NATURE
LAB Educator
Resources

FINDING YOUR FLOW:
A Toolkit for Watershed Engagement

Subject Area: Science, Environmental Science

Grades: 9-12

Time: The Introduction can be completed in one 45-minute sessions; watershed projects will vary in duration.

Essential Questions:

- What is a watershed?
- What watershed do you live in and how is it impacted by different kinds of land use?
- Who are the stakeholders in your watershed?
- What kinds of actions and changes are currently underway to benefit your watershed? What others might be enacted?
- How can students and the community get involved in protecting and improving the health of your watershed?

Purpose and Overview:
High school students may be familiar with the idea that they live in a watershed. They may even have engaged in individual community or school projects, such as stream clean ups or water testing, that benefit or relate to their watershed. Yet, in most cases, students have not explored how the watershed works or identified how the various parts—different land uses and types, different stakeholders—contribute to the whole.

Understanding a watershed as a whole provides a real-world basis for systems thinking and deeper ecological understanding. It also offers a venue for students to identify and explore different levels and kinds of engagement in science, activism, and policy.

As an introduction to this toolkit, students will view and discuss the video *The Source of Life* that follows the journey of water from an area of rural Colombia to its capital city, Bogotá. They use the video as a jumping off point to explore the issues facing the watershed in which they live and to identify ways they can become involved in protecting their water along its journey. The toolkit provides online resources for understanding watersheds, connecting to local watershed resources, engaging in watershed activities in the classroom, and identifying opportunities for watershed activism. It also includes a list of suggested projects that can make use of the resources.

Themes:

Water is the source of life. What we do in one part of a watershed affects the whole system. A healthy watershed ensures the wellbeing of everything that lives there.

Understanding watersheds as systems is fundamental to the protection the lands and waters on which we depend. A healthy, protected ecosystem helps to ensure that there is enough clean water for all.

Objectives:

The student will…
- define watershed and describe how a watershed is part of a larger system
- identify the watershed in which they live
- use one or more online watershed exploration tools to explore their own watershed
- learn about watershed research and activities in their region
- identify ways to get involved in water monitoring in their community

Standards:

Next Generation Science Standards

Disciplinary Core Ideas:
- LS2.A Interdependent Relationships in Ecosystems
- LS2.B Cycle of Matter and Energy Transfer in Ecosystems
- LS2.C Ecosystem Dynamics, Functioning, and Resilience
- ESS3.A Natural Resources
- ESS3.B Natural Hazards
- ESS3.C Human impacts on Earth Systems
- ETS1.A Defining and Delimiting Engineering Problems
- ETS1.B Developing Possible Solutions
- ETS1.C Optimizing the Design Solutions

Crosscutting Concepts:
- Cause and Effect
- Stability and Change
- Systems and Models

Science and Engineering Practices:
- Asking Questions/Defining Problems
- Constructing Explanations
- Arguing from Evidence
- Communicating information

Performance Expectations High School
- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including costs, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

AP Environmental Science Topics
- Land and Water Use
  - Other Land Use
  - Urban Land Development

- o Land Conservation Options
- o Sustainable Land Use Strategies

Common Core English and Language Arts Standards for Science and Technical Subjects and Writing
Grades 9-12

- CCSS.ELA-LITERACY.RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
- CCSS.ELA-LITERACY.RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- CCSS.ELA-LITERACY.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Vocabulary:

Scarcity: the state of being in short supply.

Watershed: an area of land that drains rainwater or snow into one location such as a stream, lake or wetland.

Water fund: a collaborative program that enables downstream users, like businesses, to invest in helping upstream users protect and restore vital lands and water sources—improving water quality for millions of people.

Water security: the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability (from http://www.unwater.org/publications/water-security-global-water-agenda/).

Materials:

Videos that support this lesson plan:
Source of Life - https://vimeo.com/262206813
How Natural Areas Filter Water (optional) - https://vimeo.com/77811268

For teachers:
- *Computer*
- *Projector or interactive board*
- *Internet connection*

For each group of students:
- Computer with Internet connection (or can be executed with one computer and interactive board in the class)
- Notebook
- ***Source of Life*** Video handout

Introduction

1. Let students know they will be exploring both the larger idea of watersheds and the watershed in which they live. Begin by developing a shared definition of a watershed.

   Elicit definitions from students. Then guide them toward the following:
   > **A watershed is an area of land that drains rainwater or snow into one location such as a stream, lake or wetland.**

2. Distribute and review the Source of Life Student Handout and show students the video, *Source of Life*. Give them 5-10 minutes after the video to complete the handout. There is an answer key on page 8 of this lesson plan.

3. Ask students to share their ideas. Discuss the following features of the video that related to watersheds and to working within a watershed:

   - A watershed can encompass many different ecosystems and types of land use;
   - Some work in a watershed is about protecting land, other work is about supporting people, most work is about both;
   - Working in a watershed may involve addressing the needs of a wide range of people and their needs—these are the stakeholders in a watershed project;
   - Pollution in a watershed can come from a number of sources;
   - Nature is a necessary ally in protecting water.

4. Ask students to specifically share how they think the issues identified in the video, above, might related to their own watershed. For example, do they know the ecosystems and land uses that make up their watershed? Can they identify the stakeholders who might be involved in their watershed? Can they identify sources of pollution in their watershed?

5. Note that students might live in a watershed different from that of the school. This is a good opportunity to discuss neighboring watersheds and nested watersheds. Are the neighboring watersheds part of a larger watershed, in which the water drains into a larger body of water? See https://edna.usgs.gov/watersheds/html_index.htm for an interactive map showing the largest scale watersheds in the U.S.

6. To reinforce the features of a watershed, you may want to have students create a model of a watershed. The "crumpled paper" activity (and variations) provides a quick way for students to model the behavior of water in a watershed and is widely available online. For example:

   - Crumpled Paper Watershed (Alice Ferguson Foundation)
     http://fergusonfoundation.org/teacher_resources/crumpled_paper.pdf
   - A Crumpled Watershed Model (University of Nebraska Extension)
     https://water.unl.edu/documents/Crumpled%20Watershed%20Model%20opt.pdf
   - Watershed Lab (The Environmental Literacy Council)
     https://enviroliteracy.org/the-teacher-exchange/tx-water/watershed-lab/

Suggested Projects

Have students explore the resources on the following pages—as well as others they discover—in support of their (or your) choice of the projects listed below.

- Develop a plan for watershed protection that involves identifying the primary impacts on water at its source and along its path, to the key stakeholders (water users), and a set of possible mechanisms for protecting and restoring the water.
- Develop a community watershed education campaign, including the following information about your community's watershed:
  - A map that identifies the watershed boundaries, the watershed in which yours is nested, and major bodies of water
  - The overall condition of the water
  - Regional current conservation and research activities
  - Any relevant legislation or other news affecting the watershed
  - How people can get involved and help at home

  You might have students create PowerPoint presentations or StoryMaps (see Esri's StoryMap platform: https://storymaps.arcgis.com/en/app-list/).

- Develop watershed lessons for younger students, including hands-on activities, field trip suggestions, and ideas for how they can use online resources.

- Create a detailed map and model of your watershed to make available to the community for education and project presentations. Label the watershed with major water bodies, key impact areas (e.g., farms, cities), primary uses, and other information relevant to the region.

- Take part in EarthEcho International's Water Challenge. This challenge helps to build public awareness and engages citizens in protecting water resources through water monitoring of their local waterbodies. Explore the challenge and resources at http://www.worldwatermonitoringday.org/.

- Consider registering your project for the Green Apple Day of Service to inspire others around the world to take action. Learn more about it and find resources at http://greenapple.org/.

Watershed Resources

Below is a list of watershed resources with a brief description of the general uses and limitations of each resource. These resources can provide standalone projects or can be useful support for the Suggested Projects listed above.

Model My Watershed (WikiWatershed, Stroud Water Research Center)
https://app.wikiwatershed.org

WikiWatershed describes itself as "a web toolkit designed to help citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students advance knowledge and stewardship of fresh water." Model My Watershed is a component of this toolkit that enables students to select a specific area of land, identify some impacts of current land use on processes such as infiltration and runoff, and model impacts of different land uses on these same processes. Students can also explore pollution sources and water quality levels.

The tool is somewhat complex to master, but worthwhile and valuable to help students gain greater understanding of issues such as pervious surfaces, housing density, land cover, etc. A useful teacher's guide for Model My Watershed has been developed by Concord Consortium:

- *Teaching Environmental Sustainability: Model My Watershed Teacher's Guide* **(Concord Consortium)**
  https://guides.itsi.concord.org/teaching-environmental-sustainability-model-my-watershed-teacher-guide-2017

* Note that the tool becomes especially rich/useful when creating new scenarios (vs. Current Conditions) and comparing the effects on evapotranspiration, runoff, and infiltration of different Land Covers and Conservation Practices.

Surf Your Watershed (EPA)
https://cfpub.epa.gov/surf/locate/index.cfm

While the interface for this site isn't very student-friendly, it is a collection of a good amount of information. Click on your state, then on your locality, and you will come to a page that compiles a number of relevant resources to your watershed. These include the Congressional districts covered in the watershed and citizen groups working in the watershed, both useful for activism, water quality data, and data from other agencies, such as Science in Your Watershed from USGS, noted below.

Science in Your Watershed (USGS)
https://water.usgs.gov/wsc/map_index.html

This site provides a wealth of data relevant to water and watersheds, such as real-time water quality samples, non-native animal and plant species, drought-watch areas, water use, and more.

Explore Your Watershed (Earth Labs)
https://serc.carleton.edu/eslabs/drought/2b.html

Provides instruction for students to explore watersheds across the contiguous USA using Google Earth.

Water Maps (USGS)
https://www.usgs.gov/products/maps/map-topics/water

USGS has compiled a large collection of water-related and other content using a range of map and/or data types.

Local Water Resource Offices (USGS)
https://water.usgs.gov/local_offices.html

The site provides a variety of water-related resources, such as streamflow and groundwater data and mapping tools, organized by state.

State Water Agencies (WaterWebster)
http://waterwebster.org/state_framebottom.htm

WaterWebster is a compilation of all things water, including news, education links, federal and local water information and more. The lists are useful and extensive, if somewhat random and not always current.

State Water Plans (Federal Support Toolbox)
http://www.watertoolbox.us/intro/f?p=689:46:0

Search by state to find your state's water plan, which in some cases may provide rich information about the condition of water in the state overall and in the largest scale watersheds. Note that not all states have current or complete water plans and that each state's site differs in the information it makes available.

Specific state or local resources of note:

- **Portland, Oregon Watershed Services**
  https://www.portlandoregon.gov/bes/32184

  Offers abundant resources on the importance of watersheds, the specific issues facing urban watersheds, and a wide range of urban watershed projects.

Local Cooperative Extension Offices
https://nifa.usda.gov/land-grant-colleges-and-universities-partner-website-directory?state=All&type=Extension

Extension offices are potential sources of information about existing research and activism in your local watershed. Select your state and *Extension* in the dropdown list for Type, under the map at the link, to find your local office.

Source of Life Video
Teacher Answer Key

1. As you watch the video, Source of Life, note the ideas that relate to the topic of watersheds or living in a watershed.

   Answers will vary:
   - *A watershed can encompass many different ecosystems and types of land use;*
   - *Some work in a watershed is about protecting land, other work is about supporting people, most work is about both;*
   - *Working in a watershed may involve addressing the needs of a wide range of people and their needs—these are the stakeholders in a watershed project;*
   - *Pollution in a watershed can come from many sources.*
   - *Nature is a necessary ally in protecting water.*

2. What is the source of most of the city of Bogotá's water?

   Answer: Chingaza National Park

3. What are the primary sources of pollution or contaminants in the water that travels from Chingaza to Bogotá?

   Answer: Agriculture, ranching activities

4. Why do you think you were shown this video?

   Answers will vary:
   The video makes it clear that water is connected in a watershed between its source and along its path (where it is used), that upstream and downstream areas are connected. We were shown the video to help us understand that what happens upstream can affect downstream users.

   Because the city of Bogotá receives the majority of its water from Chingaza National Park, it is important to protect the watershed that provides the city with water so the city can receive a good supply of high quality of water.

5. Think about what you know about your own watershed. What ideas might you use from the video as inspiration and understanding for exploring or working in your own watershed?

   Answers will vary.

FINDING YOUR FLOW
Source of Life Video Handout

1. As you watch the video, Source of Life, note the ideas the related to the topic of watersheds or living in a watershed.

2. What is the source of most of the city of Bogotá's water?

3. What are the primary sources of pollution or contaminants in the water that travels from Chingaza to Bogotá?

4. Why do you think you were shown this video?

5. Think about what you know about your own watershed. What ideas might you use from the video as inspiration and understanding for your own watershed exploration?