Environmental Aqueous Geochemistry

Dr. Tao Wen

EAR 419/619

Tao WEN; Dr. Wen; Professor Wen


https://www.pinshiwen.com/shishu/pinglun/201811241238.html

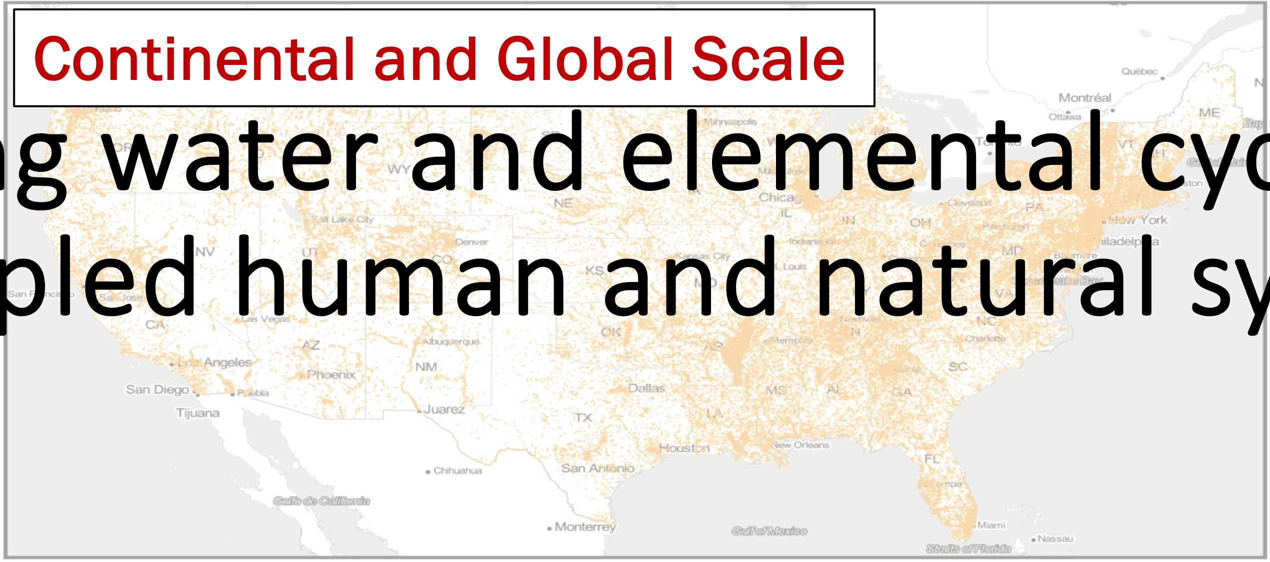

http://lswhw.ustc.edu.cn/index.php/index/info/756

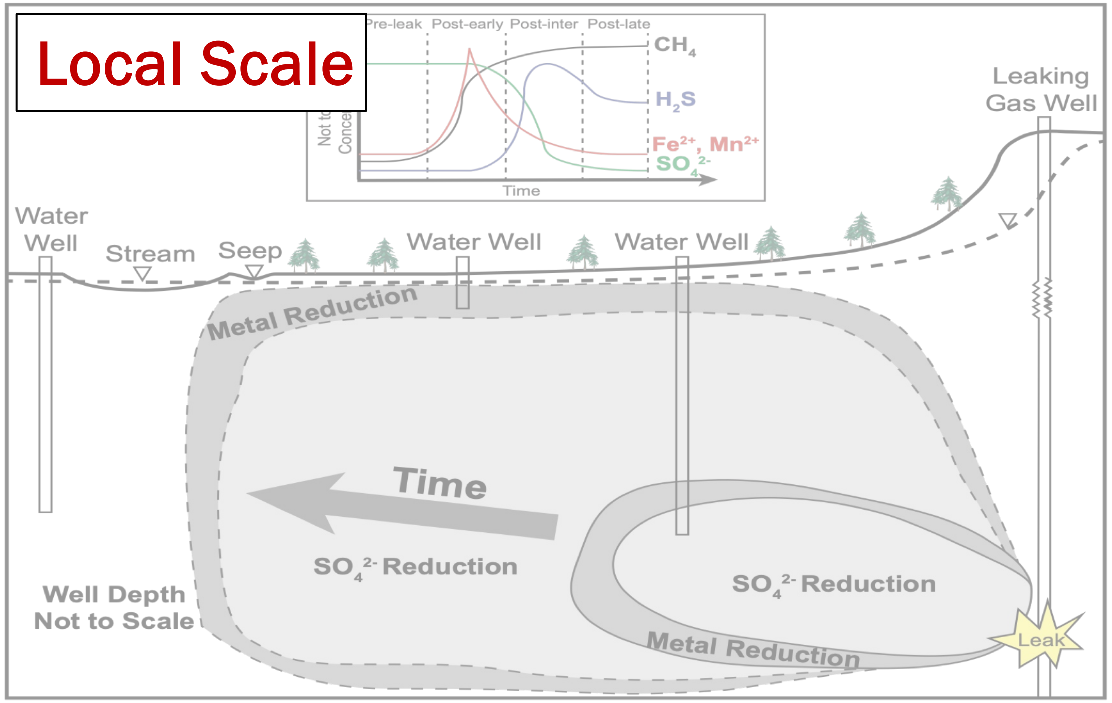

https://mgoblue.com/sports/2017/6/16/facilities-stadium-changes-2013-html.aspx

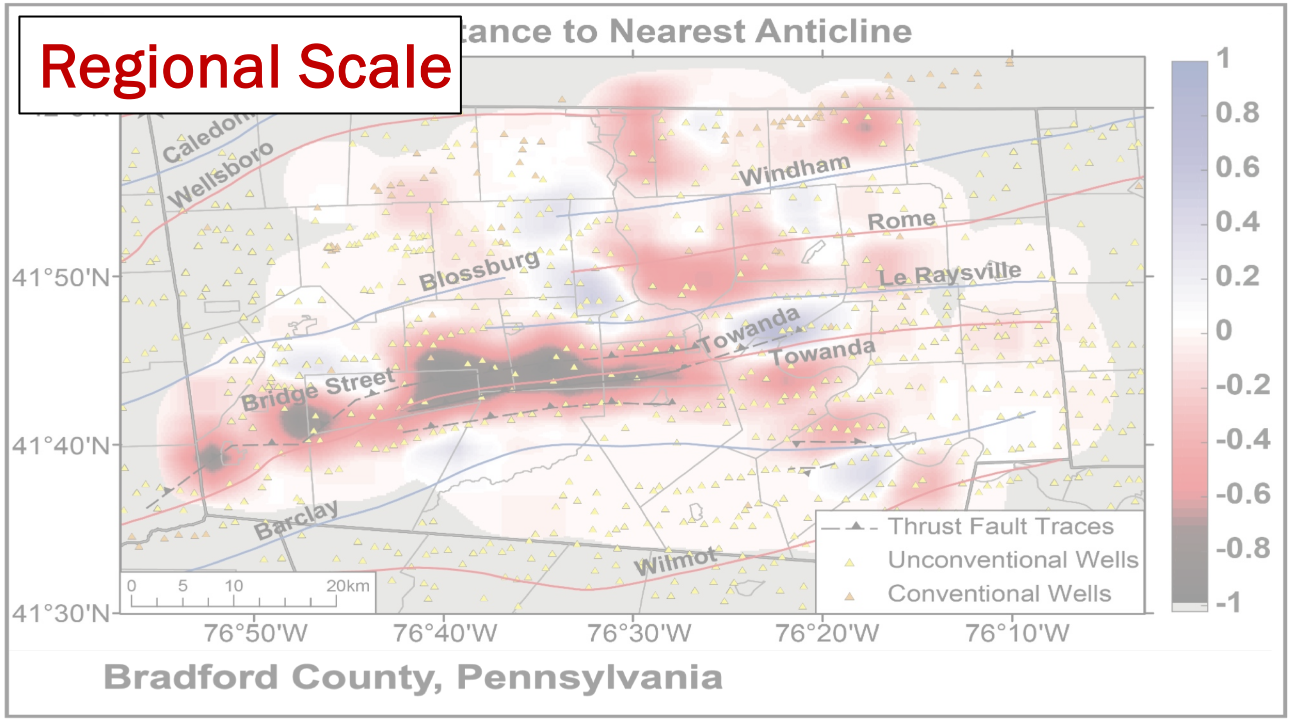

https://www.collegian.psu.edu/news/campus/article_0df89374-09f4-11e8-adc7-fbe823db3262.html


https://www.syracuse.edu/about/

Studying water and elemental cycles in the coupled human and natural systems



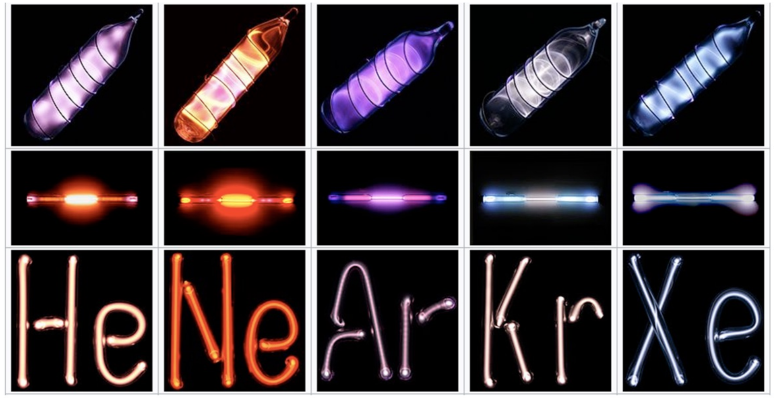




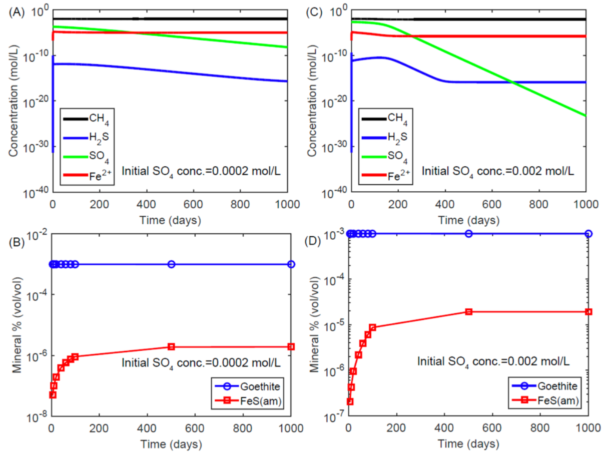
Studying water quality and water quantity in coupled human-natural systems

Geochemical Tracers,
e.g., noble gases

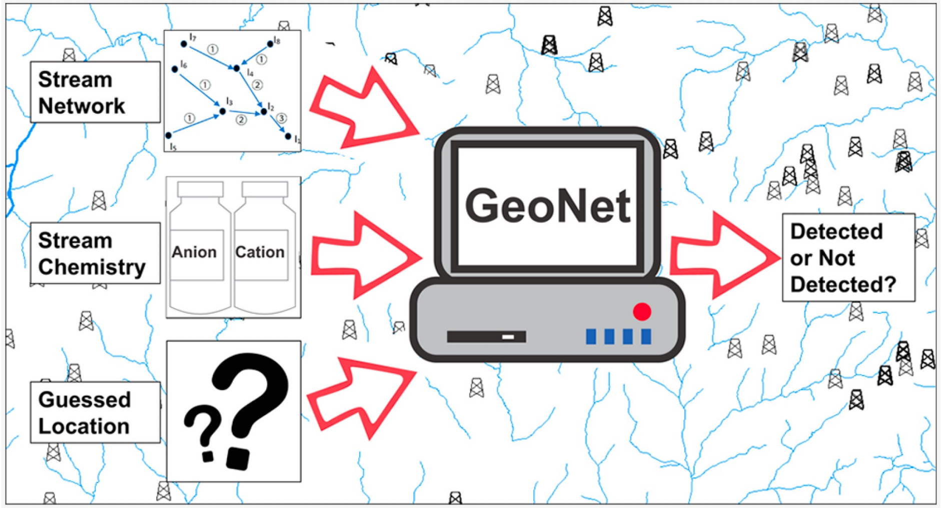
https://www.labroots.com



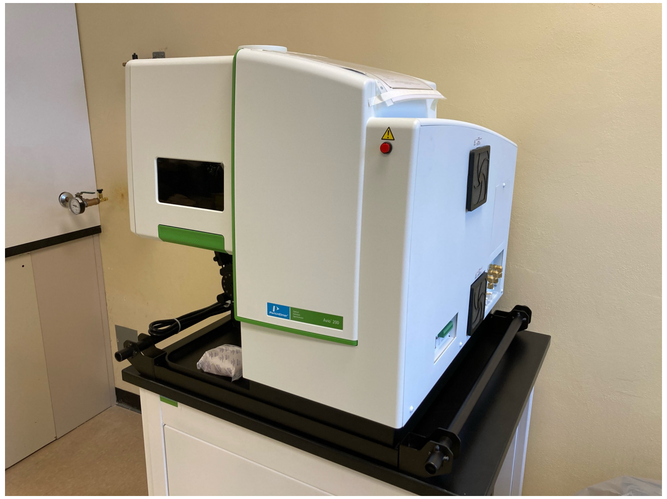
Hydro-Geochemical modeling



Statistical and machine learning models



Laboratory analyses

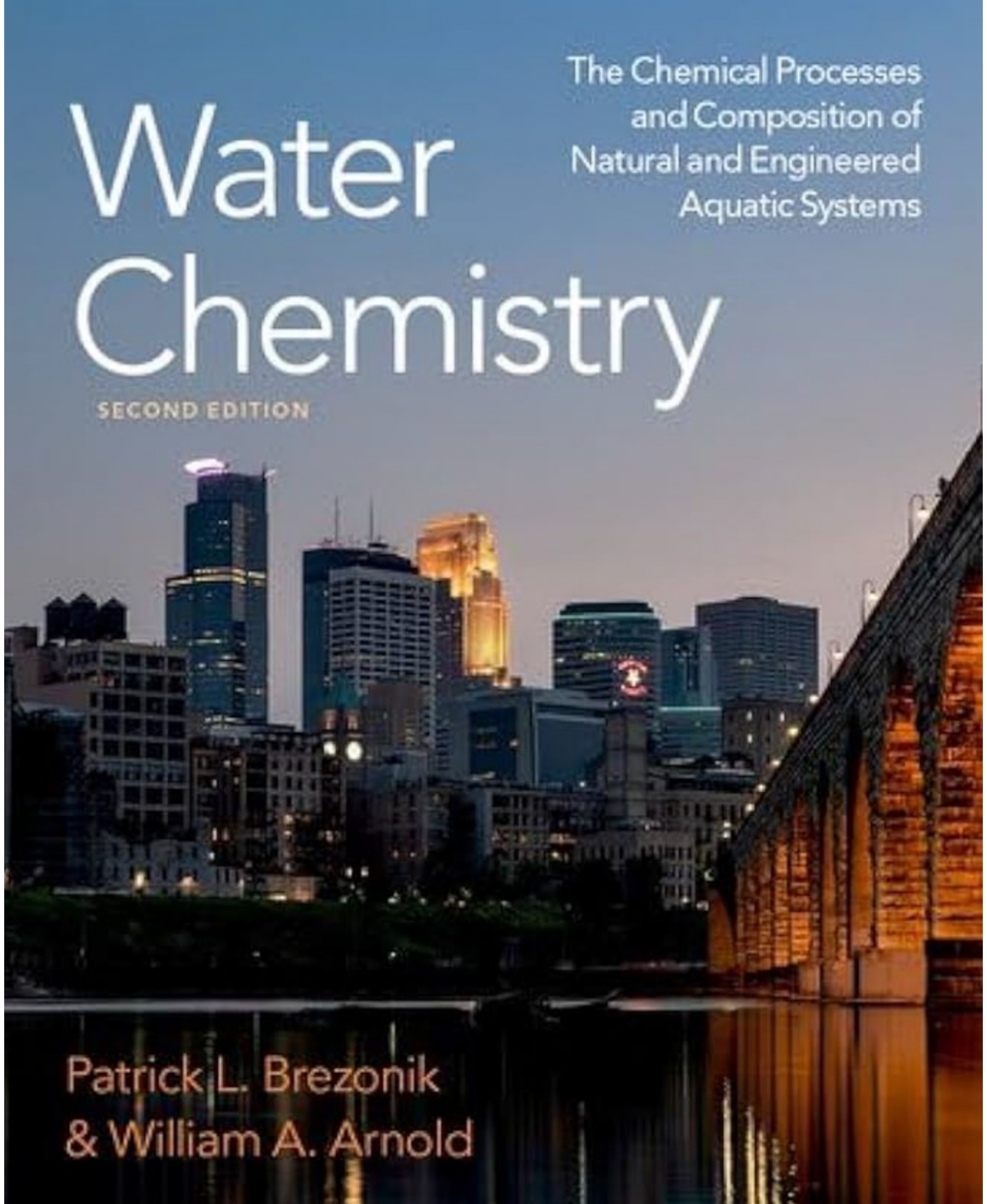


- How does water chemistry vary amongst different environments? What natural and anthropogenic processes drive the chemical signatures of the hydrosphere?
- In this course, students will learn the chemical principles that underlie water chemistry in natural and human systems.

This course is intended to provide students with the ability to critically evaluate and communicate Aqueous Geochemistry.

Student Learning Outcomes

1) evaluate chemical data to understand how water sources vary across the environment
2) calculate thermodynamic and kinetic parameters to model geochemical processes
3) use analytical techniques to determine the chemical properties of water samples collected from a field setting
4) interpret and communicate scientific results through a written research report and via class discussion of scientific literature



Water Chemistry

The Chemical Processes and Composition of Natural and Engineered Aquatic Systems

P.L. Brezonik and W.A. Arnold

*readings are supplementary to lecture and **strongly encouraged**; exam material will derive from lectures, problem sets, and labs

Grading

- Problem sets (20%) – four problem sets worth ~5% each
- Lab Reports (30%) – six lab reports each worth 5% will be turned in for each lab exercise
- Project report (15%) – a final paper due during finals week, includes work from select labs
- Midterm Exam (15%)
- Final Exam (20%)

Final Grade	Minimum Percentage
A	93% and above
A-	90%
B+	87%
B	83%
B-	80%
C+	77%
C	73%
C-	70%
D	60%
F	59% and below

****First problem set due on Blackboard by the start of the class on September 5**

Course website

- Github-hosted course website: https://jaywen.com/courses/ear-419-environmental-aqueous-geochemistry/
  - Syllabus
  - Lecture
  - Labs
  - etc.
- SU Blackboard Ultra site: https://blackboard.syracuse.edu
  - Assignments and exams releasing and submission
  - Solution releasing

Grading continued

- Grading-related questions: I recognize that you care about the score you receive in this class. However, there may be times where I may enter a wrong score in a grade book, or when you may wish to know more about why you received a certain grade. For grading related questions, I am using a 24-7 rule:
    - Immediately after new grades are added, you must wait 24 hours before contacting me about your grade. This waiting period helps with hasty reactions. I will not respond to any request made during this period.
    - The deadline for appealing a grade is 7 days after the grade is released in Blackboard. Please be sure to include any specifics in your email to me about your grade.

Class project and project report

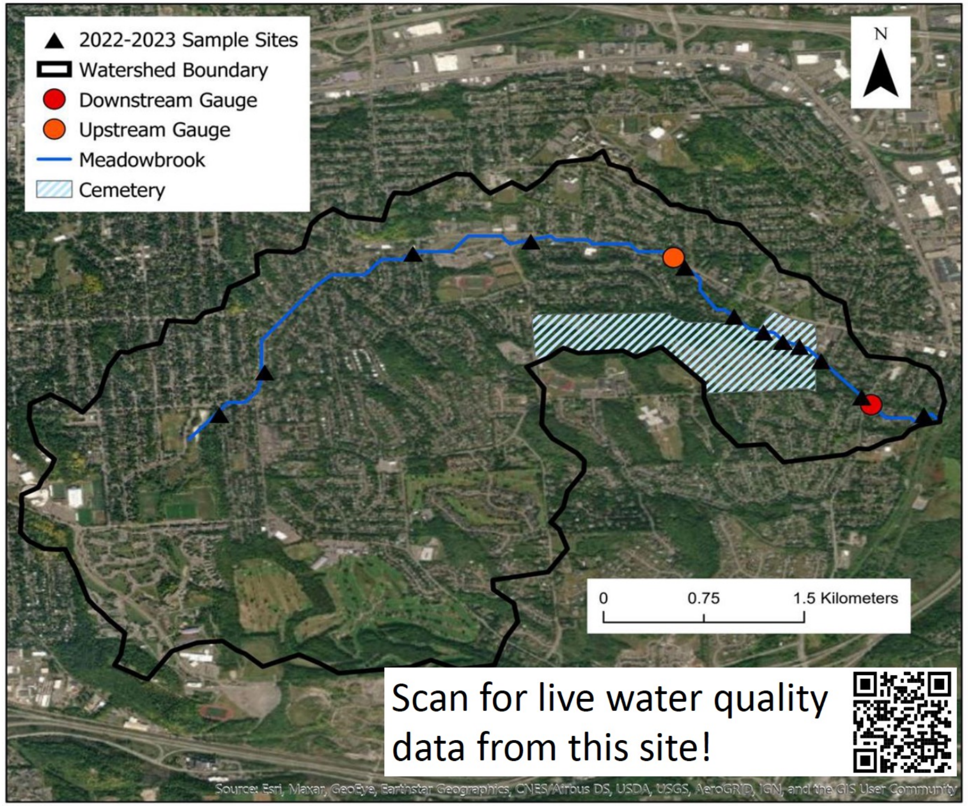
- Student will choose a topic related to this class by consulting with Tao
- In week 5, student will turn in their project idea.
- In week 10, student will turn in a one-pager of the chosen topic.
- Final project report (introduction, methods, results, figures/tables, and discussion)
- Class time will be devoted to discussion of results, and students are encouraged to discuss the project outside of class to formulate hypotheses and conclusions.

(Optional) Field trip

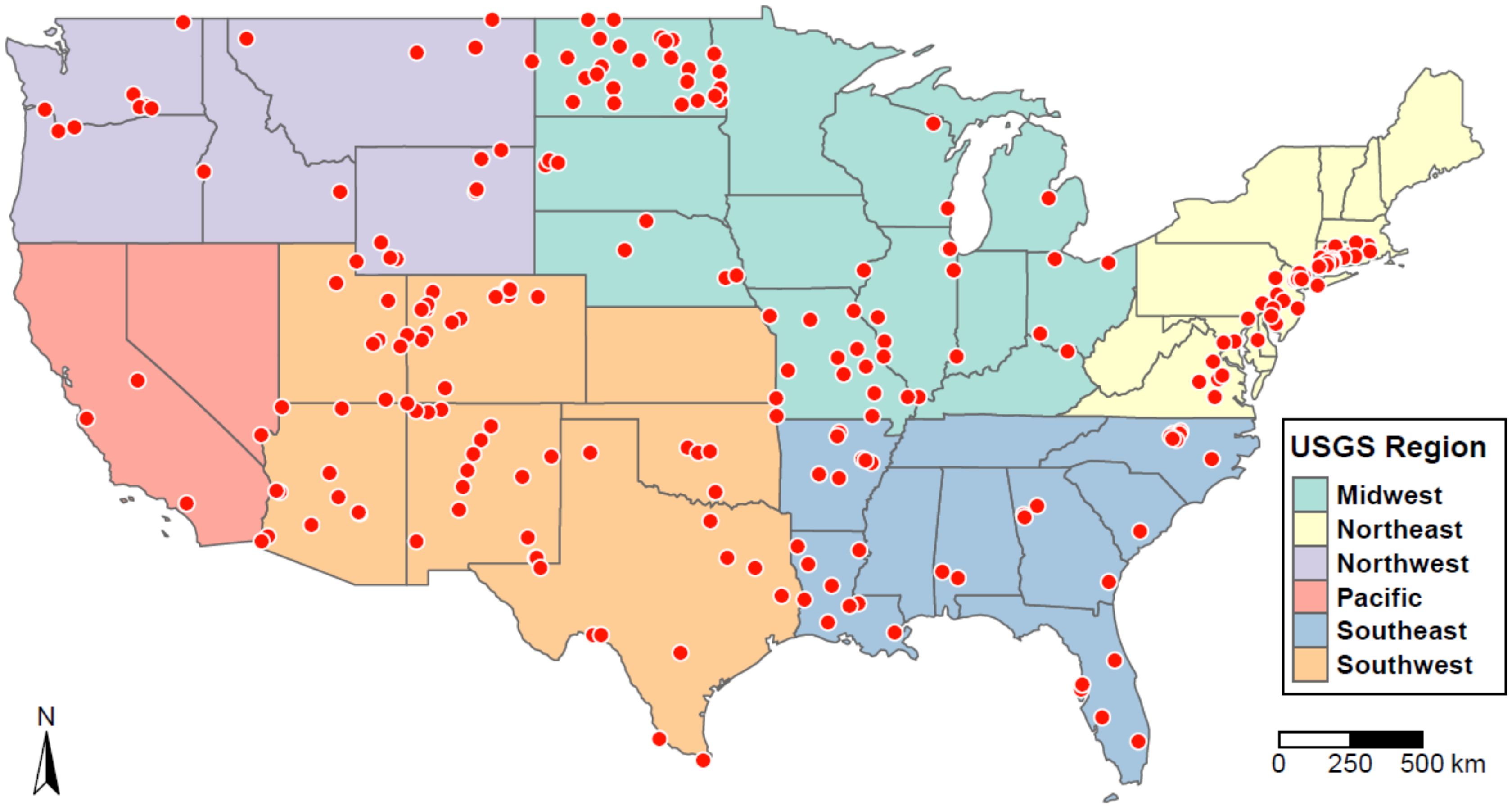
A mandatory field trip will take place on **XXXX**.

Students will travel to the Meadowbrook Creek (~10 mins southeast of SU campus) or City Line Brook (~10 mins southwest of SU campus) to collect water samples and conduct chemical analyses. Results obtained from these samples will serve as the basis for the final report, for which you will investigate the topic:

“Geochemical reactions in urban stream”



Environmental data science



Example question: Are U.S. streams getting saltier with time?

Lab Reports/Paper discussions

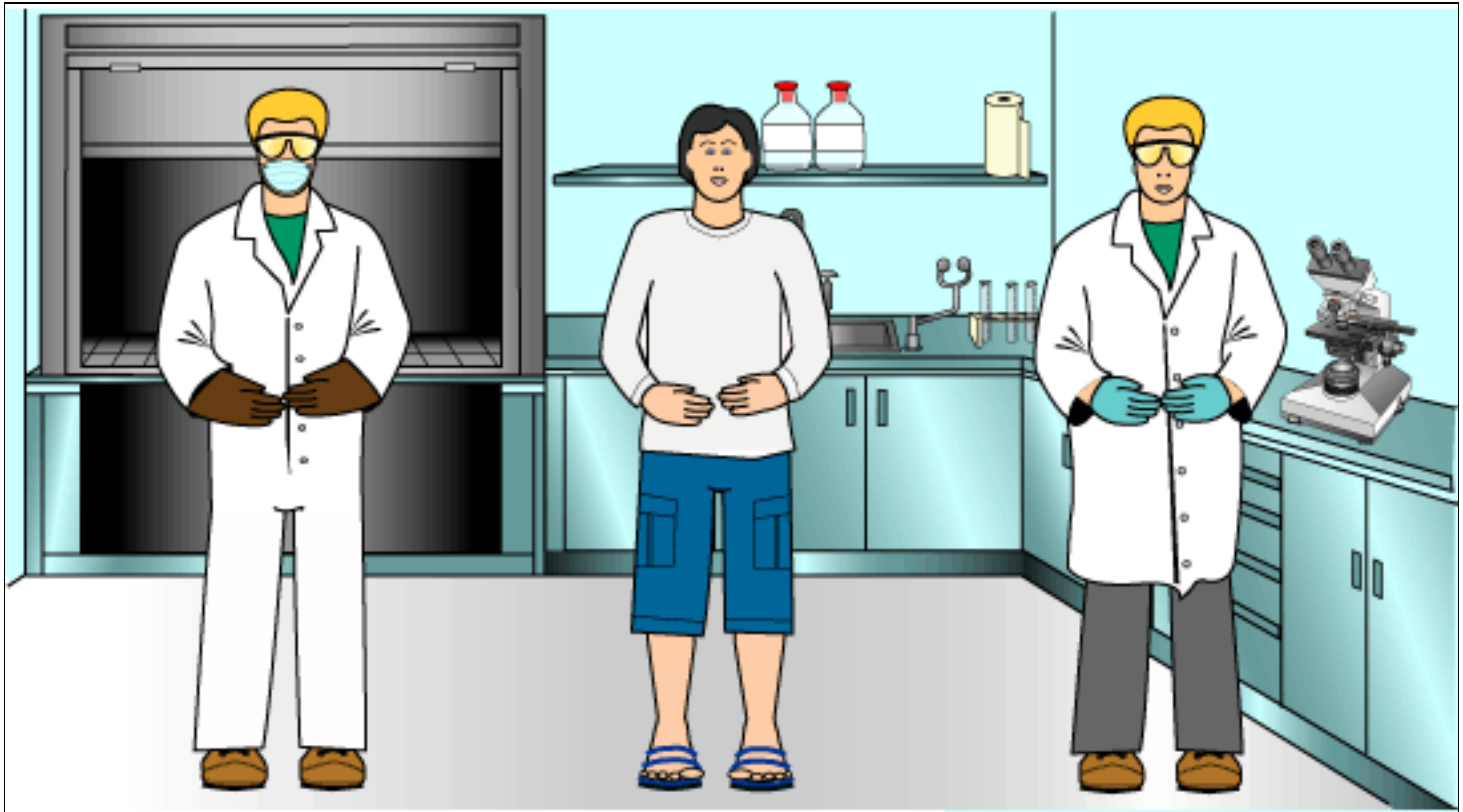
Topics:

1. Discussion paper – response due at start of class
2. pH and TDS measurements – laboratory exercise
3. Data analysis – graphical and statistical presentation of data for use in final report; classroom exercise
4. Advanced data analysis – basic R coding and data analysis; classroom exercise
5. Dissolution kinetics – laboratory exercise
6. Discussion paper – response due at start of class

****5% is deducted each day for late assignments**
*****late assignments will not be accepted after graded assignments have been returned**

Laboratory Safety

- Pants and closed toed shoes are <u>required</u> for all laboratory exercises; students must also wear googles and lab coats (will be provided)



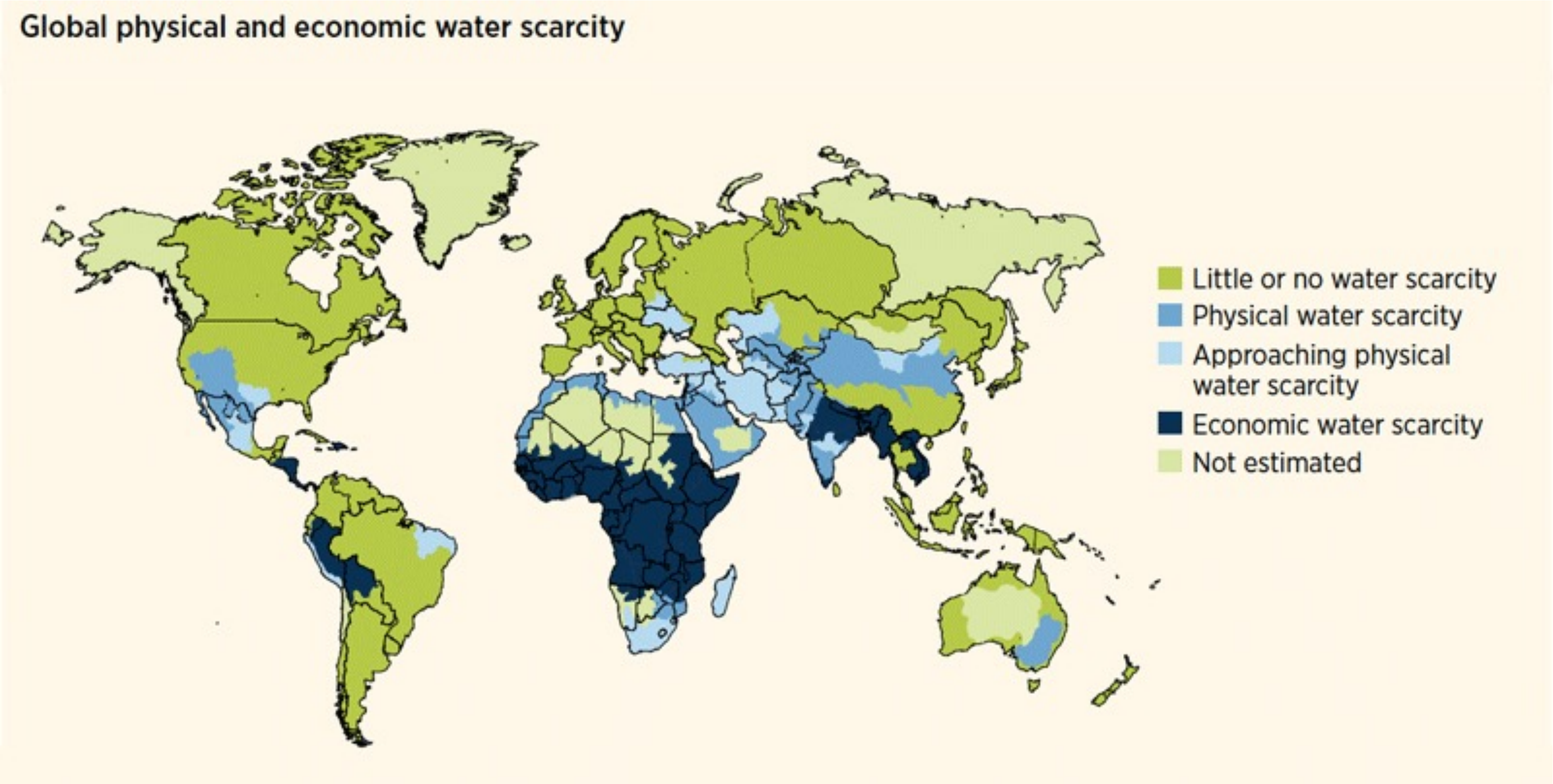
Introduction to Environmental Aqueous Geochemistry

The chemistry of water-rock interaction

The globe is facing a major water crisis

Water scarcity

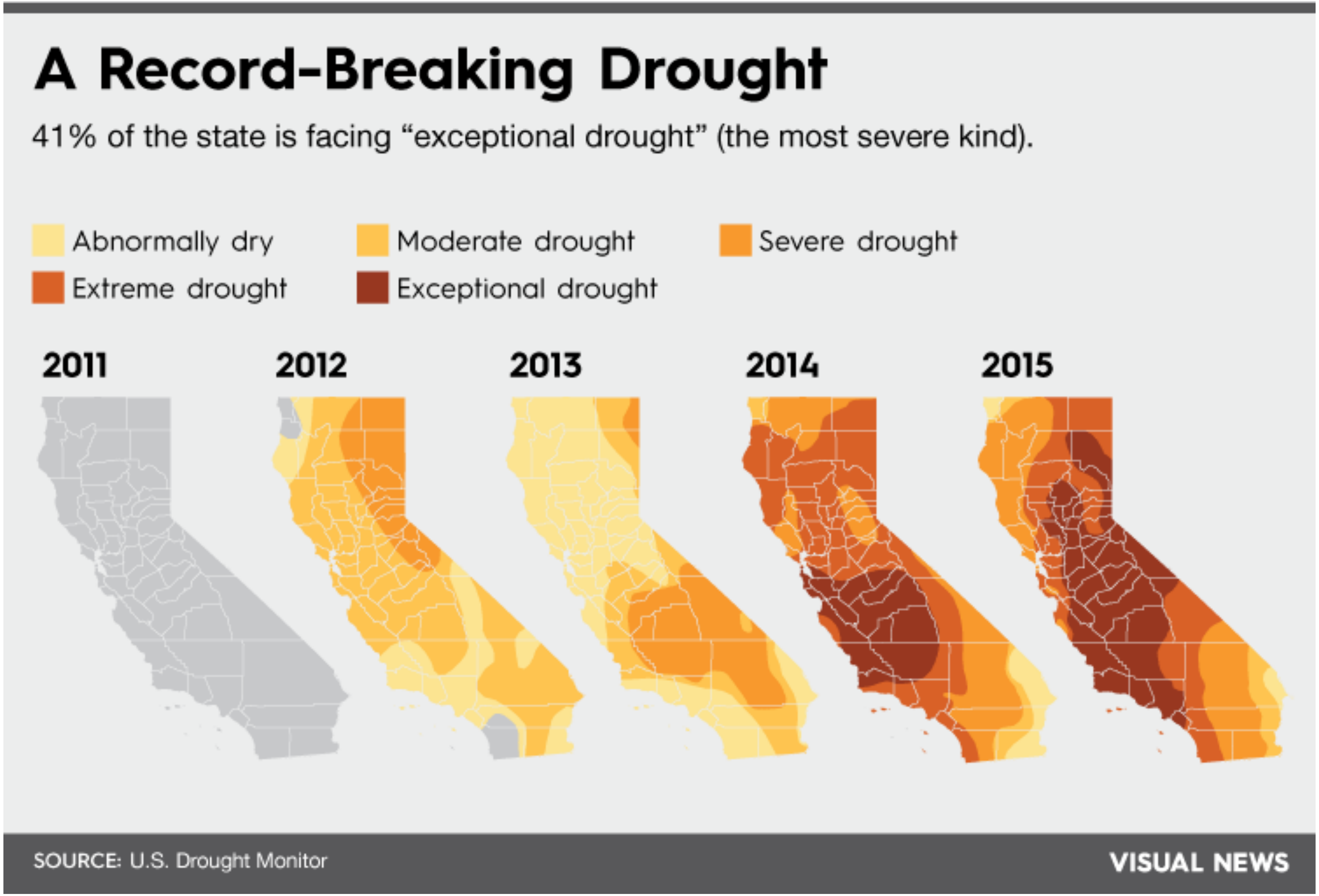
- 1.2 billion people live in areas of physical water scarcity
- Additional 1.6 billion people face water shortage due to lack of infrastructure to deliver clean water (economic scarcity)



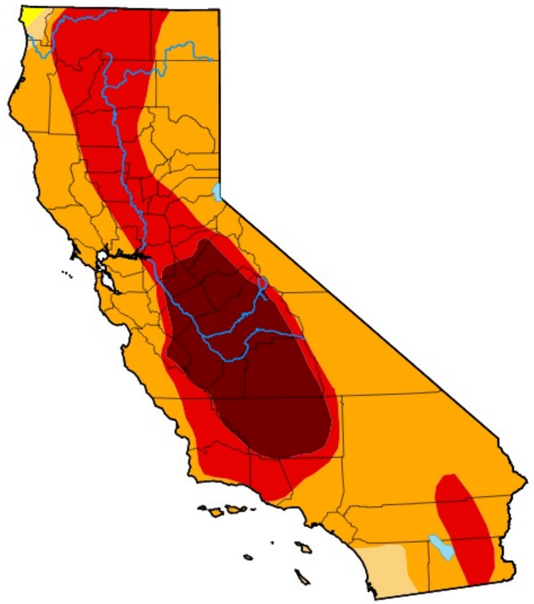
Drivers of water scarcity

- Increasing global population
- Increasing urbanization (need for concentrated water supplies)
- Increasing per-capita consumption as world becomes more developed
- Changing climate (increased temperatures, decreased precipitation in semi-arid regions)

California drought



August 23, 2022



Water quality

"Safe water" must have sufficiently low concentrations of harmful contaminants, including bacteria, viruses, pesticides, petroleum products, some metals and metalloids, strong acids, and many more substances.

– U.S. Geological Survey

How is water quality determined?

*Set by each state, water quality standards regulate how clean a water body should be. The standards consist of the water body's **designated uses**, water quality criteria to protect those uses and determine if they are being detained, and anti-degradation policies to help protect high quality water bodies. – EPA.gov*

- Protection and propagation of fish, shellfish, and wildlife
- Recreation
- Public water supply
- Agricultural, industrial, navigational, and other purposes

http://water.epa.gov/scitech/swguidance/standards/

Factors that impair water quality

- Unhygienic disposal of human and livestock waste
  → >80% of raw sewage in developing countries goes into water bodies untreated
- Inadequate treatment of industrial byproducts
  → Industries release 300-400 million tonnes of heavy metals, solvents, and toxic sludge into water each year
- Agricultural practices
  → Manure and fertilizer runoff from agriculture is single greatest source of water pollution in the United States (nitrogen, phosphorus, pesticides)
- Natural contamination from toxic materials in bedrock

Consequences of nutrient runoff

- Nitrogen and Phosphorus are plant nutrients and major components of fertilizer
- Runoff from farmland transports N and P into rivers, lakes, and oceans where is feeds harmful algal blooms

Harmful Algal Bloom in Lake Erie

NASA images

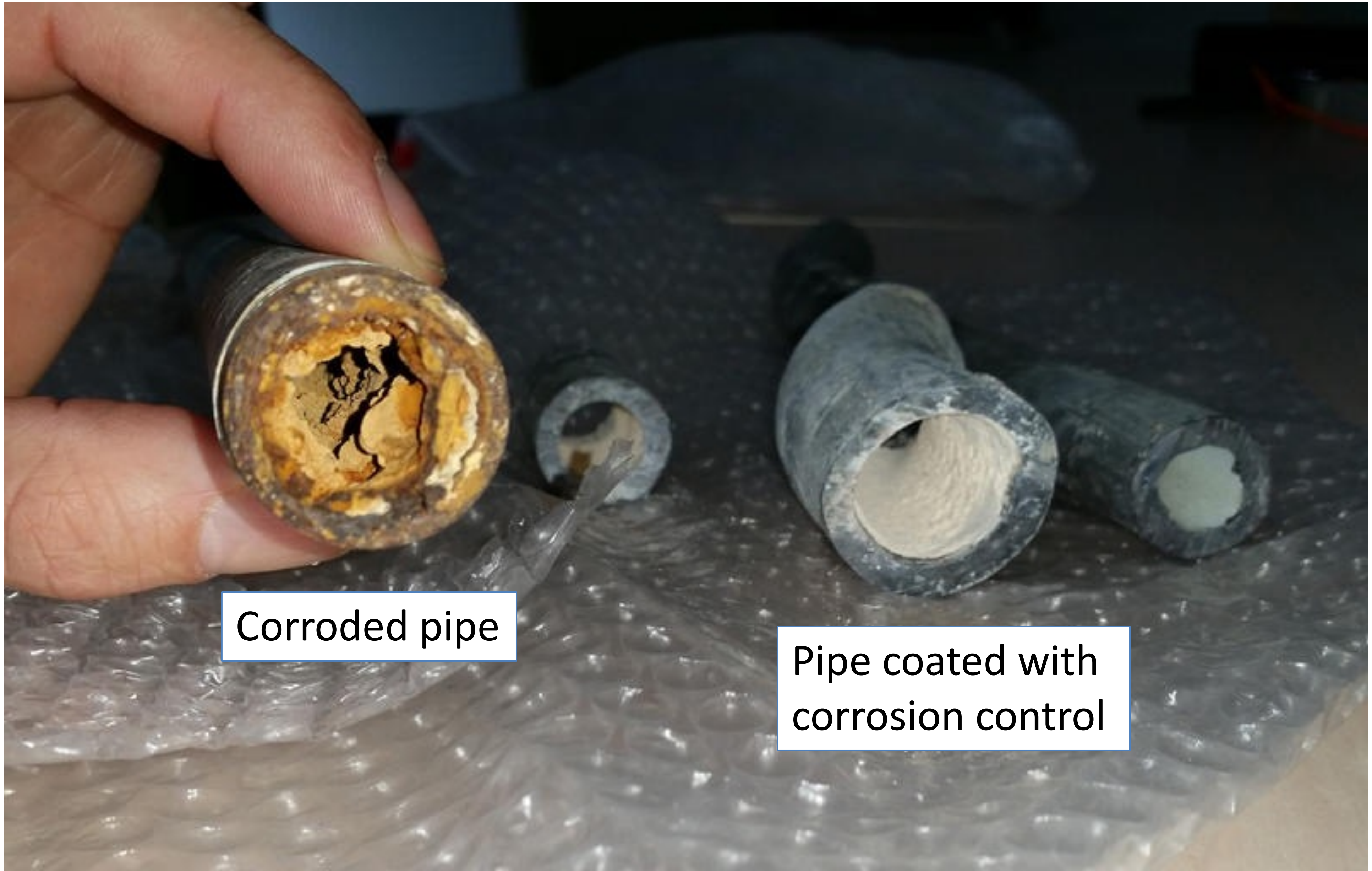
Water Quality and Lead Poisoning in Flint, MI

- Flint switched the city water supply from the Detroit River to the Flint River in 2014
- Consequent increases in blood lead (Pb) levels in children (and other water quality issues) led to water crisis

Lead (Pb) in plumbing

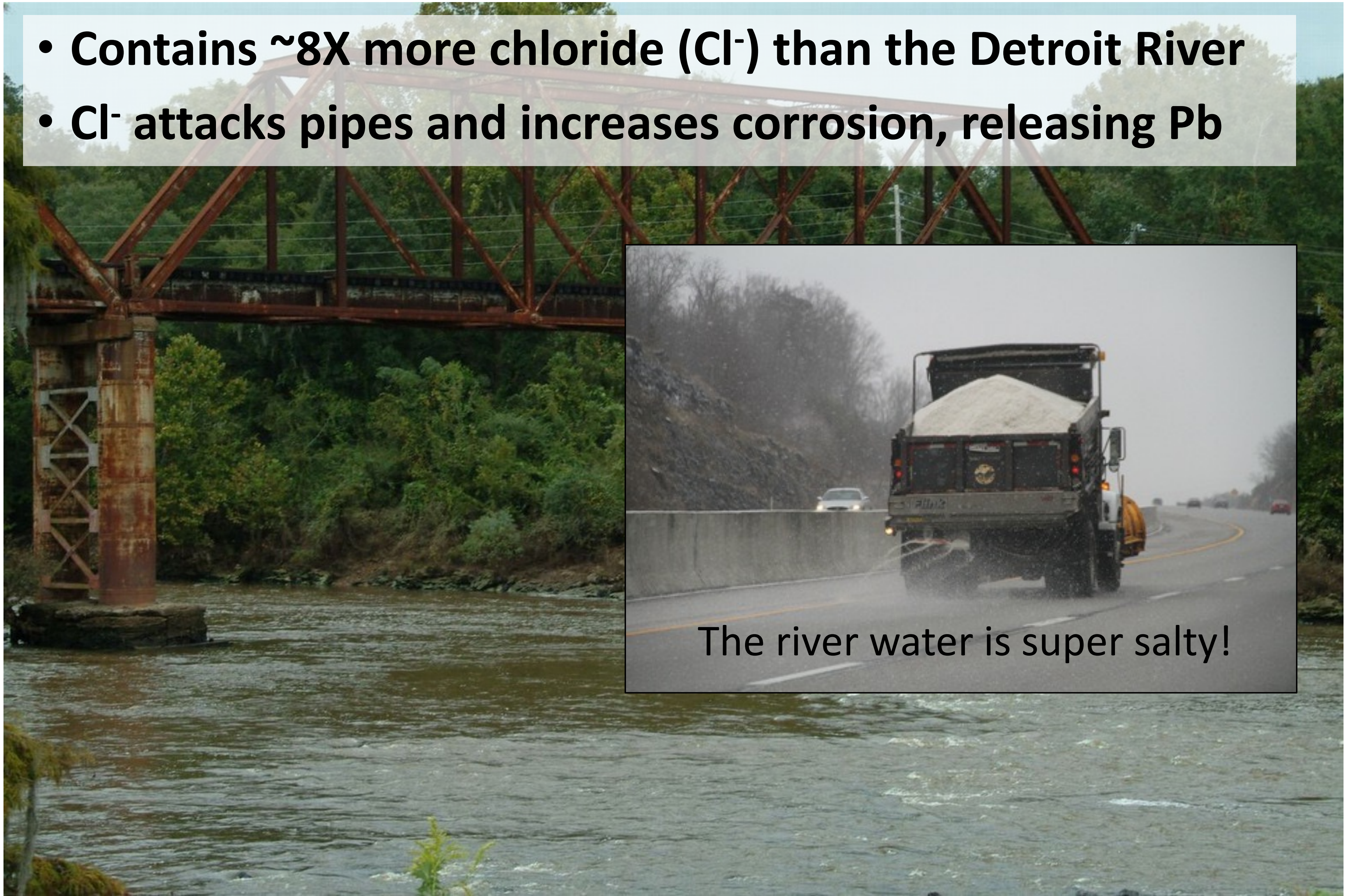
- Used since the Roman Empire to build pipes
- 70% of all U.S. cities used lead water mains in 1900
- Homes built before 1986 more likely to have lead pipes and fixtures
- Lead is leached into drinking water when pipes are corroded by acidic and/or salty water

Phosphates are usually added to water to limit corrosion (but were not being added to the Flint water supply)



What’s wrong with the Flint River?

- **Contains ~8X more chloride (Cl^-) than the Detroit River**
- **Cl^- attacks pipes and increases corrosion, releasing Pb**



How are we going to approach these questions?