



ESA21

Environmental Science Activities for the 21st Century

Biogeochemical Cycles: Capstone

Capstone Activity

Carbon Credits and Climate Agreements

As we discussed in the first week of this module, the concern over carbon dioxide emission is because CO_2 is a greenhouse gas that traps heat in Earth's atmosphere. The relationship between the increase in atmospheric CO_2 and the increase in global tropospheric temperatures indicates that humanity's effects on Earth's climate have been detrimental. In response to this, international governments throughout the 1990's began discussing ways to remedy the possible harm that has been done. Results of this effort are the Kyoto Protocol and, more recently, the Paris Agreement in which nations around the world pledged to reduce their emissions of greenhouse gases. The overarching goal of the Paris Agreement, for example, is to implement a diversity of approaches that will act to limit temperature increases on Earth to 2°C (3.6°F) above pre-industrial temperatures on our planet.



Fig. 1: Modern clear cutting operation

There are two ways to reduce our net emission of heat-trapping carbon dioxide and attempt to fulfill the goals of the Paris agreement. One way would be to start limiting how much CO_2 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 in many nations.

The other method for reducing our net emission of carbon dioxide is to increase the rate at which we absorb it from the atmosphere. One proposed method for doing this is to increase the number of trees that are in a given country. This idea has spawned the concept of *carbon credits*. A country could bring itself into compliance with climate agreements by planting enough trees to offset the amount of carbon dioxide that it emitted above its stated levels. Or, if the nation could not plant enough trees to meet this level, it could buy credits from a country that had enough trees to absorb its own emissions of carbon dioxide and still have "tree credits" left over for other nations to purchase. Some countries (the U.S. amongst them) see this as a definite win-win situation. It allows industrialized countries to continue to emit carbon dioxide at current rates (and even higher) while purchasing forest credits from other nations. At the same time, it will give industrializing countries an opportunity to earn money by keeping intact large expanses of forest.

Carbon Credits

Problems

Carbon credits seem like a great way to help both industrialized and industrializing 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. 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, putting 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 – that is, trees in a natural forest are a zero sum factor in removing carbon dioxide.

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 possible for lumber or some other commodity. This is what causes some of these critics to make their claim. The economics of the situation will cause industrializing countries to cut down their natural forests in favor of tree farms, since it 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 to be used as lumber, then the grower will get more money for its carbon credit, as well as getting money for the lumber. For a cash-strapped industrializing country, critics contend, 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.

Capstone Activity

Instructions

For this module's Capstone Activity, we will be examining the idea of using Carbon Credits to offset carbon emissions in modern America. 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 the [carbon dioxide calculator exercise](#), you will determine the number of trees that would be needed to offset your personal carbon dioxide emissions and determine if this is a practical approach to embrace in the United States. Complete the activities and questions on the Capstone Activity sheet.

ESA 21: Environmental Science Activities

Biogeochemical Cycling
Capstone Activity Sheet

Name:

Instructor:

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 an average acre of forest in the United _____ acres
States can remove and store 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 your campus and county. To do this, we will need to know how many people go to your institution, how large your institution is in acres, how many people live in your county, and how big your county is in acres. The first two sets of data can either be provided by your instructor or found from your institution's website. The latter two pieces of data can be found from the U.S. Census Bureau website or other online databases (Note: there are 640 acres to a square mile).

Number of students on campus = _____ Size of campus in acres = _____

Number of people in county = _____ Size of county in acres = _____

(a.) If all the students on your campus had the same annual CO₂ _____ acres
emissions as you, how many acres of forest would be needed to
sequester these outputs?

(b.) How many forests the size of your campus would be needed _____ forests
to store the CO₂ emissions from its students?

(c.) If all the citizens of your county had emissions like you, how _____ acres
many acres of forest would be needed to sequester these
outputs?

(d.) How many forests the size of your county would it take to sequester the county's annual emissions if everyone lived like you do? _____ forests

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

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 student population at your institution and your county.

References:

¹<http://www.forestry.uga.edu/warnell/service/library/for96-039/>