WHAT ADAPTATIONS MIGHT YOUR COMMUNITY NEED TO MAKE IN THE FACE OF A CHANGING CLIMATE?

Overview

This lesson gives students a look at rural water resources and asks them to respond to a real-life case study.

Objectives

On successful completion of this lesson, students will be able to:

- interpret data from a graph;
- identify the source of drinking/municipal water in their community; and
- describe potential affects of climate change on safe water for their community.

Alaska Standards

Alaska Science Standards / Grade Level Expectations

[6] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating

[6] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking by identifying and designing a solution to a problem

Alaska Math Standards

6.SP.5 Summarize numerical data sets in relation to their context, such as by:

a. Reporting the number of observations (occurrences).
b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
c. Giving quantitative measures of center (median and/or range), as well as describing any overall pattern and any outliers with reference to the context in which the data were gathered.
d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

Alaska English / Language Arts Standards

RST.6-7-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

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Alaska Cultural Standards

[D] Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning. Students who meet this cultural standard are able to:

[D5] identify and utilize appropriate sources of cultural knowledge to find solutions to everyday problems.

[E] Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:

[E2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

M.S. sequence 6.3 Cycling of Matter and Energy

M.S. sequence 7.9 Water Cycle and Oceans

M.S. sequence 7.10 Natural Resources

Materials

- STUDENT INFORMATION SHEET: Village Water Supplies in a Warmer World
- STUDENT WORKSHEET: Water Filters

Multimedia

REACH Multimedia 4-6: "Water Cycle"

REACH multimedia 4-6: "Conserving Fuel"
Available at: www.k12reach.org

Additional Resources

Glence Life Science Ch 20, 23

Glencoe Earth Science Ch 15-18

The Center for Climate and Health bulletin "Source Drinking Water challenges, Changes to an Arctic Tundra Lake" is available at: http://www.anthctoday.org/community/climate_health.html

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Activity Preparations

1. Make copies of the STUDENT INFORMATION SHEET and STUDENT WORKSHEET.
2. If doing the extension activity to invite a speaker into the classroom, the visit will need to be arranged.
3. If doing the extension for building water filters the materials will need to be gathered and set up.

Whole Picture

Dr. Lilian Alessa, of the University of Alaska Anchorage, states, "We are entering the century of water". Water is one of few resources for which there is no substitute. As climate changes in the Arctic, current water sources may be less available and/or water quality may deteriorate.

In rural Alaska freshwater is the center of many community resources including subsistence activities and transportation. While these are important, safe drinking water is one of the most valuable commodities in the world. Unlike many other substances, nothing substitutes water. The availability of safe, fresh drinking water is carefully considered when deciding the location of hunting and fish camps. Besides for drinking, the importance of fresh water also extends to hunting. One tradition that has been passed on through the generations is pouring fresh water down the mouth of a seal after it has been shot. The belief is that by doing so the spirit of the seal will live on and bring another body for hunters later.

Traditionally, Native people melted ice and snow to live through the long winters when all precipitation was frozen. Today communities have water tanks to hold enough water to last through the winter months. Most water in rural Alaska is surface water as permafrost ground precludes very deep wells. Many communities have filtration plants to clean the raw water that is taken from a variety of sources including snow catchment basins, lakes, creeks and rivers.

Concerns are still very high about the possibility of running out of clean water before the end of each winter, and the safety of water, especially in communities where water and sewer lines are not in place. Concern centering on a lack of sustainable, quality sources is also high as increasing temperatures, thawing permafrost and increased evapotranspiration cause traditional sources to dwindle.

Vocabulary

algae a plantlike organism that contains chlorophyll, but lacks true roots, stems, and leaves.

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Activity Procedure

1. Ask students where the water they drink comes from. Ask what problems they know of that the community has had collecting and storing water. Read with students "Village Water Supplies in a Warmer World" by Ned Rozell and discuss
2. Introduce the worksheet activity. If necessary, review graphing skills with students before they start the worksheet. Depending on the class, the introductions to each part of the worksheet could be read together with the class.
3. Discuss with the class their answers to part three on the worksheet.

Extension Activities

- Invite the person(s) responsible for maintaining the water collection and storage in your community to explain the process used to ensure the there is enough water for the winter and that the water is safe to drink.
- Have students build a water filter. Simple ones can be made with 1 or 2 liter bottles, coffee filters, sand, gravel, etc. Many examples are available online, such as from http://www.safewaterscience.org/Downloads/Lesson2.pdf or: http://tryscience.org/nld/handson2.html

References

Alaska Native Tribal Health Consortium, Center for Climate and Health, Accessed from: http://www.anthctoday.org/community/climate_health.html

Alaska Science Forum, "Village Water Supplies in a Warmer World", by Ned Rozell, Article #1735, Accessed from: http://www2.gi.alaska.edu/ScienceForum/ASF17/1735.html

"Aspects of Traditional Inupiat Education", by Paul Onftooguk. Accessed 3/28/15 at: http://www.alaskool.org/native_ed/Pauls_doc2.htm

"Authentic Alaska: Voices of Its Native Writers", by Susan B Andrew and John Creed. Accessed: https://books.google.com/books?id=mxV-oklDTawC&pg=PA128&lpg=PA128&dq=yupik+fresh+water+traditions&source=bl&ots=8heLU17vEz&sig=KOSOLJxliRe_chXVgGOvgxZPR9Y&hl=en&sa=X&ei=qOIVVZbxHYjvoASzg4GQCA&ved=0CC4Q6AEwAg#v=onepage&q=yupik%20fresh%20water%20traditions&f=false

WHAT ADAPTATIONS MIGHT YOUR COMMUNITY NEED TO MAKE IN THE FACE OF A CHANGING CLIMATE?

Answers

1. Approximately how many filter changes are needed to be done in the summer for the following years:?

   a) 2005 - 5
   b) 2006 - 10
   c) 2007 - 275
   d) 2008 - 350

2. In July of 2007, 5 to 6 filter changes (175 filter changes / 31 days in July = 5.6 changes per day) were done per day. How many filter changes were done in July of 2008?

   275 filter changes/ 31 days = 8.9 changes per day.

3. It takes an average of 10 minutes to remove, wash and replace filters. How much time was spent changing filters in:

   a) 2006 - 100 minutes or 1 hr. 40 minutes
   b) 2007 - 2750 or 45 hrs. 50 minutes
   c) 2008 - 3500 or 58 hrs. 20 minutes

4. 10
5. 17
6. answers will vary
   Note: The source of municipal water for villages in Bering Strait can be found at http://www.kawerak.org/forms/csd/2013%20Comprehensive%20Economic%20Development%20Strategy.pdf
7. answers will vary
8. answers will vary

WHAT ADAPTATIONS MIGHT YOUR COMMUNITY NEED TO MAKE IN THE FACE OF A CHANGING CLIMATE?

Student Information Sheet

Village Water Supplies in a Warmer World, by Ned Rozell

Alaska Science Forum Article #1735 January 27, 2005

This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Ned Rozell is a science writer at the institute.

A recent "water bottle airlift" from Bethel to the western Alaska village of Nunam Iqua showed how precious clean water can be in the Alaska Bush. A team of scientists is now studying how changes in climate might impact the water supplies of some Alaska villages.

Nunam Iqua is like many Alaska villages that use a variety of fresh water sources. The 35 families who live in Nunam Iqua rely on a nearby river for water that they store during the winter in a 200,000-gallon tank. When a December 2004 storm fouled the river with salt water and a tank fitting failed, draining their stored water, residents asked for help. The state Division of Homeland Security and Emergency Services began flying 500 gallons of water each day to Nunam Iqua. When the river cleared later in the month, residents were able to begin storing water again and officials called off the water airlift.

Farther north, villagers on the Seward Peninsula gather their water in many ways, from pumping wells to digging depressions in the tundra and lining them with plastic to catch snowmelt runoff, according to Dan White of UAF's Water and Environmental Research Center. White is leading a four-year study on the water supplies of Seward Peninsula villages and how a changing climate might affect those water sources.

White and his colleagues, Lillian Alessa of UAA and UAF's Larry Hinzman and Peter Schweitzer, chose the Seward Peninsula for research because much of the permafrost there is close to thawing. Permafrost acts as a barrier that traps water near the surface in many areas; when it melts, the water above it may drain away. In the warmest-case scenario of Alaska's future, permafrost wetlands could turn into an arid landscape, said White, who pointed out that areas of Alaska's North Slope receive less precipitation than Tucson, Arizona.

"The whole reason water's abundant in the Arctic is permafrost," White said. "If the permafrost melts, it likely won't be a wetlands."

White, a civil engineer, has visited the Seward Peninsula communities of Nome, Elim, Golovin, Shishmaref, White Mountain, Brevig Mission and Wales. He has seen the stream where Wales residents collect their water, the well in Elim, and the "municipal water reserve" in Shishmaref, a reservoir lined with plastic to gather snowmelt. Communities that rely on surface water need to store large amounts of it during the eight or more months their usual water source is frozen.

"Any place that relies on surface water is at risk of running out of water," White said, adding that many villages drain their storage tanks before they can replenish them in summer.

"In many communities, the water tank is just too small," White said. "When water runs out sometimes in April or May, they've got to harvest their own water, and it's a tricky time for them."

Student Information Sheet, continued

Village Water Supplies in a Warmer World, by Ned Rozell

Residents of some Bush villages harvest water by collecting ice or rainwater, or sometimes traveling to open streams and rivers. Gathering water often becomes impossible during breakup, when snow machine trails get soft and ice begins to rot.

"How's climate going to affect this?" White said. "If breakup is earlier or is prolonged, harvesting water could be more of a problem."

In addition to the possible change in water sources and more difficult water-gathering that might accompany the continuation of observed warming, waterfowl, caribou, and other local food sources might be more scarce on a dryer Seward Peninsula, White said.

During the four-year study, White and his colleagues will try to find potential problems with water supplies and also solutions that might work if a warming climate threatens fresh water supplies on the Seward Peninsula.

"Our goal is to try to understand how hydrology is likely to be impacted by climate and how those changes will impact people and the culture of the region," he said. "We can expect some changes; we just want to know how to deal with the changes."

WHAT ADAPTATIONS MIGHT YOUR COMMUNITY NEED TO MAKE IN THE FACE OF A CHANGING CLIMATE?

Student Worksheet: Water Filters

Name _____

In July of 2009, the Center for Climate and Health, part of the Alaska Native Tribal Health Consortium, worked with the community of Point Hope to help solve a water quality problem. Researchers published Source Drinking Water Challenges Resulting from Changes To an Arctic Tundra Lake, a paper that detailed concerns and outlined some ways to solve them. The following case study is taken from that paper. As you read you will be asked to use data to try to determine what might have caused some of the problems found in Point Hope.

Background: Point Hope is an Iñupiaq community of about 700 residents. The climate is Arctic and ranges from -45°C/-49°F to 26°C/78°F. Precipitation is light with ten inches annually. Cumulative snowfall is about 36 inches. Point Hope acquires drinking water from 7-Mile Lake located seven miles east of town. This tundra lake is recharged each year from snowmelt and precipitation. There is a limited time frame when the lake is ice free, and when water can be pumped, treated and transferred to above ground tanks for storage and use throughout the year. From late June until early September water is piped from the lake and treated. During the short pumping window, water plant operators work 12-hour shifts around the clock to produce enough water to last the whole year. Water system customers in Point Hope include approximately 180 homes with piped water and sewer and 11 homes on a haul system with holding tanks.

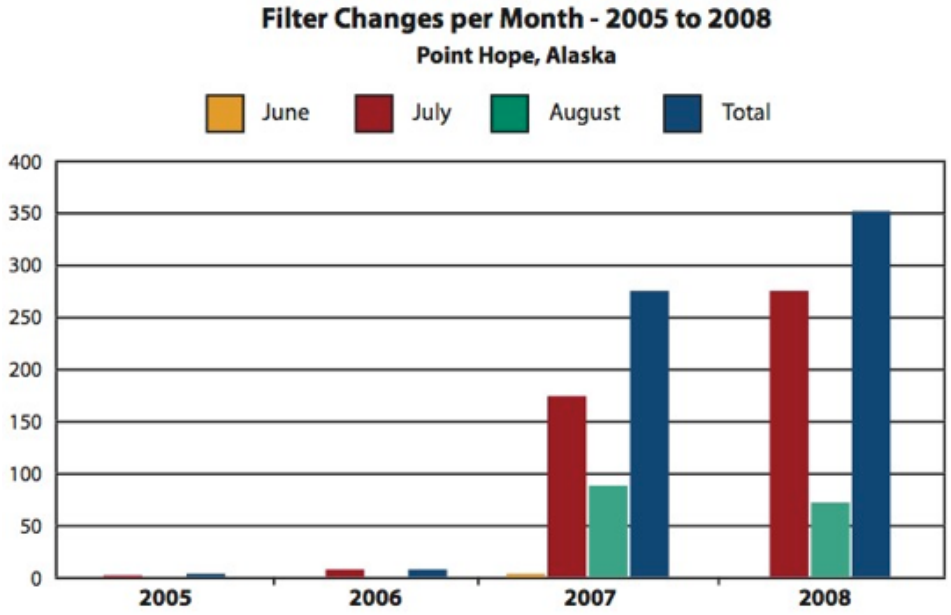
At the deepest part of the lake, where the depth is typically just over ten feet, a screened intake pipe is suspended approximately 1.5 feet below the surface. The water is pumped through a pipeline to the water treatment plant where it is passed through series of filters prior to the addition of chlorine, which is added to cleanse the water of bacteria and microorganisms. Operators measure water pressure and raw water conditions and perform regular analyses to make sure filtered water meets water quality standards.

Questions

Part 1

The Problem

Water filters at the Point Hope treatment plant became clogged and had to be cleaned at a much higher rate during the summers of 2007 and 2008 than in previous years. The logbook from the Point Hope Water Plant shows the following data. Use the graph "Filter Changes per Month – 2005 to 2008" below to answer questions 1 – 3.



1. Approximately how many filter changes are needed to be done in the summer for the following years:

   a) 2005 _____

   b) 2006 _____

   c) 2007 _____

   d) 2008 _____

2. In July of 2007, 5 to 6 filter changes (175 filter changes / 31 days in July = 5.6 changes per day) were done per day. How many filter changes were done in July of 2008?

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Student Worksheet: Water Filters

Name _____

Part 2

The Cause

Point Hope Water Plant operators pointed to lower-than-average precipitation and high temperatures as likely contributing to water-quality problems. National weather service data supports their observation. The Northwest Arctic climate has been gradually warming.

- Between 1949 and 2005, temperatures showed an annual increase of about 1.6°C/3.3°F.
- Summer temperatures have increased an average of 1.5°C/2.7°F.
- Weather data shows that records were set for low precipitation and high temperatures in 2007 and 2008.
- During the summers of 2007 and 2008 water temperatures at the Point Hope treatment plant were elevated. Typical raw water temperatures are between 4°C/40°F and 10°C/50°F, but during those years were 10°C/50°F to 16°C/60°F. Lake water temperatures were not recorded.

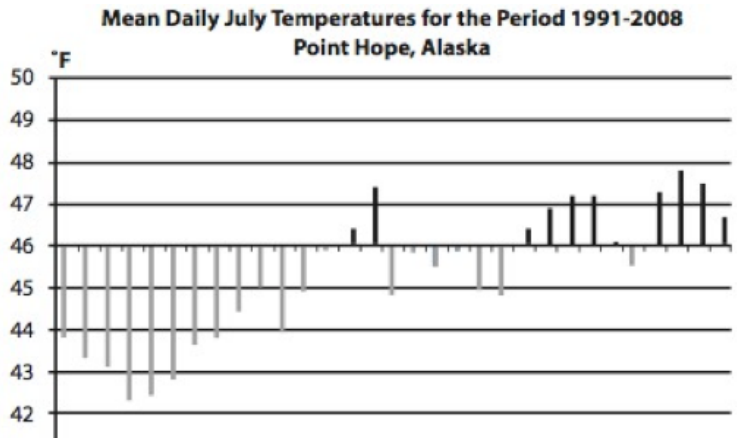
It was during that time that operators began reporting changes in the quality of raw water entering the plant, specifically the amount of mosquito larvae and algae in the filter bags.

- Workers at the treatment plant reported an increase in mosquito larva in the filters.
- Workers at the lake reported an increase in hatched mosquitoes.

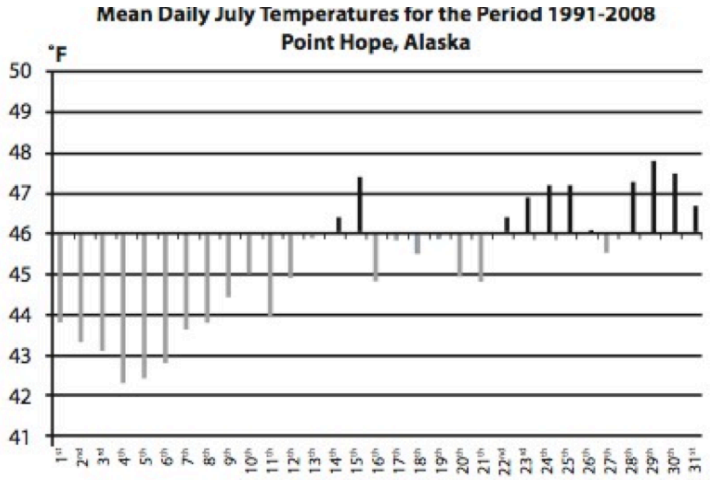
Mosquito larvae need a minimum of 46°F to develop. Larvae are usually found near the edge of large water bodies because the water is warmer and there are algae on which to feed. Algae also prefer warmer water to grow. The intake pipe is located in the middle of the lake.

Use the graphs at right to answer questions 4 and 5.

4. Look at the graph titled "Mean Daily July Temperatures for the Period 1991 – 2008." How many days in a typical July had temperatures warm enough for mosquito larvae development?



5. Look at the graph titled "Mean Daily July Temperatures for the Period 2007 – 2008." How many days in a typical July had temperatures warm enough for mosquito larvae development?



Part 3

Around the Seward Peninsula drinking water problems have occurred in several communities in the past few years. In Teller, an underground water line broke. Nearly 500,000 gallons of water were lost over nearly 4 weeks before the problem was discovered. Shishmaref doesn't have a steady stream of clean water, consequently they have difficulty storing enough water for the entire winter. They often have difficulty with water shortages in the spring. Wales has had their water lines freeze a couple of times. The school district has worked with the community to keep water running to the school. In 2013 Unalakleet's main water line to its storage tank froze. The 1 million gallon storage tank was depleted. Water from the river was diverted so residents had running water for washing clothes, showers and toilets, but they couldn't drink it.

6. What is the source of water in your community?

7. How might climate change affect your community's ability to collect and store water?

8. What can be done to ensure your community will have safe drinking water year round?