Ecosystem Restoration and Global Climate Change: The Role of Wetlands in Combating Global Warming

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There is an increasing awareness that global climate change may warrant new approaches to ecosystem restoration (Harris et al. 2006). However, there is less attention given to the degree in which ecosystem restoration can combat the effects of global warming on ecosystems. Nonetheless, a growing number of studies are suggesting that ecosystem restoration can help buffer against the adverse effects of global climate change, especially through the process of carbon sequestration (Lal 2004; USCCTP 2005; Harris et al. 2006).

Healthy Ecosystems and Carbon Sequestration

Carbon dioxide, the most important greenhouse gas contributing to global warming, results primarily from fossil fuel use, although land-use change provides a significant, yet smaller, contribution to the atmospheric carbon (C) pool (IPCC 2007). Land use change has been estimated to account for 10-30% of C emissions (Lal 2004). Major types of land use change that deplete terrestrial C and increase atmospheric C include: (1) deforestation and biomass burning and other activities related to conversion of natural to agricultural systems, (2) tillage and other soil disturbances, and (3) drainage of wetlands. Degraded ecosystems resulting from land use change have lost much of their original C pool and their present pool is below the potential capacity (Lal 2004).

One way to combat the effects of global warming is by restoring degraded soils and ecosystems in order to facilitate C sequestration (Lal 2004). Carbon sequestration involves removing CO_2 from the atmosphere into long-lived pools of C, such as terrestrial and geologic (Lal 2004). If 10% of the biomass created by photosynthesis is retained in the terrestrial ecosystem, it can balance the atmospheric C emissions from fossil fuel combustion (Lal 2004). Practices that facilitate C sequestration include afforestation and reforestation, conservation tillage, mulch farming, integrated nutrient management and adopting systems with high biodiversity (Pandey 2002; Lal 2004; Shrestha & Lal 2006)[1].

[1] *Afforestation* is the conversion of bare or cultivated land into forest; *conservation tillage* is a method of cultivating crops to reduce soil erosion; *mulch farming* is a system of farming in which plant residues are not ploughed into the ground but left on the surface.

Wetland Restoration

Wetland restoration can also greatly contribute to C sequestration in terrestrial ecosystems (USCCTP 2005; Hendricks et al. 2007). Wetlands, including coastal zones, estuaries and marshes, and northern tundra and peatlands, constitute approximately 7% of the Earth's land surface and 11.6% of the United States (USCCTP 2005). Wetland restoration has a large potential of atmospheric C uptake because erosion of topsoil and organic matter from upland catchment areas is deposited in wetlands and the decomposition rate is slow (Gleason & Euliss 1998; Lal 2004). Because wetlands are intrinsically highly productive (contributing 10% of global net primary productivity[2]), and accumulate large stocks of organic carbon, restoring lost wetlands and protecting those that remain clearly represents an immediate and large opportunity for enhancing terrestrial C sequestration (USCCTP 2005).

Despite the important ecological role of wetland ecosystems, approximately 23,700 hectares of wetlands, 98% of which are freshwater wetlands, have been lost annually between 1986 and 1997 in the United States—resulting from urban and rural development, agriculture, and forest plantations (Dahl 2000). Wetland restoration hitherto has focused on wildlife habitat, water quality improvement, erosion control, shoreline restoration, but not C sequestration (USCCTP 2005). This lack of attention to the C sequestering benefits of wetland protection and restoration is cause for concern because existing wetlands might otherwise become large sources of greenhouse gas emissions if not protected (USCCTP 2005). Moreover, efforts to manage wetlands in danger of becoming massive sources of atmospheric C do not exist at this time (USCCTP 2005).

Media Coverage & Public Awareness

The concept of restoring ecosystems to address global warming has been receiving increasing media attention, which is important for harnessing public support for restoration efforts. In a recent EMC Research poll taken to assess public support for San Francisco Bay restoration efforts, 83% of Bay Area residents polled said they would be willing to pay $10 per year in taxes to restore wetlands that would result in cleaner water, provide flood control benefits, enlarge the San Francisco Bay National Wildlife Refuge, and increase shoreline access for the public (Save the Bay 2007). The San Francisco Bay area has been drastically altered by mass urbanization, and the region's wetlands have been drained for agricultural fields and salt ponds, or filled for

[2] Net primary productivity refers to the rate at which an ecosystem accumulates energy or biomass—this typically corresponds to the rate of photosynthesis.

development (Save the Bay 2007). Moreover, scientists have found that every acre of restored, healthy salt marsh captures and converts at least 870 kilograms of CO_2 into plant material annually, which is equivalent to global warming emissions from driving 2,280 miles (Save the Bay 2007).

Recent technological advances aimed at combating global warming have also been highlighted in the media. A new San Francisco based eco-restoration company, Planktos, Inc., is focusing on restoring damaged habitats in the ocean and on land to address global warming problems (Lewis & Darbee 2007). The company has begun implementing a pilot series of commercial scale phytoplankton restoration projects to reinvigorate declining ocean life and produce millions of tons of tradable low cost greenhouse gas emission offset credit. Restoring phytoplankton to around 1980 levels is expected to generate billions of tons of CO_2 sequestering biomass and feed the entire marine ecosystem from the bottom up (Lewis & Darbee 2007). Compared to the 1980 levels, plankton photosynthesis is currently absorbing 3 billion fewer tons of atmospheric C each year, an amount equivalent to about half of our annual manmade CO_2 emissions worldwide (Lewis & Darbee 2007).

The idea of using ecosystem restoration to mitigate global climate change is even being practiced among cardinals of the Vatican, who recently accepted a donation from KlimaFa Ltd.—a Hungarian based eco-restoration firm dedicated to large-scale afforestation and reforestation projects in the European Union—in which the company offered to plant trees on a denuded stretch of land near the Tisza River to offset the Vatican's carbon emissions (Rosenthal 2007). The trees, which will be planted on a 37-acre tract of land to be renamed the Vatican climate forest, will in theory absorb as much CO_2 as the Vatican will produce in 2007 (Rosenthal 2007).

Future Directions

Although the restoring of ecosystems to address global warming has only recently begun to attract attention, this area of research will undoubtedly continue to grow, especially given the observed and projected increase in greenhouse gas emissions and the concomitant effects on global warming and sea level rise (Lal 2004). Atmospheric C sequestration in terrestrial sinks is a natural process that provides a win-win opportunity of reducing the rates of gaseous emissions while alternatives to fossil fuel take effect (Lal 2004).

There remains a need for more research in the area of restoring and increasing the ability of terrestrial ecosystems to retain and sequester carbon. This is especially so because unlike industrial emissions, greenhouse gas emissions related to land use are

controlled by a combination of biological, climatological, and management factors and show large spatial and temporal variability (Hendricks et al. 2007). This need for additional research equates to a greater need for broad, long-term public and political support. Indeed, scientists from both the United Nations and the White House have recommended wetland restoration as a strategy to fight global warming (USCCTP 2005; IPCC 2007).

What remains to be seen is whether ecosystem restoration will become ingrained as part of our lexicon for combating global warming. Of course, ecosystem restoration cannot solve the climate problem, yet it is a crucial interim step in the right direction.

Literature Cited

Dahl, T. E. 2000. Status and trends of wetlands in the conterminous United States 1986-1997. U.S. Fish and Wildlife Service, Washington, D.C.

Gleason, R. A., and N. H. Euliss. 1998. Sedimentation on prairie wetlands. *Great Plains Research* 8:97-112.

Harris, J. A., R. J. Hobbs, E. Higgs, and J. Aronson. 2006. Ecological restoration and global climate change. *Restoration Ecology* 14:170-176.

IPCC, 2007: Summary for policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lal, R. 2004. Agricultural activities and the global carbon cycle. *Nutrient Cycling in Agroecosystems* 70:103-116.

Lewis, D., and P. A. Darbee. (2007, September 28). Invest now for a healthy bay in the future. *San Jose Mercury News*. Retrieved October 10, 2007, from http://www.southbayrestoration.org/news/SJMerc92807.pdf

Pandey, D. N. 2002. Global climate change and carbon management in multifunctional forests. *Current Science* 83:593-602.

Rosenthal, E. (2007, September 17). Vatican penance: forgive us our carbon output. *The New York Times*. Retrieved October 8, 2007, from http://www.nytimes.com/2007/09/17/world/europe/17carbon.html

Save the Bay. 2007. Greening the Bay: Financing Wetland Restoration in San Francisco Bay. August 2007. Retrieved October 11, 2007, from http://www.savesfbay.org/site/pp.asp?c=dgKLLSOwEnH&b=3188269

Shrestha, R. K., and R. Lal. 2006. Ecosystem carbon budgeting and soil carbon sequestration in reclaimed mine soil. *Environment International* 32:781-796.

USCCTP (U.S. Climate Change Technology Program). 2005. U.S. Climate Change Technology Program-Technology Options for the Near and Long Term. Retrieved October 11, 2007, from http://www.climatetechnology.gov/library/2005/tech-options/tor2005-fullreport.pdf