

ESA 21: ENVIRONMENTAL SCIENCE EXERCISES

Biogeochemical Cycles: Analysis of Personal Emissions

Capstone Activity

Kyoto Protocols

As we discussed in the first week of this module, the concern over carbon dioxide emission is due to the fact that it is a greenhouse gas. The relationship between the increase in atmospheric CO₂ and the increase in global tropospheric temperatures seems to indicate that mankind's effect has been detrimental. In response to this, international governments throughout the 1990's began discussing ways to remedy the possible harm that has been done. The result of this effort is the Kyoto Protocols. These are an agreement that countries will reduce the amount of greenhouse gasses that they emit in the future by an amount that depends upon the country in question. For the U.S., this treaty would mean that we would have to reduce our carbon dioxide emissions by 2010 to 7% lower than our 1990 levels.



Moving timber on a clearcut site

There are two ways to reduce our net emission of carbon dioxide. One way would be to start limiting how much CO₂ we emit into the atmosphere as we burn fossil fuels. This could be done by replacing fossil fuels with other types of energy sources (wind, nuclear) or by changing our lifestyles so that we did not use so much energy. Incredibly, these two plans of action have met with an extreme amount of resistance. For some reason, the idea of reducing our energy usage or investing in alternative energy are not very popular ideas.

The other method for reducing our net emission of carbon dioxide is to increase the rate at which we absorb it. One proposed method for doing this is to increase the number of trees that a country has. This idea has spawned the concept of *carbon credits*. A country could bring itself into compliance with the Kyoto Protocol by planting enough trees to offset the amount of carbon dioxide that it emitted above its stated levels. Or, if the country could not plant enough trees to meet this level, it could buy credits from a country that did have enough excess trees to consume the additional carbon dioxide. Some countries (the US amongst them) see this as a definite win-win situation. It will allow developed countries to continue to emit carbon dioxide at current rates (and even higher). At the same time, it will give developing countries an opportunity to earn money without replacing forests for industrial or range land.

Carbon Credits Problems

Carbon credits seem like a great way to help both developing and developed countries. However, critics claim that using them might have unintended consequences. To understand why this might be so, let us review what we have learned over the last several weeks.

The main idea behind carbon credits is that trees are a sink for carbon dioxide. As we saw in last week's lab, plants photosynthesize more carbon dioxide out of the air than they respire back into it while they are alive. However, once a plant dies, organisms begin to break down the plant, respiring the sugars stored in it back into the atmosphere as carbon dioxide. Thus, if a tree is allowed to go through its natural stages of seed to sapling to mature tree to a dead tree that becomes nutrients for new trees, then no carbon dioxide is being stored, i.e. trees in a natural forest are a zero sum factor in removing carbon dioxide.



Forests as Carbon Sinks

Of course, there is a way to make trees be a positive force in carbon dioxide removal: do not let the trees decay back into the soil. This can be achieved by cutting down the mature trees before they die and using as much of the tree as can be used for lumber or some other commodity that does not allow the carbon to be respired. This is what causes some of these critics to make their claim. The economics of the situation will cause developing countries to cut down their natural forests in favor of tree farms, since in is only in this type of forest that carbon is actually being positively sequestered. They also fear that the tree farms that are created will be of non-indigenous species. A fast-growing tree, such as eucalyptus, will sequester carbon at a greater rate than most native species, and thus, allow the grower to claim a larger carbon credit. If this tree is cut before it can decay and used as lumber, then the grower will get more money for its carbon credit, as well as getting money for using the tree as lumber. For a cash strapped developing country, the economic incentive will not be to preserve the native forest, but to use the land for growing lumber of non-native species and getting carbon credit dollars, to boot.

As it currently stands, the U.S. has decided against signing the Kyoto Protocols (although we did sign a non-binding agreement in 1992 that said that we would lower greenhouse gas emissions). This decision by the Bush Administration has angered many countries, who see the absence of the US in this agreement effectively making it a worthless document.

Capstone Activity Instructions

For this module's Capstone Activity, we will be examining the idea of Carbon Credits. In the first two weeks of this laboratory module you saw how vegetation can sequester carbon in its tissues, and how the processes of photosynthesis and respiration affect the cycling of carbon dioxide. By integrating these activities with this week's calculator exercise, you will determine the number of trees that would be needed to offset your personal carbon dioxide emissions. Complete the activities and questions on the Capstone Activity sheet.

ESA 21: Environmental Science Activities

Name:

Professor:

Individual Impacts

In the first exercise in this module you used allometric equations to determine the amount of carbon dioxide that can be sequestered in the biomass of a typical forest in our area. Let's now look at how many trees it would take to sequester your annual carbon dioxide emissions.

First, enter your annual carbon emissions from the personal _____ lbs.
impact calculator (total emissions before making any changes).

(a.) It is estimated that one acre of forest can remove and store _____ acres
about 19,000 lbs of carbon dioxide from the atmosphere each
year¹. How many acres of forest would be needed to absorb
your annual emissions of CO₂?

(b.) If you were to drive a hybrid vehicle instead of your current _____ acres
vehicle, how many acres of forest would be needed to absorb
your CO₂ emissions? Use the CO₂ emissions value you obtained
after making the change to a hybrid vehicle in exercise 3.

If Everyone Lived As You Do:

While an individual's environmental impacts might seem reasonable, this often changes once you multiply these effects by a large number of people. Let's expand our analysis to address the number of people impacting the environment from KSU and Cobb County.

(a.) Kennesaw State University currently enrolls about 16,000 _____ acres
students. If all KSU students had the same annual CO₂
emissions as you, how many acres of forest would be needed to
sequester these outputs?

(b.) The Kennesaw State University Main Campus is 183 acres in _____ forests
area². How many forests the size of the KSU campus would be
needed to store the CO₂ emissions from KSU's students?

(c.) Cobb County had a population of 607,751 people according _____ acres
to the 2000 U.S. Census³. Census figures also show that 73.9%
of the population was 18 years old or older, making the adult
population of the County 449,128. If all the adults in Cobb
County had emissions like you, how many acres of forest would
be needed to sequester these outputs?

(d.) Cobb County contains 217,728 acres of land area. How _____ forests
many forests the size of Cobb County would it take to sequester
the County's annual emissions if everyone lived like you do?

(e.) How many County-sized forests would be needed if everyone _____ forests
switched to hybrid vehicles?

Analysis:

Did you find the amount of forest required to store your annual CO₂ emissions surprising? Explain your answer.

After performing these analyses, do you feel that reforestation efforts alone are an effective method for combating global warming, or will reductions in CO₂ emissions also be necessary? Explain your answer, citing the land areas of forests needed to sequester the outputs of the KSU student population and Cobb County you determined in this activity.

References:

- ¹<http://www.forestry.uga.edu/warnell/service/library/for96-039/>
- ²http://www.kennesaw.edu/inst_res/factbook/2001factbook/index.shtml
- ³<http://quickfacts.census.gov/qfd/states/13/13067.html>