**Terrestrial Carbon Offsets for Industry Portfolios**

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## Introduction

Substantial scientific evidence has been compiled indicating that the earth's climate is changing due to manmade carbon dioxide ($CO_2$) emissions associated with fossil fuel combustion and land clearing. The greenhouse gases (GHG) carbon dioxide, nitrous oxide, and methane are measured in terms of Global Warming Potential and are defined by metric tons of carbon dioxide equivalents ($TCO_2$ E) (Figure 1). Currently, about 80% of global $CO_2$ emissions are derived from fossil fuel combustion with land use change as the second largest contributor (IPCC 2001). Global emissions of $CO_2$ from human activity have increased from an insignificant level two centuries ago to twenty-four billion tons per year in 2003. Roughly half of the anthropogenic emissions are absorbed into oceans, forests, and other natural sinks, but the other half accumulates in the atmosphere, where the concentration of $CO_2$ is currently 379 ppm, 33 percent above pre-industrial levels, and rising at a rate of more than 1ppm per year. (US DOE 2004). Carbon emissions are not regulated in the U.S. today, however, most companies believe there will be regulations controlling emissions within the next five years. In addition, several states already have emission reduction legislation pending or laws regulating emissions. Finally, many international trading schemes (e.g. Denmark, European Union, United Kingdom) have already started to respond to the Kyoto Protocol that caps emissions by country.

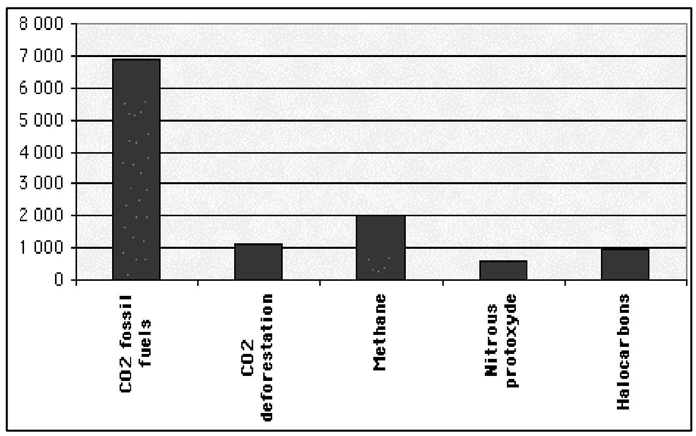


**Figure 1 Global greenhouse gas emissions in 2000 by gas (except ozone), in millions tonnes carbon equivalent ($TCO_2E$) (IPCC 2000).**

## Terrestrial Carbon Sequestration

In the U.S., large-scale land clearing has drastically altered landscapes in the last two centuries. Agricultural expansion and urban development have resulted in the loss or degradation of millions of acres of forests and grasslands and have had profound effects on the global climate and environment (Figure 2). Land surface disturbances influence temperature, precipitation, atmospheric circulation and the ability of the earth's surface to deflect solar energy. A recently completed report by National Aeronautic Space Agency (NASA) suggests that human-caused land cover changes are at least as important an influence on climate as carbon dioxide emissions because they strongly affect regional surface

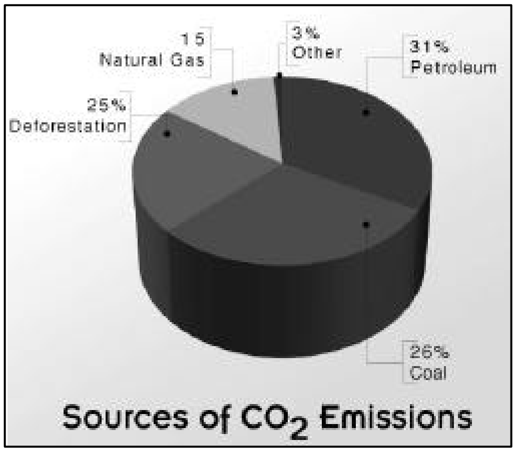


**Figure 2 Sources of CO2 emissions from International Panel on Climate Change 2001.**

temperatures, precipitation and larger-scale atmospheric circulation (NASA 2004). Additionally, the International Panel on Climate Change Third Assessment Report (IPCC 2001) has estimated that 10-30% of annual anthropogenic greenhouse gas emission is derived from land-use change and deforestation. To illustrate, approximately one-third of the current 1.5 billion tonnes of carbon emitted to the atmosphere due to changes in tropical land use is from oxidation of soil carbon. It is estimated that 40 to 60 billion tonnes of carbon may have been lost from soils as the result of forest clearing and cultivation since the great agricultural expansions of the 1800s (USDA 2004).

To proportionally address a solution to these disturbances, at least one-quarter of the reduction of anthropogenic emissions should be derived from land restoration. Currently, various carbon management methods are being proposed to counteract these emissions, including: increased efficiencies of systems for the production, conversion, and utilization of energy; alternative energy technology such as wind or solar; and emission offsets through carbon sequestration projects (geologic, ocean and terrestrial). Terrestrial sequestration is the enhancement of the uptake of $CO_2$ by plants that grow on land and in freshwater and, importantly, the enhancement of carbon storage in soils where it may reside more permanently (U.S. DOE 2004). The U.S. Department of Energy (DOE) defines carbon sequestration in terrestrial ecosystems as the net removal of carbon dioxide ($CO_2$) from the atmosphere in long-lived carbon pools. These include:

- above ground biomass (e.g. trees, grasses)
- long-lived products (e.g. lumber)
- soils (e.g. organic and inorganic soil carbon)

The primary focus of terrestrial carbon sequestration is land-use and ecosystem management at the landscape or regional scale, based on the premise that this approach offers the greatest potential for enhancing carbon storage in terrestrial systems. Terrestrial carbon offsets are valued as environmental commodities, also referred to as ecological assets or eco-assets, and can provide environmental benefits associated with the earth's restored landscape. The restoration activities associated with terrestrial offset projects generate two forms of potential carbon or greenhouse gas credits. First, because farmland is converted back to native ecosystems, the emissions of carbon dioxide, nitrous oxides, and methane associated with agricultural production are eliminated. Secondly, the re-established vegetation captures carbon dioxide from the atmosphere and accumulates it in the plant parts and soil until saturation or net flux equilibrium is achieved. Storage periods vary, but cropland converted to grassland typically takes 20-30 years and reforestation takes 60-110 years to achieve equilibrium (Birdsey 1996). These carbon emission offsets are assigned a value in the form of carbon credits that, when adequately monitored and measured, may be sold or traded to investors with environmental liabilities. The carbon credit transaction involves an investor (a buyer for the carbon) and an aggregator, who brings the credits to market. Buyers are typically from the industrial sector and need to offset the $CO_2$ emitted by their manufacturing activities. The aggregator obtains the credits from landowners who change land management practices to sequester carbon.

**Components of a Sequestration Project**

**Figure 3 Typical flooded bottomland hardwood swamp.**

Changing land use patterns to reduce the decomposition of organic matter and increase the photosynthetic carbon fixation of trees and other vegetation can achieve terrestrial carbon sequestration (Figure 3). Any project that removes active cropland from the landscape has an emission reduction benefit by removing farming practices such as fossil fuel burning tractors, trucks that transport crops, and fertilizer[1](West and Marland 2002). The degree of benefits varies due to factors including crop type, land use history, soil type and the location (latitude, climate) of the property. Many current land use management practices, such as conservation tillage or no-till farming, can increase the level of carbon in the soil and plants. Other practices that sequester carbon include, converting marginal lands to wildlife habitat, restoring degraded soils, crop residue management, elimination of summer fallow, the use of winter cover crops, longer rotations, and soil erosion management. Recent studies indicate that U.S. agricultural soils are being managed as a modest carbon sink, accounting for net sequestration of 4 million metric tons (MMT) of carbon annually (U.S. EPA 2003). However, many believe that these soils could be managed to store significantly more carbon. Sperow et al. (2003) estimate that U.S. croplands could be managed to sequester an additional 60-70 MMT of carbon per year while Lal et al (1998) put this figure at 75-208 MMT. Follett et al. (2001) estimate that U.S. grazing lands could be managed to sequester an additional 29-110 MMT of carbon per year. These studies do not consider the option of sequestering carbon by shifting marginal croplands and grazing lands to forest. Immediate emission benefits include those listed above, while long-term benefits come from carbon storage capacity of the trees and grass that replace the farmland. Effective changes in management practices will require clearly defined programs that will attract the interest of landowners and be economically viable.

Because 70% of our nation's land is in private ownership, the future of terrestrial carbon sequestration programs revolves around privately owned lands. For example, in the Lower Mississippi Alluvial Valley (LMAV) alone, less than four of the original 22 million acres of bottomland hardwoods remain with most of this acreage in private land ownership (Figure 4) (Hodgetts 2000). Approximately 13% of the LMAV region is publicly owned,

1 Fertilizer produces nitrous oxide, a very powerful greenhouse gas, approximately 296 times more potent than carbon dioxide (USDA).

including national forest and wildlife refuges, state wildlife management areas, cities, roads, and permanent open water bodies (Lower Mississippi Valley Joint Venture 2002). The remaining 87% is privately held. Similar ownership patterns exist in the Great Plains of the north central U.S., where expansive tracts of grasslands have been converted to agriculture.

Most corporate investors and newly formed GHG Exchanges are not structured to deal directly with individual landowners with offset credits to sell. Thus, aggregators

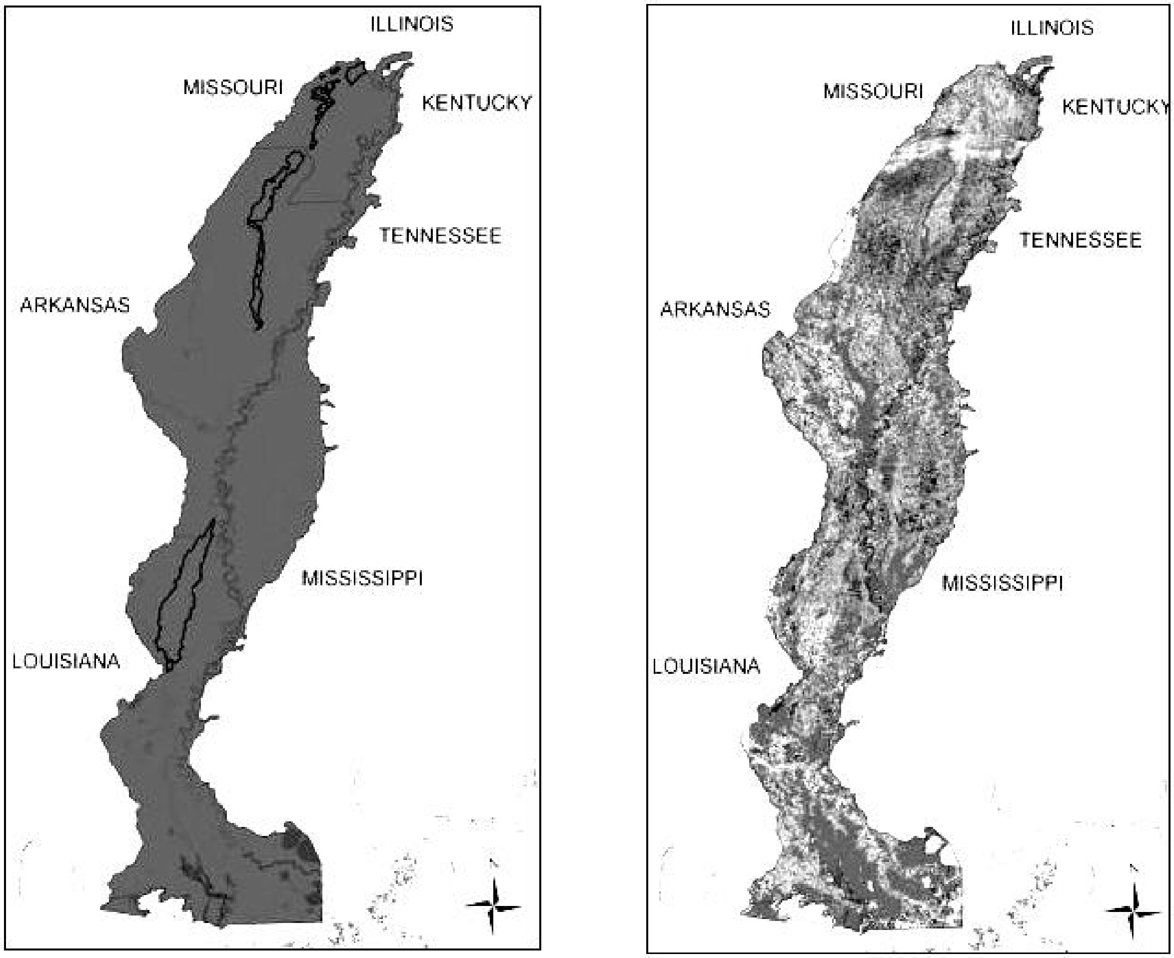


**Figure 4 Forest cover in the South has been heavily influenced by a long history of intensive land uses. Conversion of forests and forested wetlands to primarily agricultural uses started in the late 1700's and extensive logging began after the Civil War (Wear and Greas 2001). The graphic above depicts forest cover in the MAV before drastic land conversion over the last three centuries (left) and actual 2001 forest cover from Landsat ETM satellite imagery.**

typically secure the rights to the carbon assets derived from farmland conversion by crafting agreements with multiple private landowners. There is an increasing demand from industry investors for conservation organizations, farming coalitions, and consultants to serve as carbon offset aggregators that sell carbon rights to industry partners.

In the future value of carbon credits may depend on how the credits for the emission reductions were obtained, subsequent land ownership, and the source of the funding used to generate the offsets. For example, based on existing DOE guidelines, projects that use private dollars should receive full benefit and baseline protection for emission reductions, however, it is not clear whether or not projects implemented with government funding will receive full credit. Despite the uncertainties in the current DOE guidelines, carbon offset projects for industry portfolios must provide a permanent reduction of greenhouse gases or otherwise account for the time that the carbon is kept out of the atmosphere. There are two straightforward methods typically used to provide land for permanent protection – perpetual conservation easements and land acquisition.

*Perpetual Conservation Easement*. A conservation easement is a legal agreement appended to the land deed that restricts the type and amount of development that may take place on private property. The easement holder should be a stable 501(c)(3) organization with the resources to annually monitor and ensure protection of the property for the length of the easement. If the easement holding organization goes out of business then the terms of the easement may be violated without monitoring and oversight of the easement holding organization. Easements are tailored to meet the needs and interests of the landowner and easement recipient. Conservation groups seek to protect the conservation values of the property while still providing an economic return, such as carbon credits, to its owner. Payments for easements usually must be at least as high as other available government programs, e.g. the Wetland Reserve Program (WRP), to secure the carbon rights, or the credits will simply not come to market. Thus, adequate easement payments are attractive to private landowners and provide incentives to convert more marginal agriculture land to its original state. After restoration, the land can still provide economic opportunities for farmers through recreational use such as hunting leases.

The length of an easement is also an important issue with regard to conservation and carbon values. Shorter-term easements, particularly those less than 30 years, are not as beneficial for preserving long-term conservation or carbon benefits. For instance, when the shorter-term easement expires trees might be clearcut, whereas with a long-term carbon easement the carbon offsets are secured by the easement holder.

*Land Acquisition*. A carbon-offset provider (e.g. conservation NGO) may purchase land in fee title from landowners on behalf of a corporation in need of carbon-offset credits. Typically, a conservation easement is placed on the land that protects it from development in perpetuity. This easement remains with the land even if it is sold and there are three scenarios for the future of the land:

1. the purchaser owns and manages it in perpetuity;
2. the purchaser places a perpetual conservation easement on the land and sells it to a conservation-minded buyer with restricted development rights;
3. the purchaser sells the land to a government agency required by law to protect the natural resources of the land.

In all cases, the carbon value is legally defined and protected for the buyer.

## Characteristics of Quality Offsets

The programs described above will not only provide potential carbon credits, but will also improve wildlife habitat, water quality, and the ability of the landscape to absorb floodwaters. Additionally, carbon sequestration funding from industry will provide critical revenue to farmers and rural communities struggling with a depressed agricultural economy.

In order to insure quality offset projects, offset providers must adequately address the industry and market concerns regarding permanence, additionality, leakage, and monitoring as defined in the Kyoto Protocol.

*Permanence/Duration.* Permanence refers to the length of time carbon will remain stored after having been fixed in vegetation and soil. Protection of forests may only be temporary, and tree plantations will be cut after a certain time, so carbon savings achieved in forestry projects must be secure. Also, because greenhouse gases may be unintentionally released if a sink is damaged or destroyed, e.g., through forest fire or disease, it is necessary to select an appropriate carbon accounting technique for dealing with the temporal variability of sequestration. In some cases, third party insurance is available for those wanting to protect their investment. Establishing a timeframe for project analysis and project duration is also an important consideration.

*Additionality.* The concept of additionality addresses the desire and recommendation that reductions of carbon must be additional to those that would have otherwise occurred during "business as usual". Terrestrial carbon offset credit providers offer two types of carbon sequestration projects – (1) projects on land owned by private individuals or corporations and (2) projects on land owned by federal, state, or local government, such as a National Wildlife Refuge, or state Wildlife Management Area, or projects funded by government subsidized programs. While all of these offset projects are beneficial for conservation and carbon sequestration, there is debate as to whether publicly funded projects provide eligible credits since the restoration was already required without the stimulus of carbon sequestration funding. Further, in February 2002, the Bush Administration announced the Clear Skies and Global Climate Change Initiatives that set a voluntary greenhouse gas intensity reduction target of 18 % over the next 10 years. More recently, the President's FY03 budget requested a $1 billion increase in Farm Bill funding "as the first part of a ten year (2002-2011) commitment to implement and improve the conservation title of the Farm Bill, which will significantly enhance the natural storage of carbon." Specifically, the President's budget requested:

$89 million increase for the Conservation Reserve Program (CRP)
$800 million increase for Environmental Quality Incentives Program (EQIP)
$176 million increase for Wetland Reserve Program (WRP)
$16 million increase for the Forest Stewardship Program
$254 million for a new Grassland Reserve Program

In December 2003, the USDA announced sign up for a CRP Hardwood Tree Initiative to restore up to 500,000 acres. Although the program specifies that participants will retain their rights to sell or market carbon associated with tree planting according to the guidelines, the program only appears to fund acres already authorized in the 2002 Farm Bill for purposes other than carbon sequestration. This new influx of government funding needs to be followed by clear definitions of additionality for projects funded by these various conservation programs. There will be uncertainty in the market until this issue is addressed and investors can be assured that credits purchased in association with federally funded projects will be considered additional and retain their value in the future.

*Leakage.* Leakage is defined as the unanticipated decrease or increase in greenhouse gas benefits outside the project's boundaries, but which have occurred as a result of the project activities. A credible carbon sequestration project must reasonably demonstrate a land use being replaced by trees or grass without simply moving the land use elsewhere. A project that considerably changes supply and demand can produces market effects, such as reducing supply, increasing demand, or depressing the local price of wood which can cause nearby plantations to be replaced with pasture or other low-biomass land uses. (IUCN 2002).

*Monitoring.* Techniques are available with which to accurately and relatively easily measure or verify changes in carbon stocks. It is important to clarify the difference between measurement, monitoring, verification, and audit when referring to carbon stocks. Measurement is the quantification of the baseline amount of carbon before a project begins. In the case of conversion of marginal agricultural land, a baseline would be documentation of crop type, irrigation practices, and other related information for the previous 3-5 years. There is also published literature from Oakridge National Laboratory on the emission reductions rates associated with various farming practices and crop information is available from the Farm Service Agency offices in each county in the U.S. Measurement of sequestered carbon requires field sampling using traditional forest and soil mensuration techniques, including measuring standing timber, estimating canopy, and chemical laboratory analysis. Recently, remote sensing technology and GIS have been used to supplement fieldwork and increase quantification accuracy across landscapes. Monitoring involves periodic site visits to monitor seedling success and measure carbon pools to determine gains or losses from the baseline. The carbon aggregator or a consultant with the proper expertise (e.g. professional forester) can perform measurement and monitoring. For example, Winrock International, a non-profit organization offering ecosystem management services, has published "A Guide to Monitoring Carbon Storage in Forestry and Agroforestry Projects" that outlines procedures they use for forest carbon monitoring. Verification is the determination that the carbon submitted for sale is actually present on the site and must also be done by an independent third party with no vested interest in the results.

All offset providers must consider the accountability, measurement, and monitoring of carbon projects to give potential investors confidence in the terrestrial carbon sequestration market and the future value of their investments.

**Aggregators and Offset Providers**

The role of aggregators or carbon offset providers is important because the nature of trading emissions credits requires greater economies of scale than average landholders can supply. Evaluation of the carbon market and industry feedback suggests a need for aggregators to establish accounting and verification mechanisms to solidify the market structure and to build confidence from investors. Concurrently, conservation organizations and other entities involved in natural resources view land management as a vehicle to provide overall ecological gains and achieving conservation objectives while providing economic benefit to the landowner. The role of an aggregator is appropriate for a conservation organization due to the impact of climate change on natural resources and the potential funding opportunities for restoring natural habitat and improving environmental quality (Table 1). It is also perceived that landowners typically prefer to work with private organizations rather than government agencies because of the streamlined communication and administrative process.

**Table 1 The regulatory and conservation perspective of terrestrial carbon sequestration (Lower Mississippi Valley Joint Venture 2002).**

| REGULATORY PERSPECTIVE | CONSERVATION PERSPECTIVE |
|---|---|
| *An emissions offset tool with ancillary environmental benefits* | *A tool for offsetting emissions and restoring the sequestration capacity within the terrestrial carbon pool* |
| • Views the terrestrial ecosystem as storage container<br>• Focus is on the process of "storing" offsets<br>• Favors practices that optimize the storage process<br>• Primary product is emission offsets from the geologic carbon pool | • Views the terrestrial ecosystem as "natural scrubber"<br>• Focus is on the process of **"restoring"** an ecological function<br>• Favors practices that benefit multiple ecological functions<br>• Primary products are emission offsets and ecosystem restoration |
| *Views conservation benefits as ancillary* | *Views conservation benefits as intrinsic* |

As an example, Ducks Unlimited, Inc. (DU), a non-profit conservation organization, delivers habitat restoration work resulting in large volumes of carbon being removed from the atmosphere and is also an offset provider on the Chicago Climate Exchange. DU offers several opportunities for energy companies to offset their net greenhouse gas emissions by reducing agricultural emissions and restoring vegetative sinks that sequester carbon. Their conservation work includes restoring wetlands and other habitats, enhancing degraded habitats, protecting endangered habitats, managing wild lands for wildlife, and influencing wildlife-friendly legislation. DU has been working directly with industry investors to develop habitat restoration projects that restore important waterfowl habitats while providing carbon offsets. DU offers five basic types of land conversion for carbon sequestration including grassland restoration in the Northern Great Plains, bottomland forest restoration in the Mississippi River watershed, no-till winter cereal crops in the Northern Great Plains, riparian forest restoration along the east and west coasts and seasonal emergent wetlands throughout the U.S. Recent studies by USGS Northern Prairie Wildlife Research Center (NPWRC), Ducks Unlimited Canada, and USDA have been assessing the net greenhouse gas flux for prairie wetlands. Preliminary results indicate the potential to enhance carbon sequestration through wetland restoration in the Prairie Pothole Region. Previous work by NPWRC and the USDA suggests that prairie wetlands traditionally functioned as net sinks for atmospheric carbon, but cultivation, the current principal land use, has shifted their function from net sinks to net sources of atmospheric carbon (Euliss et al. 2002).

To focus its conservation activities, DU uses satellite and GIS technology to establish optimal project areas within the LMAV and the Northern Great Plains. The results of this analysis are combined with public ownership and existing DU restoration projects to locate appropriate private properties for carbon offset projects (Figure 5). DU has also been working closely with the LMAV Joint Venture to expand the capabilities of the Reforestation Tracking System to track forest management prescriptions relating to carbon sequestration quantification. Recently, DU received a National Fish and Wildlife Foundation/Budweiser grant to develop a carbon tracking system that will record project location, ownership, size, land use, planting rate, site management, carbon accumulation, and many other factors associated with carbon transactions in the LMAV. Once a suitable site is identified, private land agreements providing an unquestionable definition of carbon credit ownership are established. DU then completes the restoration work, monitors the property, and secures third party verification of carbon sequestration based on the existing land use (e.g., crop type) and the tree species/density planted. Annual tree growth curves can then be translated into an estimated carbon value/year.

DU has contact with thousands of private landowners across the country, who value their voluntary, incentive based approach (Figure 5). Projects with these landowners contribute to cleaner air by reducing emissions associated with traditional farming practices and by establishing plants that absorb carbon dioxide. Their program benefits the U.S. farmer and rural communities by providing an alternate source of income during times of low commodity prices. DU's conservation mission benefits by increasing the amount of wildlife habitat within their priority landscapes (Table 2).

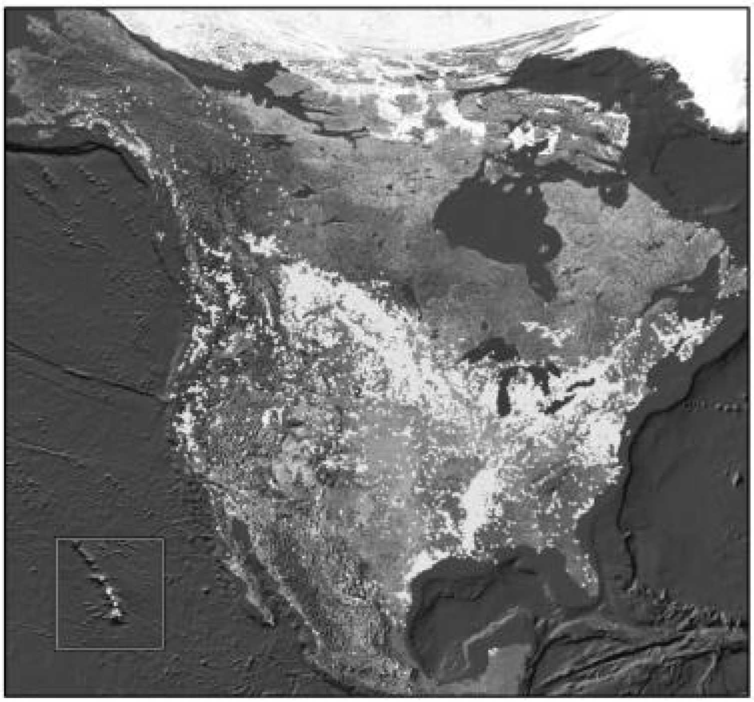

**Figure 5 Distribution of DU Projects in North America.**

These partnerships demonstrate how industry and conservation can work proactively to address GHG emissions and environmental sustainability. Other conservation based carbon sequestration approaches have been used to build successful partnerships in the Lower Mississippi Alluvial Valley between industry, non-governmental organizations (NGO's), and government agencies on public lands. However, most remaining opportunities are on private lands.

**Table 2 DU's capacity to restore thousands of acres of forest and grasslands each year may offer emissions reductions of .75 to 2.213 metric tons of carbon equivalents per year.**

| Program Areas | Habitat Restored | Acres | Emissions Reductions $MTCO_2/E$/acre/year | Carbon Sequestration $MTCO_2/E$/acre/year | Projected $MTCO_2E$ Over 80 year period |
|---|---|---|---|---|---|
| Mississippi Alluvial Valley | Bottomland Hardwood Forest | 50,000 | 2.213 | 5.831 | 32,174,551 |
| Northern Great Plains | Grassland | 35,000 | 0.999 | 1.485 | 4,357,215 |
| Chesapeake Bay | Riparian Forest | 2,000 | 0.768 | 4.528 | 856,359 |
| East Texas & Oklahoma | Bottomland Hardwood Forest | 3,000 | 2.213 | 5.804 | 1,930,473 |
| Great Lakes | Bottomland Hardwood and Riparian Forest | 5,000 | 0.774 | 4.584 | 2,143,303 |
| Puget Sound | Wetland Forest | 5,000 | 0.994 | 9.534 | 4,213,424 |
| Totals | | 100,000 | | | 45,675,325 |

## Cost Factors

Terrestrial carbon sequestration is much more cost effective than other methods. Reducing emissions via geologic sequestration or smoke stack removal is very costly, ranging from $20-150 $MTCO_2E$. Restoring land that captures carbon and reduces emissions associated with agricultural operations costs from $3-6 $MTCO_2E$, although some financial analysts have suggested most forest projects would cost closer to $10 per ton because most carbon benefits are not realized until the 10-40 year tree growth period. This does not take into account the other eco-asset benefits, e.g., water quality and habitat.

There are additional costs to consider when changing to a no-till system – a change requiring a major management shift and thus a great deal of risk. Methods to help farmers mitigate these risks must be addressed and training should be provided on how to successfully change management systems. In addition, it will be important to address those who already utilize carbon sequestering management practices. These farmers, whose soil is already richer in carbon, may not have the same opportunities to sequester additional carbon, but should not be punished or miss out because of their previous good stewardship. In the end, financial incentives, such as carbon easement payment could increase farmer's profit and reward them for good management practices.

Financial incentives such as conservation easements are important. It can be difficult to get a farmer to commit to these projects without upfront payment. This can be a catch-22 inasmuch as land must be committed for restoration before projects can be presented to industry to fund. Thus, carbon offset aggregators may spend much time explaining the carbon market and getting farmers motivated to enroll their land, but are not able to bring money until after a transaction takes place.

Finally, carbon measurement and monitoring needs to be considered when determining the cost of carbon offset projects to farmers and carbon aggregators. This will increase the cost per ton needed to attract landowners to enroll land in a carbon easement and ensure that adequate baseline and monitoring procedures are implemented.

**Conclusion**

If structured properly, terrestrial carbon sequestration projects can have a significant and immediate impact on the carbon market, thereby providing vital time needed to develop new low emission fuel sources with which to meet the world's growing energy needs. Land restoration and land management often generate multiple enhancements to the environment beyond the benefits of carbon sequestration - water quality, wildlife habitat, mitigation banking, and forest banking. Partnerships between energy companies and conservation organizations will help define this market and enable industry to demonstrate a commitment to environmental stewardship to its consumer base, regulators, U.S. Congress, international treaties, and the general public while providing critical revenue to farmers and rural communities struggling with a depressed agricultural economy.

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