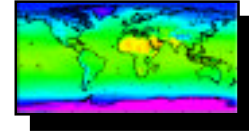




Looking at the Environment:
Investigations in Environmental Science
Using Geographic Visualization
and Information Systems



Unit 1
Lesson 1
2 Class Periods

Heat Wave and Drought: Introduction to Environmental Decision Making

Overview

Have you ever experienced a “black out?” Have you ever been told to conserve water or turn out the lights when you are not in the room? How does this make you feel? More often than not, people take electricity and water supply for granted. In today’s modern, developed communities, people don’t think about whether or not there will be enough water or electricity until there is a major heat wave and or drought that jeopardizes the supply. What would you do if electricity and water suddenly became scarce? How would your community react so that future supply isn’t threatened?

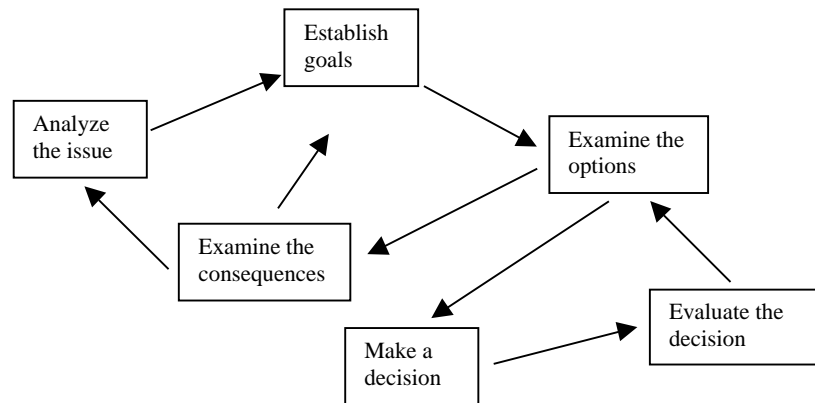
Throughout this curriculum you will be facing decisions about how to meet the future demand for electricity and water. You will be learning how to make decisions while learning the basic science in order to make informed decisions. For instance, suppose your local water comes from a nearby lake. How do you know if the lake is polluted or safe to drink? *Science* can tell you what is in the water and how the water quality is changing. But, it is up to the *community* (government, citizens, etc...) to decide if the lake is polluted.

In this activity, you are introduced to the curriculum through a scenario. You will be assigned groups that represent a community. Within your community, you will be making choices about what to do when faced with shortages of water and electricity.

There are six elements to environmental decision making process:

- Analyze the issue
- Establish goals
- Examine options
- Examine the consequences
- Make a decision
- Evaluate the decision

This process is not linear. That is, you don’t necessarily proceed from analyzing the issue to establishing goals and so forth. When making decisions, you often cycle back to a previous step. For instance, you may go back and refine your goals once you have learned more about the consequences. Thus, your decision making process about a particular issue might look like this:



Environmental decision is unique for everyone. The key is to understand *how and why you* made particular decisions. Was there new evidence that changed your mind? Did another person change your mind with smooth talk and fancy pictures?

Objectives

1. Students will learn about human dependence on two fundamental resources: energy and water.
2. Students will learn the basics of environmental decision making as related to consumption of energy and water during a heat wave and drought.

Materials (for each team of four students)

- Energy and Water Cards
- Energy and Water Use Sheet
- Household Energy and Water Use Decision Sheet (handout)
- 4 Calculators

Procedure

PART A: Selecting Your Energy and Water Consumption

1. Get into your groups according to your teacher's instructions.
2. Obtain materials from your teacher.
3. Arrange the Energy and Water Cards in the center of the table. You may choose to cut out the cards or leave them as a complete sheet of paper.

Rule: Your group represents a “community.” You represent a household in that community, consisting of four persons. The entire class represents a “region.”

Rule: For Round 1, your community starts with 3500 kWh of electrical energy and 14,000 gallons of water.

Round 1

It is early summer! The flowers in the community are in full bloom. People are walking more and more outside, as the weather is very pleasant. Community officials report that temperatures and precipitation amounts are “normal” for this time of year.

4. Look at your Household Energy and Water Use Decision Sheet. On it you will find a listing of typical household Energy and Water Items. Decide what Energy and Water items you want to select for your household. Select (or refer to) the Energy and Water Use Cards from the center of the table and record the *Average weekly use* in the appropriate space under “Round 1.” For example, if you selected an “Electric Stove,” then put “50” in the space under Round 1 on your handout.

Rule: *Once you have made your selections for Round 1, you cannot change your mind.*

5. When you have made all your selections for energy and water use, add the numbers in Round 1 and record your Household Energy and Water Use.
6. Share your answers with the rest of your community. What were the highest Energy and Water Costs in your community? The lowest?
7. Calculate the Total Community Energy Use and Total Community Water Use for your community for Round 1.
8. Subtract the total community use from the “Community Supply.” How many kWh of energy and gallons of water are still available to your community? Record the amount as “Community Reserve.”
9. About how many more households would the remaining supply support for your community?
10. If you have cut out your Energy cards and have collected them in this round, return them to the center of the table.

Round 2

11. Summer has arrived! Students are out of school. The days and nights are getting warmer. Thunderstorms seem to be less frequent. Days are sunny and the beach at the lake is full of people. Community officials report that due to increasing use of water on gardens and yards, water supplies have dropped. Increasing temperatures means more people are using their air conditioners and thus, using more electricity. Officials report that power supply is dropping due to maintenance problems at the local power plant, but no blackouts are expected.

Rule: For Round 2, your community supply has dropped to 2500 kWh of electrical energy and 10,000 gallons of water. **Record** this amount on your Household Energy and

Water Use Decision Sheet. Remember that once you have made your selections for this round, you cannot change your mind.

12. Make selections for Energy and Water use for Round 2. Collect or refer to Energy and Water Use Cards according to your selections. Add the total kWh of energy and gallons of water used in your household.
13. Share your energy and water use with your community and record their use in the appropriate rows. Calculate the total use for your community and subtract from the supply. How much energy and water is still available to your community? Are you running low on energy and/or water? Record the remaining amount as "Community Reserve."

14. Have one person from your community visit other communities in the classroom and compare your community's remaining energy and water with the rest of the class. In the space below, describe how your community compares.

15. Did you make any changes from Round 1 to Round 2? If so, describe the changes you made and why you made them.

Round 3

The days have been very sunny and warm. You haven't seen rain in what seems like weeks. The beach is overcrowded with people trying to cool off. This morning, the electricity was shut off. Community officials report "brown outs" across the region. Meteorologists are forecasting a heat wave for your part of the country. The forecast is for above normal temperatures and no precipitation for at least a week.

Rule: For Round 2, your community supply has dropped to 1500 kWh of electrical energy and 6,000 gallons of water. **Record** this amount on your Household Energy and Water Use Decision Sheet. Remember that once you have made your selections for this round, you cannot change your mind.

16. Make selections for Energy and Water use for Round 3. Collect or refer to Energy and Water Use Cards according to your selections. Add the total kWh of energy and gallons of water used in your household.
17. Share your energy and water use with your community. Calculate the total use for your community and subtract from the supply. How much energy and water is still available to your community? Are you running low on energy and/or water? Record the remaining amount as "Community Reserve."

18. Did your community have enough energy cards for all households? If not, describe what happened.

19. Have one person from your community visit other communities in the classroom and compare your community's remaining energy and water with the rest of the class. In the space below, describe how your community compares.

Wrap Up: Decisions, Decisions

(Use a separate sheet of paper for answering questions 20 and 21.)

20. Look back at the decisions you made in selecting the energy and water items for your household. Recall that there are six parts to making environmental decisions:
 - Analyze the issue
 - Establish goals
 - Examine options
 - Examine the consequences
 - Make a decision
 - Evaluate the decision

For each part above, *briefly describe* each as they relate to decisions you made during this activity. For instance, in analyzing the issue, ask yourself, “what is the major issue?” You might answer that the issue is “unusually warm temperatures and no precipitation” or “too much demand for electricity and water.” Both are valid and not necessarily independent issues.

21. As a class, make an environmental decision making flow chart similar to the one in the *Overview* section at the beginning of the activity. You should describe each element in the process. For instance, what major issue did you face in this activity? What were your goals for energy and water use? What were your options? What were the potential consequences? What decisions did you make about energy and water use? Were these “good” decisions?

Reading (Optional)

Read the following article about the 1999 Heat Wave in the Midwest. After your finished, answer the Wrap-up questions.

The Nature and Impacts of the July 1999 Heat Wave in the Midwest

Michael A. Palecki and Stanley A. Changnon
Midwestern Climate Center
Illinois State Water Survey
Champaign, IL
August 23, 1999

Heat Wave Impacts

The Human Toll.

The major loss of life was in the large cities where the urban heat island amplified temperatures by 3 to 5 degrees F or more. The loss of life attributed to the heat wave by the Associated Press, as of August 7, included 127 in Illinois, 61 in Missouri, 14 in Ohio, 13 in Wisconsin, 8 in Kentucky, 7 in Indiana, and 1 each in Michigan and Minnesota. Most of the deaths in Illinois and Missouri occurred in the Chicago, St. Louis and Kansas City metro areas, with most deaths in the other states occurring in Cincinnati, Milwaukee, and Indianapolis. As in the 1995 heat wave, the majority of those who died were elderly persons, living alone in the inner city regions, and either were without air conditioning or without the funds to pay for continuous operation of their air conditioning units. Heat-related deaths began occurring on July 22, and the initial warm period from July 20-27 was responsible for 46 deaths in the Midwest. The second peak in the heat wave, July 28-31, was far more deadly: 186 deaths occurred then, constituting 80% of the total loss of life of 232.

Although temperature and moisture extremes on July 28-30 matched those during the mid-July heat wave of 1995, many fewer persons died in July 1999. The reduction in fatalities resulted for two main reasons. First, the most extreme period was preceded by 10 hot days during which urban cooling centers and care monitoring procedures for the urban elderly were initiated. The news media provided vast amounts of useful information about behaviors to lessen heat stress and where to seek help. Second, the peak of the heat wave was sharp and brief, lasting 2 days in most of the central and eastern Midwest. In Chicago, for instance, the average maximum temperature of the warmest four consecutive days this year, July 28-31, was 97 degrees F, while maximum temperatures for the period July 12-15, 1995, averaged 101 degrees F. Compared to 1995, the 1999 heat wave had proportionally more victims in Missouri than in Illinois, possibly due to a higher degree of both length and intensity of the heat wave in Kansas City and St. Louis this year. However, the change in regional proportionality of deaths may also have been caused by a more effective response to mitigate the hazardous conditions in Chicago this year.

Electrical Infrastructure Problems.

The prolonged period of high temperatures and widespread use of air conditioning

brought new daily power use records in all major Midwestern cities including Chicago, Cincinnati, Detroit, Milwaukee, and St. Louis. These records were a result of the combination of high temperatures and the continuing growth in urban demand for electricity. During the peak heat wave period on July 29th and 30th, when 100 degrees F or higher maximum temperatures were common in large Midwestern cities, major power outages occurred in Chicago. Approximately 92,000 customers were without power for at least 4 hours, and many thousands remained without power for 1 to 3 days. The Chicago outages were caused by the overheating of old underground transmission lines. In several cases, the heat generated by the extra large electrical loads could not be dissipated because the ground was also warm. The damaged insulation would then conduct electricity, shorting out the line. In fact, another large outage of electricity occurred in Chicago several days after the heat wave ended due to electric line damage incurred during the heat wave. An even larger outage in Detroit occurred due to the severe storms that ushered in the end of the heat wave on August 1. About 160,000 people lost power for periods of hours to days.

Additional electrical system difficulties occurred due to the new open market for electricity after deregulation. Many electric companies in the region were forced to cut-off large industrial users of electricity, under previous agreements that allow this to occur at times of peak demand. Some electric concerns paid exorbitant rates to acquire extra electricity beyond their production capability. Finally, one major energy supplier, Cinergy in Cincinnati, actually defaulted on contracts to supply electricity elsewhere, losing millions of dollars in the process. The largest financial losses, though, will probably be those faced by Commonwealth Edison in Chicago. Not only must they compensate 100,000 customers for lost refrigerated food and medicine during the heat wave, but they may also be sued to reimburse businesses for up to \$100 million in losses by companies that were closed for a day on August 3rd by an electrical outage in downtown Chicago. This power loss affected the Loop area of the downtown, and occurred when power lines previously damaged by the heat wave shorted out.

Other Impacts.

The heat had other major impacts on the Midwest. Major highway damage was noted in several states due to heaving of road surfaces. Crops were stunted in the southern and eastern parts of the Midwest due to the combination of heat and lack of rainfall. Milk production at dairy farms was also hard hit, and thousands of cattle, pigs, and chickens died due to the heat. Large fish kills were reported in Iowa due to a lack of oxygen in the water caused by its heating. Several communities in Illinois and Missouri reported 1-day records for water use. Finally, many other health problems and illnesses were enhanced by high ozone levels, particularly in the larger metropolitan areas. All types of outdoor work, such as landscaping or construction, were reduced in productivity.

Questions for Part B.

Answer the following on a separate sheet of paper.

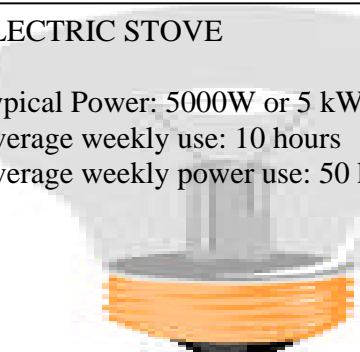
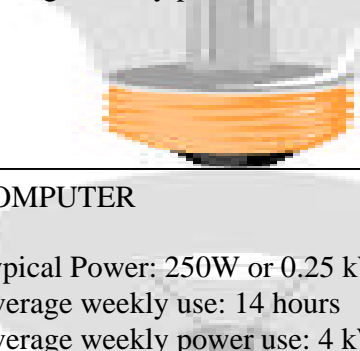
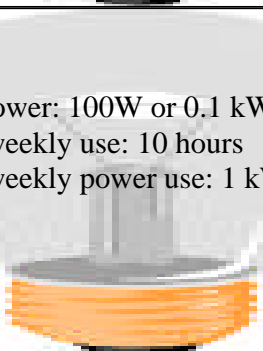
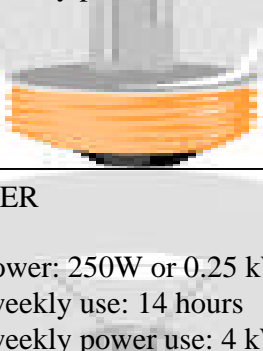
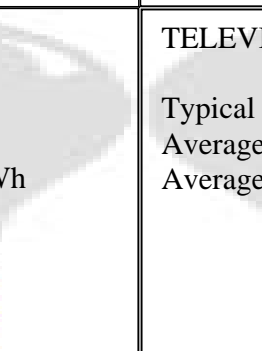
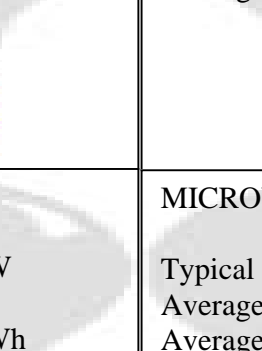
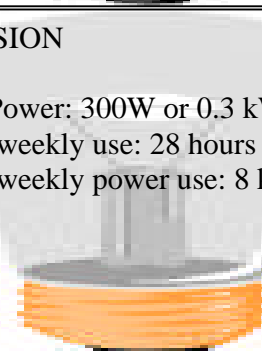
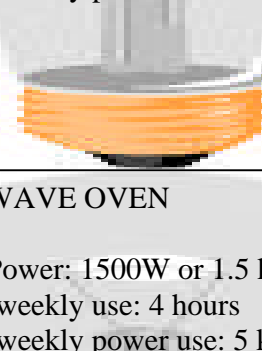
1. In your opinion, summarize the major impacts that occur during a heat wave.
2. What were the major causes for the blackouts during 1999 in the Midwest?

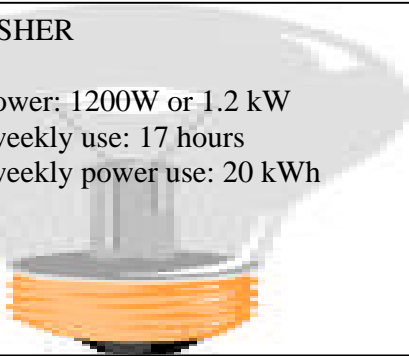
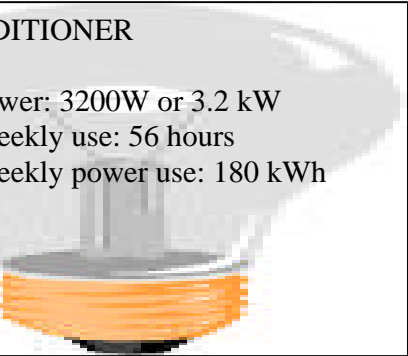
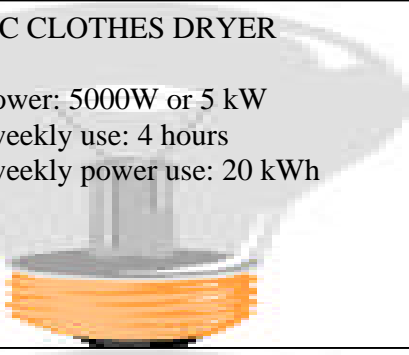
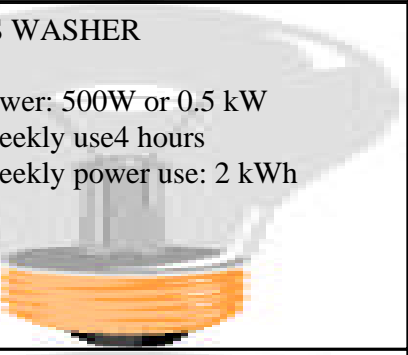
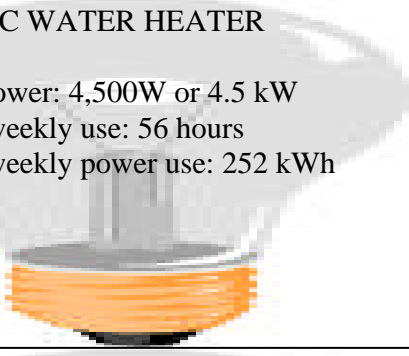
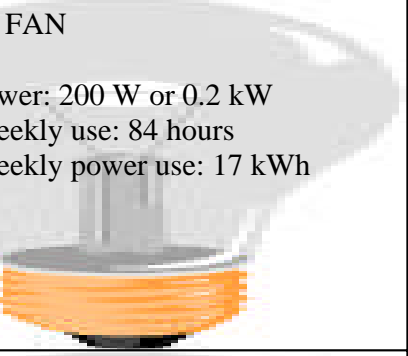

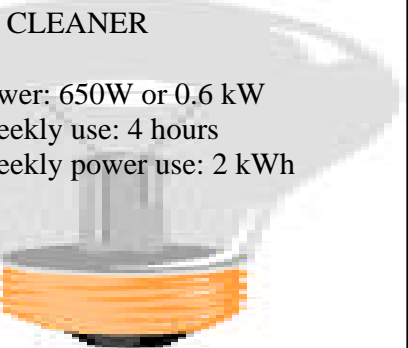
Handout



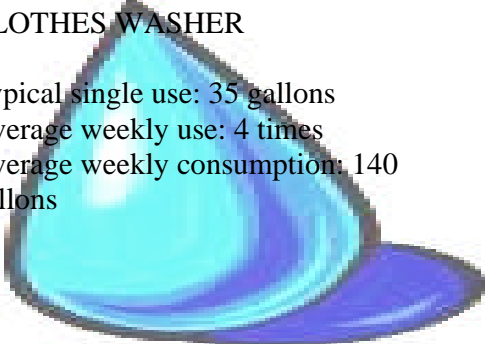
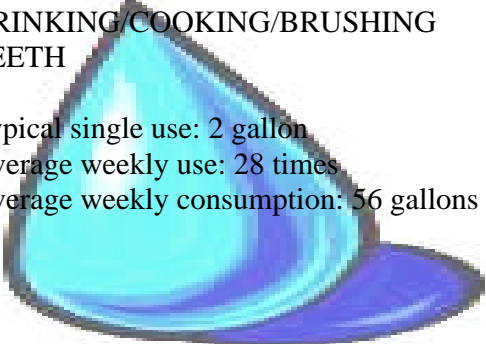


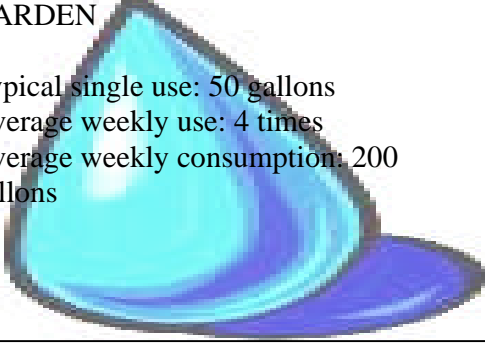

Household Energy and Water Use

Energy Items	One Week Energy Use for Each Item (kWh)		
	Round		
	1	2	3
Electric Oven/Stove			
Refrigerator/freezer			
Stereo/hi-fi			
Television, color			
Computer			
Microwave Oven			
Dishwasher			
Air Conditioner			
Clothes Dryer			
Clothes Washer			
Window Fan			
Hairdryer			
Vacuum Cleaner			
Lighting			
Clothes Iron			
Water Heater			
My Household's Energy Use			
Community Member2's use			
Community Member3's use			
Community Member4's use			
Average Household Use			
Total Community Use			
Community Supply	3,500		
Community Reserve			

Water Items	One Week Water Use for Each Item (gallons)		
	Round		
	1	2	3
Toilet			
Shower/Bath			
Drinking/Cooking/Brushing Teeth			
Washing Dishes by Hand			
Automatic Dishwasher			
Garden			
Yard/grass			
Clothes Washer			
My Household's Water Use			
Community Member 2's use			
Community Member 3's use			
Community Member 4's use			
Average Household Use			
Total Community Use			
Community Supply	14,000		
Community Reserve			

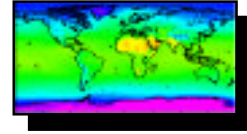
<p>ELECTRIC STOVE</p> <p>Typical Power: 5000W or 5 kW Average weekly use: 10 hours Average weekly power use: 50 kWh</p> 	<p>REFRIGERATOR/FREEZER</p> <p>Typical Power: 800W or 0.8 kW Average weekly use: 88 hours Average weekly power use: 70 kWh</p> 
<p>STEREO</p> <p>Typical Power: 100W or 0.1 kW Average weekly use: 10 hours Average weekly power use: 1 kWh</p> 	<p>TELEVISION</p> <p>Typical Power: 300W or 0.3 kW Average weekly use: 28 hours Average weekly power use: 8 kWh</p> 
<p>LIGHTING</p> <p>Typical Power: 1500W or 1.5 kW Average weekly use: 40 hours Average weekly power use: 60 kWh</p> 	<p>CLOTHES IRON</p> <p>Typical Power: 1000W or 1 kW Average weekly use: 4 hours Average weekly power use: 4 kWh</p> 
<p>COMPUTER</p> <p>Typical Power: 250W or 0.25 kW Average weekly use: 14 hours Average weekly power use: 4 kWh</p> 	<p>MICROWAVE OVEN</p> <p>Typical Power: 1500W or 1.5 kW Average weekly use: 4 hours Average weekly power use: 5 kWh</p> 

<p>DISHWASHER</p> <p>Typical Power: 1200W or 1.2 kW Average weekly use: 17 hours Average weekly power use: 20 kWh</p> 	<p>AIR CONDITIONER</p> <p>Typical Power: 3200W or 3.2 kW Average weekly use: 56 hours Average weekly power use: 180 kWh</p> 
<p>ELECTRIC CLOTHES DRYER</p> <p>Typical Power: 5000W or 5 kW Average weekly use: 4 hours Average weekly power use: 20 kWh</p> 	<p>CLOTHES WASHER</p> <p>Typical Power: 500W or 0.5 kW Average weekly use: 4 hours Average weekly power use: 2 kWh</p> 
<p>ELECTRIC WATER HEATER</p> <p>Typical Power: 4,500W or 4.5 kW Average weekly use: 56 hours Average weekly power use: 252 kWh</p> 	<p>WINDOW FAN</p> <p>Typical Power: 200 W or 0.2 kW Average weekly use: 84 hours Average weekly power use: 17 kWh</p> 
<p>HAIR DRYER</p> <p>Typical Power: 600W or 0.6 kW Average weekly use: 4 hours Average weekly power use: 2 kWh</p> 	<p>VACUUM CLEANER</p> <p>Typical Power: 650W or 0.6 kW Average weekly use: 4 hours Average weekly power use: 2 kWh</p> 

<p>TOILET</p> <p>Typical single use: 5 gallons Average weekly use: 196 times Average weekly consumption: 980 gallons</p> 	<p>SHOWER/BATH</p> <p>Typical single use: 28 gallons Average weekly use: 28 times Average weekly consumption: 784 gallons</p> 
<p>CLOTHES WASHER</p> <p>Typical single use: 35 gallons Average weekly use: 4 times Average weekly consumption: 140 gallons</p> 	<p>DRINKING/COOKING/BRUSHING TEETH</p> <p>Typical single use: 2 gallon Average weekly use: 28 times Average weekly consumption: 56 gallons</p> 
<p>WASHING DISHES (HAND)</p> <p>Typical single use: 12 gallons Average weekly use: 21 times Average weekly consumption: 252 gallons</p> 	<p>AUTOMATIC DISHWASHER</p> <p>Typical single use: 8 gallons Average weekly use: 7 times Average weekly consumption: 56 gallons</p> 
<p>GARDEN</p> <p>Typical single use: 50 gallons Average weekly use: 4 times Average weekly consumption: 200 gallons</p> 	<p>YARD/GRASS</p> <p>Typical single use: 60 gallons Average weekly use: 4 times Average weekly consumption: 240 gallons</p> 



Looking at the Environment:
Investigations in Environmental Science
Using Geographic Visualization
and Information Systems



Unit 1
Lesson 12
2 Class Periods

Urbanization

Overview

In the state of Iowa, we have seen more people leave farming for other professions. In the country of Kenya, more people are moving from rural areas to urban settings. Why do you suppose this is happening? One reason might be climate. Perhaps a flood forced the farmer to move elsewhere. Perhaps a drought forced farmers to sell and move to the city where resources might be more available. Generally, throughout history people have moved from rural areas to take advantage of economic resources available in cities. In this activity, you will compare urban growth rates from different countries and explore the reasons for urbanization.

Objectives

1. Students will compare urban and rural growth rates among different countries to identify patterns.
2. Students will use the background knowledge they have about their countries to speculate about why their urban growth is the same or different from other countries.

Materials

- WorldWatcher CD
- Computer for each group of students
- Analysis of Census in the Classroom data
- Handout: *Urbanization Data Table*

Procedure

1. Look at your class census data on Rural-Urban-Suburban movement. Look at your notes for patterns that you found in the class data. Do you think this pattern is accurate for the rest of the world or just for your class?
2. In WorldWatcher, open Urban Growth Rate 1950 (from the Urbanization folder). In general, did urban populations grow or shrink in 1950? Write the mean value (from the upper left-hand corner of the visualization) on your urbanization table. (Mean value is the average for the whole visualization, in this case, the whole world.)

Look at the visualization. Where are urban populations growing the fastest? Slowest? Think about what these areas have in common. Besides fast-growing urban populations, what else do these countries have in common?

3. Repeat step 2 for Urban Growth Rate 1990.

4. Open Rural Growth Rate 1950. Negative rates (blue and green colors on the visualization) mean the rural population is shrinking. In general, did rural populations growing or shrinking in 1950? Write the mean value (from the upper left-hand corner of the visualization) on your urbanization data table.

Look at the visualization. Where are rural populations growing? Shrinking? Think about what these countries have in common.

5. Repeat step 4 for Rural Growth Rate 1990.
6. Compare urban growth rates to rural growth rates. Which areas are growing faster, urban or rural? Why do you think urban growth rates are lower in 1990 than in 1950 in most cases?
7. Now look at each visualization and gather data about the two countries you studied in the last lesson. On your Urbanization Data Table (handout), record urban growth rates for 1950 & 1990 and rural growth rates for 1950 & 1990.
8. Share your data with the class. What kind of patterns do you see in the data?
9. Read the article about reasons people move to cities.
10. Discuss the article. Why do people move to cities?
11. Return to WorldWatcher to look at geography of your two countries. Look at Vegetation Type (found in Geography / Biosphere). How might the type of vegetation in those countries contribute to or discourage urbanization? Is there any information you collected in your country research that might explain the patterns in urbanization?
12. Share your findings with the class. How might your urbanization data relate to the vegetation of your countries? If your countries did not follow the patterns of most other countries in the world, can you explain why?

Wrap up

If you were moving to the United States from another country, would you move to a city or a rural area? Why?

Urbanization

The world is in the midst of a massive urban transition unlike that of any other time in history. “Within the next decade, more than half of the world's population, an estimated 3.3 billion, will be living in urban areas--a change with vast implications both for human well-being and for the environment. As recently as 1975, just over one third of the world's people lived in urban areas. By 2025, the proportion will have risen to almost two thirds”(World Resources, 1996). A good portion of current urban growth can be attributed to the natural growth of the urban population, measured by birth and death rates. However, this does not account for all the growth in urban areas. There is also a strong pattern in migration of people moving from rural areas to cities. The forces driving this migration are the concentration of economic opportunities and the superior infrastructure and living conditions available in cities.

Urban population growth is fueled in part by natural increase in population, simply an excess of births over deaths. As more children survive and older people live longer, populations in all areas increase. Generally, urban fertility rates are usually lower than rural fertility rates, as are urban mortality rates. Population growth in other areas of a country can also affect the growth in an urban population. High population growth rates in rural areas encourage young people to move to the cities, often in the prime of their reproductive years. The children of these migrants are added to the population of the city, increasing population growth.

Migration is the second cause of urban growth. People have historically moved from rural areas to urban centers for a variety of reasons, both because of the attraction of the city, or the deterioration of rural life. The primary reason for urban migration is the expectation that more jobs and higher wages are available in cities. Some migrants move to cities to make a new living for themselves, others take a high paying job in order to support relatives that remain outside the city. Services are also perceived as better in the city. Educational opportunities, especially those above basic education, are easier to find in urban areas. Migrants might also be attracted to the freedom from gathering wood and carrying water. Many migrants must be disappointed, however, because life in the slums and shantytowns in which many migrants live can be every bit as difficult as in the village. Even knowing that conditions are not perfect in the city does not discourage all migrants. Deteriorating quality of life in rural areas can encourage people to migrate. “Rapid population growth among low-income groups in rural areas puts pressure on land, fuel and water. These pressures may be intensified by large-scale resource-intensive agriculture, loss of traditional tenure rights on common land and other policies which reduce the need for labor and the possibility of self- sufficiency” (United Nations, 1996). Without jobs or other resources in the rural areas, people may feel that better opportunities will be found in the city. Once a few family members move to the city, it is likely that others will follow. Groups of migrants already in the city can ease the transition of their family and neighbors, encouraging more people to move to that area.

Increases in urban populations are often concentrated in a few large cities, causing them to reach unprecedented sizes -- Sao Paulo, Brazil, 16.4 million; Bombay, India, 15 million -- placing strains on the infrastructure of those cities and natural resources that support them. In the developing world, urban populations are growing at an average of 3.5 percent per year. This contrasts the industrialized world, where the most rapid urban growth took place over a century ago. "By 1995, more than 70 percent of the population in both Europe and North America was living in urban areas"(World Resources 1996). Urban growth in the industrialized world continues, although at a much slower rate on average than in previous decades. Much of the population shift now under way in the industrialized world involves movement away from concentrated urban centers to vast, sprawling metropolitan regions or to small- and intermediate-size cities.

Bibliography:

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The State of World Population (Chapter 4: Sources of City Growth). New York: United Nations Publications (1996)

World Resources: The Urban Environment (Chapter 1: Cities and the Environment) (1996-1997) Oxford University Press

Stop and Think.

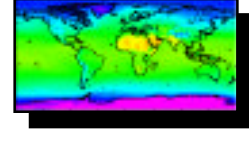
1. What other reasons might people have for moving into cities?
2. Think about how this article relates to the countries you are studying.

Urbanization Data Table

	Urban Growth 1950	Urban Growth 1990	Rural growth 1950	Rural Growth 1990
WORLD (mean value)				



Looking at the Environment:
Investigations in Environmental Science
Using Geographic Visualization
and Information Systems



Unit 2
Lesson 3
2 Class Periods

The Dynamo

Overview:

You have begun to experiment with electric charges and electric currents. But would the methods you used to generate electric power in the last lesson work well for generating large amounts of electricity? In this lesson you will take a virtual tour of a power plant and become more familiar with how electricity is generated on a *much* larger scale.

Objectives:

1. Students will learn that electricity and magnetism are related and will experience how magnets can be used to generate electric current.
2. Students will create and label diagrams of two different dynamos: a hand powered flashlight and a coal fueled power plant.

Materials:

Part A:

- computer with internet access

Part B:

- hand powered flashlight

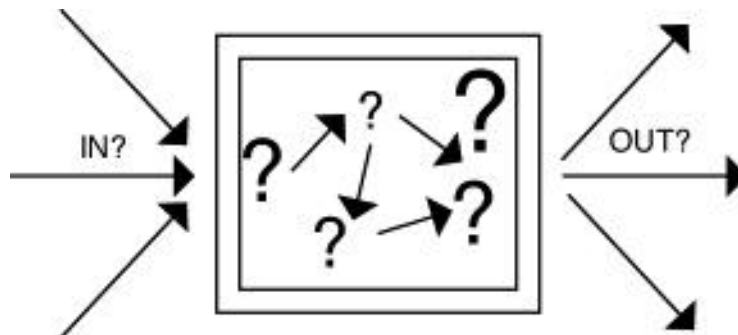
Part C:

- large U-shaped magnet
- several feet of copper wire
- ampmeter

Procedure:

PART A: VIRTUAL TOUR OF A POWER PLANT

1. You are about to take a virtual tour of a power plant. Pay close attention to what goes in and what comes out of the power plant. As you take your tour, draw a diagram showing what you think is happening at the coal plant. Be sure your diagram includes everything that goes into the plant and everything that comes out of the plant (it is OK to copy from the web site). Do your best to diagram how the "inputs" are converted to the "outputs."



2. Open your web browser to <http://www.energied.ergon.com.au/educatio/coal/what.htm>
3. Click on "Take a Virtual Tour" to start the tour. Complete your diagram as you go along and remember, there is no one correct way to represent the power plant.

PART B: A "HANDY" FLASHLIGHT

4. Take a look at the hand-powered flashlight.

STOP AND THINK: Do any of the parts in the flashlight generator look familiar? Do you think you might know what any of them might do?

Give the hand generator a whirl and watch what happens.

5. After you have had a chance to examine the hand powered flashlight, draw a diagram for the flashlight that resembles the diagram you drew for the power plant. What are the inputs? What are the outputs? What happens in between?

STOP AND THINK: Do you think the hand flashlight generates more or less power than rubbing the rubber rod with the car fur? Do you think that if everyone in the class had their own generator flashlight you would be able to generate as much light as the lights in the ceiling? How long do you think you could keep up your fastest rate of power generation?

PART C: BUILD A DYNAMO

6. Do you think you could build your own electric generator? Use the materials at your station and what you know about generating electricity to create an electric current. An "ampere" is a measure of electric current ($1 \text{ ampere} = 6.25 \times 10^{18}$ electrons per second). Given the materials at your station, how many amperes can you generate?

STOP AND THINK: What is a dynamo?

Wrap up:

Take another look at the "box" you drew to represent the power plant in Part A. Now is your chance to improve your diagram based on what you learned in parts B and C of this lesson. Try again to draw what you think is happening at the power plant. This time, in addition to thinking about the inputs and outputs, be sure to include all the *internal* parts you can (generator, coal, steam, water, etc.). Label both the places in the power plant *and* the processes that link different

places. Try to show what happens in as much detail as possible. For example, include what you think happens *inside* the generator.