

**Natural Terrestrial Sequestration (NTS):
An Exemplar for Natural Resources Trust Stewardship**
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Background

As emphasized by the Intergovernmental Panel on Climate Change (IPCC, 2007) and supporting studies, our understanding of anthropogenic influences has greatly improved “*leading to a very high confidence level [90%]*” that if the climate is to be stabilized, then GHG emissions will need to be greatly reduced --by as much as 80% by 2050. This plus the possible economic and environmental ramifications of not addressing climate change have stimulated important renewable energy and energy efficiency efforts, as well as, studies to quantify potential carbon reservoirs, and even costly geotechnical schemes to literally “scrub” the atmosphere of CO₂.

Soils are widely recognized as natural, low-cost and stable carbon storage sinks. Although oceans store most of the Earth’s carbon, soils contain approximately 75% of the terrestrial carbon pool. Wetlands and forests account for much of the stable soil carbon. Further, forest and wetland ecosystems are important in climate change scenarios due to H₂O-recharge potential, O₂ respiration potential, global productivity and the potential for large C and N reservoirs. Studies suggest carbon can remain stored in soils for millennia, or be quickly released to the atmosphere --depending on environmental conditions, soil composition, drainage, land-use disturbance. Combined land reclamation, preservation and sustainable soil practices are among the seven, “Sokolow CO₂ stabilization wedges” needed to prevent the doubling of atmospheric CO₂ by the year 2050. Recent important studies have focused on agricultural, hardwood forests, boreal peatlands, desert areas, genomic methods to enhance carbon sequestration, in addition to controversial and extremely expensive anthropogenic “deep carbon capture and storage” (CCS) schemas. Wetland, forest, watershed and disturbed areas should be the next target area for enhanced NTS efforts. According to the USFS, our western forests, watersheds and wetlands are severely threatened by drought, pest infestations and are in danger of becoming isolated islands susceptible to greater impacts with continued climate change; and the BLM has indicated that disturbed-lands now represent a new- and the 7th largest- land class. Further, the natural carbon balance of warmer global terrestrial ecosystems, including the ocean) appears increasingly susceptible to baseline pool declines due to climate warming.

As emphasized by Mary Christine Wood (this volume) and by the authors of *Natural Capitalism*, our leaders and government representatives can and must reframe a political discretion to destroy Nature into government’s moral and fiduciary *trustee obligation* to protect Nature and to ensure stewardship of our National Natural Resources Trust. Given growing climate induced drought, fire and pest management problems, grassland and agricultural productivity concerns and the need to manage the trust in light of climate forcing --- a worthy “Trust” task is to maximize soil productivity and “natural terrestrial sequestration” (NTS) potential. Increasing NTS through wise land use and natural management practices is a low cost, high performance method of sequestering atmospheric CO₂.

Proposal

This paper and the broader National Resources Stewardship- Proposed Action Items (*in* Appendix I) proposes a framework for managing and funding a National NTS assessment, in addition to other National Trust projects. At present, we have limited knowledge about either the upper limit or 'carbon carrying capacity' of soils or the kinetics of NTS processes. To make reliable predictions about NTS or the ability of soils to respond to the range of climate-related ecosystem impacts, requires a facilities-capable, integrated-systems approach such as can be achieved by a well-coordinated and cooperative Scientific Expert + Federal Management Program *entrusted* to advance both basic research and applied management important to the National Natural Resources Trust. Such a program can and should provide decision-support tools for converting observations to information that can be used to: implement greenhouse gas stabilization practices, advance fundamental research, maximize soil productivity/land reclamation/forest health/watershed health/public health/sustainable conservation programs, as well as, understanding the ecological consequences of various carbon management schemas.

In light of increasing climate change concerns, program commitments should include:

- Advancing our understanding of physical-, chemical-, and biological- weathering reactions and processes important in soil productivity, soil reclamation and NTS –for all soil types and ecosystems
- Methods for better estimating CO₂-flux caused by annual variability, fire, drought, land-use disturbance and anthropogenic factors that impact NTS
- New technologies and methods for monitoring, quantifying and validating changes in CO₂, other GHG's and contributing pollutant stocks and fluxes; Laboratory, core-sample and integrated, in-situ soil carbon measurement field instruments for assessing carbon inventories through time; Development and use of natural soil optimizers and amendments for all soil types such as low-temperature bio-char, soluble calcium, humic-complexes.
- Enhancing carbon retention and understanding the transformation between organic and inorganic carbon
- Understanding nitrogen deposition controls on the mechanics of soil health and carbon sequestration
- Clarifying starting material soil-variability and better understand open-system climate processes
- Better integrating NTS information with air, soil and water quality –nationwide
- Improving ecosystem carbon exchange to optimally manage forests and watersheds
- Understanding and increasing the NTS capacity of mined- or otherwise degraded- lands to promote better land use planning, minimize operational impacts and to support maximal reclamation efforts
- Characterizing microbe reaction pathways and how soil enzymes and organisms influence NTS

Fiduciary Obligation and Benefits

Climate change uncertainty puts a premium on all remaining natural resources, which must be protected to provide for the public welfare and ensure fundamental resources needed for our future and future generations. According to several recent polls (CBS, Fox News, Pew, New York Times, Gallup, Nathan Cummings), Americans overwhelmingly favor action on renewable energy development combined with climate change mitigation and strongly support large investments in these areas.

One important NTS goal is to better understand the costs and benefits of initiating more carbon-conscious practices. Should the United States eventually adopt a carbon-pollution tax or carbon-credit trading program, high precision and reliable NTS measuring techniques will be necessary. As with the recently established “no-till” and “sustainable range management” USDA Carbon-Trading Programs, data from the proposed program is important, for example, in: quantifying carbon sinks as targets for remediation projects, funding erosion and nitrogen run-off reduction, supporting sustainable forest and watershed management practices, quantifying the transfer of carbon credits to rural and transitional communities for use in long-term carbon management “set-aside” or other “land-donation programs,” transfer of RECs to RPS-governed electricity retailers, and Government issued ecosystem credits to land managers that adopt best land management practices and/or conserve sensitive ecosystems.

Conclusion

Enhancing NTS is now recognized as one of several important carbon management strategies. NTS offers a viable, low-cost and stable option that works, “buys us time” for mitigating rising CO₂ concentrations in the atmosphere, and supports investments in readily deployable renewable energy and energy efficiency measures. Understanding how carbon dioxide “sinks” perform and enhance ongoing natural processes may add powerful new measures to carbon management options. The proposed cooperative program is an ambitious but worthy and needed effort to better understand factors influencing NTS potential of U.S. temperate soils and to provide the underlying data for estimating a national carbon inventory and annual changes in carbon pools. The results of this proposal will directly support a number of ongoing Federal programs, academic institutions, and U.S. Policy Acts including: the Clean Air Act, Clean Water Act, National Environmental Protection Act, Wilderness Act, among others.

References

- Buringh, P., 1984, Organic carbon in soils of the World: *in* Woodwell, G.M., ed., The Role of Terrestrial Vegetation in the Global Carbon Cycle, Wiley and Sons Ltd., p. 91 – 109.
- DOE National Energy and Technology Laboratory (NETL), 2006, Carbon Sequestration Technology Roadmap and Program Plan, http://www.fossil.energy.gov/sequestration/publications/programplans/2006/2006_sequestration_roadmap.pdf
- Eve, M.D., M. Sperow, K. Paustian, and R. Follett, 2002, National-scale estimation of changes in soil carbon stocks, *Environmental Pollution*, 116: 431-438.
- Goddard Institute for Space Studies, NASA, 2007, Research Finds that Earth's Climate is Approaching 'Dangerous' <http://www.giss.nasa.gov/research/news/20070530/>
- Hawken, P., A., Lovins and L. H. Lovins, 1999, *Natural Capitalism: Creating the Next Industrial Revolution*, Little Brown Press, 396 p.
- IPCC, Intergovernmental Panel on Climate Change, Fourth Assessment Report.
- Lal, R., 2004, Soil Carbon Sequestration Impacts on Global Climate Change and Security, *Science*, vol. 304, p. 1623 – 1626
- Pacala, S., and Socolow, R., 2004, Stabilization wedges: solving the climate problem for the next 50 years with current technologies: *Science*, v. 305, p. 968-971.
- Paustain, K., Carbon Sequestration Primer, Natural Resource Ecology Laboratory Colorado State University, Ft. Collins, <http://www.nrel.colostate.edu/projects/agrocco/primer/primer.html>
- Potter, C.S., et. al., 2006, Estimating Carbon Budgets for U.S. Ecosystems: EOS, *Transactions, American Geophysical Union*, v. 87 no. 8, p. 85-96.
- Rasmussen, C.R., Torn, M.S., and Southard, R.J., 2005, Mineral assemblage and aggregates control carbon dynamics in a California conifer forest: *Soil Science*, vol. 69, p. 1711 – 1721.
- UNFCCC, United Nations Framework Convention for Climate Change, (<http://unfccc.de>)
- Yager, D.B. and Burchell, A., et. al., 2007, C, N, S, Hg, ICPAES, Stable Isotope, Bedrock ANC and Microbe Analyses for Selected Colorado Volcanic-Derived Soils, U.S. Geological Survey – Open File Report (in progress).
- Zeng, Ning; Qian, Haifeng; Qian; Munoz, Ernesto, 2004, How strong is carbon cycle-climate feedback under global warming?: *Geophysical Research Letters*, vol. 31, L20.