

Monsoons and Health: A GLOBE Data Exploration

Purpose

Students learn about the relationship between three infectious diseases and rainfall in the country of Benin.

Overview

In this activity, students consider the impacts of monsoon rainfall patterns on human health, utilizing precipitation data from a GLOBE school in Benin.

Student Outcomes

Students will be able to:

- Apply knowledge about health hazards to determine how and why meningitis, cholera, and malaria outbreaks are affected by patterns of monsoon rainfall.

Science Concepts

- *Earth Systems Science*
- *Weather and Climate*
- *Seasons*
- *Life Science: Human Health*

Science Practices

- *Analyzing and interpreting data*
- *Constructing explanations*
- *Obtaining, evaluating, and communicating information*

Time

One class period (50 minutes)

Level

Middle and high school (grades 6-12)

Materials and Tools

- Graph of Benin rainfall and table of disease timing (both on page 5)
- *Student Activity Sheet A and B*
- *Reading: Three Infectious Diseases in Benin*
- Projector, screen, and a computer with Internet access

Preparation

- Copy the activity sheets and reading for each student.
- Copy the graph and chart for each pair of students.
- Prepare to project a map of Benin on the screen. You may wish to use the map from the GLOBE Visualization Tool (viz.globe.gov) to access the data from schools in Benin, or use Google Earth.

Prerequisites

Consider doing this activity with the *GLOBE Data Exploration: Rainfall in the GLOBE Africa Region*. Starting with this activity will connect students with how rain affects people before broadening to include the science of how monsoon rains happen throughout the tropics.

Background

In this activity, students examine the relationship between rainfall and the three diseases described below: bacterial meningitis, cholera, and malaria.

Bacterial meningitis (meningococcal

meningitis) is an infection of the meninges – the three membranes that line the skull and spinal canal and enclose the brain and spinal cord. It can cause severe brain damage and is fatal in 50% of cases if untreated. The bacteria are transmitted from person-to-person through



droplets of respiratory or throat secretions from carriers.

The meningitis belt stretches from Senegal in the west to Ethiopia in the east across the Sahel and sub-Sahel regions of the African continent (see the map in the student reading). In the meningitis belt, dust, winds, cold nights, and upper respiratory tract infections combine to damage the back of one's throat increasing the risk of meningococcal disease especially during dry season weather. There are 13 known subtypes of bacterial meningitis. Types A, B, C, and W135 are the main causes of epidemics in Africa. There are also four other types of meningitis worldwide: viral, fungal, parasitic, and non-infectious meningitis.

Cholera is caused when *Vibrio cholerae* bacteria are consumed. The bacteria produce toxins that irritate the small intestine causing diarrhea. Cholera is one of the many infections known as "diarrheal diseases" that are common in places without systems for adequately treating drinking water and dealing with sewage. Cholera can occur anywhere in the world when water and sewage systems are compromised, such as during large rainfall events.

Malaria, a type of vector-borne disease, is caused by a parasite that is transmitted by *Anopheles* mosquitoes. When a mosquito bites a person infected with the parasite, the mosquito becomes a carrier of the disease. When that mosquito bites another person, they become infected, too. A person with malaria develops a fever and flu-like symptoms. Most who are infected with malaria recover, but it can be fatal, especially in children. Each year there are between 350 million and 500 million cases of malaria worldwide. Over one million of those people die from the disease. Most of the people who die from malaria are children in regions of Africa south of the Sahara Desert. Monsoon rainfall provides ample places for mosquitoes to breed, which increases the risk of an outbreak.

In this activity, students learn how each of the diseases described above is tied to patterns on rainfall in Benin. It is important to note

during the discussion that there are solutions (or solutions in development) for each of these illnesses, and that the country is taking an active role in helping communities prevent the spread of malaria. A new vaccine for malaria is in the trial stage as of 2016. A vaccine for one type of meningitis is having very good results. And ongoing efforts to improve waste disposal and water quality in many places are important for decreasing outbreaks of cholera.

About the data: The rainfall data that students use in this activity were collected according to the GLOBE Atmosphere Protocol by students at the EPP Mandina/A school in northern Benin. Students make and report measurements of rain depth in a rain gauge each day, reporting the measurement in millimeters (mm).

What To Do and How To Do It

Step 1. Engage students in unraveling the mystery of the timing of disease epidemics in Benin.

- Show students a map of Benin in West Africa. Tell students that doctors in Benin notice that people are coming to the clinics with different illnesses at different times of year.
 - In January, February, and March, people are most likely to contract meningitis.
 - From May until September, people are most likely to contract malaria.
 - In July, August, and September, people are most likely to contract cholera.
- Tell students that in this activity they will explore how these three diseases are affected by monsoon rains.

Step 2. Have students explore the pattern of rainfall in Benin.

- Hand out the Benin rainfall graph and the chart showing the timing of epidemics to each student pair. Also, hand out a copy of *Student Activity Sheet A* to each student. Have students interpret the graph using the prompts on the *Activity Sheet*.



- Ask students if the rainfall data shows that rainfall causes these diseases. Students should indicate that rainfall and disease are correlated, but that we do not know if one causes the other. If students do not have prior understanding of the concepts of correlation and causation, this is an opportunity to explain the difference.
- Ask students what they would need to know to find out if rainfall impacts the spread of any of these diseases.

Step 3. Students read about each illness and its causes.

- Hand out *Student Activity Sheet B* and have students fill out what they know about each illness and what they want to know.
- Hand out the *Reading: Three Infectious Diseases in Benin* and have students take notes on what they learn about each illness as they read, noting how and why each disease is affected by rain.

Step 4. Discussion

- Ask students if they found information in the reading in support of or against a relationship between the three illnesses and rainfall.
- Discuss as a class to make sure all understand that there is a relationship between each illness and rainfall, and that each relationship is different.
- Have students consider what might happen to the spread of these diseases if climate change causes more severe monsoon rainfall events and more severe drought. (*More severe rain and drought will make people more vulnerable to these diseases.*)
- Ask students to recall from the reading what can be done to stop the spread of these three diseases. (*Students should mention that the spread of meningitis can be stopped with a vaccine, that there is a new vaccine for malaria as well as chemicals that kill mosquitoes, and that cholera can be prevented by improving*

water quality and sanitation.)

Assessment

Student explanations on *Activity Sheets A* and *B* will indicate whether they understand the pattern of monsoon rainfall in the graph of rainfall data and if they understand how each illness is affected by rainfall.

Extensions:

Delve Deeper into GLOBE Data

Have students use the GLOBE Visualization Tool (viz.globe.gov) to find other environmental data from sub-Saharan Africa.

Have students research what illnesses in their area are affected by seasonal changes. Use GLOBE protocols to collect data about seasonal changes in your local area that are connected to human health.

Have students research what people are doing to eradicate malaria, cholera, and meningitis. Allow students time to research each online. Check out these resources:

Benin’s Presidential Malaria Initiative:

https://www.pmi.gov/docs/default-source/default-document-library/country-profiles/benin_profile.pdf?sfvrsn=24

The Malaria Atlas Project:

<http://www.map.ox.ac.uk/explore/countries/BEN/>

US Centers for Disease Control and Prevention (CDC)

<http://www.cdc.gov>

The World Health Organization (WHO)

<http://www.who.int>

Credits

This activity is part of *GLOBE Data Explorations*, a collection of activities developed by the UCAR Center for Science Education (scied.ucar.edu), a GLOBE partner. Activities were reviewed by science educators and staff at GIO and field tested by teachers.



About Rainfall in Benin:

Look at the graph of rainfall in Benin. These data were collected by students at a GLOBE school between 1999 and 2003. The pattern is common for regions with monsoon rains.

Which months of the year are driest?

Which months of the year are wettest?

About Epidemics in Benin:

The chart, Timing of Epidemics in Benin, shows when epidemics of three diseases are most likely. An epidemic is a time during which a disease is widespread.

Meningitis is most common in these months:

During that time, it is...

- Likely to rain
- Unlikely to rain

Cholera is most common in these months:

During that time, it is...

- Likely to rain
- Unlikely to rain

Malaria is most common in these months:

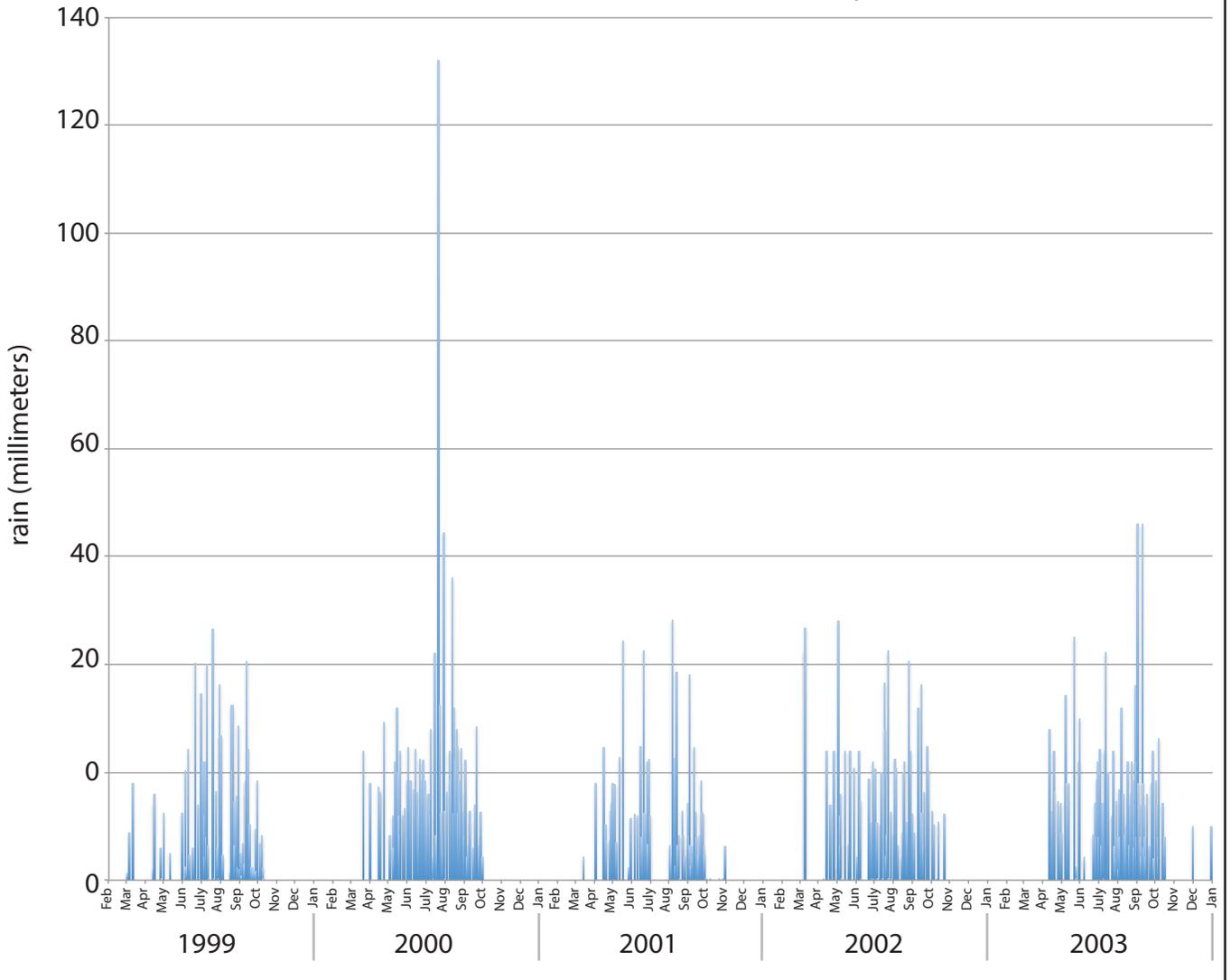
During that time, it is...

- Likely to rain
- Unlikely to rain

Compare rainfall and disease. Do you see a correlation between the patterns of rain and disease? If so, which diseases correlate with wet or dry times of the year?



GLOBE Rainfall Measurements from EPP Mandina/A, Benin



Timing of Epidemics in Benin

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Meningitis	Shaded	Shaded	Shaded									
Cholera						Shaded	Shaded	Shaded	Shaded			
Malaria					Shaded	Shaded	Shaded	Shaded	Shaded			



Name _____

Date _____

Meningitis

Cholera

Malaria

WHAT I KNOW

WHAT I WANT TO KNOW

WHAT I LEARNED



Monsoons and Health

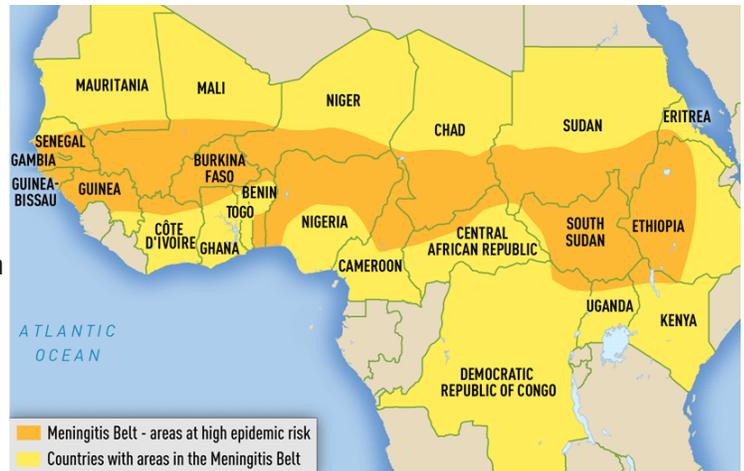
Reading: Three Infectious Diseases in Benin

Meningitis

Bacterial meningitis is a serious infection of the membranes around the brain and spine. In the region of Africa just south of the Sahara desert, meningitis is a risk in places where dust is blown in the wind, which happens when there is little rainfall. There is a connection between meningitis in North Africa and dust blown in the wind. This area, known as the meningitis belt, is home to nearly 300 million people.

During an epidemic in 2001, more than 7,500 people in Benin contracted bacterial meningitis between 1 January and 18 March. The disease stopped spreading when monsoon rains started.

There are vaccines that prevent certain types of meningitis. For many years the only vaccine was effective for a year or two; it was given during epidemics, but not to prevent them. In 2010 the World Health Organization started to give everyone in the meningitis belt a new, long lasting vaccine. It only is effective for one type of meningitis, but has been very successful in reducing the cases of that type.



Areas with meningitis epidemics (Image: US Centers for Disease Control map made with data from the World Health Organization)

Cholera

Cholera is caused when *Vibrio cholerae* bacteria are consumed. The bacteria produce toxins that irritate the small intestine causing diarrhea. Cholera is one of the many infections known as “diarrheal diseases” that are common in places without systems for adequately treating drinking water and dealing with sewage.

According to a survey done in 2000 by UNICEF and the World Health Organization, 46% of people living in Benin’s cities and 6% of people in rural areas had access to improved sanitation systems including public sewer systems and safe latrines. 76% of people living in Benin’s cities and 55% of people in rural areas had access to a clean water source within one kilometer from their home.

In 2001, nearly 4,000 people in Benin contracted cholera during an epidemic that started in July after heavy rains compromised sewage and water systems leaving people with unclean drinking water.

Malaria

Malaria is caused by a parasite that is transmitted by *Anopheles* mosquitoes. When a mosquito bites a person infected with the parasite, the mosquito becomes a carrier of the disease. When that mosquito bites another person, they become infected, too. Malaria is a type of vector-borne disease meaning that animals, known as vectors, carry the disease from person to person.

A person with malaria develops a fever and flu-like symptoms. Most who are infected with malaria recover, but it can be fatal, especially in children. Each year there are between 350 million and 500 million cases of malaria worldwide. Over one million of those people die from the disease. Malaria is the number one cause of death for children under age five in Benin.



An *Anopheles* mosquito (CDC)

Mosquitos that spread malaria are common in the tropics. They often breed in containers filled with rainwater – from large water barrels and ponds to small coconut shells. They have more places to breed during the monsoon rains when those containers are full of water. That leads to more mosquito bites that spread disease.

Stopping malaria often means killing mosquitoes, especially during the rainy season. However, as of 2016 a new vaccine is being tested. If successful, it may end malaria outbreaks worldwide.