Objective

In this task, the team will be focusing on the following questions from the question map.

• What is the distribution of mosquito-borne diseases around the world?
• What factors influence the spread of mosquito-borne diseases?

The team will now examine a variety of maps to think about the relationship between mosquitoes, diseases spread by mosquitoes, temperature, and precipitation. The team will also read some frequently asked questions (FAQs) about the different mosquito-borne diseases, to learn more.

1. Go to the Task 4-1 folder and get the Mosquito-Borne Disease FAQ Sheets, maps, and analysis questions. There is only one version of this task, but two options for organizing are provided.

2. As a team, use the maps and FAQ sheets to complete the analysis questions.

3. As a team, share all important information that could be useful to the research.

4. As a team, discuss the following questions:
   • How can maps be helpful when studying mosquitoes and mosquito-borne diseases?
   • How does understanding the environmental conditions (temperature, precipitation, elevation) of your location help when thinking about the problem question: How can we ensure health for all from mosquito-borne diseases?
• How does understanding the distribution of different mosquitoes and diseases help when thinking about the problem question: How can we ensure health for all from mosquito-borne diseases?

• How do the environmental conditions (temperature and precipitation) change throughout the year in your location? Does it rain more or less in your community at different times of year? Does it snow in your community? Does the temperature change at different times of the year in your community?

• Have you been monitoring the environmental conditions of your location since Task 3-3? If so, what have you learned so far? If not, how could you monitor the changes in temperature and precipitation in your community throughout the year? Look at the instructions in Task 3-3 to get started.

Research Tip
What other mosquito-borne diseases are affecting people in your location or in other parts of the world? Do some research to find out and compare it to the analysis you did here.

Citizen Science Tip
Collecting and sharing data about your research site can be helpful to scientists when making and updating maps like these about diseases around the world. Think about how you could share your data with others.

Hooray! You completed Task 4-1. Check it off the task list. Go to Task 4-2!
Task 4-1

Investigating Mosquito Borne Disease Distribution

Analysis Questions
Task Options

• A – Jigsaw this task. Four diseases will be covered in this task: Malaria, Dengue Fever, Zika, and West Nile.
  • Break the team into four groups.
  • Have each group read the FAQ sheet and analyze the maps for one disease.
    • Have each group share out important information they identified in the FAQ sheet.
    • Have each group share out to the team their map analysis of their disease according to the questions in this document.
    • Post the information so all groups can see the analysis.

• B – Have each team member or small group look at all four diseases and FAQ sheets. Compare and contrast all four diseases.
  • Have individuals or groups share out important information they identified in the FAQ sheet.
  • Have each group share out to the team their map analysis of their disease according to the questions in this document.
Political Distribution

• Look at the Political map of the World. (Map 1)
• As a team, find the country where you live. Where inside this country do you live?
• What are the names of some other countries near or around you?
Malaria Disease Distribution

• Read the Malaria Frequently Asked Questions Sheet to learn more about this disease.
  • Identify 3-5 Very Important Parts from the FAQ sheet.
• Look at the Malaria Disease Distribution Map (2).
• Find your country on this map.
• Determine the color of your location. This color tells you if your location is at risk or not.
  • Use the key to determine the risk status of your country. Red means high risk of getting malaria. Blue means lower risk. Light grey means no risk. Dark grey means risk is unstable, so not likely.
• Make a list of 10 countries that have higher risk of malaria (reds, yellows) according to this research in the year 2010. Use the political map to find names.
• Make a list of 10 countries that have lower risk of malaria (blues) according to this research in the year 2010. Use the political map to find names.
• Make a list of 10 countries that have no current risk of malaria transmission (grey) according to this research in the year 2010.
Malaria – *Anopheles* Mosquito

- Malaria is spread by the *Anopheles* mosquito.
- Look back at pictures and information about the *Anopheles* mosquito from task 3-2.
- Look at the Distribution map of the *Anopheles* mosquito (3)
- Compare the *Anopheles* map to the Malaria Risk Map (2+3)
  - Determine some countries where *Anopheles* mosquitoes live, but Malaria is currently not a risk. What could be causing this?
- Compare and contrast the Malaria map with the temperature and precipitation maps. (2+ 4 + 5)
- Describe the relationships between temperature, precipitation, *Anopheles* mosquitoes, and malaria (2+3+4+5).
- Compare and contrast the Malaria map with the Income map. (2+ 6)
- Describe the relationships between temperature, precipitation, *Anopheles* mosquitoes, malaria, and income (2+3+4+5+6).
Dengue Fever Disease Distribution

• Read the Dengue Fever Frequently Asked Questions Sheet to learn more about this disease.
• Identify 3-5 Very Important Parts from the FAQ sheet.
• Look at the Dengue Fever Suitability Map (7).
• Find your country on this map.
• Determine the color of your location. This color tells you if your location is good for Dengue Fever or not.
• Use the key to determine the how suitable your country is for Dengue fever. Red means more suitable and more likely to have Dengue. Blue means lower suitability and less likely to have Dengue. Grey means unsuitable, so Dengue should not be found in these places.
• Make a list of 10 countries that have higher suitability of dengue (reds, yellows) according to this research in the year 2012. Use the political map to find names.
• Make a list of 10 countries that have lower suitability of dengue (blues) according to this research in the year 2012. Use the political map to find names.
• Make a list of 10 countries that have no current suitability of dengue transmission (grey) according to this research in the year 2012.
Dengue Fever – *Aedes* Mosquito

- Dengue Fever is spread by the *Aedes* mosquito.
- Look back at pictures and information about the *Aedes* mosquito from task 3-2.
- Look at the Distribution map of the *Aedes* mosquito (map 8).
- Compare the *Aedes* map to the Dengue Fever Suitability Map.
- Compare and contrast the Dengue map with the temperature and precipitation maps (4+5+7).
- Describe the relationships between temperature, precipitation, *aedes* mosquitoes, and dengue (4+5+7+8).
- Compare and contrast the Dengue map with the Income map. (6+7)
- Describe the relationships between temperature, precipitation, *Aedes* mosquitoes, dengue, and income (4+5+6+7+8).

*Mosquito! © 2018 Smithsonian Institution*
Zika Disease Distribution

- Read the Zika Frequently Asked Questions Sheet to learn more about this disease.
- Identify 3-5 Very Important Parts from the FAQ sheet.
- Look at the Zika Risk Map (9).
- Find your country on this map.
- Determine the color of your location. This color tells you if your location has a risk of Zika or not.
- Use the key to determine how suitable your country is for Zika.
  - Orange means your location is at risk due to only environmental factors, such as temperature and precipitation.
  - Purple means your location is at risk because of Socioeconomic status and accessibility. Socioeconomic status is based on income, education, and occupation. Accessibility has to do with how easily people can move into and out of these places.
  - Blue means that all factors (environmental, socioeconomic status, and accessibility) are in place at these locations.
  - Grey indicates that Zika cases are currently unlikely at these locations.
- Make a list of 10 countries that have risk for Zika for environmental reasons (orange) according to this research in the year 2016. Use the political map to find names.
- Make a list of 10 countries that have risk for Zika for Socioeconomic and Accessibility reasons (purple) according to this research in the year 2016. Use the political map to find names.
- Make a list of 10 countries that have risk for Zika for all factors (blue) according to this research in the year 2016. Use the political map to find names.
- Make a list of 10 countries that have no current risk of Zika (grey).
Zika—Aedes Mosquito

• Zika is spread by the Aedes mosquito.
• Look back at pictures and information about the Aedes mosquito from task 3-2.
• Look at the Distribution map of the Aedes mosquito (8).
• Compare the Aedes map to the Zika Risk Map (8+9).
• Compare and contrast the Zika map with the temperature and precipitation maps (4+5+9).
• Describe the relationships between temperature, precipitation, aedes mosquitoes, and Zika (4+5+8+9).
• Compare and contrast the Zika map with the Income map. (6+9)
• Describe the relationships between temperature, precipitation, Aedes mosquitoes, Zika, and income (4+5+6+8+9).
West Nile Virus Disease Distribution

• Read the West Nile Virus Frequently Asked Questions (FAQ) Sheet to learn more about this disease.

• Identify 3-5 Very Important Parts from the FAQ sheet.

• Look at the West Nile Virus Distribution Map (10).

• Find your country on this map.

• Determine if your country is Red, Blue, or Grey. This color tells you if West Nile is present in your country or not.

• Use the key to determine the status of your country.

• Make a list of 10 countries that have human cases of west nile virus (red) according to this research in the year 2015. Use the political map to find names.

• Make a list of 10 countries that have nonhuman cases of west nile virus (blue) according to this research in the year 2015. Use the political map to find names.

• Make a list of 10 countries that have no data or positive cases of west nile virus (grey) according to this research in the year 2015.
West Nile Virus – *Culex* Mosquito

- West Nile virus is spread by the *Culex* mosquito.
- Look back at pictures and information about the *Culex* mosquito from task 3-2.
- Look at the Distribution map of the *Culex* mosquito (11).
- Compare the *Culex* map to the West Nile Map (10 +11).
  - On the West Nile map (1) there are some dashed lined circles. What do you think those areas indicate?
  - Determine some countries where *Culex* mosquitoes live, but West Nile is currently not found. What could be causing this?
  - Determine some countries where West Nile is currently found, but *Culex* mosquitoes do not live there. What could be causing this?
- Compare and contrast the West Nile map with the temperature and precipitation maps (4+5+10).
- Describe the relationships between temperature, precipitation, *Culex* mosquitoes, and West Nile (4+5+10+11).
- Compare and contrast the West Nile map with the Income map. (6+10)
- Describe the relationships between temperature, precipitation, *Culex* mosquitoes, West Nile, and income (4+5+6+10+11).
Task 4-1

Investigating Mosquito Borne Disease Distribution

Maps
Map 2  Malaria Risk Map - Spread by Anopholes Mosquito

Malaria risk (P. falciparum prevalence)
- 70%
- 0%
- No risk
- Unstable transmission

Map 4

Average Annual Temperature

Data taken from: CRU 0.5 Degree Dataset (New, et al.)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison
Map 5

Annual Total Precipitation

Data taken from: CRU 0.5 Degree Dataset (New et al)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison
Map 6 - Income


Source: UN Human Development Index 2008
Map 7  Dengue Fever Environmental Suitability Map – Spread by Aedes Mosquito

Map 8

Distribution of Aedes Mosquitoes

Map 9 Zika Risk Map – Spread by Aedes Mosquito

Source: Samy, Thomas, Wahed, Cohoon, Peterson. 2016. Mapping the global geographic potential of Zika virus spread. Mem Inst Oswaldo Cruz
Map 10

West Nile Distribution – Spread by *Culex* Mosquitoes

Red – Human Cases reported
Blue – Nonhuman (birds, horses) and Mosquito Cases reported
Gray – No data or no positive cases reported

Map 11

Distribution of the Culex mosquito - carrier of the West Nile virus

Source: WHO
Task 4-1 – Investigating Mosquito-borne Disease Distribution

Dengue—Frequently Asked Questions

Q: What is dengue?

A: Dengue (pronounced DEN-gee) is a disease transmitted to humans by the bite of an infected mosquito. In the Western Hemisphere, the Aedes mosquito is the most important transmitter or vector of dengue viruses. It is estimated that there are more than 100 million cases of dengue worldwide each year.

Q: How is dengue transmitted?

A: Dengue is transmitted to people by the bite of an Aedes mosquito that is infected with dengue virus. The mosquito becomes infected with dengue virus when it bites a person who has dengue virus in their blood. The person may have symptoms of dengue fever, or they may have no symptoms. After about one week, the mosquito can then transmit the virus while biting a healthy person. Dengue cannot be spread directly from person to person.

Q: What are the symptoms of dengue?

A: The main symptoms of dengue fever are high fever, severe headache, severe pain behind the eyes, joint pain, muscle and bone pain, rash, and mild bleeding (for example, the nose or gums bleed, easy bruising). Generally, younger children and those with their first dengue infection have a milder illness than older children and adults.

Q: What is the treatment for dengue?

A: There is no specific medication to treat a dengue infection. People who think they have dengue should use pain relievers with acetaminophen and medicines containing aspirin. They should also rest, drink plenty of fluids, and consult a physician. If they feel worse (for example, start vomiting and develop severe abdominal pain) in the first 24 hours after the fever declines, they should go immediately to the hospital for evaluation.

Q: Where can outbreaks of dengue occur?

A: Outbreaks of dengue occur primarily in areas where Aedes mosquitoes live. This includes most tropical urban areas of the world. Dengue viruses may be introduced into other areas by travelers who become infected while visiting areas of the tropics where dengue commonly exists.
Q: What can be done to reduce the risk of acquiring dengue?

A: There is no vaccine for preventing dengue. The best preventive measure for residents living in areas infested with *Aedes* is to eliminate the places where the mosquito lays her eggs, primarily containers that hold water.

Items that collect rainwater or store water (for example, plastic containers, 55-gallon drums, buckets, or used automobile tires) should be covered or properly discarded. Pet and animal watering containers and vases with fresh flowers should be emptied and cleaned (to remove eggs) at least once a week. This will eliminate the mosquito eggs and larvae and reduce the number of mosquitoes present in these areas.

Using air conditioning or window and door screens reduces the risk of mosquitoes coming indoors. Proper application of mosquito repellents containing 20 percent to 30 percent DEET as the active ingredient on exposed skin and clothing decreases the risk of being bitten by mosquitoes. The risk of dengue infection for international travelers appears to be small. There is increased risk if an epidemic is in progress or if visitors are staying in housing without air conditioning or screened windows and doors.
Malaria—Frequently Asked Questions

Q: What is malaria?

A: Malaria is a serious and sometimes fatal disease caused by a parasite that commonly infects *Anopheles* mosquitoes that feed on humans. People who get malaria are typically very sick, with high fevers, shaking chills, and flu-like illness.

Globally, the World Health Organization estimates that in 2015, 212 million clinical cases of malaria occurred, and 429,000 people died of malaria, most of them children in Africa. Because malaria causes so much illness and death, the disease is a great drain on many national economies. Since many countries with malaria are already among the poorer nations, the disease maintains a vicious cycle of disease and poverty.

Q: How is malaria transmitted?

A: Usually, people get malaria by being bitten by an infected female *Anopheles* mosquito. Only *Anopheles* mosquitoes can transmit malaria, and they must have been infected through a previous blood meal taken from an infected person. When a mosquito bites an infected person, a small amount of blood is taken in, which contains microscopic malaria parasites. About one week later, when the mosquito takes its next blood meal, these parasites mix with the mosquito’s saliva and are injected into the person being bitten. Because the malaria parasite is found in the red blood cells of an infected person, malaria can also be transmitted through blood transfusion, organ transplant, or by sharing needles or syringes contaminated with blood. Malaria may also be transmitted from a mother to her unborn infant before or during delivery (known as “congenital malaria”).

Q: Who is at risk for malaria?

A: Anyone can get malaria. Most cases occur in people who live in countries with malaria transmission. People from countries with no malaria transmission can become infected when they travel to countries with malaria or through a blood transfusion (although this is very rare). Also, an infected mother can transmit malaria to her infant before or during delivery.
Q: What are the signs and symptoms of malaria?

A: Symptoms of malaria include fever and flu-like illness, including shaking chills, headache, muscle aches, and tiredness. Nausea, vomiting, and diarrhea may also occur. Malaria may cause anemia and jaundice (yellowing of the skin and eyes) because of the loss of red blood cells. If not promptly treated, the infection can become severe and may cause kidney failure, seizures, mental confusion, coma, and death. For most people, symptoms begin 10 days to four weeks after infection, although a person may feel ill as early as seven days or as late as one year later.

Q: What is the treatment for malaria?

A: Malaria can be cured with prescription drugs. The type of drugs and length of treatment depend on the type of malaria, where the person was infected, their age, whether they are pregnant, and how sick they are at the start of treatment.

Q: Where can malaria occur?

A: Malaria typically is found in warmer regions of the world—in tropical and subtropical countries. Higher temperatures allow the *Anopheles* mosquito to thrive. Malaria parasites, which grow and develop inside the mosquito, need warmth to complete their growth before they are mature enough to be transmitted to humans. Malaria occurs in more than 100 countries and territories. About half of the world’s population is at risk. Large areas of Africa and South Asia and parts of Central and South America, the Caribbean, Southeast Asia, the Middle East, and Oceania are considered areas where malaria transmission occurs. Yet malaria does not occur in all warm climates. For example, malaria has been eliminated in some countries with warm climates, while a few other countries have no malaria because *Anopheles* mosquitoes are not found there.

Q: What can be done to reduce the risk of acquiring malaria?

A: You and your family can most effectively prevent malaria by taking all three of these important measures.

- Take antimalarial medication to kill the parasites and prevent becoming ill.
- Keep mosquitoes from biting you, especially at night.
- Sleep under insecticide-treated bed nets, use insect repellent, and wear long-sleeve clothing if you’re out of doors at night.
Task 4-1 – Investigating Mosquito-borne Disease Distribution

West Nile Virus—Frequently Asked Questions

Q: What is West Nile virus?

A: West Nile virus is a disease most commonly spread by infected *Culex* mosquitoes. West Nile virus can cause fever, encephalitis (inflammation of the brain), or meningitis (inflammation of the lining of the brain and spinal cord).

Q: How is West Nile virus spread?

A: Most people get infected with West Nile virus from the bite of an infected *Culex* mosquito. Mosquitoes become infected when they feed on infected birds. Infected mosquitoes can then spread the virus to humans and other animals. In a very small number of cases, West Nile virus has been spread through blood transfusions, organ transplants, and from mother to baby during pregnancy, delivery, or breastfeeding.

Q: What are the symptoms of West Nile virus disease?

A: Most people (70 to 80 percent) who become infected with West Nile virus do not develop any symptoms. About one in five people who are infected will develop a fever with other symptoms, such as headache, body aches, joint pains, vomiting, diarrhea, or rash. Most people with this type of West Nile virus disease recover completely, but fatigue and weakness can last for weeks or months. Less than 1 percent of people who are infected will develop a serious neurologic illness, such as encephalitis or meningitis (inflammation of the brain or surrounding tissues). The symptoms of neurologic illness can include headache, high fever, neck stiffness, disorientation, coma, tremors, seizures, or paralysis.

Q: What is the treatment for West Nile virus?

A: There are no medications to treat or vaccines to prevent West Nile virus infection. Over-the-counter pain relievers can be used to reduce fever and relieve some symptoms. People with milder symptoms typically recover on their own, although some symptoms may last for several weeks.
In more severe cases, patients often need to be hospitalized to receive supportive treatment, such as intravenous fluids, pain medication, and nursing care.

Q: Who is at risk for infection with West Nile virus?
A: Anyone living in an area where West Nile virus is present in mosquitoes can get infected. The risk of infection is highest for people who work outside or participate in outdoor activities, because of greater exposure to mosquitoes.

Q: How soon do people get sick after getting bitten by an infected mosquito?
A: The incubation period is usually two to six days, but ranges from two to fourteen days. This period can be longer in people with certain medical conditions that affect the immune system.

Q: Where can outbreaks of West Nile occur?
A: West Nile virus transmission has been documented in Europe and the Middle East, Africa, India, parts of Asia, and Australia. It was first detected in North America in 1999, and has since spread across the continental United States and Canada.

Q: How can people reduce the chance of getting infected?
A: The most effective way to avoid West Nile virus disease is to prevent mosquito bites.

- Use insect repellents when you go outdoors. Repellents containing DEET, picaridin, IR3535, and some oil of lemon eucalyptus and para-menthane-diol products provide longer-lasting protection.
- Wear long sleeves and pants from dusk through dawn, when many mosquitoes are most active.
- Install or repair screens on windows and doors. If you have it, use your air conditioning.
- Help reduce the number of mosquitoes around your home. Empty standing water from containers such as flower pots, gutters, buckets, pool covers, pet water dishes, discarded tires, and bird baths.
Q: What is Zika?
A: Zika virus disease is caused by the Zika virus, which is spread to people primarily through the bite of an infected Aedes mosquito. The illness is usually mild, with symptoms lasting up to a week, and many people do not have symptoms or will have only mild symptoms. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly, and other severe brain defects.

Q: How is Zika spread?
A: Zika is spread to people primarily through the bite of an infected Aedes mosquito. A pregnant woman can pass Zika to her fetus during pregnancy or around the time of birth. Also, a person with Zika can pass it to his or her sex partners. People who have traveled to or live in places with a risk of Zika are encouraged to protect themselves by preventing mosquito bites and sexual transmission of Zika.

Q: What are the symptoms of Zika virus disease?
A: The most common symptoms of Zika virus disease are fever, rash, headache, joint pain, red eyes, and muscle pain. Many people infected with Zika won’t have symptoms or will have mild symptoms, which can last for several days to a week.

Q: What health problems can result from getting Zika?
A: While people infected with Zika will have no symptoms or mild symptoms, Zika infection during pregnancy can cause a serious birth defect called microcephaly (an abnormally small head) and other severe fetal brain defects. Once someone has been infected with Zika, it’s very likely they’ll be protected from future infections. There is no evidence that past Zika infection poses an increased risk of birth defects in future pregnancies.

Q: What is the treatment for Zika?
A: If you have symptoms of Zika (fever, rash, headache, joint pain, red eyes, or muscle pain) and you live in or recently traveled to an area with a risk of Zika, you should see your doctor or health care provider and tell him or her about your
symptoms and recent travel. There is no specific medicine for Zika, but you can treat the symptoms.

If you are diagnosed with Zika, protect those around you by taking steps to prevent mosquito bites and to prevent sexual transmission of Zika. Because Zika can generally be found in blood during approximately the first week of infection, and can be passed to another person through mosquito bites, help prevent others from getting sick by strictly following steps to prevent mosquito bites during the first week of illness.

Q: **If I am traveling to an area with a risk of Zika, should I be concerned about Zika?**

A: Travelers who go to places with a risk of Zika can become infected. Many people will have mild or no symptoms. However, Zika can cause microcephaly and other severe birth defects. For this reason, pregnant women should not travel to any area with a risk of Zika, and women trying to get pregnant should talk to their doctor before traveling to an area with a risk of Zika. Those traveling to areas with a risk of Zika should take preventive steps during and after they travel.

Q: **What can people do to prevent Zika?**

A: The best way to prevent Zika is to protect yourself and your family from mosquito bites.

- Use Environmental Protection Agency (EPA)-registered insect repellents.
- Wear long-sleeve shirts and long pants.
- Sleep under a mosquito bed net if air conditioned or screened rooms are not available, or if you are sleeping outdoors.

Zika can be spread by a person infected with Zika to his or her sex partners. Condoms can reduce the chance of getting Zika from sex. Condoms include male and female condoms. Pregnant couples with a partner who traveled to or lives in an area with a risk of Zika should use condoms every time they have sex or not have sex during the pregnancy.
Zika Awareness and Prevention (ZAP) Game

The Zika Awareness and Prevention (ZAP) Game was developed to strengthen students and communities in their ability to stop Zika virus disease. Zika virus is a mosquito-borne virus, spread primarily by the bite of an infected *Aedes* species mosquito. Through simulation, this game educates students about Zika virus, common mosquito breeding sites, Zika virus disease symptoms, and pregnancy risks associated with Zika. Practices that help to prevent mosquito bites are also covered such as using an EPA registered insect repellent with DEET, the importance of wearing long sleeved shirts and long pants when outdoors, and treating clothing with permethrin. Multiple choice and matching games are provided to gauge how much you learned about Zika.

Use the following link to access the game, and have fun!
http://zika.vmasc.odu.edu/zap/

Computer WebGL Compatibility: Chrome 64 bit Version 57 and newer, Microsoft Edge version 16 or newer, Safari version 11 or newer, and Firefox version 52 or newer. Firefox users check your privacy settings.

For more information about the ZAP Game or for any other concerns please email us at Zapzika@odu.edu or contact:

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