

A Sink for Missing Carbon Discovered in Northern Forests

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NASA developed satellite data combined with forest inventory data indicate that forests in Europe, Russia and America have been storing nearly 700 million metric tons of carbon a year, or about 12% of annual global carbon emissions from industrial activities, during the 1980s and 1990s. European forests soaked up 120 million tons of carbon a year, which is about 11% of Europe's annual emissions.

With the exception of Canada's boreal forests, which were found to be losing carbon, most northern forests were storing carbon. Russia, the country with most forests, accounted for almost 40 percent of the biomass carbon sink. "This is only a piece of the total carbon sink in the north which may be as large as 2 billion tons" said **Compton Tucker** of NASA's Goddard Space Flight Center suggesting that more carbon may be stored in other pools in the north, such as the soils.

Wood from forests is the raw material for a multi-billion dollar global industry. While sophisticated ground based forest inventories are routinely done in some countries, vast tracts of forests in large countries such as Canada and Russia are rarely inventoried because of their remoteness. "This study suggests the possibility of surveying forests from space and making wood volume maps across a wide variety of forests" said **Ranga Myneni** of Boston University. The results of this NASA funded study will be published in the December 18th issue of the Proceedings of the National Academy of Sciences of the USA. An electronic version of this article will appear in an early edition of PNAS on December 11th at www.pnas.org.

Part of the puzzle of greenhouse gases and climate change is determining where carbon

dioxide (CO₂) is absorbed, and what causes a region to become a "carbon sink." The land and oceans are known to store half of the 6.5 billion tons of carbon emitted annually from fossil fuel burning and industrial activities. The other half is accumulating as CO₂ in the atmosphere, the increasing concentration of which is thought by many to be responsible for global warming. Analyses of atmospheric CO₂ concentration changes indicate a carbon sink of about 1 to 2 billion tons on land in the northerly regions.

Elsewhere the land is suggested to be neutral, which implies that emissions of another 1.5 billion tons of carbon a year from cutting and burning of tropical forests are nearly balanced by sinks of similar magnitude there. The geographical detail of the land carbon sink has however remained elusive.

Highest Carbon Storage in Europe

The researchers combined forest greenness observed from sensors on National Oceanic and Atmospheric Administration satellites with wood volume data from forest inventories to produce high resolution maps of carbon stocked in about one and half billion hectares of northern forests located above the 30th parallel. They identified where forests were

storing carbon and where they were losing carbon by comparing the carbon stock maps of the late 1990s and early 1980s. The researchers report that about 61 billion tons of carbon is contained in the wood of these northern forests.

The American and European forests contained more carbon than the Canadian and Russian forests (56 versus 41 tons per hectare). Among the European countries, Austria, France and Germany had notably large stocks. The rate of storage, in tons carbon per hectare per year, varied from country to country during the 1980s and 1990s. It was highest in Europe (0.84) and America (0.66), and least in Canada and China (0.29), with values for Russia in between (0.44). Thus, the sink distribution between North America and Eurasia was roughly in proportion with the forest area.

According to the researchers, increased fires and infestations in Canada, forest cultivation in the Nordic countries, declining harvests in Russia, fire suppression and forest regrowth in the USA, and longer growing seasons from warming in the north are possible reasons for why some forests are storing carbon and others are losing it. "This means that we do not know whether these forests will continue to store carbon in the future or release it at some point. That is why we need to monitor them both from space and on ground" said **Jiarui Dong** of Boston University.

"This study has important scientific, economic and policy implications" remarked **Robert Kaufmann** of Boston University. The scientific implication is, it deconstructs the mystery of the land carbon sink by providing geographically detailed maps of forest carbon pools, sources and sinks. The economic implication is, the wood volume maps are valuable information to the forest industry. "The study may also have political relevance as a potential tool to monitor carbon sequestration in the future", says **Jari Liski** of the European Forest Institute.

The team of authors from Austria, Finland, Russia, and the USA includes Ranga Myneni, Jiarui Dong, Compton Tucker, Robert Kaufmann, Pekka Kauppi, Jari Liski, Liming Zhou, Vladislav Alexeyev and Malcolm Hughes. The paper was communicated by Academy member Charles Keeling of the Scripps Institution of Oceanography. The work was made possible by funding through NASA Headquarter's Earth Science Enterprise, a long-term research program dedicated to understanding how human-induced and natural changes affect our global environment.

A map that shows the large carbon sinks of forests in Europe, Russia and eastern North America is available on the Internet at:

<http://cybele.bu.edu/biomass/figures/sphere/sink.sm.jpg>

Additional information is available on the Internet at:

<http://cybele.bu.edu/>

<http://www.gsfc.nasa.gov/topstory/20011204carbonsink.html>

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Copies of the article are now available to reporters from

<http://cybele.bu.edu/biomass/biomass.html> or the PNAS news office, Tel. +1 (202) 334-2138, email: pnasnews@nas.edu