

# CO<sub>2</sub> FARMING

**Imagine a new kind farming in the Sacramento-San Joaquin Delta... Carbon-capture farming**

Instead of growing corn or asparagus, degrading the peat soils into carbon dioxide (CO<sub>2</sub>) and causing land subsidence, farmers could “grow” wetlands. They would rebuild the Delta’s unique peat soils and permanently take CO<sub>2</sub> out of the atmosphere.

The U.S. Geological Survey (USGS), in cooperation with the California Department of Water Resources (DWR), is already making it happen.

In a pilot project, USGS scientists have created two seven-acre wetlands on Twitchell Island that are “re-building” peat soils and taking carbon out of the atmosphere.

Now, the USGS, in a joint venture with DWR, has proposed the next step in the R&D process – the farm-scale Carbon Capture Farming Demonstration Project. It would develop the design, operational, and engineering parameters necessary to safely bring this concept to full scale in a scientifically defensible way. Spreading across hundreds of acres, the project will develop wetland management approaches that maximize carbon sequestration and subsidence reversal, and minimize the potential for adverse consequences.

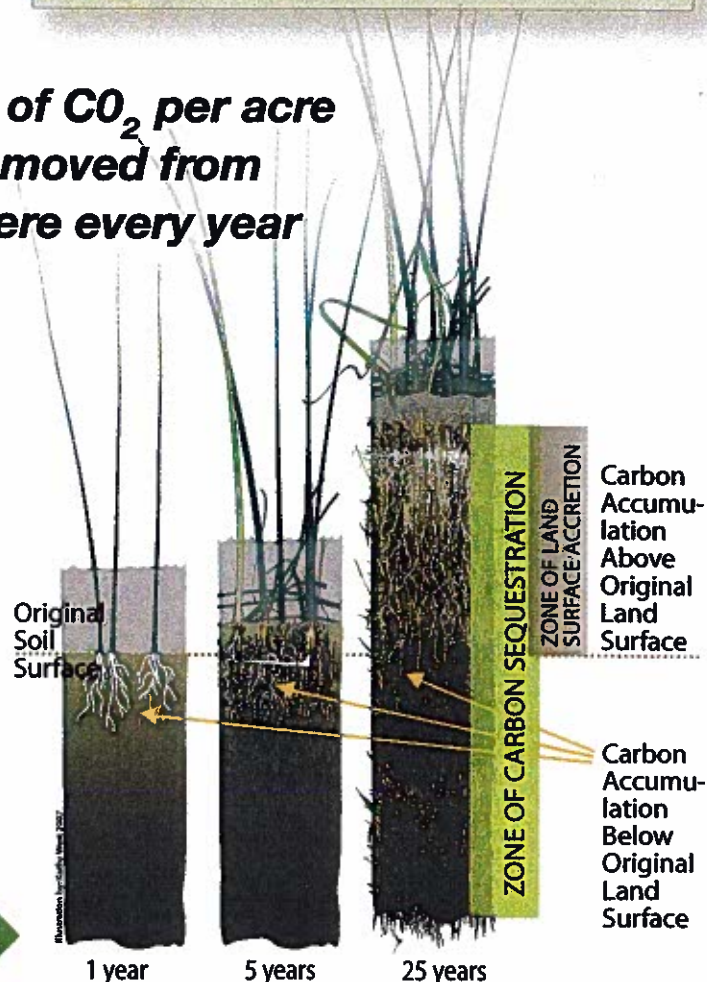
The proposed project is an investment in science that would reap multiple benefits over several decades – for California, the nation and the world. It would build on the results of the ongoing Twitchell Island Pilot Project and assess at full scale the ability of re-established wetlands on Delta peat islands to sequester carbon, reverse subsidence and provide an economically sustainable land use practice.

*How atmospheric CO<sub>2</sub> is fixed by plants and then incorporated into soil biomass as land surface accretes over time. These linked processes have the combined benefits of sequestering atmospheric carbon and rebuilding land surface on subsided Delta islands.*

## IF CARBON-CAPTURE FARMING IS WIDELY ADOPTED, IT COULD:

- Be a profitable NEW way to capture and sequester CO<sub>2</sub>, a greenhouse gas.
- Nearly eliminate CO<sub>2</sub> emissions currently caused by oxidation of peat soils.
- Provide a 10-fold or greater return on a \$30 million investment.
- Stabilize Delta levees, providing greater security to California’s water supply.

**25 metric tons of CO<sub>2</sub> per acre could be removed from the atmosphere every year**



**How carbon-capture farming works**



## WHAT ARE OTHER BENEFITS FROM CARBON-CAPTURE FARMING IN THE DELTA?

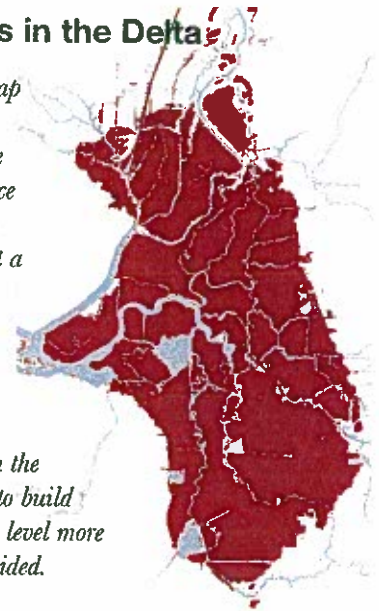
Besides sequestering a major greenhouse gas, large-scale carbon-capture farming in the Delta would:

- Help preserve the region's farm economy and communities
- Virtually eliminate oxidation of peat soils, reversing land subsidence
- Reduce pressure on levees, first by raising groundwater levels and then raising land levels
- Reduce the space on islands that would fill if a levee breaks, thereby reducing the regional and statewide consequences of levee failures

## Subsided lands in the Delta

The red areas on the map of the Sacramento-San Joaquin Delta show the extent of land subsidence below sea level. These subsided lands represent a particular hazard to California's water supply in the event of a levee break.

Widespread creation of carbon-capture farms in the Delta has the potential to build land surface back to sea level more quickly than it has subsided.



## HOW BIG COULD THIS BE?

If California converted an area the size of subsided lands in the Delta into carbon farms, the benefits every year would be about the equivalent of...

**Turning all SUVs in California into small hybrids**

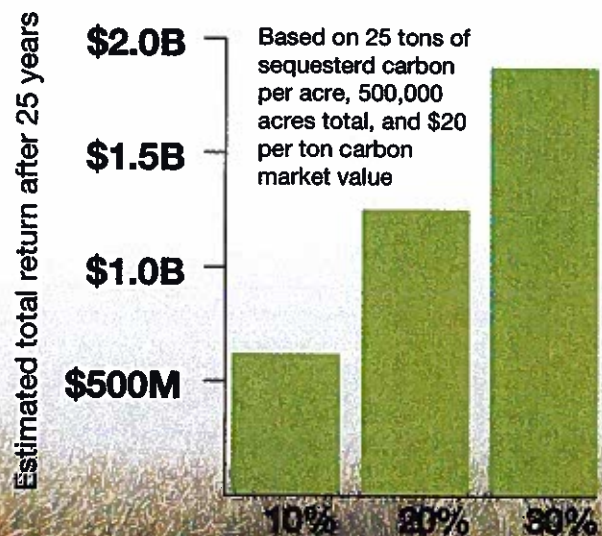
**Changing from standard lightbulbs to compact fluorescents in all California households**

**Turning off all residential air conditioners in California**

## HOW DOES THE FINANCIAL PICTURE LOOK?

The USGS has outlined an investment of \$30 million to research and develop carbon-capture farming into a safe, effective and economically sound activity. The potential Delta-wide financial return on carbon-capture farming depends, of course, on how widely it is implemented. If we assume that only 5 percent of Delta land currently in agricultural production is converted to carbon-capture farming, nearly 16 million tons of CO<sub>2</sub> will be captured in 25 years. In today's dollars, that represents a market value of more than \$300 million. Returns will be much higher if this farming is more widely adopted. For the farmer, this means a net annual return of \$325 per acre could be realized even after research and development costs are taken into account.

## Potential Financial Returns





## THE USGS R&D PROPOSAL

The USGS has prepared a preliminary description of the technical developments, performance documentation, and research needed to ensure a positive outcome from large-scale carbon-capture farming, and perhaps improve its economic returns.

### GOAL 1: Gaining the best bang for the buck

The Twitchell Island pilot farm has shown that it is highly feasible to use managed wetlands to sequester carbon and reduce subsidence. Additional work is necessary to make sure future carbon-capture farms perform well and minimize any potential adverse environmental impacts.

*Our research would address such key questions as:*

- Can the USGS results at the Twitchell pilot farm be replicated on a larger scale?
- Can we determine why some portions of Twitchell are capturing carbon twice as fast as other areas?
- How will climate change affect carbon farms? For example, what will happen if sea levels rise and nutrient loads, water temperatures and salinity increase?

USGS will lead a team of university and private researchers to address these questions. Planned products include a series of technical reports and a “handbook” on how and where to build and maintain a successful carbon-capture farm.

### GOAL 2: Preventing harm to human and environmental health

Large-scale efforts to manage the environment have a decidedly mixed record of success and often can cause undesirable consequences to environmental and human health. If carbon farms are not managed properly, they could end up adding to global warming, as well as causing other problems.

Much of the scientific effort the USGS proposes is to establish farming and monitoring systems that ensure this does not happen. Our research would address three major areas of concern:

- **Production of methyl mercury** – Methyl mercury is a neuro-toxin that can be produced in wetlands and accumulate up the food chain. Because of high mercury concentrations, human consumption warnings have been issued for several fish species in and around the Delta. If methyl mercury is widely produced and released from carbon farms, it could increase concentrations of methyl mercury in Delta fish.
- **Production of DOC** – Dissolved organic carbon (DOC) is a significant potential human health problem because it forms carcinogenic compounds during drinking water treatment. Some DOC can be removed in water treatment, but it is difficult and expensive to do so. If carbon farming in the Delta increases the amount of DOC in drinking water sources used by utilities, it will be much more difficult to reach regulatory targets and protect the quality of water served to the public.
- **Production of greenhouse gasses** – Although wetlands can sequester CO<sub>2</sub> under some conditions, they can produce greenhouse gasses that are much more problematic: methane and nitrous oxide. Methane has more than 20 times the warming effect of CO<sub>2</sub>, and nitrous oxide nearly 300 times. Great care must be taken to ensure carbon-capture wetlands do not produce excess methane or nitrous oxide.

The USGS, in collaboration with a team of university researchers and consultants, proposes detailed investigations into the wetland processes that result in the formation of methylmercury, DOC, methane, and nitrous oxide.





## THE CALIFORNIA MARKET FOR SEQUESTERED CARBON

Because of its huge and growing economy, California is the world's 12th largest emitter of greenhouse gasses. The California Global Warming Solutions Act (AB32) requires the State to reduce total greenhouse gas emissions to help mitigate the potential effects of global warming. AB32 requires that the California Air Resource Board use the most feasible and cost-effective means to reduce greenhouse gas emissions. This includes developing a carbon-trading market by 2011 where greenhouse gas reductions, including those from forests or wetlands, may be marketed to industries for which greenhouse gas reductions are prohibitively expensive or impractical. Although the market is not fully established, trading of this nature is already under way, with the value of high quality carbon futures currently trading in the range of \$20 per ton of CO<sub>2</sub>. We anticipate a full carbon marketplace will soon be available for Delta carbon-capture farmers.

### For more information on the project proposal, contact:

**Roger Fujii**, USGS Research Chemist,  
rfujii@usgs.gov, 916/278-3055

**Brian Bergamaschi**, USGS Research Chemist,  
bbergama@usgs.gov, 916/278-3053

**Stuart Siegel**, Restoration Ecologist,  
Wetlands and Water Resources, 415/457-0250,  
stuart.siegel@usgs.gov



### Project Leadership Team



**ROGER FUJII**, San Francisco Bay and Delta Program Chief for the USGS California Water Science Center, is a soil and water chemist who has long served as lead scientist for the Twitchell Island Wetlands Pilot Project. He is now the project director for the proposed demonstration project.



**BRIAN BERGAMASCHI** is the head of the Organic Carbon Research Group of the USGS California Water Science Center, and the chief scientist of the proposed Carbon Capture Farm Demonstration Project. He received his doctorate from the University of Washington in 1995, specializing in the biogeochemistry of wetland and terrestrial systems.



**STUART SIEGEL** is the project manager for the proposed Carbon Capture Farming Demonstration Project. A wetlands ecologist with more than 20 years' experience, he founded Wetlands and Water Resources in 1996. He has designed, managed, permitted, constructed and monitored dozens of wetland restoration projects in Northern California.

*This is a USGS briefing paper. It was produced to describe in general terms a proposal in development by the USGS, and as such may not be cited or used for any other purpose.*