



Time:

One 50-minute period

Summary:

In the previous two lessons, students looked at climate change within the savanna human-land-climate system loop. They learned about changes in temperature and rainfall in East Africa and compared the rates of change in the highland savanna to the rates of change on the coast. In this lesson, students will examine how rainfall and temperature affect vegetation, and as a result, livelihood and land use options.

Materials:

Computer with internet access

Projector

PowerPoint presentation: Changing Vegetation

Student handout and answer sheet:

- Predictions
- Predictions answer sheet
- Discussion questions
- Discussion questions with answers

Changing Vegetation

Objectives

Students will be able to

- describe how temperature and rainfall affect moisture availability.
- predict how climate change will affect what vegetation will grow in the savanna.
- discuss the possible effect changes in vegetation will have on livelihoods and land use.

Background

Climate change affects different ecosystems in East Africa in different ways. In Lessons 2 and 3, students compared changes in temperature and rainfall in a savanna ecosystem to a coastal ecosystem, and found that temperatures are increasing more rapidly on the coast, while rainfall is decreasing much more rapidly in the savanna. The overall effect of changes in temperature and rainfall is seen in the amount of moisture available for plant growth. As researchers examined the data, they found the savanna to be the most vulnerable ecosystem in East Africa. Savanna vegetation is highly vulnerable to changes in temperature and moisture availability. These changes affect people's ability to grow crops and keep livestock in the savanna (their main livelihoods). The EACLIPSE Project focuses on the savanna in order to have the greatest possible impact..

Vocabulary

Biome

Vegetation

Ground cover

Transect

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Changing Vegetation

Procedure

1. Activate students' prior knowledge by asking them:

- What did you learn about the effect of climate change on temperatures in East Africa (Lesson 2)? (Temperatures are rising)
- Are changes the same in all parts of East Africa? (No--they are rising faster on the coast)
- What did you learn about the effect of climate change on rainfall in East Africa (Lesson 3)? (Average yearly rainfall is decreasing)
- Are changes the same in all parts of East Africa? (No—rainfall is decreasing faster in the savanna)

Ask leading questions that will be addressed in this lesson:

- Which of these two ecosystems (savanna or coastal) do you think might be more vulnerable to changes in temperature and rainfall? Why?
- Would you expect rainfall and temperature to affect what kind of vegetation will grow?

2. Show students the PowerPoint presentation on Changing Vegetation.

- Show slides 1-6
- Stop and hand out Student Sheet Predictions. Slides 8-10 can be projected if images are not clear on Student Sheet. Otherwise skip these slides.
- Review students predictions
- Show slides 11-20

3. Hand out copies of the discussion questions to students.

Help students use the savanna vegetation chart to discuss how temperature and rainfall determine moisture availability, how that affects what vegetation will grow in the savanna, and how that in turn affects people's livelihoods and land use. The

chart should help them see that as temperatures increase and rainfall decreases, savanna vegetation will change, causing a shift to the next moisture availability zone in the continuum (woodland to bushland to scrubland), and that extreme changes could lead to desertification.

Discussion questions:

- How does climate change affect vegetation in the savanna?
- What factors affect moisture availability?
- What happens to savanna vegetation as moisture availability decreases?
- What would happen if there were not enough moisture available for bushland and scrubland vegetation?
- How does the changing vegetation affect people's livelihood/land use options?
- How does changing vegetation fit into the human-land-climate system loop?

4. Conclusion: In the following lesson, we will look at how changes in livelihoods and land use affect vegetation, and how that may affect the climate, closing the savanna human-land-climate system loop.

Optional Extensions:

If you would like to provide students more in-depth lessons on rainfall, vegetation, and agricultural land use in East Africa using Google Earth, use the supplemental lessons available on the CLIP (Climate Land Interaction Project) website: www.clip.msu.edu.
Crops and Vegetation 1: Physical and Agricultural Geography of Kenya
Crops and Vegetation 2: Exploring the Biogeography and Agricultural Geography near Mt. Kenya

Changing Vegetation

Assessment

By answering the discussion questions, did students demonstrate an understanding of how temperature and rainfall affect moisture availability, how climate change affects savanna vegetation, and how changes in vegetation could affect livelihoods and land use?

Web Resources

Descriptions of World Biomes

www.blueplanetbiomes.org/world_biomes.htm

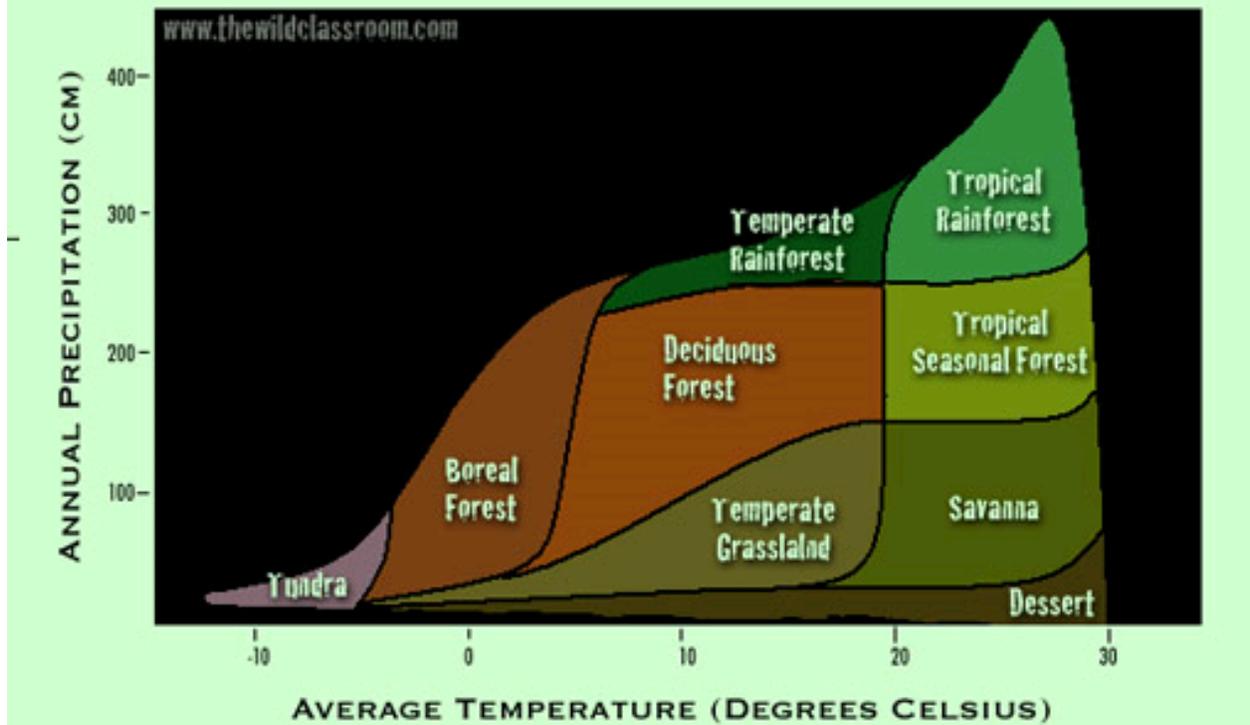
Article: "Linkages between climate change and desertification in East Africa" <http://ag.arizona.edu/oals/ALN/aln49/eriksen-part1.html>



Predictions

Researchers use existing data to help them make predictions on what they think might happen to the savanna. Below are one graph and two tables. Based on what you have learned in past lessons on temperature and rainfall patterns in the savanna you are going to make predictions on what will happen to the vegetation in the savanna due to climate change.

Temperature vs Precipitation Biome Graph



Source: The Wild Classroom. <http://www.thewildclassroom.com/biomes/>

1. What would happen if average rainfall increases above the range necessary for a savanna biome?
2. What would happen if rainfall decreases below the range necessary for a savanna biome?

Predictions

Table A MOISTURE AVAILABILITY ZONES with an indication of rainfall, evaporation, vegetation, potential for plant growth and risk of crop failure

| zone | r/Eo (%) | classification | r | Eo | vegetation | potential for plant growth | risk of failure of an adapted maize crop |
|------|----------|-------------------------|--|---|-------------------------------|--|--|
| | | | average annual rainfall (mm) | average annual potential evaporation (mm) | | | |
| | | | excluding areas above 10,000 ft altitude | | | assuming that soil conditions are not limiting | |
| I | > 80 | humid | 1100 - 2700 | 1200 - 2000 | moist forest | very high | extremely low (0 - 1%) |
| II | 65 - 80 | sub-humid | 1000 - 1600 | 1300 - 2100 | moist and dry forest | high | very low (1 - 5%) |
| III | 50 - 65 | semi-humid | 800 - 1400 | 1450 - 2200 | dry forest and moist woodland | high to medium | fairly low (5 - 10%) |
| IV | 40 - 50 | semi-humid to semi-arid | 600 - 1100 | 1550 - 2200 | dry woodland and bushland | medium | low (10 - 25%) |
| V | 25 - 40 | semi-arid | 450 - 900 | 1850 - 2300 | bushland | medium to low | high (25 - 75%) |
| VI | 15 - 25 | arid | 300 - 550 | 1900 - 2400 | bushland and scrubland | low | very high (75 - 95%) |
| VII | < 15 | very arid | 150 - 350 | 2100 - 2500 | desert scrub | very low | extremely high (95 - 100%) |

Source: Kenya Ministry of Agriculture 1980: Agro-climatic zone map of Kenya 1980

The chart above shows different moisture availability zones in East Africa.

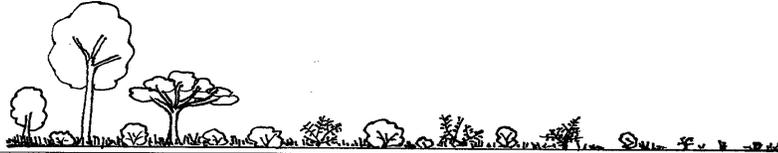
- Within the savanna, there are different gradations of rainfall and temperature, and these affect the composition and percentage of grass, bush, and tree species that will grow there.
- Temperatures affect evaporation (higher temperatures cause greater evaporation and evapotranspiration).
- The combination of rainfall and evaporation determine “moisture availability”, or how much water is available for plant growth.
- In East Africa, seven ecological zones have been described based on moisture availability.
- Three of these zones (IV, V, and VI) include the savanna.

1. What is the potential for crop growth in the three savanna zones?

2. What is the risk of crop failure in the three savanna zones?

Predictions

Savanna vegetation in response to moisture availability



| Vegetation | dry woodland and bushland | bushland | bushland and scrubland |
|--------------------------------------|-----------------------------|------------------------------|------------------------|
| Moisture availability zone | IV: semi-humid to semi-arid | V: semi-arid | VI: arid |
| Potential for plant growth | medium | medium to low | low |
| Risk of failure of maize crop | low (10-25%) | high (25-75%) | very high (75-95%) |
| Livelihood/land use options | crops, livestock | crops (high risk), livestock | livestock (high risk) |

Based on Kenya Ministry of Agriculture 1980. Agro-climatic zone map of Kenya 1980

The table above shows the three the moisture availability zones that include the savanna. You can see the progression from higher rainfall and lower temperatures (greater moisture availability) to lower rainfall and higher temperatures. Understanding the relationship between moisture availability and vegetation makes it possible to predict the effects of climate change on the savanna.

1. As temperature increases and moisture availability decreases how do people's livelihoods change?
2. Predict the changes you expect to see in the savanna due to climate change based on the data in the graph and two charts. Explain your predictions.
3. What other data would you need to make a complete prediction on the changes that will occur in the savanna to not only the vegetation but to the whole ecosystem?

Predictions Answer Sheet

1. What would happen if average rainfall increases above the range necessary for a savanna biome?

- It would turn into a tropical seasonal forest

2. What would happen if rainfall decreases below the range necessary for a savanna biome?

- It would turn into a desert

3. What is the potential for crop growth in the three savanna zones?

- Medium to low

4. What is the risk of crop failure in the three savanna zones?

- Low to very high

5. As temperature increases and moisture availability decreases how do people's livelihoods change?

- Crops become harder to grow and people rely more on livestock. As the savanna turns to bushland livestock herding becomes risky.

6. Predict the changes you expect to see in the savanna due to climate change based on the data in the graph and two charts. Explain your predictions.

- More of the savanna is going to turn to desert. There is a high risk of crop failure and people turn to livestock. As moisture decreases even more livestock herding becomes risky and people might have to move to find a new livelihood.

7. What other data would you need to make a complete prediction on the changes that will occur in the savanna to not only the vegetation but to the whole ecosystem?

- Are there other livelihoods in the area?
- Are there other factors increasing the rate of change in vegetation (such as deforestation)?
- Will moisture decrease steadily or will there be more severe weather?
- How will crops and animals respond to drought?
- How will people respond to the changes?



Changing Vegetation in the East African Savanna

Discussion Questions

1. How does climate change affect vegetation in the savanna?
2. What factors affect moisture availability?
3. What happens to savanna vegetation as moisture availability decreases?
- 4.
5. How does the changing vegetation affect people's livelihood/land use options?
6. How does changing vegetation fit into the human-land-climate system loop?

Changing Vegetation in the East African Savanna Answer Sheet

Discussion Questions

1. How does climate change affect vegetation in the savanna?

As temperatures rise and rainfall decreases, the kind of vegetation that grows in the savanna will change. Ground cover and species composition changes (kinds of trees, shrubs, and grasses).

2. What factors affect moisture availability?

Rainfall and evaporation (which is affected by temperature).

3. What happens to savanna vegetation as moisture availability decreases?

There is less vegetation. It shifts from woodland to bushland to scrubland.

5. How does the changing vegetation affect people's livelihood/land use options?

In the woodland and bushland zone, people can grow crops and keep livestock. As the climate changes and there is less moisture, the vegetation can change to bushland and it becomes much riskier to grow crops, and people may have to rely mainly on livestock. If there is even less moisture, the vegetation can change to scrubland, and even keeping livestock becomes risky.

Even where farmers can still grow crops, the crops they can grow may change depending on moisture availability and the timing of the rainy season, and crops may be less productive.

6. How does changing vegetation fit into the human-land-climate system loop?

Climate change causes higher temperatures and less rainfall. That causes less moisture availability and the vegetation begins to change. When the vegetation changes, people have to change their livelihood systems away from farming to grazing, and then may have to stop using the land altogether.

