Future Fuels from Forests Teaching Unit for Gr. 10-12 Earth Science

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Table of Contents

Future Fuels from Forests Teacher Institute

Target grade & Subject: Gr. 10-12; Earth Science

Unit Overview:
Predicting and mitigating the potential impact of global climate change requires an understanding of the mechanisms of Earth's climate (HSSCE Companion Document 2007). This unit is designed to assist students in their ability to use this knowledge to understand the need to make fuels that are sustainable and thereby stabilizing or even reducing the recent escalation of human induced greenhouse gases. Topics to be covered in this unit include 1) the carbon cycle, 2) how the movement of carbon can benefit or harm society with an emphasis on the growing interest in grain and cellulosic ethanol, 3) critiquing arguments about personal or societal issues based on scientific evidence, and 4) investigating the changes over the past 50 years in the use, distribution, and the importance of natural resources on human life. Students will accomplish these goals by describing and evaluating changes in spatial distribution and use of natural resources (biomass), and the social and environmental consequences of development, distribution, and use of natural resources such as biomass (HSSSCE 2007).

Goals:
- Explain the carbon cycle and how it relates to biofuels
- Explain how human interactions with carbon benefit and harm society
- Critique the efficacy of grain & cellulosic ethanol based on scientific evidence
- Investigate changes in the use, distribution, and importance of natural resources such as grains and woody biomass

Sources Consulted

High School Science & Social Studies Content Expectations 2007
Power point presentations found on the Future Fuels CD 2008
Variety of websites – all URLs are found in each section
Flaspohler, David, Chris Webster, and Robert Froese. *In press*. Ch. 7 Bioenergy, Biomass and Biodiversity. In: Renewable Energy from Forest Resources in the U.S.; Solomon, B.D. and V. A. Luzadis, eds., Routledge.
U.S. Dept of Energy. (2006). *Breaking the Biological Barriers to Cellulosic Ethanol: A Joint Research Agenda* resulting form the Biomass to Biofuels Workshop, Dec. 7-9, 2005, Rockville, MD.

Learning Objectives
Students will be able to:
1. Draw and explain how carbon cycles through the four earth systems
2. Explain how human use of carbon can benefit or harm society
3. Use scientific evidence to defend whether grain (corn) or cellulosic ethanol is more sustainable
4. Use maps and photographs of Michigan to determine how the use and distribution of natural resources has changed
5. Design and implement a community survey to determine local views regarding natural resources

Michigan State Content Curriculum Addressed [E=Earth Science, C=Chemistry, CG=Contemporary Global Issues (Social Studies)]:

E2.3d Explain how carbon moves through The Earth system (including the geosphere) and how it may benefit or harm society

E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another

C1.2B Identify and critique arguments about personal or societal issues based on scientific evidence

CG2 Explain the changes over the past 50 years in the use, distribution, and importance of natural resources on human life by describing and evaluating changes in spatial distribution and use of natural resources, and the social and environmental consequences of development, distribution, and use of natural resources

4 Blocks (80 minutes each) of Classroom or Field Activities:

Block 1: THE CARBON CYCLE

Learning Objectives 1 & 2

10 minutes
Warm-up:

Students will read the article called "Understanding the Global Carbon Cycle" (found at http://www.whrc.org/carbon/index.htm). The article has been modified so that students need to fill in the missing words to the best of their ability (use of prior knowledge or inference). A teacher page with answers has been provided.

Teachers should collect the warm-up. This article should be used by teachers to assess background information that students have regarding the carbon cycle. Also, this same article can be given at the end of the unit as an un-graded post-assessment for the purpose of showing students how they have made gains in understanding the global carbon cycle.

15 minutes
Lecture:

Using the Power point provided by Maria Janowiak, teach about the reality of climate change, what the carbon cycle is, and the carbon budget. The teacher needs to provide a complete definition for climate change before the Power point and emphasis should be placed on how carbon cycles through ALL 4 SYSTEMS (emphasis given by teacher during the lecture – not in Power point).

Students should be given the student handout "Bioenergy and Biofuels: A low Carbon Response to Climate Change?" as a way of taking notes and following along

during the lecture (a quiz over the material will occur during the next block). Also, students should be given a color copy of the poster called "The Carbon Cycle" from The Forest Foundation (www.calforestfoundation.org or 800-241-TREE) to help study the carbon cycle on their own.

55 minutes
Activity

Students should be placed into groups of 4-6 to write and perform a song dedicated to the carbon cycle. The tune used should be a commonly recognized tune such as "Twinkle, Twinkle Little Star," "Happy Birthday," etc. Students should be given approximately 35-40 minutes to creatively write lyrics about all or part of the carbon cycle. The song should be at least 3 verses long – each verse about a different aspect of the carbon cycle such as human impact/fossil fuels, nature's impact (like volcanism), plant/animal interactions, or the ocean's contribution to the carbon cycle. The remaining 15-20 minutes will be for performance time. Encourage students to use their hands as instruments or to make instruments from items found in the classroom. A rubric has been attached to evaluate this activity.

Block 2: BIOFUELS – GRAIN VS. CELLULOSIC ETHANOL

Learning Objective 3

5 minutes – Warm-up

List as many foods as you can think of that contain corn
List as many foods as you can think of that contain wood or grass

10 minutes – Assessment from yesterday's lecture

Quiz on Bioenergy and Biofuels

10 minutes – rules for debate of GRAIN VS. CELLULOSIC ETHANOL

Include how the debate will be conducted and what a debate is NOT (a way to insult people, etc)

1. The debate is 20 minutes: I suggest giving each team 5 minutes to make their argument, 3 minutes for rebuttal and 2 minutes for closing statements
2. Additional information on debates for classrooms can be found at http://www.educationworld.com/a_lesson/lesson/lesson304b.shtml

25 minutes – research

Students should be given the following articles to use as resources for the debate

1. Power point from Future Fuels by Marilyn Shy (Biomass Utilization and Restoration Network in the UP: BURN-UP!
2. Power point from Future Fuels by Kurt Thelen (Biofuels and the Bioeconomy in Michigan)
3. Searchinger, Timothy, et al. (2008). Use of U.S. Croplands for Biofuels Increases Greenhouse gases Through Emissions from Land use Change. www.scienceexpress.org

4. Fargione, Joseph, et al. (2008). Land Clearing and the Biofuel Carbon Debt. www.scienceexpress.org
5. Flaspohler, David, Chris Webster, and Robert Froese. *In press*. Ch. 7 Bioenergy, Biomass and Biodiversity. In: Renewable Energy from Forest Resources in the U.S.; Solomon, B.D. and V. A. Luzadis, eds., Routledge.
6. U.S. Dept of Energy. (2006). *Breaking the Biological Barriers to Cellulosic Ethanol: A Joint Research Agenda* resulting form the Biomass to Biofuels Workshop, Dec. 7-9, 2005, Rockville, MD.
7. Response to New Fuels Alliance and DOE Analysts Criticisms of Science Studies of Greenhouse Gases and Biofuels. http://www.princeton.edu/~tsearchi/writings/Response_to_Criticisms_of_New_Biofuel_Studies.pdf
8. US Corn Ethanol Plants Show Efficiency Gains Since 2001 http://www.greencarcongress.com/2008/04/us-corn-ethanol.html
9. Corn Ethanol's Greenhouse Gas Emission Reduction Better Than Thought, New Study Shows http://www.treehugger.com/files/2009/01/corn-ethanol-greenhouse-gas-emissions-reductions-better-than-previous-estimates.php

20 minutes – Debate

10 minutes – Journaling

Students should record in a journal 1) what they learned about the topic, 2) what they learned from the opposing side, and 3) what they learned about the use of scientific information to make a reasoned argument.

Blocks 3 – 4: SOCIETY AND NATURAL RESOURCES

Learning Objectives 4 & 5

BLOCK 3

10 minutes – Warm-up

In a journal, students should answer the question "How has your house or neighborhood/area in which you live changed in the last year and in the last 5 years?"

40 minutes – Student research

1. Students should go online to find images of Michigan's natural resources, both present and in the past
2. Each student or group of students should be given a specific natural resource to investigate. A brief list of natural resources is found below:
    a. Lake levels
    b. Forested areas
    c. Bird migration patterns
    d. Active oil extraction sites
    e. Agricultural land
    f. Animal population changes (frogs, fish, etc.)
    g. Sand dune changes

3. Assessment:
    a. Based on the maps/photos found, students should prepare a poster showing how the distribution and use of the natural resource has changed. A rubric for the poster is attached.

30 minutes – What is a Survey?

1. Students will learn about various types of survey questions. You will need to review the information at the website: http://www.readwritethink.org/lessons/lesson_view.asp?id=1084 to learn about writing surveys.
    a. An example survey can be found at http://edweb.sdsu.edu/courses/ed791b/TritonPatternsSurvey.pdf
2. Students will get into groups of 3-5 and write practice survey questions for a particular natural resource such as ”Should carbon dioxide be sequestered underground?” or “Should wetlands be developed?” Using a question relevant to the area in which you live or the school is found would be best.
3. Students could use the form found at http://www.docstoc.com/docs/2563015/How-To-Write-A-Good-Survey-Questionnaire as a guide for writing survey questions.

BLOCK 4

5 minutes – Warm-up

Describe three characteristics of a good survey question.

10 minutes – Review survey writing info

20 minutes – Peer critiquing

Students exchange questions made on the previous day and critique them using the forms found at the websites list in BLOCK 3

15 minutes – Group review

As a class, each group will identify a good survey question and given a reason why it was classified as such.

30 minutes – Making a survey

1. Students should re-exchange questions and design and write a 5-10 question survey on the topic question.
2. Assessment: Students should implement their survey. Rubric for assessing survey is attached.

Unit Assessment:

Carbon Cycle Song
Quiz: Bioenergy and Biofuels
Poster on natural resource changes
Survey

Fill in the missing information to the best of your ability.

Use prior knowledge and inference to assist you.

Understanding the Global Carbon Cycle

We (ecologists) have been interested in carbon for a long time, first, because carbon is what we (as well as all of the other _____ and animals on earth) are made of (_____% of our dry weight). Ecologists can learn a lot about ecosystems and what they do for us by constructing _____ budgets (or energy budgets) from measurements of productivity, food chains, and nutrient cycling.

The second reason that carbon is of interest is because carbon, in the form of _____, is the major greenhouse gas released to the atmosphere as a result of _____ activities. The continued release of greenhouse gases is _____ the temperature of the earth, disrupting the _____ we and our agricultural systems depend on, and raising sea-level. The concentration of CO_2 in the atmosphere has already increased by about _____% since the start of the industrial revolution sometime around the middle of the 19th century and will continue to increase unless societies choose to change their ways.

Most of the increase in atmospheric CO_2 concentrations came from and will continue to come from the use of fossil fuels (_____,_____, and _____) for energy, but about 25% of the increase over the last 150 years came from **changes** _____ for example, the clearing of forests and the cultivation of soils for food production [Figure 1].

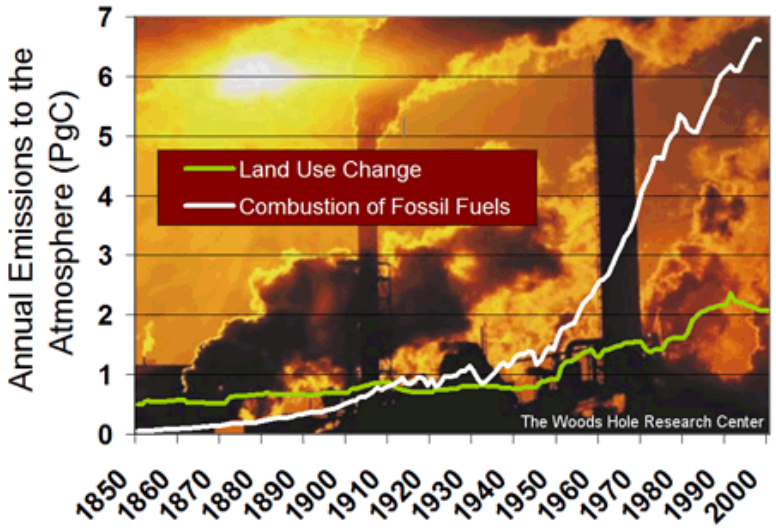


Figure 1

The global carbon cycle involves the earth's _____, fossil fuels, the _____, and the vegetation and _____ of the earth's terrestrial ecosystems [Figure 2].

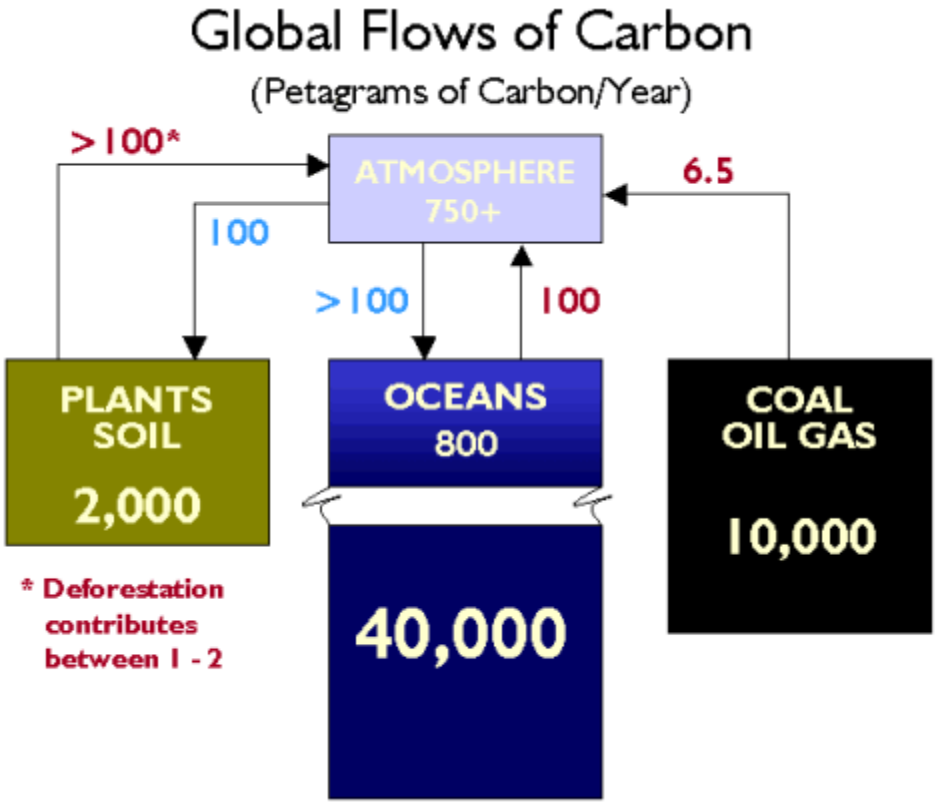


Figure 2

We at the Woods Hole Research Center are involved with determining the role terrestrial ecosystems play in the global carbon cycle. Each year the world's terrestrial ecosystems withdraw carbon from the atmosphere through _____ and add it again through respiration and _____. The withdrawals and additions of carbon can be seen in the regular seasonal oscillation of CO_2 concentrations in the atmosphere.

If the global totals for photosynthesis and respiration are not equal, carbon either accumulates on _____ or is released to the _____. Unfortunately, the global rates of photosynthesis and respiration are neither known nor measured well enough to determine annual changes in carbon storage. On the other hand, human use of the land, for example the clearing of forests for croplands, is relatively well documented, both historically and with _____, and thus can be used to determine changes in the storage of carbon.

Research at the Center has focused on the current and historic releases of carbon that result from changes in land use. The approach we use is based on the fact that much of the carbon stored in trees and soils is released to the atmosphere when forests are cleared and cultivated. Some of the release occurs rapidly with _____; some of it occurs slowly as dead plant material _____. When forests re-grow on cleared land, they withdraw carbon from the atmosphere and store it again in trees and soils. The difference between the total amount of carbon released to the atmosphere and the total amount withdrawn from the atmosphere determines whether the land is a net source or sink for atmospheric carbon. Our approach is thus based on two types of data: rates of land-use change (e.g., annual rates of deforestation) and the changes in carbon that follow changes in land use.

Our work shows that between 1850 and 2000 about 155 Pg of carbon were released to the atmosphere from changes in land use, worldwide (one Pg [petagram]=one billion metric tonnes=1000 x one billion kg). The amount released each year generally increased over the period, and by the 1990s the rate of release averaged about 2 Pg of carbon per year.

When considered with the other terms in the global carbon equation (the atmosphere, fossil fuels, and the oceans), there is an apparent imbalance in the global accounting, and considerable effort has gone into explaining and finding this residual sink, or **missing sink**, of carbon.

Atmospheric increase	=	Emissions from fossil fuels	+	Net emissions from changes in land use	-	Oceanic uptake	-	Missing carbon sink
3.2 (±0.2)	=	6.3 (±0.4)	+	2.2 (±0.8)	-	2.4 (±0.7)	-	2.9 (±1.1)

Concern about the consequences of a changing climate has led us to explore how forests might be used to withdraw carbon from the atmosphere. They have a significant potential for reducing the rate at which carbon builds up in the atmosphere, but the major contributor to climatic change, and hence the human activity most in need of change, is use of _____ for energy. Advances in the technology of renewable energy sources, including _____fuels, might reduce our reliance on fossil fuels and thus reduce global emissions of carbon dioxide significantly.

(Modified from http://www.whrc.org/carbon/index.htm)

Original article written by: Richard Houghton, Senior Scientist, Carbon Research

Fill in the missing information to the best of your ability.

Use prior knowledge and inference to assist you.

Understanding the Global Carbon Cycle

We (ecologists) have been interested in carbon for a long time, first, because carbon is what we (as well as all of the other ____PLANTS_____ and animals on earth) are made of (__50_% of our dry weight). Ecologists can learn a lot about ecosystems and what they do for us by constructing ____CARBON_____ budgets (or energy budgets) from measurements of productivity, food chains, and nutrient cycling.

The second reason that carbon is of interest is because carbon, in the form of ____CARBON DIOXIDE_____, is the major greenhouse gas released to the atmosphere as a result of ____HUMAN_____ activities. The continued release of greenhouse gases is __RAISING_____ the temperature of the earth, disrupting the ____CLIMATE_____ we and our agricultural systems depend on, and raising sea-level. The concentration of CO_2 in the atmosphere has already increased by about _30__% since the start of the industrial revolution sometime around the middle of the 19th century and will continue to increase unless societies choose to change their ways.

Most of the increase in atmospheric CO_2 concentrations came from and will continue to come from the use of fossil fuels (____COAL_____,____OIL_____, and ___NATURAL GAS_____) for energy, but about 25% of the increase over the last 150 years came from **changes** _____IN LAND USE_____ for example, the clearing of forests and the cultivation of soils for food production [Figure 1].

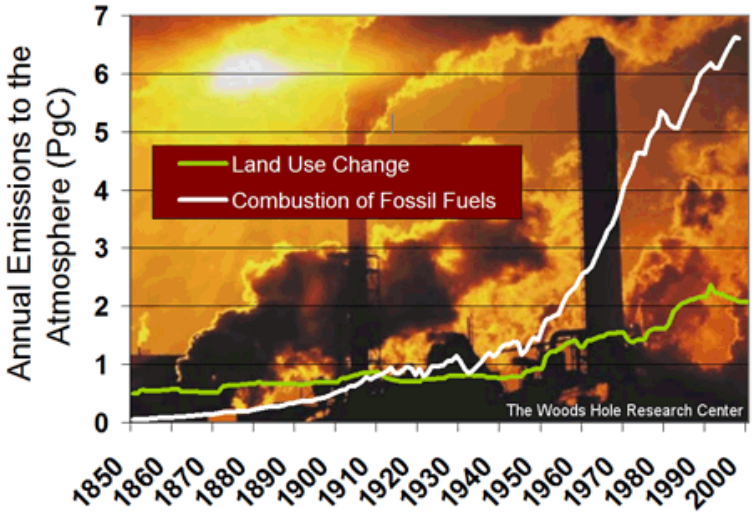
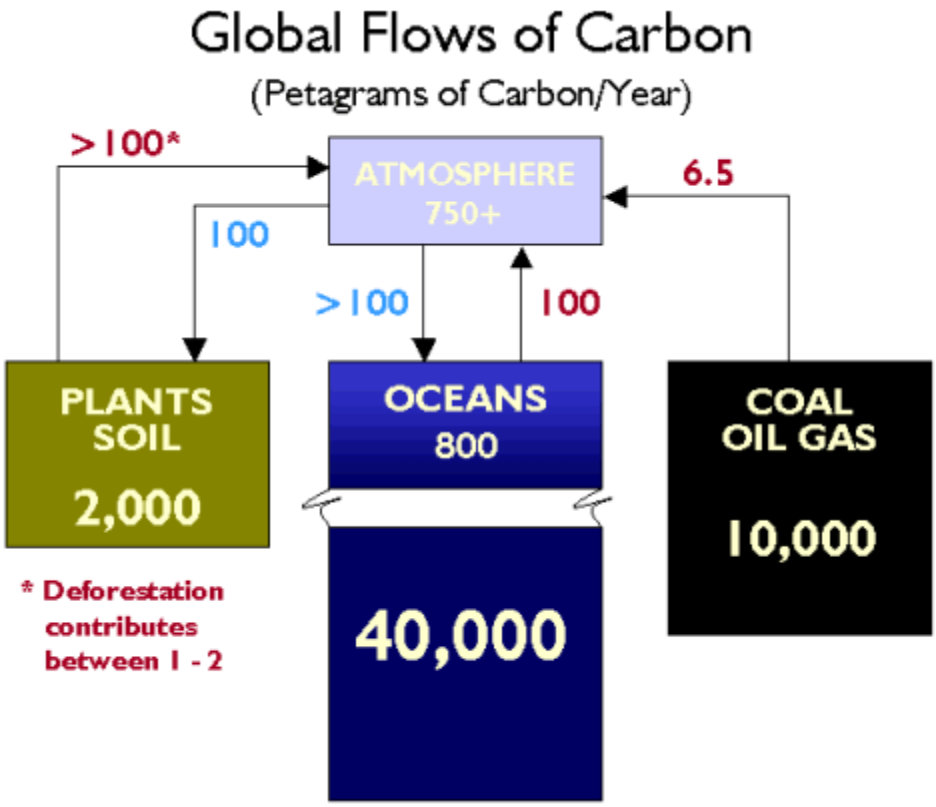


Figure 1

The global carbon cycle involves the earth's _____ATMOSPHERE_____, fossil fuels, the ___OCEANS_____, and the vegetation and ____SOILS_____ of the earth's terrestrial ecosystems [Figure 2].



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If the global totals for photosynthesis and respiration are not equal, carbon either accumulates on __LAND_____ or is released to the ____ATMOSPHERE_____. Unfortunately, the global rates of photosynthesis and respiration are neither known nor measured well enough to determine annual changes in carbon storage. On the other hand, human use of the land, for example the clearing of forests for croplands, is relatively well documented, both historically and with _____SATELLITES_____, and thus can be used to determine changes in the storage of carbon.

Research at the Center has focused on the current and historic releases of carbon that result from changes in land use. The approach we use is based on the fact that much of the carbon stored in trees and soils is released to the atmosphere when forests are cleared and cultivated. Some of the release occurs rapidly with _____BURNING_____; some of it occurs slowly as dead plant material _____DECOMPOSITION_____. When forests re-grow on cleared land, they withdraw carbon from the atmosphere and store it again in trees and soils. The difference between the total amount of carbon released to the atmosphere and the total amount withdrawn from the atmosphere determines whether the land is a net source or sink for atmospheric carbon. Our approach is thus based on two types of data: rates of land-use change (e.g., annual rates of deforestation) and the changes in carbon that follow changes in land use.

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(Modified from http://www.whrc.org/carbon/index.htm)

Original article written by: Richard Houghton, Senior Scientist, Carbon Research

BIOENERGY AND BIOFUELS QUIZ

Multiple choice. Write the letter of the correct answer on the blank provided (1 pt ea)

_____ 1. How are GHGs measured?

a. by the mole
b. by the pound
c. by metric ton CO_2 equivalents
d. by kilograms

_____ 2. Which of the following energy sources is the most damaging to our global environment?

a. fossil fuels
b. solar energy
c. biofuels
d. Hydroelectric

_____ 3. The ocean is a major reservoir of which atmospheric gas?

a. carbon dioxide
b. oxygen
c. ozone
d. nitrous oxide

_____ 4. Carbon exists in many different forms on earth, which form is the most harmful to humans in light of climate change?

a. limestone
b. carbon dioxide
c. carbon monoxide
d. coal

_____ 5. Which of the GHGs blocks UV radiation in the stratosphere, and is considered a pollutant in the troposphere?

a. carbon dioxide
b. methane
c. ozone
d. nitrous oxide

_____ 6. Long term climate changes can occur from changes in the amount of sunlight received by the earth. Which of the following would affect our sunlight the most?

a. earthquake
b. volcanic eruption
c. tornado
d. hurricane

_____ 7. Over the past two centuries, carbon dioxide levels in the atmosphere have steadily increased. Which of the following help to lower the levels of carbon dioxide?

a. using petroleum to produce energy
b. afforestation
c. using natural gas to produce energy
d. deforestation

_____ 8. Which GHGs have been banned by most countries?

a. methane
b. water vapor
c. fluorocarbons
d. carbon dioxide

_____ 9. What percentage of US GHG do US forests sequester?

a. 5%
b. 10%
c. 25%
d. 50%

_____10. How is CO_2 sequestered?

a. in the soil as down dead wood
b. in the plants as leaves or roots
c. as plants release it into the air
d. in the soil and plants

Short answer (1 point each)

11. Write a definition for climate change.

12. How are CO_2 emissions from biofuels different from those released by fossil fuels?

Labeling (1 point each)

Teachers will need to supply either the carbon cycle or carbon budget diagrams for this portion of the quiz.

Lecture Notes

BIOENERGY & BIOFUELS:
A LOW-CARBON RESPONSE TO CLIMATE CHANGE

1. What is climate change?

2. What is the principle cause of climate change?

3. What are Greenhouse Gases (GHG)?

4. List 6 GHG.

5. How are GHG measured? WHY?

6. Using the attached carbon cycle diagram, fill in the missing blanks.
7. How is CO_2 removed from the ATMOSPHERE?

8. How is CO_2 sequestered (stored) in the BIOSPHERE?

9. How is CO_2 sequestered in the GEOSPHERE?

10. Using the attached Carbon Cycle and Budget, fill in the missing blanks
11. What percentage of US GHG do US forests sequester?

12. What is mitigation?

13. What are the two categories that forest mitigation usually falls into?

14. What is the goal of forest carbon sequestration?

15. What are three ways to attain this goal?

16. How can we increase Carbon stored in forests?

17. How are CO_2 emissions from biofuels different from those released by fossil fuels?

Lecture Notes – Teacher Page

BIOENERGY & BIOFUELS:
A LOW-CARBON RESPONSE TO CLIMATE CHANGE

18. What is climate change?
    a. Observed increases in global temperature and changes in other climate variables (Power point)
    b. Significant change in the mean values of meteorological elements (especially temperature and precipitation) in the course of a certain period of time [definition from Arctic Climatology and Meteorology glossary at http://nsidc.org/arcticmet/glossary/climate_change.html]
    c. Refers to any significant changed in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). [definition from EPA at www.epa.gov/climatechange/glossary.html#C]
19. What is the principle cause of climate change?
    a. Increased levels of GHGs in the atmosphere (Power point)
    b. Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun; natural processes within the climate system (e.g. ocean circulation); human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.) [definition from EPA at www.epa.gov/climatechange/glossary.html#C]
20. What are Greenhouse Gases (GHG)?
    a. Any gas that absorbs infrared radiation in the atmosphere
21. List 6 GHG.
    a. Carbon dioxide (CO_2)
    b. Methane (CH_4)
    c. Nitrous oxide (N_2O)
    d. Hydrofluorocarbons (HFCs) – banned by most countries
    e. Perfluorocarbons (PFCs) – banned by most countries
    f. Sulfur hexafluoride (SF_6)
    g. Others include: water vapor (H_2O), ozone (O_3) – protects us from UV radiation in the stratosphere, but is harmful to humans in the troposphere, chlorofluorocarbons (CFCs) – banned by most countries
22. How are GHG measured? WHY?
    a. Metric tons of CO_2 equivalent (CO_2e)
    b. Measured this way so that we can easily compare GHG's impact on the environment to that of CO_2.
23. Using the attached carbon cycle diagram, fill in the missing blanks.
    a. Use the diagram of the Carbon Cycle found courtesy of NASA at http://earthobservatory.nasa.gov/Library/CarbonCycle/carbon_cycle4.html
    b. You will need to make a fill in the blank copy per your discretion
24. How is CO_2 removed from the ATMOSPHERE?
    a. Plants absorb it during photosynthesis
25. How is CO_2 sequestered (stored) in the BIOSPHERE?
    a. Sequestered in plant tissues such as in leaves, wood, and roots
26. How is CO_2 sequestered in the GEOSPHERE?

    a. Sequestered in the soil as down dead wood
27. Using the attached Carbon Cycle and Budget, fill in the missing blanks
    a. You will need to print a copy of the image from the power point slide and make a fill in the blank copy per your discretion
28. What percentage of US GHG do US forests sequester?
    a. 10%
29. What is mitigation?
    a. Perform actions that decrease “sources” and increase “sinks” of GHGs to slow, stop, or reverse the buildup of emissions and minimize the effects/extent of climate change
30. What are the two categories that forest mitigation usually falls into?
    a. Carbon sequestration
    b. Bionenergy
31. What is the goal of forest carbon sequestration?
    a. Increase carbon stored in forests/wood
32. What are three ways to attain this goal?
    a. Afforestation (plant trees)
    b. Avoid deforestation
    c. Forest management
33. How can we increase Carbon stored in forests?
    a. Afforestation – by planting trees!
34. How are CO_2 emissions from biofuels different from those released by fossil fuels?
    a. Emissions from biofuels are minimal if vegetation growth is maintained
    b. Emission cycle back into the system (plant)

Rubric for “Carbon Cycle Song” Activity

	A (5 points)	B (4 points)	C (3 points)	D (2 points)	F (0 points)
Common tune?	Yes – teacher recognized	Yes – teacher not recognized, but students in the class did			No
3 verses?	4 distinct verses – 3 describing the parts of the carbon cycle and one containing info from the power point	3 distinct verses describing 3 parts to the C cycle	2 distinct verses	1 distinct verse	No verses
Use of instruments?	Yes – 2 or more	Yes – 1			No

Rubric: Poster on Natural Resources Changes

	A (5 points)	B (4 points)	C (3 points)	D (2 points)	F (0 points)
2 maps showing natural resource change over a time period	2 maps in color	2 maps, not in color	1 map in color	1 map, not in color	No maps
Neat, Colorful	Very neat, colorful	Neat, colorful	Colorful, but not neat		Neither neat nor colorful
Bibliography	Correct format	Present, but format is incorrect			No bibliography
Description of how natural resource has changed in its distribution	Complete description	Incomplete description			No description
Description of how natural resource has changed in its use	Complete description	Incomplete description			No description
Description of how natural resource has changed in its importance	Complete description	Incomplete description			No description

Rubric for Survey

	A (5 points)	B (4 points)	C (3 points)	D (2 points)	F (0 points)
Typed, grammar, mechanics, spelling	0-3 mistakes	4-6 mistakes	7-10 mistakes	11-13 mistakes	14+ mistakes
Easy to read format	Great formatting	Good formatting	Poor formatting		No discernable formatting
Data compiled	Compiled all data		Only compiled some data		Compiled no data
Data analysis	Complete analysis		Some analysis		No analysis
Validity of questions	90% questions are valid	80% questions are valid	70% questions are valid	60% questions are valid	59% or less of the questions are valid
Number of people surveyed	30-25	24-20	19-15	14-10	Less than 9