Land Use in Watersheds

Adapted from: An original Creek Connections activity.
Creek Connections, Box 10, Allegheny College, Meadville, Pennsylvania, 16335

Grade Level: Intermediate to Advanced

Duration: One class period

Setting: Classroom

Summary: Students use topographic maps to investigate the potential effects of land use on watersheds.

Objectives: Students will be able to identify the major land uses in a watershed and determine how these land uses might be impacting the watershed.

Vocabulary: land use

Related Module Resources:
- Activity: Topo Map Explorer

Materials (Included in Module):
- Laminated partial topographic map quads: Meadville (20) and Conneaut Lake (20)
- Land Use Impacts on Water Quality Parameters *(Teacher-only Resource)*
- USGS document Topographic Map Symbols *(Please return with module!)*
- Worksheet: Land Use in Watersheds
- Answer Key: Land Use in Watersheds
- Key Transparency: Delineated Watersheds for questions 1, 3, and 7.

Additional Materials (NOT Included in Module):
- None

ACADEMIC STANDARDS:

ENVIRONMENT & ECOLOGY

7th Grade

4.3.7.B. Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.

4.8.7.C. Explain how human activities may affect local, regional and national environments.
- Explain how a particular human activity has changed the local area over the years.

10th Grade

4.1.10.A. Describe changes that occur from a stream's origin to its final outflow.
- Describe changes by tracing a specific river's origin back to its headwaters including its major tributaries.

4.1.10.E. Identify and describe natural and human events on watersheds and wetlands.
- Identify the effects of humans and human events on watersheds.

4.3.10.B. Explain how multiple variables determine the effects of pollution on environmental health, natural processes and human practices.
- Explain how human practices affect the quality of the water and soil.

4.8.10.C. Analyze how human activities may cause changes in an ecosystem.
- Analyze and evaluate changes in the environment that are the result of human activities.
- Compare and contrast the environmental effects of different industrial strategies (e. g., energy generation, transportation, logging, mining, agriculture).

12th Grade

4.1.12.E. Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
- Evaluate the effects of natural events on watershed and wetlands.
- Evaluate the effects of human activities on watersheds and wetlands.

GEOGRAPHY

9th Grade

7.4.9.B. Explain the impacts of people on physical systems
- Forces by which people modify the physical environment (e.g., increasing population; new agricultural techniques; industrial processes and pollution)

BACKGROUND:

Topographic maps are rich in information and have myriad applications. In addition to representing the natural, physical features of the land, they provide information about **land use**. Land use is how humans utilize and/or alter the landscape.

The first indication of land use at a particular location on a topographic map is the color of the map at that point. Green areas represent intact forests, woods or reforested areas. White areas indicate cleared land that is completely lacking trees or only containing some trees. These white areas on the map may be croplands,

pasturelands, meadows, lawns, athletic fields, golf courses, industrial lands, or wetlands (although some larger wetlands are indicated by the symbol  . In Western Pennsylvania, white areas commonly denote agricultural land.

On topographic maps, houses or other buildings are shown as black rectangles or squares and can commonly be found along roadways. If there are too many houses or buildings too close together to be shown individually on the map, then the area will be shaded light pink or grey to represent regions that are densely built-up or urban. If a square on a map is not colored in black, but is empty, it usually represents a barn. In Western Pennsylvania, you will see many barns on topographic maps.

Brown is used mainly for contour lines, which indicate elevation and are helpful when delineating watersheds. But brown can also represent some natural resource extraction areas (strip coal mines, gravel pits). Blue areas on topographic maps represent water: creeks, streams, rivers, ponds, and lakes. Bright pink or purple highlights features that have been added to the map since the publication of the last map edition.

There are lines everywhere on a topographic map. Previously mentioned brown contour lines dominate the maps. Other lines reveal human-made structures or activities. Roadways are depicted on the map as a variety of lines depending on their use classification (primary highway or light duty road or unimproved road). Railroads and canals are also shown on topographic maps. Geographical boundary lines (such as county lines, township lines, and municipal boundaries) are shown on the maps, as varying dashed black lines. Other lines on the map include trails (light black dashed lines), fence lines (light red dashed lines that are also commonly seen in agricultural areas of Western PA on the maps), power transmission lines, and pipelines.

In addition to the land uses that are indicated by certain colors or lines on topographic maps, other land uses such as particular types of human activities or industries are labeled individually. These include, industrial waste ponds, trailer parks, gravel pits, cemeteries, water treatment facilities (WTs), fairgrounds, golf courses, athletic fields, gas and oil wells, sewage disposal facilities, and current or reclaimed strip mines. Waterways might be in close proximity to a variety of land uses.

Each land use affects waterways differently. Some, but not all land uses negatively impact streams and rivers. For example, fertilizers that are added to cropland may wash into streams, potentially resulting in eutrophication; cleared land is more easily eroded, carrying sediment into waterways and increasing turbidity. Waterways in urban settings might be negatively affected by the increased storm runoff due to all the impermeable, paved surfaces. Gravel pits might exacerbate erosion, resulting in increased turbidity of nearby waterways. Conversely, waterways situated near intact forests with healthy riparian buffers have better water quality as a result of the cooling, filtering, and absorbing functions of those buffers.

After delineating a watershed, one can determine which land uses occur within the boundaries of the watershed and thus make predictions about how these land uses might be affecting the health of the waterway(s) in the watershed.

OVERVIEW:

Students use previously delineated watersheds or delineate new watersheds to work through various scenarios on a worksheet to determine which land uses might be to blame for water quality problems in the watershed.

PROCEDURE:

Teacher Preparation:

1. Locate the laminated Meadville and Conneaut Lake partial 11x17" quadrangles and the wet-erase markers included in the module.

2. Make copies of the Land Use in Watersheds worksheet for your students.

Student Activity:

1. Distribute the laminated quads and wet-erase markers to students. There should be enough laminated quads so that each student has one to work with.

2. Review what the different colors on topographic maps symbolize and relate these colors to land uses. Discuss how various land uses might affect waterways. Then explain that one can determine the different land uses that are impacting waterways by delineating watersheds and then looking at the land uses that occur within the boundaries of each watershed. Quickly review how to delineate watersheds. See the Watershed Delineation activity for more detailed

3. Distribute "Land Use in Watersheds worksheets" to students and explain that they will be using topographic maps to answer the five questions. Students who received the Meadville quad should also get a Blooming Valley Quadrangle and start by working through questions one, two, and three. Students who received the Conneaut Lake quad should do questions four and five.

4. Have students work individually or in groups to delineate the watersheds or use watershed delineations from the Watershed Delineation activity and complete the questions.

5. If time permits, have students exchange laminated quads so that they can complete the remaining questions.

6. Go over the answers with your students.

DISCUSSION:

Note: Discussions will inevitably arise as you go over the answers to the various scenarios with your students. Below are several more discussion questions.

How did you identify the land uses present in various watersheds? *You delineate the watershed and then use the topographic map colors, symbols, and individual labels to determine the different land uses in the watershed.*

What were the most common land uses in the watersheds in the various questions? *See topographic maps.*

How do different land uses affect waterways? *See "Land Use Impacts on Water Quality Parameters" at the end of this activity.*

Would local environmental professionals rely solely on topographic maps to determine which land uses are negatively affecting waterways? *No!* After using topographic maps to determine the land uses that are potentially causing the water quality problems described on the worksheet, how might you further investigate which land use(s) is indeed responsible for the decline in water quality? *Water quality monitoring, contacting local environmental professionals, field studies, etc.*

EVALUATION:

- Correctly completed worksheet.
- Discussion questions above.
- Select a waterway and have students delineate the watershed and then, progressing from headwaters to mouth, list the land uses and how they might be affecting water quality.
- Use two or three of the scenarios as practice and the remaining questions as a test.

EXTENSIONS AND MODIFICATIONS:

- In addition to answering the specific worksheet questions, have students list all the land uses present in the watersheds for each scenario.
- Delineate your watershed and determine the land uses that might be affecting water quality in local waterways.
- Use topographic maps to interpret water quality data.
- Have students create scenarios like those on the worksheet and test each other.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

WORKSHEET: LAND USE IN WATERSHEDS

Name_____Date_____

Use the laminated sections of the appropriate quadrangles to answer the following questions. You may need to refer to the boundaries of watersheds you delineated for the Watershed Delineation activity or delineate new watershed boundaries.
PLEASE NOTE: The regional scenarios described below are fictitious and have been created to use as educational examples.

Meadville Quad *(Use laminated 11x17" quad sections)*
1. a) A toxicologist studied the levels of the herbicide 2,4-D in macroinvertebrates in various streams in the Meadville area. She found the highest levels in Bennyhoof Creek just downstream of the headwaters. Where might the 2,4-D be coming from? Use your watershed delineation of Bennyhoof Creek from the Watershed Delineation activity to answer this question.

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b) Upon learning about the toxicologist's findings about Bennyhoof Creek, Allegheny College decided to find alternatives to herbicides to use on their Athletic Field (which can be seen on the topographic map). While this a great idea, will these changes in lawn care actually benefit the insects of Bennyhoof Creek. Why or why not?

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2. The Saegertown High School Creek Connections students have been chemical testing Woodcock Creek at its mouth (end) just prior to entering French Creek all year long. The students consistently obtain very high nitrate and phosphate levels in their samples. Based on the information available on this topographic map, what are some possible sources of these high levels?

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3. Some fish in the small, intermittent tributary of French Creek southeast of Blacks Corner have shown evidence of arsenic poisoning. Local residents suggest that the arsenic contaminating the waterway might be leaching out of Cole Cemetery because some of the graves in this cemetery date back to the 1800s when arsenic was commonly used to embalm bodies. Could Cole Cemetery be the source of the arsenic contamination of the small, intermittent tributary of French Creek to its southeast? Why or why not?

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4. Of all the land uses and human activities that are shown on this topographic map, which one do you think is the biggest threat to the waterways? Why?

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Conneaut Lake Quad *(Use laminated 11x17" quad sections)*

5. Find the Gravel Pit near the northwest corner of the topographic map quad section. Gravel pits can sometimes be a source of soil erosion and wind erosion, which can add sediments to nearby waterways. Which side/s/ (north, east, south, west) of this gravel pit has the greatest potential to cause soil erosion problems?

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6. A water quality scientist has been studying Unger Run and its riparian (streamside) zone forests. Trace the stream and all of its tributaries on the topographic map. The scientist would like help estimating the percentage of the stream that has riparian zone forests. Determine this for him.

_____

What benefits do you think a riparian zone forest would provide to Unger Run?

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7. Mr. Jackson's class, a participant of Creek Connections, collects samples for water quality analysis from McDowell Run. They need your help determining the land uses that affect this waterway. Trace McDowell Run from its headwaters to where it meets Crooked Creek and describe the land uses along McDowell Run and how they might negatively and/or positively affect water quality. It is not necessary to delineate McDowell Run's watershed (but if you delineated it earlier in the Watershed Delineation activity, you can use your delineation again as a guide).

Land use	Effect on water quality

ANSWER KEY: LAND USE IN WATERSHEDS

Use the laminated sections of the appropriate quadrangles to answer the following questions. You may need to refer to the boundaries of watersheds you delineated for the Watershed Delineation activity or delineate new watershed boundaries.
PLEASE NOTE: The regional scenarios described below are fictitious and have been created to use as educational examples.

Meadville Quad *(Use laminated 11x17" quad sections)*
1. a) A toxicologist studied the levels of the herbicide 2,4-D in macroinvertebrates in various streams in the Meadville area. She found the highest levels in Bennyhoof Creek just downstream of the headwaters. Where might the 2,4-D be coming from? Use your watershed delineation of Bennyhoof Creek from the Watershed Delineation activity to answer this question.
The 2,4-D contamination might be due to herbicide application on the greens of the golf course near the headwaters of Bennyhoof Creek. 2,4-D can be used to control weeds on golf courses. The herbicide might also be washing from the lawns of the apartment complex (numerous, bright pink buildings) or the Home of the Aged. Perhaps people are not following the directions for proper amounts of herbicides to apply to their lawns. See Key transparency for watershed delineation.

b) Upon learning about the toxicologist's findings about Bennyhoof Creek, Allegheny College decided to find alternatives to herbicides to use on their athletic field (which can be seen on the topographic map). While this a great idea, will these changes in lawn care actually benefit the insects of Bennyhoof Creek. Why or why not?
Actually, no. The Allegheny College Athletic Fields are not in the Bennyhoof Creek Watershed. However, the fields are in a different watershed, and the elimination of herbicides will benefit the insects of the small intermittent stream south/southwest of the Athletic Field.

2. The Saegertown High School Creek Connections students have been chemical testing Woodcock Creek at its mouth (end) just prior to entering French Creek all year long. The students consistently obtain very high nitrate and phosphate levels in their samples. Based on the information available on this topographic map, what are some possible sources of these high levels?
The elevated nutrient levels might be from the sewage disposal facility located upstream, especially is the facility is outdated or malfunctioning. Most of the land surrounding Woodcock Creek is cleared land with no streamside forest, which increases soil erosion potential (which can raise nutrient levels). Some of this land may be agricultural land, there is one barn symbol (□) and some fences (−−−−-) south of the creek. There is also an industry nearby that might discharge some nutrient waste into Woodcock Creek.

3. Some fish in the small, intermittent tributary of French Creek east of Blacks Corner have shown evidence of arsenic poisoning. Local residents suggest that the arsenic contaminating the waterway might be leaching out of Cole Cemetery because some of the graves in this cemetery date back to the 1800s when arsenic was commonly used to embalm bodies. Could Cole Cemetery be the source of the arsenic contamination of the small, intermittent tributary of French Creek to its southeast? Why or why not?
No, Cole Cemetery is not in this watershed. Blacks Corner is right on a watershed divide/boundary. Arsenic leaching from Cole Cemetery would flow southwest into the unnamed intermittent stream that runs along the telephone lines, not southeast into the unnamed, intermittent tributary of French Creek. See Key transparency for watershed delineation.

4. Of all the land uses and human activities that are shown on this topographic map, which one do you think is the biggest threat to the waterways? Why?
This is an opinion question. Students should supply good reasons to support their opinion. Some possible answers could be: industrial waste ponds/industrial activity, the city of Meadville in general and its urban impacts (paved surfaces, industry, sewage treatment, lack of streamside forest), Saegertown (same reasons as above), or agricultural land, especially without streamside forest buffers.

Conneaut Lake Quad *(Use laminated 11x17" quad sections)*
5. Find the Gravel Pit near the northwest corner of the topographic map quad section. Gravel pits can sometimes be a source of soil erosion and wind erosion, which can add sediments to nearby waterways. Which side/s/ (north, east, south, west) of this gravel pit has the greatest potential to cause soil erosion problems?
The north and east sides because no forest/trees border it. Forest surrounds the southern and west sides of the gravel pit, and the trees help create a wall of protection – tree roots anchor soil, slow down runoff from the gravel pit, and cut down on the wind. The east side also has 2 dirt/gravel access roads, which can also erode. Water can drain out of the gravel pit from both the north and east side, with water eventually entering Jackson Run.

6. A water quality scientist has been studying Unger Run and its riparian (streamside) zone forests. Trace the stream and all of its tributaries on the topographic map. The scientist would like help estimating the percentage of the stream that has riparian zone forests. Determine this for him.

approx. 2/3 of the stream has riparian zone forest

What benefits do you think a riparian zone forest would provide to Unger Run?
Riparian zone forests provide shade to a stream, keeping it cool for the aquatic life. Trees help anchor the soil in place, keeping it from eroding into the creek, and slowing down overland flow and soil erosion. Riparian zone vegetation also can uptake extra nutrients washing off adjacent agricultural land and use those nutrients for plant growth, keeping those nutrients from entering the creek.

7. Mr. Jackson's class, a participant of Creek Connections, collects samples for water quality analysis from McDowell Run. They need your help determining the land uses that affect this waterway. Trace McDowell Run from its headwaters to where it meets Crooked Creek and describe the land uses along McDowell Run and how they might negatively and/or positively affect water quality. It is not necessary to delineate McDowell Run's watershed (but if you delineated it earlier in the Watershed Delineation activity, you can use your delineation again as a guide).

Land use	Effect on water quality
Wetland at headwaters	***Feeds stream, keeps it perennial, filters out pollutants and sediment, sequesters nutrients***
Cleared land—probably agriculture	***Little riparian vegetation so warmer water temperatures (resulting in decreased dissolved oxygen); little vegetation so more soil erosion and no buffer to filter out sediment and pollutants out of and slow down runoff → turbid water and associated problems for aquatic life, etc.***
Strip Mine	***Removal of surface vegetation leading to increased erosion →increased turbidity; little riparian vegetation so warmer water temperatures (resulting in decreased dissolved oxygen); potentially acid mine drainage that would drastically reduce pH; high TDS due to runoff from mining site; decreased alkalinity because water's buffering capacity being used up by acid mine drainage; potentially toxic metals contaminating the stream; etc.***
Forest/Healthy Riparian Buffer	***Cool, oxygen rich water; runoff absorbed and filtered by riparian buffer so decreased turbidity, nutrient levels in waterway; increased pH and high alkalinity because water is more in contact with soil, bedrock; decreased TDS because tree roots reduce soil erosion and absorb nutrients that are part of TDS measurement.***
Roads/Railroads	***Runoff warms and picks up solids and TDS as it flows over impermeable, warm surfaces; warmer, turbid water holds less dissolved oxygen; pollutants from cars enter air and come back to earth as acid rain →decreasing pH and using the waterways alkalinity; increased TDS from road salt; etc.***

The McDowell Run Watershed delineation appears on the answer key for your reference.