Eye in the Sky

Lesson Focus: Land use and water quality

Learning objectives:

- Students will develop an understanding of how to use an aerial photograph to determine land cover and use
- Student will use land cover to infer land use possibilities
- Students will predict what impact local land use might have on both groundwater and surface water at the school site
- Students will understand the flow of water across a watershed

Enduring Understandings for the Lesson:

- Human choices and actions have consequences for the environment
- The way land is used affects the quality of water that flows across and through it

Georgia Performance Standards Addressed:

- **S5E1 Students will identify surface features of the Earth caused by constructive and destructive processes.**
  c. Relate the role of technology and human intervention in the control of constructive and destructive processes
- **S5CS4 Students will use ideas of system, model, change, and scale in exploring scientific and technological matters.**
  b. Use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories to represent corresponding features of objects, events, and processes in the real world. Identity ways in the representations do not match their original counter parts.
- **SSMap and Globe skills11. Compare maps of the same place at different points in time and from different perspectives to determine changes, identify trends, and generalize about human activities**

Grade level: 5th

Materials:

Access to Google Maps (www.maps.google.com)
Satellite image of your school area printed (one per student) or projected
Road and topography maps of school area (one per student)
Key of satellite images that represent common ground cover (attached)
Digital projector or smart board
Internet connection

Colored pencils

Time needed: One class session

Background information: Land cover refers to the features present on the surface of the Earth. For example, farm fields, lakes, rivers, forests, roads, and parking lots are all types of land cover. These coverings can be categorized as biological and physical. Land cover includes the type and quality of vegetation, water, and earth materials. Both physical and biological land covers can be influenced by human and social needs such as agriculture, housing or industry. Land use refers to the purposes that are associated with the land cover, such as raising cattle, recreation, or urban living. A single category of land use can be associated with a variety of land covers, and a single land cover may support multiple uses. For example, residential land may have tree cover, grass cover, road cover, and roof cover while a forest may be used for timber production, recreation, or wildlife habitat.

Streams, rivers, and lakes are an important part of the landscape, as they provide drinking water supply, recreation, and transportation for humans, and a place to live for plants and animals. Groundwater also is an important water resource that serves as a source of drinking water.

Fresh water sources are fed by rain water. Water quality is affected by the land cover and use of the land it drains from. Land use is partly determined by environmental factors such as soil characteristics, climate, topography, and vegetation. It is also determined by human activity such as agriculture, recreation, and urban living.

Pollution sources that affect surface water may be separated into two categories: point and nonpoint. Point sources include sewage treatment plants, industrial discharges, or any other type of discharge from a specific location (commonly a pipe) into a body of water. Underground point sources may be difficult to locate and identify, such as buried septic systems and leaking underground fuel tanks. By contrast, nonpoint sources—which include runoff from lawns, roads, or fields—are diffuse sources of contaminants that are not as easily identified or measured as point sources.

Movement of contaminants is often affected by rainfall that results in runoff and infiltration. Contaminants can travel from a variety of sources through multiple pathways into nearby stream channels or lakes. If contaminants are found in water, it is assumed that the source can be found in the surrounding watershed. Sometimes these sources can be inferred from the type and intensity of land use in the contributing area.

Land Use and Groundwater Contamination

- Nitrate (a form of nitrogen) is essential for plant growth, but too much can contaminate wells and groundwater. Nitrate can come from domestic sewage and lawn fertilizers in residential areas, and from crop fertilizers and manure in agricultural areas. Land-use data that shows housing density and agricultural practices can indicate the likelihood of nitrate contamination.
- Bacteria are present in human sewage and manure from cattle, hogs, chickens or other animals. It contains pathogens that can cause human illness. Land-use data on densities of septic tanks and animals are useful indicators of the possible presence of bacteria.
- Road salt used to treat winter iced roads can carry sodium and calcium chlorides into the groundwater. Data on road density, salt application rate, and locations of salt storage piles can be indicators for detection of elevated chloride concentrations in water.
- Pesticides are used to kill unwanted pests, such as termites, ants, and rodents around homes and businesses; nematodes in soil, and fungi and insects in crops. Similarly, herbicides are used to kill weeds and grasses in lawns, along roads, and in agricultural areas. Types and amounts of pesticides can be related to land-use factors such as population and housing density, number of roads, and type of cropland. In recent studies, the concentrations of most pesticides in water have rarely exceeded state or federal standards for drinking water; however, the effects of chronic, low-level exposures to pesticides on ecological and human health have not yet been fully assessed.
- Volatile organic compounds (VOCs) have affected groundwater locally throughout the United States. Many VOCs are carcinogenic; so their presence in groundwater creates a serious problem. VOCs are commonly found in groundwater in industrial and commercial areas where petroleum fuels and organic solvents are used. A major source is leaking fuel tanks, which contaminate the underlying aquifers with an additive used in gasoline to reduce smog-producing emissions. The presence of VOCs in groundwater is directly related to urban and suburban development.

Land Use and Surface Water Contamination

- Sediment is eroded and transported mostly during heavy rainfall events and high stream flows. Sediment can become a problem because its deposition in streams and lakes can ruin the habitat of aquatic plants and animals. It can also fill in stream channels, lakes, and harbors, which then need expensive dredging. Many contaminants can attach (adsorb) and move with the sediment particles,

like phosphorus, a nutrient which can cause excessive plant growth in rivers and lakes, and persistent organochlorine compounds such as PCBs and DDT. Persistent compounds have been shown to be present 40 years after the initial release. The amount of suspended sediment in rivers can be related to natural factors such as soil type and local geology. However an important factor for sediment transport is the amount of land cleared of vegetation.

- Wastewater discharges from municipal sewage treatment plants, from industrial and commercial sources, and from confined animal feedlots can impair the quality of the receiving waters. Municipal sewage, for example, contains high concentrations of organic compounds that may deplete the dissolved oxygen content of water downstream from the discharge. Depleted oxygen levels are toxic to bottom dwelling fauna and fish. Wastewaters also contain significant amounts of phosphorus and nitrogen. The volume of wastewater discharges is often directly related to land use within the contributing watershed.

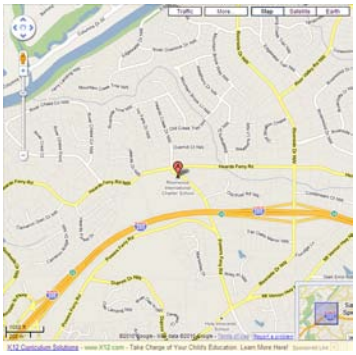
- The category of "emerging contaminants" has been added to water studies since the 1990s. These newly identified contaminants include human and veterinary pharmaceuticals, industrial and household wastewater products such as caffeine, detergent byproducts, insect repellants, and reproductive and steroidal hormones. Studies have shown that these organic wastewater contaminants can persist in water bodies far downstream of their discharge points, which are commonly found in cities and livestock production areas. Concentrations of these compounds are typically low, often at trace levels. The significance of these contaminants is unknown, particularly for the effects of long-term exposure at low levels.

Learning Procedure:

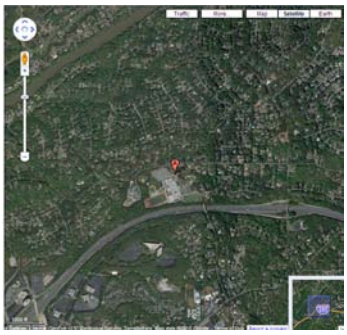
In this lesson, students will use aerial photographs and satellite images to identify land use. Studying the Earth from above allows students to see things and how they relate to each other. Students will learn to recognize familiar landmarks from a "birds-eye" perspective. .

Preparation:

1. Open Google Maps (www.google.com/maps) and type in the address for your school. Focus the map so that the scale on the bottom left corner of the map shows 1:1000 ft. Make sure that the "Map" tab is turned on (this will look like a regular road map) Print off a copy of the road map for each student or group of students.



2. Click the "Satellite" tab and print off a copy of this map for each student or group of students. If you can, print this off in color. The scale should still be 1:1000 ft.



3. Under the "More" tab, check the "terrain" box. This will be your topographic map for the students to use. Print off a copy of this map for each student or group of students to use. The scale should still be 1:1000 ft.

Lesson:

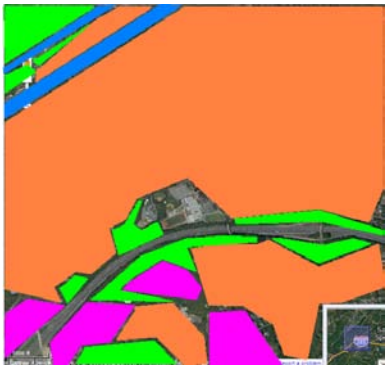
1. Open Google maps on a projector for the class to see. The first screen shows a political map of the whole United States. Have your students locate Georgia. Type in the name of the town where your school is located and zoom into it.

2. Use the local map to locate the school property. You can type in the name and address of the school if you wish to make it easier.

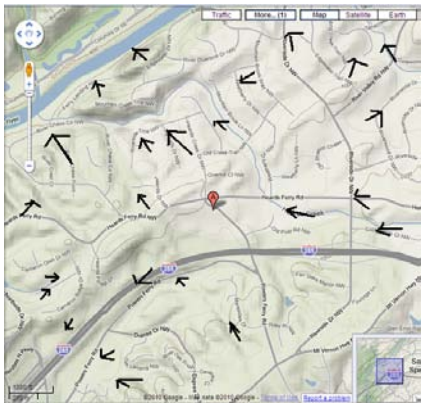
3. Pass out the road map print out and identify any local water sources. Small creeks and streams will typically not be shown on a road map. Have student indicate where a creek or stream would be if there is one in the school area.

4. Pass out the satellite image of the schools area as well as the land use key. Discuss and identify what the local area consists of: forests, neighborhoods, etc. Introduce "land use" and explain that what an area of land is used for can greatly affect the area around it, especially when water flows over it.

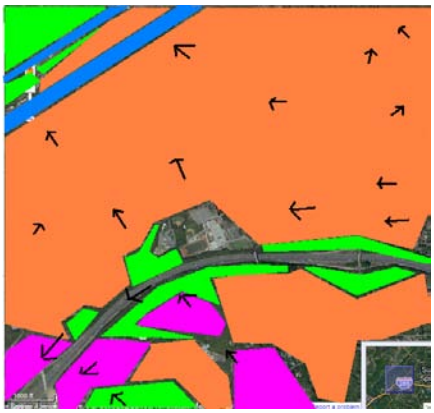
5. Have the students draw on the satellite maps to color code the different land uses for the area around the school according to the land use key.



6. Pass out the terrain map and explain that this will help describe how water moves in their neighborhood. The lines and shading on this map show hills and valleys. Have the students find the highest area and the lowest areas of the map and draw arrows down the sides of hills as water would flow down the hillsides. Note that if these topographic lines are close together, it is a steep hill, and if the lines are far apart, it will represent a gradual hill.



7. Have the students add the land use information from the satellite image to the terrain map (lightly shade areas with colored pencil so features and arrows show through) to show how water moves through the areas. Have the students identify any patterns they see. Does any water flow through industrial areas before flowing into a river? What kind of land use areas did the water flow past before it comes to the school?



8. Discuss how manmade structures might impact the flow of water in the environment. Brainstorm structures that stop, redirect, or slow down water flow in rivers. These include dams, levees, channelization etc.
    a. Damns: a barrier that stops water from flowing down a river or stream.
    b. Levee: a manmade bank on a river that keeps water in the river if it floods
    c. Channelization: making a river straighter or deeper
9. With Google Maps again, display examples of each of these structures to the class and have then identify how the structure has changed the way which water flows through the region. Feel free to use the satellite imagery as well as the topographic terrain map layers.
    a. Examples of these structures are as follows:
        i. Morgan Falls Reservoir, Sandy Springs, Ga. (dam)
        ii. Buford Dam, Buford, Ga (dam)
        iii. Gallet Lane, Buras, LA (Levee Rd runs along the side of the Mississippi river to keep flood waters from flooding the residential

homes, but allowing for natural flooding to the other side of the river onto the flood plains)

iv. Savannah River, Savannah, Ga. (this river is channelized to allow large ships to navigate upstream to load and unload their cargo. The stretch of the river next to downtown savannah is easily seen as being straight compared to the natural patterns of the surrounding rivers.)

10. Discuss with your class if there are any of these manmade structures in your neighborhood. If there is, why was it placed in that location? What aspect of a river/stream is it controlling? Does the structure benefit or harm the river/stream? How?

Evaluation: Have the students write a story from the stand point of being a raindrop that falls in your neighborhood. What would they see as they flows into a local body of water? What would they pass, etc.

Extensions: Have the students recreate the activity with their home addresses and present on what they found.

Resources:

Google Maps:
http://maps.google.com – readily available aerial photography, street maps, etc.

Photography changes land use planning:
http://click.si.edu/Story.aspx?story=158 – An article describing the use of aerial photography to track historic changes in land use

U.S. Geological Survey's Earth Resources Observation and Science program:
http://eros.usgs.gov – high resolution photography from high altitude showing many different land features

Lesson developed by: Caye Guidry, Myers Elementary and Mihkel Allpere, Georgia Aquarium

This activity is a product of the Rivers to Reef Teacher Workshop sponsored by the Georgia Aquarium and Gray's Reef National Marine Sanctuary that the author participated in. For more information about this workshop, Georgia Aquarium, or NOAA Gray's Reef National Marine Sanctuary, please visit our websites at www.georgiaaquarium.org or http://graysreef.noaa.gov/

GEORGIA AQUARIUM
Pemberton Place

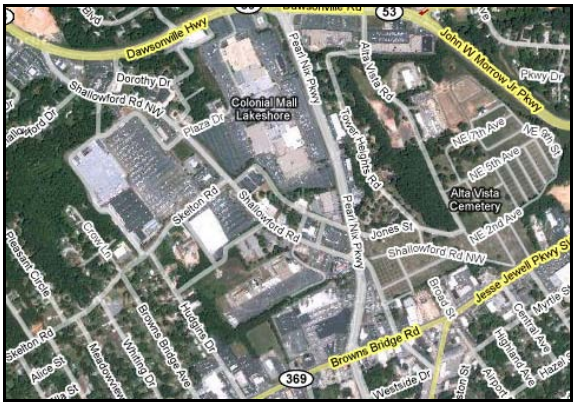
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Land Use Key

Forest:green

Surface Water: blue

Commercial use: grey



Industrial: purple

Residential: orange

Agriculture: yellow