Chloride in Agriculture

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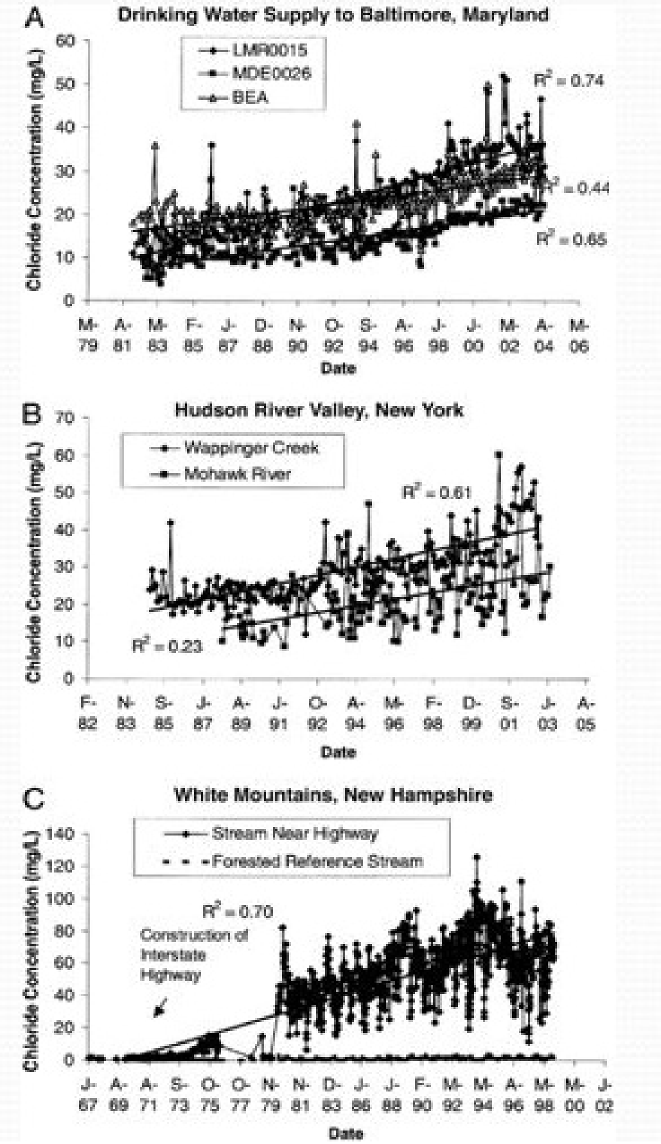
Salinization of Freshwaters



- Represented as increased baseflow concentrations of chloride
  - Deicing salts
  - Wastewater treatment plants

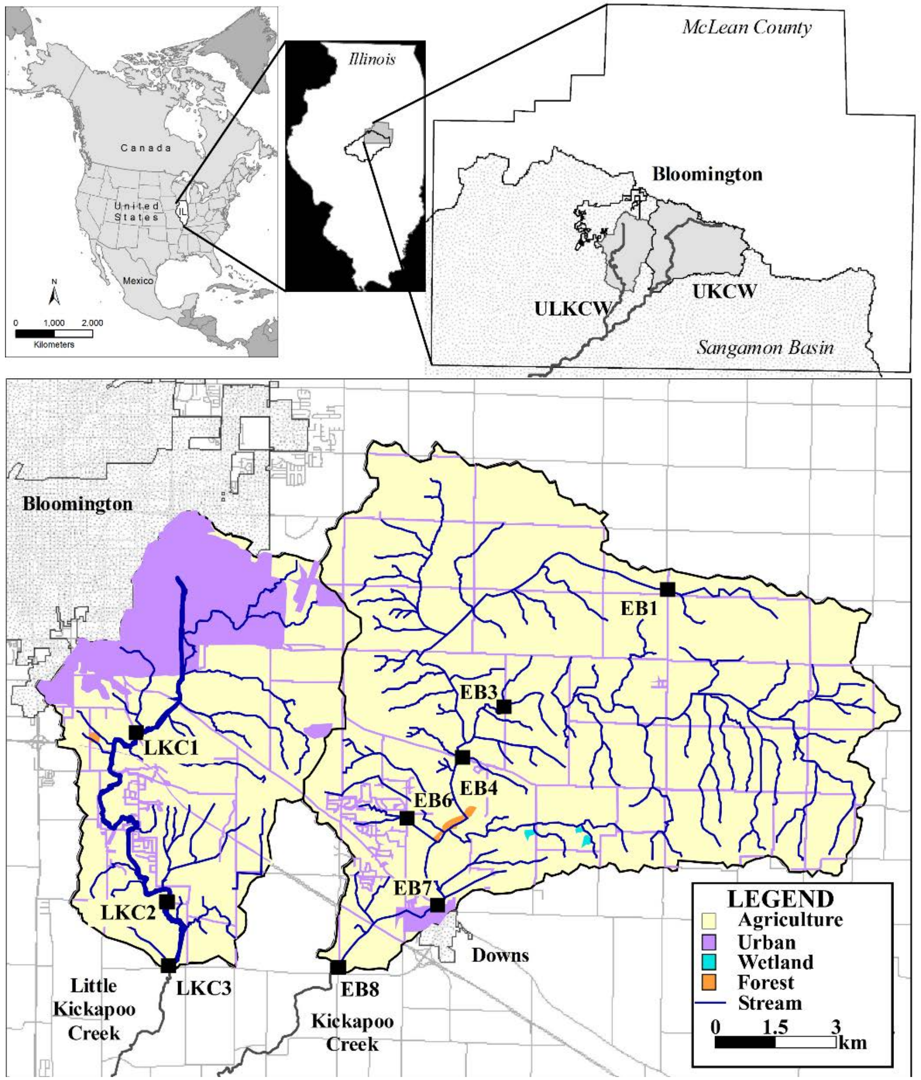
Kushal et al., 2005

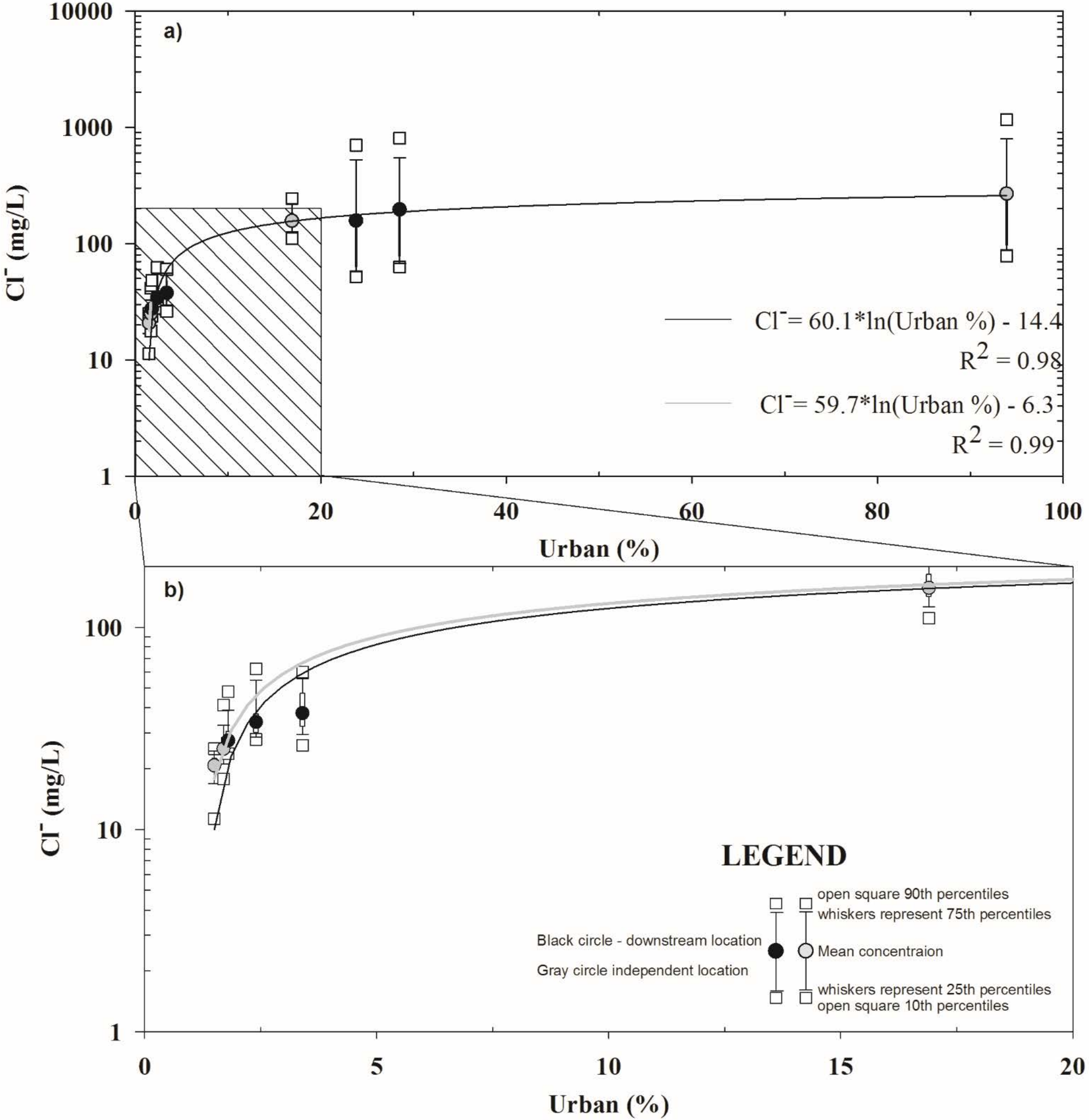
Background – Problems with Chloride (Cl^-)

- High chloride concentrations can have negative even fatal effects on stream organisms and surrounding vegetation (Panno et al., 1999; Environment Canada, 2001; Corsi et al., 2010; Findlay and Kelly, 2011)
- Chloride (Cl^-) is also highly corrosive to steel and pipes used in water treatment plants and local bridges, which contributes to high and frequent repair cost (Kelly et al., 2012).
- Secondary EPA drinking standard of 250 mg/L

Photo of Little Kickapoo Creek located in central Illinois.

Land Use & Chloride Concentrations





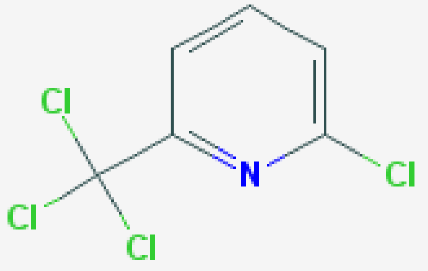
(Lax et al., 2017)

Evidence of Agricultural Input

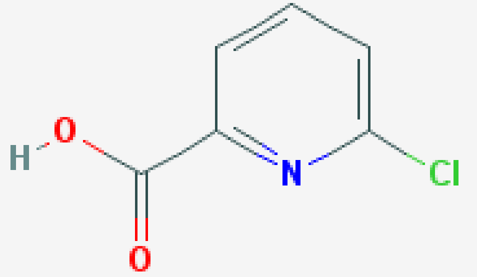
- **Chloride build up in rural watersheds**
  - Kelly et al., 2008
  - Lax et al. 2017
  - Oberhelman and Peterson, 2019
  - Overbo et al., 2021

- **Agricultural Contributions**
  - Animal Feed & Waste
  - Fertilizers
  - Nitrification inhibitors

Nitrification Inhibitors



2-Chloro-6-(Trichloromethyl)Pyridine

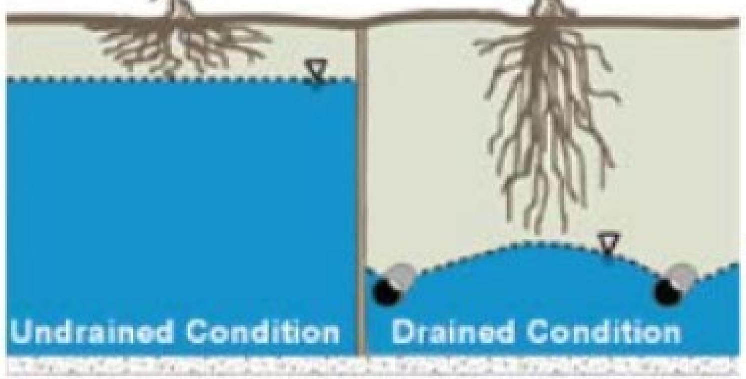


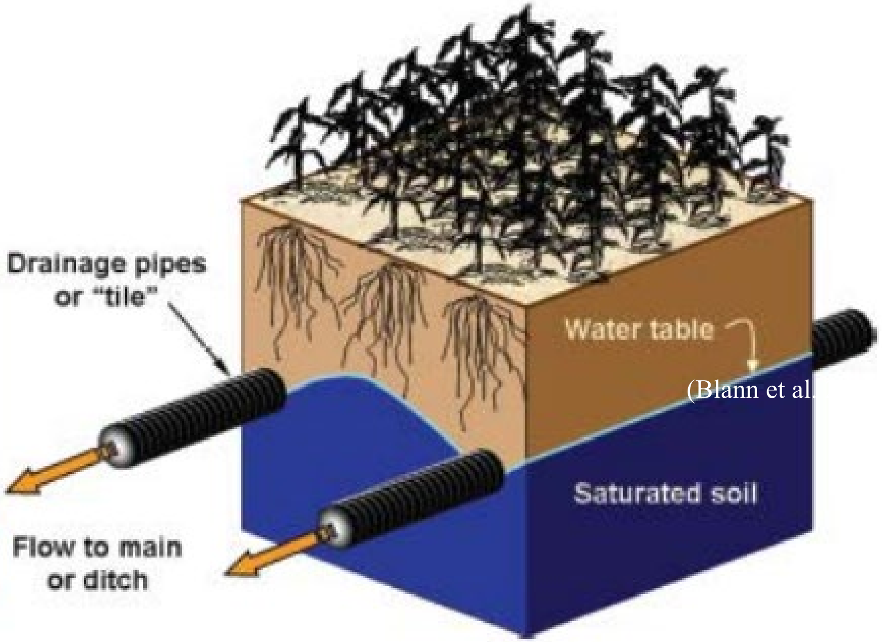
6-Chloropicolinic Acid

Midwest Agriculture - Context

- Midwest – Predevelopment – Marshy wetlands
- Not suitable for agriculture
- Worked to Drain

Actions – Tile Drainage and Channelization

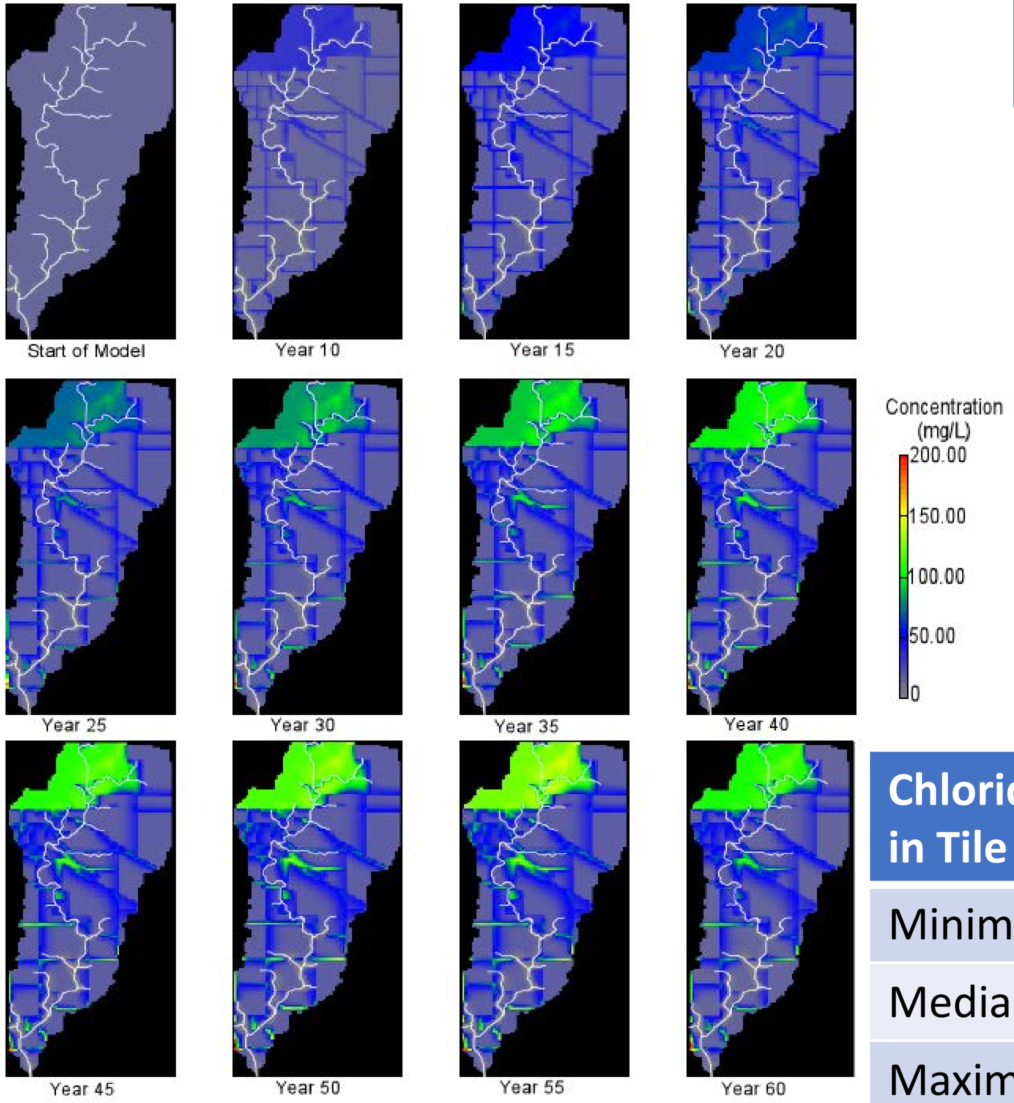




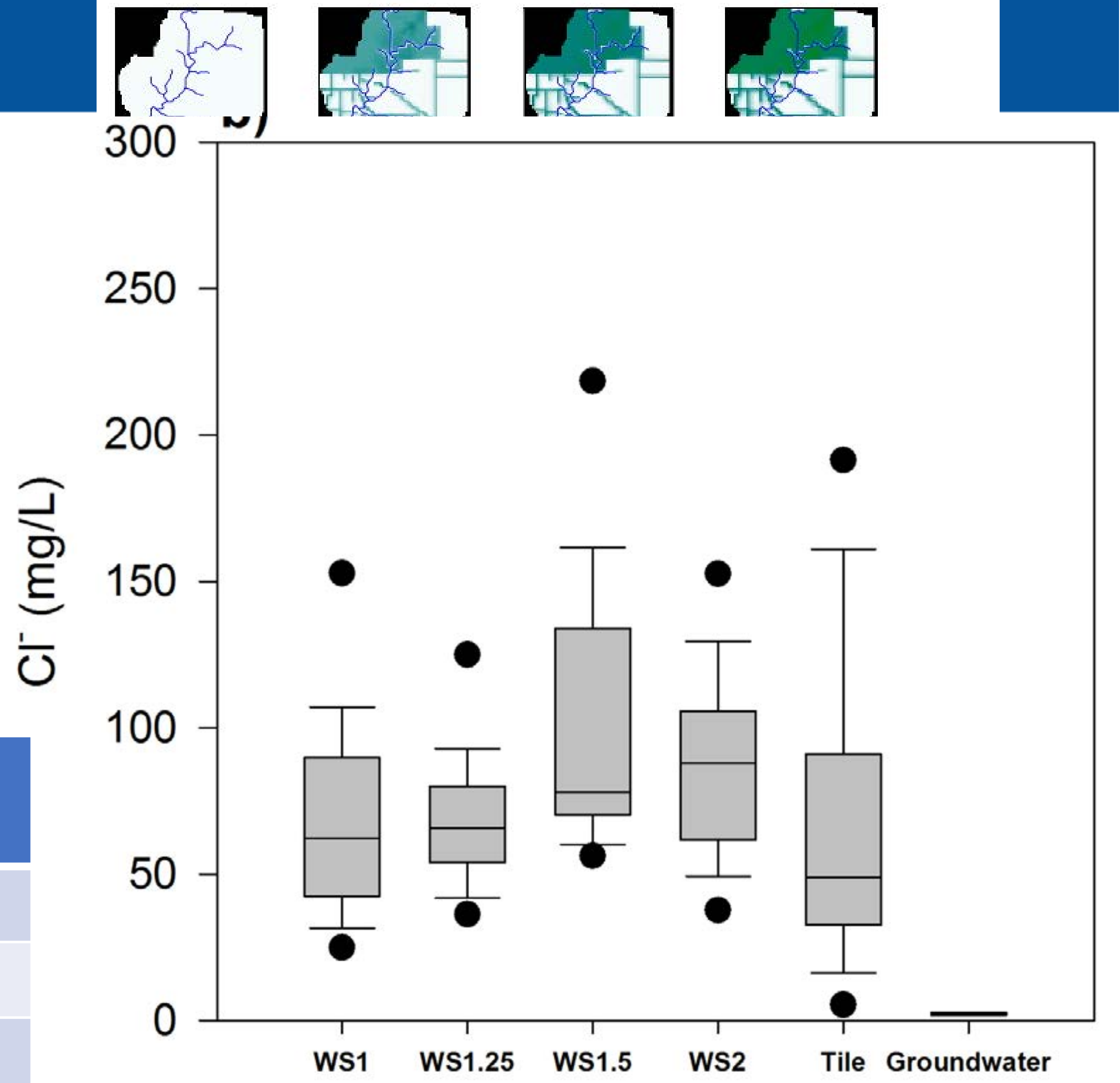
(Blann et al.

Outcome

Chloride Distribution – 60 cycles of winter & summer seasons



Chloride Concentrations in Tile Water (mg/L)	
Minimum	4.4
Median	49.0
Maximum	464.0



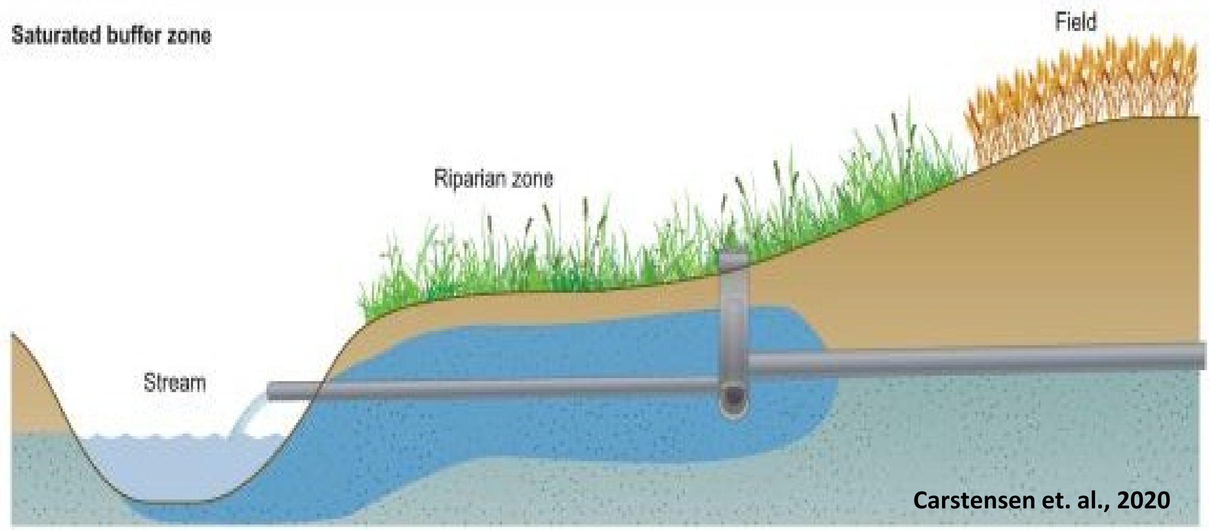
Scenario 1: Application rate - 1,500 mg/L

Scenario 2: Application rate - 10,000 mg/L

Best Management Practice - Saturated Buffer Zone(SBZ)

- Saturated Buffer Zone(SBZ) is the type of buffer in which water is directed to drain through it to make the land saturated

- The goal of SBZ is to hydrologically reconnect tile water from the agricultural land with a strip-of-filled buffer



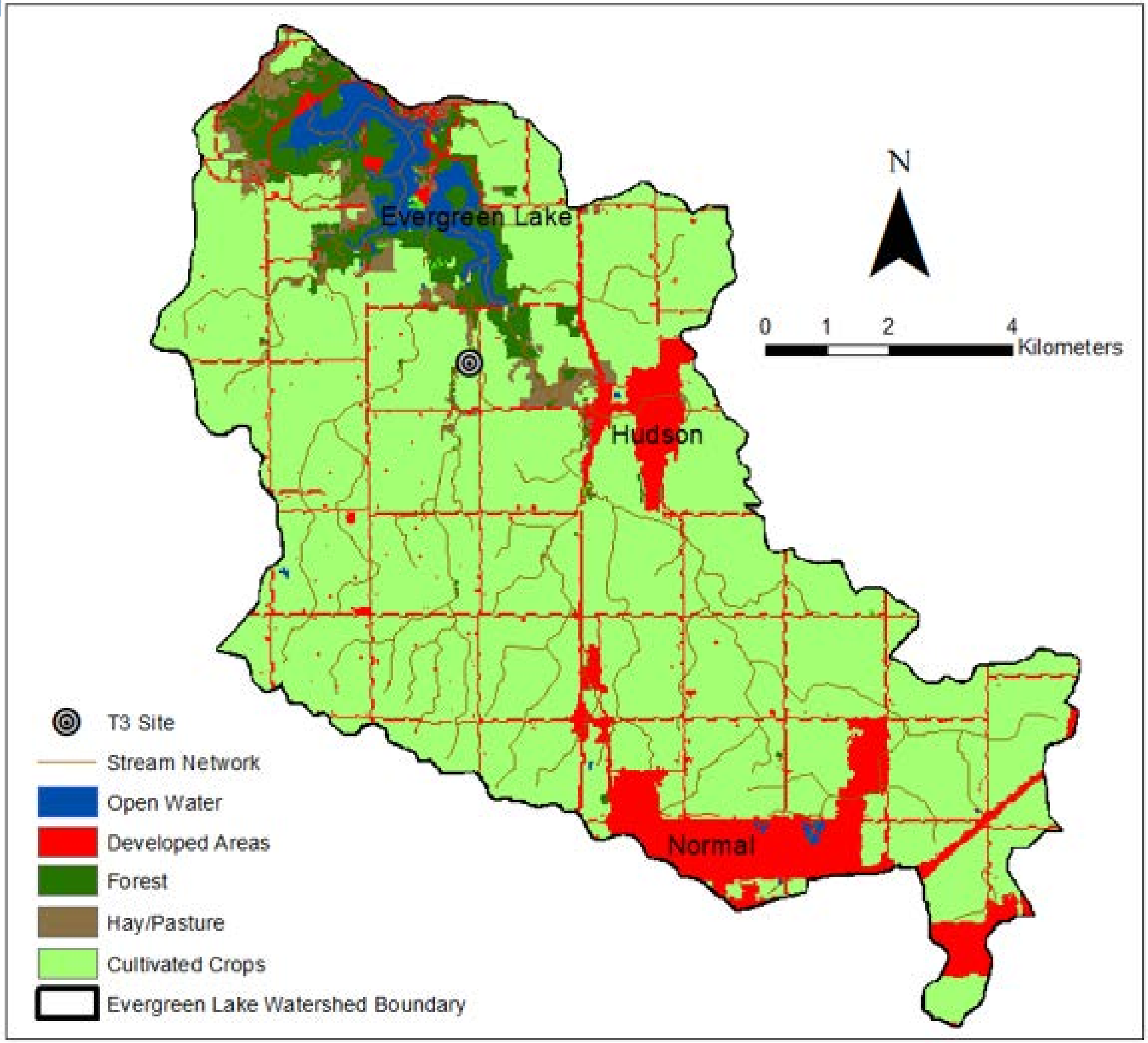
Carstensen et. al., 2020

Objectives

1. Assess spatial and temporal variations of chloride concentration in the groundwater within the study area.
2. Identify the number of contributing populations of chloride to substantiate agricultural influence in the study area.
3. Determine if agriculture contributes to chloride to rural watersheds.

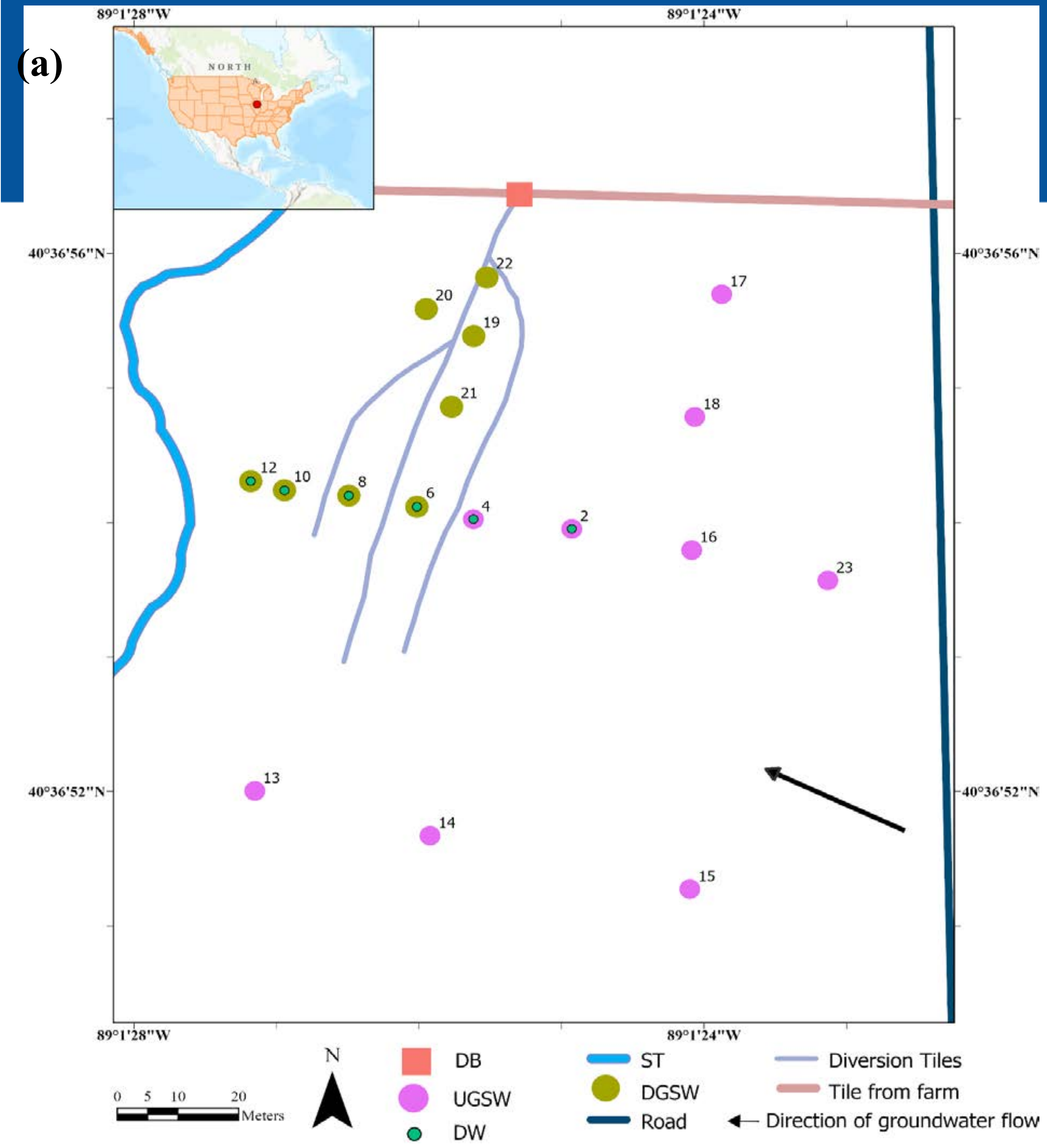
Land Use

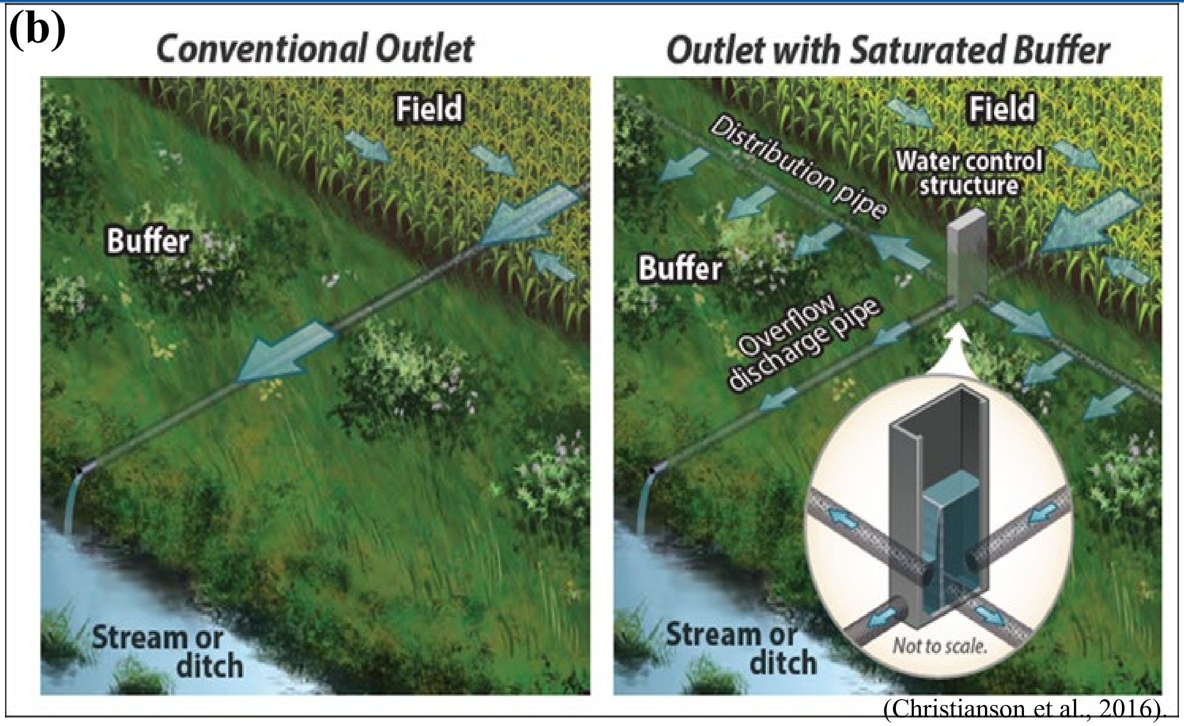
- Agriculture represents the dominant land use (>87%) in the Evergreen Lake Watershed where the study site is located.
- The farm upgradient of the site rotates corn and soybean on an annual basis, with no livestock agriculture.



STUDY SITE

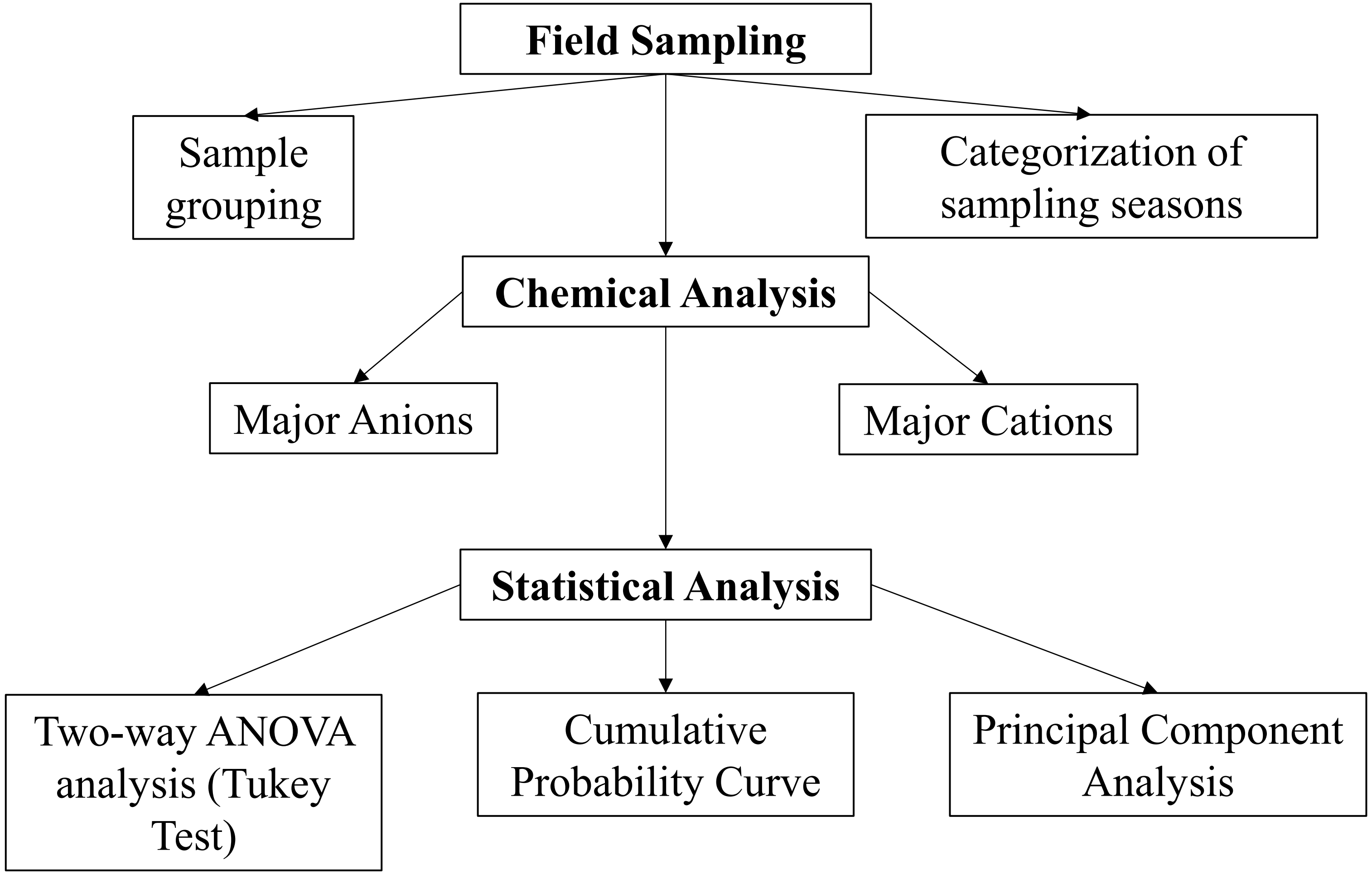
- **General Description**





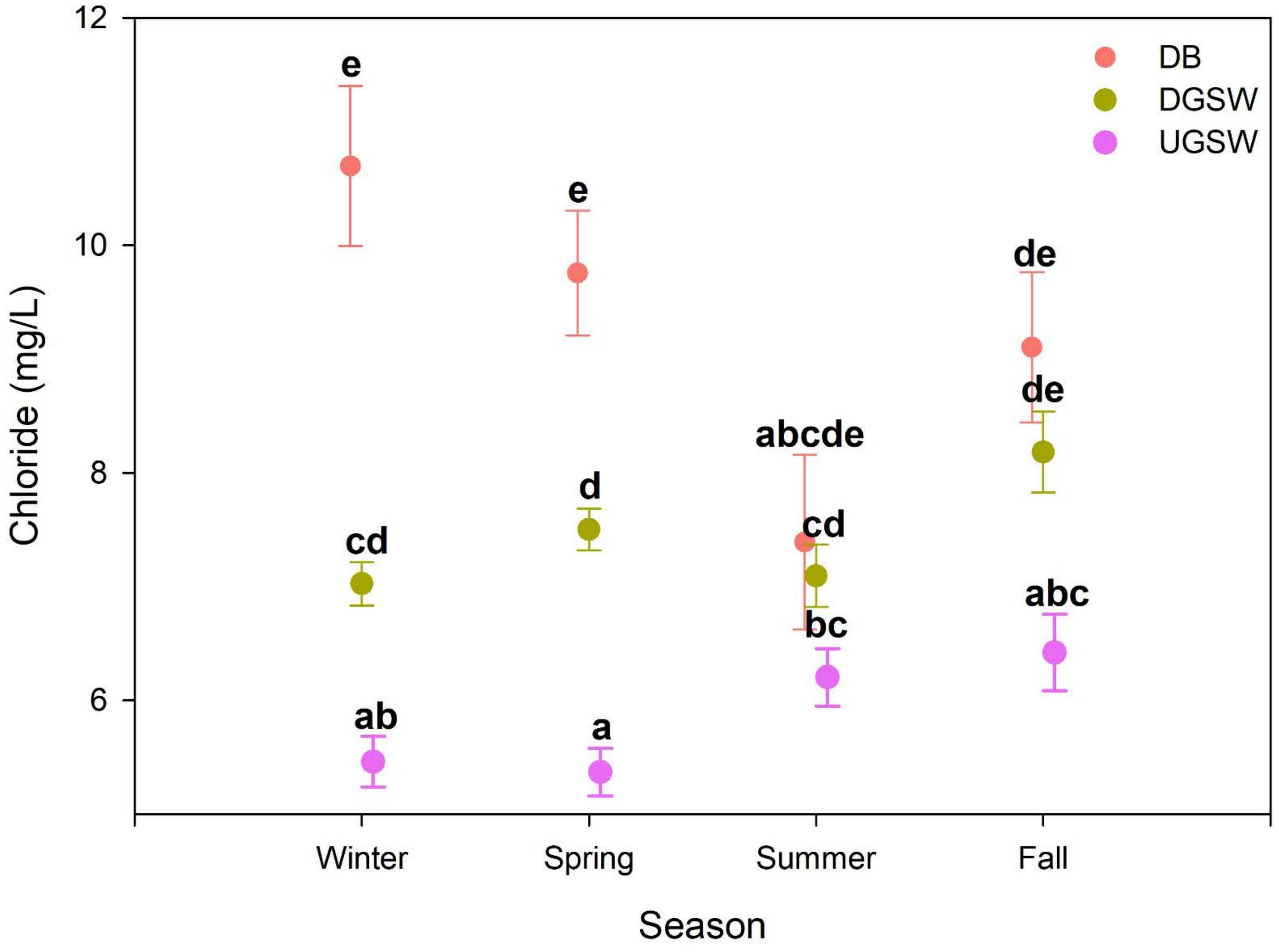
(Christianson et al., 2016).

METHODS



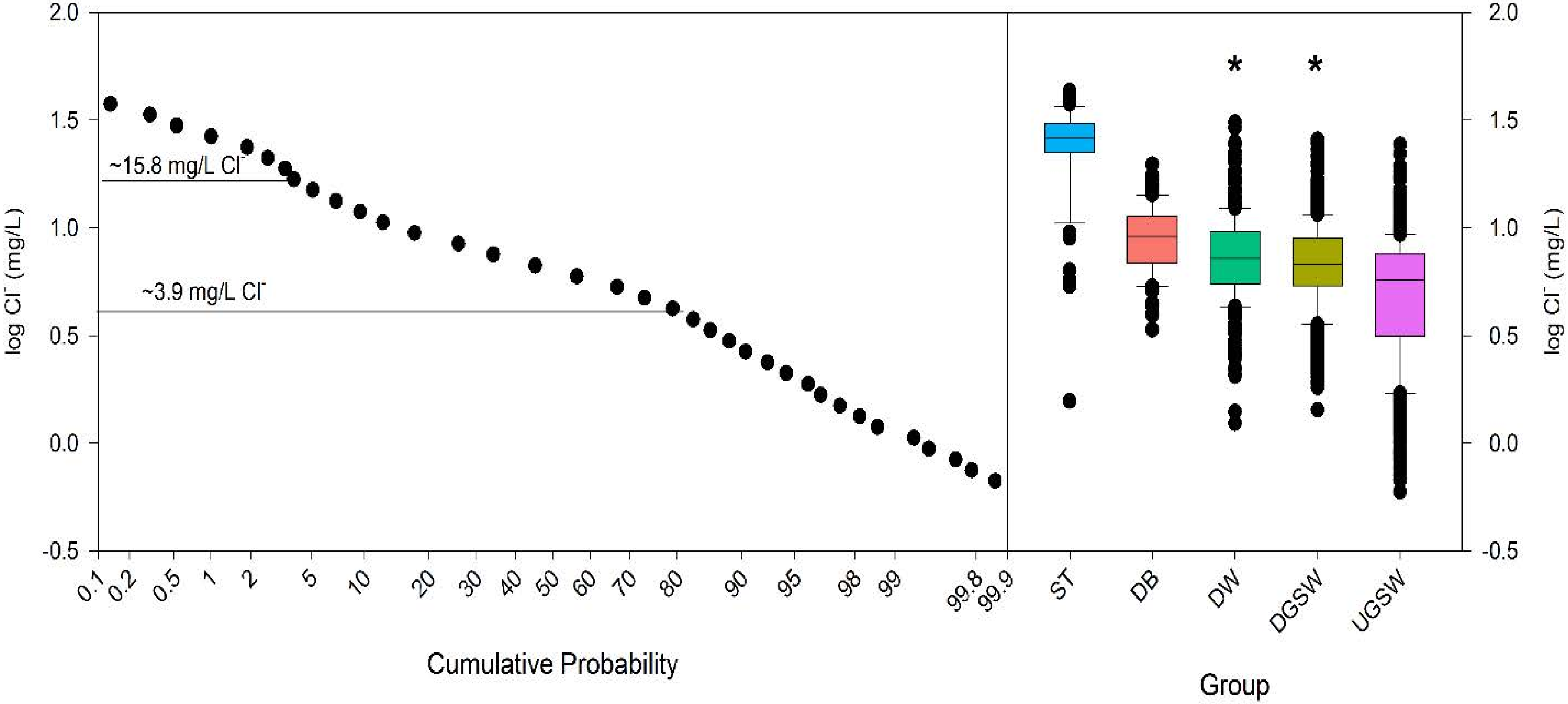
Field Sampling
Sample grouping
Categorization of sampling seasons
Chemical Analysis
Major Anions
Major Cations
Statistical Analysis
Two-way ANOVA analysis (Tukey Test)
Cumulative Probability Curve
Principal Component Analysis

RESULTS & DISCUSSION



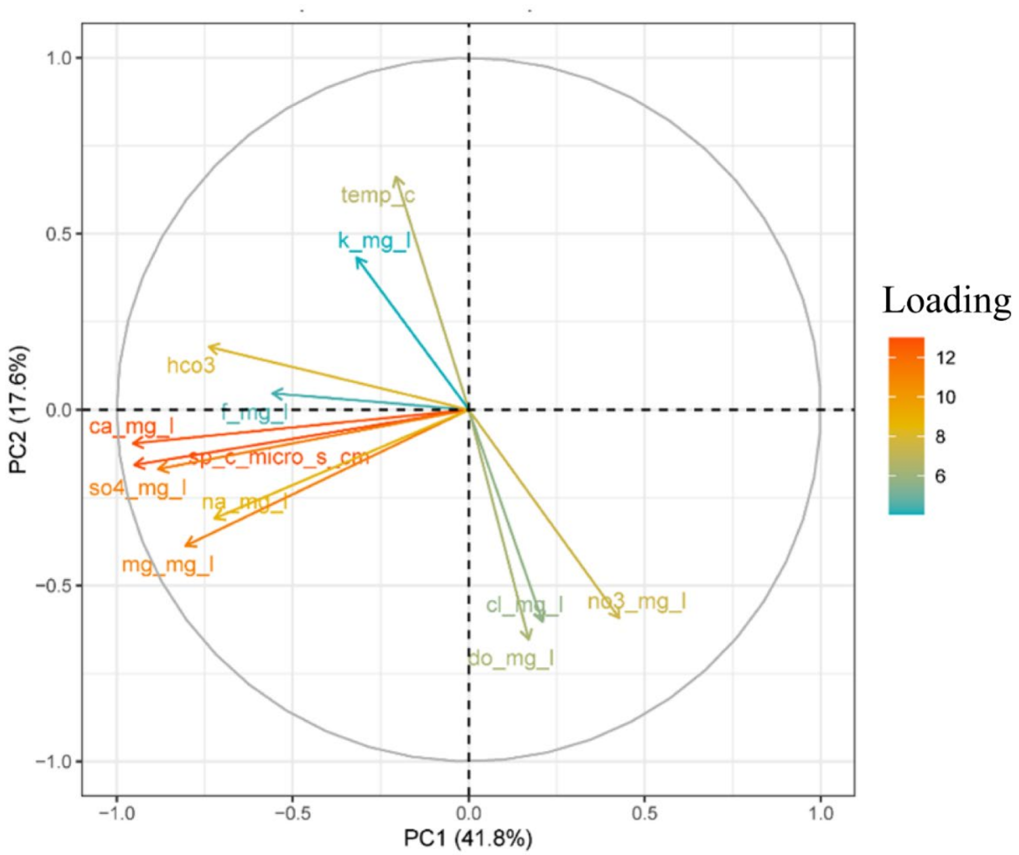
Tukey test indicated significant differences ($p < 0.05$) for grouped waters within and across the seasons.

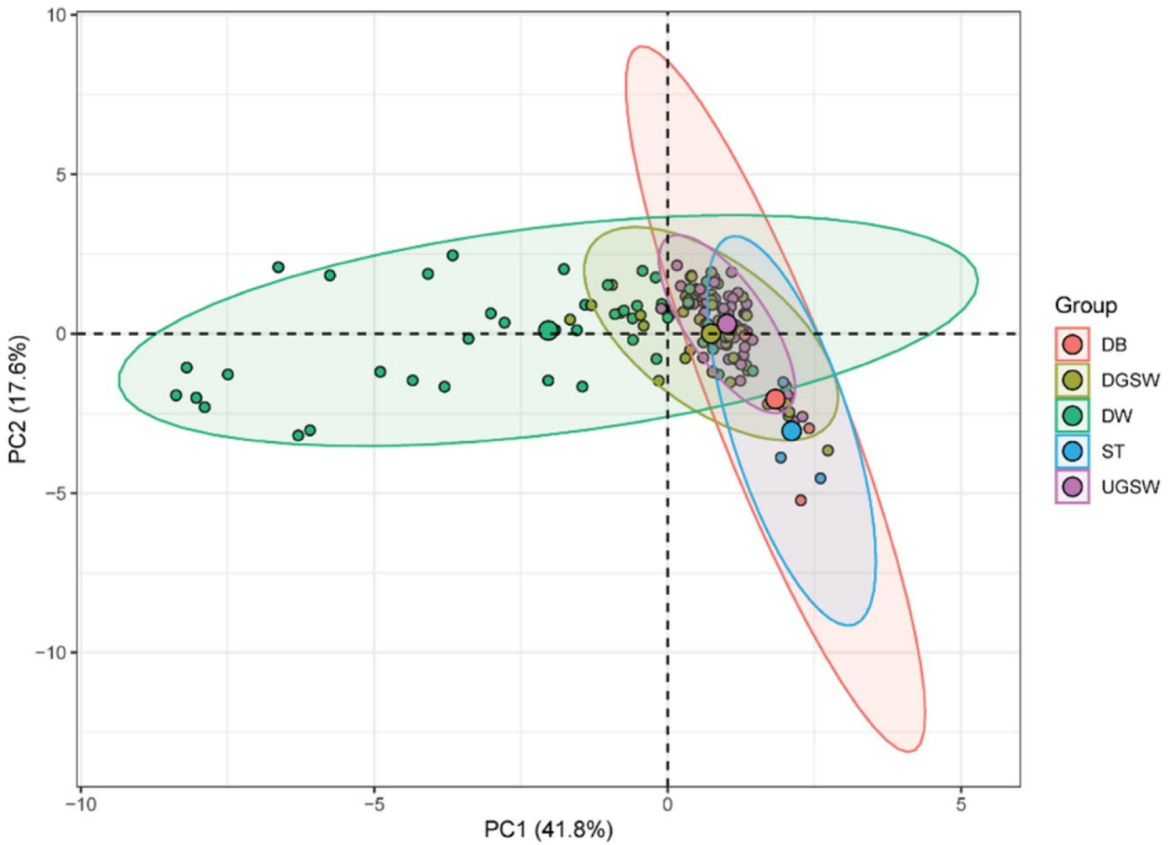
Cumulative Probability Plot



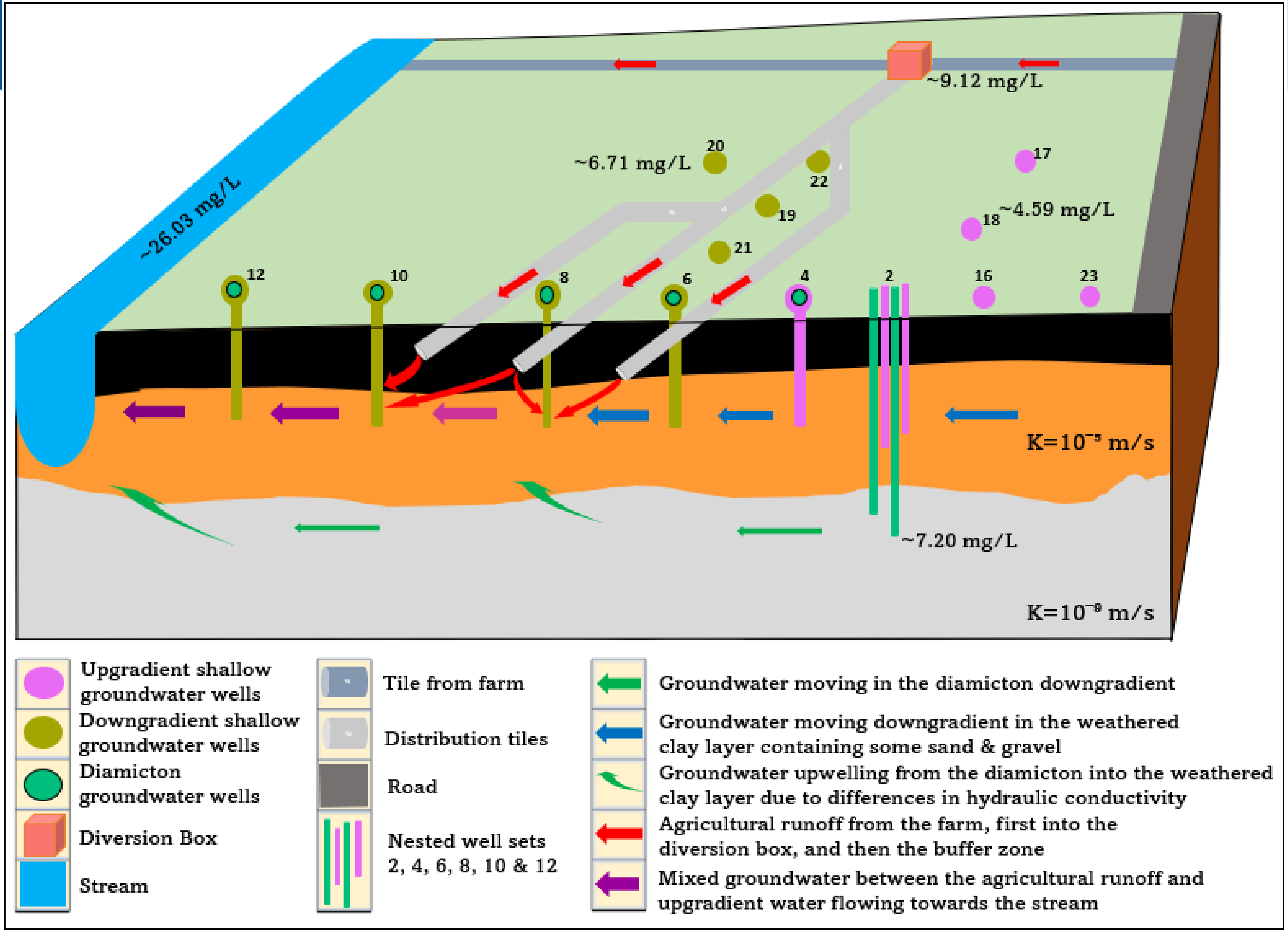
Cumulative probability plot with boxplots of chloride concentrations for the different groups. The lines represent inflection points indicating threshold values for different populations of chloride

Principle Component Analysis





Conceptual Model



Conclusions

- Background chloride concentration - 3.9 mg/L.
- Surface processes (agricultural runoff) impacted the diversion box water chemistry.
- The diversion box water has a higher chloride concentration than the upgradient groundwater. The farm provides the water; thus, the elevated chloride is interpreted to be a result of agricultural practices. Previous works within the SRB confirm the contribution of nitrate from agricultural runoff into the diversion box.

Acknowledgements

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Thank You