Click and Learn
Gorongosa Interactive Map

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Educator Materials

EXPLORING BIOMES IN GORONGOSA NATIONAL PARK

OVERVIEW

This activity complements the Click and Learn "Gorongosa National Park Interactive Map" (http://www.hhmi.org/biointeractive/gorongosa-national-park-interactive-map) developed in conjunction with the short film, *The Guide*. Gorongosa National Park in Mozambique is a region with high ecological diversity, containing several different vegetation types and two distinct biomes. The activity is designed to introduce students to the concept of biomes using Gorongosa National Park as a case study.

As students complete the accompanying worksheet, they will analyze climate and vegetation data to draw conclusions about the characteristics of specific biomes. They will also explore the connections between temperature, precipitation, and vegetation in the biomes of Gorongosa National Park and their own region. This activity encourages students to draw upon prior knowledge about climate, make predictions, and then explore those predictions using the Gorongosa interactive map.

The worksheet is divided into three sections. In the first section, students analyze climate data to predict the biome of two regions of Gorongosa National Park using classroom resources. In the second section, students explore their predictions by using the Interactive Map to learn more about the biomes and corresponding biodiversity within specific regions of the park. In the third section, students create their own climate graph using an external website and compare this data to the information gathered about the two regions of Gorongosa.

KEY CONCEPTS AND LEARNING OBJECTIVES

- A biome is a region characterized by the dominant vegetation type resulting from the climate and geography of that region. Regions at similar latitudes across the planet tend to have similar climates and thus similar biomes. However, climate is also influenced by a region's geography, leading to changes in biome characteristics in regions located at the same latitude.
- Temperature and rainfall patterns within a region can be used to predict the biome and its broad vegetation characteristics.
- Biodiversity is the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness of an ecosystem's biodiversity is often used as a measure of its health.
- The organisms found within a biome have adaptations that allow them to survive and reproduce in that environment.
- Natural disturbances, such as fire, storms, and disease, can impact the vegetation and organisms adapted to a biome.
- The interactions among living and nonliving factors, such as symbiotic relationships, competition, climate, geography, natural phenomena, and human impact, within an ecosystem can influence the biodiversity within a biome.

Students will learn to:

- make claims based on observations and provide evidence based on those claims.
- interpret, construct, and compare graphs based on real-world data.
- make connections between climate, vegetation, and biodiversity to understand biome characteristics.

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CURRICULUM CONNECTIONS

Curriculum	Standards
NGSS (April 2013)	MS-LS2-1, MS-LS4-6 HS-LS2-2, HS-LS2-6, HS-LS4-4, HS-LS4-5
AP Biology (2012–13)	2.D.1, 4.A.5, 4.A.6, 4.C.2, 4.C.4 Science Practices 1.1, 1.2, 5.1, 5.3
IB Biology (2016)	4.1, 5.3, C.2, C.4
AP Environmental Science Themes and Topics (April 2013)	I.B, II.C

KEY TERMS

biome, climate, precipitation, temperature, climatogram, Gorongosa, vegetation, adaptation, biodiversity, Great Rift Valley, savanna, tropical rainforest, woodland, grassland

TIME REQUIREMENTS

Allow 1 to 2 hours to complete the entire worksheet.

SUGGESTED AUDIENCE

The interactive map and worksheet are appropriate for high school biology (all levels including AP and IB), high school environmental science, and introductory college biology. This activity incorporates several AP and NGSS science practices.

PRIOR KNOWLEDGE

Questions in the student worksheet can be answered using information from the Gorongosa interactive map and other web-based references listed in the activity. However, students will benefit from having some familiarity with the concepts of adaptations of organisms to their environment as well as the climatic, geologic, and biotic features of various biomes.

MATERIALS

Internet-connected computers/tablets, student worksheet, and textbook or other resource describing/defining Earth's biomes

TEACHING TIPS

- If you do not have sufficient class time, allow students to do part of the activity in class and the last section for homework.
- Middle school students or lower level readers might need extra language and vocabulary support.
- Students will be asked to use information from the climate graphs to predict which biomes the graphs represent. Consider having textbooks or additional text-based or web-based resources available for students to reference when using the data to predict the biome. The following websites provide information regarding the characteristic climate and vegetation of various biomes on Earth: http://www.ucmp.berkeley.edu/exhibits/biomes/ and http://www.blueplanetbiomes.org/world_biomes.htm
- For question 10 in the student worksheet, it may be difficult for students to imagine the vegetation within their own region, especially if they live in an urban area. Provide students with images of the natural areas surrounding the city or town in which they live so they may make informed predictions about the biome of their region.

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RELATED RESOURCES

Gorongosa National Park Interactive Map
(http://www.hhmi.org/biointeractive/gorongosa-national-park-interactive-map)
This interactive map of Gorongosa National Park allows users to explore different features of the park, including key components of the conservation strategy.

The Guide: A Biologist in Gorongosa
(http://www.hhmi.org/biointeractive/the-guide-a-biologist-in-gorongosa)
This is a short film about a young man from Gorongosa who discovers a passion for science after meeting world-renowned biologist E.O. Wilson.

Film Guides: "The Guide: A Biologist in Gorongosa"
(http://www.hhmi.org/biointeractive/film-guides-guide-biologist-gorongosa)
Two classroom-ready film guides provide background and resources for the film "The Guide: A Biologist in Gorongosa."

Gorongosa Timeline
(http://www.hhmi.org/biointeractive/gorongosa-timeline)
This interactive timeline allows users to explore the history of Gorongosa National Park.

Gorongosa: Restoring Mozambique's National Treasure
(http://www.hhmi.org/biointeractive/gorongosa-restoring-mozambiques-national-treasure)
This article by Gorongosa National Park staff explains the project's history, mission, and future goals.

ANSWER KEY

1. *For each graph, describe the trend in the amount of rainfall throughout the year. Include which month(s) have the highest rainfall and which month(s) have the lowest rainfall.* **In the main park territory, rainfall is highest in December, January, and February with around 200 mm of average rainfall per month. The amount of rain decreases and is lowest in the months of May through October with around 10 to 25 mm of average rainfall per month. On Mount Gorongosa, rainfall is highest from December through March with monthly averages of more than 300 mm of rainfall. Rainfall decreases rapidly from April through June and is lowest in July through September with around 25 mm of average rainfall per month. Both graphs show there is a distinct wet season and dry season.**

2. *For each graph, describe the trend in the temperature throughout the year. Include which month(s) have the highest temperature and which month(s) have the lowest temperature.* **In the main park territory, temperature remains around 28°C for most of the year and gradually drops to around 20°C during the months of June through August. On Mount Gorongosa, temperatures range from 20°C to around 15°C. Similar to the Park Territory, the temperature decreases from 20°C to 15°C between June and August and then steadily begins increasing back to 20°C by November.**

3. *Based on these two graphs, how are temperature and rainfall trends related? Use evidence to support your claim.* **The trends in temperature and rainfall are directly related. They show similar patterns in both graphs. Average precipitation is highest during the months when the average temperature is higher. As temperature decreases, the precipitation also decreases. Similarly, when the temperature increases, precipitation also increases.**

4. *Based on these temperature and precipitation graphs, predict which biome you think each site belongs to. Use evidence from the graphs to support your reasoning.* **Student answers may vary; an exemplar response is provided here. The main park territory belongs to the "savanna" biome because it has a**

characteristic wet and dry season indicated by rainfall averages as well as warm average temperatures. In this biome, the wet season corresponds to warmer temperatures and the dry season corresponds to cooler temperatures. The graph supports this, showing that the three wettest months (December through February) are also the three hottest months and the driest months (June through September) are also the coolest months. Mount Gorongosa belongs to the rainforest biome because it has an abundance of precipitation (more than 2000 mm annually) with some seasonal variation and warm temperatures (15° to 20°C).

5. *How does the information on the two biomes in the interactive map compare to your prediction in question 4? Is the information about temperature and precipitation of the two biomes in the map the same or different from the climate graphs on the first page?* **Student answers may vary depending on their predictions in question 4. The "savanna" biome has a dry season and a wet season. It also experiences year-round high temperatures between 24° and 29°C. The temperatures get slightly cooler during the dry season and the warmer wet season occurs during December through April. This information is similar to the climate graph for the main park territory and matches the prediction that this biome is "savanna." The "tropical rainforest" biome has an extremely high average rainfall (over 2000 mm of annual rainfall) and consistently high temperatures ranging between 25° and 29°C. The precipitation data is similar to that of the Mount Gorongosa climate graph; however, the graph shows that the mountain has slightly cooler temperatures ranging between 15° and 20°C, which differs from the biome description from the map.**

6. *List the types of vegetation present in each biome. Explain how temperature and precipitation might influence the vegetation within each biome.*

Biome Type: Savanna

Vegetation Types	Temperature Influence	Precipitation Influence
Savanna has a grassy understory with some trees but an open canopy. Gorongosa's savanna has patches of grassland and woodland. Grassland is made up of large expanses of open grassy plains with no trees. Woodland is a closed canopy with little grass in the understory.	The wet season is hot and humid, while the dry season hot and dry during the day and cool at night. The dry heat of the dry season influences natural fires, which limit tree growth.	The wet season brings seasonal flooding and the dry season brings natural fires. The precipitation in the wet season supports vegetation growth, while the fires in the dry season limit the growth of trees.

Biome Type: Tropical Rainforest

Vegetation Types	Temperature Influence	Precipitation Influence
Tropical rainforest is made up of huge tropical trees, mosses, ferns, and mangrove trees.	The high heat combined with the moisture of precipitation creates humidity. The closed tree canopy creates a cool, moist climate inside the forest, which benefits the growth and productivity of mosses and ferns on the forest floor.	Very high rainfall throughout the year supports the growth of very large trees with a dense, closed canopy.

7. *Using evidence from your climate graph and the biome resources used in question 4, which biome best describes your region? Why?* **Student answers will vary based on the region and climate graph.**

8. *Describe how rainfall trends in your region compare to rainfall trends at the two Gorongosa sites: Does it rain during the same time of year in your region as at the two Gorongosa sites? Does it rain the same amount? Explain the similarities or differences.* **Student answers will vary based on the region and climate graph.**

9. *Describe how temperature trends in your region compare to temperature trends at the two Gorongosa sites. Explain your answers.* **Student answers will vary based on the region and climate graph.**

10. *Based on your own observations of nature or using provided resources, describe the vegetation in your region and explain how it differs from that of the two Gorongosa sites.* **Student answers will vary based on the region.**

11. *In addition to climate, what other factors might determine biomes?* **Aside from climate, which includes average annual precipitation and temperature trends, factors such as the geography, geology, soil types, disturbances, and topography can also influence the biome of a region.**

12. *Why do you think scientists study biomes in a place like Gorongosa? Why is it important to understand the biome where you live?* **Each biome is characterized by a specific set of environmental conditions and is home to a unique array of living things. Humans have an impact on biomes and the biodiversity of organisms supported by each biome. Thus, scientists study biomes in order to develop a deeper understanding of the complex interactions that allow for the area's specific biodiversity and to determine how human impact has negatively and/or positively affected a region. Similarly, it is important to understand your local biome so that you may have a higher awareness of the needs and relationships of all living things and make informed decisions about how our actions impact the world around us.**

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