

# ESA21

## Environmental Science Activities for the 21st Century

### Biogeochemical Cycles: Capstone

#### 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 CO<sub>2</sub> 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.



**Fig. 1: Modern clear cutting operation**

There are two ways to reduce our net emission of carbon dioxide. One way would be to start limiting how much CO<sub>2</sub> 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 is 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 rangeland.



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**Topic:** Forest Credits and the Kyoto Protocol

**Date:** November 17, 2000

**Summary:** One of the biggest debates emerging from the global warming treaty discussions taking place in the Hague is whether or not the terms of the 1997 Kyoto Climate Change protocol will allow the U.S. to meet most of its obligations by planting or preserving forests that suck up carbon dioxide. As NPR's John Nielsen reports, delegates from Europe and elsewhere are determined that nothing of the kind should happen. (<http://www.npr.org>). (5:00)

**Link:**

<http://www.npr.org/templates/dmg/dmg.php?prgCode=ATC&showDate=17-Nov-2000&segNum=15&NPRMediaPref=RAM>

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|  <p><a href="#">Listen</a><br/>Requires RealPlayer</p> | <p><b>Topic:</b> Trees and Global Warming<br/> <b>Date:</b> November 9, 2000<br/> <b>Summary:</b> NPR's Richard Harris reports on new research that both illuminates and further complicates the picture of how the Earth is warming. It's long been thought that forests mitigate the warming effect of the earth, and that as the amount of carbon in the atmosphere grows, more trees will grow. But this built-in braking system on warming may not take place. More trees cause the earth to reflect less solar radiation and absorb more. The findings make calculating future temperatures even more complicated (<a href="http://www.npr.org">http://www.npr.org</a>). (4:30)<br/> <b>Link:</b> <a href="http://www.npr.org/ramfiles/atc/20001109.atc.04.ram">http://www.npr.org/ramfiles/atc/20001109.atc.04.ram</a></p> |
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## 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. 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, i.e. 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 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, which see the absence of the U.S. 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 the [carbon dioxide 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

Biogeochemical Cycling  
Capstone Activity Sheet

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 impact calculator (total emissions before making any changes). \_\_\_\_\_ lbs.

(a.) It is estimated that one acre of forest can remove and store about 19,000 lbs of carbon dioxide from the atmosphere each year<sup>1</sup>. How many acres of forest would be needed to absorb your annual emissions of CO<sub>2</sub>? \_\_\_\_\_ acres

(b.) If you were to drive a hybrid vehicle instead of your current vehicle, how many acres of forest would be needed to absorb your CO<sub>2</sub> emissions? Use the CO<sub>2</sub> emissions value you obtained after making the change to a hybrid vehicle in exercise 3. \_\_\_\_\_ acres

## 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](http://www.census.gov) by clicking on the appropriate state and county (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 CO<sub>2</sub> emissions as you, how many acres of forest would be needed to sequester these outputs? \_\_\_\_\_ acres

(b.) How many forests the size of your campus would be needed to store the CO<sub>2</sub> emissions from its students? \_\_\_\_\_ forests

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

(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 CO<sub>2</sub> 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 CO<sub>2</sub> 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:**

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