BORON ISOTOPE AS A POWERFUL TOOL FOR NUTRIENT SOURCE TRACKING

A Multi-isotope study of Surface-water in South Florida

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Outline

Background

- Florida's Aquifer System
    - Climate and Human Impact
    - Sources of Contamination

Materials and Methods

- Sampling Sites
- Analytics

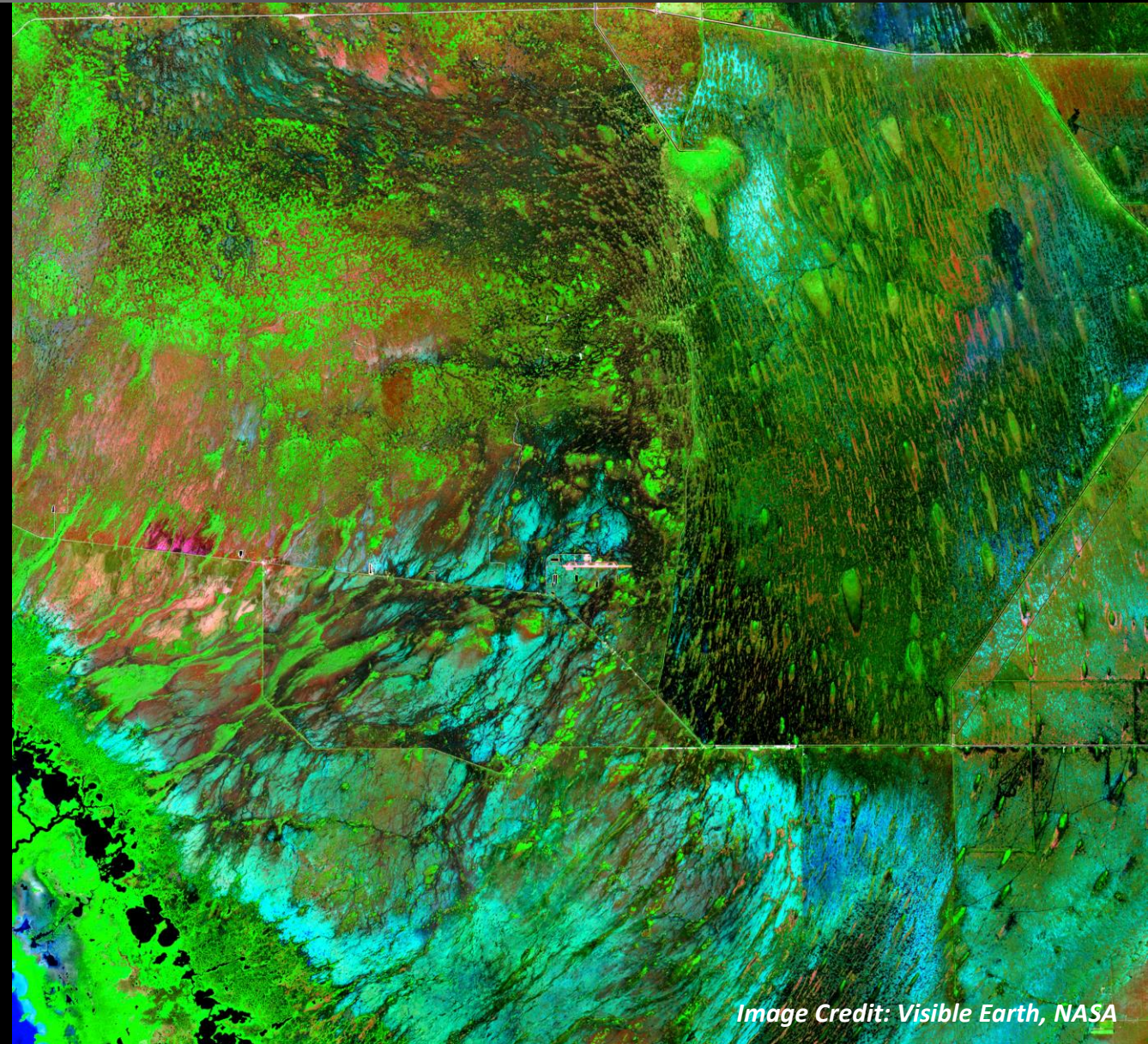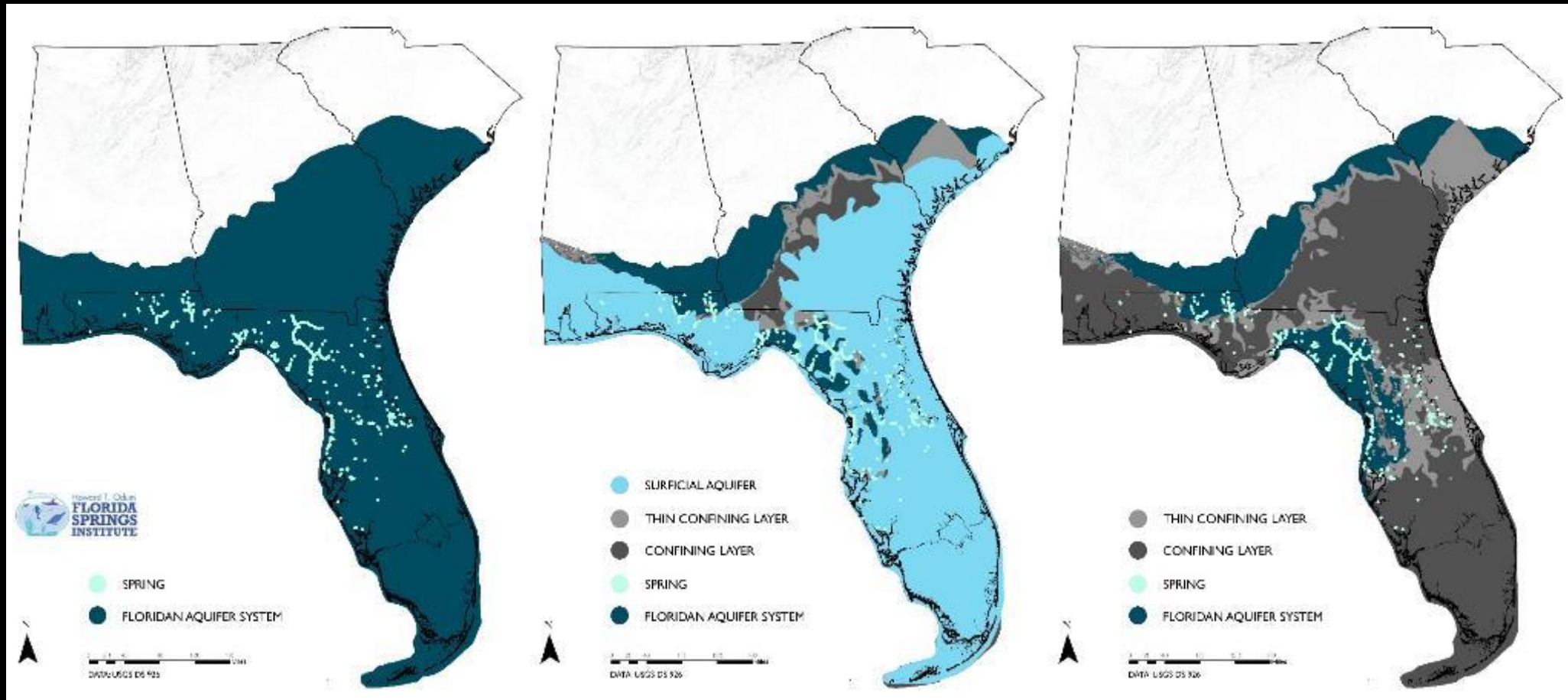## Results

- Source Assessment
- Water Characterization

Conclusion

Image Credit: Visible Earth, NASA

Background
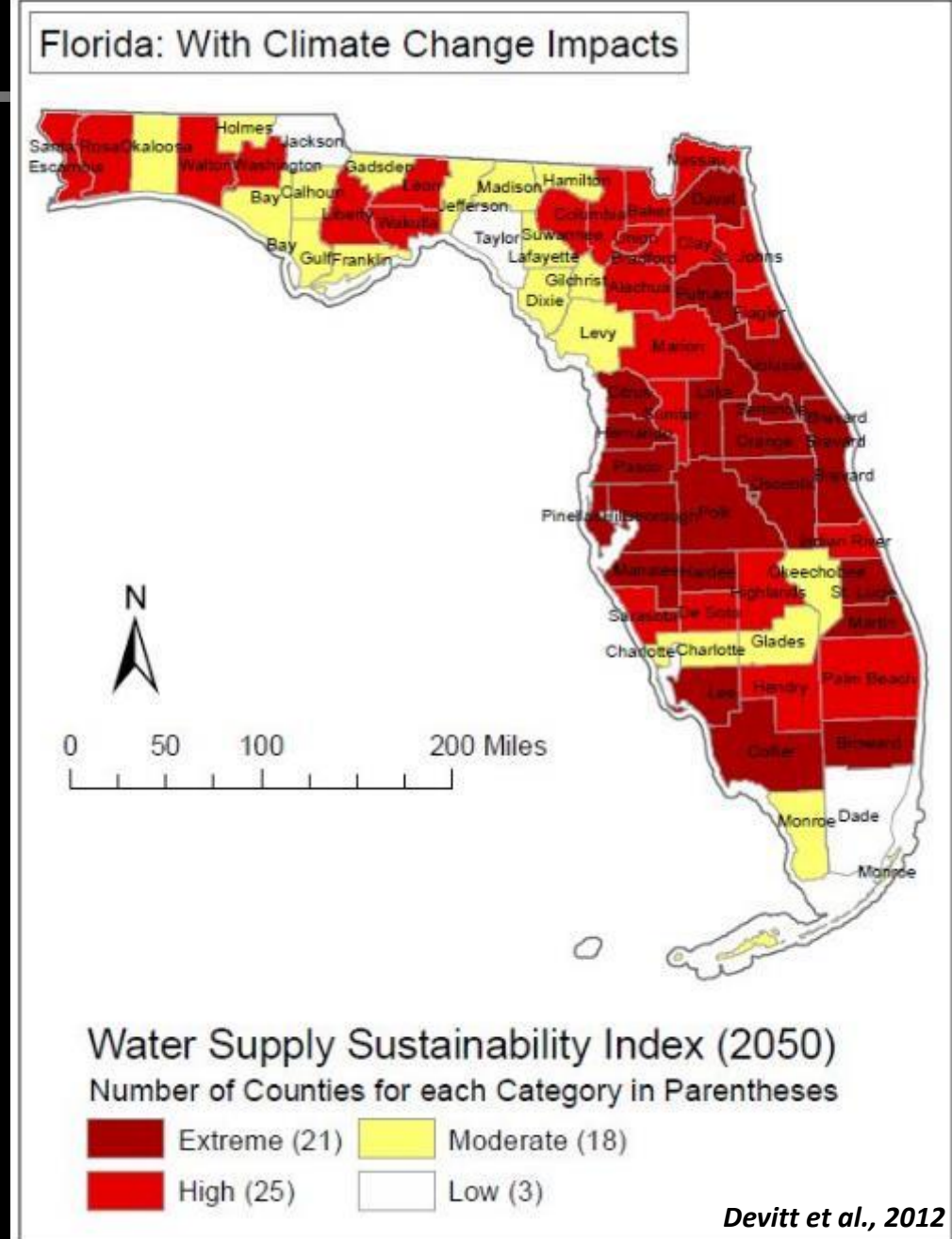
Florida's Aquifer System

- Spans an area of 260,000 km^2
- Underling four states; FL, AL, GA, SC
- Supply water to 11 million Floridians

- Surficial Aquifer System
- Floridan Aquifer System (Confined or unconfined)
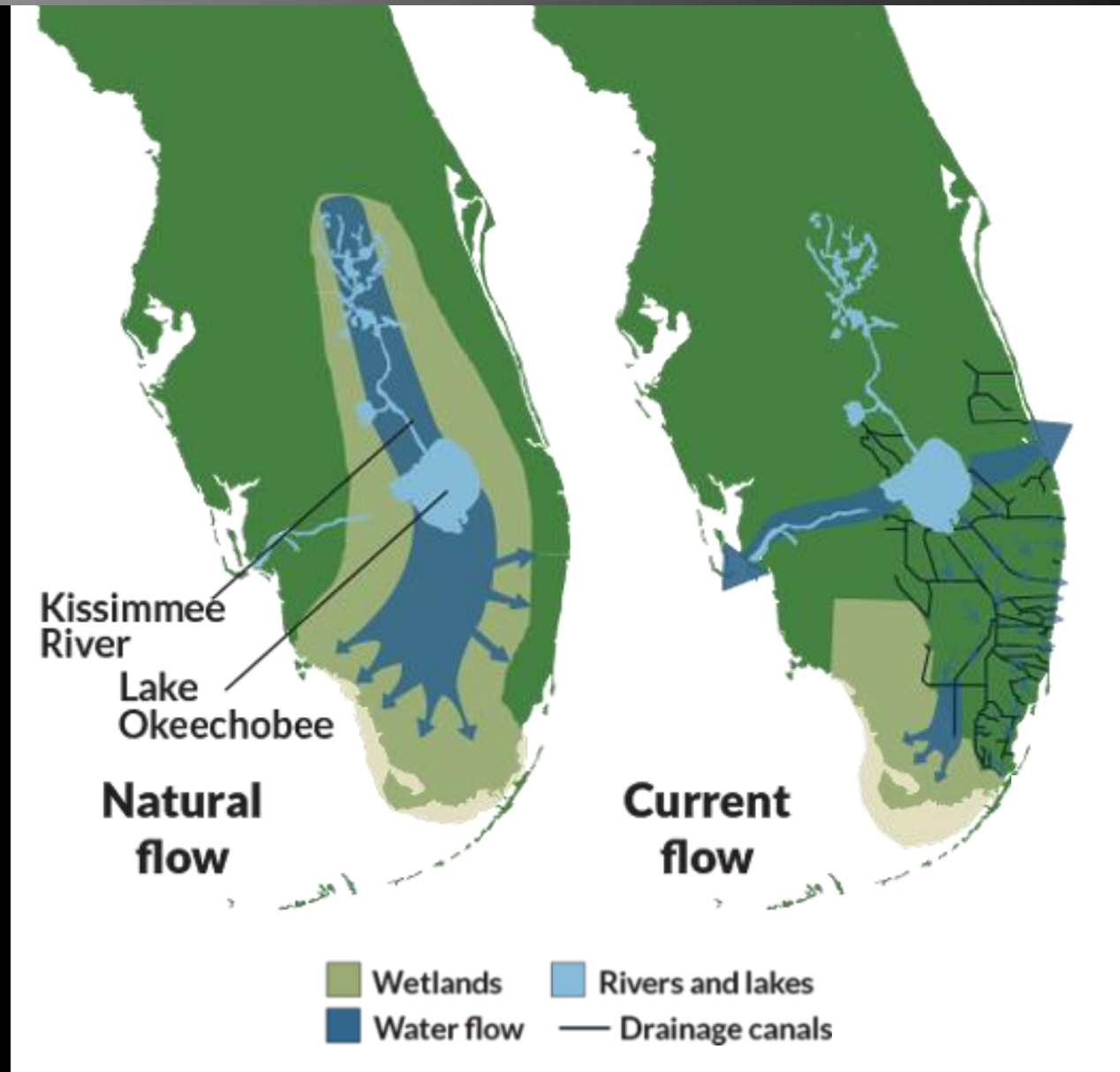
Background

Climate Impact

Under the climate change scenario, demand for agricultural irrigation will increase leading to water shortage across Florida and create conflicts over availability of freshwater
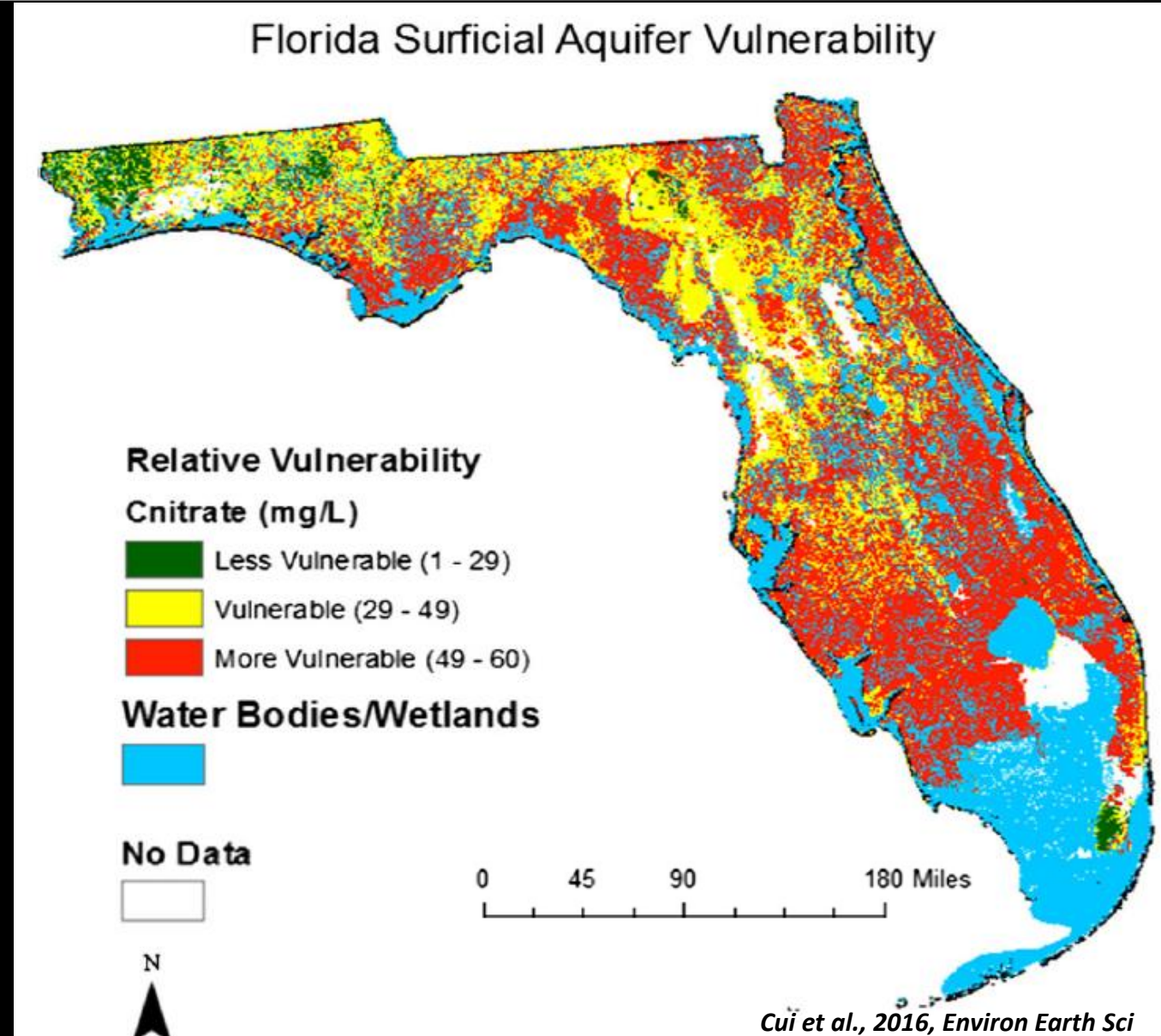

Florida: With Climate Change Impacts

Water Supply Sustainability Index (2050)
Number of Counties for each Category in Parentheses

- Extreme (21)
- High (25)
- Moderate (18)
- Low (3)

Devitt et al., 2012

Background

Natural flow of water is disturbed to accommodate water supply for heavily populated areas and vast agricultural fields

Kissimmee River
Lake Okeechobee

Natural flow

Current flow

Wetlands — Rivers and lakes
Water flow — Drainage canals

Background

Human Impact

- Susceptible to contamination from land use practices

- Vulnerable to nitrogen contamination

- Shallow water table depth, high nitrate concentrations

Florida Surficial Aquifer Vulnerability

Relative Vulnerability
Cnitrate (mg/L)
- Less Vulnerable (1 - 29)
- Vulnerable (29 - 49)
- More Vulnerable (49 - 60)

Water Bodies/Wetlands

No Data

0   45   90   180 Miles

N

Cui et al., 2016, Environ Earth Sci

Background

Sources of Contamination

- Nonpoint source and point source contamination can be difficult to distinguish.

- When mitigating nutrients or developing wetland project it is necessary to understand the sources of nutrients into and out of a system.
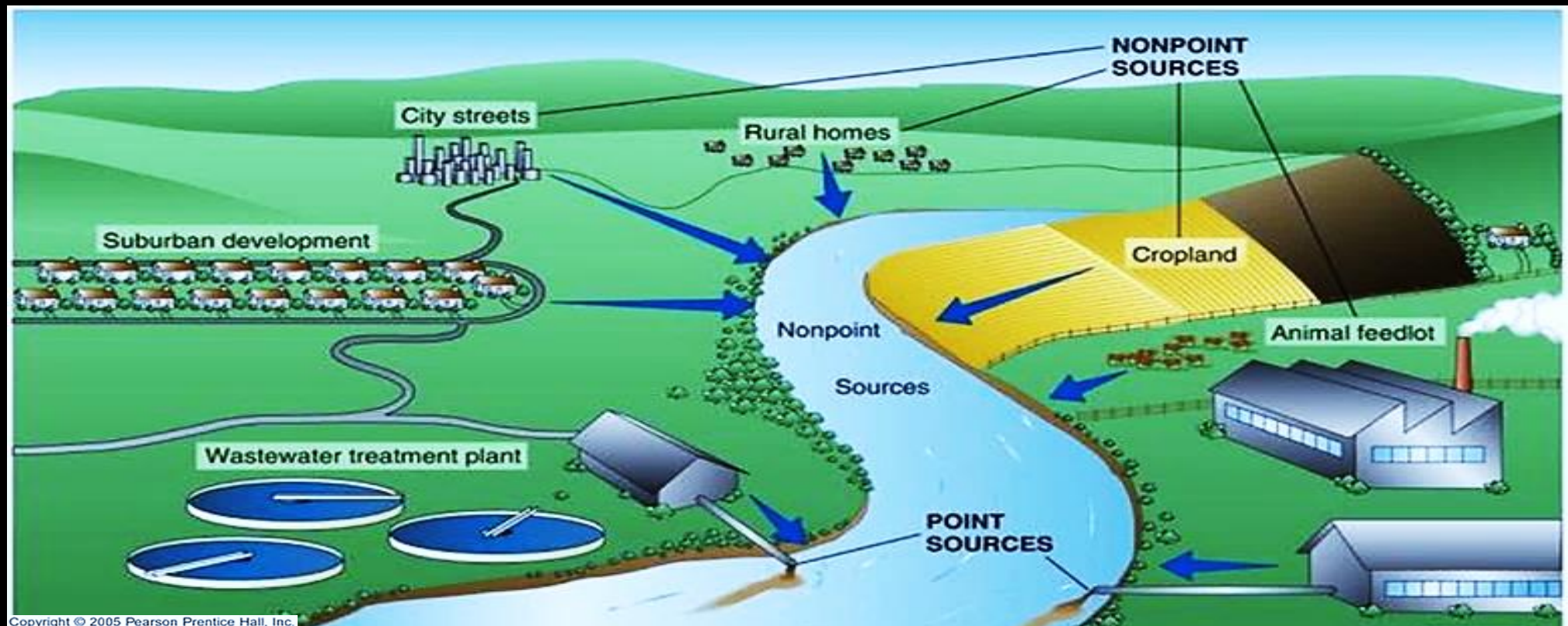
Materials and Methods

- Six sites were randomly selected in S Florida
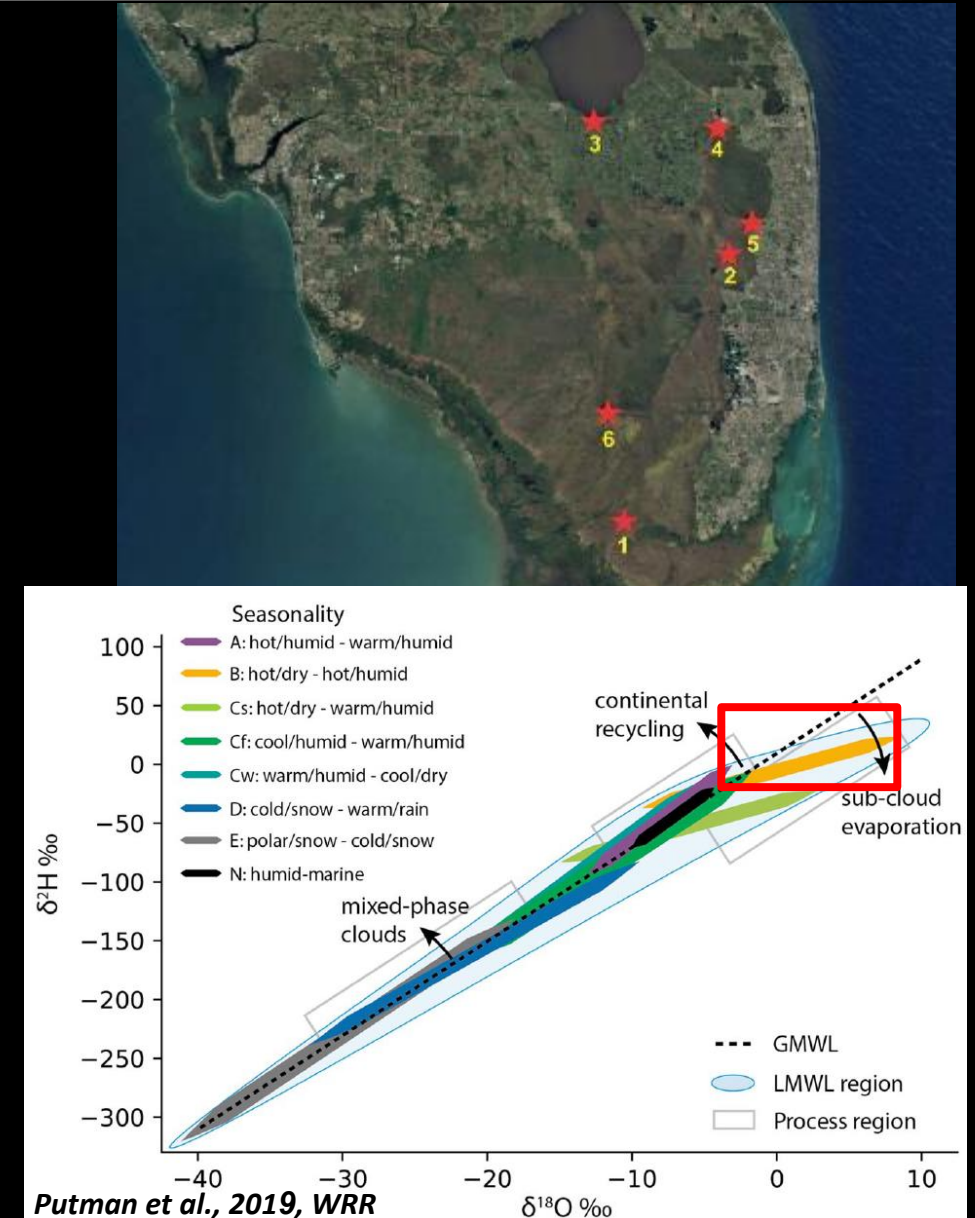
- Water samples were analyzed for

  - $\delta^{18}O$
  - $\delta^{2}H$
  - $\delta^{18}O_{NO3}$
  - $\delta^{15}N_{NO3}$
  - $\delta^{18}O_{PO4}$
  - $\delta^{11}B$
  - $^{87}Sr/^{86}Sr$
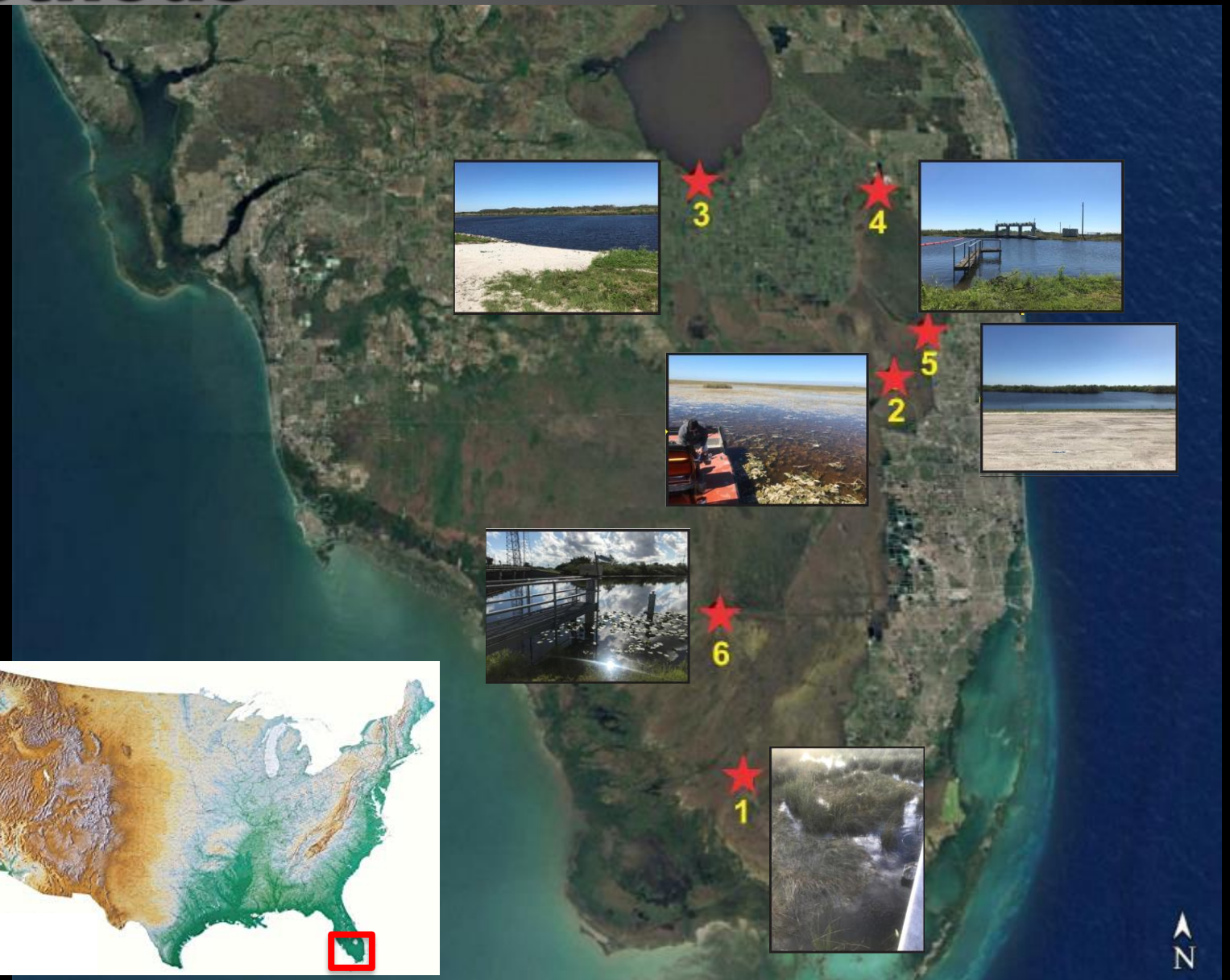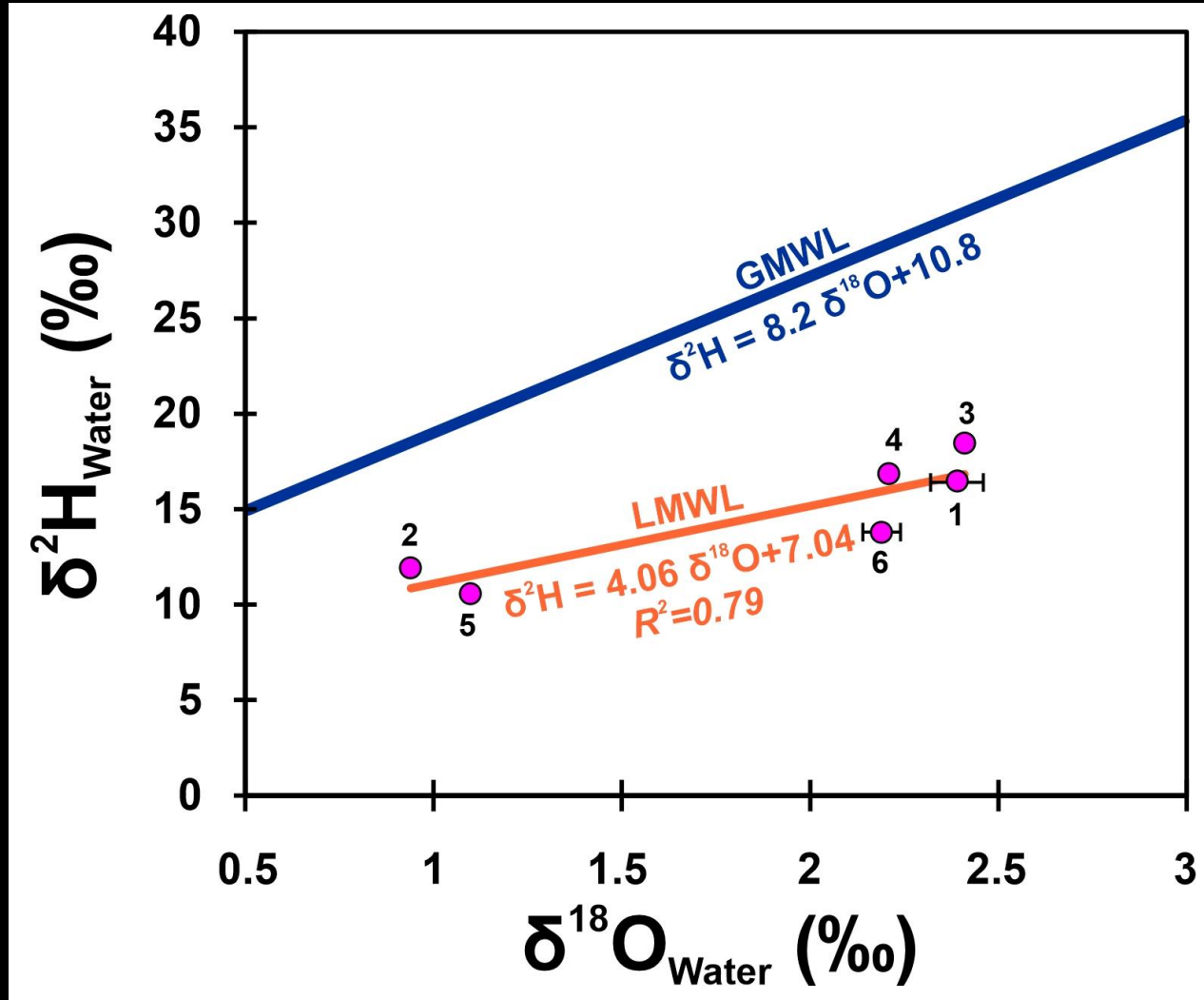
Effect of hot and humid climate of the region on shaping the local meteoritic water line

Putman et al., 2019, WRR

Results

Oxygen and nitrogen isotopes of nitrate can be used to trace the source of nitrate in water,

Source regions are greatly overlapped and it is hard to pinpoint a contamination source
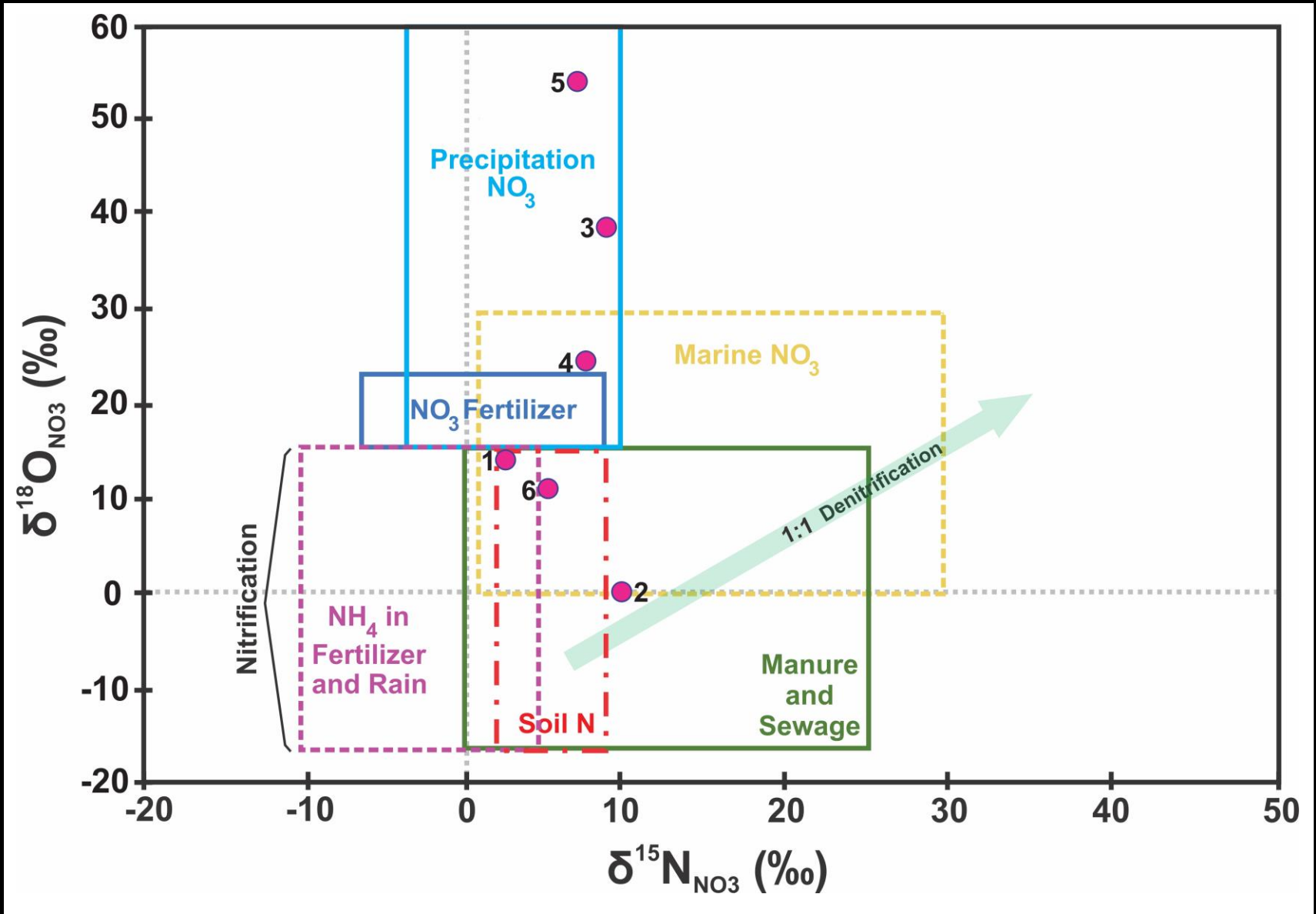
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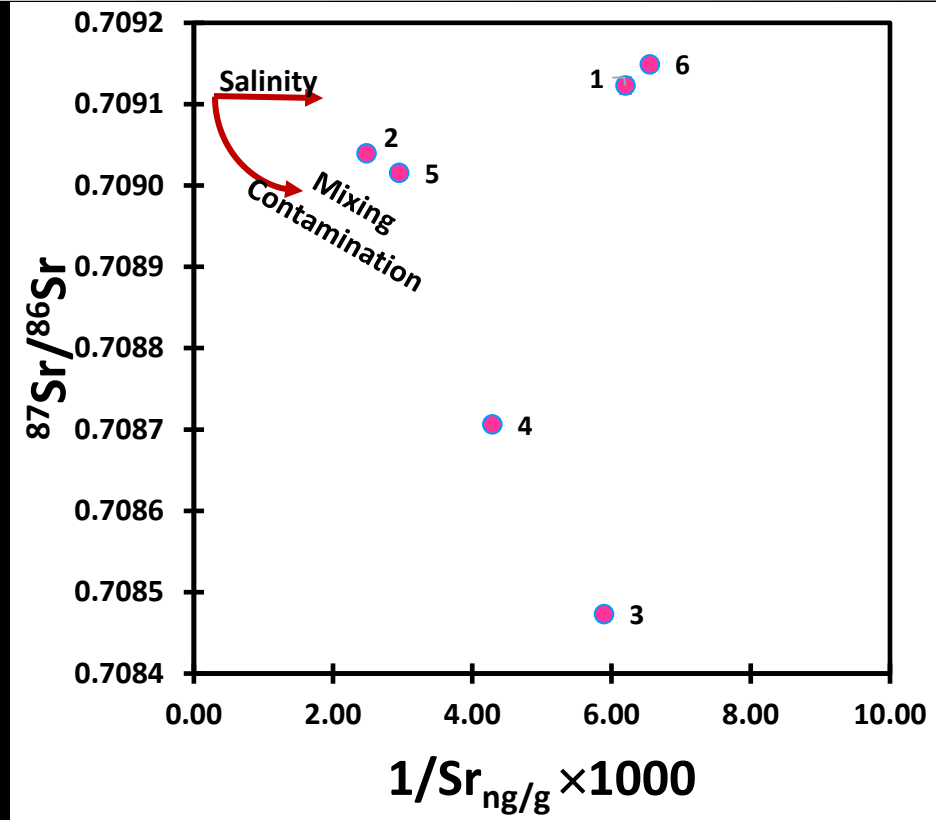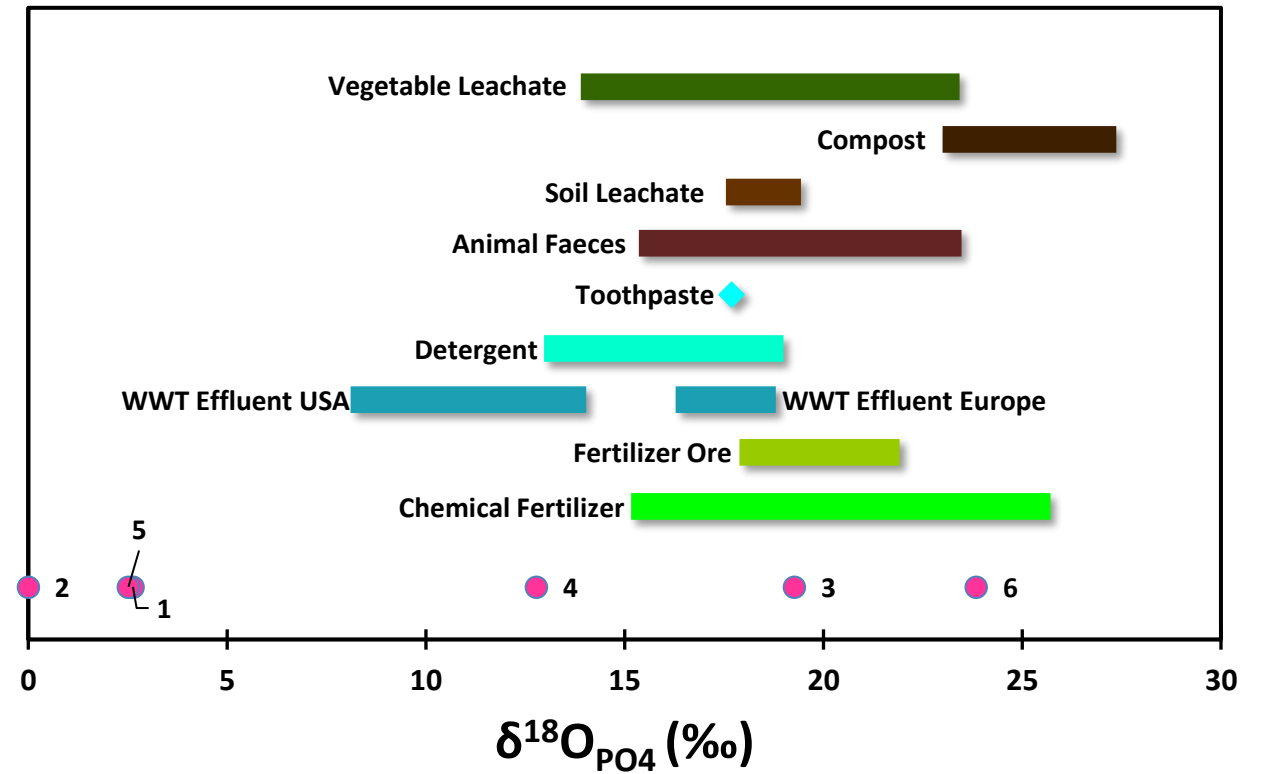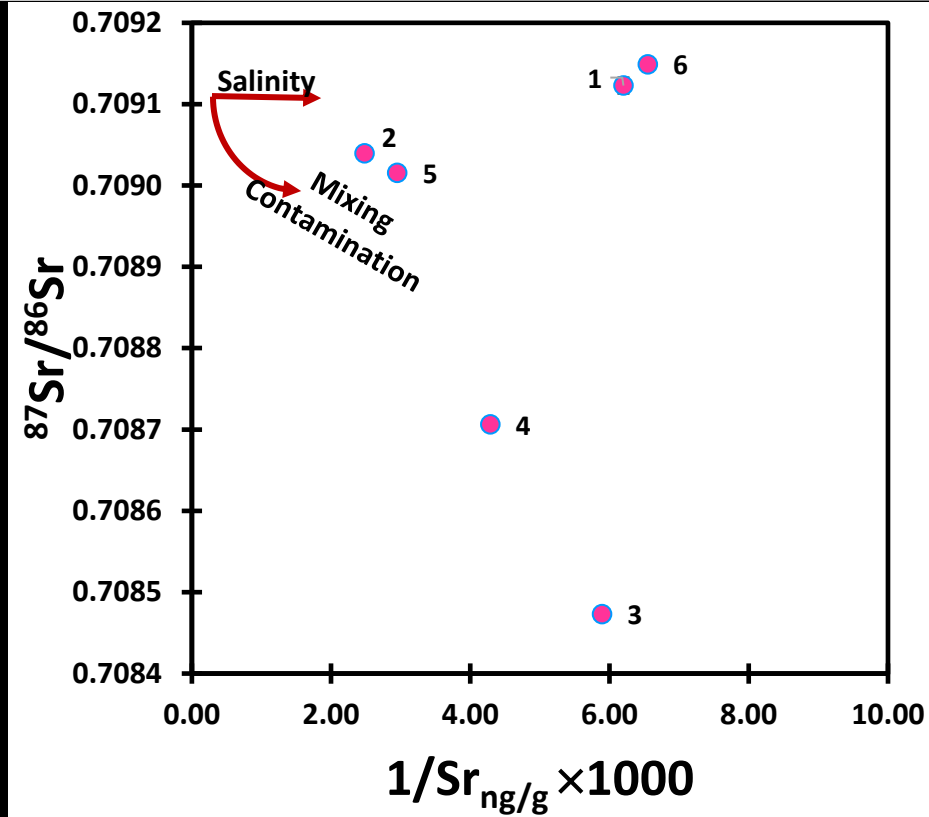Boron isotope, tracer for source of contamination
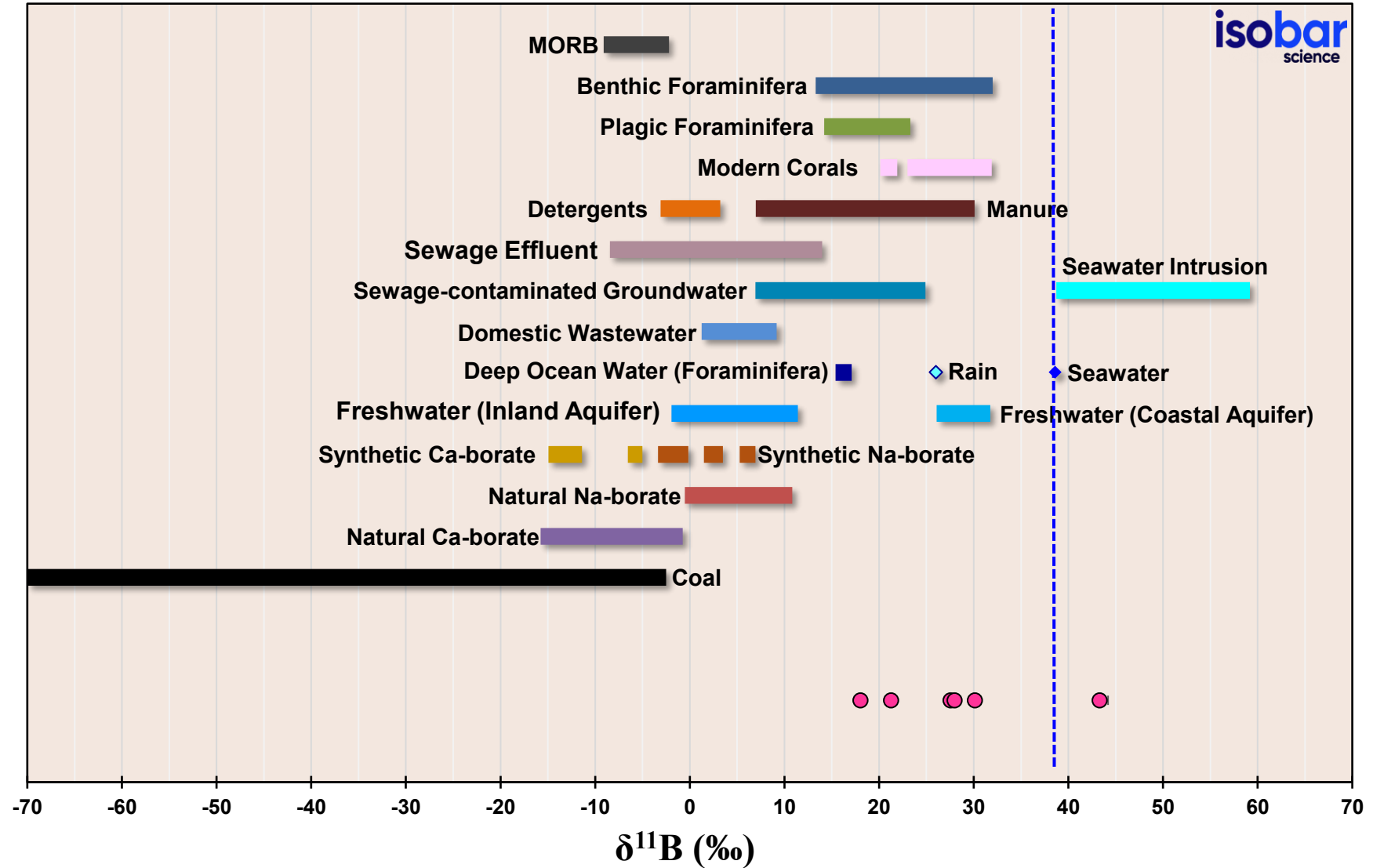
Results

Combining $\delta^{15}N_{NO3}$ with $\delta^{11}B$ provides a better distinction between the sources of nutrients
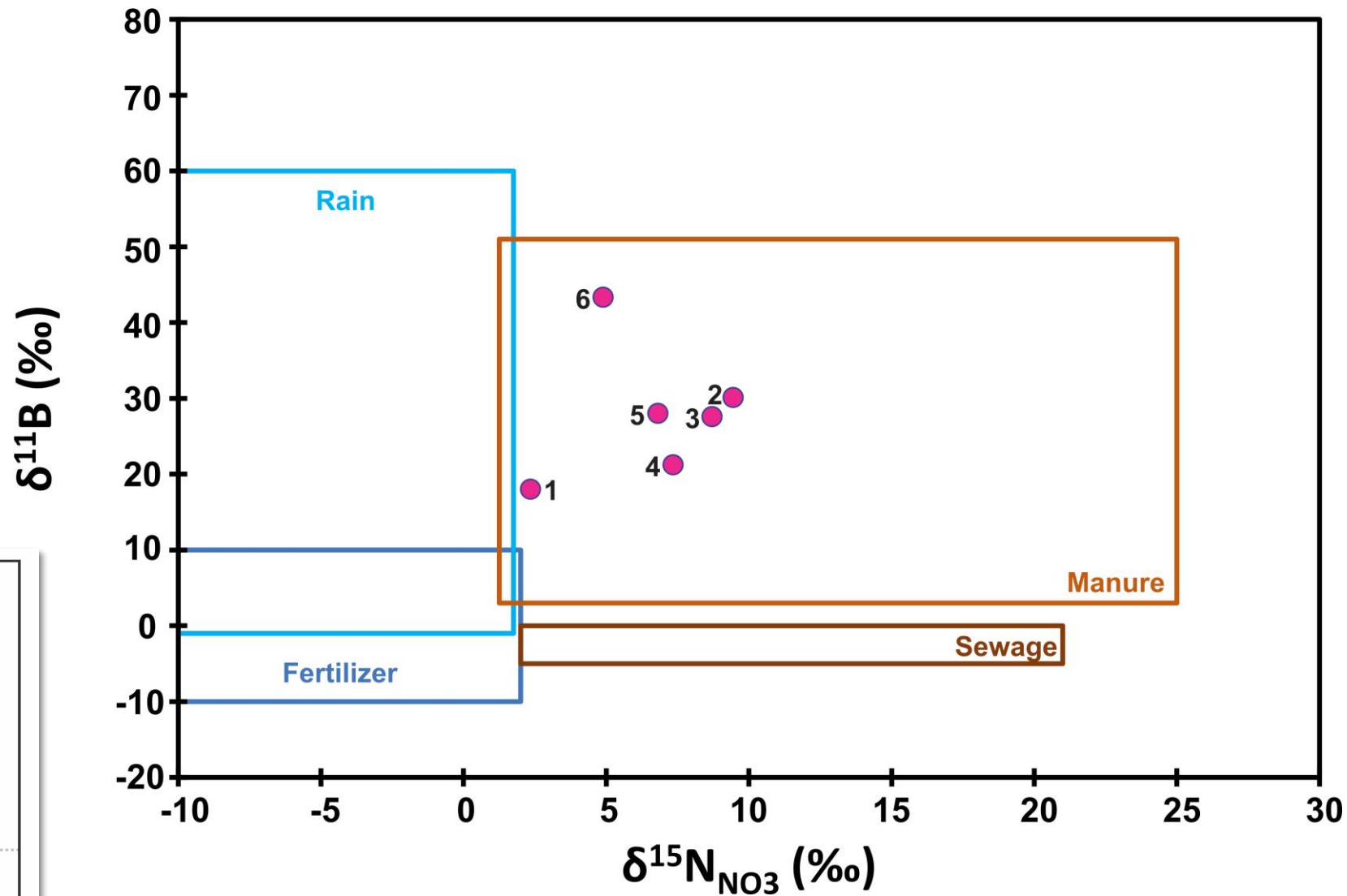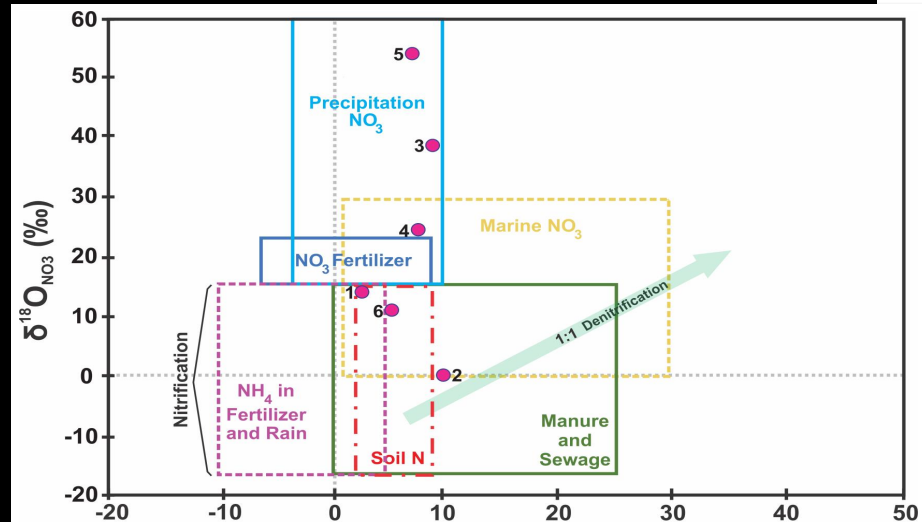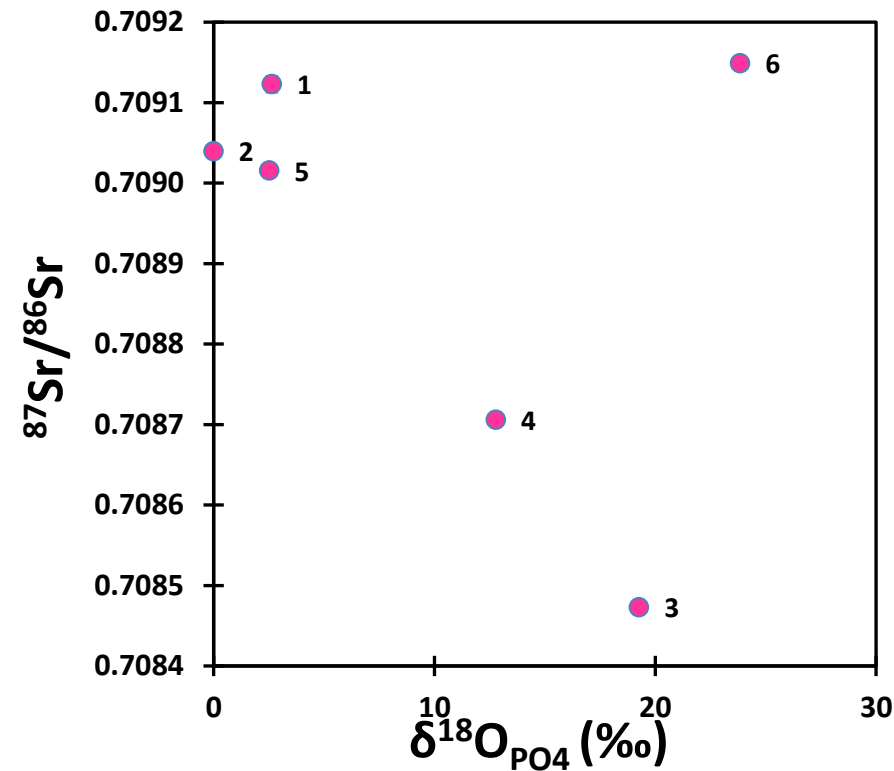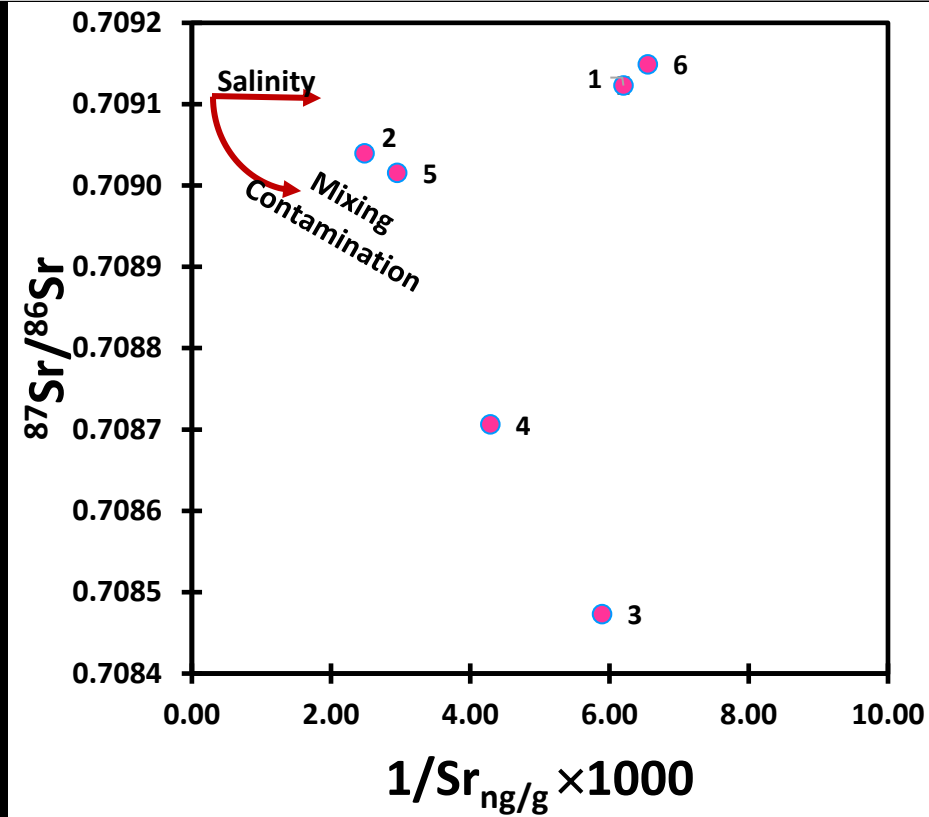
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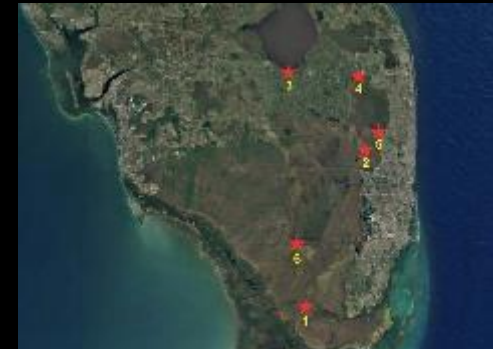
Results

- Wide range of $\delta^{18}O_{PO4}$

- Correlation with Sr isotope

- Sr isotopic signature of pollutants must be established

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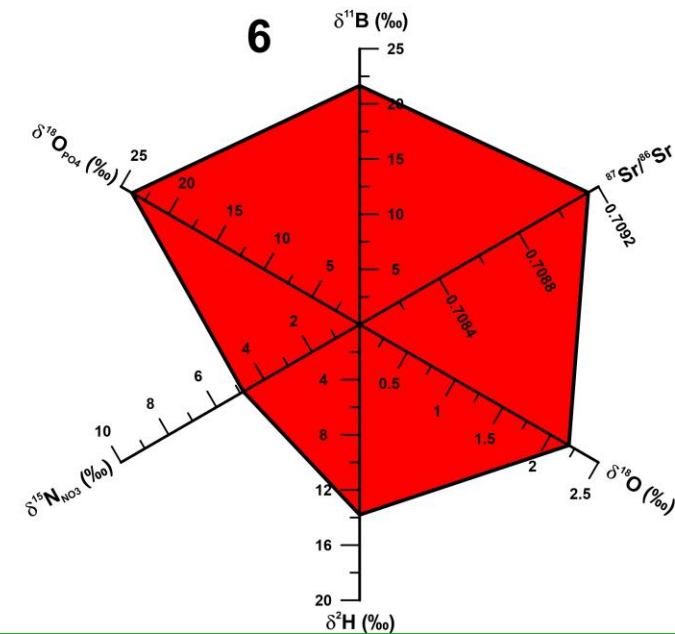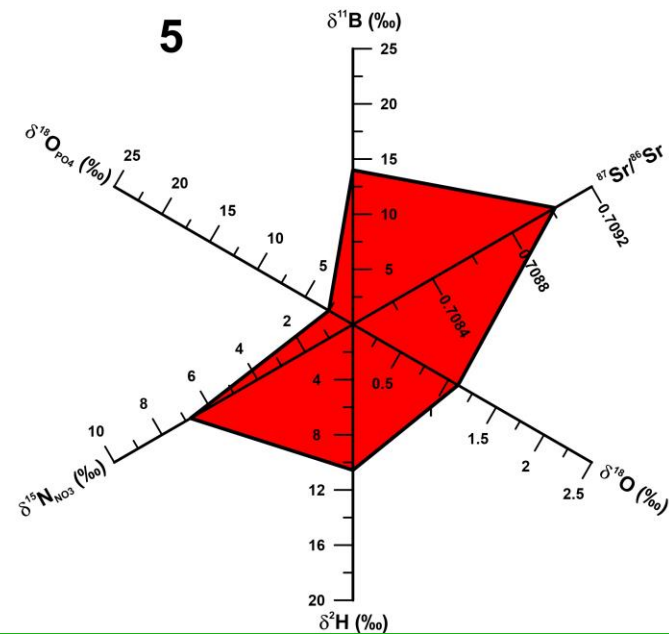

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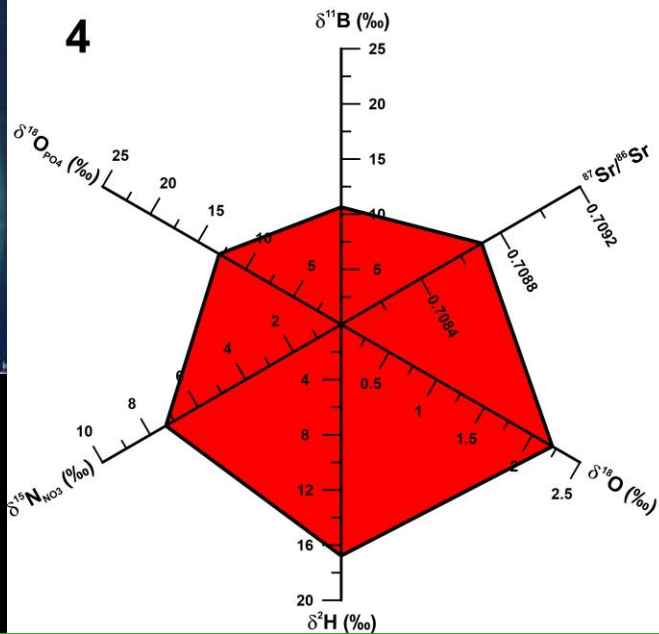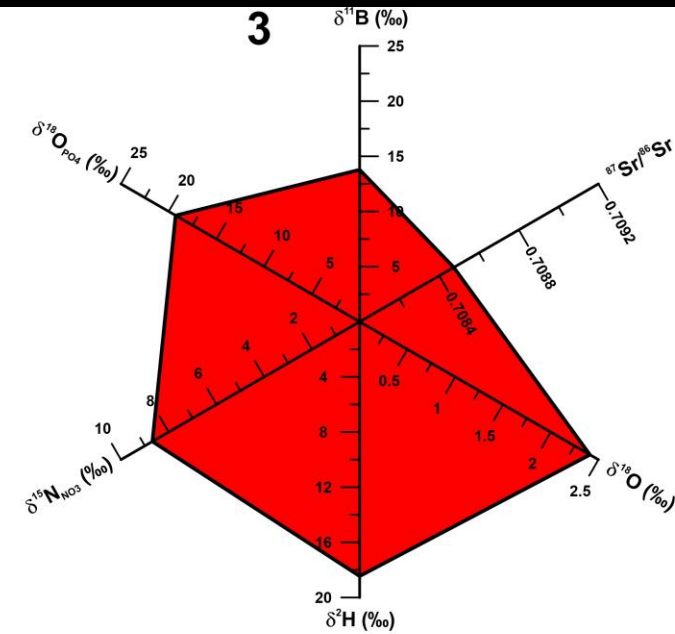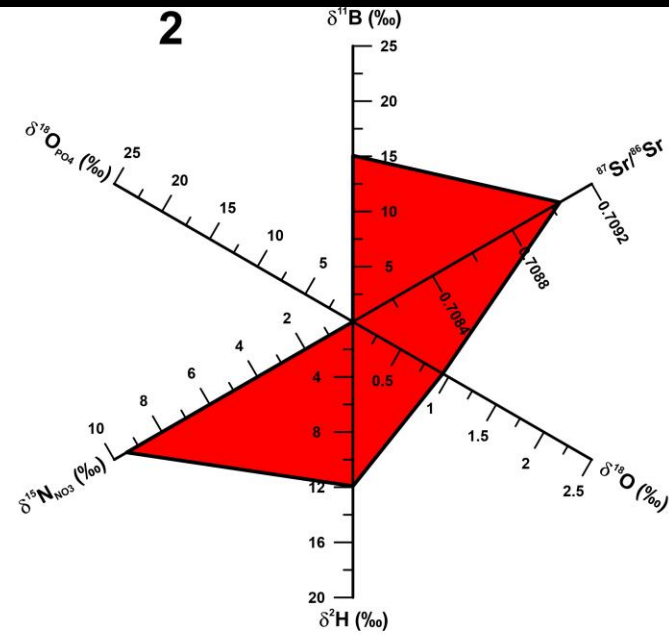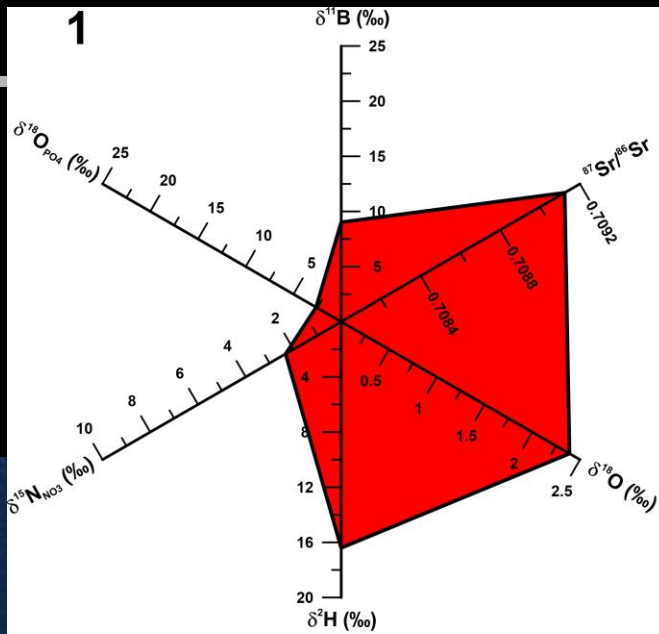
Water samples can be characterized based on multiple isotopic values

Conclusion

Pinpointing the source of contamination by adding boron isotope to the traditional O and N isotope

Oxygen isotope of dissolved phosphate and Sr isotopic ratio provide more information on type of the pollutants

Characterization of water based on multiple isotopic values