WATERSHED RESOURCES LESSON - Human Land Use Impacts & Pollution Sources



TOPIC: Human land use changes create point and non-point pollution sources and impact water quality.

AUTHOR: BWD

CLASS TIME NEEDED: Two class periods of 45-60 minutes.

SUBJECT/GRADE LEVEL: Physical Science/Biology/Earth Science/Environmental Science 9th-12th

ARKANSAS SCIENCE STANDARDS:

Grades 9-12

- Physical Science - PSI-LS2-7, PSI-LS4-5, PSI-ESS2-1, PSI-ESS3-1, PSI6-ETS1-1, PSI6-ETS1-2, PSI6-ETS1-3, PSI6-ETS1-4
- Biology – BI-LS2-1, BI-LS2-2, BI-LS2-6, BI-LS2-7, BI-LS4-6, BI3-ETS1-3, BI3-ETS1-4, BI-ESS2-2, BI-ESS2-4, BI-ESS2-5, BI-ESS3-5, BI6-ETS1-2, BI6-ETS1-3, BI-ESS3-1, BI-ESS3-2, BI-ESS3-3, BI-ESS3-4, BI-ESS3-6, BI7-ETS1-1, BI7-ETS1-4
- Earth Science - ES-ESS2-2, ES-ESS2-5, ES2-ETS1-1, ES2-ETS1-3, ES-ESS3-1, ES-ESS3-2, ES-ESS3-4, ES3-ETS1-1, ES3-ETS1-2, ES3-ETS1-4
- Environmental Science - EVS-ESS2-2, EVS-ESS2-3, EVS-ESS2-5, EVS-ESS2-6, EVS-ESS3-5, EVS1-ETS1-1, EVS-LS2-1, EVS-LS2-2, EVS-LS2-6, EVS-LS2-8, EVS3-ETS1-3, EVS-ESS3-1, EVS-ESS3-2, EVS-ESS3-3, EVS-ESS3-4, EVS-ESS3-6, EVS-LS2-7, EVS-LS4-6, EVS4-ETS1-3

LEARNING PERFORMANCE TARGET(S): (learning expectations for this lesson; combines a science practice, crosscutting concept and core idea embedded in the lesson)

Students will acquire and/or further develop conceptual understanding of and skill related to:

- Designing experiments
- Identifying urban and agricultural point and nonpoint pollution sources and tracking pollutant transport through a watershed
- Best Management Practices that help mitigate human land use impacts

SCIENCE AND ENGINEERING PRACTICES:

Lab and field work, asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, obtaining, evaluating, and communicating information.

CROSSCUTTING CONCEPTS:

Patterns, cause and effect, scale/proportion/quantity, systems and system models, structure and function, stability and change

CCSS CONNECTIONS: (include mathematical concepts and reading, writing, speaking and listening opportunities in the lesson) • All exist throughout the lesson. • ELA/Literacy • Mathematics

MATERIALS:

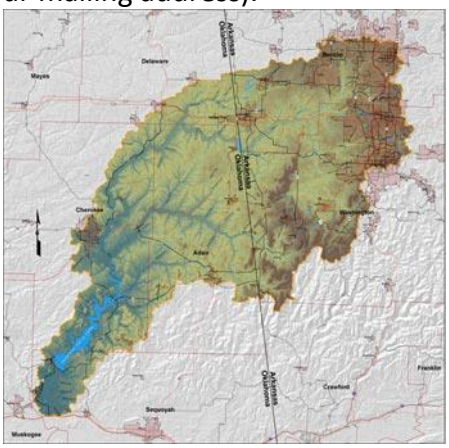
- Spray bottles, pipettes/eyedroppers
- Waxed paper & dissecting/flat pans or cookie sheets
- Build your own watershed model (links to instructions, below) or NW Arkansas educators may request temporary use of the Beaver Lake Watershed Model and Accessory Kit online at: bwdh2o.org/education-and-outreach/tours-outreach or email "education@bwdh2o.org"
- Land Use Categories (p. 6)
- Pollutant "Proxies": brown cake sprinkles (dog waste), cocoa powder (dirt), green food coloring or cake sprinkles (fertilizer), red food coloring (toxic waste), cooking spray or oil or honey (oil from cars on pavement or machinery), dish soap or baking soda (detergents from laundry and car wash soapy water). You can get creative with these materials.

Watershed model instructions online:

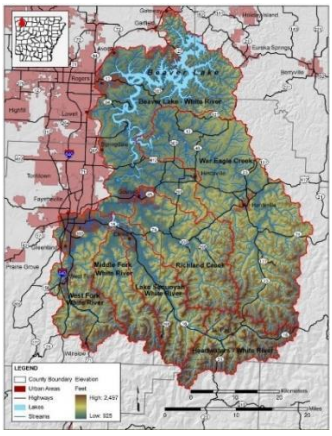
- **Desktop/Tabletop Watershed Model**
  EPA Exploring Your Watershed Module (Wax Paper Watersheds)
  epa.gov/sites/default/files/2017-12/documents/watershed_wax_paper_k-3.pdf
  PBSKids "Build A Watershed"
  pbskids.org/plumlanding/educators/activities/pdf/build_a_watershed_fam.pdf
  ProjectWET "Discover Water" discoverwater.org/
- **Tarp Watershed Model**
  PBS "Troubled Waters: Wonderful Watershed"
  pbs.org/strangedays/educators/season1/ag_tw_watershed.html

TEACHER PREPARATION:

1. Conduct an online search for the watershed in which your school is located and neighboring watersheds. Acquire and display digital or print maps of watersheds from your county extension service or state Geological Survey. Links to Beaver Lake Watershed Maps for digital display or projection and other watershed resources are accessible on the Beaver Water District Website (bwdh2o.org). Printed Beaver Lake Watershed Maps may be requested at: education@bwdh2o.org (include reference to this lesson and your mailing address).



Illinois River Watershed Physiography & Hydrography



Beaver Lake Watershed Physiography & Hydrography

2. Research local watersheds, land use categories, and various activities within them. Know the name of the watershed in which your school is located and neighboring watersheds. Research environmental problems and pollution issues associated with these watersheds.

Links to NW Arkansas Watershed Resources:

1. Arkansas Environmental Education Association – arkansasee.org
   - Seeing Watersheds Stormwater Extension - arkansasee.org/wp-content/uploads/2018/06/SeeingWatershedsStormwaterExtension.pdf
2. Beaver Water District (BWD) – bwdh2o.org
   - Watershed Maps and Information - bwdh2o.org/beaver-lake/watershed-maps
3. Beaver Watershed Alliance (BWA) – beaverwatershedalliance.org
   - History and Strategy - beaverwatershedalliance.org/history-and-strategy
4. Ozarks Water Watch at Beaver Lake (OWW-BL) - owwbeaverlake.org
   - Home Owners Education Program - owwbeaverlake.org/education/home-owners-education-program
5. Northwest Arkansas Land Trust (NWALT) - nwalandtrust.org
   - Initiatives & Priority Areas - nwalandtrust.org/learn
6. Northwest Arkansas Regional Planning Commission (NWARPC) - nwarpc.org
   - Environment - nwarpc.org/environment
7. Illinois River Watershed Partnership (IRWP)- irwp.org
   - Land Conservation and Stewardship irwp.org/onlinelearningcenter/landconservation

BACKGROUND INFORMATION/CONTENT:

Problem Question:

What are the impacts of human land use changes and point and nonpoint source pollution in watersheds?

Teachers:

Review Keywords

View the Beaver Lake Watershed Model Demonstration video for an introduction to **Point and Nonpoint Source Pollutant**:

Students:

Prepare for the activity with a class conversation about keyword meanings, how humans change and use land, and possible pollution sources resulting from alteration of the natural landscape or the way the land is used after it has been modified.

Keywords:

Watershed: An area of land in which precipitation inside its boundaries is conveyed along a system of drainages (consisting of rills, gullies, ditches, creeks, streams) to a common water body (e.g. lake, river, or ocean) or an outlet at the lowest elevation. The basic features and function of a watershed are comparable to those of a bathtub (e.g. tub rim = watershed boundaries, back wall = higher elevations, drain = the outlet at the lowest lying point or elevation to which all precipitation falling within the watershed eventually flows).

Land use change – Adaptation, alteration, modification, or transformation of a natural landscape to make it functional or suitable for human purposes.

Point source pollution: Contamination delivered to a body of water through a pipe or from a specific site.

Non-point source pollution: Contamination from multiple sources delivered to a body of water by wind or the flow of rain or irrigation water across a large land surface area.

ACTIVITY:

Point and Nonpoint Source Pollution in a Watershed -

The following represent nonpoint and point source pollutants that individuals may find in their watershed:

Brown cake sprinkles = dog waste

Ask the students who have dogs to tell a short story of how this individual is on a walk with their dog and of course there is dog waste as a result – what if the owner does not pick up the dog waste? Let the sprinkles remain on the model. **(See Pet Waste Calculator p. 8)**

Cocoa powder = loose dirt

Choose another section of the model and sprinkle some cocoa powder, explaining to participants that this part of the watershed used to be a forest, but it was recently clear cut and all the trees were removed, exposing what (loose soil that is carried with rainwater and snowmelt as runoff into nearby bodies of water)?

Green food coloring or green cake sprinkles = fertilizer

- Identify a third section of the watershed (near the dog trail area) where there are many nice homes that have very green grass. Ask participants what types of chemicals are used for green grass, discussing over application of fertilizer will oftentimes not improve the growth of the grass or shrubs and may enter the storm drain as runoff.
- Fertilizers are also applied to golf courses and public and private parks and gardens.

Red food coloring = toxic waste

Discuss a family who finds a container of hazardous waste in their garage and wants to get rid of it in a hurry, so they dump it down the storm drain in front of their house. Use only a few drops of food coloring for adequate effect.

Cooking spray or oil or honey or soy sauce = oil from cars or machinery

Ask who drove to the location and drop oil or honey along an imagined road, discussing how car owners were not properly maintaining their cars and oil is leaking.

Dish soap, Alka-Seltzer or baking soda = detergents

Identify a few homes where people are washing their cars in front of their homes on the driveway, letting the soapy water run down the driveway into the storm drain.

Other nonpoint and point source pollutants – feel free to add!

Here comes the rain! Ask participants to identify what they see happening to the pollutants in the watershed, how do they mix with the bodies of freshwater, what pollutants are remaining, what will happen to the remaining pollutants still on the land and in the water?

Identify and discuss:

1. Activities that introduced or increased point or non-point source pollution;
2. **Best Management Practices** individuals could used to prevent or minimize contamination, such as:
   - Pick up dog waste and put into trash can or decomposing waste bags
   - Plant tree saplings, shrubs or ground cover in areas where there is exposed soil
   - Apply fertilizer according to container directions, try organic gardening or growing
   - Contact your Environmental Protection Agency for Hazardous Waste Household Pick-Up Days or Waste Collection Programs
   - Keep your car maintained and watch for oil spots on your garage floor
   - Wash your car at a facility that recycles wastewater or sends it directly to a treatment facility
   - Keep animals out of waterways (fences);
3. Ways you could educate people about these pollutants and runoff affecting water quality in your watershed.

7E'S HUMAN LAND USE IMPACTS & POLLUTION SOURCES IN A WATERSHED

Elicit

Show video clips from Beaver Water District. Other available media about watersheds and issues may be accessed online using the following search terms: "Watershed", "Point Nonpoint Source Pollution", "Runoff", "Stormwater", "Urban Flash Flooding".

Engage

Have a class conversation about ways humans change and use land; possible pollution sources resulting from alteration of the natural landscape or land use after it has been modified; and pollution sources from land use near the school and where the water drains when it rains. As an example, the **Pet Waste Calculator (p. 8)** may be used to estimate the volume of pet waste generated in a community and generate discussion on how pet droppings left on the ground can be a potentially significant pollution source.

Explore

Form Watershed Model Project Groups to gather materials and build watershed model inside the classroom or outside in an appropriate area on the school grounds. Spray water on the model to imitate a light rain and a heavy rain, then examine the model after rain event(s).

Explain

Each group reports findings to the class, noting use of an urban, agricultural, or combination of both settings for the model, identifying pollution sources, and describing how much polluted runoff was produced.

Elaborate

After completing the model and observing precipitation and pollution phenomena, groups **compare and contrast** model features, pollution sources, and processes with those that are found or occur in the actual watershed in which the school is located or another local watershed.

Evaluate

Assess student functional knowledge by evaluating model(s), results, presentation(s), and/or unit test.

Extensions

Use this lesson along with Lessons on Building a Watershed Model, Water Erosion, Total Suspended Solids (TSS) and Turbidity in Streams, Chemical Testing of Water, and Stormwater Runoff Filtration. Plan a project to locate and assess potential point and non-point pollution sources. Brainstorm on ways the pollution could be reduced or eliminated. Contact and schedule a meeting with your local County Extension Service Agent or City Stormwater Management Department Staff to discuss available resources and proactive options for addressing pollution issues.

Towns & Cities

Mines

Farms & Ranches

Outdoor Fun & Play

Forests

Area Growth

Calculating Pet Waste Runoff

Copy and paste this URL into your browser (http://factfinder2.census.gov) OR

Click on the link below: In Community Facts, type name of City, State & click "GO". Under Population Menu, select "Housing." Under 2010 Census click "General Housing Characteristics" to get "OCCUPIED Housing Units" number.

City of (enter your city's name here)					
*Amount pooh using 35% **					
Number of OCCUPIED houses in city					Total number of households in the community.
Number of Households with dogs		0	x .35	0	Equals X number of households with dogs
Number of dogs in the community		0	x 1.5	0	Equals Y number of dogs in the community
Number of dogs walked		0	x .55	0	Equals Z number of dogs who are walked
Number of dogs walked and not picked up after		0	x .35	0	Equals A amount of pooh for these dogs/day
Pounds/dog/day (not picked up)		0	x .75	0	Equals B amount of pooh for these dogs/day
Pounds/dog/year		0	x 365	0	Equals C amount of pooh in ton/year
Tons/dog/year		0	/ 2,000	0	Equals P amount of pooh in ton/year
Amount pooh using 10%					
Number of Households with dogs		0	x .35	0	Equals X number of households with dogs
Number of dogs in the community		0	x 1.5	0	Equals Y number of dogs in the community
Number of dogs walked		0	x .55	0	Equals Z number of dogs who are walked
Number of dogs walked and not picked up after		0	x .10	0	Equals A amount of pooh for these dogs/day
Dog pooh left/day in community		0	x .75	0	Equals B amount of pooh for these dogs/day
Pounds of dog pooh left/year in community		0	x 365	0	Equals C amount of pooh in tons/year
Tons of dog pooh left/year in community		0	/ 2,000	0	Equals P amount of pooh in tons/year

* National studies show 35% of dogs walked aren't picked up after and Dane County survey showed 10%

Calculator Equations

Number of households x .35 = X number of households with dogs
X x 1.5 = Y number of dogs in the community
Y x .55 = Z number of dogs who are walked
(40 - 50% of all dogs aren't walked, therefore you could use 50 - 60%)
Z x .35 = A Number of dogs who are walked and not picked up after
A x .75 = B amount of pooh for these dogs/day
B x 365 = C amount of pooh in pounds per year
C / 2,000 = P amount of pooh in tons/year
P = city's Pooh Index

Contact Suzanne Wade, UWEX Rock River Basin Educator for information about this calculator at suzanne.wade@ces.uwex.edu or 920-674-8972