SYSTEMS ENRICHMENT EXERCISE

Feedback Loops in the News: Forests and Climate Change

Students use a causal loop diagram to explore feedback loops.

Objectives

After completing this exercise, students will be able to

- explain the difference between balancing and reinforcing feedback,
- identify balancing and reinforcing feedback loops pertaining to forests and climate change, and
- assess claims that increased atmospheric carbon dioxide will be good for forests.

Materials

- Copy of the New York Times article by Justin Gillis and student page for each student, available online at www.nytimes.com/2011/10/01/science/earth/01forest.html?_r=4&hp& or you can access a PDF file at http://sfrc.ufl.edu/extension/ee/climate/systems (under Activity 5)

Introduction

While Activity 5 helps students focus on the dynamics of one forest in response to climatic changes, a *New York Times* article by Justin Gillis[1] explains important feedback loops occurring at the global scale between forests and climate.

Doing the Exercise

1. In this exercise, students practice converting information in paragraph form (in the article) to relationships indicated on a causal loop diagram. The diagram is provided, but it is not complete. Distribute the reading and student page and direct students to label the arrows with S (Same) or O (Opposite) and identify the two feedback loops in the diagram. Remind students that if the two variables increase or decrease in the same direction, they are connected by an S arrow. If they move in opposite directions (one increases while the other decreases), then they should be connected by an O arrow. After completing the diagram, students should answer the discussion questions.

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2. Review the answers with students using the Answer Key. You may need to help students to see the two feedback loops, which are indicated by the circles on the key. They can identify them as reinforcing or balancing loops by the number of O arrows. An even number of O arrows suggests a reinforcing loop. An odd number indicates a balancing loop. (Notice that in this exercise, the larger feedback loop (1) has two O arrows, making it reinforcing, and the smaller loop (2) has one O arrow, making it balancing.)

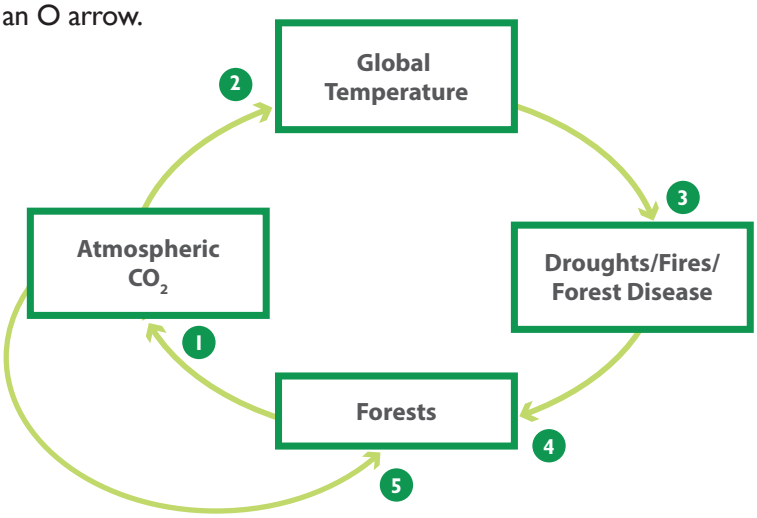
This exercise allows students to explore how factors such as wildfire and drought are related.

[1] http://www.nytimes.com/2011/10/01/science/earth/01forest.html?_r=4&hp&

Feedback Loops in the News: Forests and Climate Change (1 of 3)

NAME DATE

After reading Justin Gillis's *New York Times* article on forests and climate change, label the arrows in the causal loop diagram and cite specific information from the article to support your label for each arrow. Remember to label the arrows with S (Same) or O (Opposite). If the two variables increase or decrease in the same direction, they are connected by an S arrow. If they move in opposite directions (one increases while the other decreases), then they should be connected by an O arrow.



Arrow 1: _____

_____

Arrow 2: _____

_____

Arrow 3: _____

_____

Arrow 4: _____

_____

Arrow 5: _____

_____

Feedback Loop 1: _____

_____

Feedback Loop 2: _____

_____

Feedback Loops in the News: Forests and Climate Change (2 of 3)

1. What specific examples of forests being impacted by climate change does the author provide?

2. The author explains that thinning overgrown forests is one strategy for addressing the stresses of climate change. How would this help forests resist added stresses from climate change?

3. Is the feedback loop from Forest to Atmospheric CO_2 and back to Forests a balancing loop or a reinforcing loop? Explain your answer. On your diagram, label the feedback loop as a reinforcing feedback loop by using the letter "R" or as a balancing feedback loop by using the letter "B."

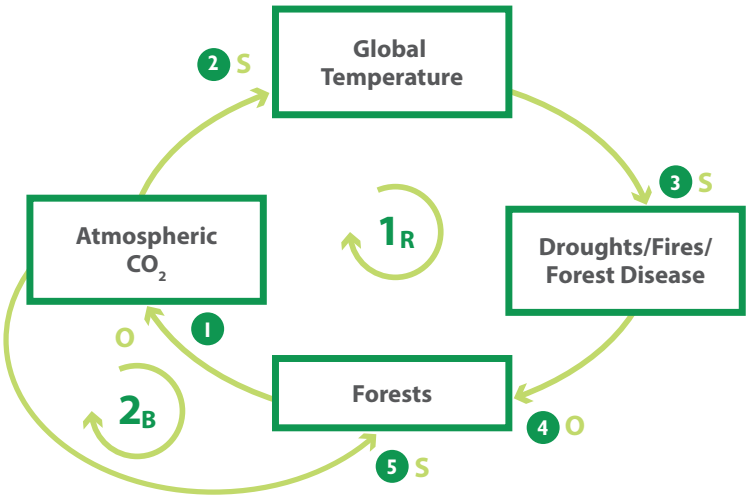
Feedback Loops in the News: Forests and Climate Change (3 of 3)

4. Is the feedback loop from Forests to Atmospheric CO_2 to Global Temperature to Droughts/Fires/Forest Disease a balancing loop or a reinforcing loop? Explain your answer. On your diagram, label the feedback loop as a reinforcing feedback loop by using the letter "R" or as a balancing feedback loop by using the letter "B."

5. Explain how each of the feedback loops would affect forest behavior in response to increased CO_2.

6. When a balancing loop is part of a system, it will help maintain the system, so why are scientists concerned about climate change?

Feedback Loops in the News: Forests and Climate Change (1 of 2)



Note: The paragraphs pointed to here are not the only places in the article where these concepts are covered. Students may identify other similar passages.

Arrow 1 (Opposite): *Page 1: "Scientists have figured out — with the precise numbers deduced only recently — that forests have been absorbing more than a quarter of the carbon dioxide that people are putting into the air by burning fossil fuels and other activities."*

Arrow 2 (Same): *Page 2: "Carbon dioxide is an essential part of the cycle of life on Earth, but geologic history suggests that too much can cause the climate to warm sharply."*

Arrow 3 (Same): *Page 1: The authors list several impacts of climate change, including pests (for example, beetles), fires, and droughts.*

Arrow 4 (Opposite): *Page 2: "Researchers refer to events like these as forest die-offs, and they have begun to document what appears to be a rising pattern of them around the world."*

Arrow 5 (Same): *Page 3: "Climate-change contrarians tend to focus on this 'fertilization effect,' hailing it as a boon for forests and the food supply. 'The ongoing rise of the air's CO_2 content is causing a great greening of the Earth,' one advocate of this position, Craig D. Idso, said at a contrarian meeting in Washington in July."*

Feedback Loop 1: *The loop involving Forests, Atmospheric CO_2, Global Temperature, and Droughts/Fires/Pests is a reinforcing feedback loop. Following this sequence of cause-effect relationships, we can see that a decrease in forests would cause a further decrease in forests. This is the loop that concerns scientists.*

Feedback Loop 2: *The loop involving Forests and Atmospheric CO_2 is a balancing loop. A decrease in forests causes an increase in CO_2, which causes an increase in forest growth. This is the loop that is emphasized by the contrarians mentioned in Gillis's article.*

ANSWER KEY

Feedback Loops in the News: Forests and Climate Change (2 of 2)

1. What specific examples of forests being impacted by climate change does the author provide?

   On page 2, the author includes a quotation by Dr. Thomas Swetnam regarding unusually intense and widespread fires in Siberia and the American Southwest.

2. The author explains that thinning overgrown forests is one strategy for addressing the stresses of climate change. How would this help?

   On page 2, the author explains that thinning overgrown forests reduces the threat of forest fires and disease. [See the description in the Activity 5 slide presentation for more information on this.]

3. Is the feedback loop from Forest to Atmospheric CO_2 and back to Forests a balancing loop or a reinforcing loop? Explain your answer.

   This is a balancing loop. If Forests decrease, then Atmospheric CO_2 increases (Arrow 1 is an Opposite arrow). The increase in Atmospheric CO_2 causes an increase in Forests (Arrow 5 is a Same arrow). This increase in Forests would then cause a decrease in Atmospheric CO_2 (Arrow 1 is an Opposite arrow). In short, within this loop, change in one direction is always met with a balancing change.

4. Is the feedback loop from Forests to Atmospheric CO_2 to Global Temperature to Droughts/Fires/Forest Disease a balancing loop or a reinforcing loop?

   This is a reinforcing loop. A decrease in forest will go around the loop and cause a further decrease in forests. In other words, a small change is reinforced, causing it to become a larger change.

5. Explain how each of the feedback loops would affect forest behavior in response to increased CO_2.

   Feedback Loop 1 would have a reinforcing effect. The added CO_2 would add stress to the forests, resulting in loss of forests and further increase of atmospheric CO_2. Feedback Loop 2 would have a balancing effect. The increased atmospheric CO_2 would increase the growth rates of forests, which would then store more carbon.

6. When a balancing loop is part of a system, it will help maintain the system, so why are scientists concerned about climate change?

   In this causal loop diagram, we have two feedback loops. Change in the forests is part of both loops. Therefore, whether a decreasing forest is balanced or reinforced depends on the relative strength of the two loops and the limitations involved with each loop. Most scientists agree that the reinforcing loop is stronger and has more of an impact than the balancing loop. In other words, it is true that increased CO_2 and other changes, such as increased growing season or increased precipitation, may increase tree growth in some places. However, the loss of forests resulting from additional stresses caused by climate change (fires, drought, insect and disease damage) is likely to have more severe impacts.