

WATERS

Watershed Awareness using (Free) Technology and Environmental Research for Sustainability



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WATERS

The WATERS project increases student interest in STEM careers while building environmental awareness about watersheds.

FOCUS AREA

Data Science Education, Engineering & Science Connections, STEM Models & Simulations, Tools for Inquiry

SUBJECT

Earth & Space Science

GRADE

Middle School



Importance

Across the country, every minute of every day, water glasses are filled from a tap, toilets are flushed, laundry is washed, and bathtubs are filled almost without a thought as to how the water got there, where it goes when it leaves, or who helps to assure that our water is safe. As the need for clean water increases with a growing population, so does the need for increased participation in water careers. Students from all backgrounds should learn about their local watersheds as well as the wide variety of available water careers.

The Watershed Awareness using Technology and Environmental Research for Sustainability (WATERS) project is developing and researching a student-centered, universally accessible curriculum for teaching water concepts and water career awareness. The project is applying principles from Universal Design for Learning (UDL) to create a powerful, scalable approach to water learning open to all students. By providing flexibility in information presentation and student responses, reducing barriers in instruction, and offering appropriate supports and challenges, the WATERS project is paving a path to increased access to proven curricula and approaches that hold the potential to greatly increase awareness of and engagement with water concepts and career pathways in learners nationwide.

<https://concord.org/our-work/research-projects/waters/>

Origins

*Give students access to **real data** and **real tools** in **real places** so they can make **real decisions** about their environment.*

Students will:

- learn about watershed science*
- explore their local watershed*
- evaluate local watershed conditions*
- design and test solutions to current watershed challenges*
- engage in watershed activities/groups/causes in their neighborhood*



Water SCIENCE

Supporting Collaborative Inquiry, Engineering, and Career Exploration with Water

Middle school students from southern Arizona, central California, southeastern Pennsylvania, and eastern Massachusetts completed hands-on science at streams, and engineering activities while designing and testing water filters, received guidance and instruction from undergraduate student mentors, and learned about careers in environmental and water conservation while investigating their community's local water resources.

Teaching Environmental Sustainability: MMW



*Give students access to **real data** and **real tools** in **real places** so they can make **real decisions** about their environment.*

Promoted geospatial literacy and systems thinking by providing students and teachers with access to scientifically valid and easy-to-use watershed tools to accurately examine their own neighborhoods, to define local environmental problems or challenges, and to develop solutions to improve their environment.



Innovative Technology Experiences for Students and Teachers (ITEST)

Funding for the ITEST program is provided by revenue from the **H-1B visa program**, which permits overseas workers to fill vacant U.S. engineering, science or mathematics positions.

The ITEST program seeks to enrich the formal and informal learning experiences of PreK-12 students by supporting projects that:



ITEST Project STUDIO: Build Our World

Increase awareness
of STEM and ICT careers

Motivate students
to pursue the education necessary to participate in those careers

Provide students with technology-rich experiences
that develop their knowledge of related content and skills (including critical thinking skills) needed for entering the STEM workforce

WATERS STEM Careers

- High School Diploma / Certification
- Associate Degree
- Bachelor's Degree or Higher



GOVERNMENT & REGULATORY

- Erosion & sediment control technicians
- Conservation district officers
- Fish & boat commission officers
- Extension agents
- State foresters
- Fisheries biologists
- Wildlife biologists
- Research scientists



AGRICULTURE & FARMING

- Farmers
- Agricultural technicians
- Irrigation engineers
- Livestock production managers
- Biologists
- Agronomist
- Drought operations managers
- Firefighters
- Soil scientist and engineers



WATER PROCESSING

- Engineers
- Drinking & wastewater facility certified operators
- Microbiologists
- Chemists
- GIS technicians
- Electrical engineers
- Programmable logic control (PLC) programmers
- Electrician
- Plumber



DEFENSE & MILITARY

- Army & Navy & Air Force—Corps of Engineers
- Coast Guard—marine debris specialist
- Meteorologists
- Structural & environmental engineers
- Drinking & wastewater operators
- Water transportation specialists
- Hydro technicians (cleaning & operating equipment)



DESIGN & SUPPORT

- CAD technicians
- GIS analysts
- Mathematicians
- Statisticians
- Data analysts
- Computer programmers
- Graphic designers
- Landscape architects
- Electrical engineers & designers



STORMWATER MANAGEMENT

- Land use planners
- Engineers
- Landscape architects
- Wetland scientists
- Hydrologists
- Geologists
- Green infrastructural technicians & landscapers
- Horticulturists
- Surveyors
- GIS technicians

Figure 1. Water STEM Careers based on required levels of education

Career Videos



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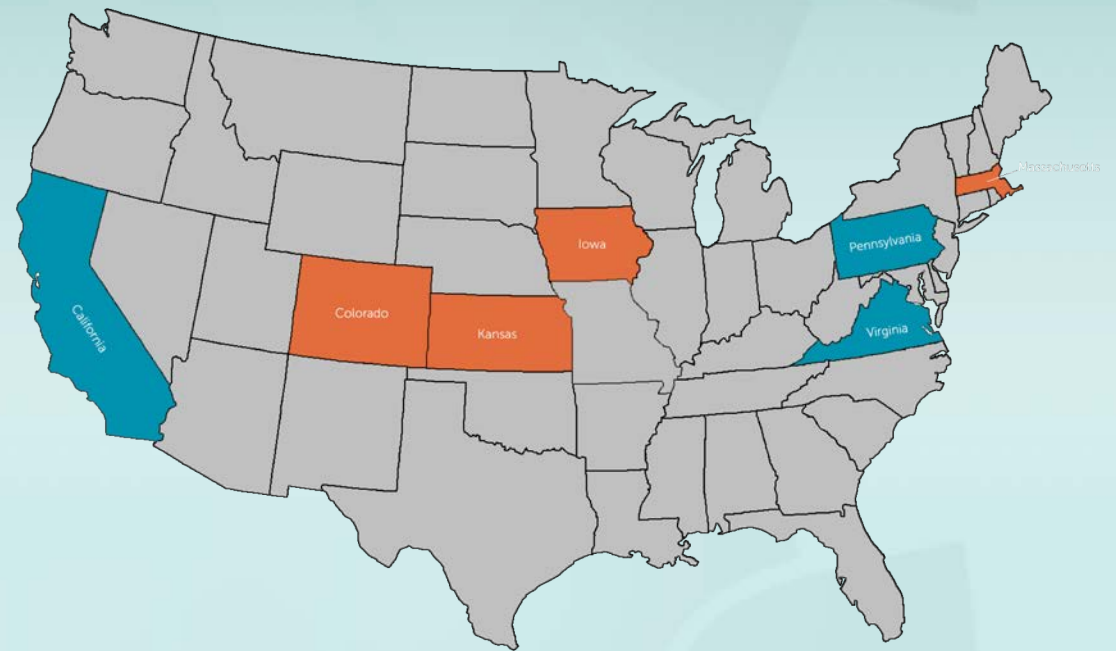
Career Videos

Ikey Sealy, Student Intern, Philadelphia Wastewater

Participants

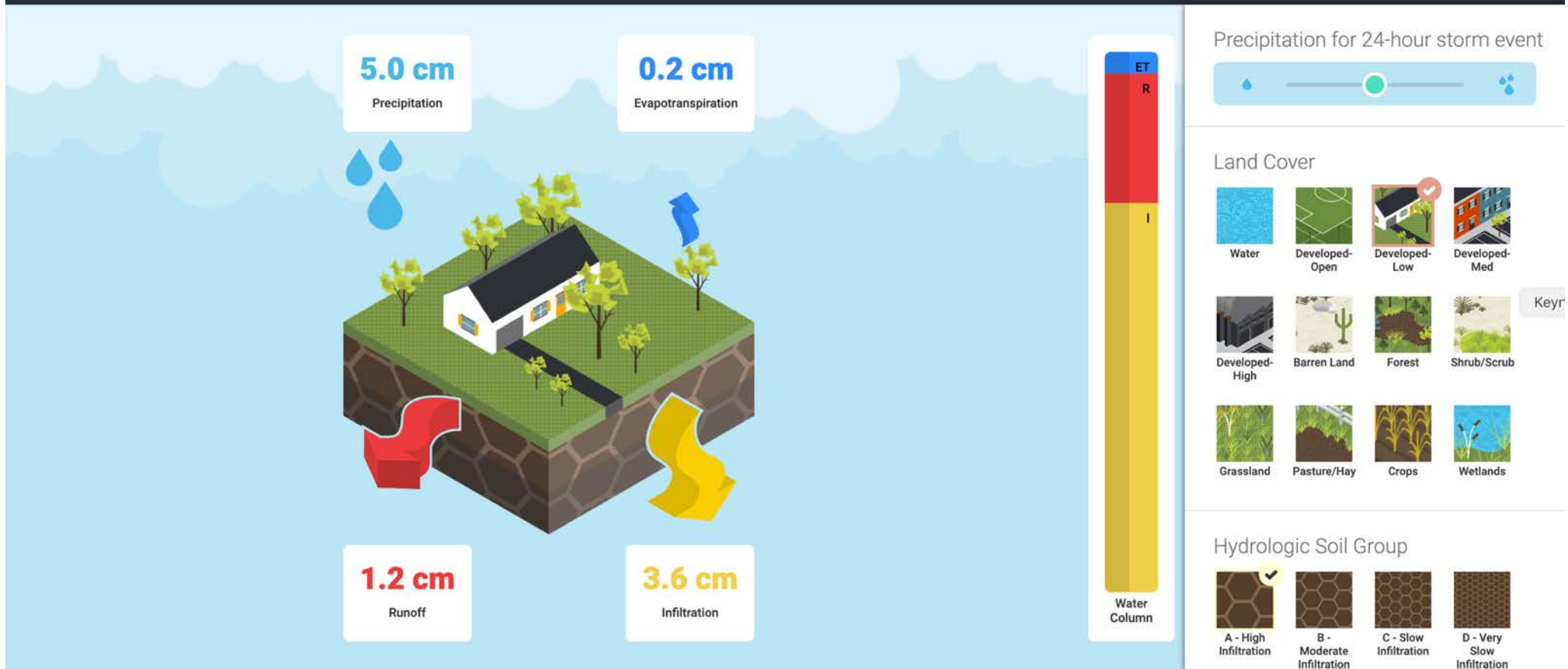
Past/Present Participating States

*Past Research states:
CA, CO, IA, KS, MA,
MO, PA, and VA*



*WATERS Research states (in blue):
CA, PA, and VA and now possibly OR.*

Tools, Models and Resources



The **Runoff Simulation** animates results from applying the TR-55 runoff model developed by the US Department of Agriculture for a single 24-hour rain storm over a hypothetical small unit of land with a single land cover class and a single hydrologic soil group. Students can vary cover type, soil type and rainfall to obtain a typical water budget that petitions evapotranspiration, runoff, and infiltration.

<https://runoff.modelmywatershed.org/>

My Models

Stream A

F +

Stream B

F +


Stream C

F +

Stream D


F +

A PTI: Time: 3 Weeks



H Habitat **M** Macroinvertebrates **C** Chemistry

Stream Sketch



Stream Habitats

Pools

Riffles

Runs

Stream Banks

Many trees

Some trees

No trees

Grass only

Pavement

1 2

E Environment

Stream A

S Sunny Days

Few Many

R Rewind **S** Start

Leaf Pack Simulation

<https://leaf-pack.concord.org/>

My Models

Stream A

F +8

H M

Stream B

F +

Stream C

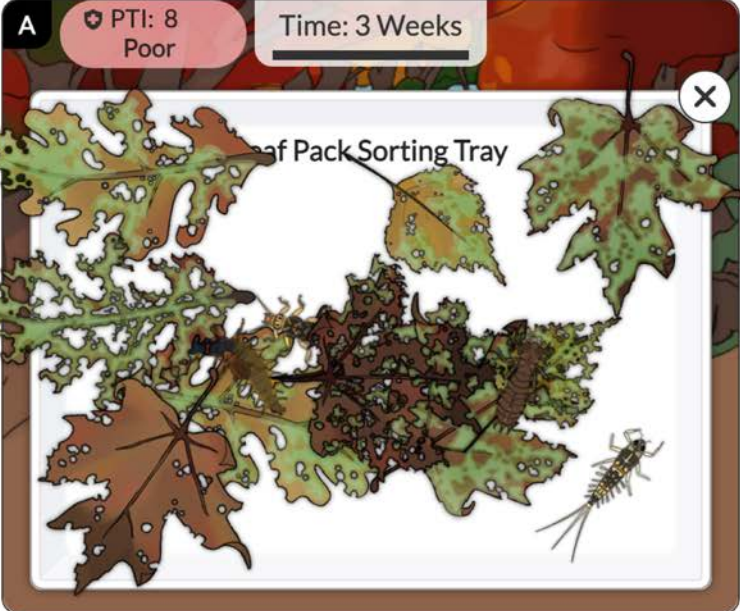
F +

Stream D

F +

A PTI: 8
Poor

Time: 3 Weeks



Leaf Pack Sorting Tray

Habitat Macroinvertebrates Chemistry

	Aquatic Worms	<input type="range"/>	7	Tolerant
	Black Flies	<input type="range"/>	0	Tolerant
	Caddisflies	<input type="range"/>	14	Sensitive
	Clams / Mussels	<input type="range"/>	2	Somewhat Sensitive
	Crayfish	<input type="range"/>	3	Somewhat Sensitive

1 2 3 4

Environment

Stream A

Sunny Days

Few Many

Rewind Start

Sorting Macroinvertebrates

<https://leaf-pack.concord.org/>

Explore Human Impacts on Your Watershed

Analyze mapped watershed data, visualize monitoring data, and run model simulations of human impacts on water quality.

Select Area and Analyze

Explore map layers and select your area of interest. Analyze land cover, hydrologic soil groups, permitted point source discharges and other natural and human influenced features.

Monitor My Watershed

Search for monitoring data in various data repositories. Share your monitoring data to view in WikiWatershed.

Model My Watershed

Run one of two models to compare impacts of different conservation and development scenarios on water quality. Share your modeling results for others to find, copy, and edit.

Get started →



The **Model My Watershed (MMW) Site Storm Model** simulates storm runoff and water quality by applying the TR-55 and STEP-L water quality models for a single 24-hour rainstorm over a selected land area within the continental United States. The results are calculated based on actual land cover data (from the USGS National Land Cover Database 2011) and actual soil data (from USDA Gridded Soil Survey Geographic Database) for selected land cover.

<https://modelmywatershed.org/>

Select Area

Explore mapped layers, such as streams, land cover, soils, boundaries and observations, using the layer selector in the lower left of the map. See [our documentation on layers](#).

Select an [Area of Interest](#) in the continental United States, using the suite of tools below, to analyze the factors that impact water in your area and to begin to model different scenarios of human impacts.

Select boundary

Choose a predefined boundary from several types

USGS Subwatershed unit (HUC-12): Click on a boundary.

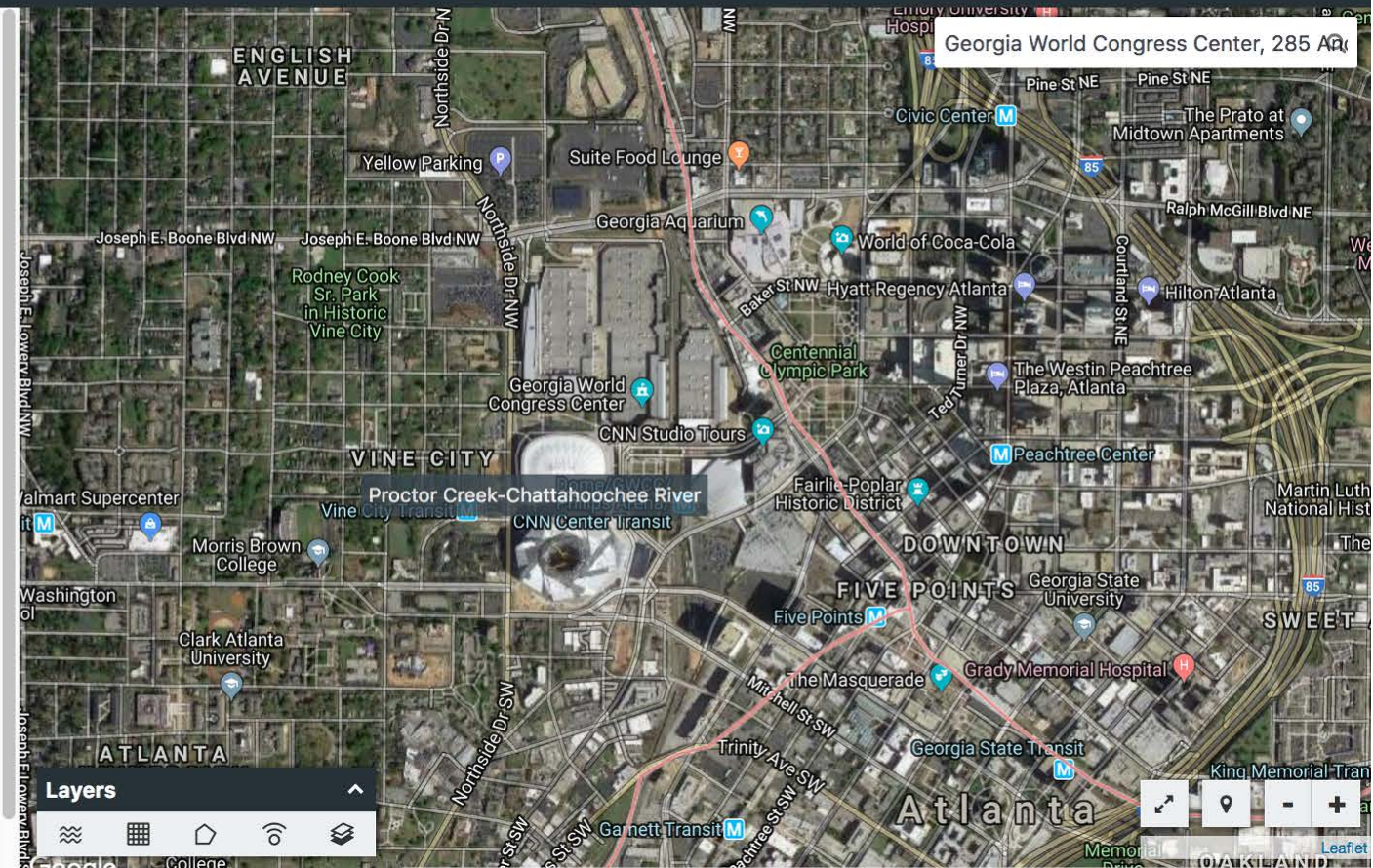
Draw area

Free draw an area or place a square kilometer

Delineate watershed

Automatically delineate a watershed from any point

Upload file



Users can define an area in many ways. You can select USGS HUC units or you can use the "Draw Area" tool to draw a precise area of any size or a 1 km box to change into geospatial analysis mode.

<https://modelmywatershed.org/>

Analyze Monitor Model

1 Square Km 1 km²

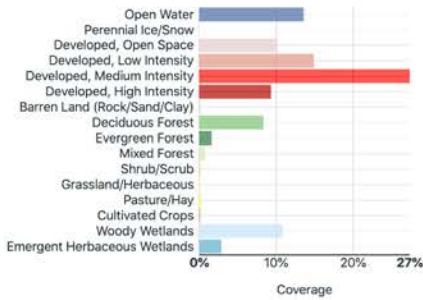
Streams Land Soil Terrain Climate Pt Sources Animals Water Qual

Land cover distribution

Land cover distribution

Related Layer: National Land Cover Database Turn on

Source: National Land Cover Database (NLCD 2011)



Type	Area (m ²)	Coverage (%)	Active River Area (m ²)
Open Water	135,433.59	13.55	135,433.5
Perennial Ice/Snow	0.00	0.00	0.0
Developed, Open Space	101,350.96	10.14	70,855.9

Change area



Calculations and analysis are done on the fly for each area based on nationally available data and are not pre-computed estimate or “canned” numbers. These are **real values** based on the most recently available national land cover and soil type datasets.

<https://modelmywatershed.org/>

Model My Watershed[®] About Help Projects Login

Untitled Project - 1Passwor

Analyze Monitor **Model**

Current Conditions Precipitation 2.50 cm [Add changes to this area](#)

Runoff Water Quality

24-hour hypothetical storm event
Simulated by SLAMM and TR-55 model algorithms.

Level (cm)

Current Conditions

Runoff Partition	Water Depth (cm)	Water Vol (m ³)
Runoff	0.888	8,893.18
Evapotranspiration	0.303	3,035.85
Infiltration	1.309	13,111.29

Explore how land use and soil determine runoff with our **Runoff Simulation**. Info and help at <http://wikiwatershed.org/model/>.

[Download this data](#)

Layers

Basemaps

- Topography
- Satellite
- Satellite with Roads
- Terrain

Conservation practices menu:

- Rain Garden
- Veg Basin
- Porous Paving
- Green Roof
- No-Till Ag
- Cluster Housing

Land cover legend:

- Open Water
- Developed-Open
- Developed-Low
- Developed-Med
- Developed-High
- Barren Land
- Forest
- Shrub/Scrub
- Grassland
- Pasture/Hay
- Crops
- Wetlands

Students can make changes by adding **conservation practices**, (adding green roofs, rain gardens, and porous paving) to reduce impact. Students can change **land cover** (planting trees or reducing development) to impact their watershed.

<https://modelmywatershed.org/>

Compare

Runoff Water Quality

Precipitation 2.50 cm

Scenarios



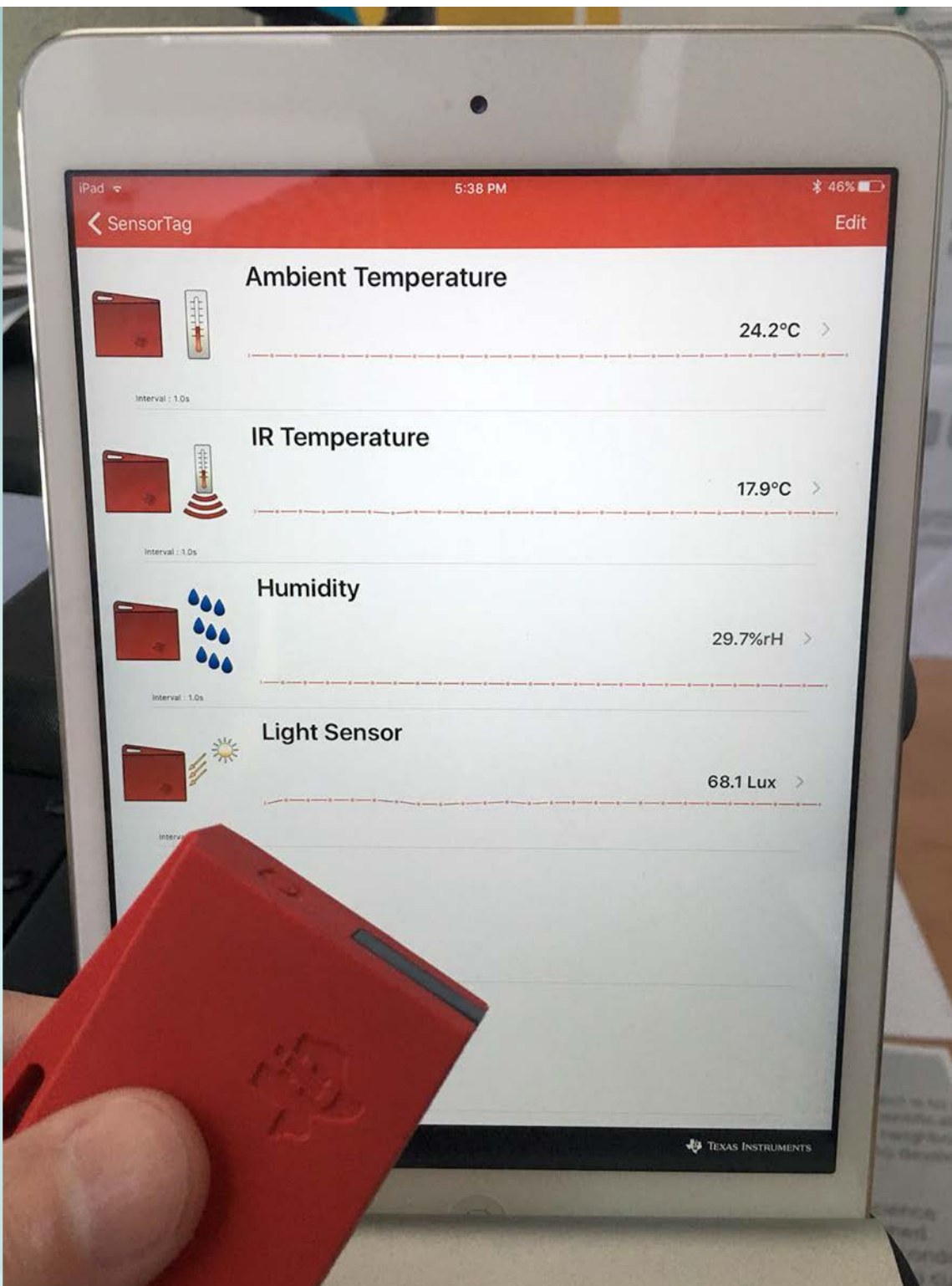
- Predominantly Forested
- Current Conditions
- New Scenario

Combined Hydrology

- Evapotranspiration
- Runoff
- Infiltration



Compare Scenarios



Students collect light, temperature, humidity data using a low-cost Blue Tooth (BT) environmental monitoring device. Students use their mobile device to view their sensor data so they can enter it in the Innovative Technology in Science Inquiry portal where the data can be viewed, graphed, and analyzed.

<https://www.ti.com/tool/TID-C-CC2650STK-SENSORTAG>



Monitor Your World

Question #2: Data From Study Site #1: Pervious Area

You are viewing a preview of the activity. NO DATA IS BEING SAVED!

 Label  Collect  Note & Photo

[EDIT](#) [USE SENSOR](#)

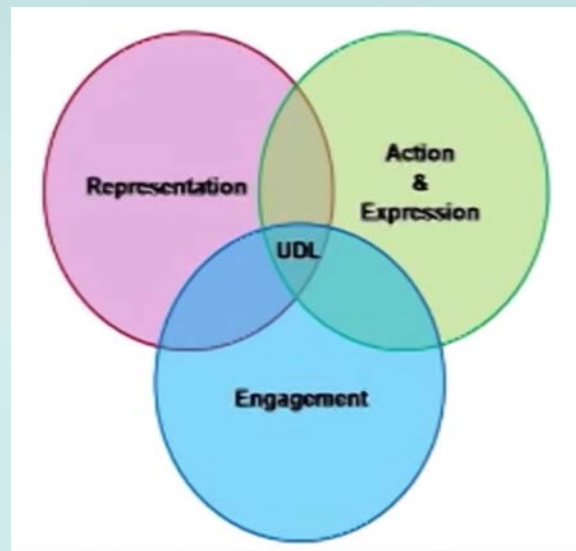
Location	Temperature (°C)	Humidity (%)	Light (lux)
Corner 1			
Corner 2			
Corner 3			
Corner 4			
Center			
Average	--	--	--

Download in App Store (any mobile device)

Research Study

UDL at a Glance

See how the UDL framework guides the design of instructional goals, assessments, methods, and materials that can be customized and adjusted to meet individual needs.



<https://youtu.be/bDvKnY0g6e4>

cast.org

Universal Design for Learning (UDL) is a research-based set of principles to guide the design of learning environments that are accessible and effective for all. Now endorsed by federal policy and that of many states and districts, UDL informs all of our work in educational research and design, professional learning, workforce development, and publishing.

cast.org

Glossary



What Have You Learned?

Today you explored what a watershed is and how human activities affect water quality in watersheds everywhere!

You also explored how **human choices affect the natural resources** that not only meet the needs of the present (us!), but must someday meet the needs of the future (the generations to come after us!). You will learn more about this important approach to **using resources wisely**, or sustainability, in future lessons.

Take a moment to think about everything you learned today and answer the following questions.



The watershed is affected by human activity.
Image by DUOTONE from Pixabay



Question #14

Where does water flow in a watershed?

Please type your answer here.

Term: watershed



The mountains direct the rain water downhill to a river.

What do you think "watershed" means?



Write the definition in your own words here.

Submit

I don't know yet

Term: watershed

A system defined by the area of land over which all water drains downhill through a series of streams and rivers to a common outlet (river, lake, bay or ocean).



The mountains direct the rain water downhill to a river.

My Definition:
Where water runs off.

Term: watershed

A system defined by the area of land over which all water drains downhill through a series of streams and rivers to a common outlet (river, lake, bay or ocean).



The slope of the mountain directs the rain water into the lake.

My Definition:
Where water runs off.

Where does water flow in a watershed?

Ten Research WATERS Lessons

Lesson 1: Discover Your Local Watershed

Lesson 2: Stream Study: What Do Stream Organisms Tell Us?

Lesson 3: Stream Study: What Does the Chemistry Tell Us?

Lesson 4: The Water We Drink

Lesson 5: Runoff Simulation

Lesson 6: Exploring My Schoolyard

Lesson 7: Investigating My Schoolyard

Lesson 8: Modeling Improvements to My Schoolyard

Lesson 9: Road Map to Action!

Lesson 10: Communicating My Action Plan!

Non-research activities - <https://learn.concord.org/waters>

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