Tools for Reasoning

Formative Assessments

Reasoning Tools for Understanding Water Systems

Kristin L. Gunckel, University of Arizona
Beth A. Covitt, University of Montana
Charles W. Anderson, Michigan State University

CADRE Meeting, Washington D.C.
June 15, 2012

Tools for Reasoning

Formative Assessments

Research Support

This research is supported in part by grants from the National Science Foundation: Targeted Partnership: Culturally Relevant Ecology, Learning Progressions and environmental literacy (NSF-0832173), and Tools for Reasoning about Water in Socio-ecological Systems (DRL-1020176). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Tools for Reasoning

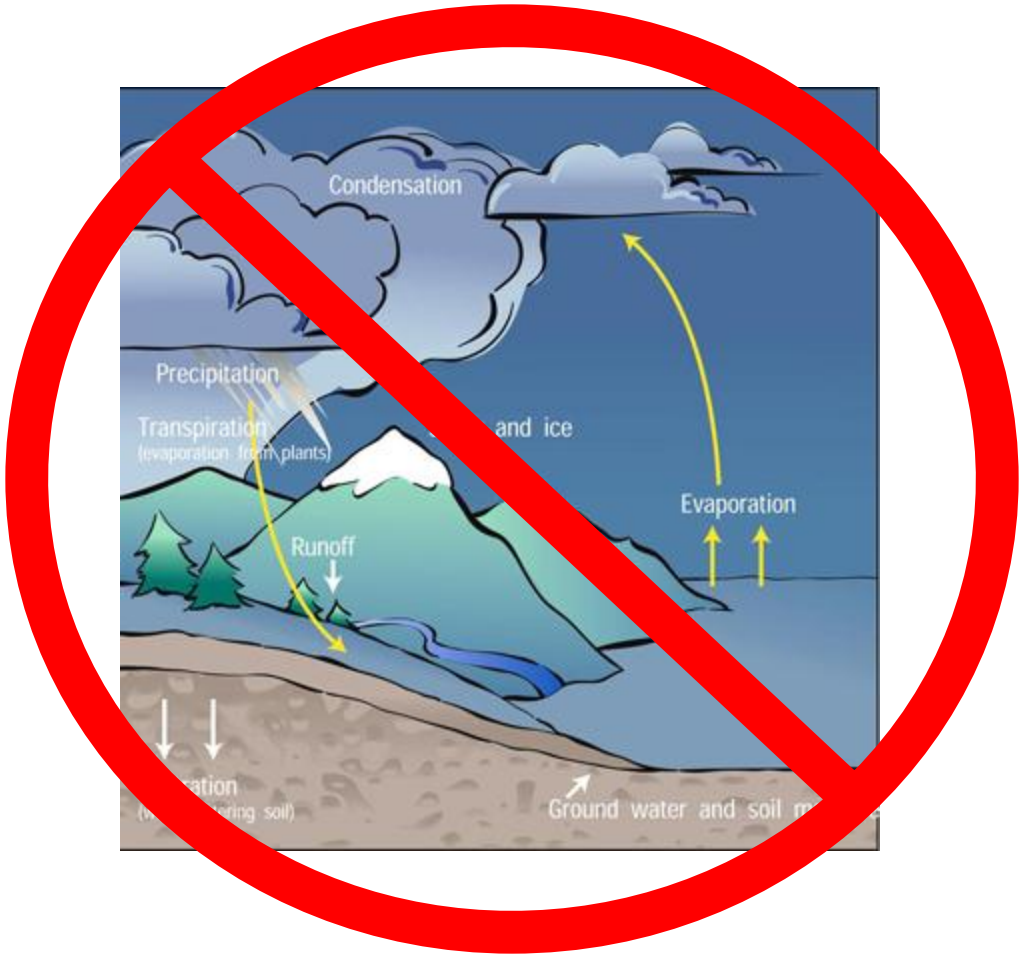
Formative Assessments

CLAIM #1: FRAMING SCIENTIFIC KNOWLEDGE AND GOALS FOR TEACHING

Tools for Reasoning

Formative Assessments

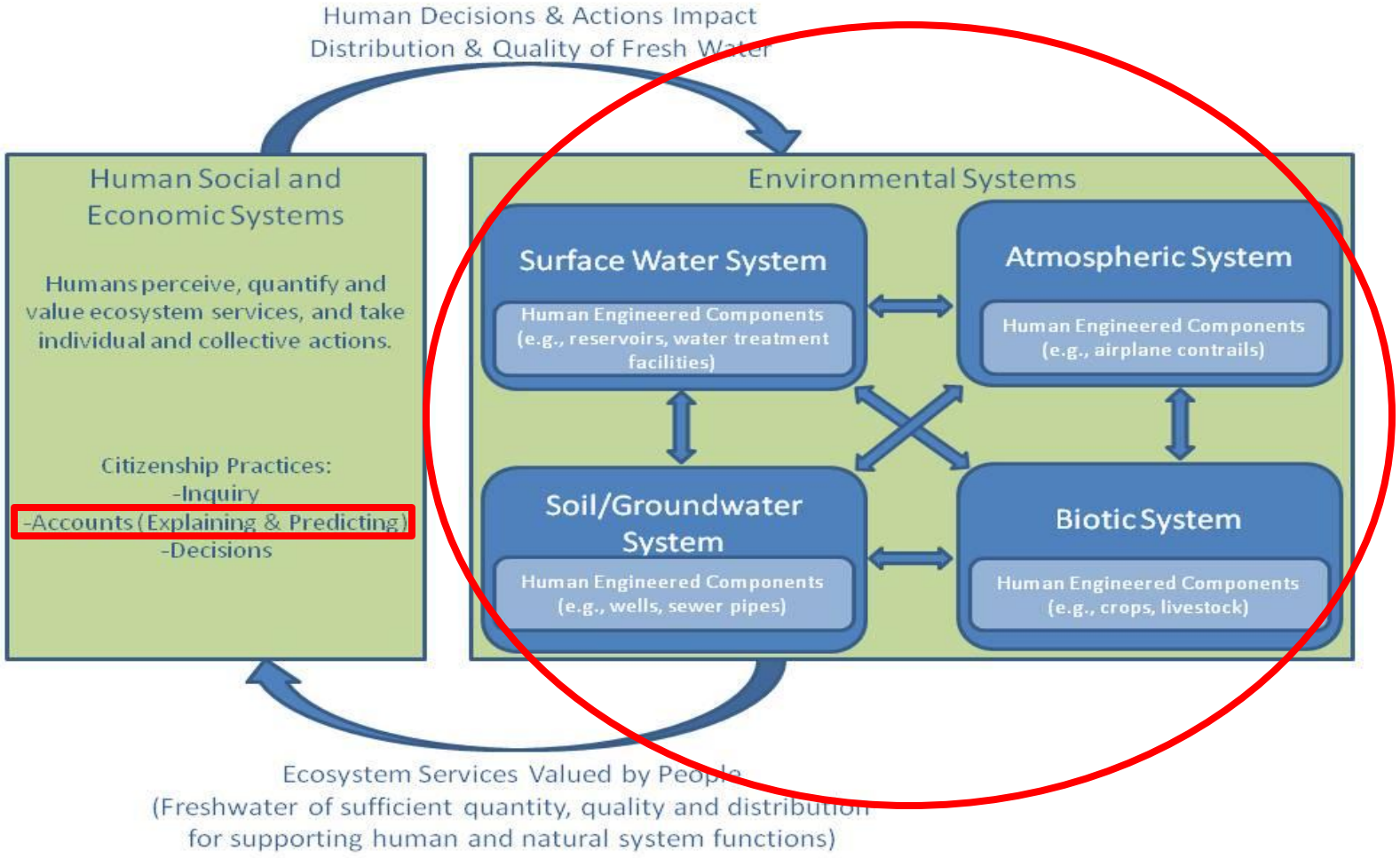
Typical Water Cycle Learning Goal



Water Systems Learning Progression

Accounts (Explanations and Predictions)

Moving Water & Substances in Water



Tools for Reasoning

Formative Assessments

Water Systems Learning Progression

Level 4 – Qualitative Model-Based Reasoning

- Driving forces & constraining factors (hows and whys)
- Atomic-molecular to landscape scales

Level 3 – School Science Stories

- Events in order
- Names processes
- Microscopic to landscape scales

Level 2 – Force Dynamic with Mechanisms

- Actors, enablers, antagonists
- Macroscopic only

Level 1 – Force Dynamic

- Water in isolated locations
- Human-centric

Tools for Reasoning

Formative Assessments

Using Water Systems LP to Select Learning Goals

- Start where students are, move towards next level of achievement
  - From isolated water to connected pathways, including human-engineered systems
  - From visible water to hidden and invisible water and processes
  - From macroscopic to atomic-molecular and landscape scales
  - From naming processes to providing and using model-based accounts

Tools for Reasoning

Formative Assessments

Using Water Systems LP to Select Learning Goals

- Focus on building student reasoning rather than "covering the content" or replacing misconceptions
- Move beyond description
- Focus on content fused with practices
  - Model-based accounts (explanations and predictions)
  - Driving forces and constraining factors

Tools for Reasoning

Formative Assessments

CLAIM #2: FORMATIVE & SUMMATIVE ASSESSMENT

Tools for Reasoning

Formative Assessments

LP-Based Formative Assessments

- Support teachers in identifying intermediate indicators of student progress
- Provide potential pathways for instruction

Tools for Reasoning

Formative Assessments

5 Design Criteria for LP-based Supports

#1 Develop teachers' capacity to recognize and construct scientific model-based accounts

#2 Support eliciting, analyzing, & responding to student thinking

#3 Support developing model-based accounts

#4 Facilitate classroom norms for engaging in social and epistemic scientific practices (e.g., conducting investigations, building explanations and arguing from evidence).

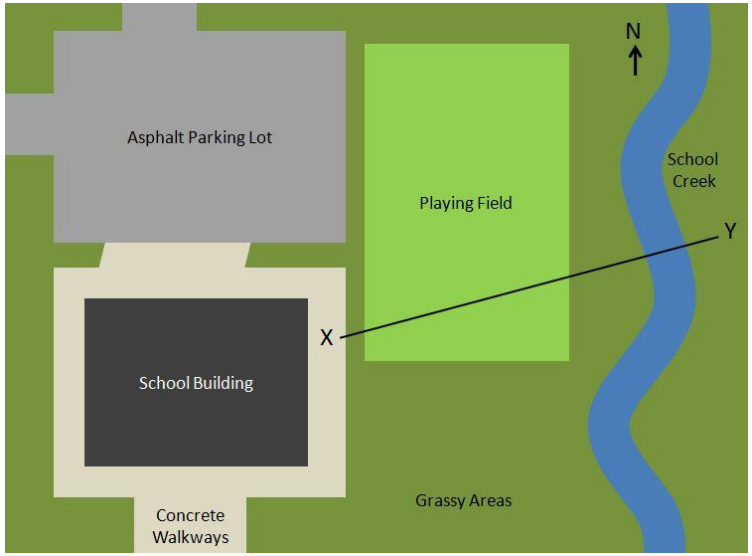
#5 Support flexible use

Tools for Reasoning

Formative Assessments

School Map Formative Assessment

If you were looking from the side instead of from above, what would the shape (height) of the land be like across the distance from Point X to Point Y? (Circle the answer you think is the best.) Explain your reasons for your answer.



A 	D 
B 	E 
C 	F There's no way to know.

Key for Evaluating Responses

Level	If you were looking from the side instead of from above, what would the shape (height) of the land be like across the distance from Point X to Point Y?	Circle which direction you think School Creek is flowing
1	**C. (**  **)** The map is flat. OR **F.** Can't tell.	**South.** Rivers and creeks always go South. OR The water runs down the page.
2	**A. (** ) The line in choice A slants up from point X to point Y like the line does on the map. The land must go up like the line goes up. OR **E. (** ) The land is bumpy near the creek. OR **F.** (There's no way to know) The map doesn't show the shape of the land.	**North.** I can tell because the compass is pointing North.
3	 **B. (**) The land goes down to the creek. OR  **D. (** **)** The creek is lower.	**You can't tell from the map** The map doesn't show which way the creek is going.
4	**D. (**  **)** Playing fields are usually pretty level and in D, the land starts out level from X. A creek has to be lower than the land around it because water flows down. In option D, the land dips down where the creek is.	**You can't tell from the map** Sometimes you can tell the direction of water from a map, but not here. There's no river or other body of water that the creek is flowing into to provide a clue about the direction the water is flowing.

Tools for Reasoning

Formative Assessments

Suggestions for Level 3 Students

Provide activities that focus on driving forces and constraining factors that determine which way surface water flows, and clues to direction of surface water flow that are on some maps.

- Provide map showing river entering familiar lake
- Ask students to describe the way water is flowing and to explain how they know
- Encourage students to describe what force moves surface water (i.e., gravity), what factors constrain direction of surface water flow (i.e., topography), and what you can tell about these things by looking at a map.

Tools for Reasoning

Formative Assessments

Formative Assessments

Characteristics	Criterion
Provide teachers with LP-embedded descriptions of goal & lower level accounts	1
Support teachers in eliciting, analyzing & responding to students' ideas	2
Provides opportunity for explanations and predictions	3
Can support participatory classroom discourse and using models to make arguments	4
Accessible to students at all LP levels	5
Flexible for use w/ diverse curriculum materials	5

Tools for Reasoning

Formative Assessments

Successes

- Teachers are enthusiastic about formative assessment packages
- Teachers are interested in their students' ideas and sometimes surprised at what they learn about student thinking
- Formative assessment packages were more successful with teachers who had had previous experience using formative assessments.

Tools for Reasoning

Formative Assessments

Challenges

- Assessment <u>of</u> teaching vs. assessment <u>for</u> teaching
  - Assessment to check for understanding rather than to adapt instruction
  - Response is to re-teach rather than to match instruction to student level of achievement
  - Sorting students into ability levels rather than locating students on pathways to learning
  - Standards for achievement based on rubrics other than learning progression

Tools for Reasoning

Formative Assessments

CLAIM #3: SCAFFOLDING STUDENT SCIENTIFIC PRACTICES FUSED TO CORE SCIENTIFIC CONTENT

Tools for Reasoning

Formative Assessments

Tools for Reasoning

- Form similar to a graphic organizer
- Intended to scaffold development of scientific accounts
- Address specific LP-related challenges students encounter
  - Attending to driving forces and constraining factors
  - Considering likelihood of multiple/diverse pathways
  - Distinguishing scale and using scale in scientific accounts

Tools for Reasoning

Formative Assessments

Tools for Reasoning

Tool	Connection to WSLP
Pathways	Tracing water along multiple converging/diverging pathways
Drivers & Constraints	Moving water; Considering driving forces and constraining variables.
Tracing Mixtures with Water	Substances in water
Scale	Scale

Pathways Tool

Before

Before

Before

After

After

After

Pathways Tool

Before

Before

In a cloud above Idaho

In the groundwater

Snow on ground in Anaconda

Running off over the ground near Blackfoot River

Before

Falling as rain in E. Missoula

In groundwater near Milltown

Running off over the ground in Clinton

In Rattlesnake Creek

After

In Clark Fork River by Frenchtown

In the atmosphere

In Missoula Aquifer

After

In Clark Fork River near Superior

In a fish in the Clark Fork

In a Mountain Water Well in Missoula

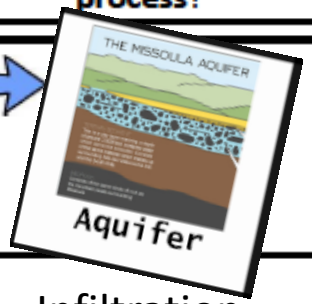
In a cloud above Turah

After

In a Mountain Water pipe heading to my house

In my belly (I caught and ate the fish, but this is not very likely)

Drivers & Constraints Tool

Where does the water **start**?	Where can the water **go**? What is the **process**?	What **drives or moves** the water? How?	What are the **constraining factors**, and how do they work?
	 Infiltration	Gravity – pulls water down	Permeability – Water infiltrates into spaces between sediment; larger sediment size results in greater permeability.

Tools for Reasoning

Formative Assessments

Tools for Reasoning

Characteristics	Criterion
Support teachers in developing capacity to recognize and construct scientific accounts	1
Support teachers in eliciting, analyzing & responding to students' ideas	2
Scaffolds level 4 accounts	3
Intended to be used in student-centered discussion & argumentation	4
Accessible and/or adaptable for students at multiple LP levels	5
Designed to be used w/ diverse curriculum materials	5

Tools for Reasoning

Formative Assessments

Successes

- Teachers liked the Tools for Reasoning and thought they were useful for teaching.
- The Pathways Tool was used most often.
  - Great flexibility in use
  - Accessible to students at level 2
  - Supported students in tracing water along specific rather than general pathways
- Teachers who used the Drivers & Constraints Tool appreciated the focus on model-based accounts.

Tools for Reasoning

Formative Assessments

Challenges

- Use of Tools to facilitate engagement in scientific practice may require shift in teaching commitments
  - From performance for grade exchange to scaffolds for reasoning
  - From focus on smoothly running classrooms and activities that work to attention to reasoning and disciplinary practices

Tools for Reasoning

Formative Assessments

Conclusions

- In order for LPs to be effective in classrooms, more research is necessary to explore how teachers make sense of and learn to use learning progressions so that we can better support teachers in using LPs to transform their practice rather than assimilate LP-based tools into their existing practices.

Tools for Reasoning

Formative Assessments

Contact Info

kgunckel@email.arizona.edu

beth.covitt@umontana.edu

andya@msu.edu

Resources Available At

www.umt.edu/watertools

Tools for Reasoning

Formative Assessments

Tools for Reasoning

Formative Assessments

Ongoing Goals

Help teachers use LP to inform instruction through…

- Shifting focus from “covering” content to attending & responding to student thinking.
- Supporting students in developing Level 4 accounts.
- Testing/revising tools & formative assessments with teachers & students.
- Developing & sharing productive examples of tool and formative assessment use in the classroom.
- Developing effective professional development for using tools and formative assessments.

Tools for Reasoning

Formative Assessments

River Clean-up
Formative Assessment

5 friends were volunteering for an annual river clean-up in their town. One friend asked, “If we didn’t pick this bottle out of the river, where do you think it would go?”

Alberto: Maybe bottles follow water from this river to a smaller river.

Brenda: I think the bottles float downstream.

Cheng: I think the bottles float away.

Elan: Well, the bottles could go to the town of Pueblo Rio. The river in Pueblo Rio is connected to this creek.

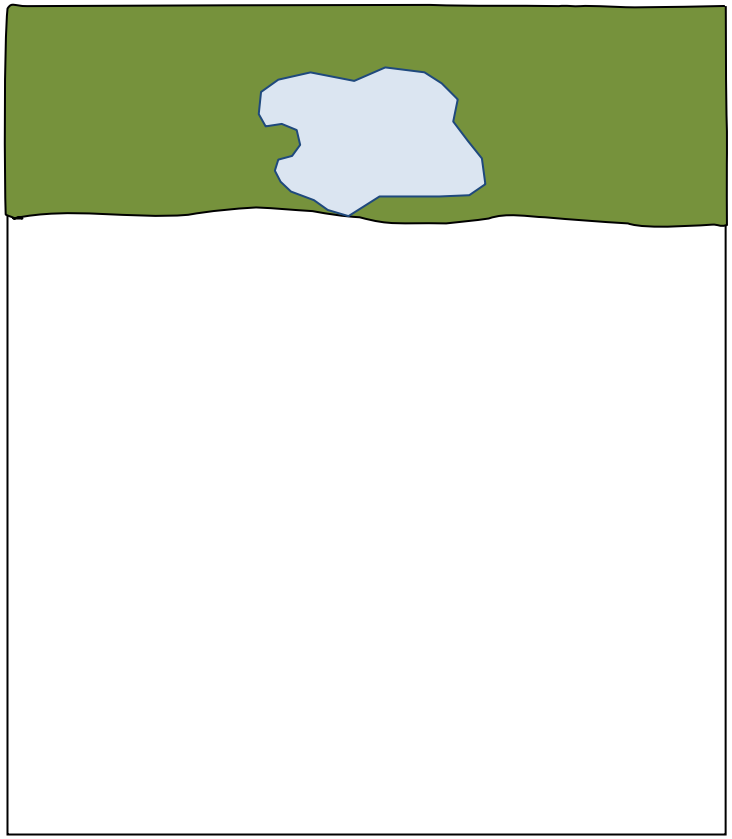
Deja: I disagree because Pueblo Rio is up in the hills. This river goes to the town of Sweetwater, which is in the lowlands.

Who do you agree with most? Explain your reasons.

Tools for Reasoning

Formative Assessments

Tracing Water: Infiltration



In the drawing, show where the water in a puddle goes when it soaks into the ground. Be sure to show what it looks like underground and where the water goes.

Tracing Mixtures With Water Tool

Tracing Back

Where did the substance come from?

Where did the water come from?

How did the substance get into the water?

The Mixture

What's mixed in the water?
(Teacher provides)

Where is the mixture now?
(Teacher provides)

What kind of mixture is it?
Suspension or Solution

How do you know?

Tracing Forward

If the water moves (new place) _____, will the substance stay mixed with the water?
Yes or No

If no, how and why will it separate?

Where will the substance end up next?

Tracing Mixtures With Water Tool

Tracing Back

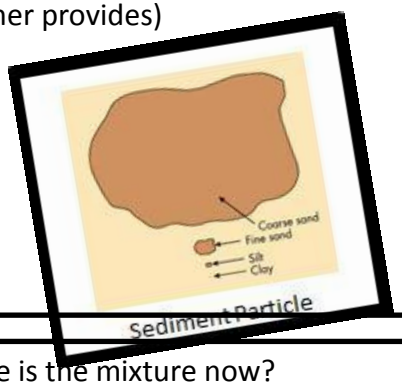
Where did the substance come from?

Where did the water come from?

How did the substance get into the water?

The Mixture

What's mixed in the water?
(Teacher provides)



Where is the mixture now?
(Teacher provides)

What kind of mixture is it?
Suspension or Solution

How do you know?

Tracing Forward

If the water moves (new place) _____, will the substance stay mixed with the water?
Yes or No

If no, how and why will it separate?

Where will the substance end up next?

Scale Tool

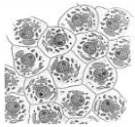
Atomic-Molecular

Not visible
Nanometer or smaller
($<10^{-9}$m)

Molecule

Microscopic

Visible with microscope
(10^{-8}m to 10^{-4}m)



Cells

Macroscopic

Visible with naked eye
Millimeter (10^{-3}m) to Meter (10^{0}m) to Hectometer (10^{2}m)

Water Drop

Football Field

Landscape

Larger than what you can see at once
Kilometer or more (>10^{3}m)

Watersheds

Scale Tool

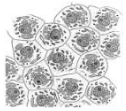
Atomic-Molecular

Not visible
Nanometer or smaller ($<10^{-9}$m)

Molecule

Microscopic

Visible with microscope (10^{-8}m to 10^{-4}m)

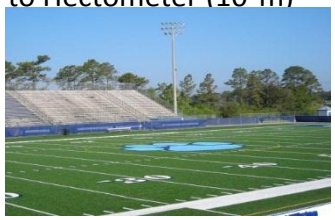


Cells

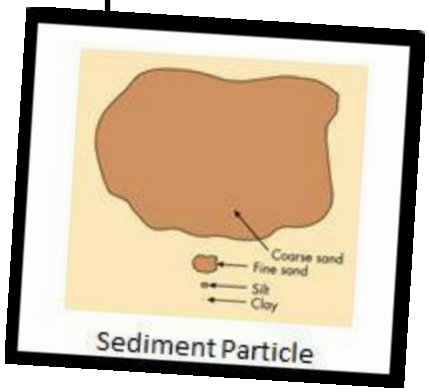
Macroscopic

Visible with naked eye
Millimeter (10^{-3}m) to Meter (10^{0}m) to Hectometer (10^{2}m)

Water Drop



Football Field



Sediment Particle

Landscape

Larger than what you can see at once
Kilometer or more (>10^{3}m)

Watersheds