School of Earth Sciences
www.earthsciences.osu.edu

Stream discharge and nutrient export from the Ohio River watershed under future climate change scenarios

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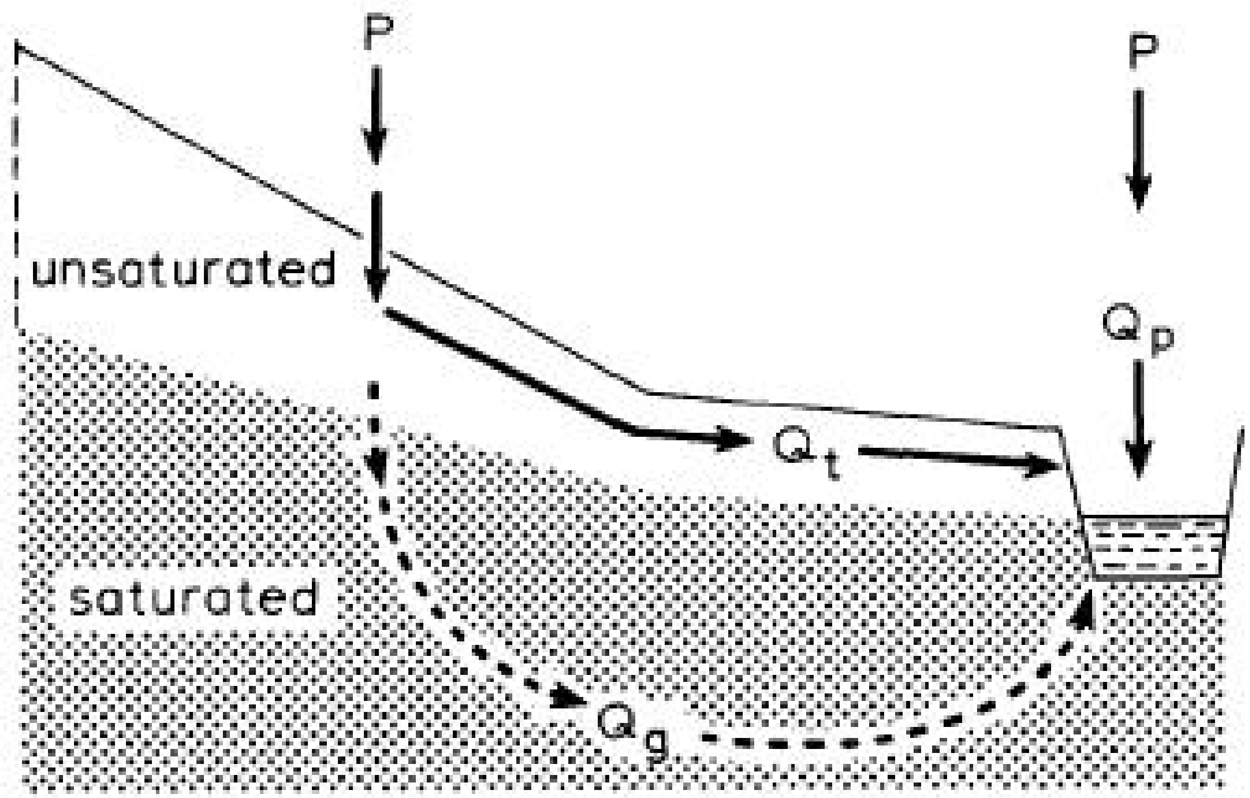
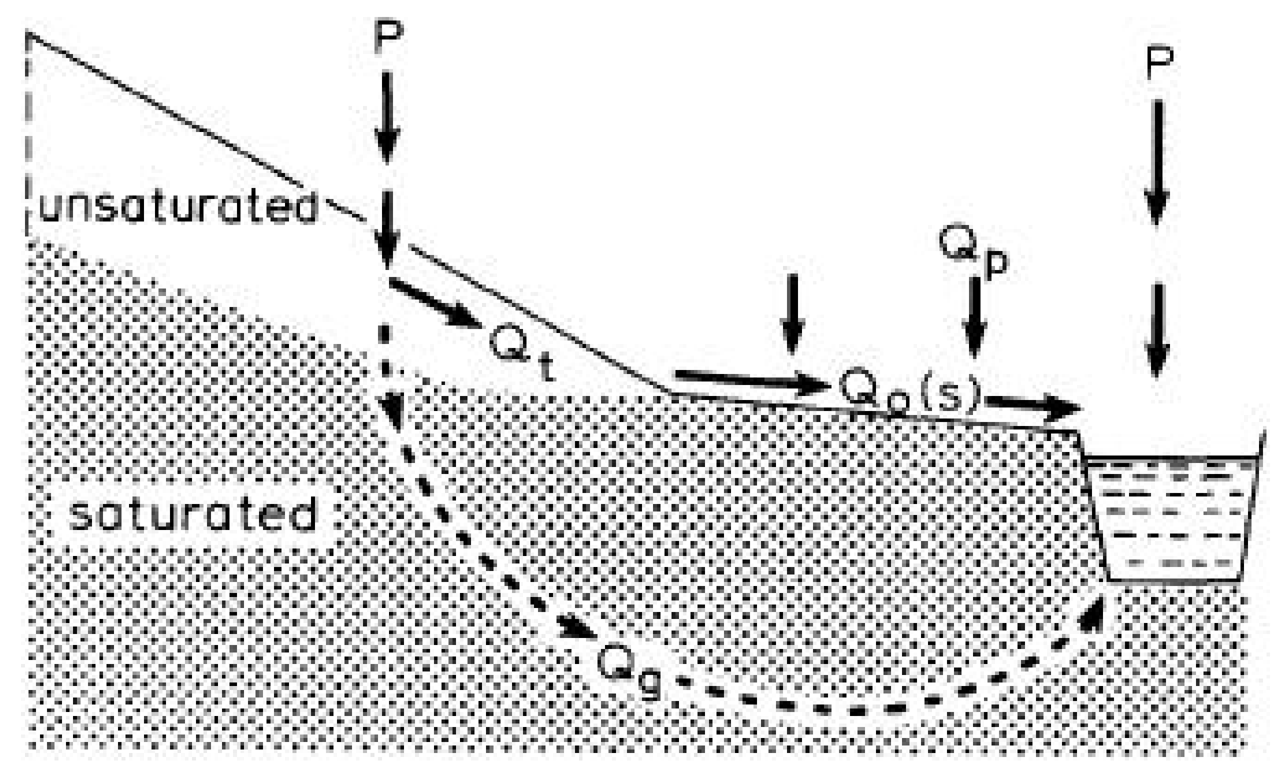
Runoff generation in streams

The Variable Source Area concept



Natural landscapes

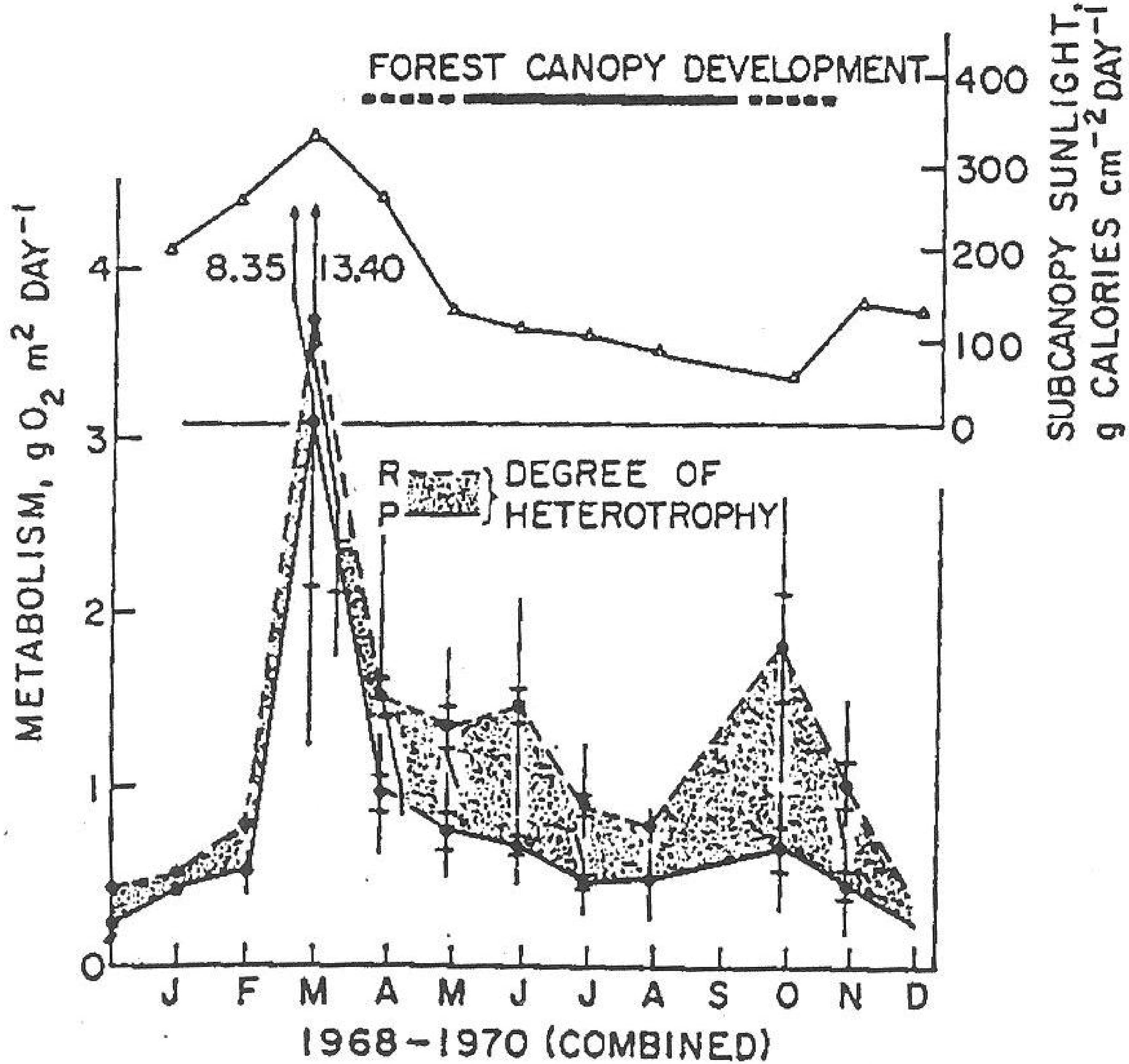


Agricultural landscapes

The prevailing assumption in catchment hydrology at the time was that direct runoff was a ‘product of overland flow and that other types of flow were mere exceptions to that general rule’

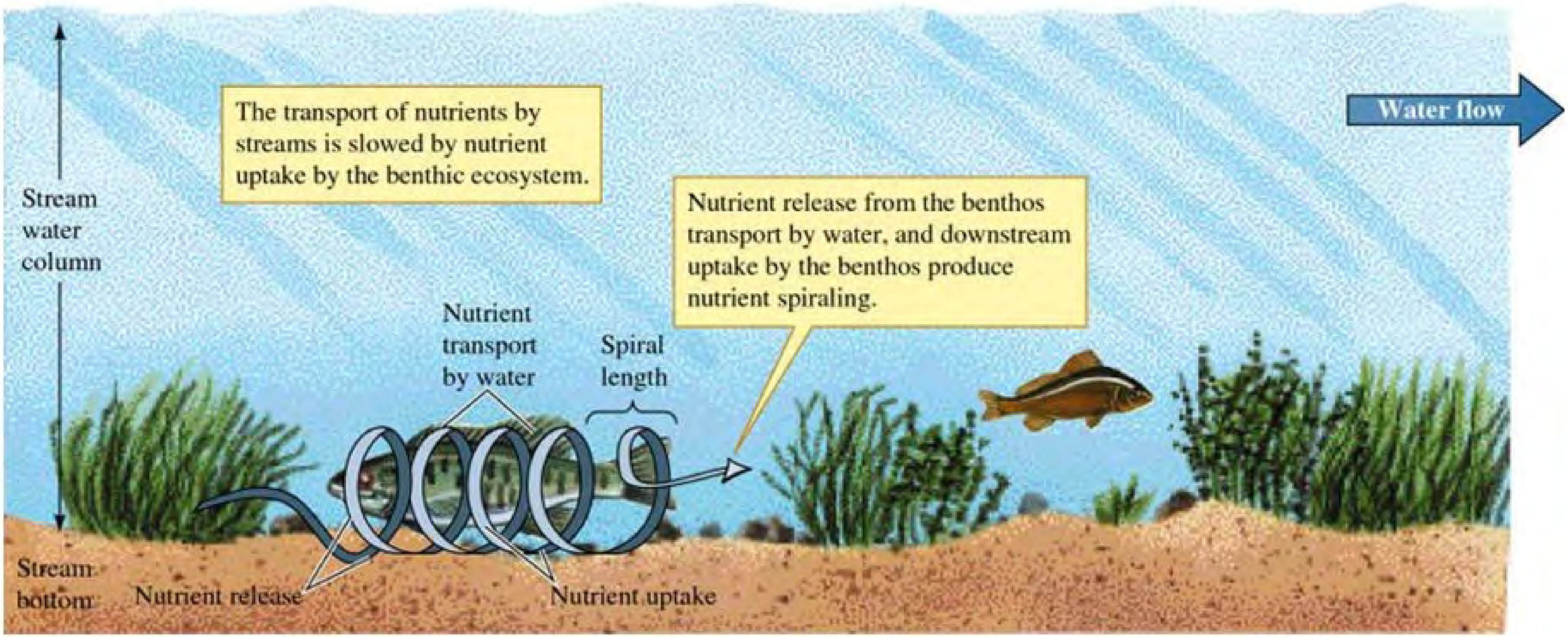
Hewlett & Hibbert (1967)

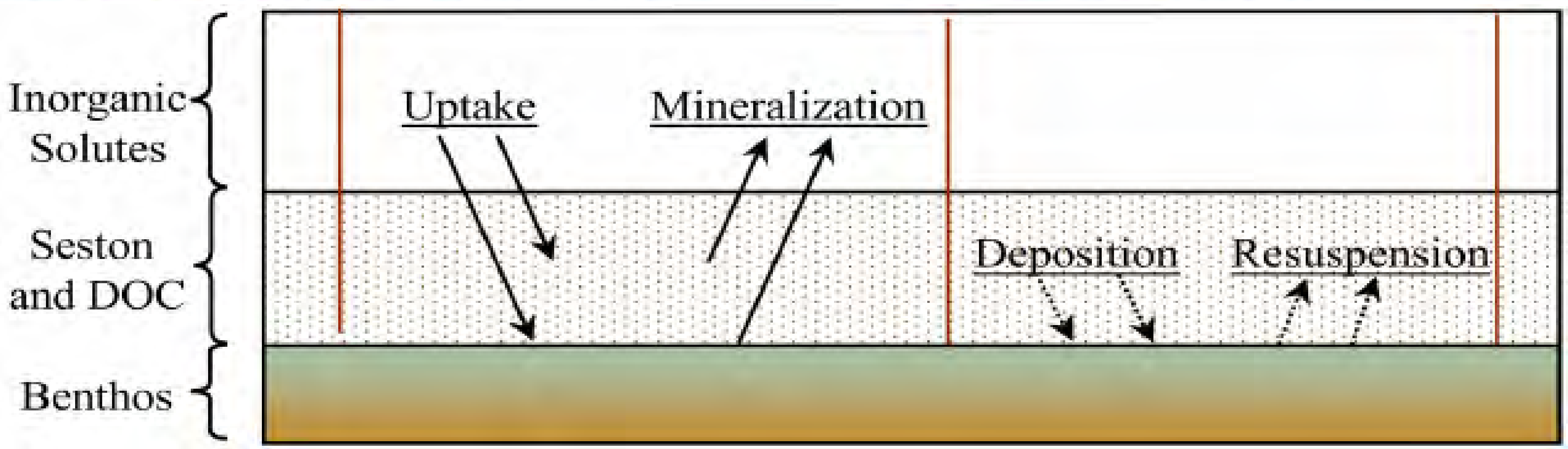
Connectivity between the stream and its watershed



Hynes (1975)

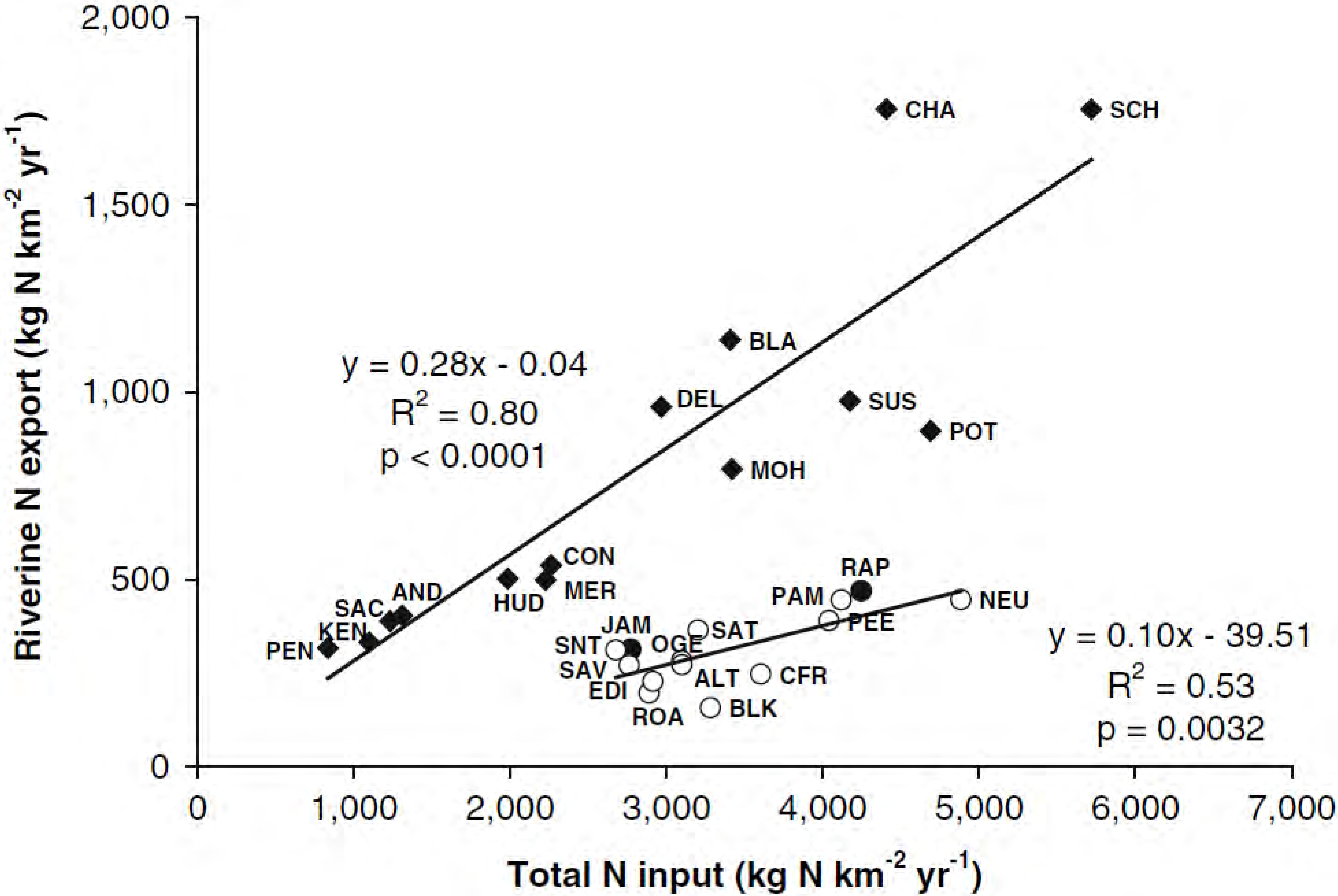
Nutrient spiraling in streams





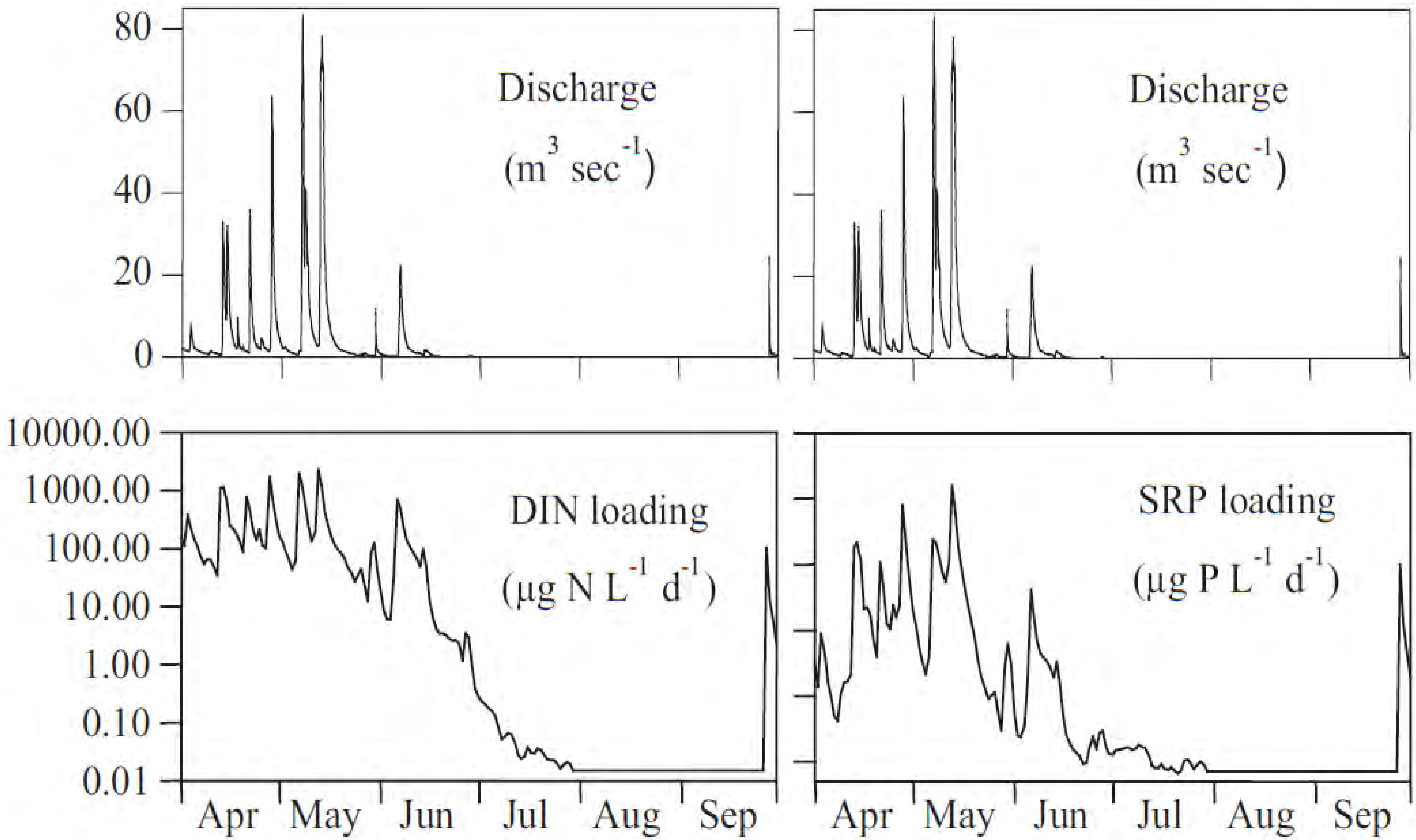
Webster (1975), Newbold et al. (1981)

In-stream nutrient removal processes



Schaefer & Alber (2007)

Short-term hydrological variability of material flux

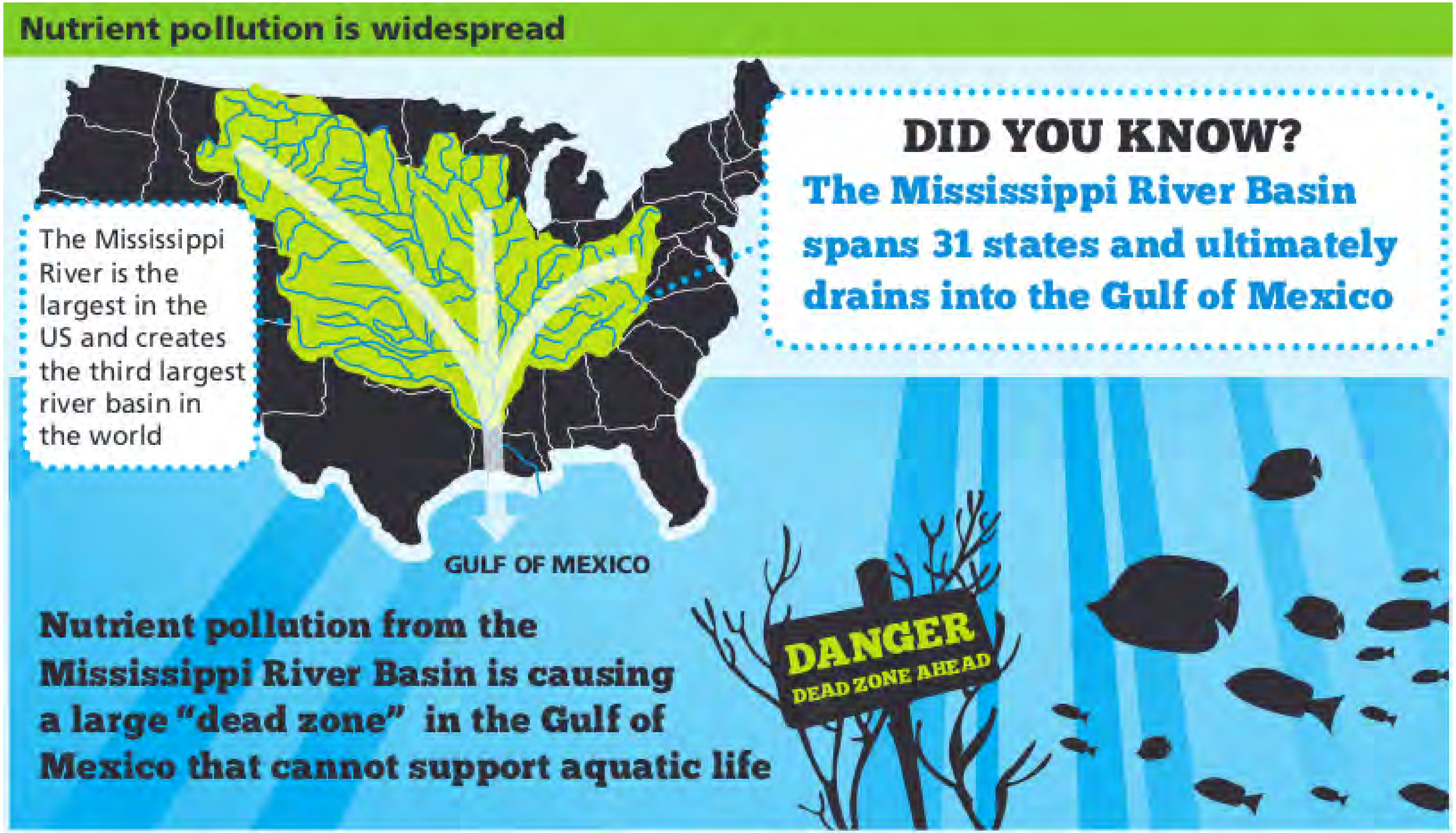


Vanni et al. (2006)

Effects of variable discharge on nutrient export rate

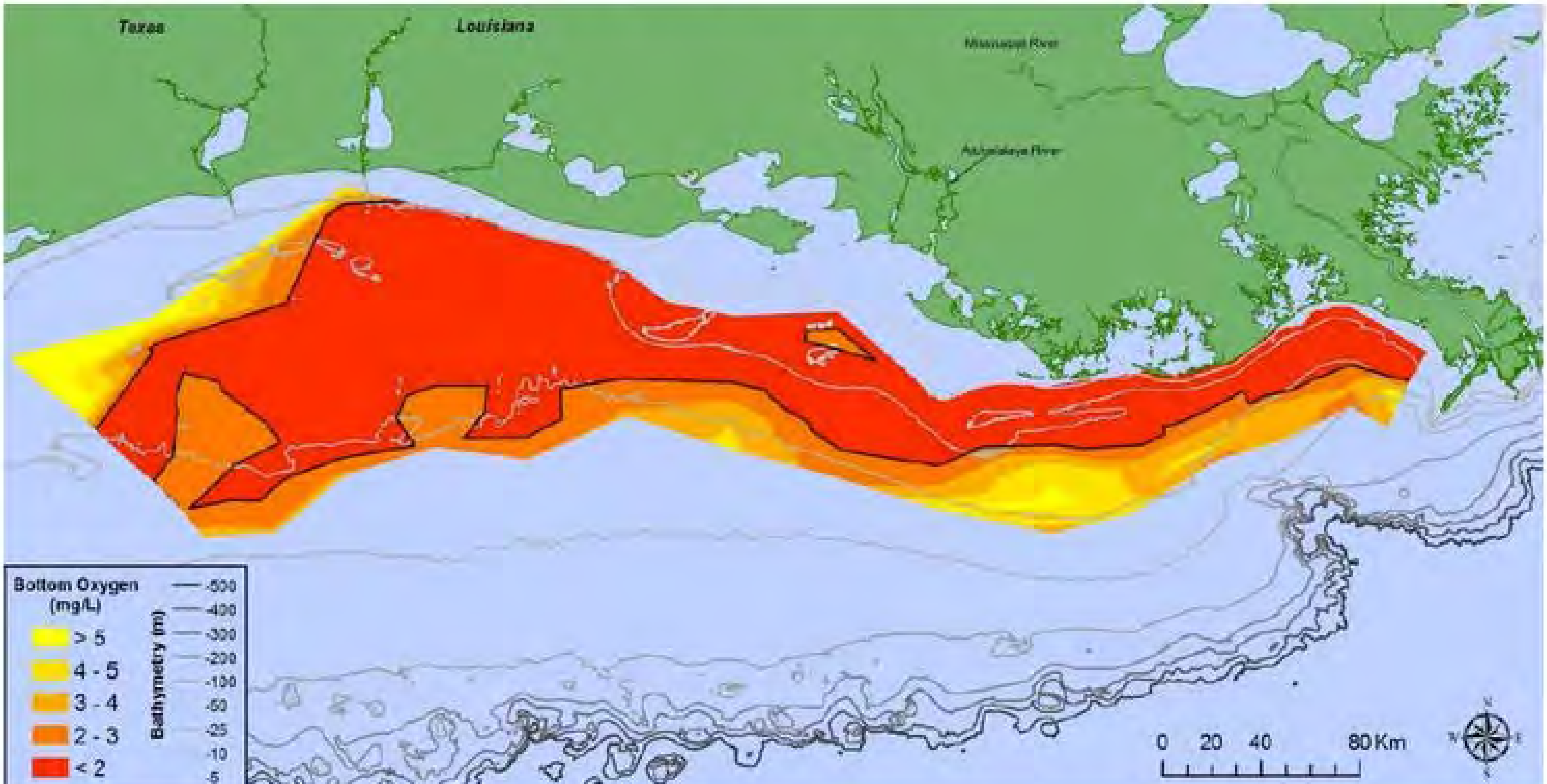
Why is this important?

The dead zone is caused by nutrient pollution



EPA (2012)

2017 Gulf dead zone is largest ever, size of New Jersey, researchers say



NOLA.com | The Times-Picayune

High-frequency nutrient & stream flow monitoring

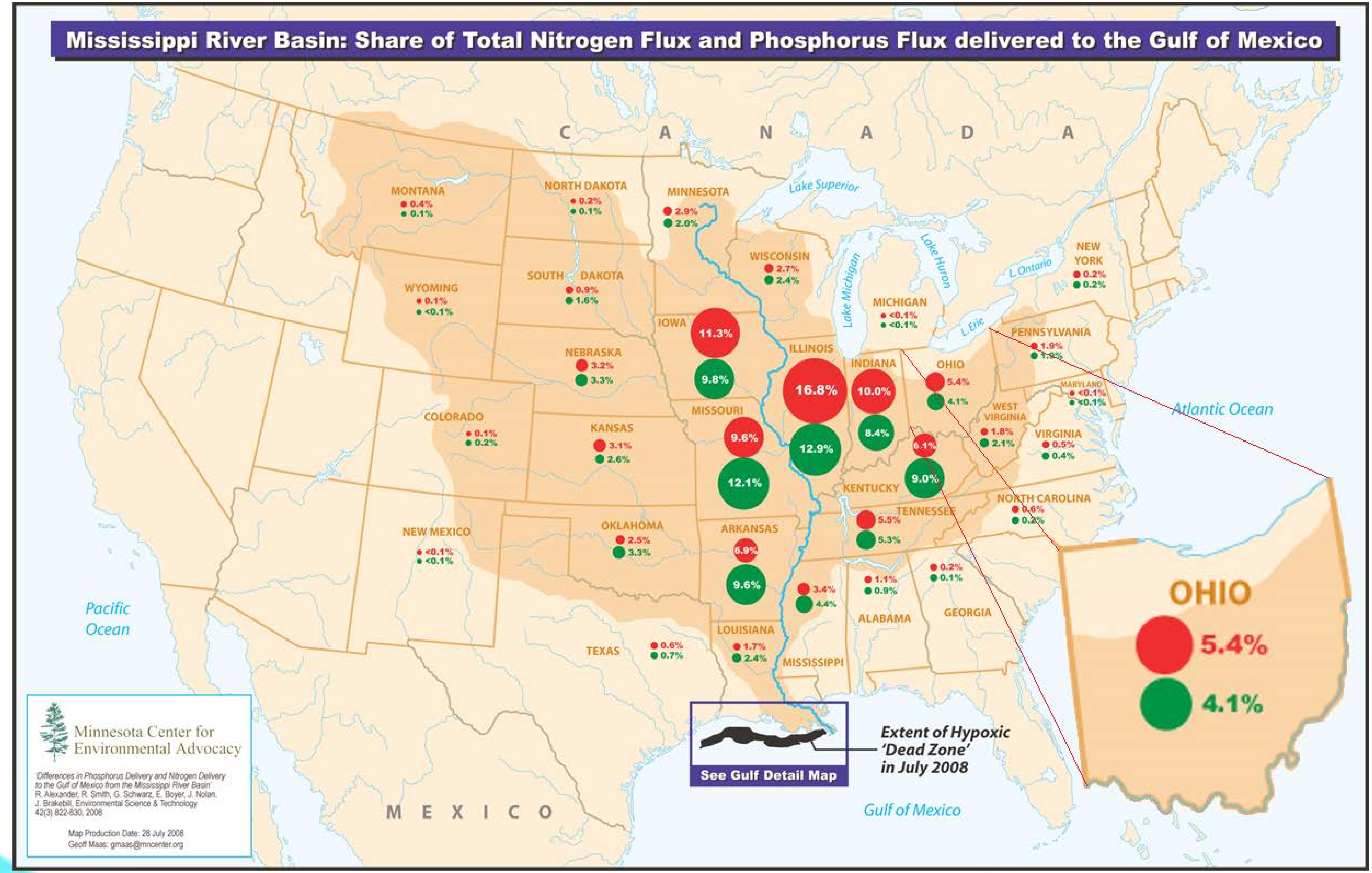
Daily sampling
May 1996 – Oct 2017

NCWQR - Heidelberg

High-frequency nutrient & stream flow monitoring

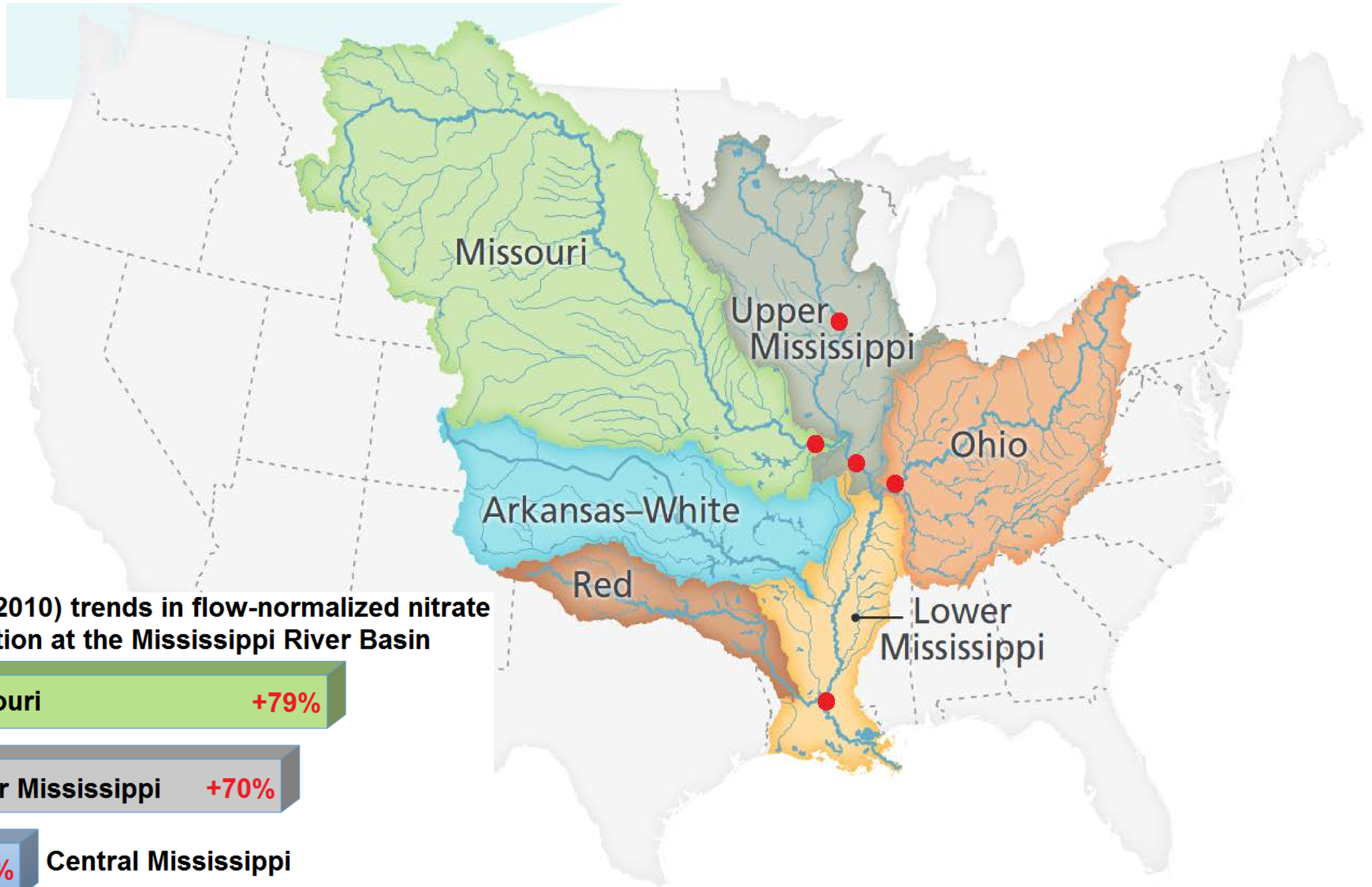
NCWQR - Heidelberg

Nutrient loads from Mississippi basin watersheds

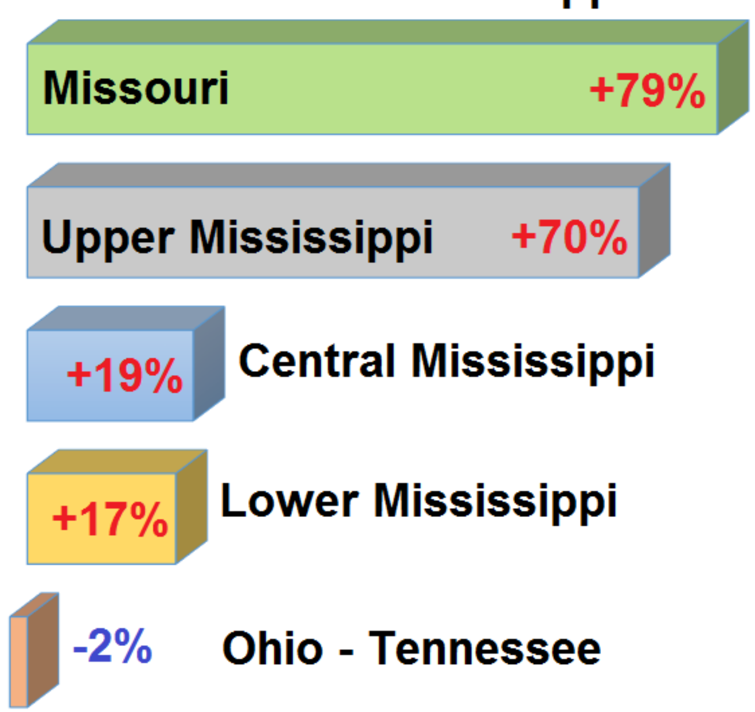


Alexander et al. (2008)

Nutrient loads from Mississippi basin watersheds

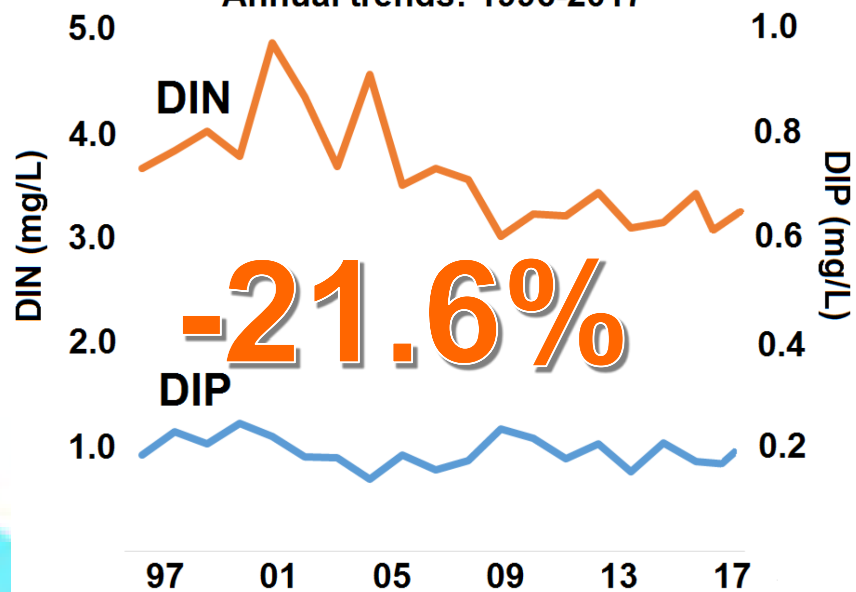


30-year (1980-2010) trends in flow-normalized nitrate concentration at the Mississippi River Basin

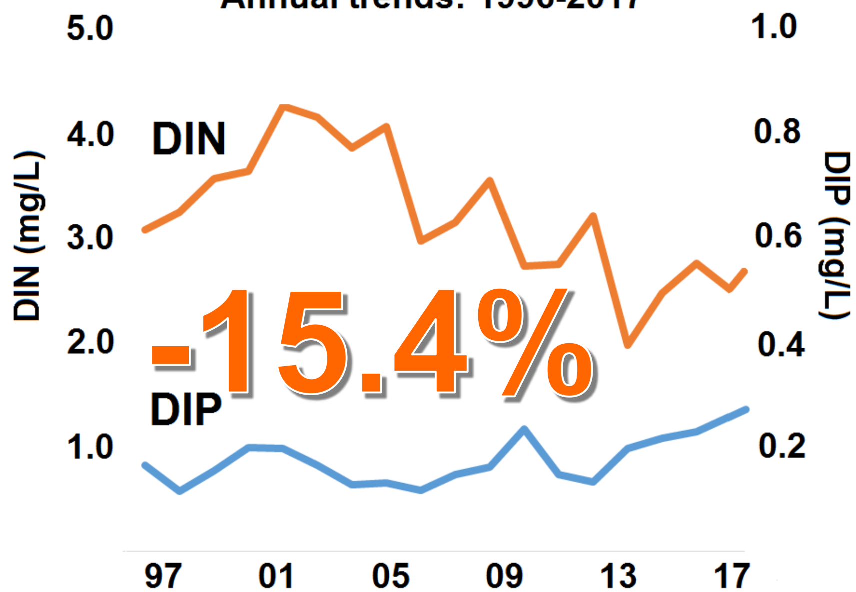


Murphy et al. (2013)

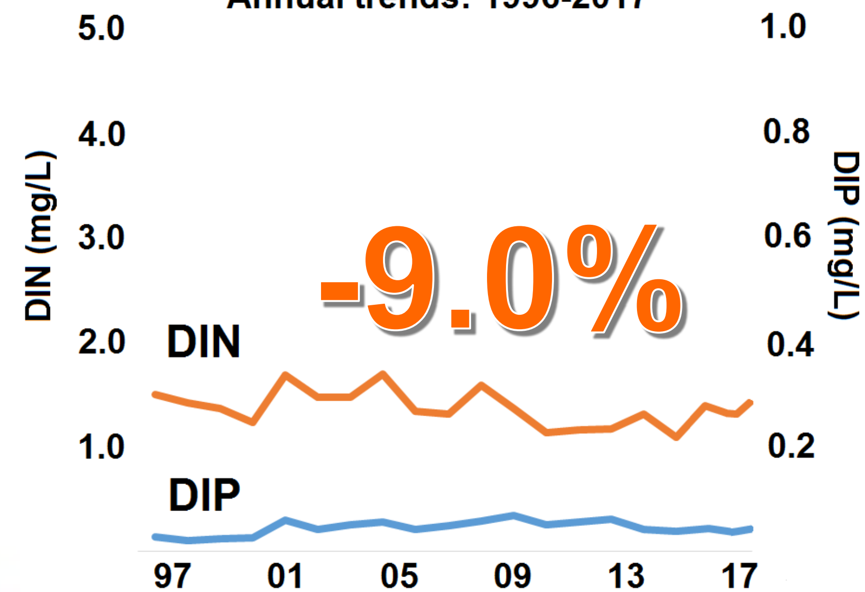
Great Miami River Watershed
Annual trends: 1996-2017



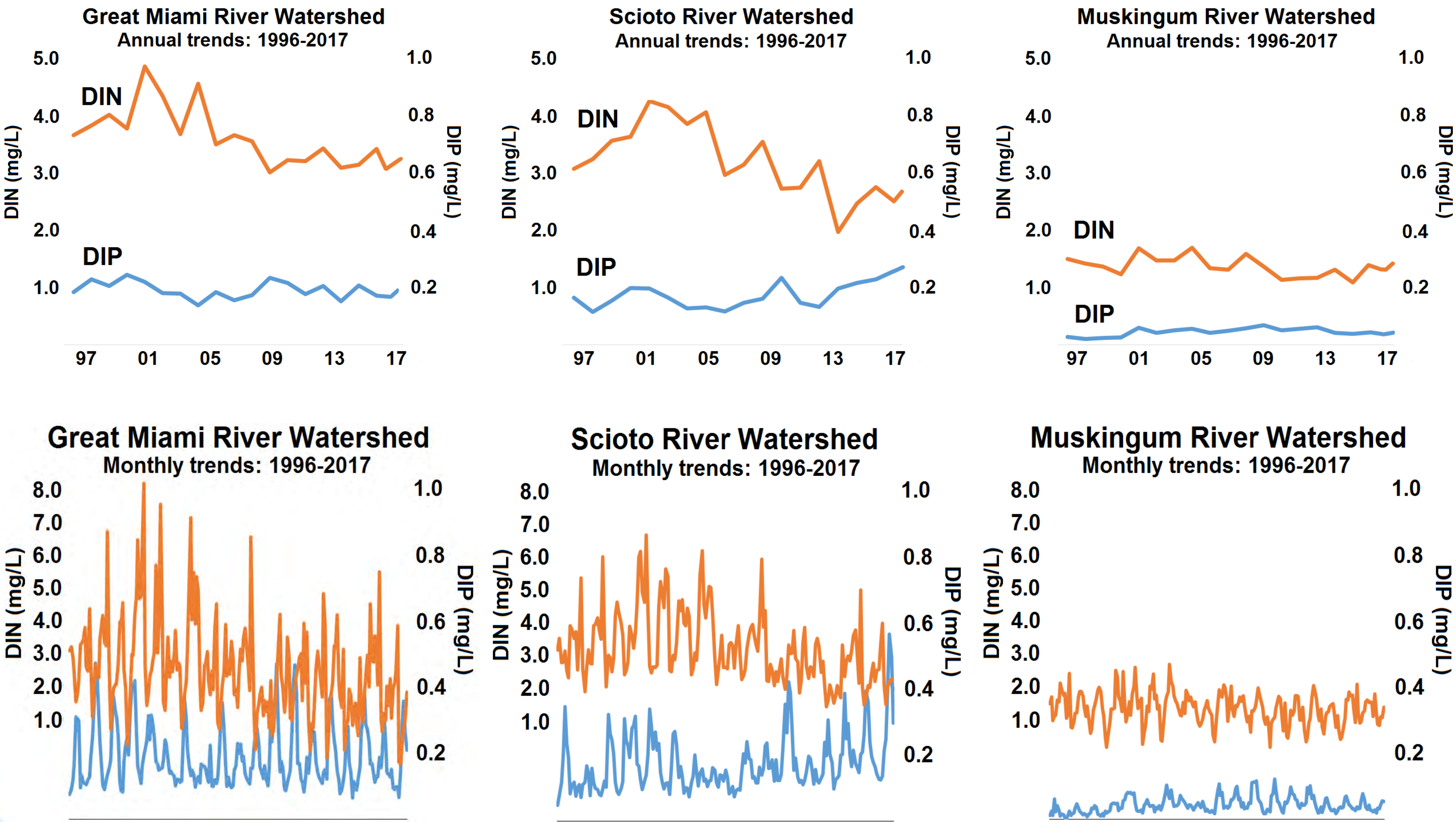
Scioto River Watershed
Annual trends: 1996-2017



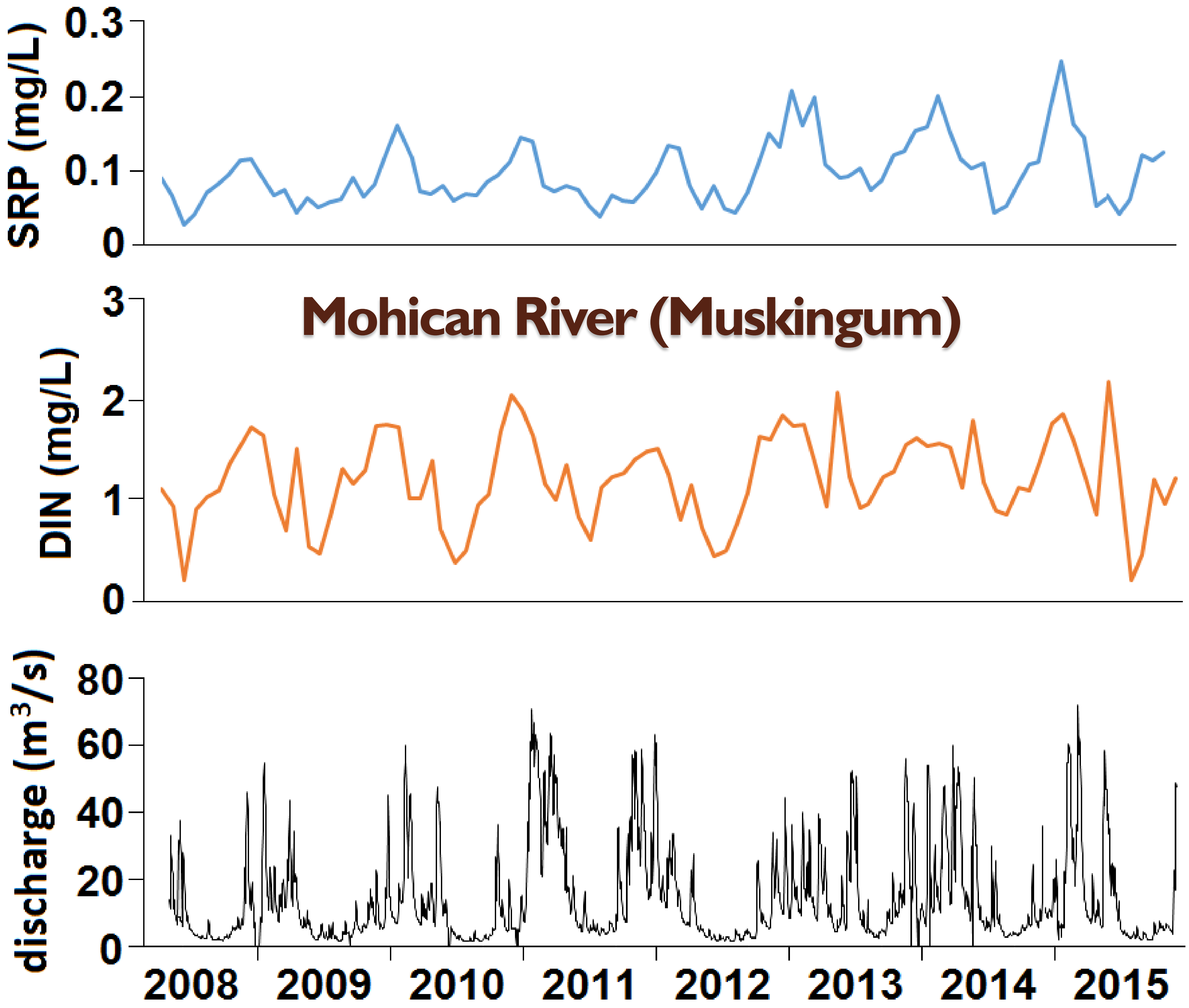
Muskingum River Watershed
Annual trends: 1996-2017



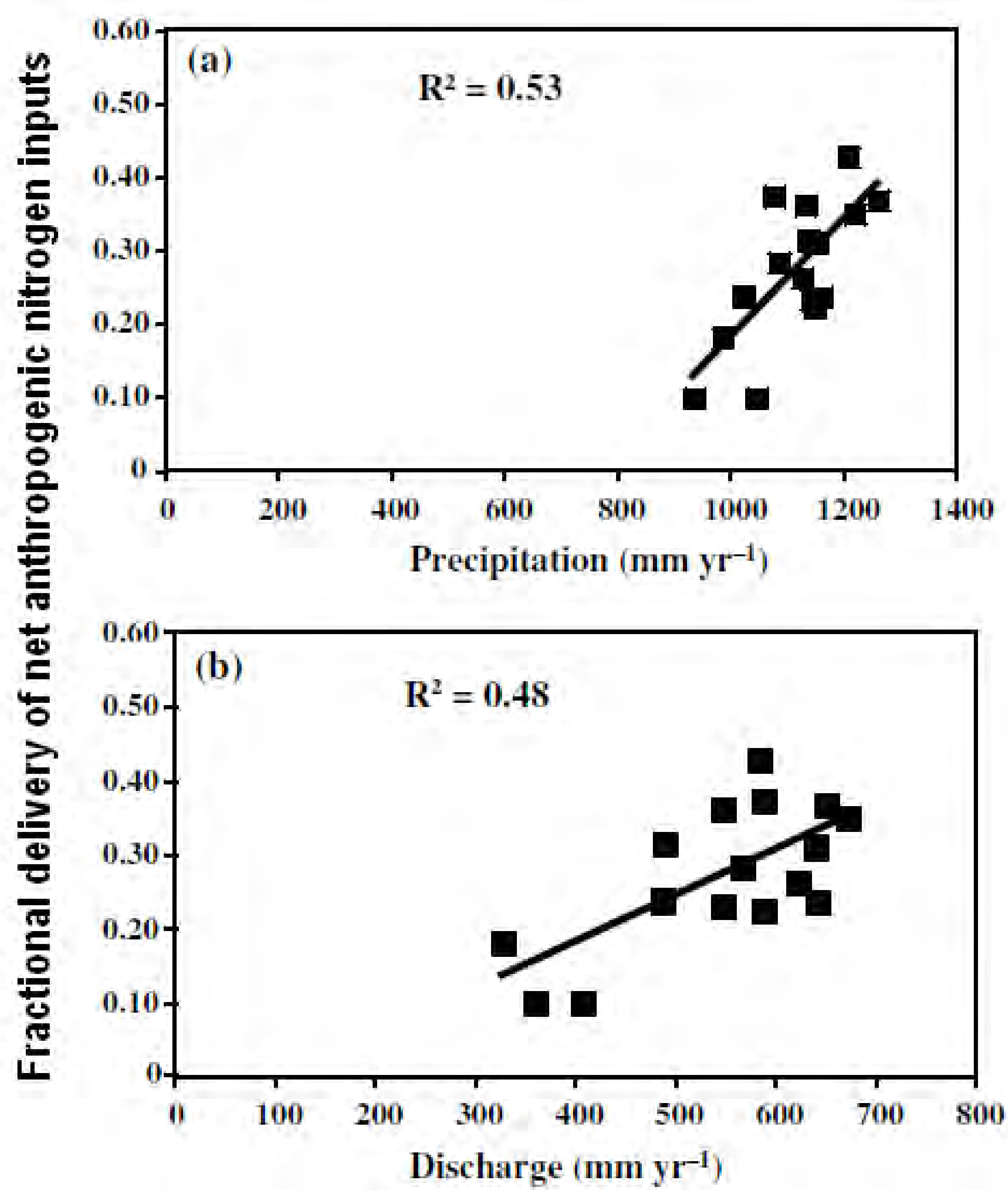
Short-term hydrological variability



Hydrological control on nutrient concentration

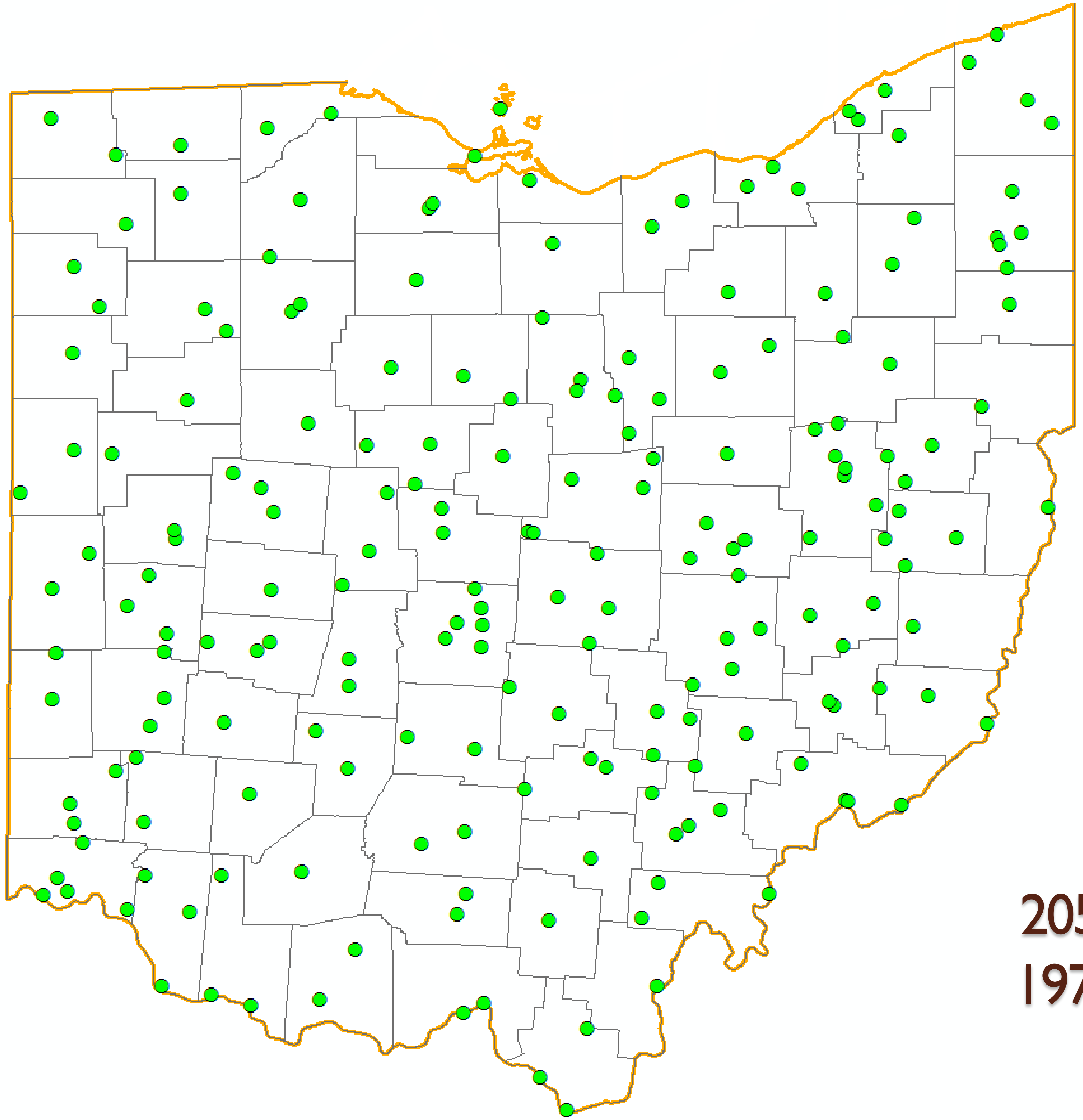


Long-term geomorphic and climatic change



Howarth et al. (2006)

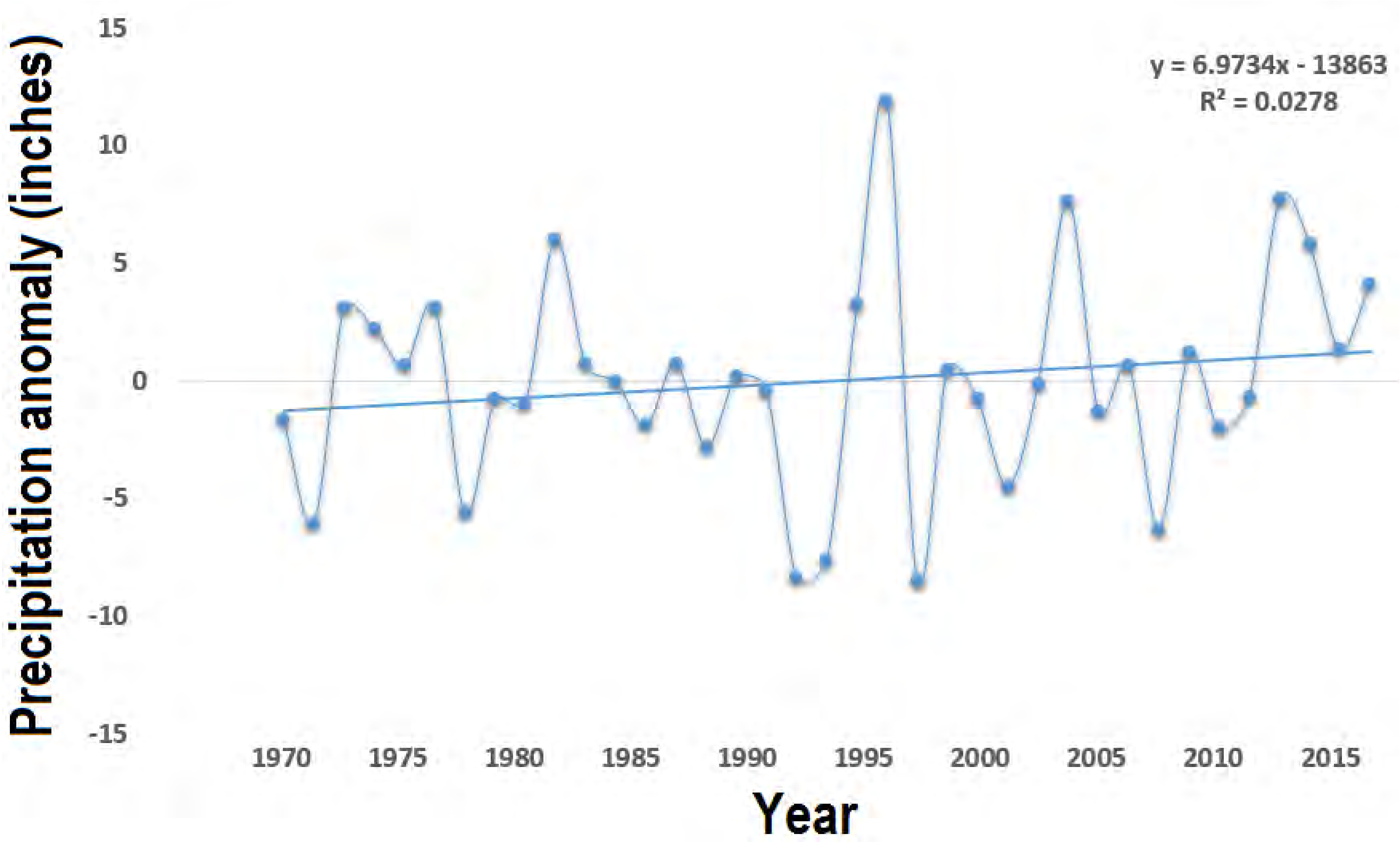
Log-term precipitation record



205 stations
1970 – 2016

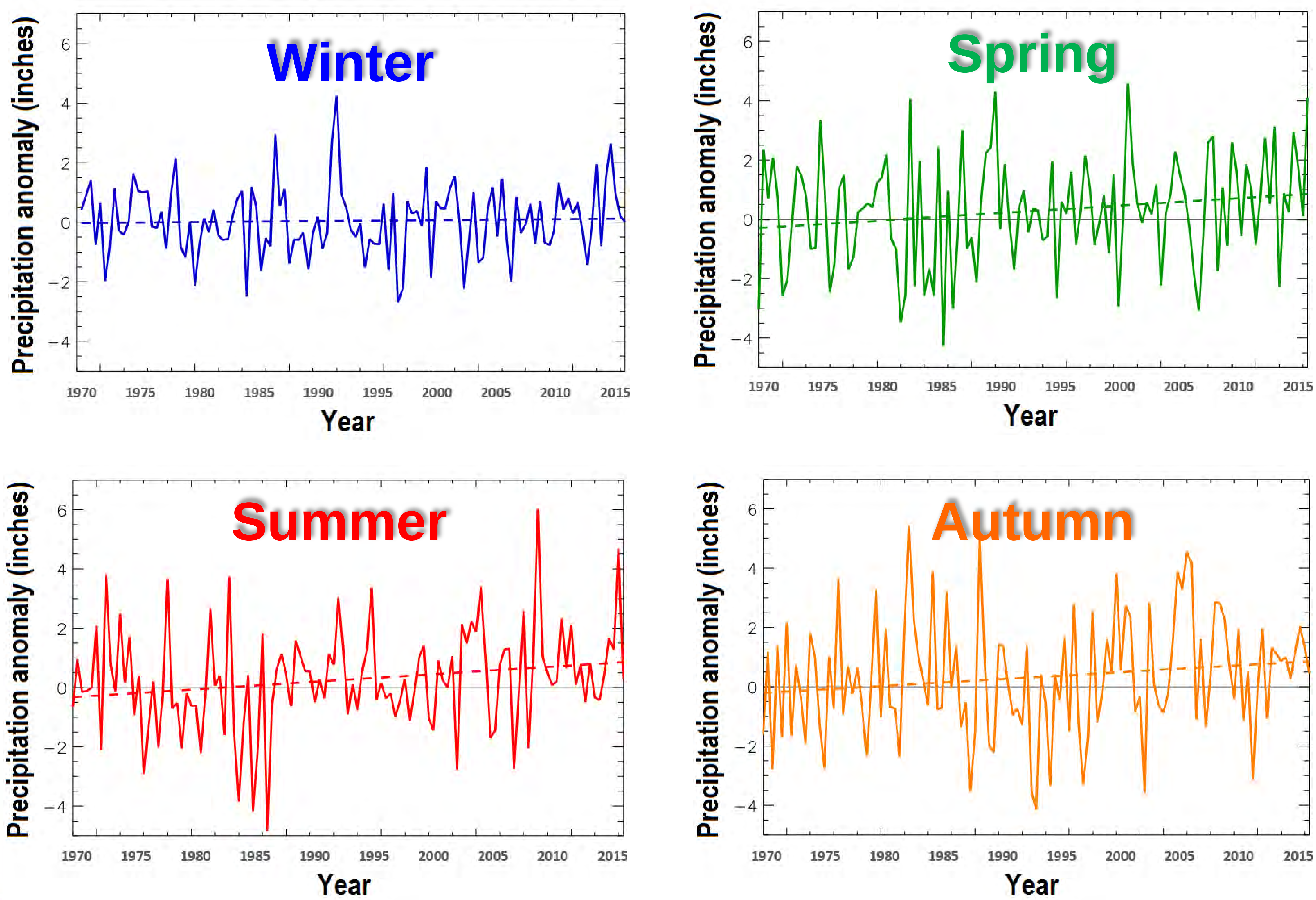
NCDC - NOAA

Annual precipitation trends in Ohio

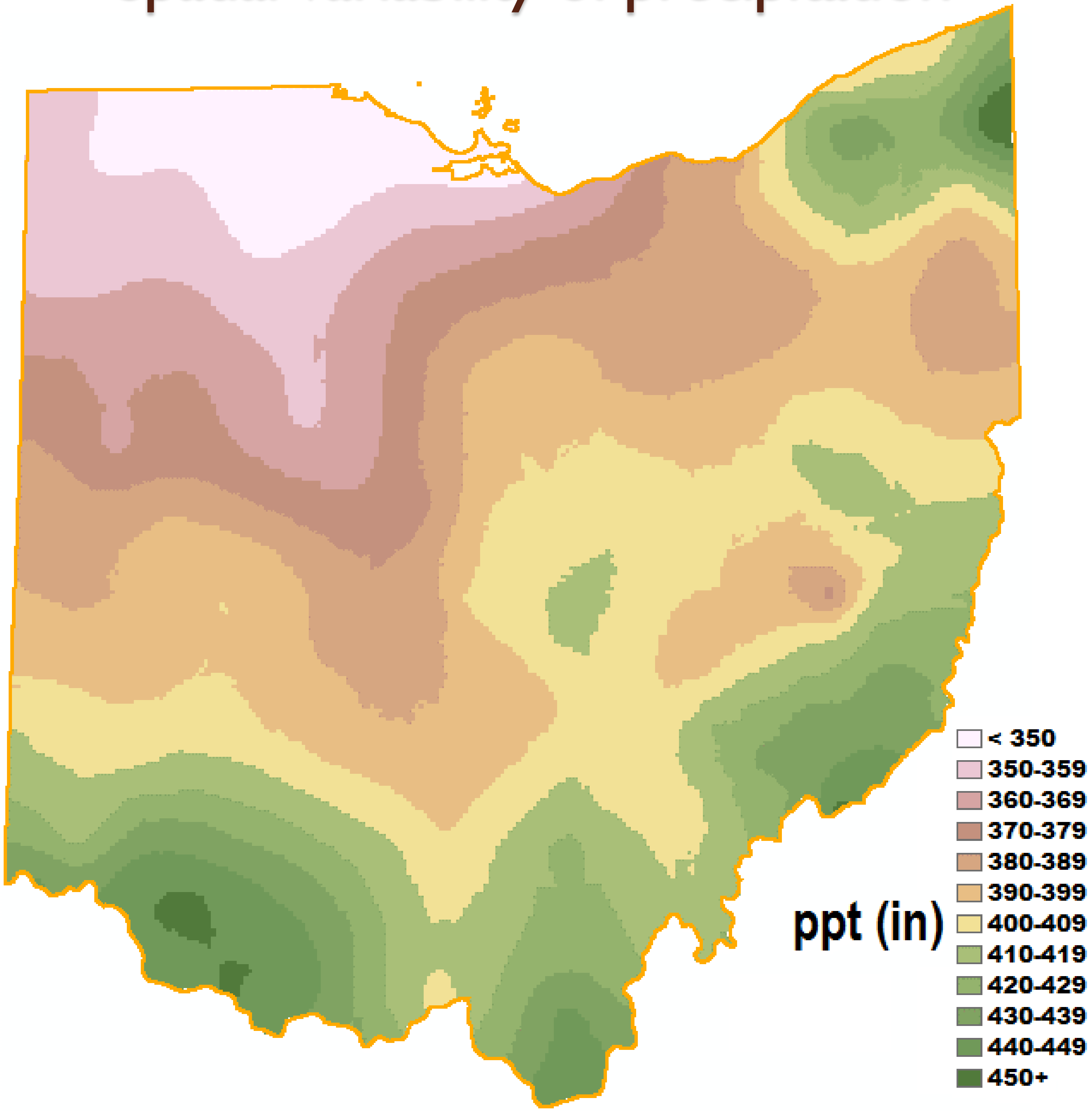


Deviation from 1970-2016 average

Seasonal variability of precipitation

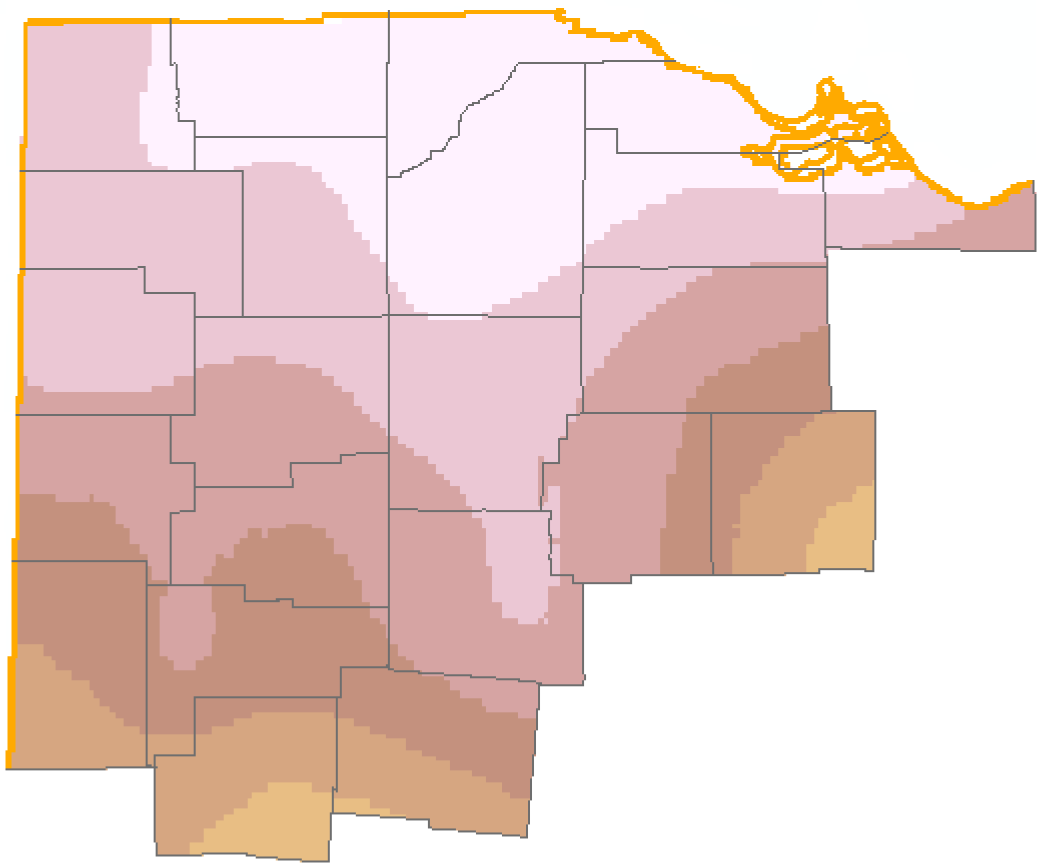


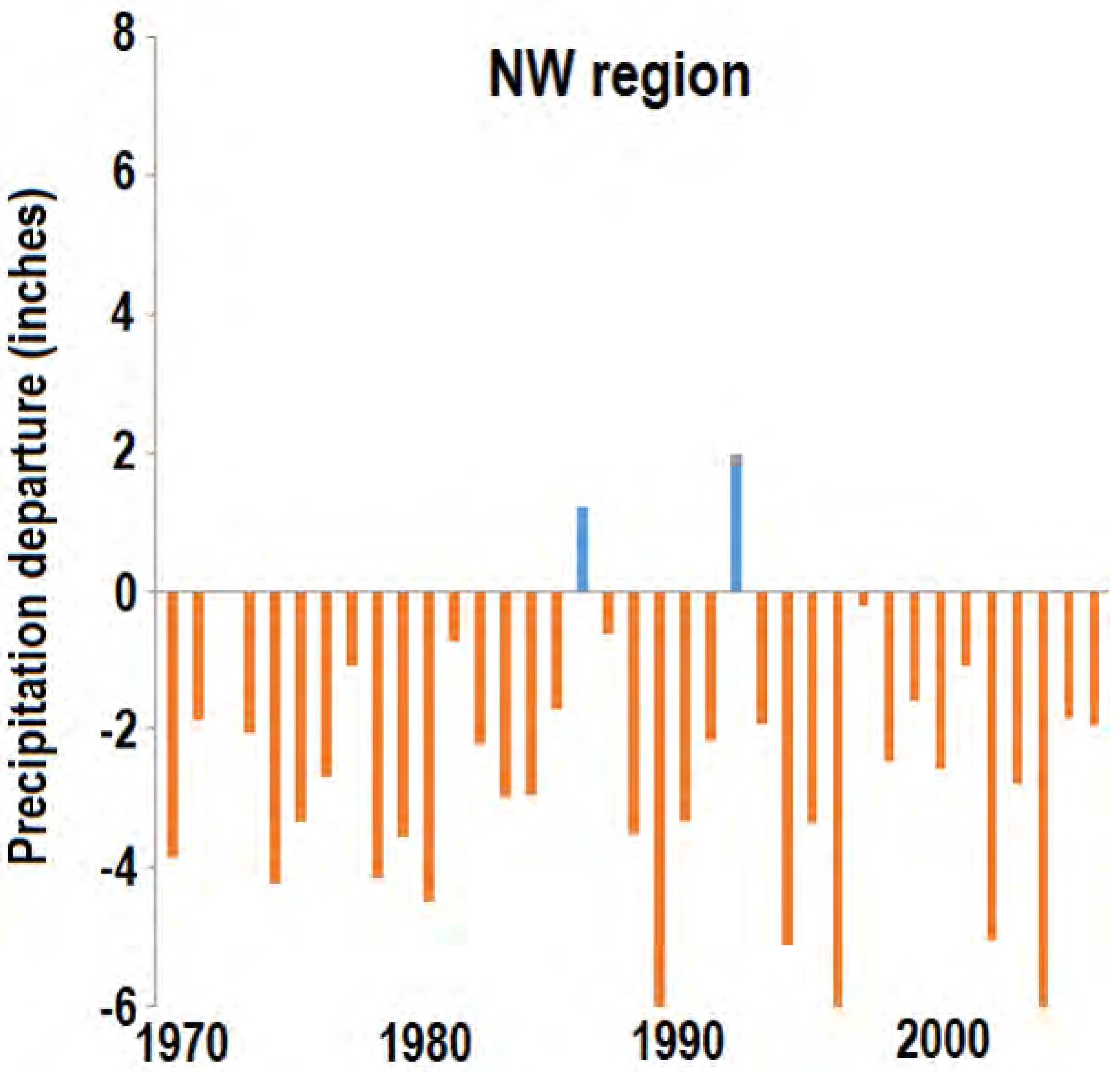
Spatial variability of precipitation



Annual precipitation trends by region

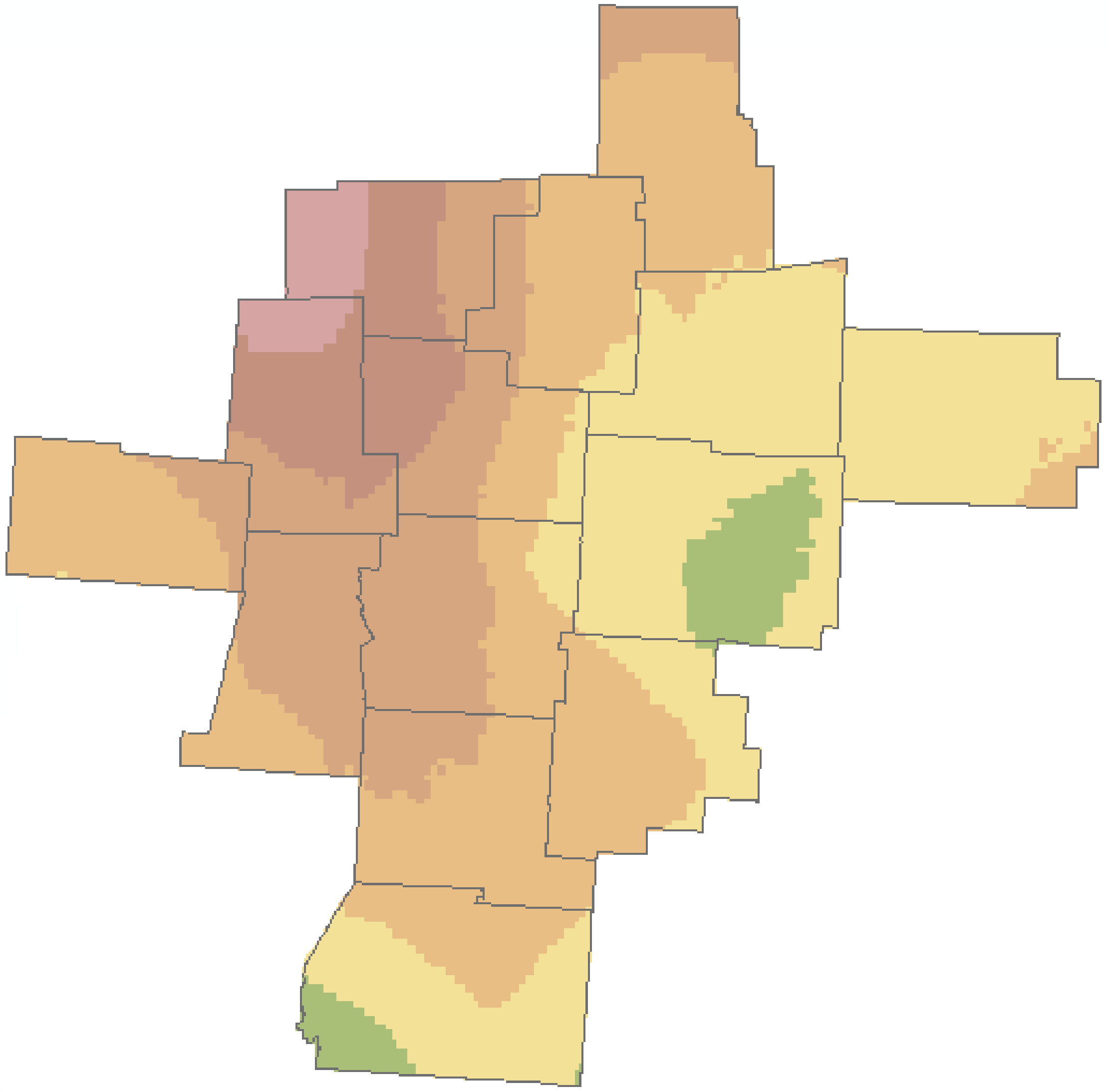
NW region

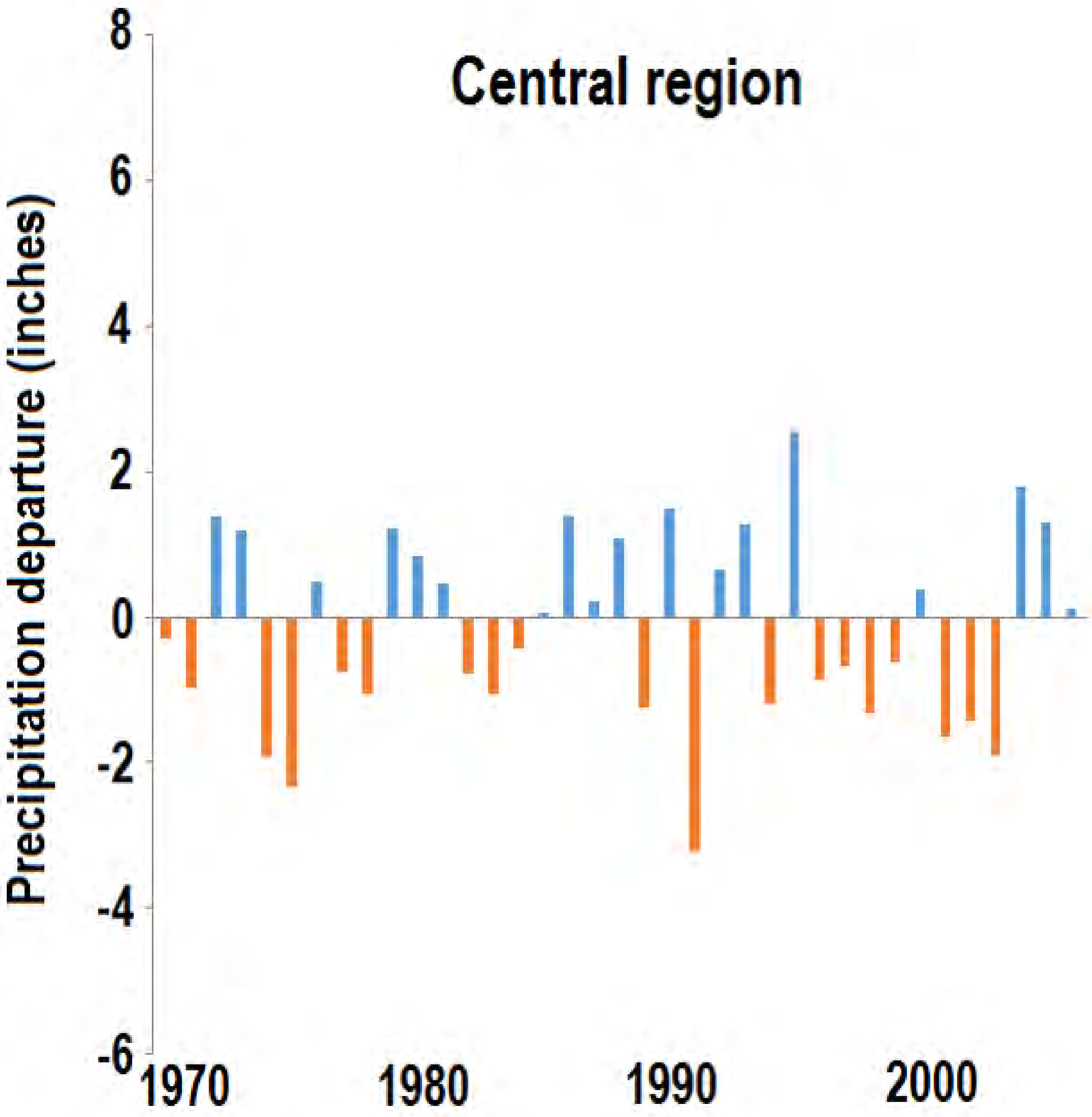




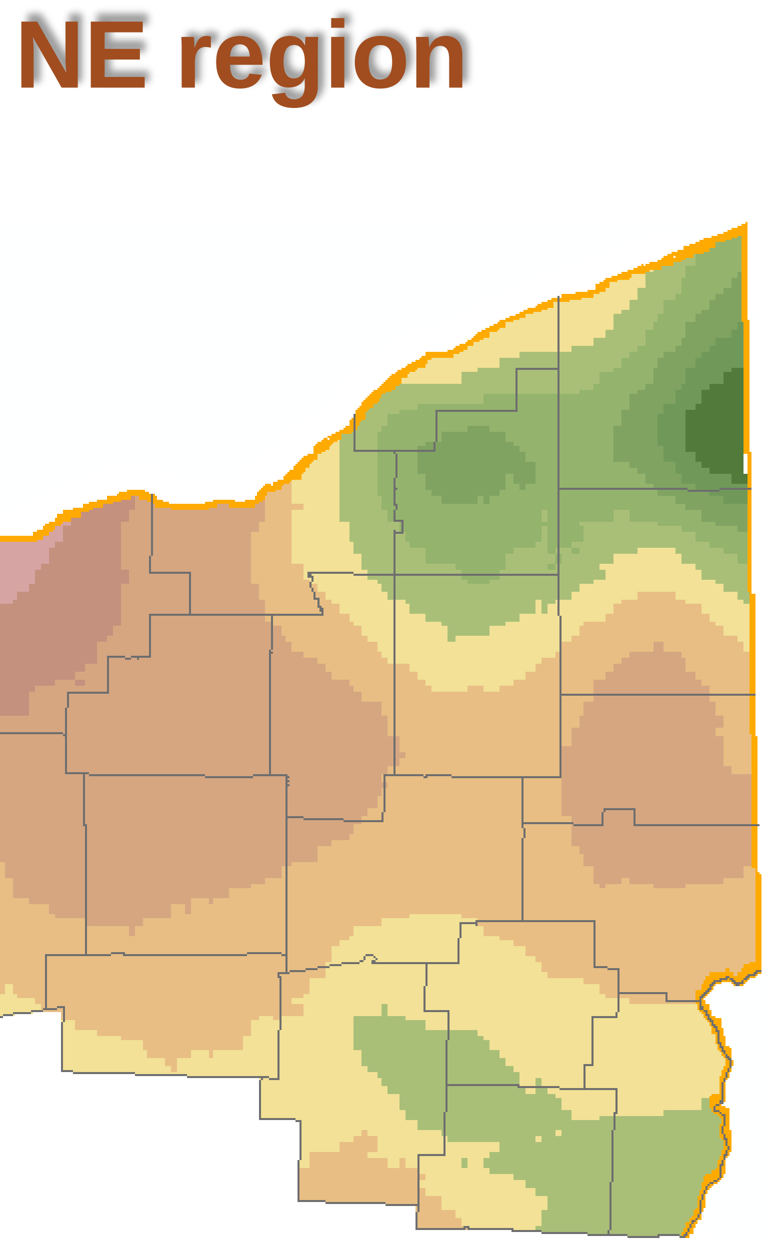
Annual precipitation trends by region

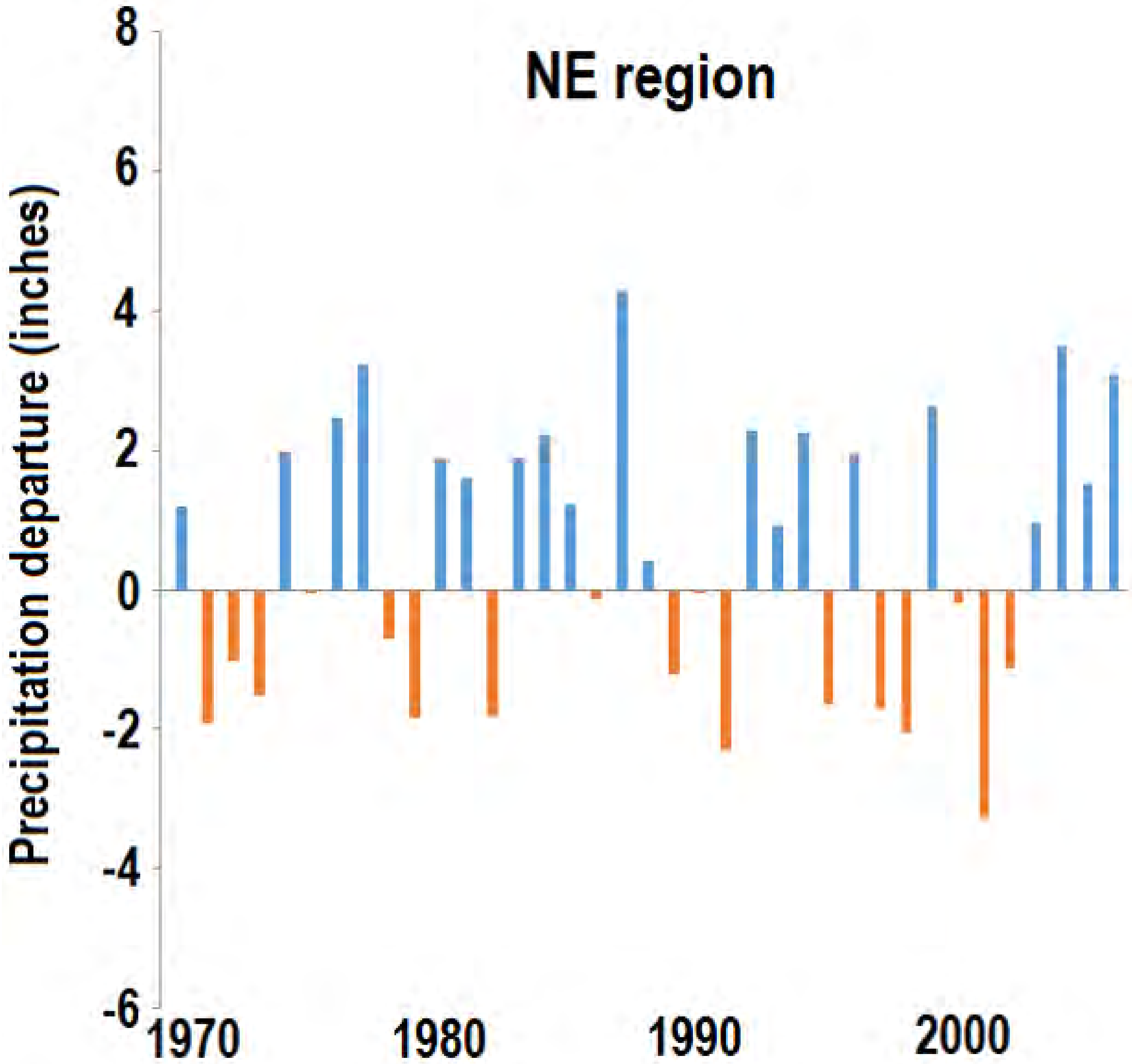
Central region





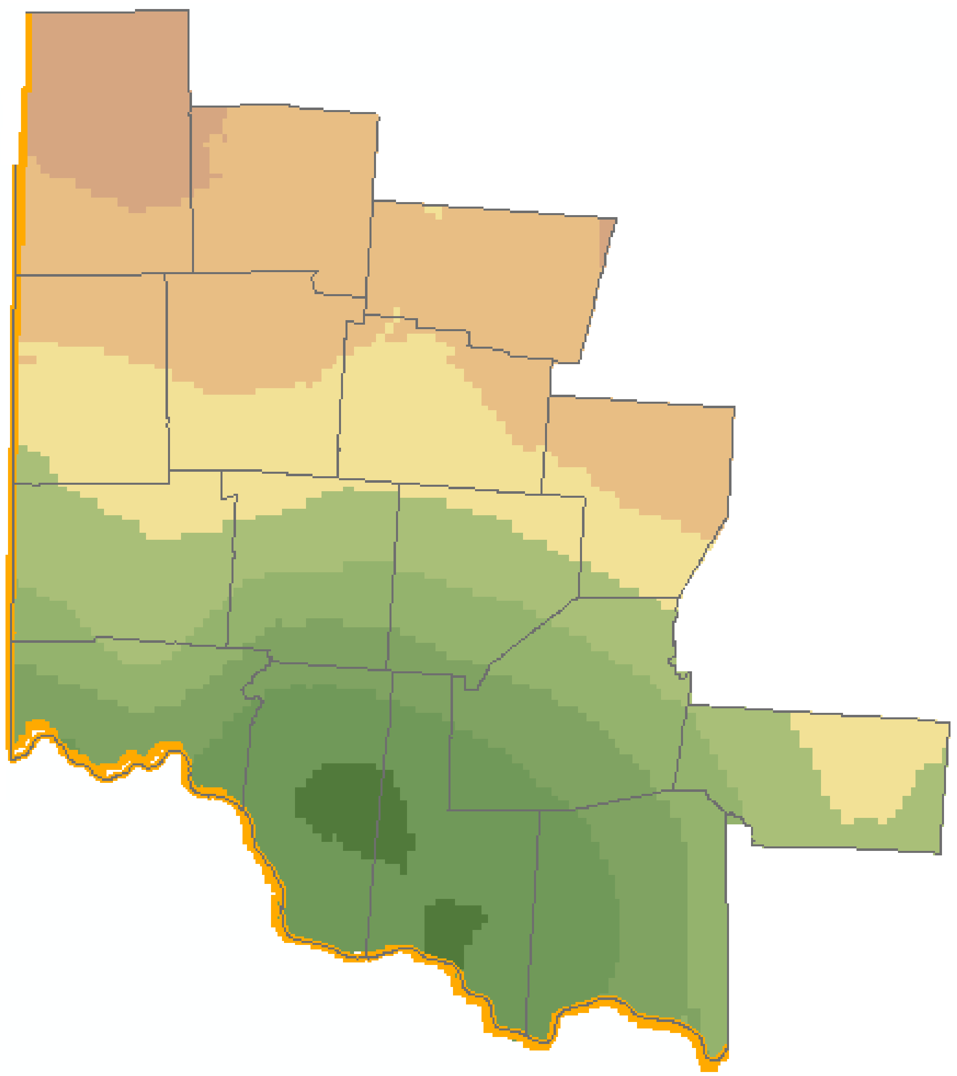
Annual precipitation trends by region

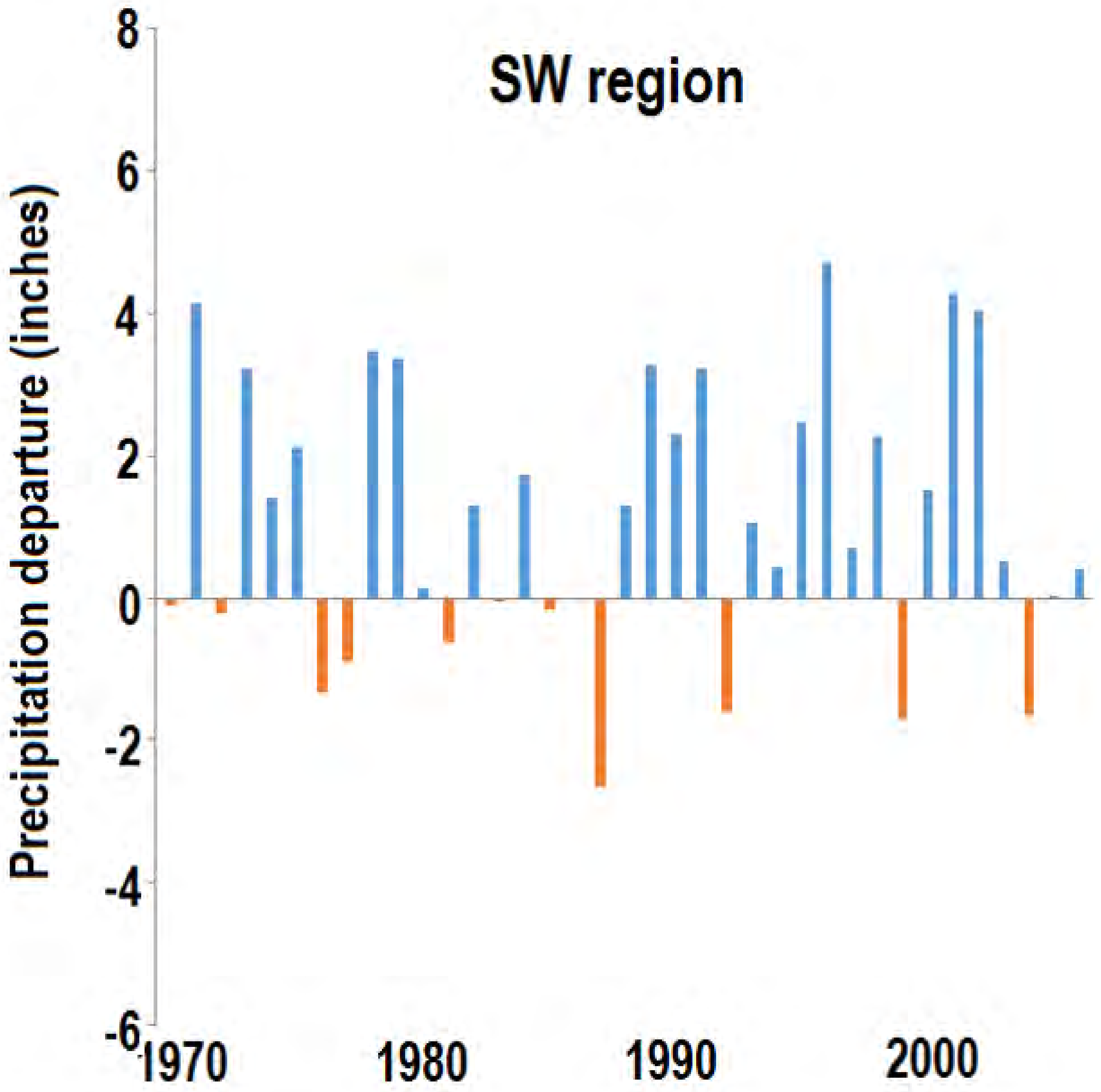




Annual precipitation trends by region

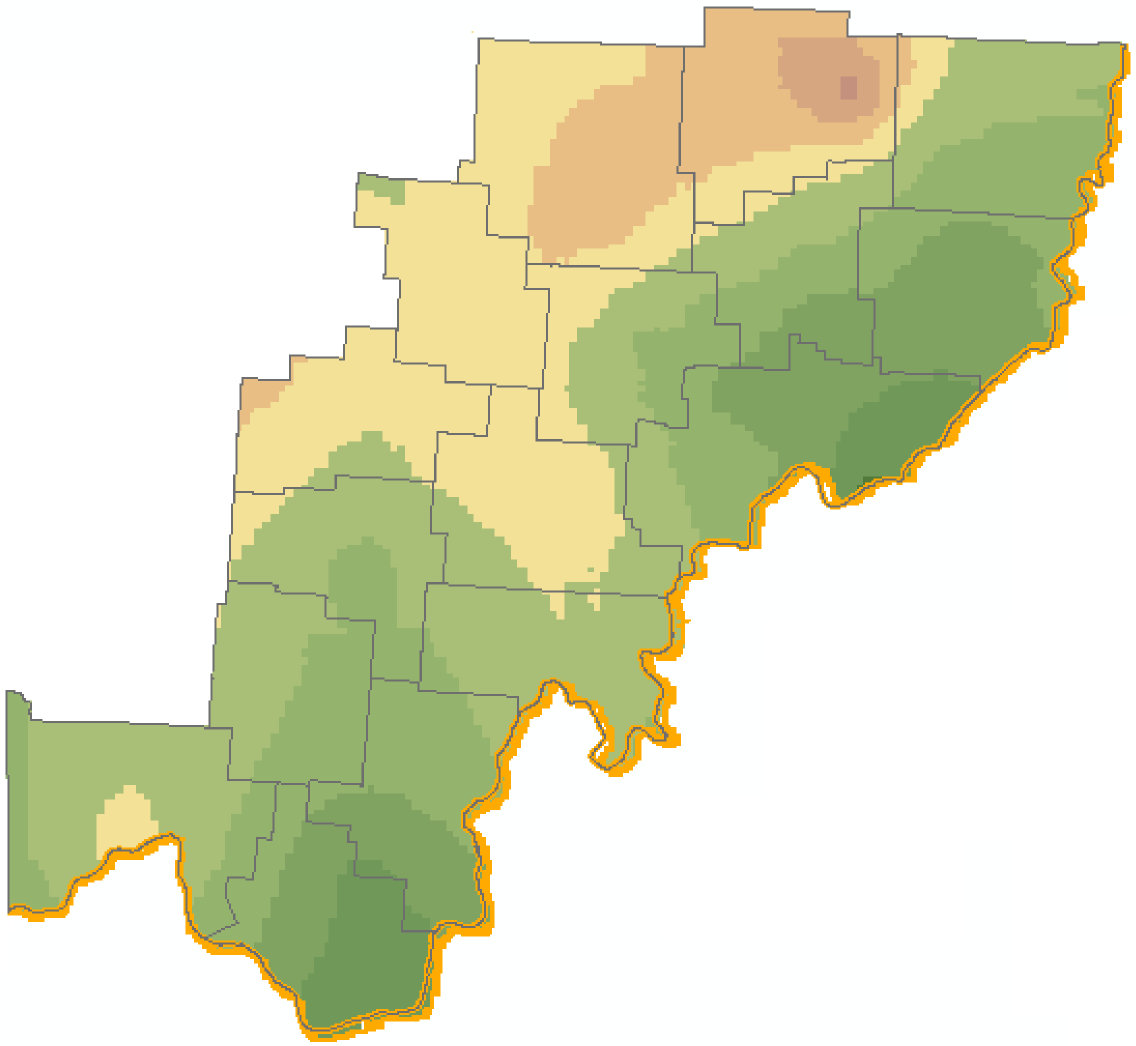
SW region

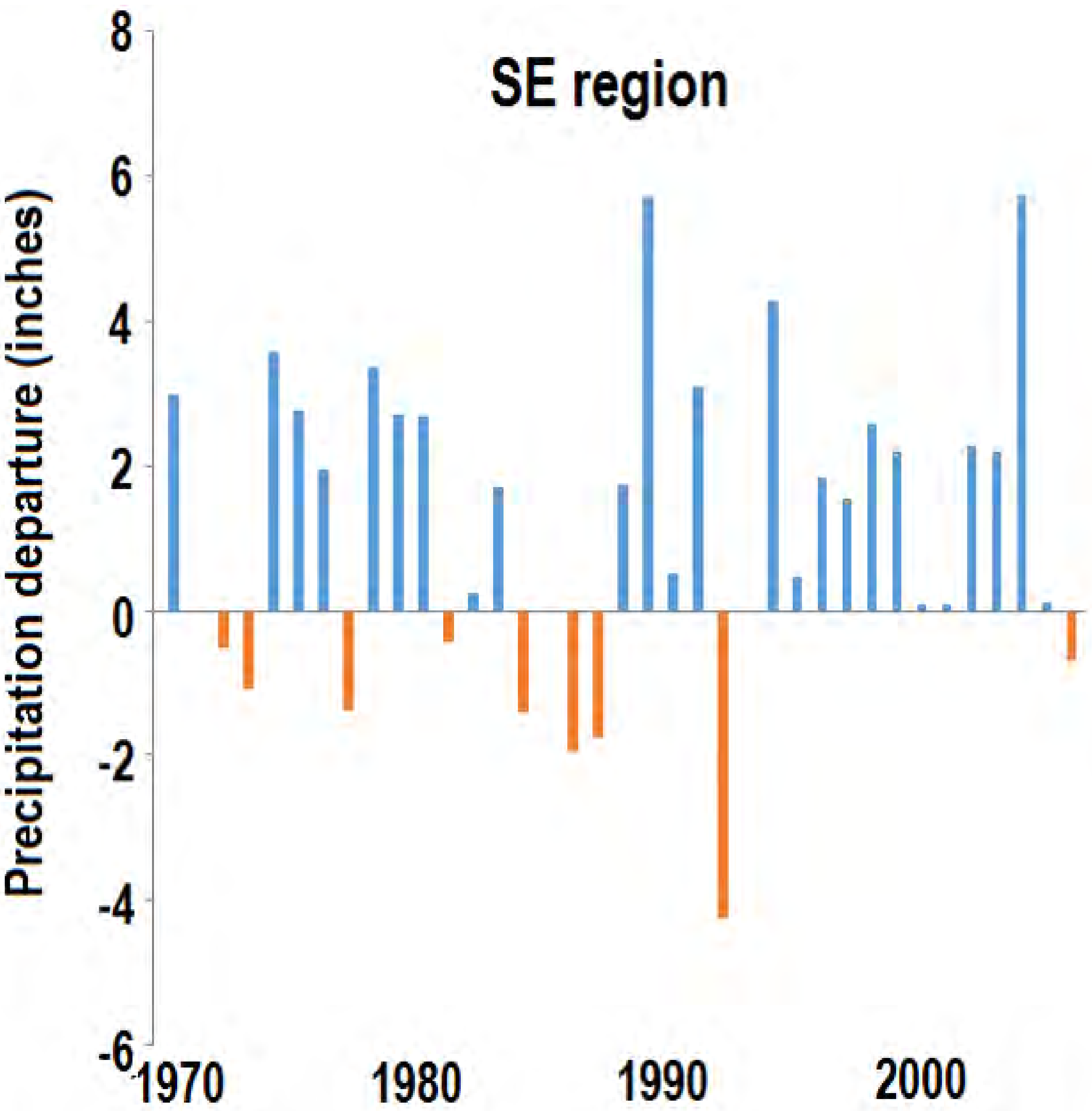




Annual precipitation trends by region

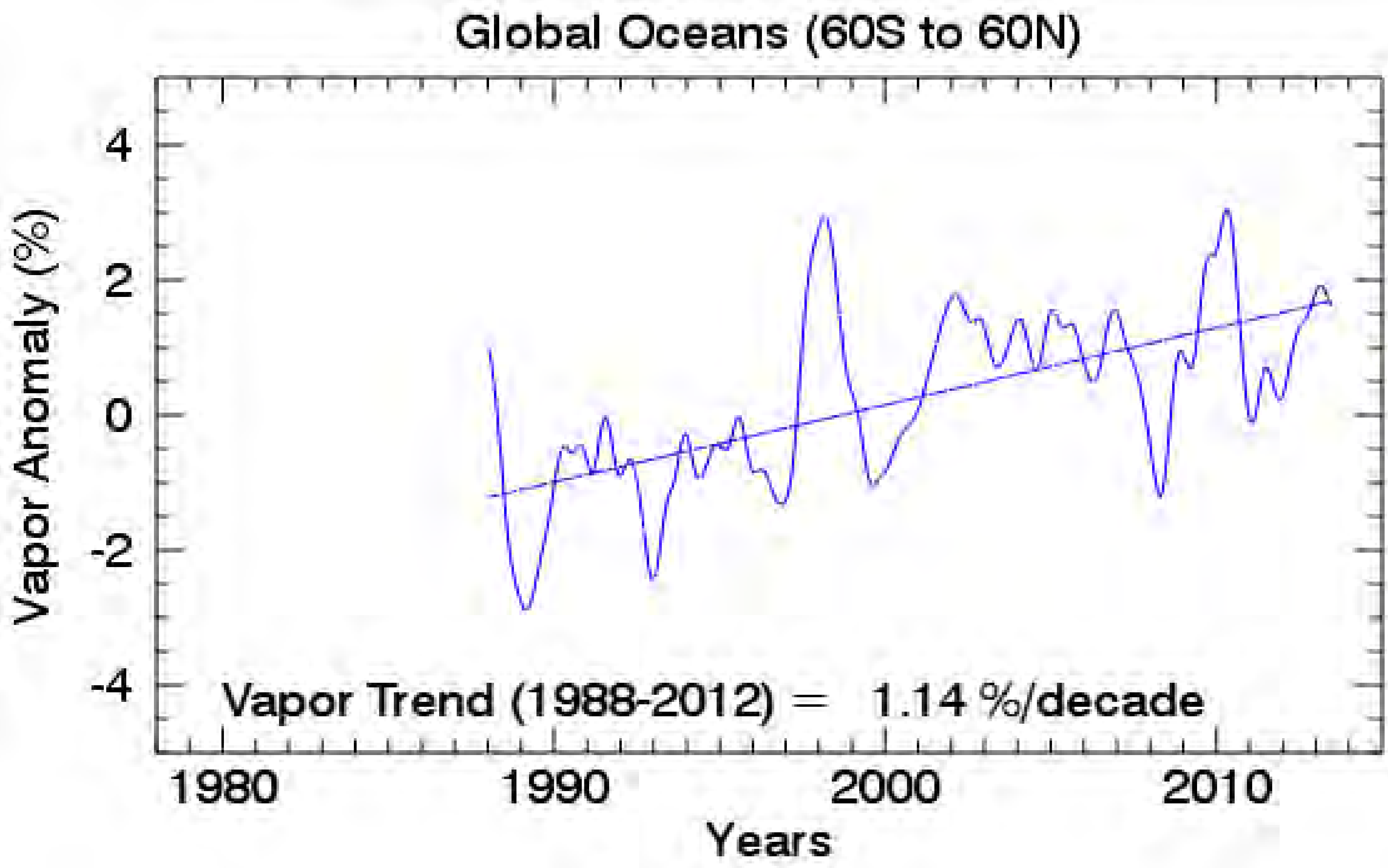
SE region





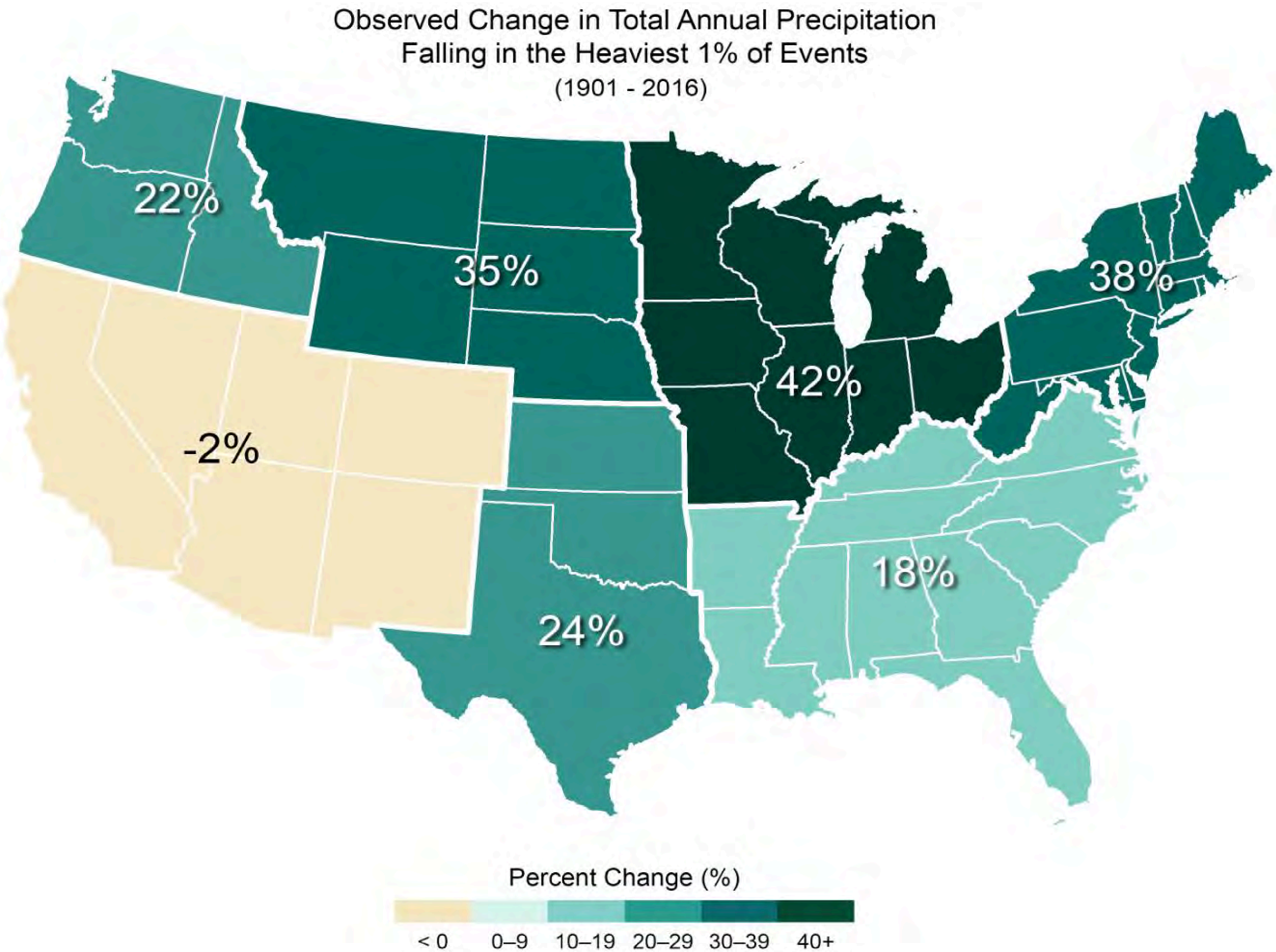
Water vapor anomaly

Reference period: 1979-2008



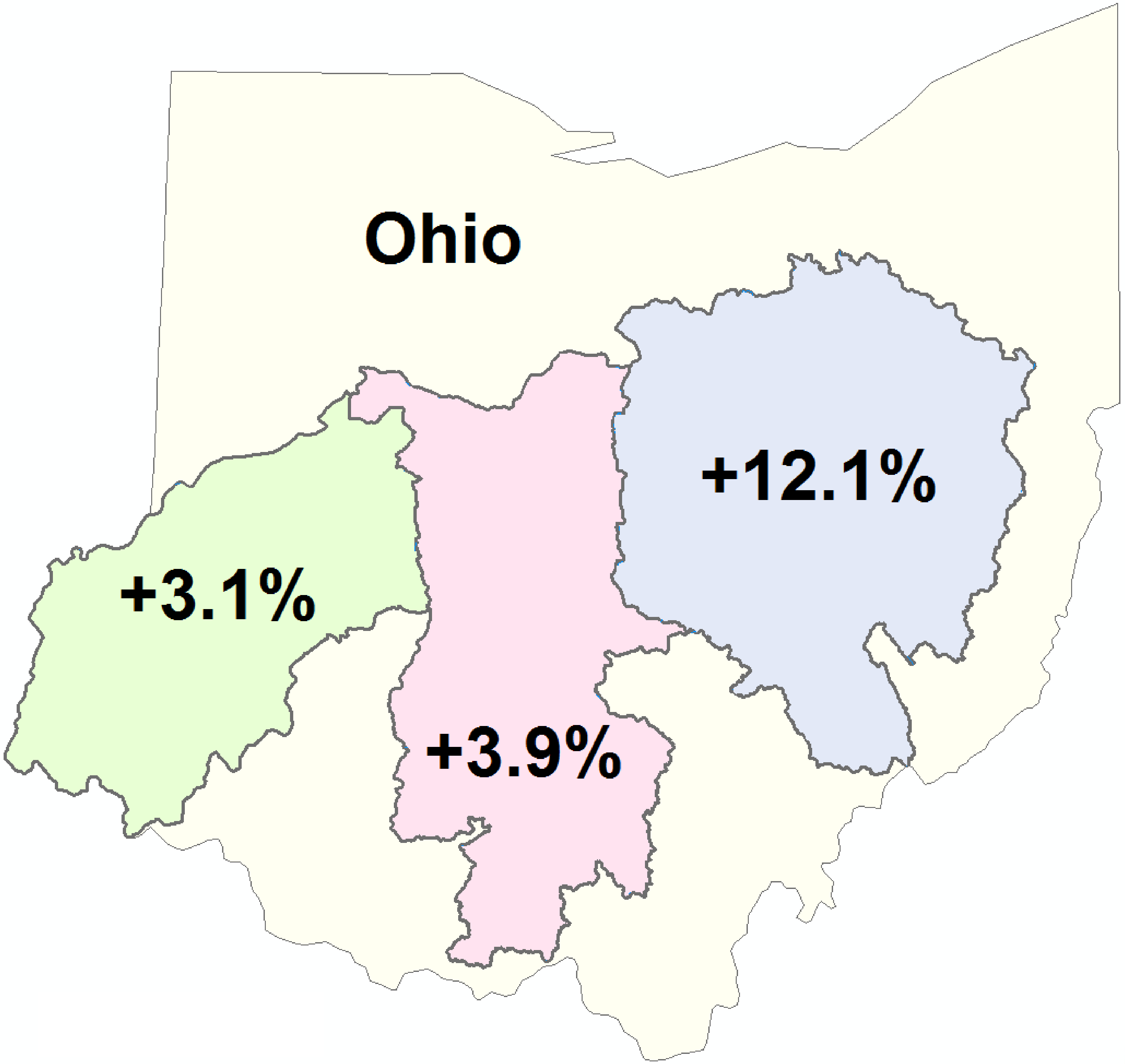
Mears et al. (2007)

Observed change in very heavy precipitation

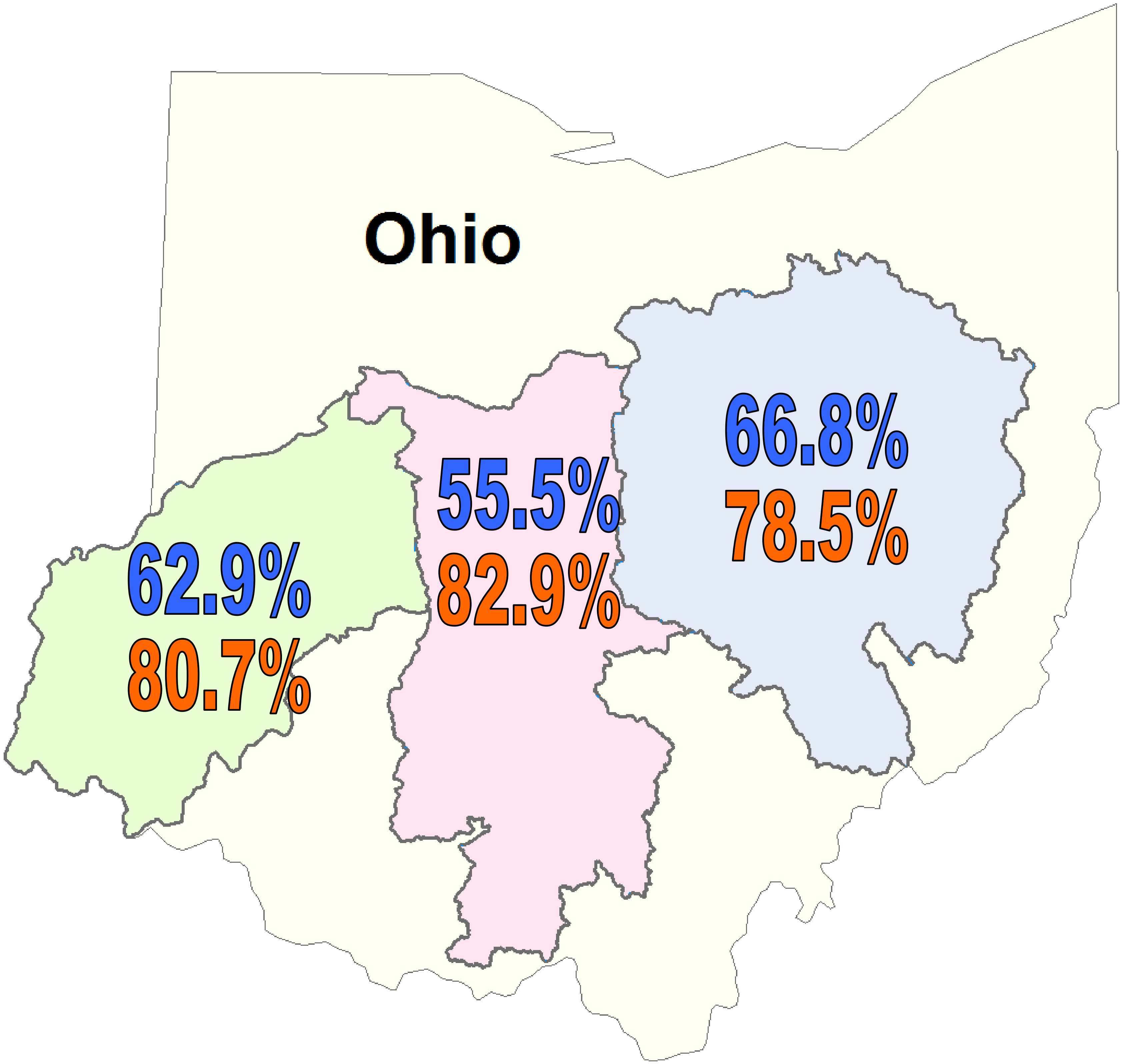


Fourth National Climate Assessment Update: (May 2018)

Observed change in very heavy precipitation (2010-2017)

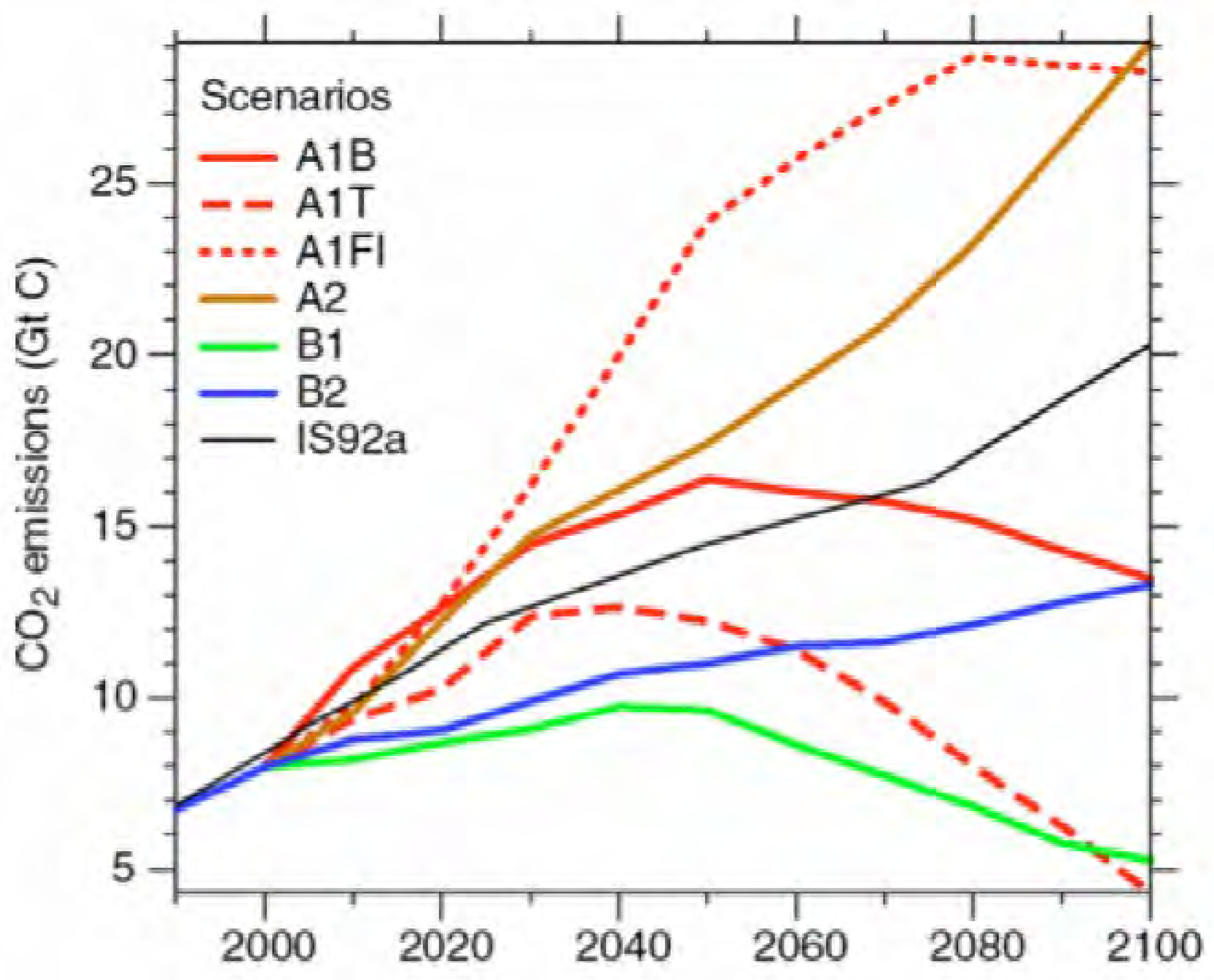


Nutrient flux during heavy rainfall conditions



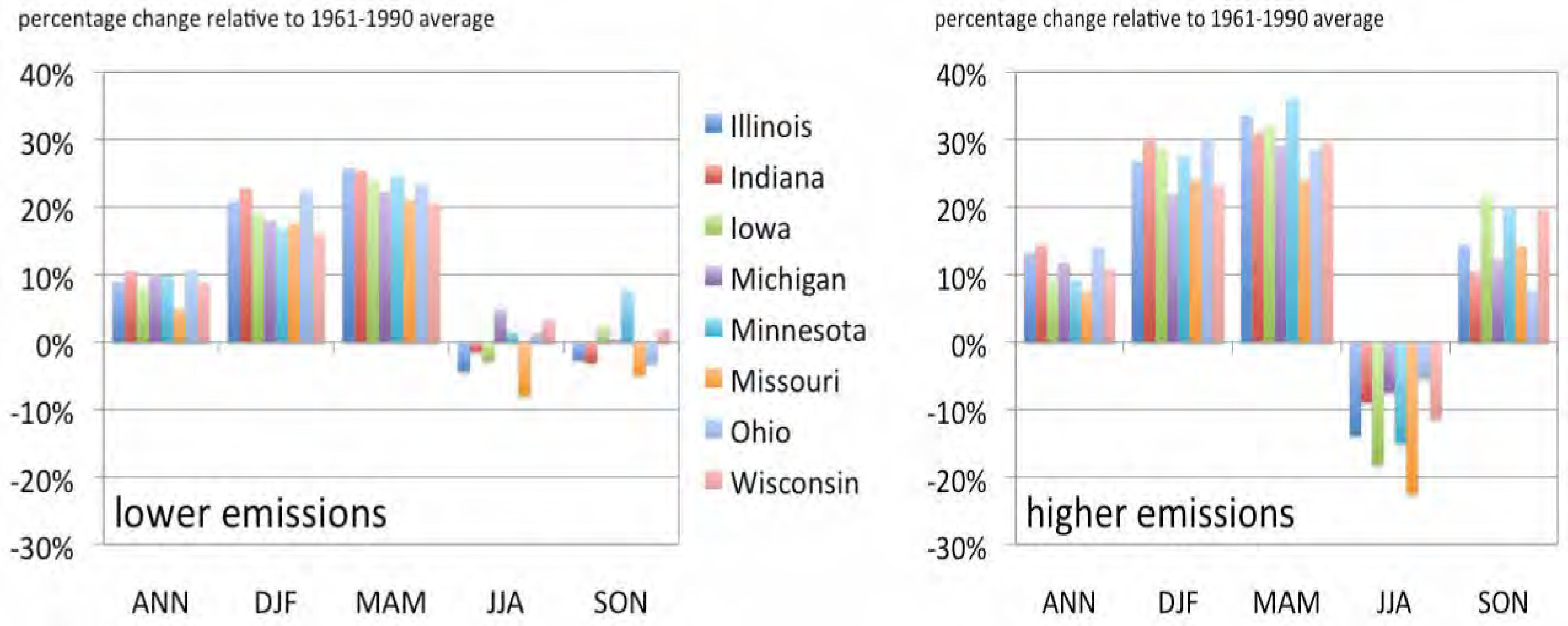
Projections of future changes

SRES emissions scenarios



Nakicenovic et al. (2000)

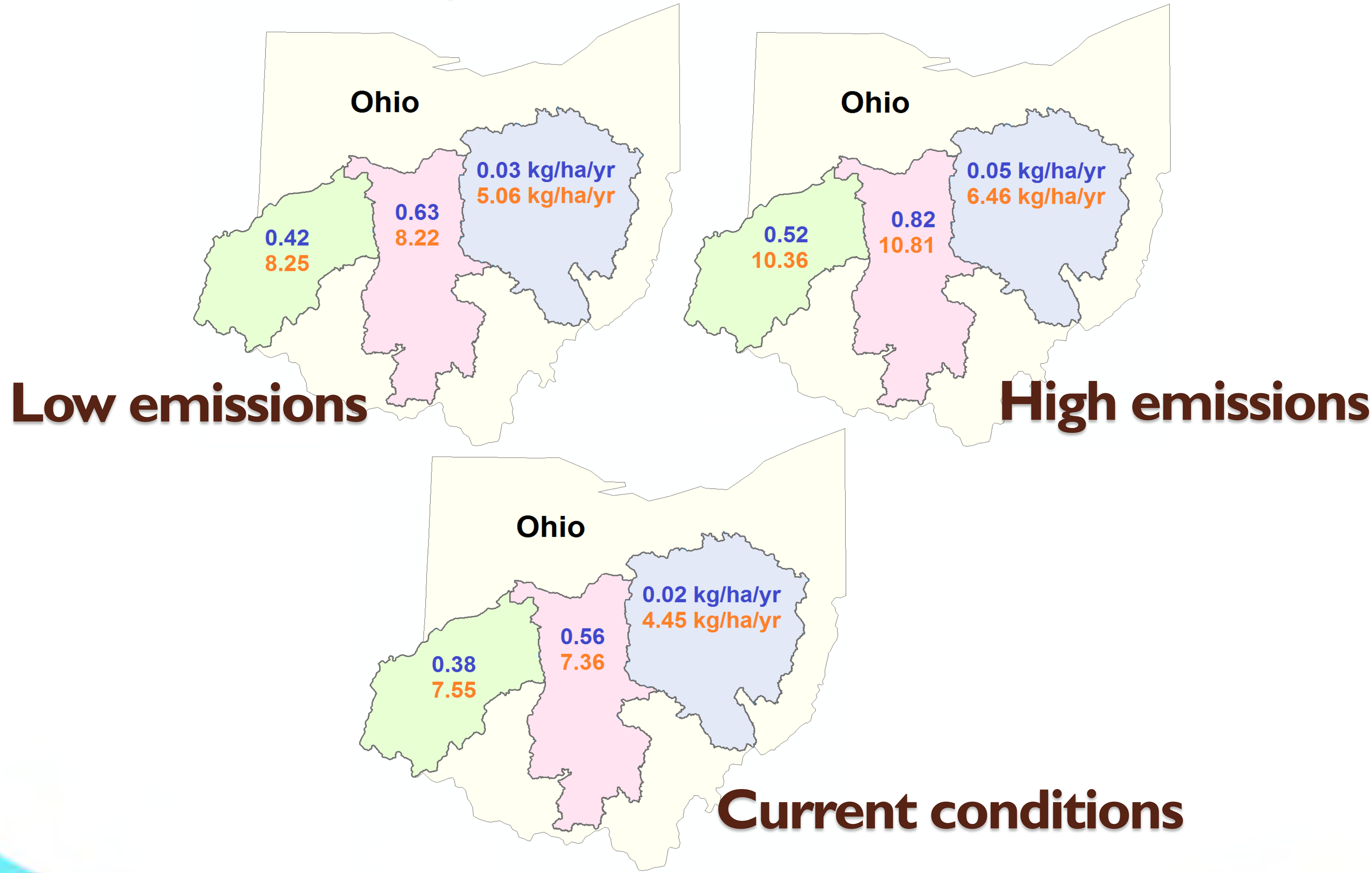
Projection of future temperature changes in the U.S. Midwest



Average annual precipitation increases:
+2-5% in the near term, +0-6% by mid-century, 5-14% by end of century
Much larger shifts at the seasonal scale and
higher frequency of extreme precipitation events

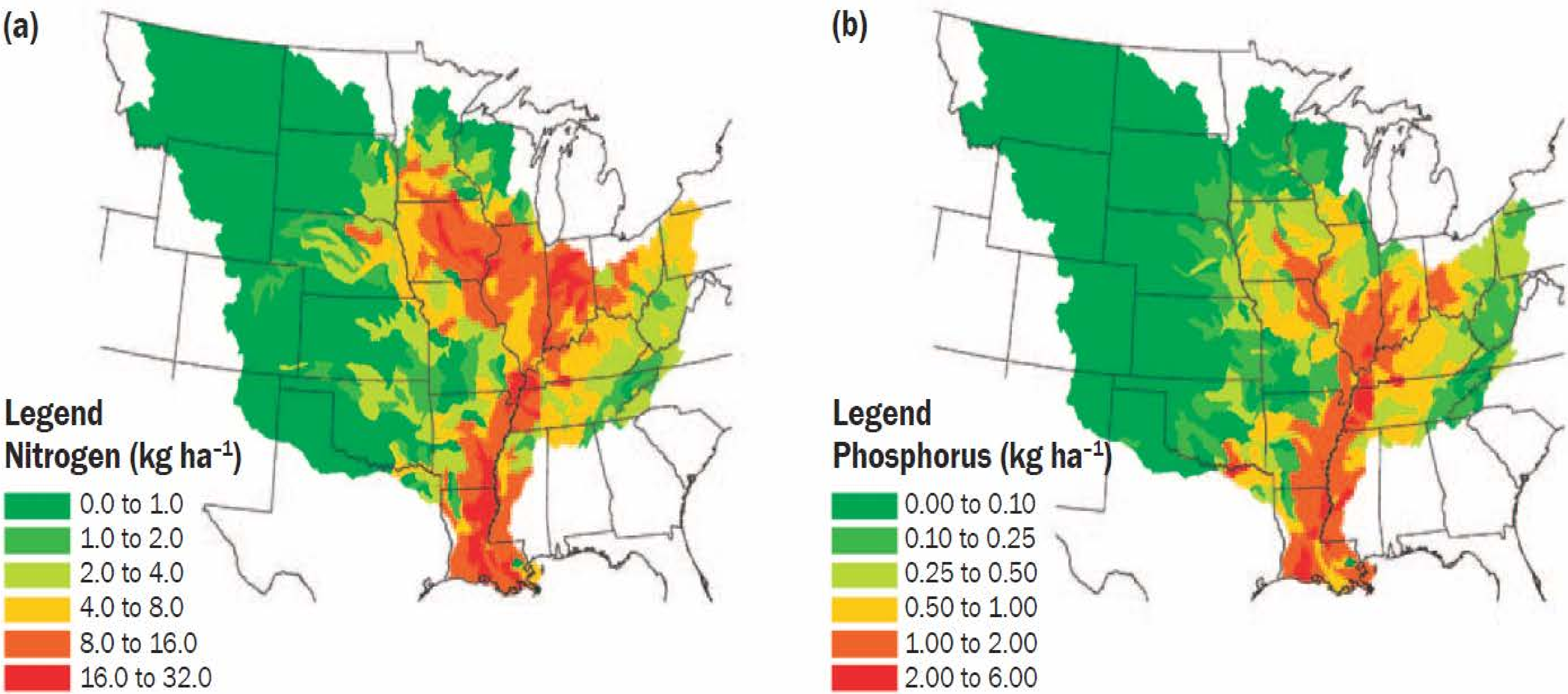
Hayhoe et al. (2000)

Nutrient export rates under various scenarios



Modelled predictions based on current land use

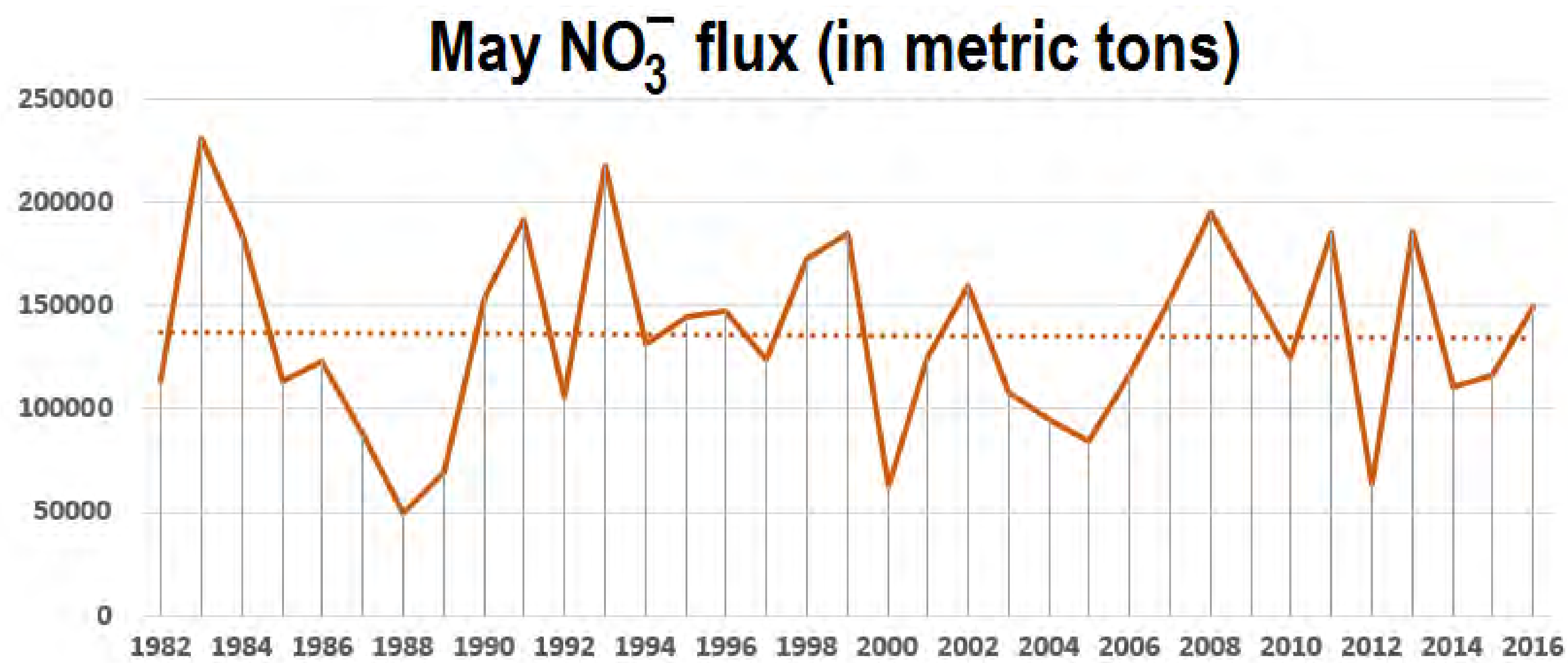
(a) Nitrogen and (b) phosphorus yields from the landscape (all land uses) delivered to the Gulf of Mexico as predicted by the Conservation Effects Assessment Project modeling framework.

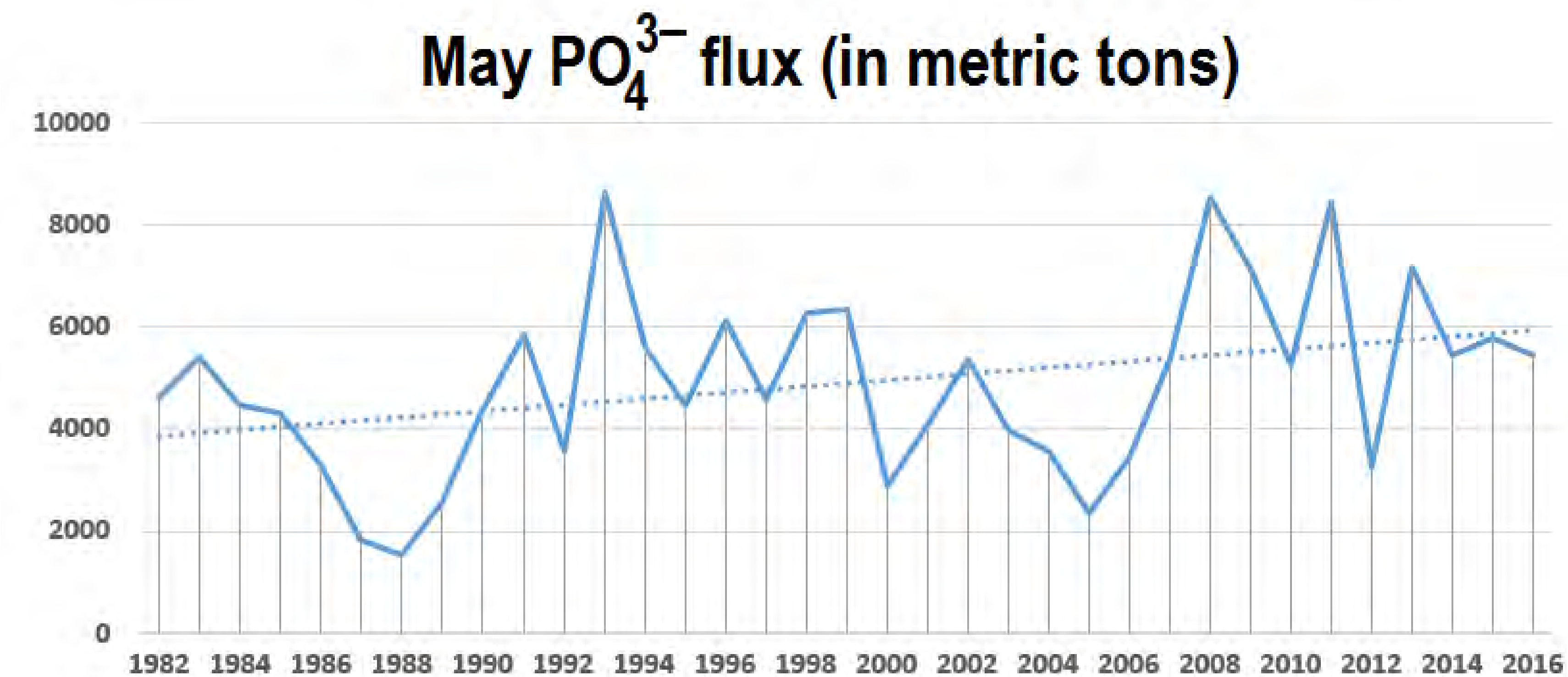


White et al. (2014)


Questions?

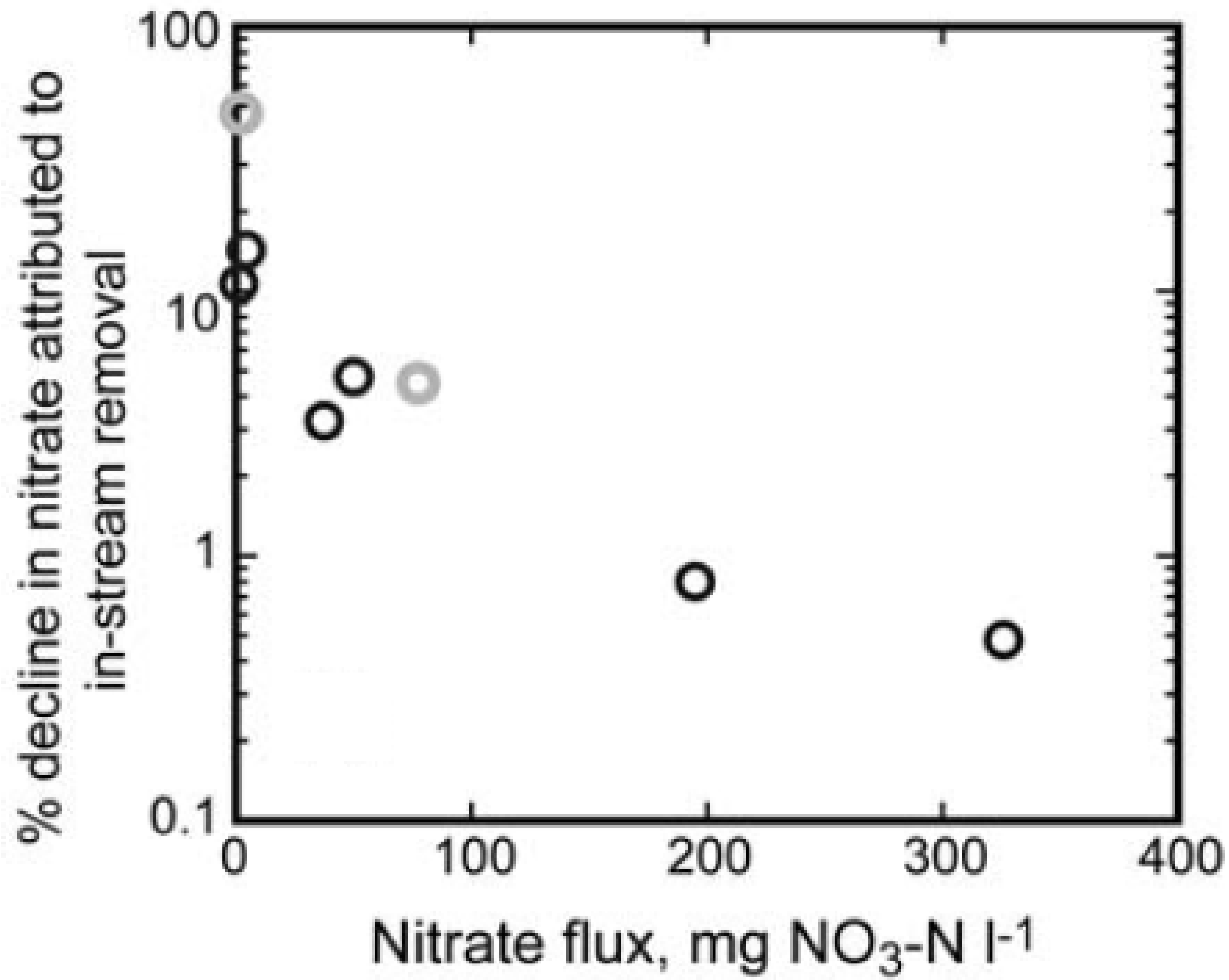
Trends in nutrient fluxes to the Gulf of Mexico





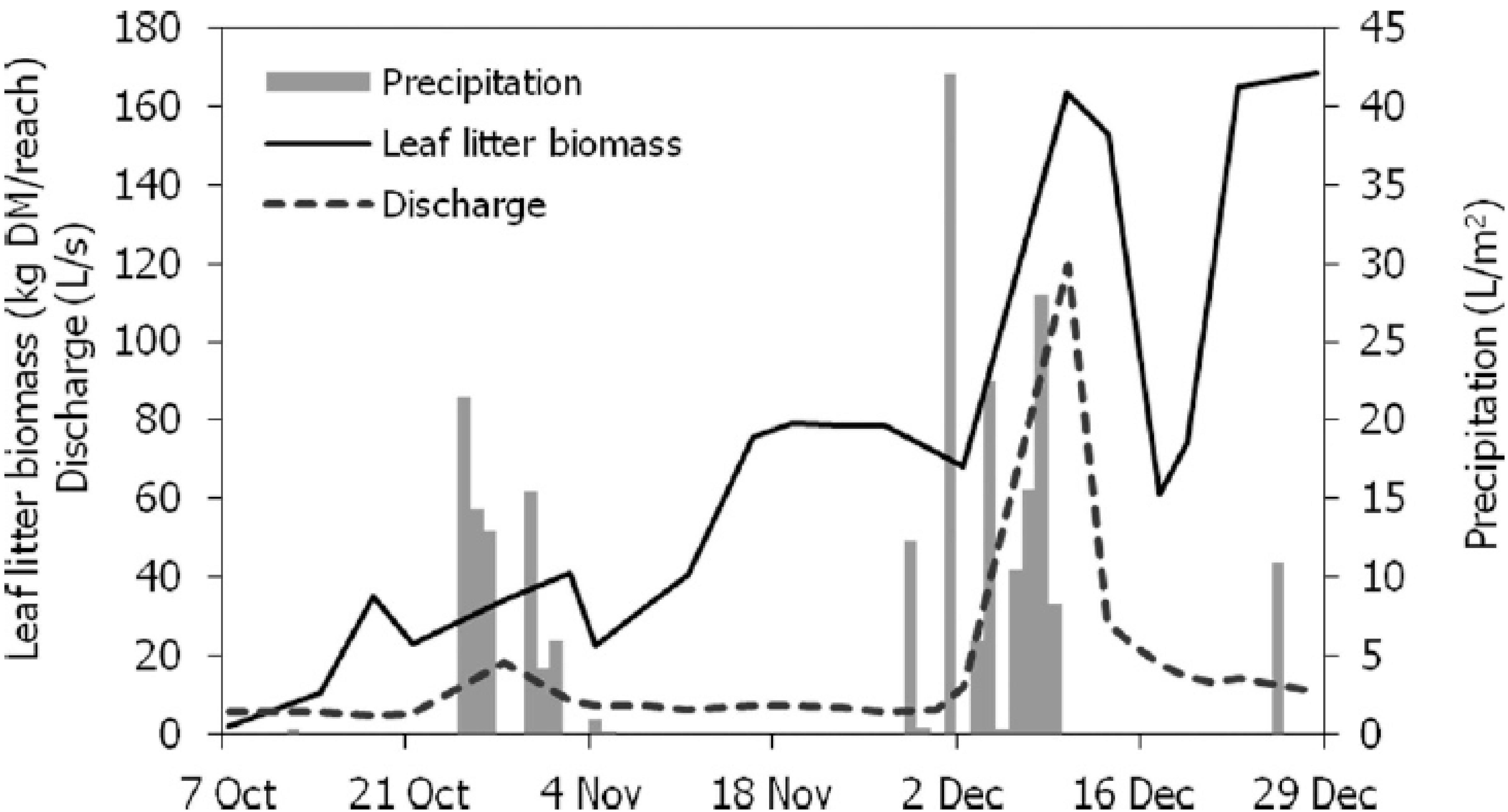
Hypoxia Task Force (2017)

Discharge affects in-stream removal processes



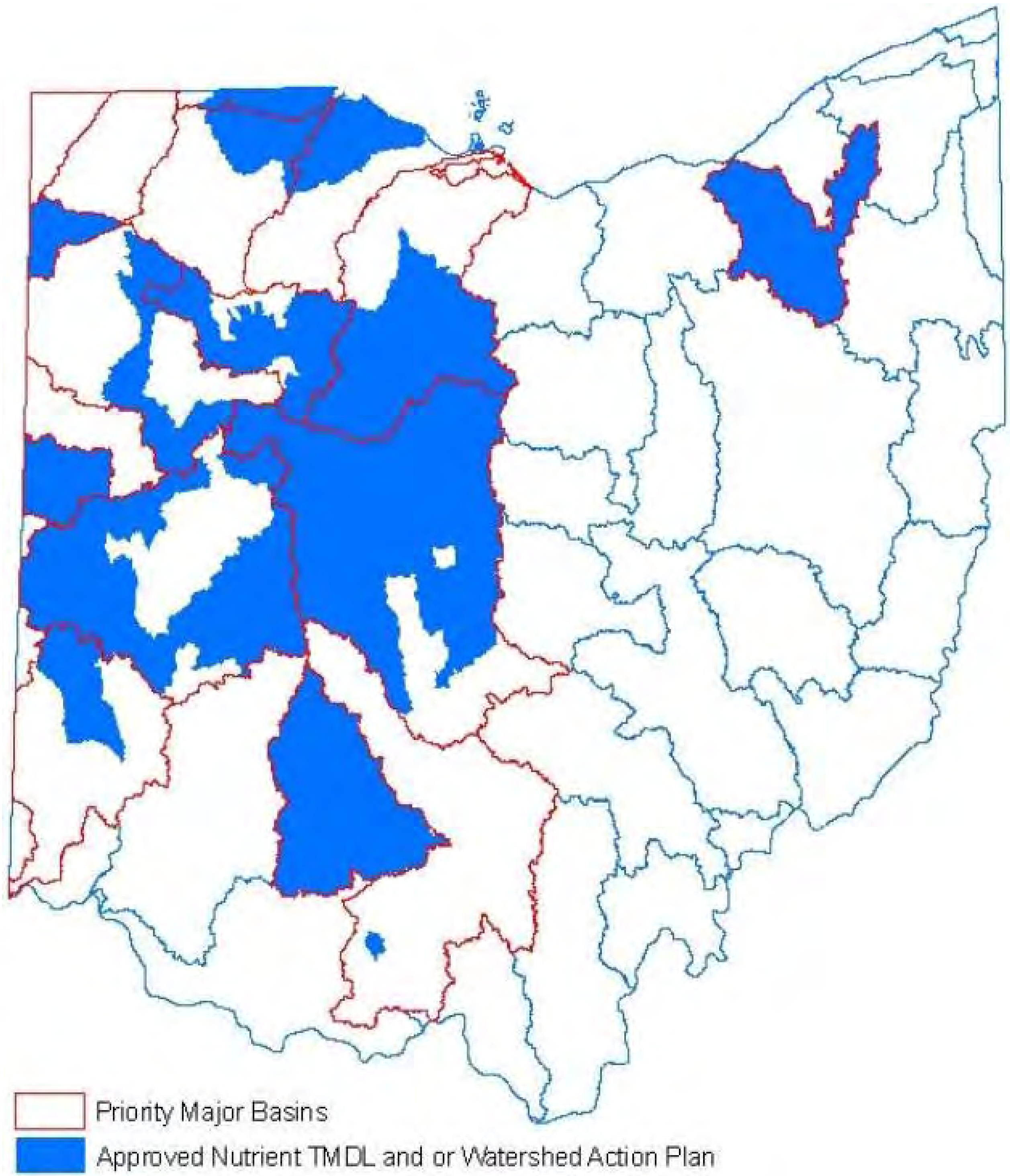
Scanlon et al. (2010)

Relationship between discharge & precipitation

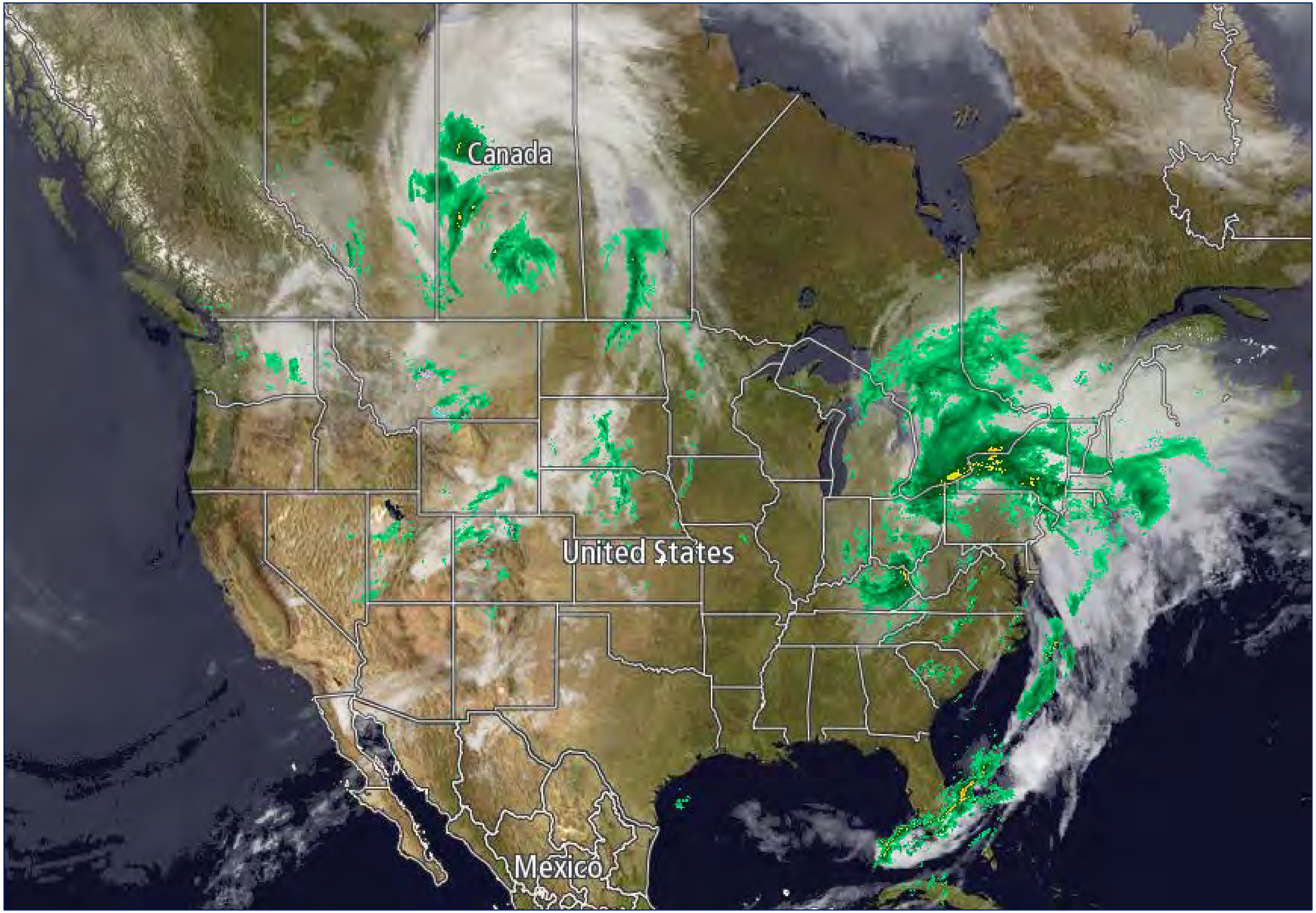


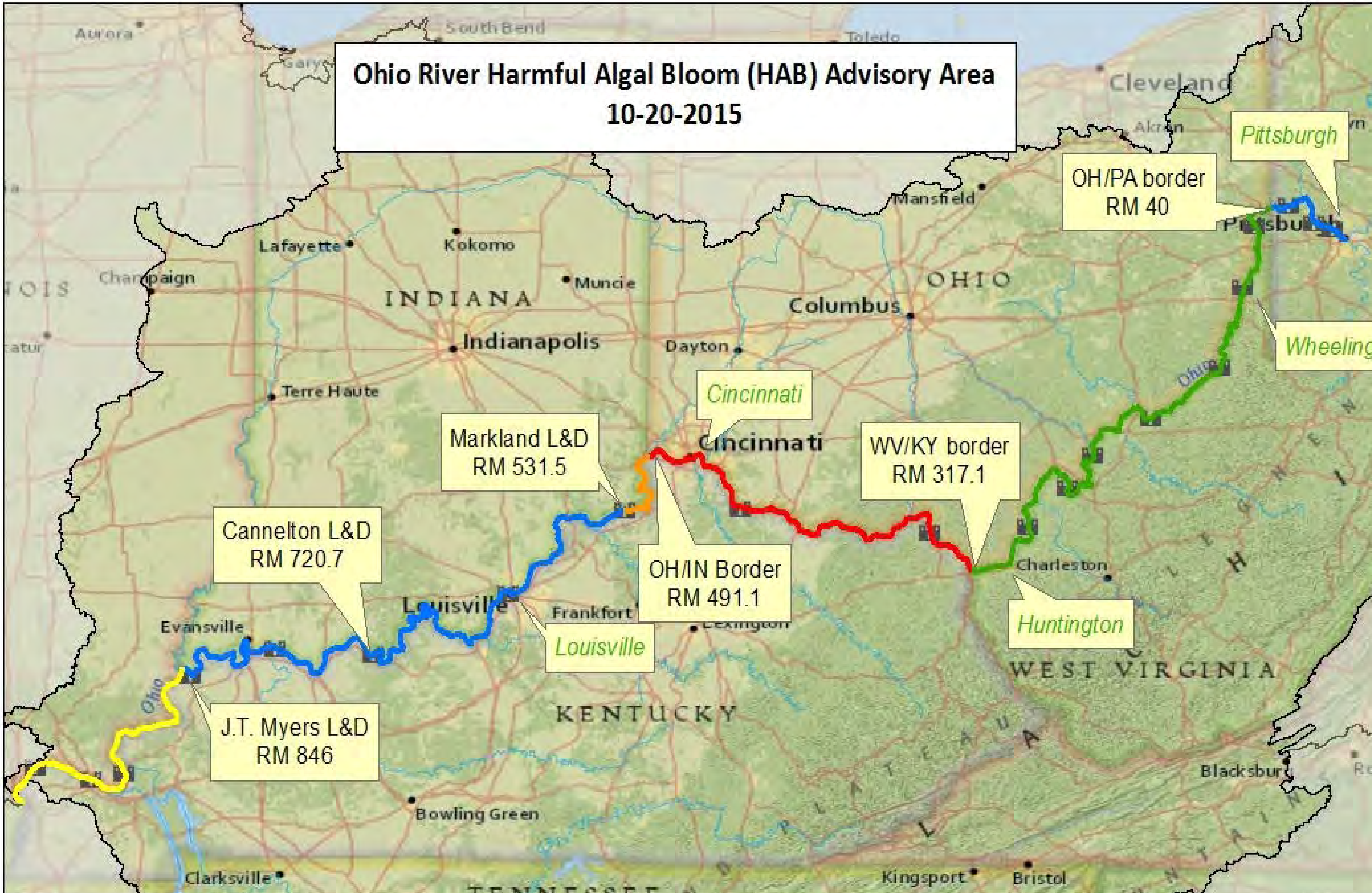
Argerich et al. (2011)

Ohio Nutrient Reduction Strategy



Water vapor over land …

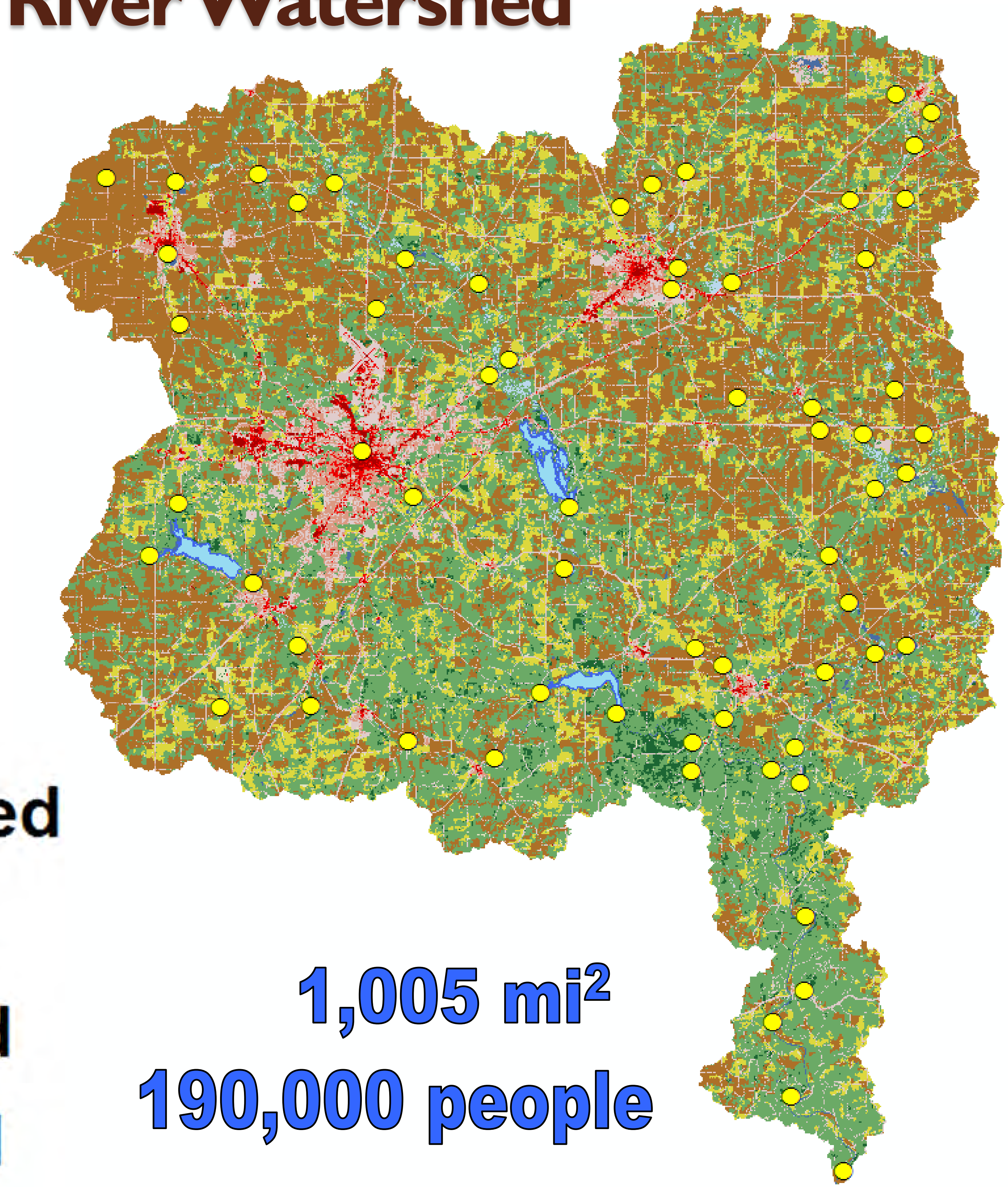




- HAB advisory Issued by both Kentucky and Ohio
- OH/PA border (RM 40) to WV/KY border (RM 317.1) HAB advisory issued by OH side only
- OH/IN border (RM 491.1) Markland L&D (RM 531.5) to Cannelton L&D - HAB advisory issued by KY side only
- Myers L&D (RM 846.0) to Mississippil Confluence (RM 981) - HAB Precautionary Statement issued for IL side only
- Lock and Dams
- Ohio River (No advisory Issued)

ORSANCO (2015)

Mohican River Watershed



12% Developed

14% Pasture

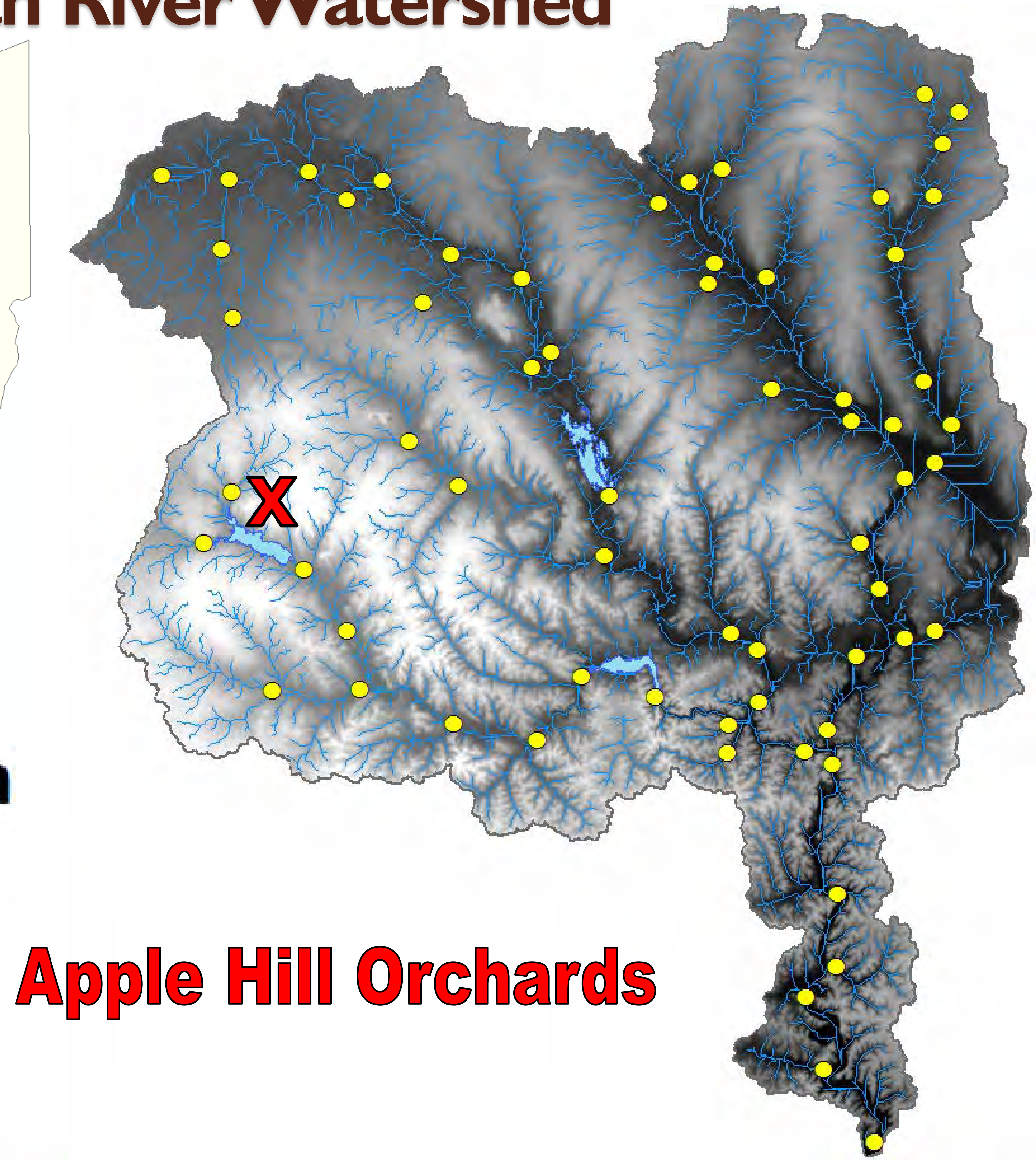
36% Cropland

37% Forested

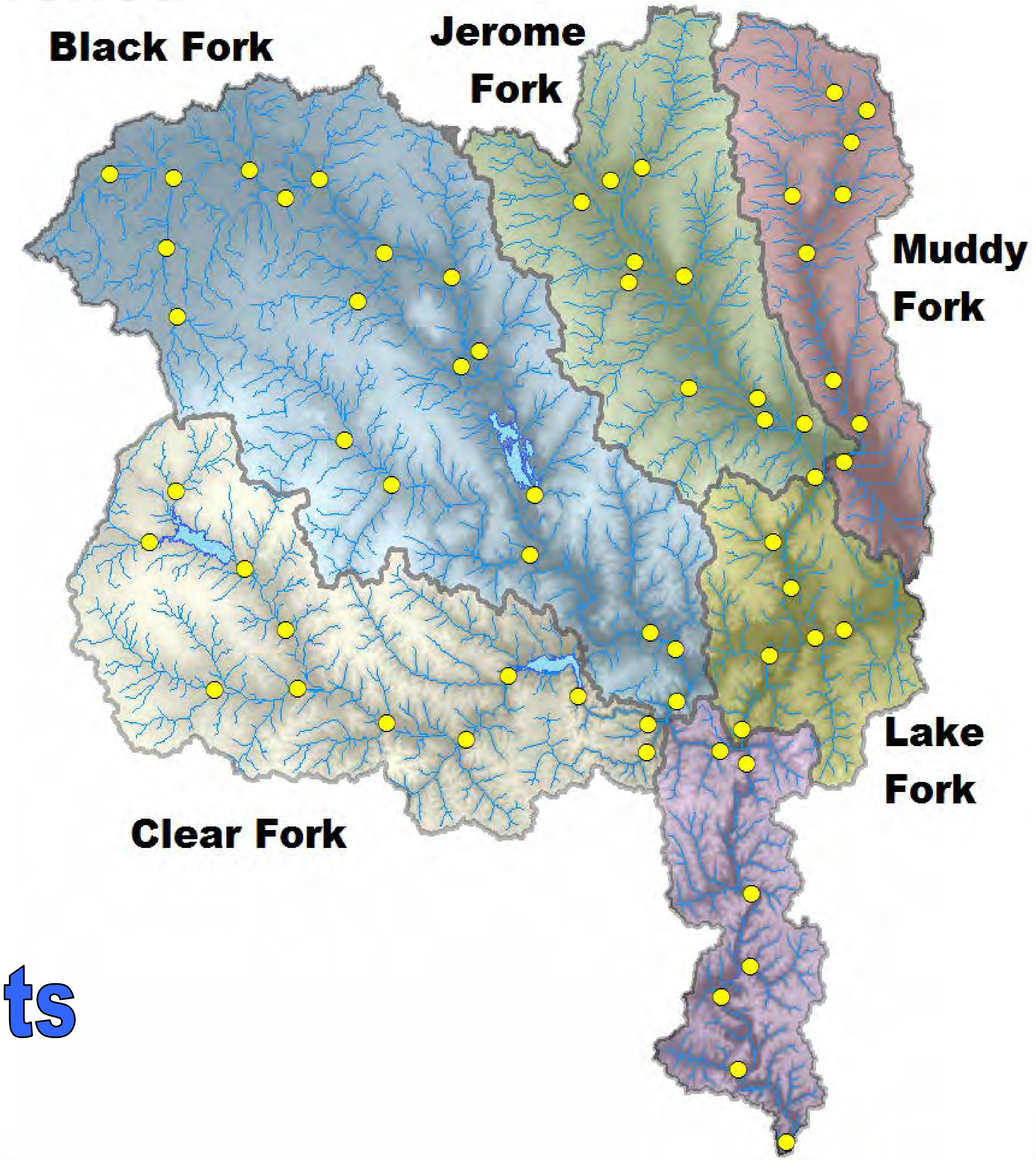
1,005 mi^2

190,000 people

Mohican River Watershed

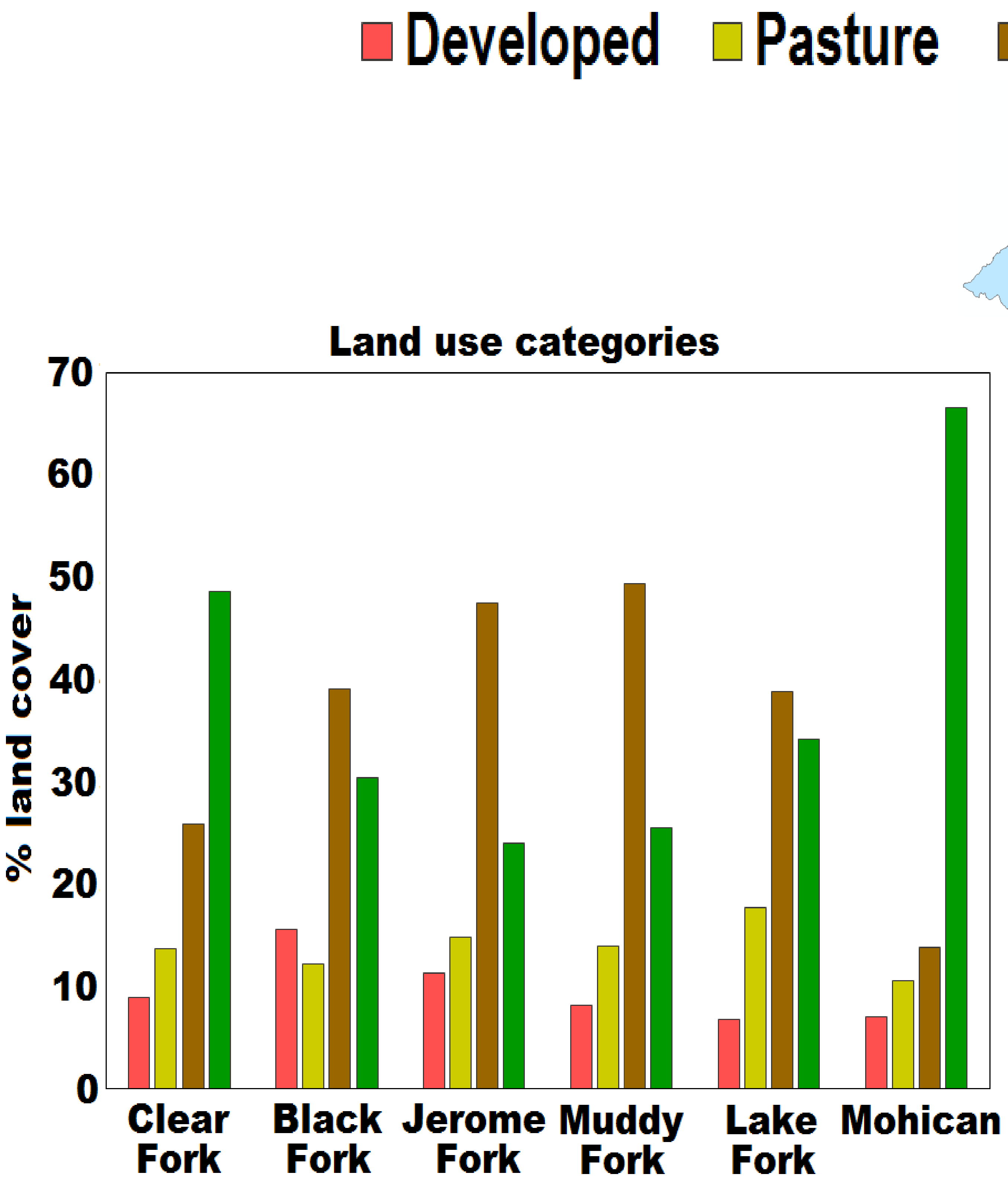


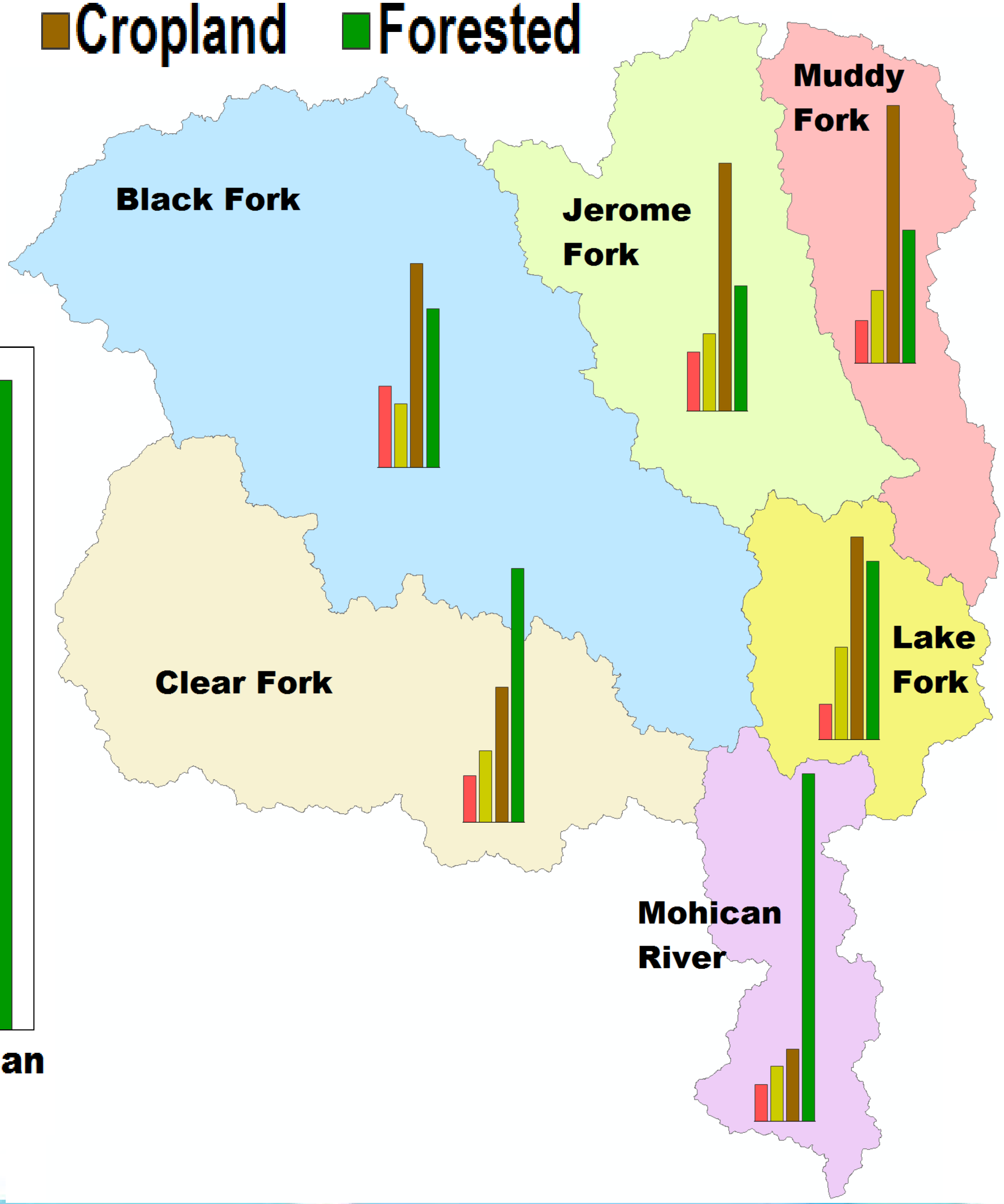
Mohican River Watershed



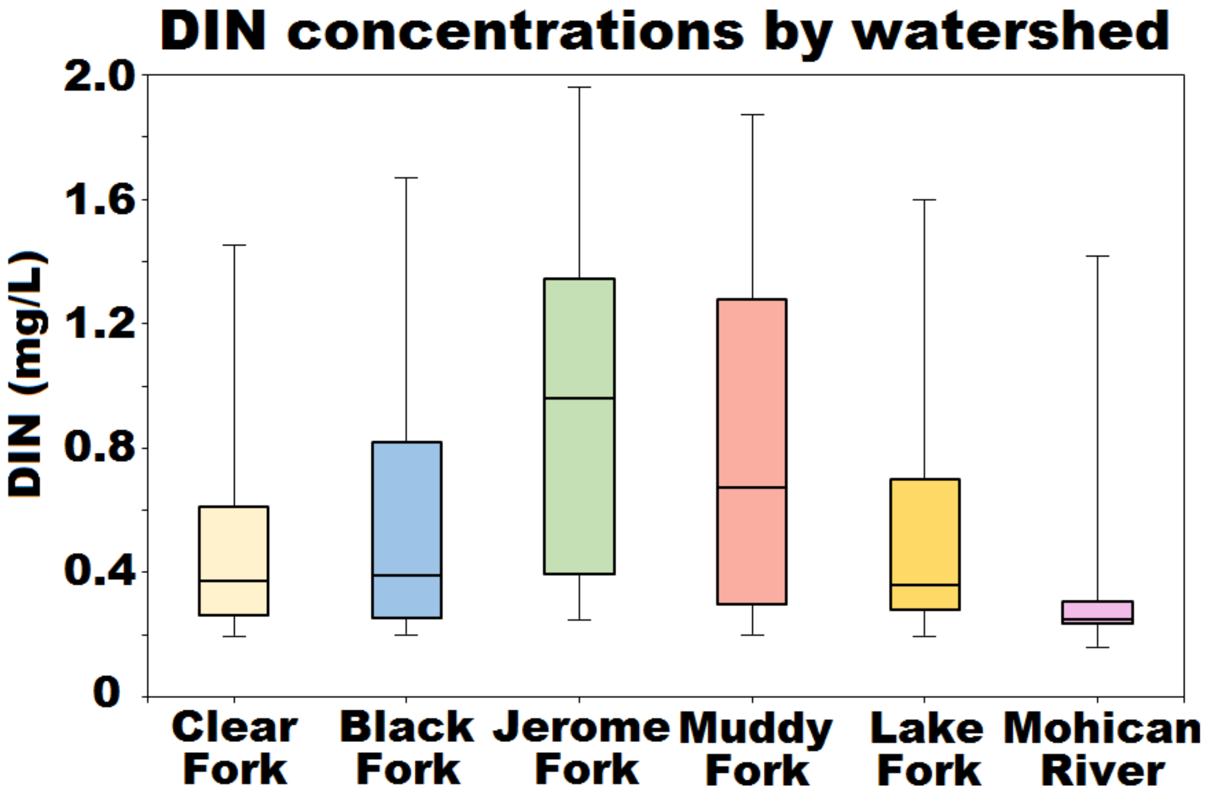
HUC 10 units

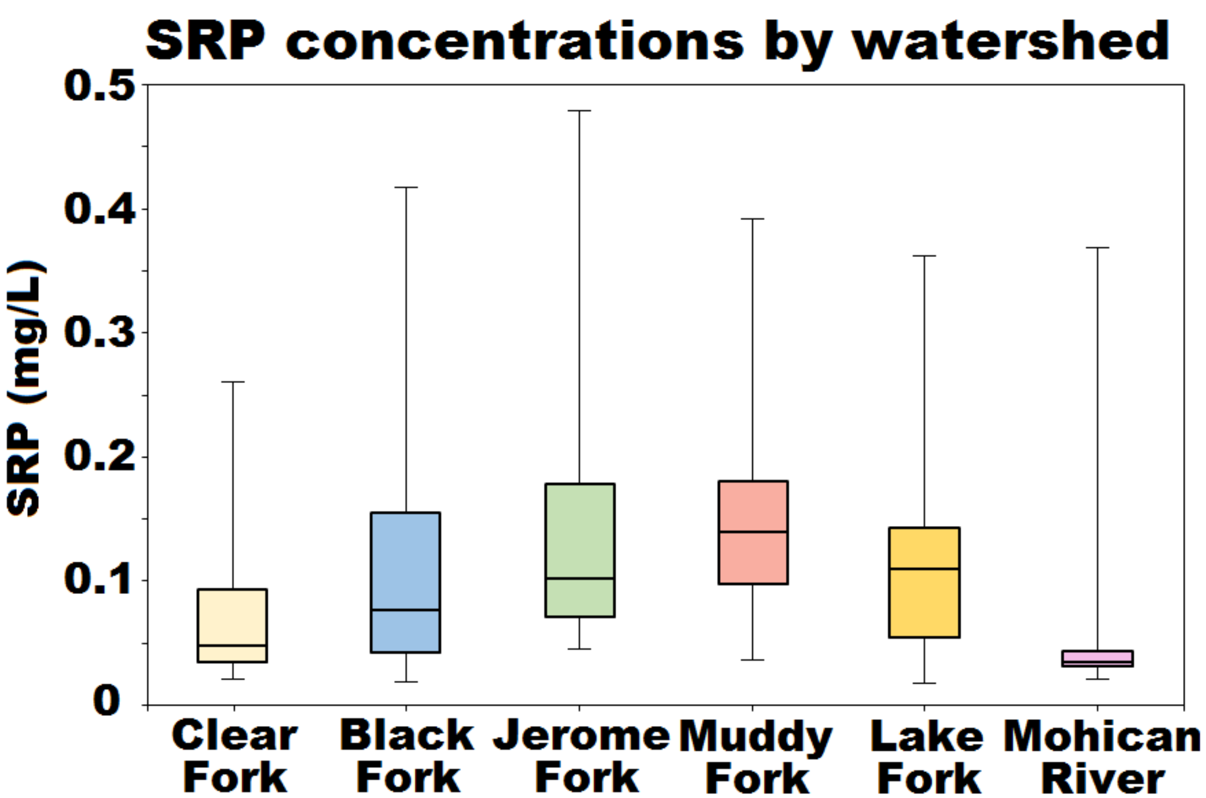
The Mohican is a mixed watershed



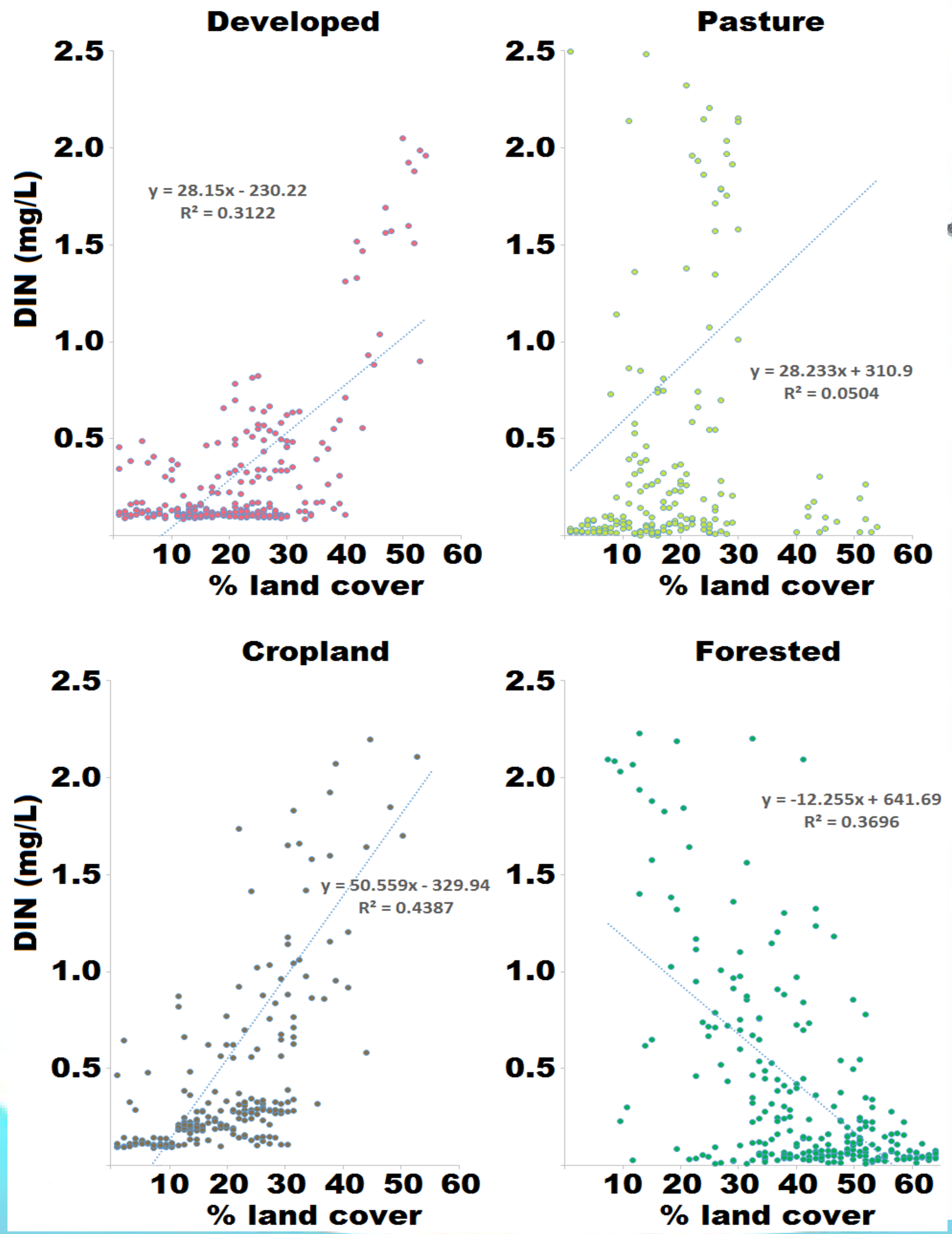


Nutrient concentration by watershed

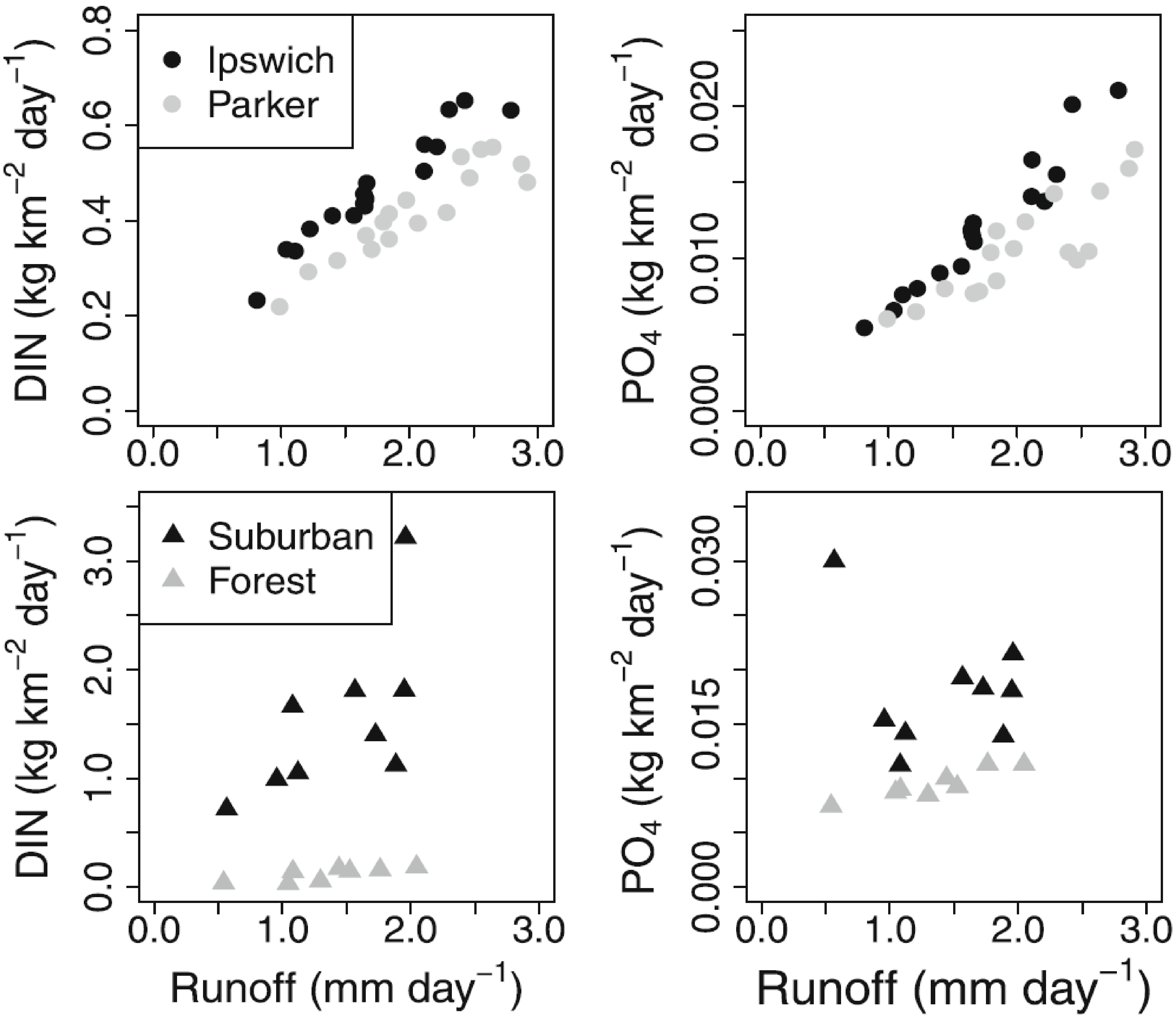




What is the strongest predictor of N levels?

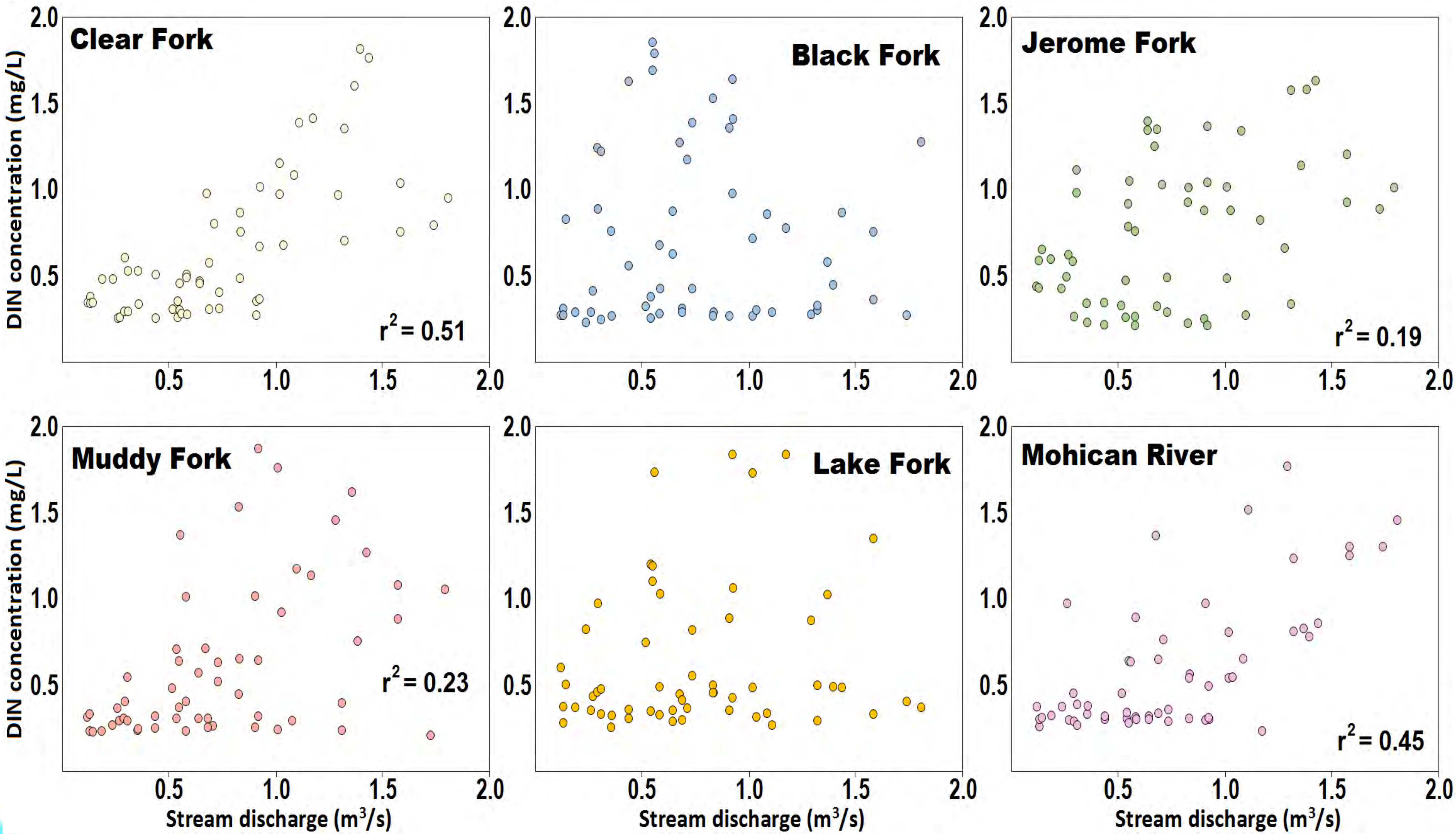


The effect of hydrology

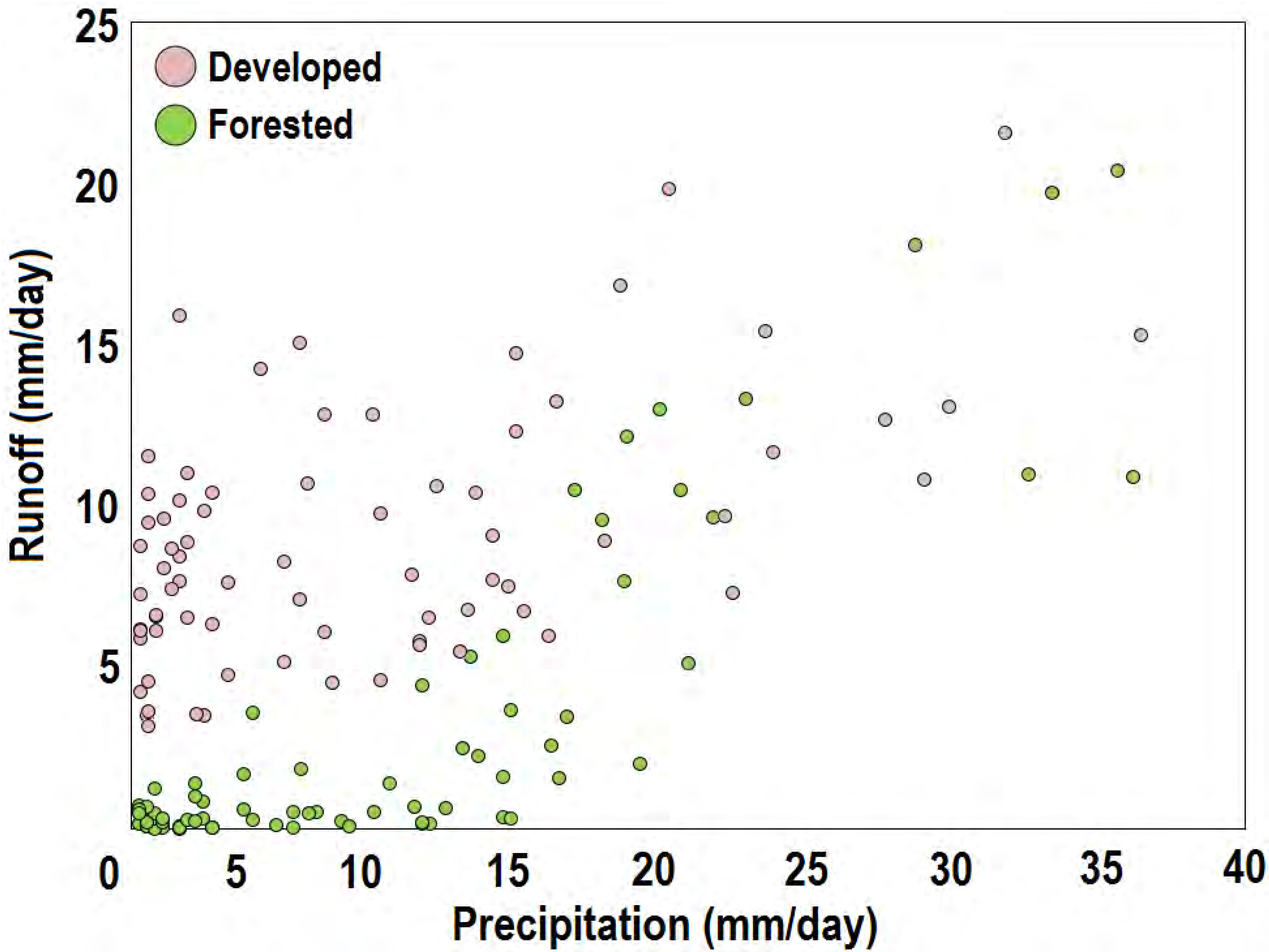


Morse & Wollheim (2014)

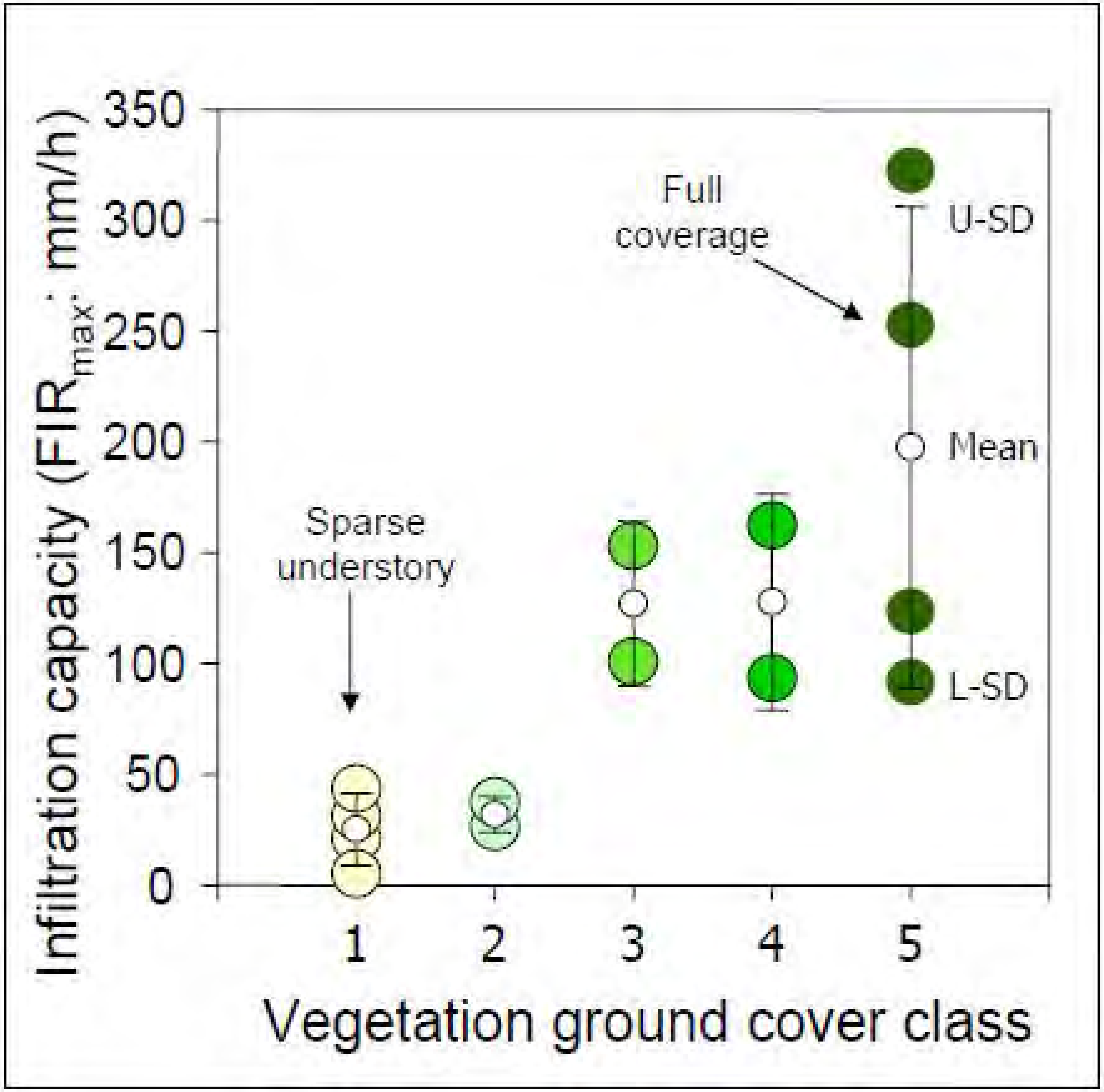
Hydrological controls in the Mohican Watershed



Runoff generation in natural and developed landscapes

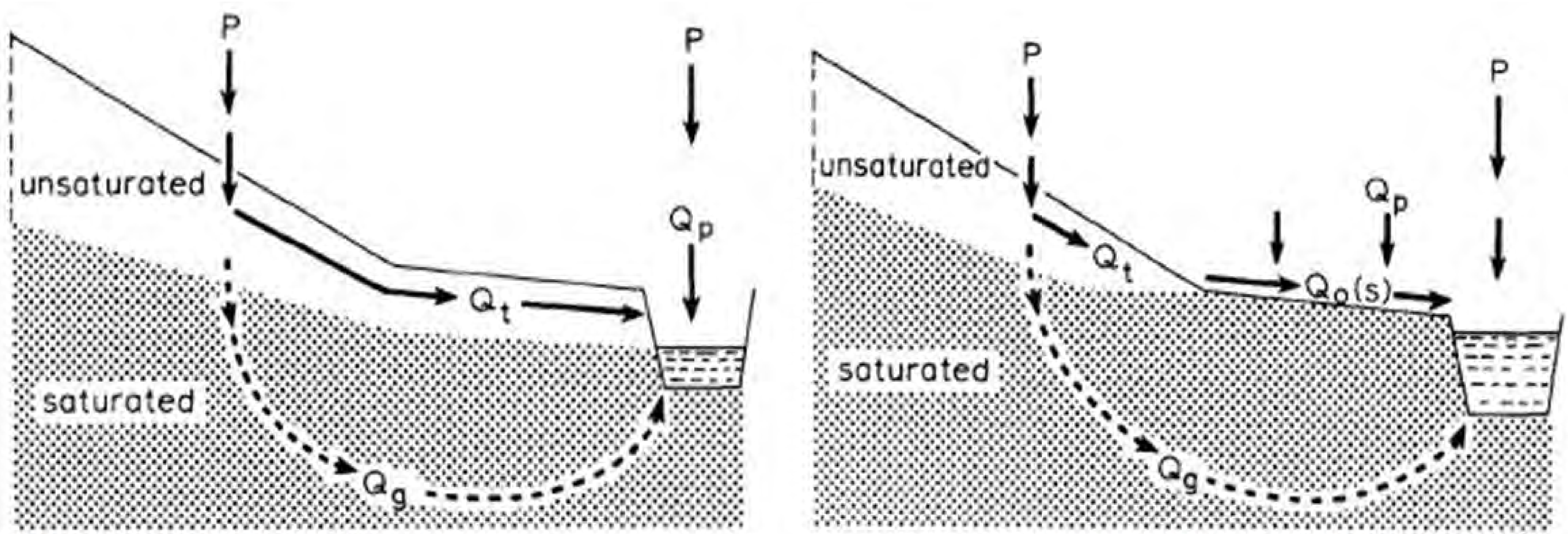


Infiltration and runoff generation



Onda et al. (2010)

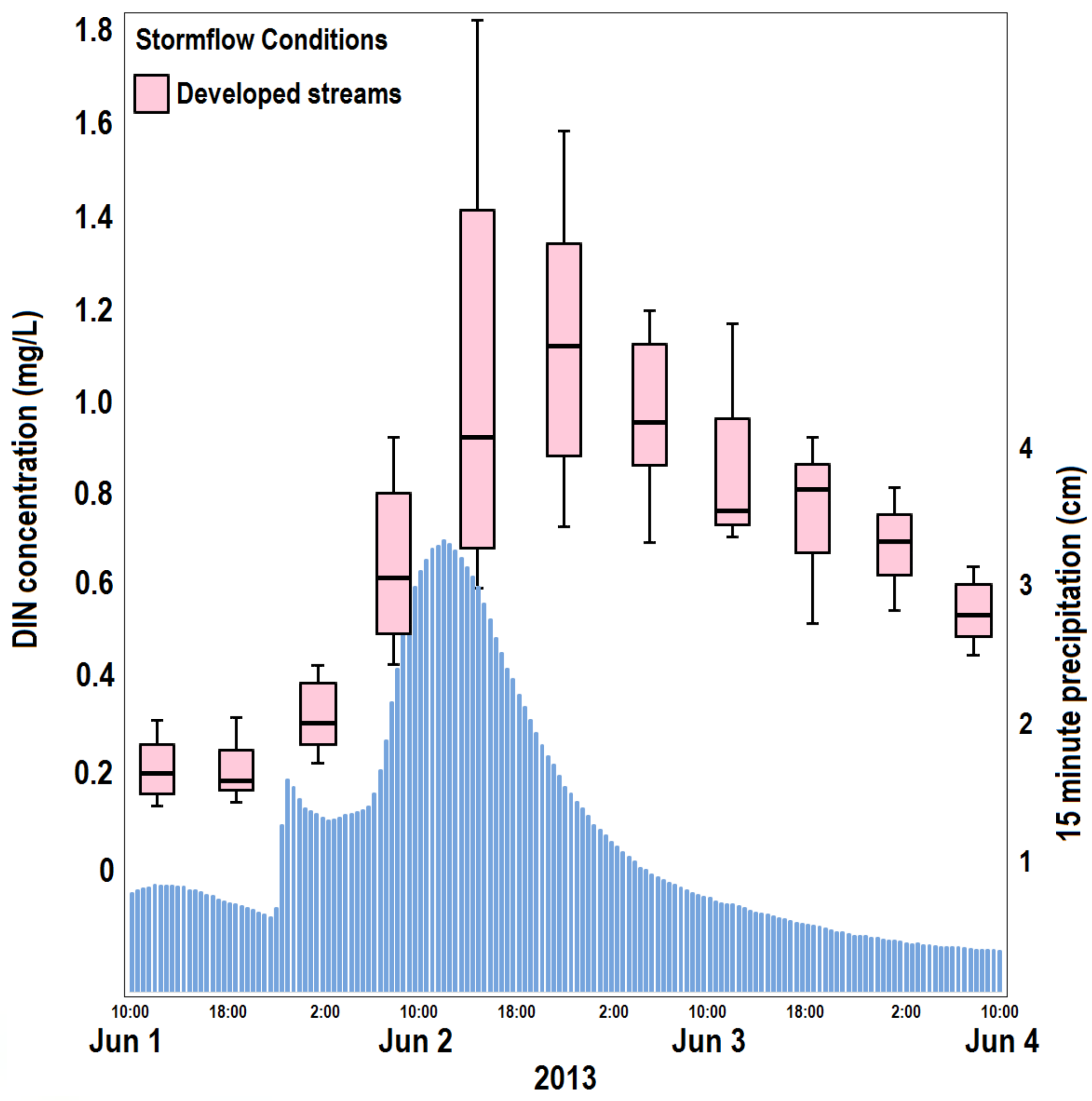
Runoff generation in natural and developed landscapes

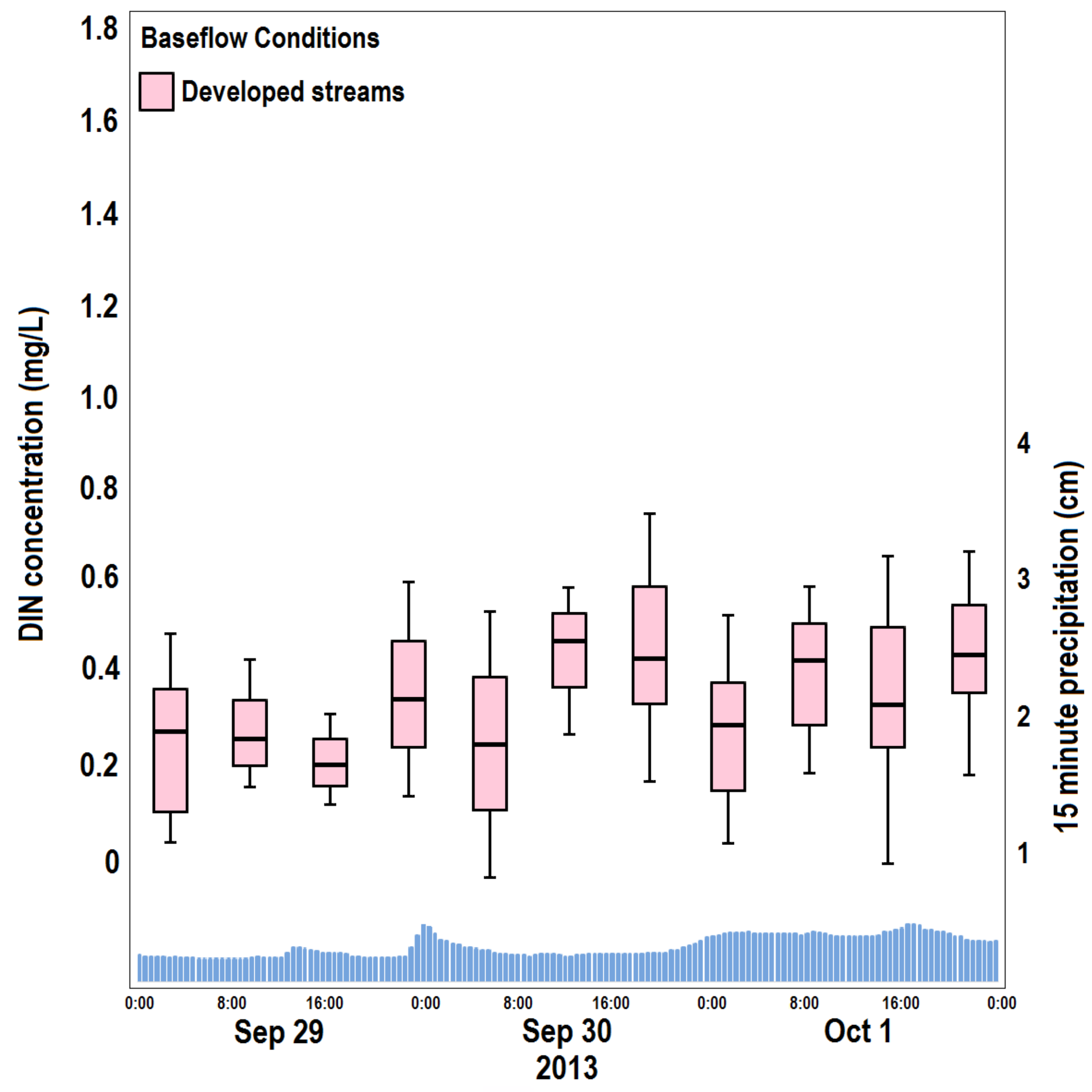


Natural landscapes **Developed / Agricultural**

Hewlett and Hibbert (1967)

Shift between local and external controls under baseflow and stormflow conditions





The combined effect of hydrology and land use