Grade 8 Program: Water Systems

"Our Lessons Really Rock!"

Collingwood Scenic Caves Nature Preserve

Scenic Caves Nature Adventures Education Program 2002

Water Systems

Introduction

When living on the shore of one of the Great Lakes it is very easy to take water for granted. We must celebrate our good fortune that about 20% of the WORLD'S available fresh water is nearby. It is difficult to imagine that 40% of the world's population live with water scarcity daily. Yet last summer in many parts of Ontario, especially Grey County, may people experienced severe water shortages. The wells were dry and some municipalities rationed water.

In Canada the average citizen uses 342 litres of water per day. How does this level of consumption affect the resource? Are the groundwater and surface water resources sustainable? This unit encourages students to think about water as a very valuable resource, ask questions and seek answers.

Students will study the water cycle to increase their understanding of weather, erosion, water treatment, consumption patterns, health and political issues. Without water we cannot survive for more than a few days. Without adequate clean water there would be few jobs. Water, personal and economic health are interconnected.

Student Demonstration

Students will evaluate human use of water at the Scenic Caves site and the economic and environmental impacts of the choices made about water in their own community.

Students will research and prepare data to stage a debate with the following resolution:
"Let it be resolved that Canada should remove groundwater and surface water for export to other countries."

Program Areas

Science and Technology, Geography, Language

Vocabulary

groundwater, surface water, aquifer, recharge, hydrologic cycle, tide, gravitational force of moon, available fresh water, water table, saturated zone, unsaturated zone, permeability, groundwater flow rate, spring, delta, vapour

Teaching Strategies and Learning Activities

Lesson #1

- ✓ Introduce the water unit to students by reading through the **United Nations' report** on water.

- ✓ Discuss the article and have students complete the **questions** about the UN report.

Lesson #2

- ✓ Have students become aware of issues surrounding water and water pollution, using newspapers as a resource and a springboard for further interest.

- ✓ Correct the answers from the previous day.

- ✓ Introduce the Background Information - **Did You Know?**

- ✓ Discuss the world's major bodies of water and have students locate and label these waters on a map of the world.

Lesson #3

- ✓ Discuss which way(s) the water flows. Looking at a topographical map, have students guess which direction the water flows in different parts of Canada and the world. Introduce the **Great Divide**.

- ✓ Introduce the difference between salt water and fresh water. Inquire as to which water is used for drinking and whether it is possible to drink salt water. This will lead to a discussion about salt water.

- ✓ Have students complete **true/false worksheet** about salt water.

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Lesson #4

- ✓ Ask students if they know from where their drinking water comes.
- ✓ Introduce the concept of water filtration and if possible, use material from a local water filtration plant.
- ✓ Discuss groundwater and the type of **aquifers** that may be found locally.

Lesson #5

- ✓ Introduce the **water cycle**.
- ✓ Have students consider from what source the water in a glass of water that they drank recently came.
- ✓ Discuss the difference between hard and soft water and complete the **Experiment**.

Lesson #6

- ✓ Discuss how the ocean affects climate.
- ✓ Complete **worksheet.**

Lesson #7

- ✓ Introduce the Scenic Caves Internet Scavenger Hunt.
- ✓ Assign *Day One* of 20 Questions or More

Lesson #8

- ✓ Take up *Day One* and assign *Day 2*
- ✓ Introduce students to Habit@Earth and have them track storms/monsoons

(www.bconnex/~lepages/educate or www.discovery.earthalert.com)

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Lesson #9

- ✓ Take up Day 2 and assign Day 3
- ✓ Have students prepare research to debate that "Canada should remove groundwater and surface water for export to other countries."

Lesson #10

- ✓ Take up Day 3 and assign Day 4.
- ✓ Let students work on debate.

Lesson #11

- ✓ Take up *Day 4.*
- ✓ Continue to work on debate.
- ✓ Introduce the trip to Scenic Caves and prepare students with activity sheets.

Finally - present the debate when you feel the students are prepared.

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World Water Crisis Looms, U.N. Warns

– source: the Environmental News Network, Friday, March 19, 1999

"Thirty percent of the world's population will face water shortages by the year 2050, according to the United Nations Environment Program.

Over 3.35 billion cases of illness and 5.3 million deaths are caused each year by unsafe water. The water could be treated so that it is not "poisonous" - and it would cost less than what Americans and Europeans pay for pet food in one year. This money could be used on technologies such as hand pumps, gravity-fed systems and rainwater collection.

In many countries, water shortages are caused by an inefficient use of the water, an abuse of the water in that it has become a "dumping" ground for pollution and the unsustainable use of underground water in aquifers.

The water crisis is so bad that, according to UNEP:

- Every eight seconds, a child dies from a water- related disease;
- 50 percent of people in developing countries suffer from one or more water related diseases;
- 80 percent of the diseases in the developing world are caused by contaminated water;
- 50 percent of people on Earth lack adequate sanitation;
- 20 percent of freshwater fish species have been pushed to the edge of extinction by contaminated water.

The United Nations foresees wars being waged all over the world - over clean water. *"Conflicts over water, both international and civil war, threaten to become a key part of the 21st century landscape,"* said van Ginkel. It is impossible to lay

claim over the world's water resources, as most of the basins are shared between two or more countries.

Background Information

Did you know?

_ Raindrops are not tear-shaped. Scientists, using high-speed cameras, have discovered that raindrops resemble the shape of a small hamburger bun?;

_ About 70% of the human body is water?;

_ Life on earth probably originated in water?;

_ More than half of the world's animal and plant species live in the water?;

_ Almost 75% of the earth is covered in water?;

_ The human body needs 2 litres of water a day in our climate; we can last only a few days without water?;

_ Most of our food is water: tomatoes (95%), spinach (91%), milk (90%), apples (85%), potatoes (80%), beef (61%), hot dogs (56%)?;

Oceans (and Seas)

The world's seas include: the North and South Pacific, North and South Atlantic, Indian and Arctic Oceans and the Antarctic waters or seas.

Scientists believe that the seas are as much as 500 million years old because animals that lived then occur as fossils in rocks which once were under ancient seas. It is believed that the ocean was formed when the Earth was cooling from its active volcanic stage. Water vapour escaped from the interior to form clouds

surrounding the cooling Earth. After the Earth's surface had cooled to a temperature below the boiling point of water, rain began to fall and continued to fall for centuries. The water drained into the lower regions of the Earth and collected to form the oceans.

The Continental Divide

The Continental Divide is the highland that separates the waters flowing into the Atlantic Ocean from those flowing into the Pacific Ocean. In the United States and Canada the Great Divide is high in the Rocky Mountains. Waters flowing down the west of the Rockies flow to the Pacific - those to the east, flow to the Atlantic.

Salt Water

Sea water has been defined as a weak solution of almost everything. Ocean water is a solution of mineral salts and of decayed sea matter. Most of the ocean's salts came from the cooled igneous rocks of the Earth's crust. Through weathering and erosion, minerals were transported down to the sea. Some of the ocean's salts have been dissolved from rocks and sediments below its floor. Other sources of salts include the solid and gaseous materials that escaped from the Earth's crust through volcanic vents or that originated in the atmosphere.

In the beginning the seas were only slightly salty. When the first rains broke up rocks and transported their minerals to the seas, the ocean has became saltier. Throughout the world, rivers carry an estimated 4 billion tons of dissolved salts to the ocean annually. About the same tonnage of salt from the ocean water probably is deposited as sediment on the ocean bottom, and thus, yearly gains may offset yearly losses. In other words, the oceans today probably have a balanced salt input and outgo.

Groundwater

When we think of groundwater, we tend to see it collected underground in pools and flowing as rivers. Groundwater, however, is not restricted to channels or depressions in the same way that surface water is concentrated in streams and

lakes. It exists, rather, almost everywhere underground. It is found underground in the spaces between particles of rock and soil, or in crevices and cracks in rock.

The water filling these openings is usually within 100 metres of the surface. Much of the earth's fresh water is found in these spaces. At greater depths, because of the weight of overlying rock, these openings are much smaller, and therefore hold considerably smaller amounts of water. The **water table** is not really a table - but more like a level where all the available spaces are filled with water. Since the spaces cannot hold any more water than they already hold, this layer is also referred to as the **saturated zone**. It is here that **groundwater** is defined.

Above the water table is the **unsaturated zone**. Here the spaces in the rock and soil contain both air and water. Water in this zone is called soil moisture.

Groundwater runs slowly through water-bearing formations known as **aquifers**. In some places, where groundwater has dissolved limestone to form caverns and large openings, its rate of flow can be relatively fast.

Groundwater - A major link in the hydrologic cycle

The sun causes surface water to evaporate. Once the water molecules hit the colder temperatures found in the higher atmosphere, they condense to form clouds. Once the clouds have reached saturation, they precipitate in the form of rain, ice or snow.

When precipitation falls on the land surface, part of the water runs off into the lakes and rivers. Some of the water from melting snow and from rainfall seeps into the soil and **percolates** into the saturated zone. This process is called **recharge**. Places where recharge occurs are referred to as **recharge areas**.

Eventually, this water reappears above the ground. This is called **discharge**. Groundwater may flow into streams, rivers, marshes, lakes and oceans, or it may discharge in the form of springs and flowing wells.

Groundwater discharge can contribute significantly to surface water flow. In dry periods, the flow of some streams may be supplied entirely by groundwater. The saturation levels of underground formations have a significant effect on the volume of surface runoff. If the underground areas are saturated, then rain cannot be absorbed and it simply runs away. If the underground areas are not saturated, however, the water is readily absorbed into the ground.

Water may spend as little as days or weeks underground, or as much as 10,000 or more years. By comparison, the average time it takes the water in rivers to completely replace itself, is about two weeks.

The Water Cycle

Glaciers: A huge quantity of fresh water is frozen in polar ice caps and in high mountain glaciers. Snow that is packed down over many years at high elevations becomes glacial ice.

Glaciers affect the Earth's hydrologic cycle by slowing the passage of water through the cycle. Like lakes and groundwater reservoirs, glaciers are excellent natural storehouses, releasing water when it is needed most.

Snow: Much of Canada's annual precipitation comes as snow:
in the North, 50%;
in the Prairies, 25%;
and on both coasts and in southern Ontario, as little as 10%.

Snow affects stream flow throughout the year as the water is first stored as snow for several months.

The Oceans' Effects on Climate

The sun's energy heats the continents and the oceans. The continents (land) absorb the heat more quickly than the oceans. The land also cools (loses heat) more quickly than the oceans. Scientist believe the way the oceans store and transport heat is related to climate.

The oceans' waters are constantly in motion. These movements are caused by

powerful wind-driven currents (see our "Currents" page). Earth's rotation, continents, and "things" going on inside the ocean can create currents or movement of water. Deep ocean movement is created by density - the density of seawater (ocean water) is greater than the density of pure water at the same temperature because seawater contains salts. Less dense substances will float on more dense liquids.

Climate's Role:

Latitude affects the temperature of ocean water. Cold winds blowing across the ocean at high latitudes cool and evaporate the water. If it is cold enough, sea ice will form. The sea ice is fresher water than the sea water. Since the salts are left behind when the sea ice forms the cold water becomes more dense and sinks deep into the ocean. This sinking of cold dense water at high latitudes is due to temperature and salinity (how much salt) differences. The sinking and spreading of cold water is known as the **Thermohaline Circulation** or the **Meridional Overturning Circulation.**

The existence of this very cold water in the ocean basins (even at the tropics) has been known about for a long, long time. There is much more of this deep water than there is of the surface water. The currents in the deep water are not as strong as those of the surface water.

So what does the atmosphere have to do with deep ocean movement? Clouds, which are part of the atmosphere, block the sun's rays from the ocean. The ocean cools. These same clouds could also bring rain, which is fresh water. The fresh water reduces the salinity (saltiness) of the ocean. Winds blow in and evaporate some of the ocean water. The H2O (water) goes up and the salt stays behind.

Temperature, precipitation, and wind can affect density, which affects deep ocean movement.

The Ocean's Role:

The oceans are main reservoirs of readily available carbon dioxide (CO2), an important greenhouse gas. The cold, deep water in the ocean is the main reservoir of dissolved CO2.

TRY THIS: Shake a hot can of coke and open it.
Shake a cold can of coke and open it.
What happened? What does this experiment demonstrate?

Oceans transport (carry) heat from the tropics to the higher latitudes (towards the poles) to maintain Earth's temperature. The Gulf Stream and the North Atlantic Drift carry heat to warm Europe.

Norway at 60o north is far warmer than southern Greenland and northern Labrador which are at the same latitude. This ocean part of this heat transport system can be compared to a giant conveyor belt. It is called the Global Conveyor Belt.

"CURRENT" EVENTS :

Wind energy is converted to water movements called *"currents"* by friction between the moving air (wind) and the water surface. The surface currents resemble the surface winds. Once these surface currents are set in motion they are affected by three other factors:

Coriolis effect,
The presence of coasts, and
Horizontal pressure gradients.

Because Earth rotates, the winds and currents are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This is referred to as the **Coriolis Effect.**

The presence of coasts (land masses) create massive barriers, like dams of granite, that deflect the flow of currents. The easterly (flowing to the east) currents bumping into the continents change direction and flow toward the equator. The westerly (flowing to the west) currents hit land masses and flow toward the

poles. This creates in the northern hemisphere a closed circulation loop with a clockwise rotation. Only the Antarctic circumpolar current can flow unimpeded (without obstructions or barriers) around Earth.

Aquatic ecosystems

In nature nothing exists alone. Living things relate to each other as well as to their non-living, but supporting, environments. These relationships are called ecosystems. Each body of water is a balanced ecosystem in continuous interaction with the surrounding air and land.

Whatever occurs on the land and in the air also affects the water. If a substance enters a river or lake, the water can purify itself biologically — but only to a degree. Whether it is in the smallest stream or lake — or even in the mighty oceans — the water can absorb only so much. It reaches a point where the natural cleaning processes can no longer cope.

The Great Lakes: A Chemical Hot Spot

Over 360 chemical compounds have been identified in the Great Lakes. Many are toxic chemicals — *alkylated lead, benzo(a) pyrene, DDT, mercury and mirex* — potentially dangerous to humans and already destructive to the aquatic ecosystems.

For example, various species of fish now suffer from tumours and lesions, and their reproductive capacities are decreasing. Populations of fish consuming birds and mammals also seem to be on the decline. Of the ten most highly valued species of fish in Lake Ontario, seven have now almost totally vanished.

World Water Crisis Looms, U.N. Warns

Name:_____

Respond to the following questions, using complete sentences.

1. By the year 2050, what percent of the world's population will be hard pressed to find water?

_____

_____

2. How many people become ill, or die every year as a result of using unsafe water?

_____

_____

3. What causes water shortages?

_____

_____

4. What percent of diseases in the developing world would be eliminated if people there had clean water available to them?

_____

_____

5. How have fish been affected by the water pollution?

_____

_____

6. How will nations deal with the water crisis, according to van Ginkel, if the problem is not solved in the near future?

_____

_____

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1. By the year 2050, what percent of the world's population will be hard pressed to find water?

   Thirty percent of the world's population will have difficulty obtaining fresh water by the year 2050.

2. How many people become ill, or die every year as a result of using unsafe water?

   Over 3.35 billion cases of illness and 5.3 million deaths are caused each year by unsafe water.

3. What causes water shortages?

   Water shortages in developing nations, are caused by negligence and inefficient use. Clean water is being contaminated at alarming rates by illegal AND legal dumping into the rivers and streams. Finally, there is a growing use and abuse of underground aquifers.

4. What percent of diseases in the developing world would be eliminated if people there had clean water available to them?

   Eighty percent of diseases in the developing world could be avoided by replacing contaminated water with clean water.

5. How have fish been affected by the water pollution?

Twenty percent of freshwater fish species are now threatened because of water pollution.

6. How will nations deal with the water crisis, according to van Ginkel, if the problem is not solved in the near future?

According to van Ginkel, nations will go to war over fresh water.

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The Ocean's Effects on Climate

Respond to the following questions using complete sentences.

1. Why do temperatures differ at different latitudes?

_____

_____

2. Why do temperatures vary at different locations at the same latitude?

_____

_____

3. Which has a greater capacity to store heat--the oceans or the atmosphere?

_____

_____

4. Which has a greater heat capacity--water or land?

_____

_____

5. In what way(s) does the atmosphere influence the ocean?

_____

6. In what way(s) does the ocean influence the atmosphere?

7. How would our global climate be different if 71% of Earth were covered by continents and 29% by water?

Hard Water or Soft?

What is hard water???

Introduction:

We are all very concerned about our own appearance. One of the most critical distinguishing features of a person - is their hair. We all know what it's like to have a "*Bad Hair Day*". Can the type of water that you use to wash your hair affect its behaviour? Complete the following experiment to find out...

Materials: 4 pop bottles
Samples of shampoo
Water (both rainwater and hard water - from the tap)

Procedure:

1. Rinse out bottles completely
2. Put equal amounts of water in each bottle. (2 with hard and 2 with soft water)
3. Add 2 drops of shampoo to each bottle.

4. Put lids on the bottles and give each one a couple of shakes.

Observations: Is there any difference between the appearances of the bottle contents?

Research:

1. How could the availability of hard or soft water affect a manufacturing process?

2. How can hard water be made soft?