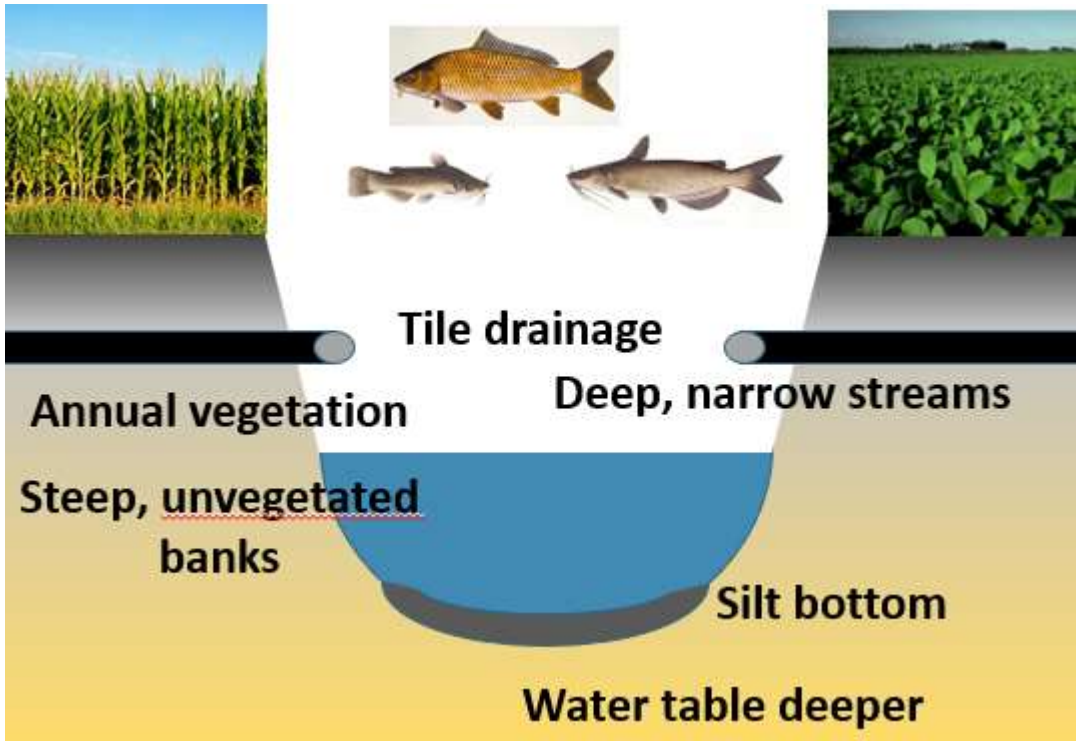


Image courtesy of B. Beck, ISU



Images courtesy of B. Beck, ISU

Modified Streams



Transformation of Iowa Farms

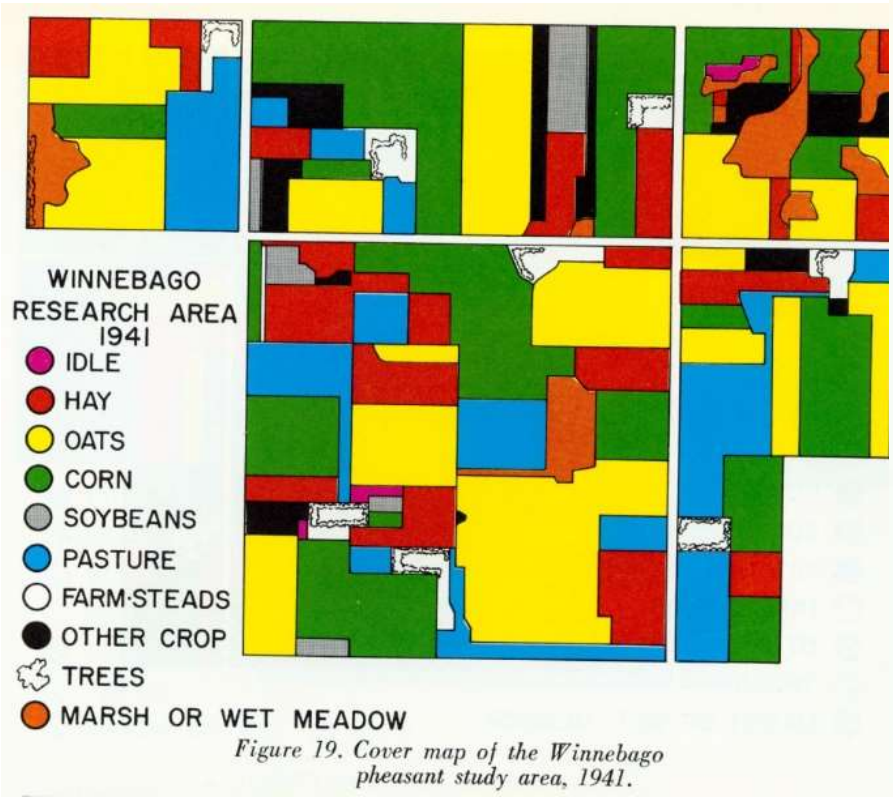


Figure 19. Cover map of the Winnebago pheasant study area, 1941.

1941

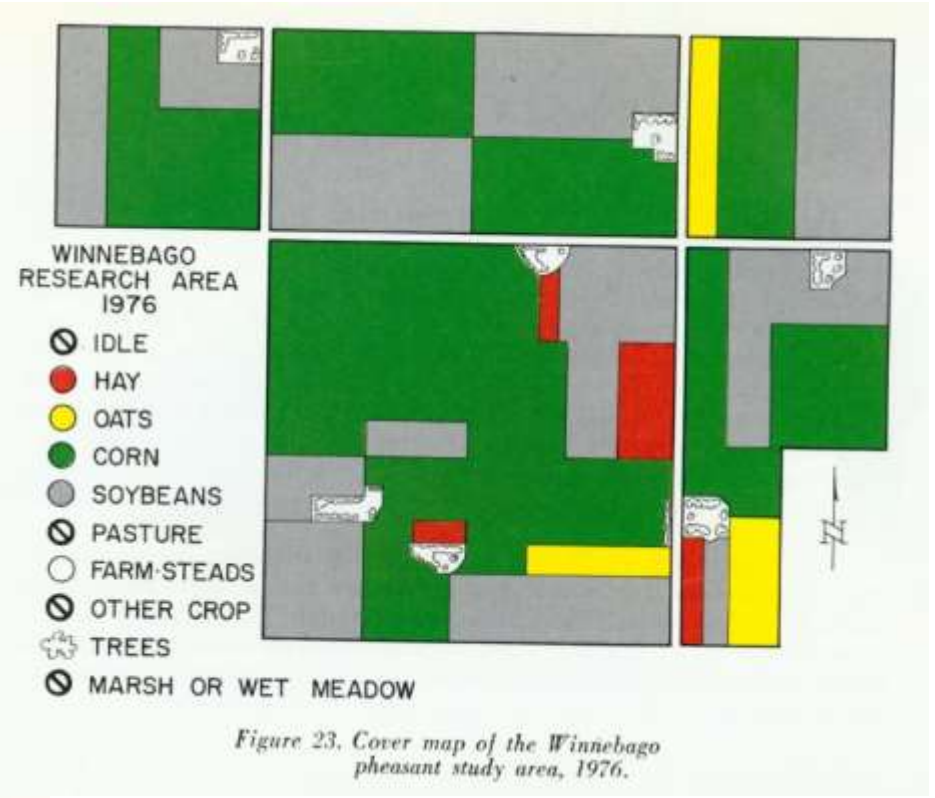
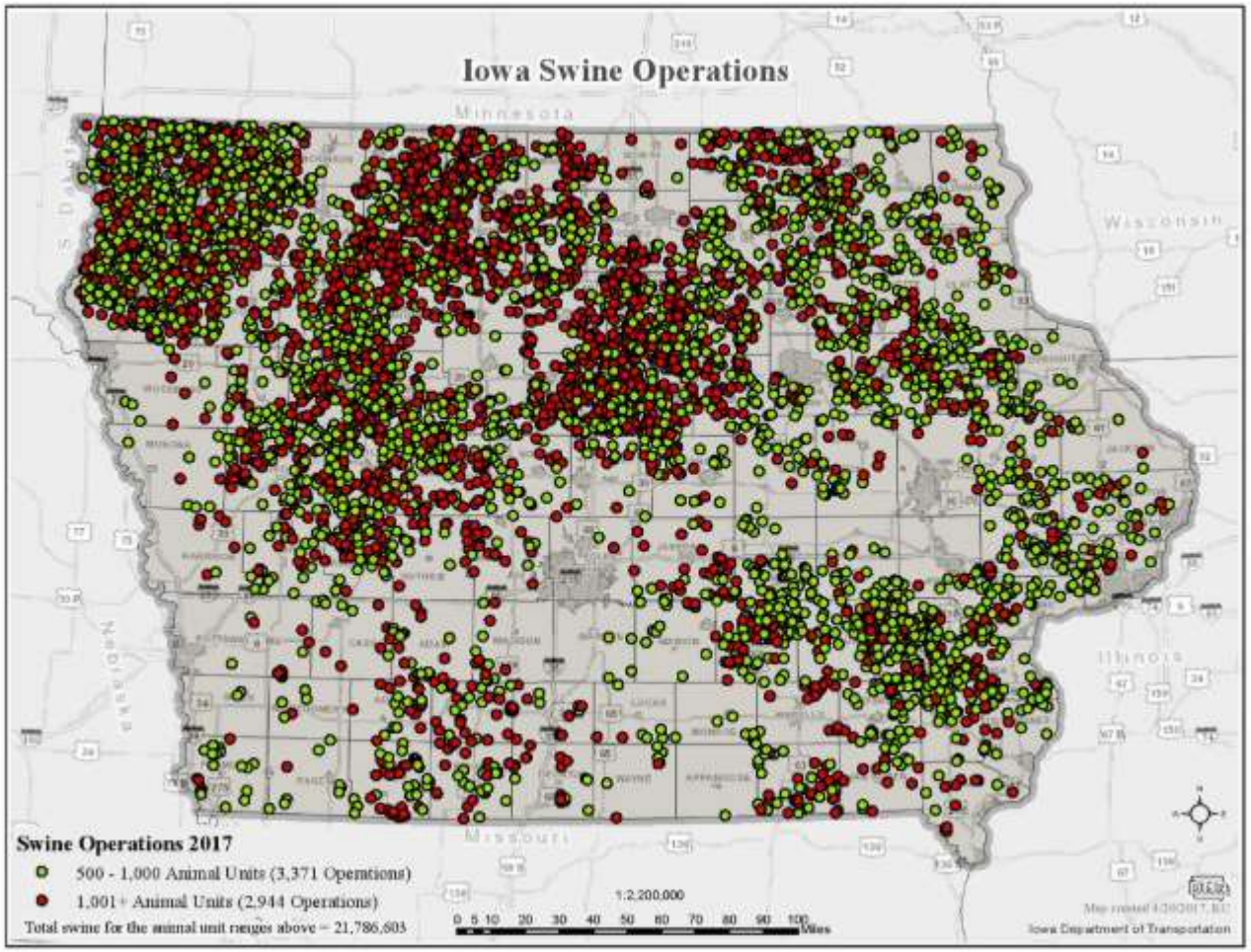


Figure 23. Cover map of the Winnebago pheasant study area, 1976.

1976

8000 CAFOs

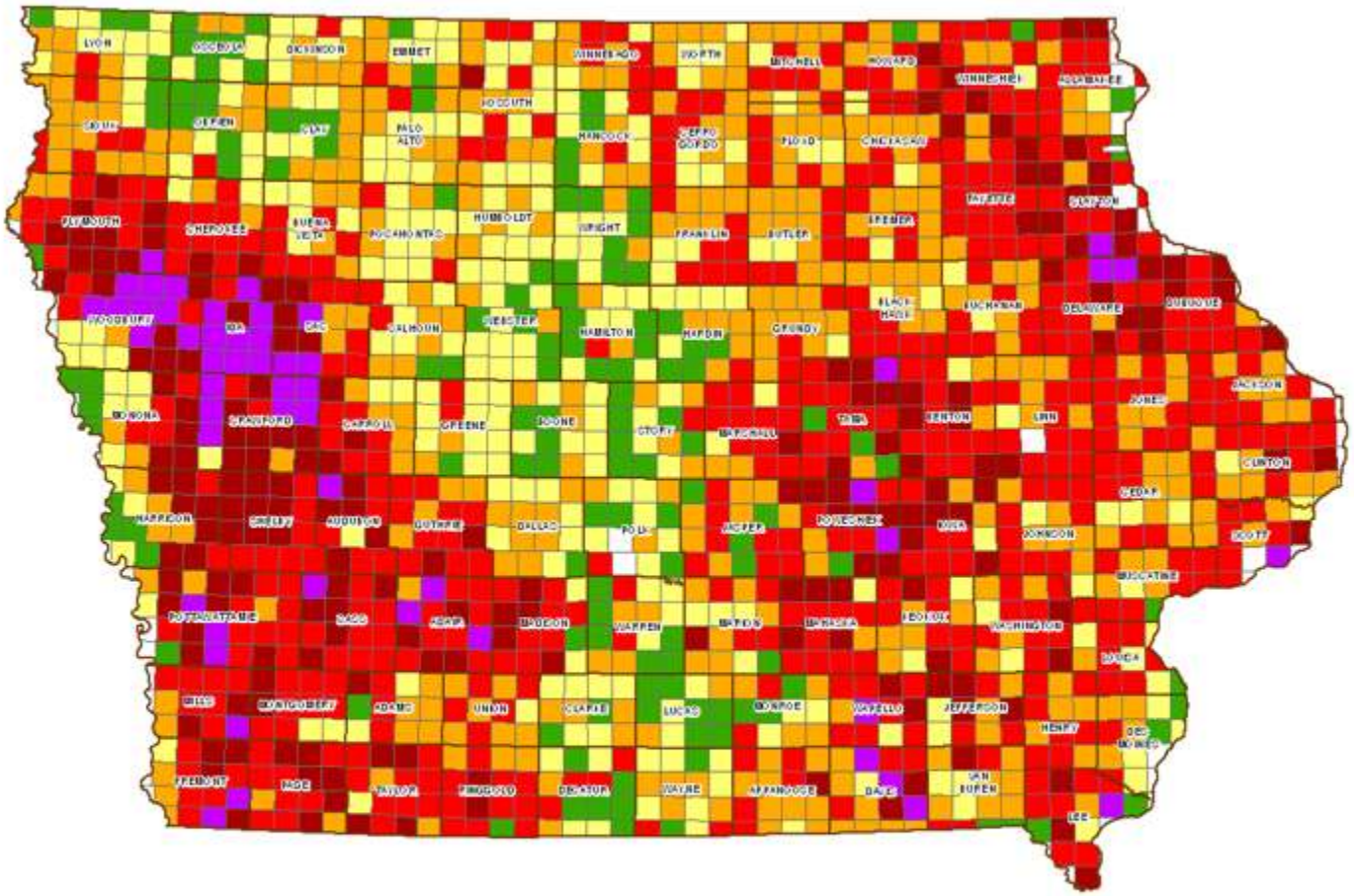

Iowa Swine Operations
Minnesota
Wisconsin
Illinois
Missouri
Swine Operations 2017
500 - 1,000 Animal Units (3,371 Operations)
1,001 + Animal Units (2,944 Operations)
Total swine for the animal unit ranges above = 21,786,603
1:2,200,000
0 5 10 20 30 40 50 60 70 80 90 100 Miles
Iowa Department of Transportation

Problem of Scale

- 70% of land in corn-soy rotation
- 11,000 square miles used for ethanol production
- 25 million hogs
- 4 million beef cattle
- 80 million laying chickens
- 5 million turkeys
- 4 million broiler chickens
- 220,000 dairy cows

Water Quality Consequences

Soil loss is still very high

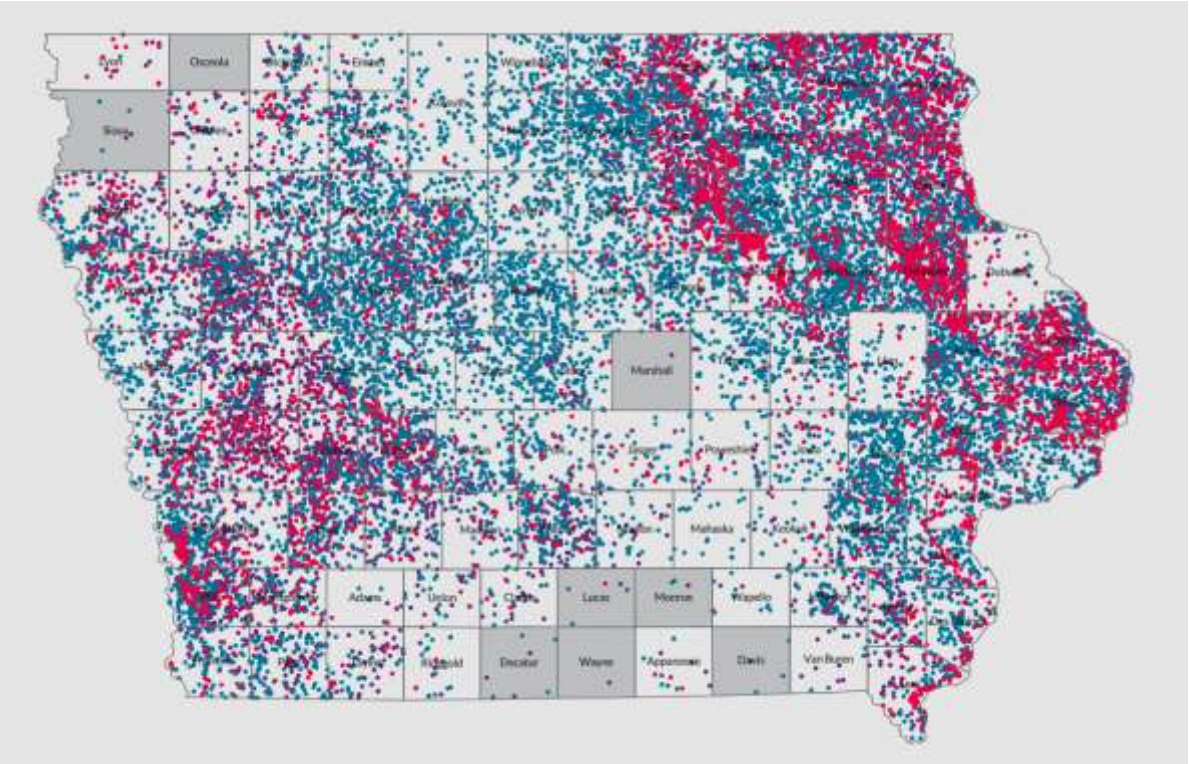


Source:
EWG

Average Soil Erosion (tons/acre)

No Data | 0 - 5.0 | 5.1 - 10.0 | 10.1 - 20.0 | 20.1 - 50.0 | 50.1 - 100.0 | Greater than 100

Drinking Water



7000 private wells have tested above the safe drinking water level of 10 mg/L since 2000

1/3 of Iowa's Public Water Supplies are vulnerable to nitrate contamination

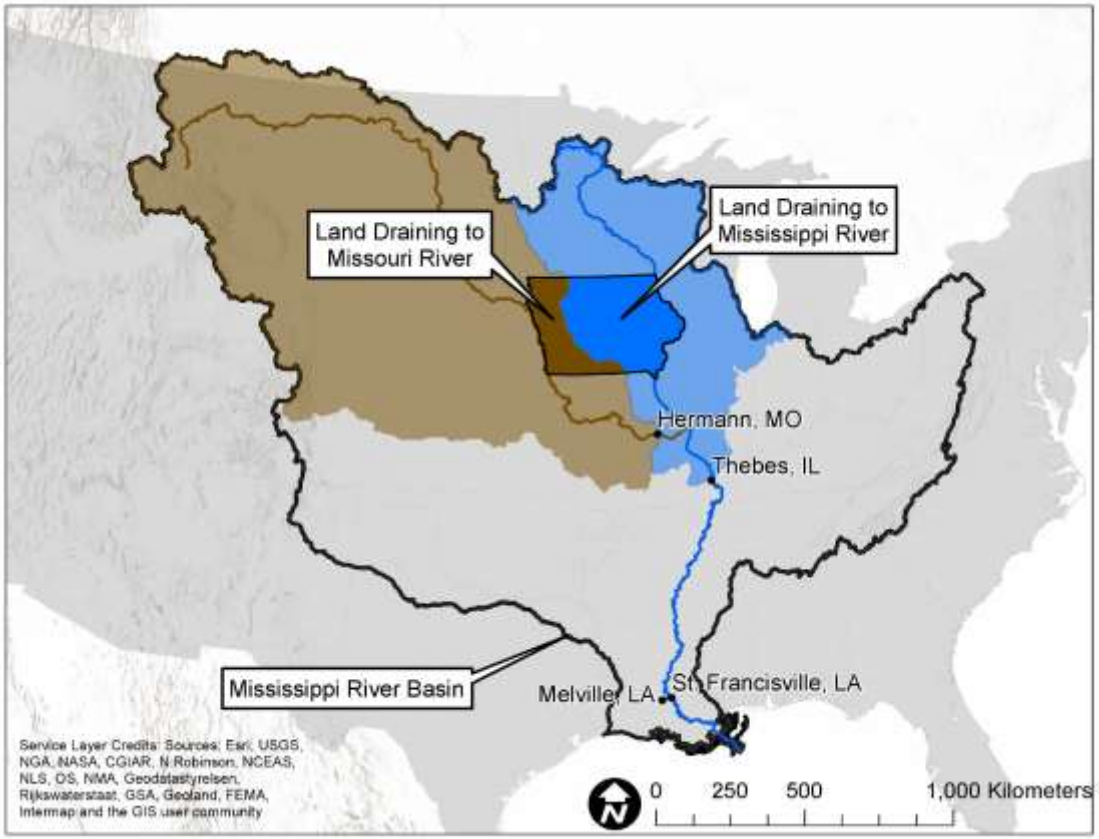
60 PWSs are removing nitrate

25% of Iowa drink water that has been treated for nitrate reduction

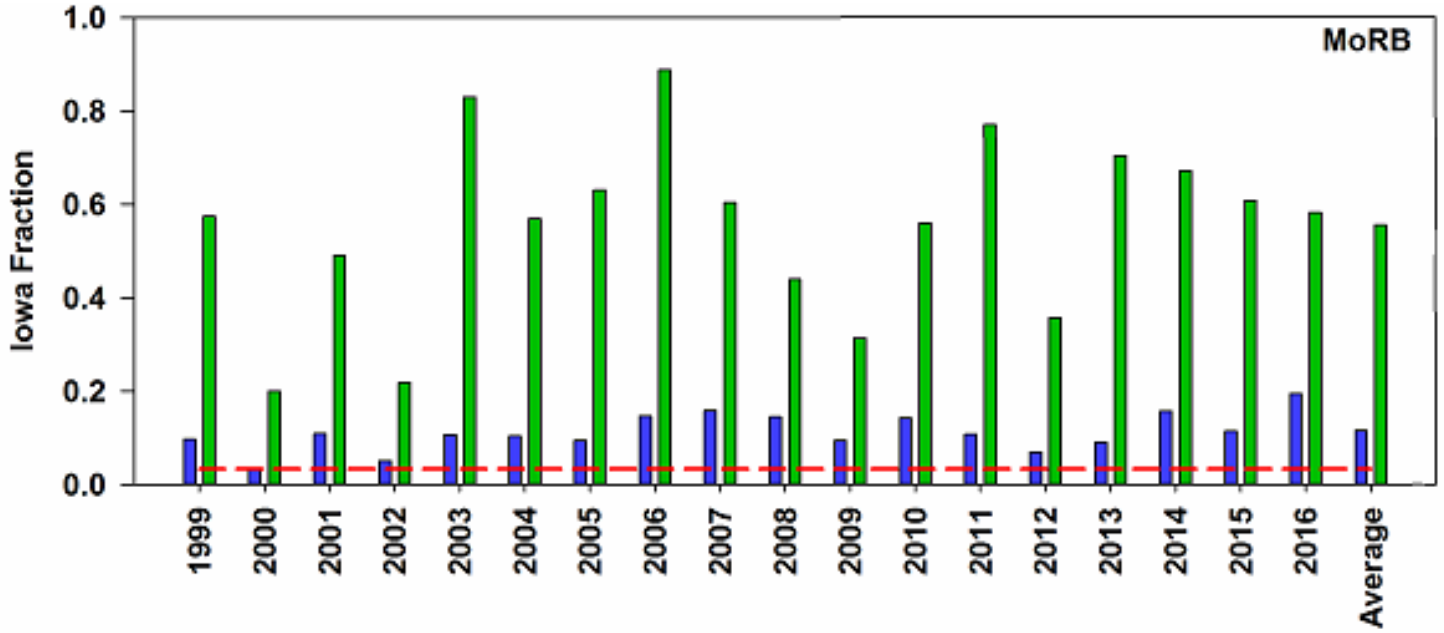
Drinking Water

Toledo, OH

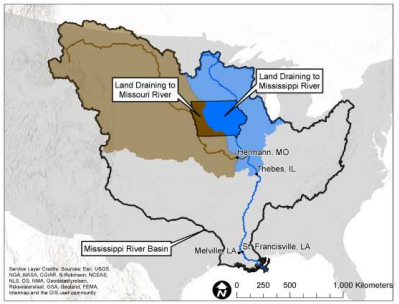
Iowa Contributions



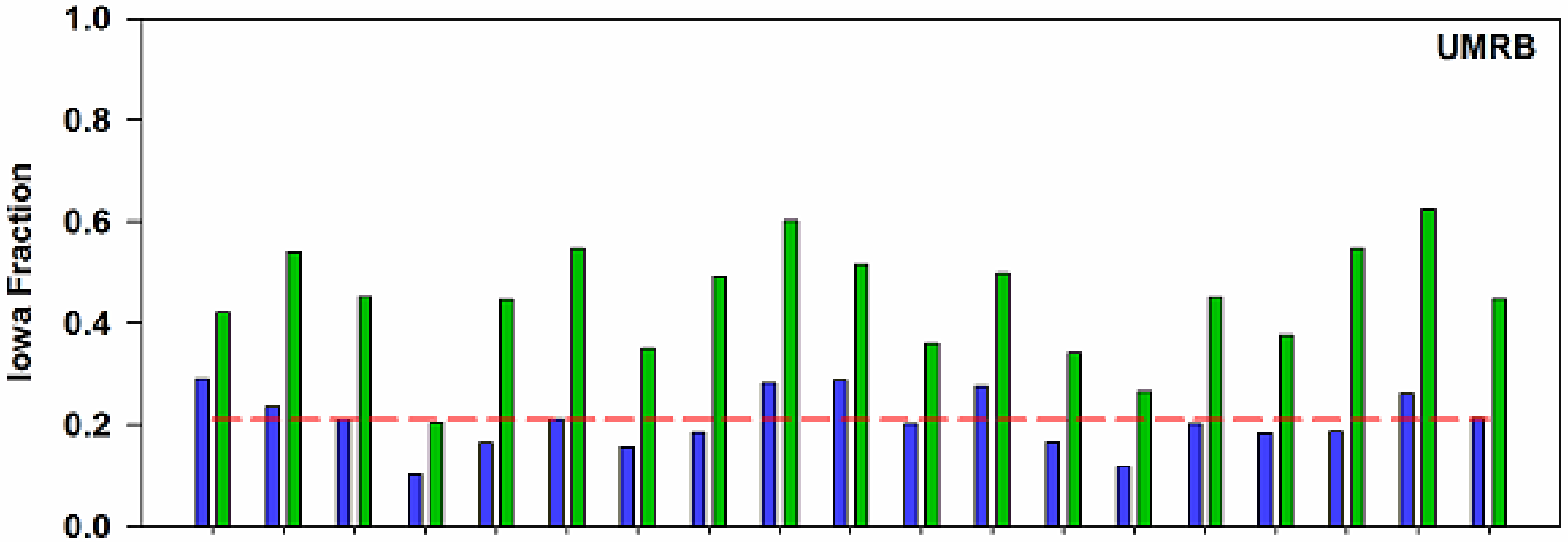
Missouri Basin: Nitrogen



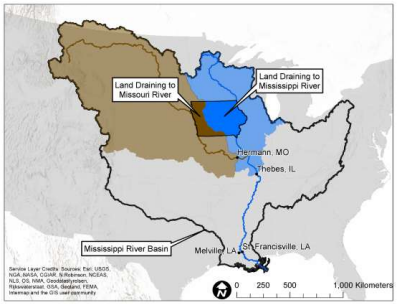
3.3% of the land
12% of the water
55% of the nitrate



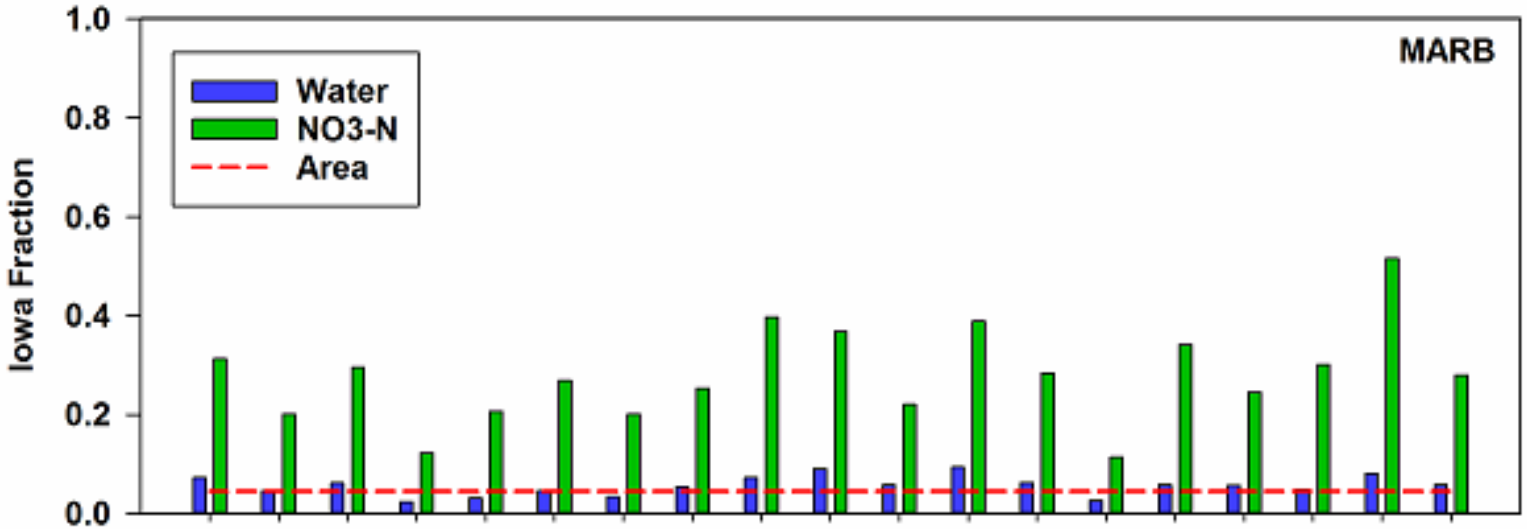
Upper Mississippi: Nitrogen



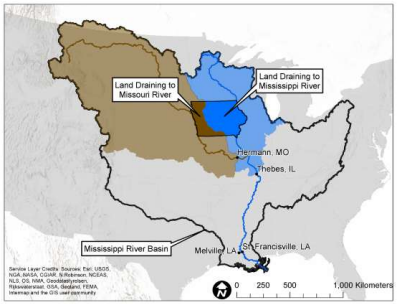
21% of the land
21% of the water
45% of the nitrate



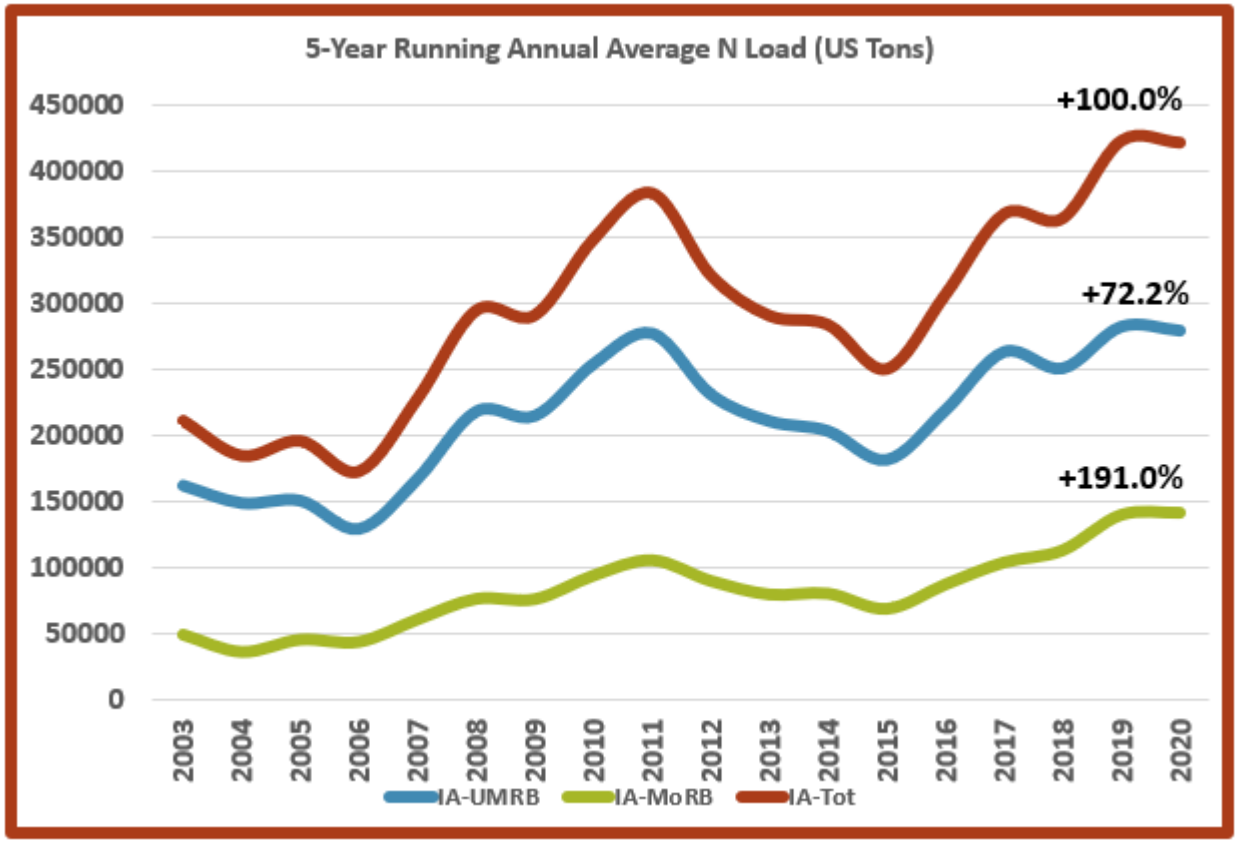
Mississippi-Atchafalaya: Nitrogen



4.5% of the land
5.9% of the water
29% of the nitrate



How Much Nitrogen Leaves Iowa?



Phosphorus

Iowa contributes 15% of Phosphorus Load to Gulf of Mexico (4.5% of Area)

“P concentrations in Iowa streams are likely 2–3 times higher than Illinois streams on average”

“P loads 43% higher in 2017 than in 2004”


Journal of Hydrology 583 (2020) 124397

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/jhydrol

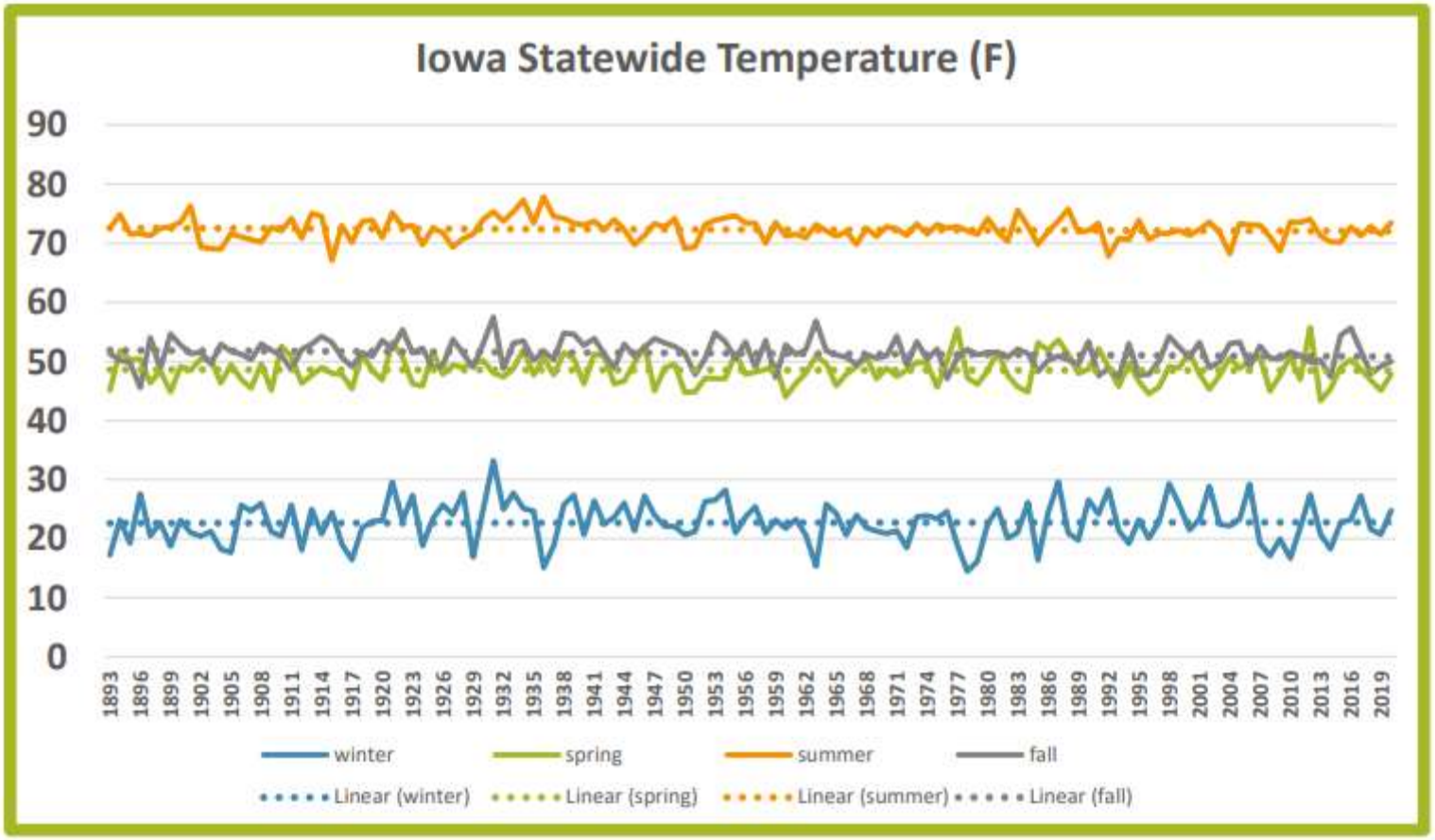
Research papers

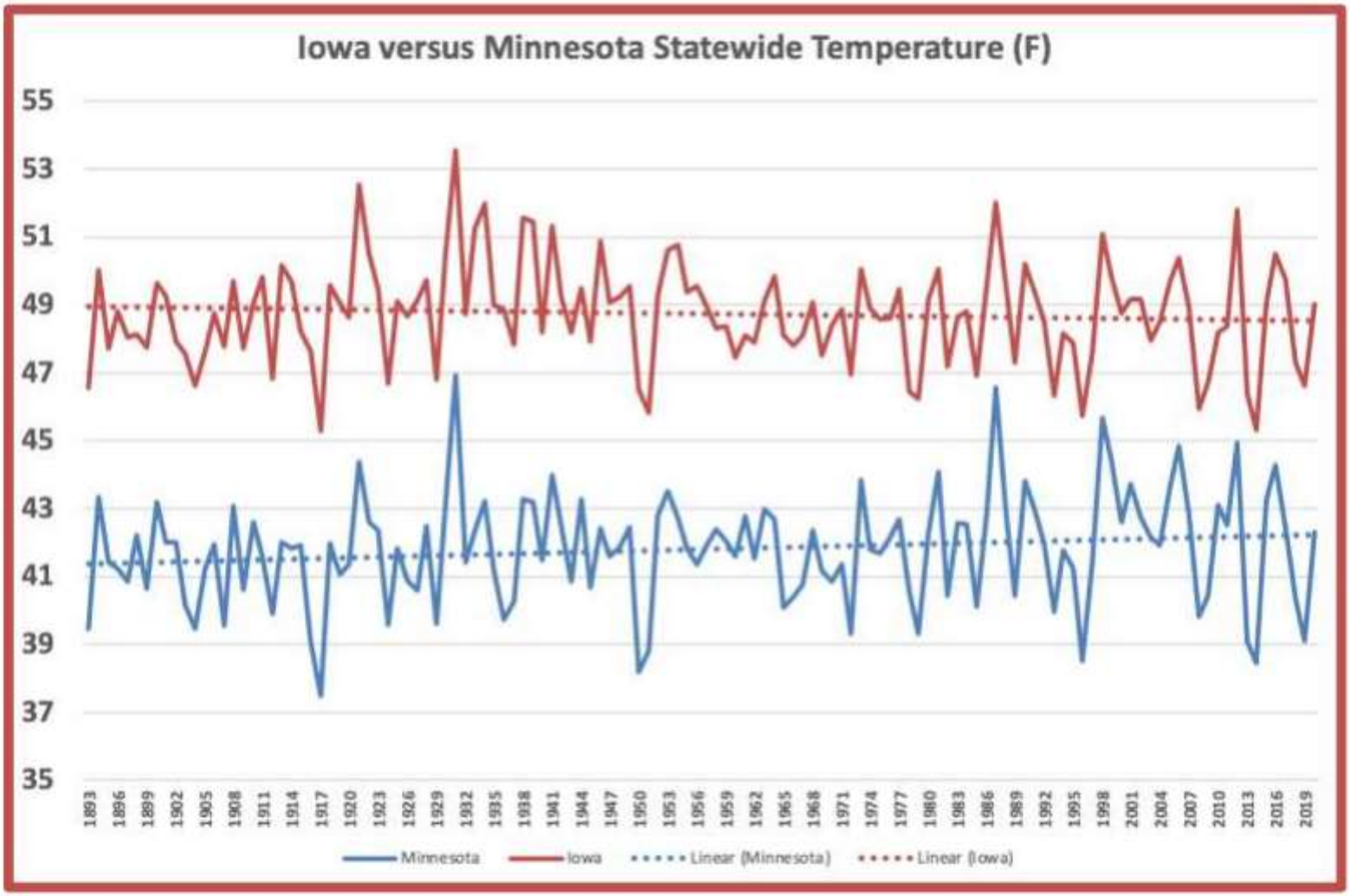
Total phosphorus export from Iowa agricultural watersheds: Quantifying the scope and scale of a regional condition

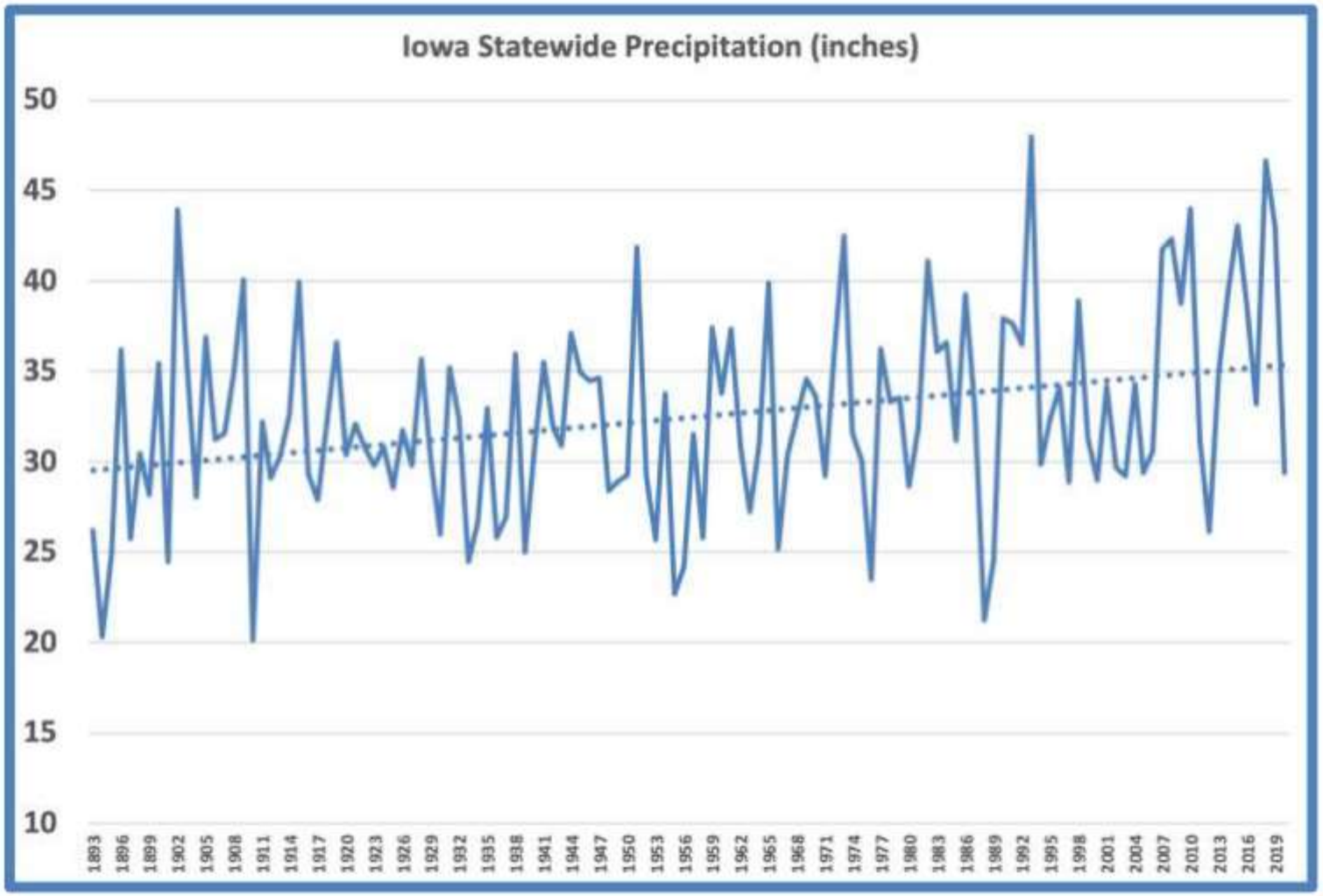
Keith E. Schilling[a,*], Matthew T. Streeter[a], Anthony Seeman[b], Christopher S. Jones[c], Calvin F. Wolter[d]

[a] Iowa Geological Survey, University of Iowa, Iowa City, IA, United States
[b] Iowa Soybean Association, Ankeny, IA, United States
[c] IIHR Hydroscience and Engineering, University of Iowa, Iowa City, IA, United States
[d] Iowa Department of Natural Resources, Des Moines, IA, United States

Iowa Temperature since 1893




Iowa versus Minnesota Statewide Temperature (F)
55
53
51
49
47
45
43
41
39
37
35
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
Minnesota
Iowa
Linear (Minnesota)
Linear (Iowa)


Iowa Statewide Precipitation (inches)
50
45
40
35
30
25
20
15
10
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
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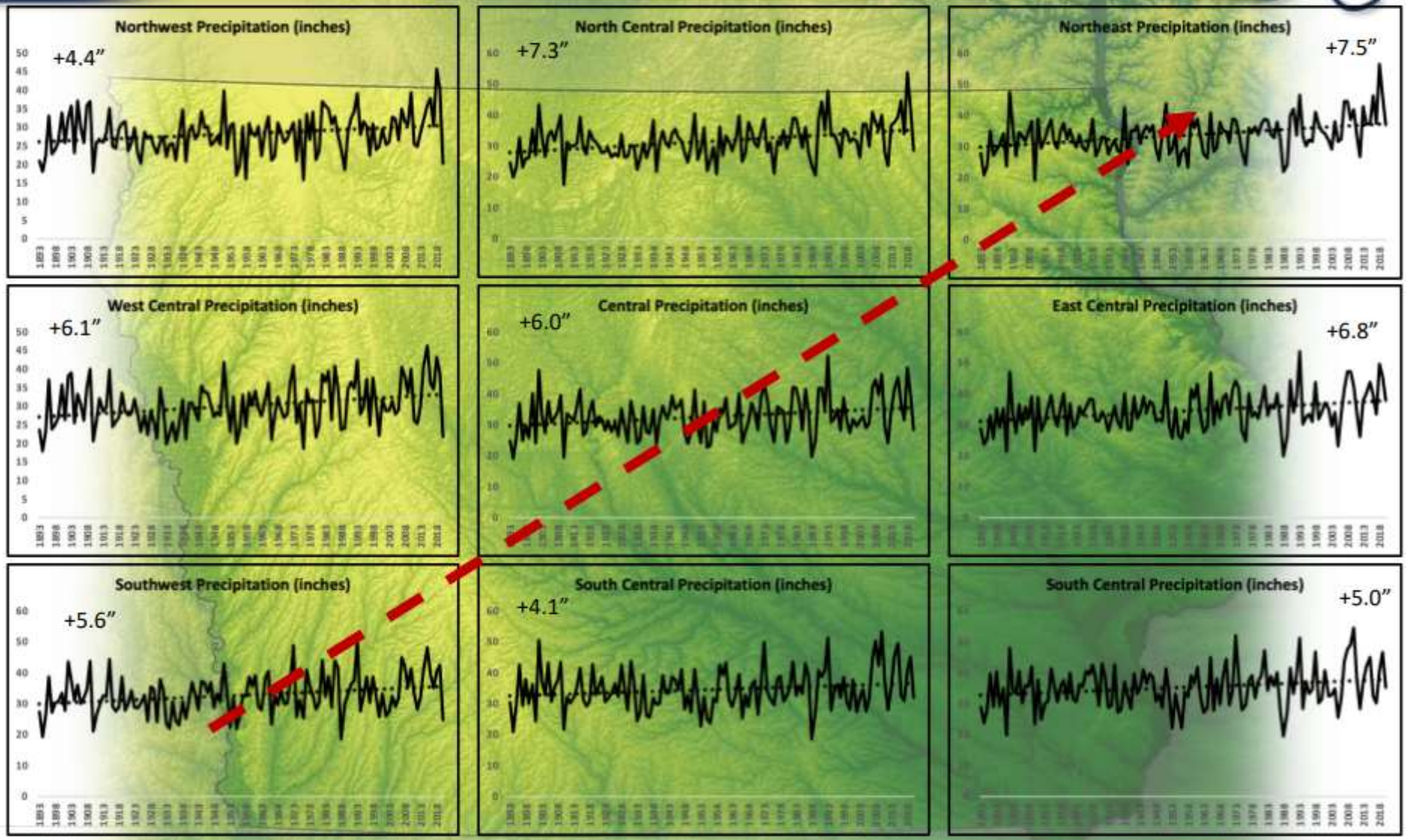
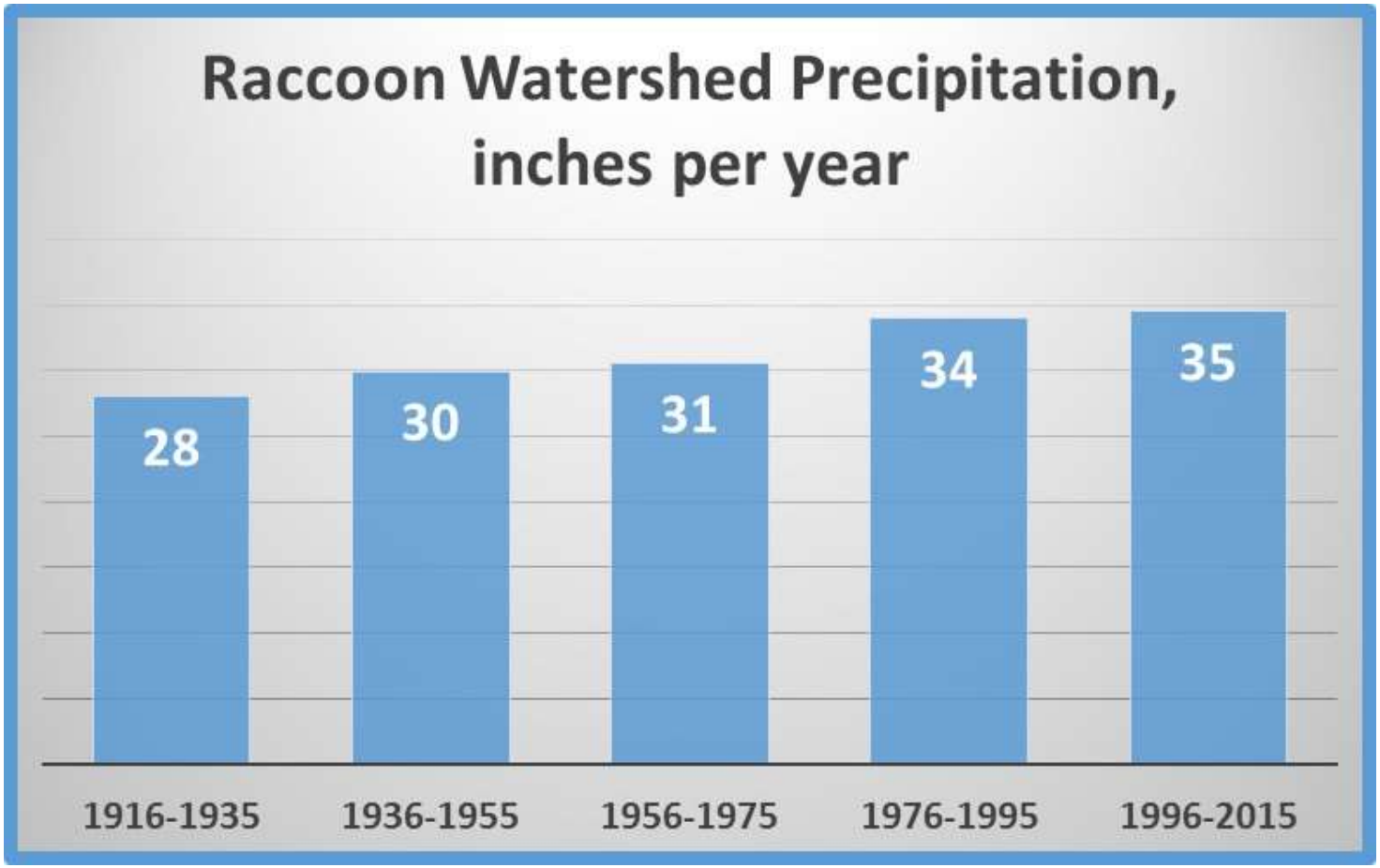
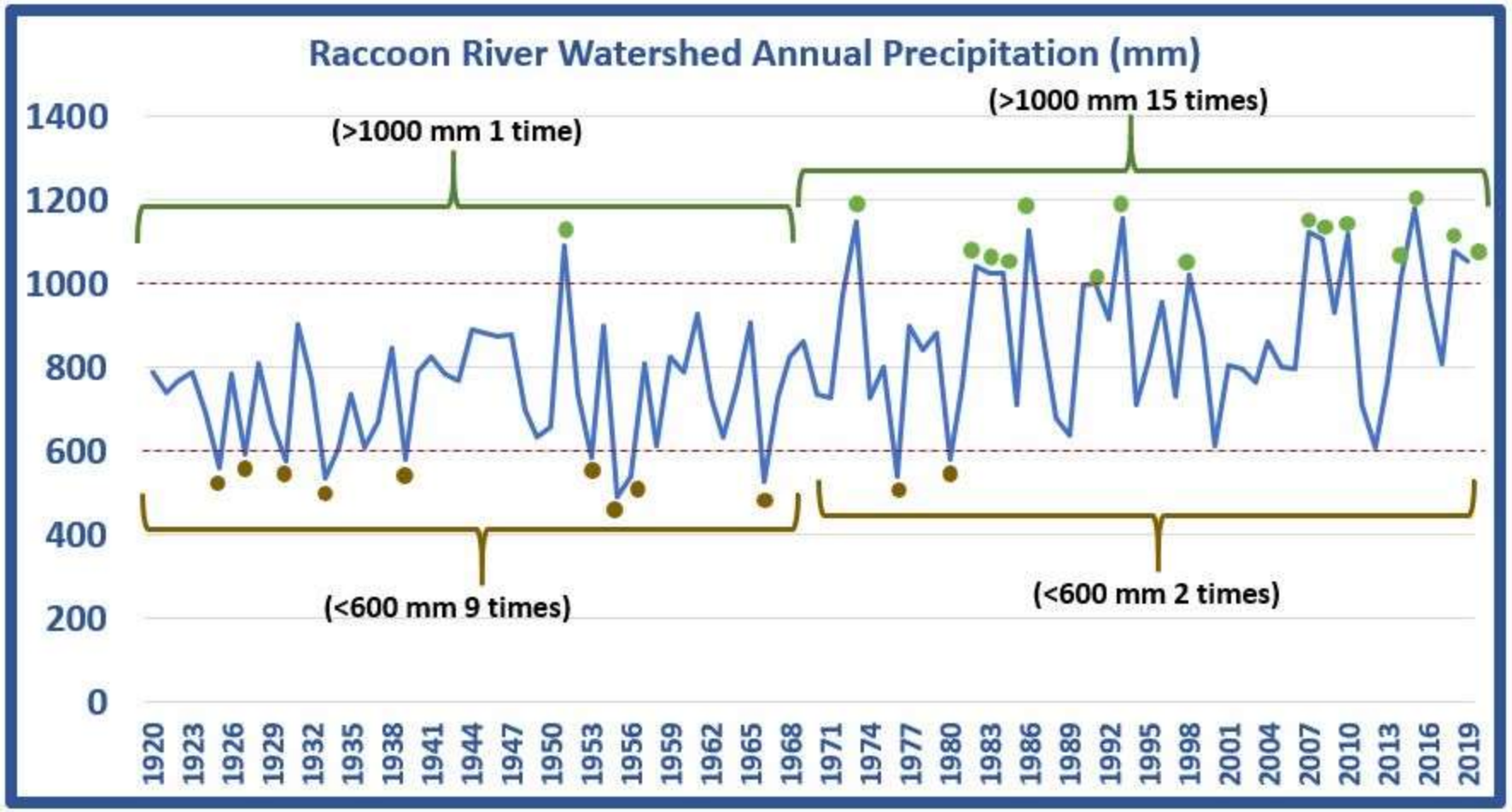
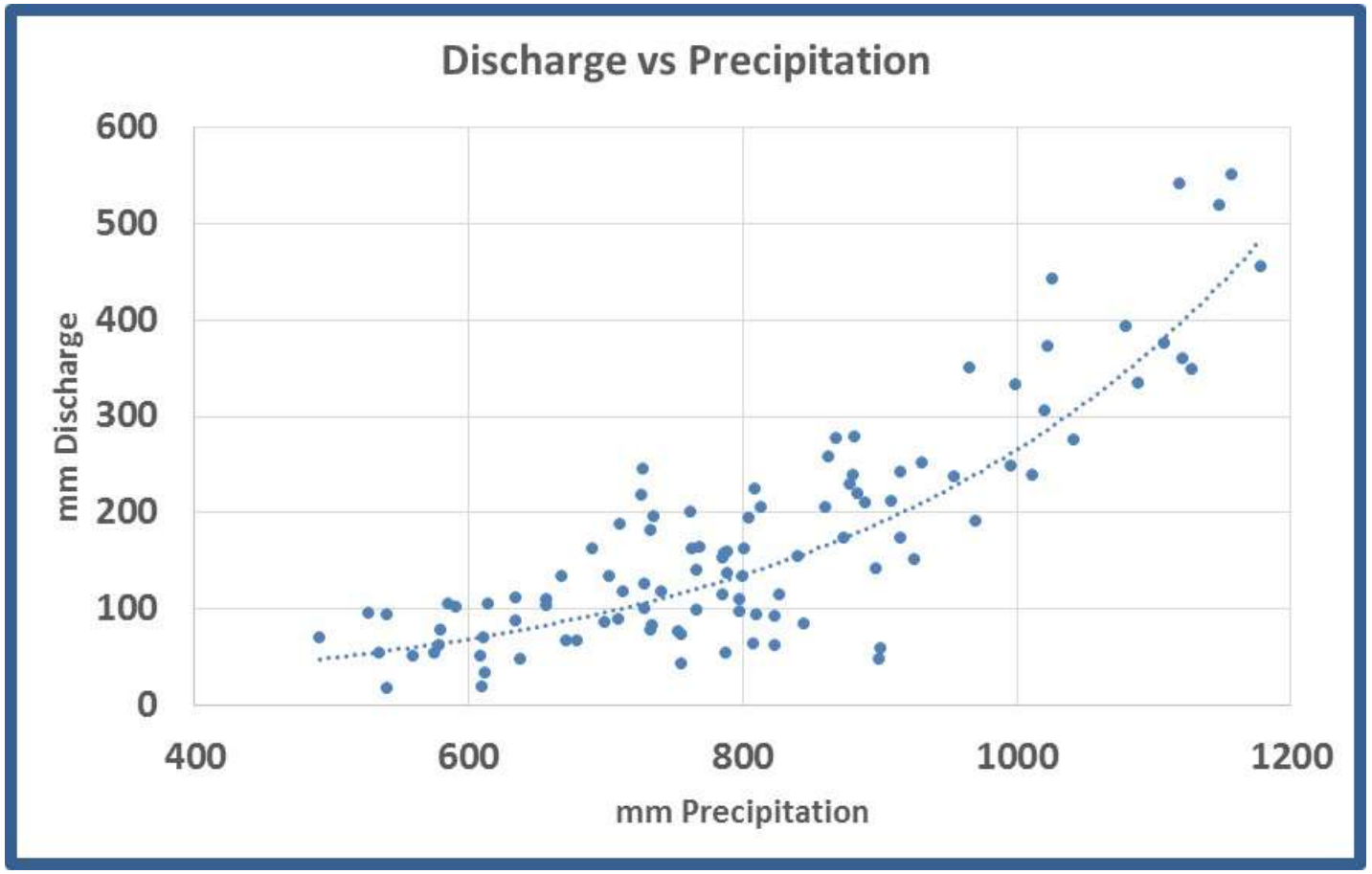
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019



Raccoon Watershed

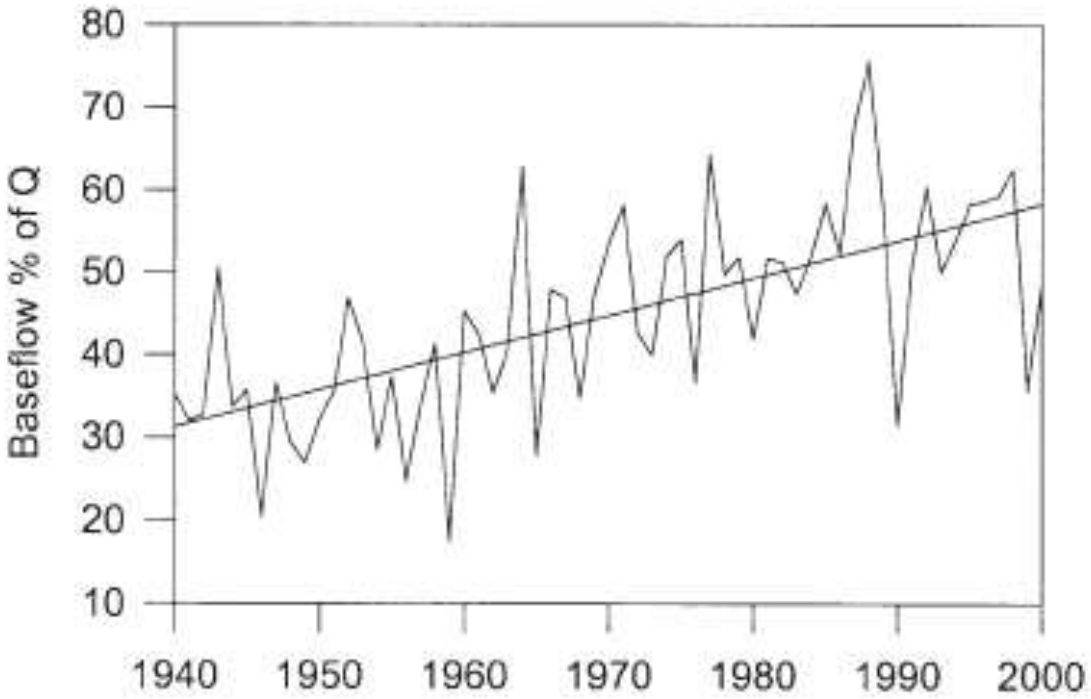



Raccoon River Watershed Annual Precipitation (mm)
(>1000 mm 1 time)
(>1000 mm 15 times)
(<600 mm 9 times)
(<600 mm 2 times)
1400
1200
1000
800
600
400
200
0
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019


Discharge vs Precipitation
600
500
400
300
200
100
0
mm Discharge
400
600
800
1000
1200
mm Precipitation

Streams have more water

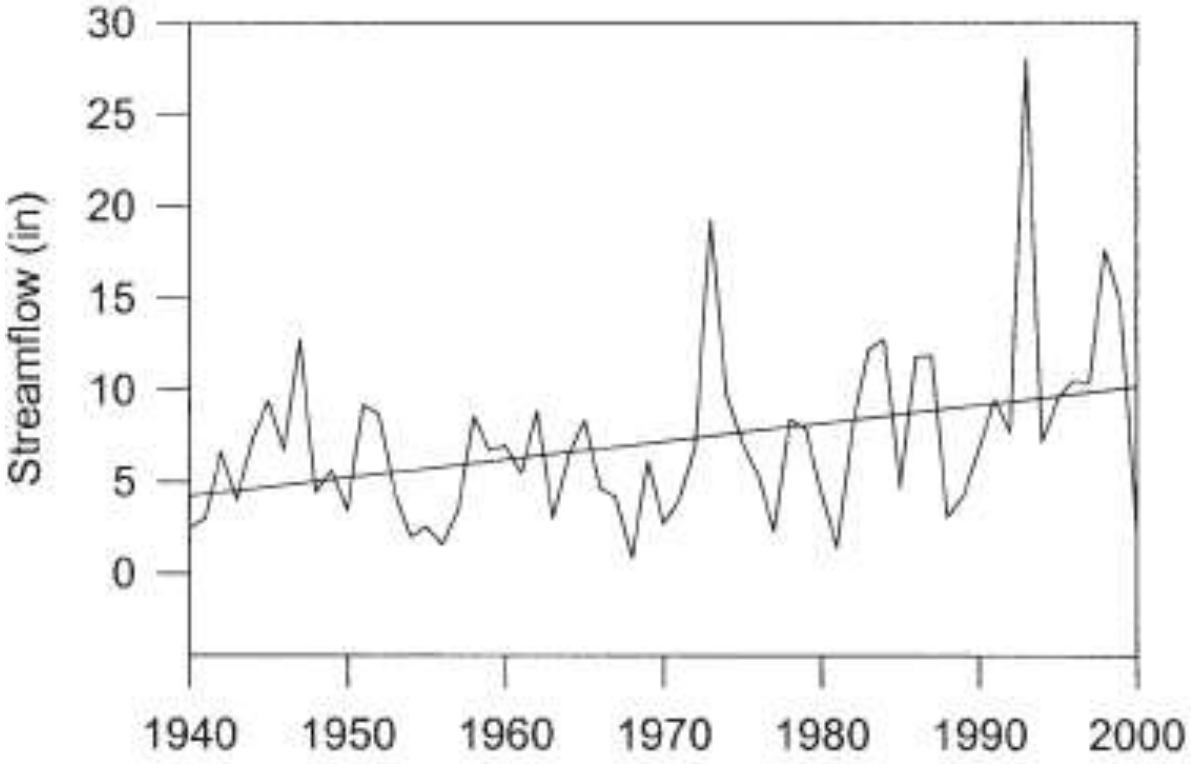
Wapsipinicon



Baseflow=is the portion of streamflow that comes from "the sum of deep subsurface flow and delayed shallow subsurface flow".

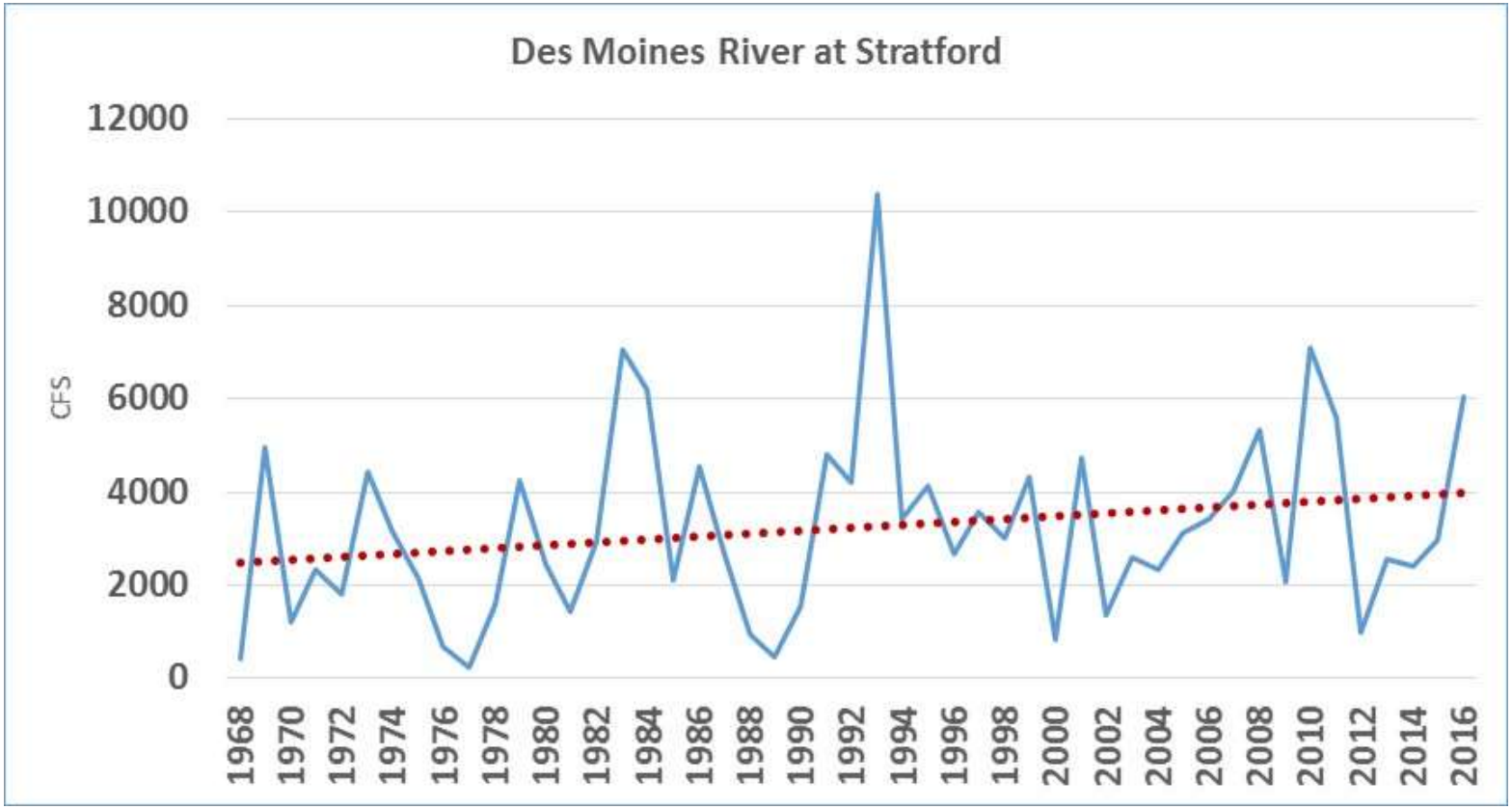
Schilling, K. E. and Libra, R. D. (2003), INCREASED BASEFLOW IN IOWA OVER THE SECOND HALF OF THE

E. Nishnabotna



Schilling, K. E. and Libra, R. D. (2003), INCREASED BASEFLOW IN IOWA OVER THE SECOND HALF OF THE

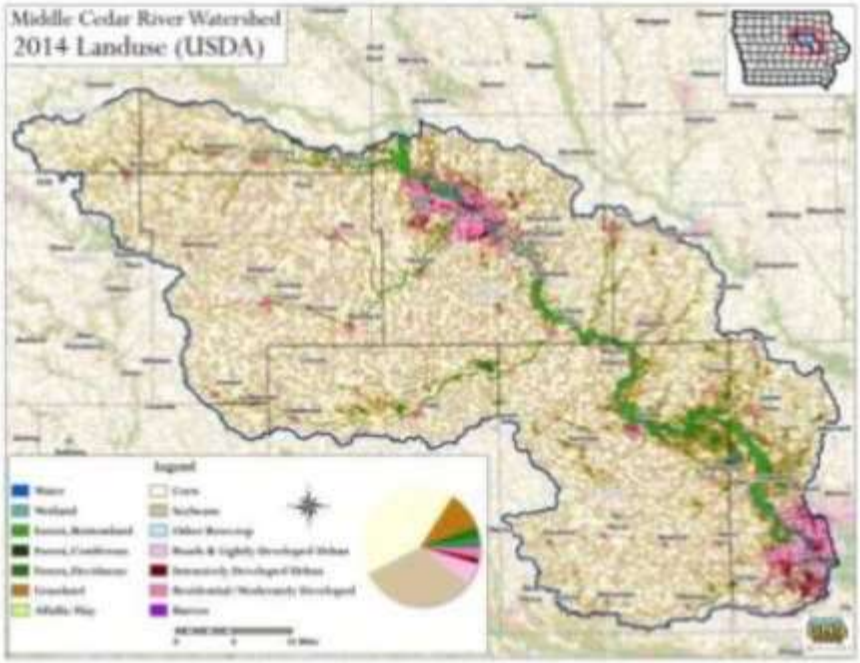
Des Moines R. at Stratford



More tile

Hand digging tile, Boone Co. IA. ca 1914
Source: 'An Iowa album: a photographic history, 1860-1920' by M. J. Bennet, University of Iowa Press, Iowa City, Iowa

More N loss: Middle Cedar Example



Iowa's Middle Cedar Watershed (credit: Middle Cedar Watershed Management Authority and Iowa DNR)

1200 miles new tile per year

1 acre of pattern tile = 1452' (0.275 mi)

1200 miles = 4364 acres

2018 N loss = 31.5 lbs/ac

New tile multiply N loss by 1.5 (15.9 lbs)

Increase watershed N load by 69,000 lbs

- 136 woodchip bioreactors (we currently have about 50 statewide), or,
- 3 constructed wetlands (currently we have about 100 statewide), or
- Around 7000 new acres of cover crops (currently we have million ac statewide).

Potential Impact of Climate Change on Subsurface Drainage in Iowa's Subsurface Drained Landscapes

R. Singh[1]; M. J. Helmers[2]; Amy L. Kaleita[3]; and Eugene S. Takle[4]

JOURNAL OF IRRIGATION AND DRAINAGE ENGINEERING © ASCE / JULY/AUGUST 2009 / 459

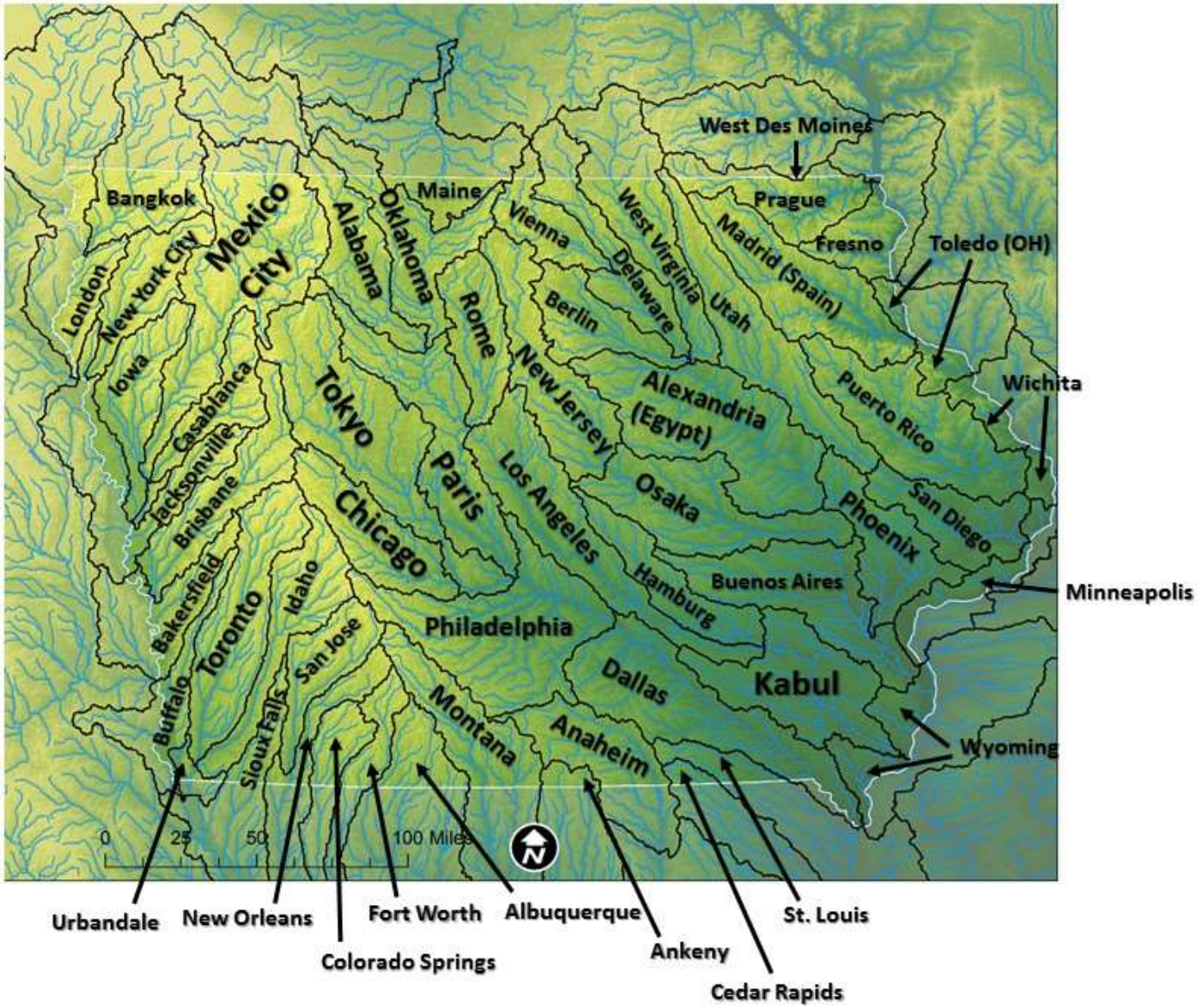
Perry, Iowa

- **24-32% increase in annual precipitation**
- **Increase tile drainage flows**
- **Change distribution of flows within the calendar year**

IOWA STATE UNIVERSITY

THE UNIVERSITY OF IOWA College of Engineering

IIHR Hydroscience & Engineering


West Des Moines
Bangkok
Maine
Prague
Vienna
Fresno
Toledo (OH)
Mexico City
Alabama
Oklahoma
West Virginia
Madrid (Spain)
London
New York City
Delaware
Utah
Berlin
Rome
Iowa
Wichita
Alexandria (Egypt)
Puerto Rico
Casablanca
Tokyo
New Jersey
Jacksonville
Paris
Los Angeles
Osaka
San Diego
Brisbane
Chicago
Phoenix
Hamburg
Buenos Aires
Minneapolis
Bakersfield
Idaho
Toronto
Philadelphia
San Jose
Dallas
Kabul
Buffalo
Montana
Anaheim
Wyoming
Sioux Falls
0
25
50
100 Miles
N
Urbandale
New Orleans
Fort Worth
Albuquerque
St. Louis
Colorado Springs
Ankeny
Cedar Rapids

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