Why a Marin Carbon Project?

Reducing greenhouse gas emissions is not enough to reverse global warming: we must also reduce the concentration of carbon dioxide in the atmosphere. The Marin Carbon Project is investigating the potential for specific land management practices to enhance sequestration of atmospheric carbon dioxide as organic matter in rangeland and agricultural soils in California.

Soil carbon sequestration is the process of moving carbon dioxide from the atmosphere into the soil. Through the process of photosynthesis, plants pull carbon dioxide out of the atmosphere and transfer that carbon below ground via root exudates and sloughing of roots; and to the soil surface when they drop leaves or other plant parts, and when they die. In this way, atmospheric carbon dioxide becomes soil organic matter.

Soil organic matter is approximately fifty percent carbon. Over the past 150 years we may have lost fifty to eighty percent of our topsoil worldwide. It is estimated that more than a third of the carbon dioxide we have added to the atmosphere during that time has come from changes in land use and poor land management. This soil-derived change in atmospheric carbon dioxide concentration suggests the potential for improved land management practices to result in sequestration of significant amounts of atmospheric carbon dioxide in the soil as organic matter.

Increasing soil organic matter has innumerable benefits in addition to helping to slow or reverse global warming. Improved soil water holding capacity, improved soil fertility, improved soil tilth, improved water quality, decreased need for petroleum-based pesticides and fertilizers, decreased erosion and increased production are all well-documented effects of increasing soil organic matter.

As climate change worsens, and climate change legislation, including California's AB32, comes into effect, more and better solutions will be needed for reaching targeted atmospheric carbon dioxide reductions. In this dynamic context, soil carbon sequestration provides numerous ecological and economic opportunities.

Mission:

In response to the rapid pace of global climate change caused by human activity, the Marin Carbon Project seeks to enhance carbon sequestration in rangeland, agricultural, and forest soils through applied research, demonstration and implementation.

Vision:

Our vision is to establish land owners and land managers as soil carbon sequestration champions by providing economical and ecological solutions to global climate change.

Strategy:

The Marin Carbon Project is a consortium of researchers, agricultural extension, agricultural producer organizations, county and federal agricultural agencies, the resource conservation district, private rangeland consultants and land owners/managers. This consortium seeks to understand the potential for soil carbon sequestration to contribute to greenhouse gas reductions. The consortium will work together and independently to promote, through applied research and demonstration, enhanced carbon sequestration in Marin's agricultural and rangeland soils. The consortium also will help facilitate development of a carbon market that supports soil carbon sequestration efforts on agricultural, forest and rangelands in Marin County and globally.

Reversing the impacts of climate change requires both reduction of greenhouse gas emissions and removal of carbon dioxide from the atmosphere through carbon sequestration. The focus of the Marin Carbon Project is to sequester carbon in soils through land management while reducing associated greenhouse gas emissions.

Marin Carbon Project Programs and Goals

Scientific Research

Program Goal: The Marin Carbon Project seeks to identify verifiable approaches to soil carbon sequestration in managed ecosystems.

Our research will use range management science, biogeochemistry, soil science, plant ecology, and ecosystem ecology to determine the best approaches for long-term carbon storage in managed ecosystems. Our research will focus on the mechanisms responsible for soil carbon storage and loss, and test promising management approaches for increased plant productivity and long-term soil carbon sequestration. The research results generated as part of the Marin Carbon Project will be subject to peer review and contribute to the growing body of literature on carbon cycling in managed ecosystems.

Verification Protocols

Program Goal: The Marin Carbon Project will help develop verification protocols for measuring change in soil carbon pools and fluxes.

Verification is a critical step in quantifying soil carbon sequestration and carbon sequestration potential. Verification protocols using the century model will facilitate carbon accounting and contribute to broader participation in carbon markets.

Implementation

Program Goal: The Marin Carbon Project will support and facilitate implementation of tested and verfied management approaches and practices to increase sequestration of carbon on private and pubic lands.

The Implementation program will utilize the research, protocol and outreach guidance developed by the consortium as the foundation for technical and financial assistance to land owners/managers to sequester carbon.

Education and Outreach

Program Goal: The Marin Carbon Project will promote public awarness through education and outreach of the potential to positively affect global climate change by sequestering carbon in rangeland and agricultural soils.

This program will share research results and promising managmeent practices thorugh its web site and activities such as demonstrations, field days, journal articles, workshops and conferences with land owners, practitioners, resource managers, funders and the general public.

Market Development

Program Goal: The Marin Carbon Project seeks to contribute to the development of a viable market for soil carbon sequestration as an ecosystem service to support more sustainable land use.

Carbon markets can provide incentives for landowners to modify or diversify their management activities by offsetting initial costs of implementation. It is our goal to develop management approaches that are both ecologically and economically sustainable.

Research Projects

Soil Carbon Sequestration through Rangeland ManagementPrincipal Investigator, Whendee L. SilverSilver Lab, University of California, Berkeley

This study involves basic and applied research in biogeochemistry, soil

science, range management science, plant ecology and ecosystem ecology to determine the best approaches for long-term carbon storage in soil. A preliminary survey in Marin and Sonoma Counties indicated that rangelands have considerable potential to sequester carbon in soils through changes in management practices. We are currently conducting controlled field experiments in Marin County (Nicasio) and in Browns Valley (Sierra Foothills Research and Extension Center), California, to test two promising approaches for soil carbon sequestration in rangeland soils: compost addition and subsoiling using the Yeoman plow. We have sampled for soil carbon and nitrogen pools, residual dry matter (standing dead plant biomass), and soil CO2 emissions. This served as the baseline for the treatments, which are being applied now. We are adding compost and using the subsoiler. Treatments include (1) control (grazing only), (2) compost + grazing, (3) subsoiling + grazing, and (4) compost + subsoiling + grazing. We have three replicate plots of each treatment in Marin and six replicate plots of each treatment in Browns Valley.

Life Cycle Analyses of Key Management ApproachesPrincipal Investigator, Whendee L. SilverSilver Lab, University of California, Berkeley

To determine the potential for management approaches to mitigate climate change and provide value-added through policy and market forces, we need to better understand the complete life cycle of greenhouse gas production and consumption from start to finish. We propose to conduct a life cycle analysis of organic amendments and subsoiling in rangeland soils from our field experiments in Marin County and Browns Valley. The analysis will start with the composting process and finish with the rangeland soil carbon pools and fluxes. This analysis includes:

- Greenhouse gas emissions from compost piles over the course of processing by measuring fluxes directly
- Greenhouse gas savings from landfills, particularly lower methane and nitrous oxide emissions, determined by sampling landfills and

modeling the role of green waste

Greenhouse gas emissions from transporting compost to ranches and field application, determined by using existing transportation models

Greenhouse gas emissions from applied compost (compared to uncomposted fields), determined by direct measurement

Soil carbon sequestered determined by direct measurement.

Verification is the critical step in quantifying soil carbon sequestration and carbon sequestration potential. If the life cycle analysis shows a significant net greenhouse gas savings, not only from the soil carbon sequestered, but from the methane and nitrous oxide emissions reduction from landfills, this research may be used to develop verification protocols for measuring change in soil carbon pools and fluxes. Methane and nitrous oxide have much greater radiative forcing than CO2, meaning that they are much more potent gases from a global warming perspective. Transport to ranches will result in some greenhouse gas costs depending upon the location of landfills relative to composting facilities and rangelands. Any greenhouse gas savings we uncover from the life cycle analysis will increase the value of organic amendments as a tradable carbon offset for ranchers and as a means to slow global climate change.

Determining the Long-Term Fate of Sequestered CarbonPrincipal Investigator, Whendee L. SilverSilver Lab, University of California, Berkeley

For carbon sequestration to make a significant impact on climate, the carbon must be stored for at least several years, and ideally for decades or longer. Soils in general have great potential to store carbon for long time periods. This is measured as the mean residence time, which is the length of time, on average, carbon remains in soil. To determine the mean residence time of sequestered carbon we can use isotopically labeled compost and track its movement through solid (mineral, organic, microbial), liquid (dissolved organic carbon), and gas (CO2, methane) phases. We then measure the radioisotope signature of the surrounding soil matrix to estimate its age, and infer storage time-spans of the added

carbon. Determining how much, in what form, and where in soils compost carbon is saved or lost from soils will allow us to estimate its impact on the atmosphere. By using a combination of natural stable isotope tracers and the existing radiocarbon signatures, we can determine the long-term fate of sequestered carbon. This is state of the art research that has been developed and applied at Berkeley and surrounding National Labs.

Many additional research, implementation, verification, market development and education and outreach projects are currently being reviewed by the Steering Committee for integration into the Marin Carbon Project.