

Forests and Climate Change

Trees are essential to a stable climate. They help remove the heat-trapping greenhouse gas carbon dioxide, CO₂, from the air by storing it in their leaves, wood, roots and in soils. New York and New England forest ecosystems represent about 4.2 billion metric tons of carbon storage.

Climate change and forests are intrinsically linked. On the one hand, changes in global climate are already stressing forests through higher mean annual temperatures, altered precipitation patterns and more frequent and extreme weather events. At the same time, forests and the wood they produce trap and store CO₂, playing a major role in mitigating climate change. And on the flip side of the coin, when destroyed or over-harvested and burned, forests can become sources of the CO₂.

Understanding the nature and consequences of climate change on a regional and local level is a challenge we have just begun to address.

References:

<http://www.climatechoices.org/assets/documents/climatechoices/confronting-climate-change-in-the-u-s-northeast.pdf>

http://www.env-en.org/ENE_Climate_Change_Roadmap_New_England_Canada.htm

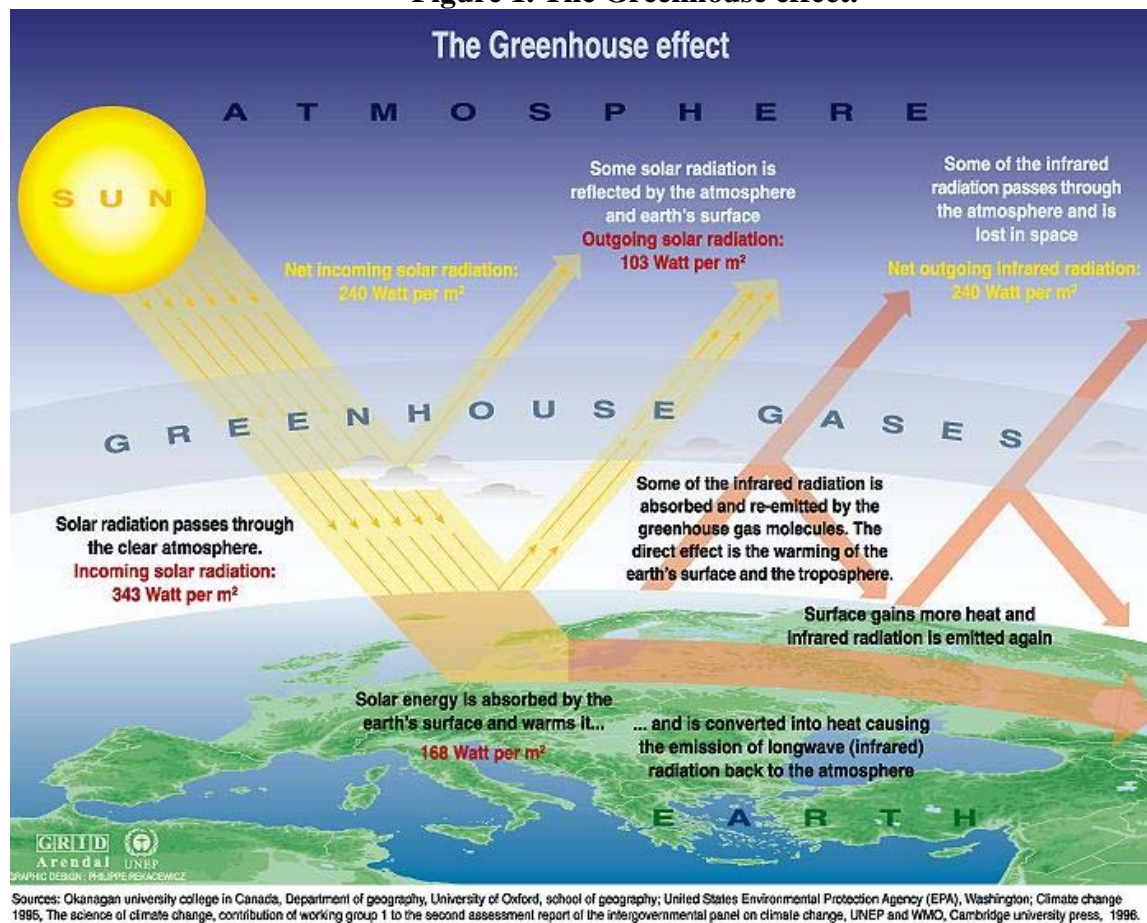
1) CO₂ and Climate Change

1. General

CO₂ is one of the main greenhouse gases. A greenhouse gas is an atmospheric gas, like CO₂, that contributes to the greenhouse effect by absorbing infrared radiation produced by the solar warming of the Earth's surface. CO₂ is emitted naturally through the carbon cycle and through human activity such as the burning of fossil fuels and deforestation (conversion of forested areas to non-forest land for use as pasture, crop land, urban development, or wasteland.)

When the earth is warmed by the sun's energy, it radiates its own infrared heat rays. Some rays escape past the atmosphere, others are absorbed by the greenhouse gases. [Carbon dioxide](#), [methane](#), [nitrous oxide](#) and three groups of [fluorinated](#) gases are the major greenhouse gases. These gas molecules and clouds absorb and re-emit the infrared rays, which warm the earth's surface. This greenhouse effect moderates the atmospheric temperature, keeping it in a zone conducive to life as we know it.

Figure 1. The Greenhouse effect.



A schematic representation of the exchanges of energy between outer space, the Earth's atmosphere, and the Earth surface. The ability of the atmosphere to capture and recycle energy emitted by the Earth surface is the defining characteristic of the greenhouse effect.

Reference: www.grida.no/climate/vital/.03.htm

However, since the beginning of the Industrial Revolution, the burning of oil, coal, gasoline and deforestation have increased the concentration of CO₂ in the atmosphere. With the increased production of CO₂ and other greenhouse gases, more heat is being absorbed and trapped in the atmosphere. Rising temperatures, in turn, produce changes in weather, sea levels, and land use patterns, commonly referred to as "climate change."

Reference:

www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-faqs.pdf

2. Effects of Climate Change on New York Forests

Higher temperatures during the winter, frequent flooding and summer droughts will affect the health and productivity of forests of the Northeast. The shifting climate zones may result in forests, and entire ecosystems, migrating northward and upward along the mountainous region of the Northeast corridor. Tree species such as sugar maple, paper birch and beech may dwindle in number and eventually disappear from New York entirely. With increased temperature and changes in precipitation, New York and other states in the Northeast are projected to experience a 10-20% increase in the risk of forest fires.

Scientific evidence also indicates that forest trees could absorb less CO₂ as the temperature rises. If temperatures continue to rise and the amount of carbon absorbed by trees and soils decreases, then global warming will accelerate.

References:

<http://people.eku.edu/pedersonn/presentations.html>

<http://guardian.co.uk/environment/2008/jan/03/climatechange>

2) Forests and CO₂

A) Storage of CO₂

i. Carbon cycle

CO₂ from the atmosphere is absorbed by trees through photosynthesis and stored as carbon in the tree trunk, branches, foliage, and roots, with oxygen as a byproduct. The organic matter in forest soils – such as the humus produced by the decomposition of dead plant material -- also acts to store carbon.

B) Carbon stored in forests stabilizes GHG emissions

3) Carbon Flows in Forest Areas

A) Carbon Stored

Carbon is stored in tree trunks, branches, foliage, and roots and surrounding soils. The factors affecting the quantity of CO₂ accumulated are the type of species of tree, climate, soil type and forest management practices.

B) Carbon Released

With deforestation, carbon is released in two stages: during combustion and processes. Forest land conversion to cropland provides immediate carbon release and the soil disturbance. The amount of carbon released varies according to the mode of forest conversion and type of forest. Forest harvests release some carbon immediately via logging or milling consequence of providing low carbon storage. Forest fires provide immediate release of carbon into the atmosphere.

C) Carbon Sequestered

i. Natural

Carbon sequestration is the removal of CO₂ from the atmosphere and storage in forests at a rate greater than its release back to the atmosphere. There are several forms of carbon sequestration: afforestation (new tree plantings), reforestation (replanting of trees in deforested areas) and avoided deforestation.

ii. Artificial

Artificial sequestration is defined by the process of harvesting wood. For carbon to be artificially sequestered, carbon must be captured or significantly delayed or prevented from being re-released into the atmosphere. Harvested wood can be incorporated into construction material or durable products such as furniture.

Reference:

<http://www.epa.gov/sequestration/index.html>

4) Forest Management

A) Afforestation – the planting of trees and/or seedlings on land that is not a forest or has not been for a long time

i) “Trees for Tribs”

Site Reference: <http://www.dec.ny.gov/lands/4920.html>

1. Protection and restoration of stream buffers

Trees, shrubs and grasses reduce pollution entering streams by filtering runoff.

2. Planting of trees and shrubs improve carbon sequestration

In addition to carbon sequestered in the trees themselves, establishing tree buffers can sequester CO₂ in the soil from the accumulation of organic matter and any additional vegetative biomass.

“Volunteers will plant nearly 2,000 trees and shrubs at 11 different sites throughout the Hudson River Estuary Watershed to participate in the inaugural “Trees for Tribs” Initiative this fall 200 and spring 2008. Volunteers will be planting native trees and shrubs along more than 6,000 ft. of streams and rivers in the Hudson Valley.”

(NYS DEC Hudson River Estuary Program, NYS DEC, 2007)

3. Avoid Deforestation

“The clearing of land for residential development may remove as much as 50-67% of above ground biomass and its associated carbon, while removing 22-25% soil carbon. In New England the rate of land conversion from rural agriculture and timber land to residential and commercial

development is estimated at 1,724 acres (698 hectares per week...In certain parts of the region, conversion of forest and farm land through development threatens carbon loss as well as the viability of sustainable working forests.”

(Environment Northeast, “Climate Change Roadmap for New England and Eastern Canada 2007, page 26)

B) Manage Forests

- i) Increase onsite storage of carbon**
- ii) Produce forest products which continue to store CO₂**
- iii) Maintain or increase harvestable timber**

5) Mechanism: Regional Greenhouse Gas Initiative (RGGI)

Site Reference: <http://www.rggi.org>

“The Regional Greenhouse Gas Initiative, or RGGI, is a cooperative effort by Northeastern and Mid-Atlantic states to reduce carbon dioxide emissions – a greenhouse gas that causes global warming. Climate change is expected to raise sea level, change precipitation and impact other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems.”

1. CO₂ Offset Projects

An offset is the result of a specific project of action implemented to avoid, sequester or displace greenhouse gas emissions. Carbon offsetting is the act of mitigating the effects of greenhouse gas (GHG) emissions. Offset projects are implemented in order to avoid, sequester or displace GHG emissions. Some examples of carbon offsets include tree planting, emissions trading, energy conservation measures and use of renewable energy.

i. Afforestation – the only forestry carbon offset recognized by RGGI

1. Afforestation is the process of establishing a forest on land that is not a forest, or has not been a forest for a long time by planting trees or their seeds. This is in contrast to reforestation, which takes place on land that has recently been deforested, for example to harvest the timber.

2. Improvement in carbon sequestration – CO₂ capture and storage

3. Opportunity to increase forest land is limited

“Because of land patterns, economics and forest Regeneration dynamics in the Northeast, there is little opportunity for afforestation. The Northeast is 67 percent forested compared to 49 percent in the Pacific Northwest and 33 percent nationally.”

(Forest Guild, Climate Change, Carbon, and the Forests of the Northeast 2007, page 19)

“The majority of the non-forested, non urbanized land in the

northeast region is prime and /or protected agricultural lands, or is a strong candidate for residential and commercial development, making the cost of purchasing land for reforestation prohibitive.”

(Draft, Maine Forest Service et al, “A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule, September 13, 2007, page 4)

ii. Recommendations to RGGI - Forest Offset Projects

RGGI requested that the partnership of the Maine Forest Service, Environment Northeast and Manomet Center for Conservation Sciences present research proposing rigorous forest management offset practices for its model rule

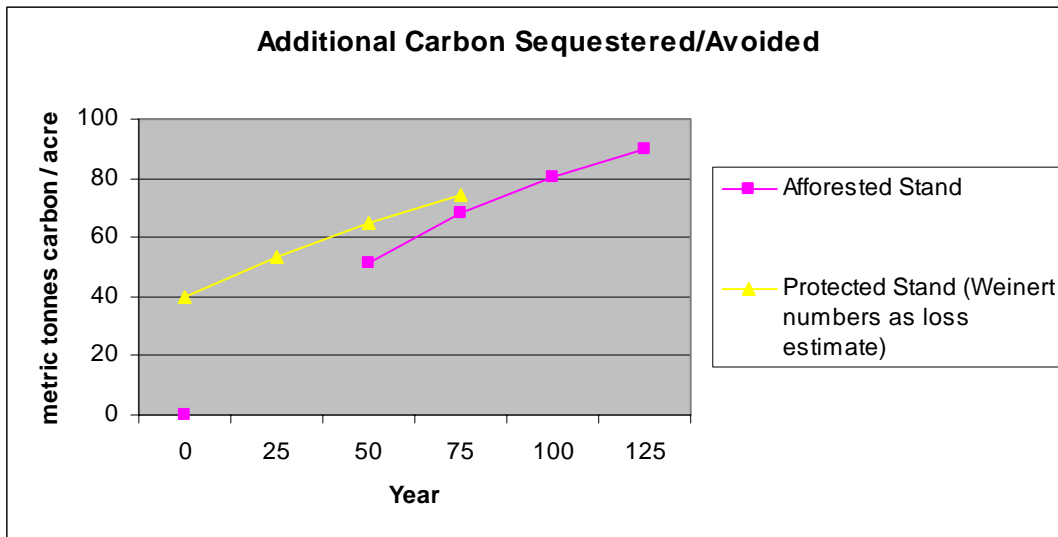
1. Avoid deforestation

The carbon emissions generated by the conversion of forested land to other uses vary according to the type of timber stand, the use of the land and the amount of development. “In New England, the clearing of timberland for residential development may remove as much as 50-67% of the above ground biomass (plant matter) and associated carbon, while also removing 22-25% of soil carbon.”

“Protection of land under imminent development prevents near term carbon emissions, thus providing immediate environmental benefits. For this reason, it would take an afforestation project about 75 years to catch up to the benefits provided by an avoided deforestation project, despite the fact that a newly planted forest is sequestering carbon at a faster rate than an older forest.”

Draft, Maine Forest Service et al, “A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule, September 13, 2007, page 6

Figure 2. Comparison of the benefits of an afforestation project vs. an avoided deforestation project over time



NOTE: Additional carbon in the afforested stand refers to carbon that is in addition to what was stored in the soil and other vegetation in year 0. Additional carbon in the avoided deforestation case refers to the avoided emissions in year 0, plus whatever additional carbon is sequestered in years 0-75. The protected stand is based on a 50-year-old stand, which is therefore 125 years old at year 75. Carbon storage cannot be modeled with confidence past this age.

Draft, Maine Forest Service et al, "A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule, September 13, 2007, page 7

2. Carbon friendly forest management

"Carbon friendly forest management would both increase onsite storage of carbon (which produces other environmental benefits, as well as being easier to monitor and verify than off-site carbon) and maintain or increase the amount of timber going into forest products (thus, avoiding leakage)."

Draft, Maine Forest Service et al, "A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule, September 13, 2007, page 7

Research from the Maine Forest Service indicates it is possible to sequester additional carbon through altering harvesting practices. Using northern hardwood poletimber, the researchers modeled the impacts of different harvesting methods. Switching from heavy harvesting when stands reach small timber sizes to harvests that mimic natural stand development resulted in 107 metric tons of CO₂/acre added over the next 90+ years.

Draft, Maine Forest Service et al, "A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule, September 13, 2007, page 8

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Figure 3. Net carbon impacts on atmospheric greenhouse gas levels 2003-2095
 Net carbon impacts on atmospheric greenhouse gas levels, 2003-2095

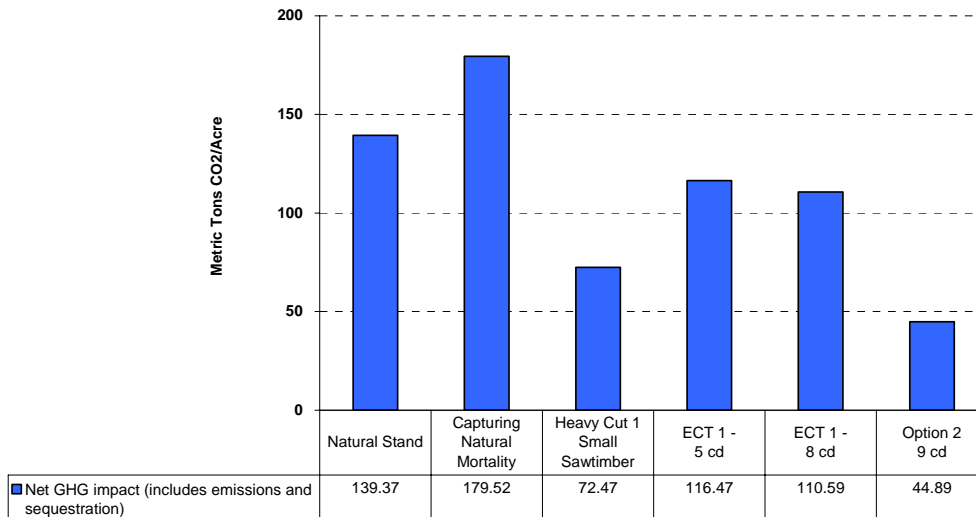
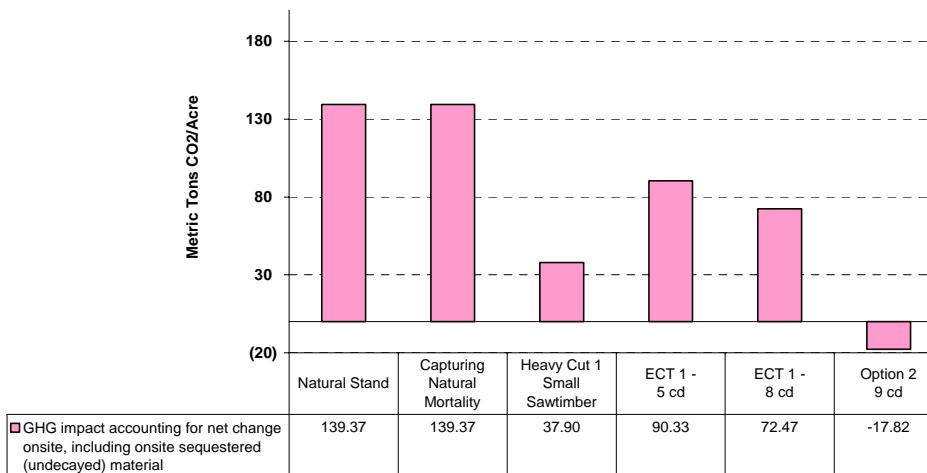


Figure 4. Total carbon stored on site, year ending 2095.
 Total carbon stored on site, year ending 2095
 (2095 estimate less 2003 estimate)



1 .

*Note – The MFS and ENE are working to have other researchers duplicate these results to insure their accuracy.

3. Conclusion

According to the Maine Forest Service and its partners, Environment Northeast and Manomet Center for Conservation Sciences – *“it is important that RGGI makes sure that opportunities to use the region’s forest to sequester carbon are not overlooked as the policy is developed. The basic protocols have been laid out in the RGGI rules for afforestation efforts.”*

References:

www.forestguild.org/news/climatechange

American Forest & Paper Association and Empire State Forest Products Association, “Comments on the New York State CO₂ Budget Trading Program (Part 242)”, December 21, 2007.

Draft, Maine Forest Service et al, “A Policy Framework for Including Avoided Deforestation and Active Forest Management Practices as Forest Offset Types in the RGGI Model Rule,” September 13, 2007.