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Carbon Sequestration Projects: A Short-term Mitigation to Global Climate Change

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Introduction

The changing demands of consumers on timber markets, products, and amenities is creating unprecedented research in the valuation of non-timber products from forest owners. Both public and private owners of forest lands are beginning to explore the expanding markets into which the products of forests can be marketed. This has occurred before as businesses in the forest products market have searched for ways to bring returns to stockholders in a market known for its volatility, unpredictability, and constant changes over the last century. Now the opportunity to sell the goods and services delivered by standing forests has expanded as society and specifically governments have begun searching for innovative solutions to global climate change.

While businesses on the smaller scale have been focusing on marketing and stockholder returns, the leaders of the global community have been meeting to address the pressing issue of global climate change and its effects on environments, economies, and the people of the world. Meeting in Rio in 1992, in Kyoto in 1997, and again in a third international summit planned for the Hague in 2000, governments are acknowledging the need to address global climate change with political and international action.

The forestland owner and global leaders come together to create solutions for global warming, taking the first steps in a long transition to sustainable energy production in the global community. The carbon absorption processes of forest ecosystems inherently mitigate the effects of carbon release from the burning of fossil fuels and increased deforestation. By creating a market for standing forests to serve as carbon sinks, a short-term solution to increased global warming is created. Owners receive a return for their investment in forest lands while the global community receives an immediate mitigation to global climate change. These forest sinks act as a short-term mitigation while research and development of renewable and sustainable energy sources is expanded, and eventually implemented into the production process. The long-term goal of stabilizing global climate change and reducing emissions levels will be reached as production processes are altered in the transition to a sustainable energy cycle.

I. Global Warming

The 1999 White House Economic Report identifies the Greenhouse effect as arguably the most significant environmental, economic, social, and political problem facing this century. Indications of global warming are demonstrated on all levels of changing climates and environments. Global average temperature is increasing, cloudiness is increasing from the evaporation of oceans, precipitation patterns are changing, and sea level is rising.[i] Increase in clouds leads to warmer winter and cooler summer temperatures, resulting in environments changing that are dependent on specific seasonal temperatures. Today's changes occur at unprecedented rates, having never changed as rapidly in history.

The Earth's climate is determined by the atmosphere, where small amounts of greenhouse gases keep the climate warm but too much causes warming. Greenhouse gases include CO_2 at 0.03% volume and water vapor, methane, nitrogen oxides, and CFC's all in trace amounts. Sea level is rising 2.5 mm/yr. from glacial melt and the expansion of warmer water. Fossil fuels previously stored below the Earth's surface are now reflected in the atmosphere from the burning of stored carbon.

The impact of climate change will be seen in the alteration of natural systems including changes in the earth's freshwater supply, agriculture production shifts, altered trade patterns, and increased costs of food, potentially resulting in major shortages in less developed countries (LDCs). Sea level will rise submerging beach towns and resorts, and marine and terrestrial ecosystems will change causing species migration and change in chemical composition. Direct effects on human health include increased heat stress, air pollution, and disease vectors will change and follow climactic trends.

The economic costs to adapt to climate change are equally as striking as the environmental alterations. Adaptation, for example in the form of emission-reduction technology, costs the U.S. $61-74 billion per year, or 1.1 - 1.5% GDP per year.[ii] In LDCs, the cost is approximately 5% of GDP per year. The loss of species and other environmental alterations are also significant costs.

II. Kyoto Protocol

The 1992 United Nations Framework Convention on Climate Change established the goal for all signatories to return jointly to their 1990 greenhouse gas emission levels. The Kyoto Protocol of December 1997 altered standards and goals and further detailed mechanisms for greenhouse gas reductions. The United States acknowledged its inability to meet reductions stated in Rio in 1992 and modified its commitment to a 7% reduction from 1990 levels over the period 2008-2012.[iii] Included in the Kyoto Protocol are market-based mechanisms to encourage reduced emissions and encourage coordination between countries. These flexibility mechanisms are joint implementation, a "cap-and-trade" permitting system, such as implementing a carbon tax and a system of tradable emission permits, and the Clean Development Mechanism, a mechanism proposed by

Brazil to direct a flow of capital allocated by developed countries for shifts in energy production into developing countries. Countries are permitted to accumulate reductions by reducing emissions in other countries. Mechanisms to reduce the effects of emissions as part of the plan include promoting and sustaining carbon sinks, for example forests, oceans, and grasslands. Eighty-three countries and the European Union have signed, but only 19 countries have ratified the agreement, excluding the U.S. Fifty-five countries are needed to make the agreement compulsory.

A shift in energy consumption patterns and the development of renewable energies are necessary to collectively reduce the impacts of global warming on the earth. Such mechanisms include but are not limited to alternative and renewable energy sources, technology to improve recycling and reduce wastes, new energy policy to institute a carbon tax, expand mass transit, provide incentives for energy alternatives, and create market-based incentives for responsible consumption of energy and waste disposal.

III. Externalities and Market Based Incentives

Externalities exist when part of the cost of production and consumption is borne by a third party other than the producer or consumer. It involves the failure of a property rights system to fully assign ownership of a resource, therefore failing to have an owner bear the full costs of production. In the case of CO_2 emissions, polluters do not pay the disposal costs of emissions, the byproduct of production, because it can be emitted into the air free of charge. The prices of products are "too low", failing to reflect the environmental, health, and aesthetic costs of the emissions associated with the production process, and no incentive exists to develop production methods with less pollution per output. Pollution regulation attempts to remedy this problem by limiting pollution by putting some of the cost onto the producer to discourage pollution.

Traditional command-and-control (C&C) regulation has been found not to be cost-effective in regulating ambient air quality standards. Studies have shown C&C policy costs at least 78% more than the least-cost allocation.[iv] C&C regulation discourages the implementation of technology to reduce emissions by creating even more stringent standards for updated facilities and discourages research and development for increased emissions reductions below the regulated standards. The failure of traditional C&C regulation has led to the increased use of market-based incentives to develop cost-effective solutions to environmental problems. Tradable permits allow more flexibility in meeting requirements for emissions reductions and reduce the cost of compliance. Emission reduction credits allow firms who reduce emissions below regulatory standards to apply for credits to be banked or sold.

IV. Scientific Process

In attempting to quantify the significance of carbon sinks in atmospheric gas levels maintenance, one must understand the scientific process of carbon sequestration. Through photosynthesis, green plants take carbon dioxide from the air, separate the carbon atoms and the oxygen atoms, turning the carbon into biomass such as roots, stems, and foliage, and returning the oxygen atoms to the air. Carbon is released into the atmosphere from vegetative respiration, combustion of wood as fuel, degradation of manufactured wood products, consumption of biomass by animals, and the decay of vegetation.[v] Globally, approximately 100 billion metric tons of carbon are sequestered in biomass annually. The net numerical difference, or flux, between absorption and release is estimated to be a positive net "sink" of 5 billion metric tons of carbon per year.[vi] However, it is important to remember that this is an approximate number considering the numerous variables, making an accurate estimate difficult.

Trees are approximately 25 percent carbon by weight, and the potential of plant carbon sequestration depends on species and age. The carbon sequestration can be significant in a forest ecosystem. For example, one large sugar maple tree has the potential to remove close to 450 pounds of carbon dioxide from the atmosphere in a year. Preserving 29 large sugar maples per operating car in the United States would offset annual U.S. automobile related carbon dioxide emissions.[vii]

Other approaches to reducing global warming through carbon sequestration include optimizing ocean sequestration. Research is being done in Hawaii where carbon is released at 3600 meters below the surface. Researchers are studying the rate of spread of deposited CO_2 molecules in the water, dissolution, and reaction with ocean bacteria.

> "The key to deep ocean sequestration will be making sure the materials don't escape their resting place anytime soon. At 3600 meters, Brewer observed that the reaction between CO_2 and ocean water produced frozen clathrate hydrates, which are cage-like molecules that form around CO_2 molecules. The hydrates sank into the liquid and converted the CO_2 into a solid mass, locking up the CO_2 and possibly making it even less likely to dissolve rapidly into the surrounding water." (Rickey, 16).

Depositing the CO_2 deep enough in the ocean is crucial so as to ensure it will not come into contact with coral which are threatened by increased CO_2 in oceans. Scientists expect CO_2 droplets to rise as they dissolve, sink back to initial level of deposit, and remain for hundreds of years.

V. Forestry Projects

Forests and forest soils store 20 - 100 times more carbon per hectare than pastures or cropland.[viii] Carbon can be preserved by leaving trees standing and carbon in the atmosphere can be stored in sinks created by carbon sequestration projects. The idea of creating projects to make salable permits first came into being in 1976, and was first implemented by power plants offsetting CO_2 emissions by sponsoring sustainable forestry projects in 1989. Also, since 1992, power companies have been allowed to "bank" carbon offset credits which may be redeemable at some date in the future for tax credits. (U.S. Congress, 1992)

Carbon sequestration projects originated in developing countries for a variety of reasons. The potential growth rates and carbon accumulation in trees is higher in tropical countries. The people are more dependent on the products of the forests, and locally supported projects have higher success rates. Larger potential for grant leveraging including debt-for-nature swaps, foreign aid, and volunteer services exists. Finally, it is much less expensive to maintain and develop sinks in developing countries than to reduce output at the source in the United States.

The World Resources Institute (WRI) first began its investigation into carbon sequestration projects in 1988. Applied Energy Services Inc. (AEI) asked WRI to investigate forestry projects as a possible offset to a coal-fired power plant that AEI was building. WRI's research began in an attempt to establish evaluation criteria for various carbon sequestration projects around the world. The initial criteria for evaluation of the projects had four parts: (1) the potential for the projects to offset carbon emissions from the power plant, (2) active local support and participation, (3) ability to leverage additional funds, and (4) experience and commitment of the implementing organization.

The carbon sequestration potential was evaluated using project site data and a simple land-use model. The model was designed to assess the changes in the land uses over time, incorporating the variables of human population growth, need for food and energy, technological change, resource management, and land-use change.

The WRI developed a Land Use and Carbon Sequestration (LUCS) Model to enable comparison between sites and different management regimes. Estimating the amount of carbon sequestered using scientific measurements alone was insufficient. Tree planting, soil conservation, and suppression of forest fires is significant, but ignores the dynamic human interaction with and alteration of the land. The model also included the variables of forest and agricultural management in rural areas, the effects of population growth, and the physical interactions among people and forests in developing countries. Many assumptions had to be made about changes over time in order to isolate essential elements such as population and agricultural productivity. An objective model that "represents the social, physical, and ecological interactions as simply as possible" (WRI, 9) was the goal of the WRI model.

Projects attempting to remove carbon from the air are inherently subject to human induced risks, such as political instability and economic forces, and environmental risks, such as drought and pest attacks. Risks can be mitigated by improving data collection and project monitoring, as well as by endowing projects. Endowment guarantees long-term support, reducing the need to make short-term trade-offs that can jeopardize an entire project, and allows for shifts in funding when problems do arise. Projects need baseline data to establish criteria to make better estimates of future project benefits and monitor performance throughout the project. Relative benefits need to be ranked for funding purposes. An independent agency acting as a monitor provides more accuracy in data comparisons and predictions.

The cheapest and most immediate way to sequester carbon is to preserve standing forests.[ix] A shift in human treatment of the land is the second most immediate way to reduce unnecessary CO_2 releases and improve sequestration. A variety of secondary benefits besides carbon sequestration come from projects, including improving the local people's standard of living, wildlife protection, and biodiversity conservation. When ranking the relative benefits of a project for funding purposes, quantifying potential benefits is difficult based solely on land management for the purpose of carbon sequestration. The secondary effects of slowing deforestation are the immediate benefits of carbon sequestration projects. The projects are providing new funding for essential problems under the guise of research for carbon sequestration.

Economic efficiency is an essential part of evaluating projects. Difficult questions must be asked about the value of any given quantity of carbon sequestered. For instance, is there a benefit from the project if there is still a release of carbon, even if it is a reduced release, or should only projects that have a net improvement be worthy of funding? Displacement becomes significant when forests are closed off and turned into reserves which ignore the reality of indigenous people who live on or use the land for a subsistence lifestyle. The establishment of a reserve must improve the standard of living for those involved and meet basic economic needs so as not to push the people out of their land without viable options.

Projects must account for and foresee the dynamic nature of resource demand and technology. Increased agricultural productivity can in itself, by stopping the expansion of agricultural land, make a major contribution to halting CO_2 release into the atmosphere. Reducing the need to exploit land for agricultural purposes stabilizes land use, and is just as essential as sustainable forest management techniques in protecting forest lands and preventing CO_2 release.

Social projects that benefit local people also tend to sequester carbon. A direct connection exists between the welfare of local people and conserving the surrounding environment. "When agricultural productivity is increased, land hunger is reduced and forest is conserved. Most importantly, the people of the area benefit" (WRI, 66). Forests managed for a stream of income tend to improve the sustainable use of the resource base, encouraging local sustainable development.

The problems of CO_2 release from deforestation are small compared to the CO_2 output from the burning of fossil fuels. Comparing a sink on the ground versus the actual reductions in the amount of CO_2 released into the atmosphere make the significance of one area's contribution seem minor and raise the issue of evaluating the usefulness of projects collectively or individually. The preservation of forests not only stops the immediate release of carbon, it carries the potential to store released carbon in the future. Consequently, it is that much more imperative to examine carbon sequestration projects early so that they may be utilized later when valid, scientifically accredited solutions to global warming are increasingly demanded by governments and social organizations.

VI. The Clean Development Mechanism

The effectiveness of the Framework Convention on Climate Change in Kyoto hinges on 55 countries ratifying the agreement to enter it into force.[x] Developed countries are reluctant to sign anything that may make them worse off than current levels, while LDCs refuse to forfeit their right to cheap energy that rich countries have enjoyed and benefited from for years. Debates over the exacerbation of the separation between winners and losers as well as issues of global equity come into play. Under the convention, Annex 1 countries agree to reduce their emissions by 10%, while non-Annex 1 countries, generally LDCs, are not forced to make any commitment to limitations.[xi]

Despite the absence of ratification, many countries are enacting laws to bring themselves into compliance. Environmental benefits can be gained form pro-active policy reforms in all economies. The Convention outlines two "flexibility mechanisms" to encourage economically and socially efficient reductions in GHG concentrations. The first is Joint Implementation, essentially a global cap-and-trade system of permitting. The second is the Clean Development Mechanism.

Article 12 of the Kyoto Protocol implemented the Clean Development Mechanism (CDM) to identify and finance lower emission development paths in developing countries. The CDM came out of a proposal from Brazil for a "Clean Development Fund" to simultaneously provide an incentive for developed countries to comply with the Convention and provide a source of revenue for developing countries to implement the Protocol.[xii] The purpose of the CDM is similar becasue it meets the goal of the Protocol to stabilize global GHG concentrations by redirecting the flow of capital that must be invested into changing polluting technology in developed countries into developing countries. Under the CDM, reductions in GHG concentrations are relatively efficient. By investing in the development of LDCs' energy production process, the global community receives a significantly larger amount of pollution reduction per dollar than if the same money were invested in developed countries. Further, it affects the development path of

LDCs, promoting renewable energies and production sources that can be sustainable and environmentally friendly in the long-run.

The Protocol outlines three key elements to achieve the stated purposes: certified emissions reductions from project activities in developing countries, a financial mechanism that funnels investments towards these emission reduction and sequestration activities, and the application or use of some or all of these certified reductions in meeting Annex 1 emissions limits.[xiii] "It responds to the needs of Annex 1 nations by offering lower-cost, more flexible options in meeting emissions constraints, while providing a source of capital for the financing of clean, energy-efficient economic development and finances projects with the potential to reduce deforestation and forest degradation in non-Annex 1 countries.

Developing countries would receive expensive technology, funded by Annex 1 GHG reduction funds, allowing LDCs the opportunity to "leapfrog" inefficient and environmentally degrading energy production choices used by developed countries. Developed countries would provide technological "leapfrogging" in the form of the latest, cleanest, and most environmentally friendly energy production technologies available. This is not limited only to the energy sector, but can be applied to land-use and agricultural practices as well. The ability to protect forestlands and make the optimum choices for resource use will reinforce the sequestration projects developing under the CDM.

Baseline criteria for types of forest projects must be clearly established to ensure credit validity under the CDM. Sustainable forest management and reduced impact logging must be measured against a standard baseline to avoid yielding greater carbon credits to the most destructive harvest operations. Only improvements above a standard baseline for forest management within that country would be credible. The income from credits would make sustainable forest management more profitable than clearing the land for low-productivity agriculture. Shifting forest management regimes from intensive harvesting for commodity production provides an opportunity for significant carbon sequestration while not shifting land-use patterns dramatically.

The CDM would not credit carbon stored in wood products.[xiv] Increasing harvesting to increase production generally results in less carbon stored in the long-run as most wood products deteriorate or are used for a short period of time and then disposed of, resulting in a net release of carbon. Some wood products produced on land managed for sequestration and under sustainable regimes may be sold, but only as a small part of projects where sequestration is the primary objective.

Forest conservation provides the largest opportunity for climate and biodiversity elements while simultaneously creating the greatest incentive to threaten global forestlands on a massive scale. Because of the incentive to make all forests threatened to receive the most amount of credits, evidence must be presented to demonstrate the immanent threat to a forest. Projects under the CDM would provide protection as well as providing alternatives to land use conversion, such as increased agricultural productivity on already existing agricultural lands. Applying the income from the carbon credits at a competitive level to forest conversion would create a value-reference point and ensure conservation.[xv]

The institutional structure of the CDM and guidelines for project eligibility form the basis for a successful CDM program, and a few additional elements would enhance the CDM and its effectiveness greatly. First, countries must analyze their own policies that may encourage deforestation through subsidies, tax breaks, or below-cost sales.[xvi] Minimum performance standards for individual countries' forest practice policies may be necessary so as not to waste time and investment funds on mitigating poor environmental policies. Land–use projects must be undertaken with a significant determinant being social benefits and sustainable development. Both factors can play a dramatic role in determining a project's success as well as being a secondary goal of the CDM. Finally, implementation of a monitoring and measurement program for GHG reductions is necessary to determine the projects' success, value, and progress. "The associated monitoring and verification costs should be considered integral to the project, not as unnecessary transaction costs to be eliminated. To realize the potential biodiversity and climate benefits of the CDM, it is critical to build it with appropriate project guidelines, as well as auditing and verification systems." (WRI, *Forest Frontiers Initiative*, 1998) Monitoring and measurement technologies allow the scientific study of climate and biodiversity effects, leading to effective policy development.

VII. Evaluating the Potential of the CDM – Case Studies in Brazil, India, and China[xvii]

The twin objectives of the CDM to reduce GHG concentrations and encourage sustainable development recognize that only through sustainable development of LDCs can all countries play a meaningful role in climate protection.[xviii] The uncertain boundaries and definitions within the CDM in combination with mixed global reactions to the Mechanism result in difficult questions in prioritizing projects when the twin objectives do not naturally align. Creating carbon abatement projects within the LDCs is arguably another version of the developed world using land in LDCs, and directly or indirectly the people, as low-cost alternatives to addressing the source of the problem – the production process.[xix] Designing, selecting, and prioritizing projects must be evaluated not only as low-cost abatement but also as to how they align with the development goals and objectives of the individual countries and cultures.

The World Resources Institute conducted case studies in Brazil, India, and China to evaluate the CDM's ability to fund sustainable development in developing countries. The greatest potential for clean development existed in transforming power generation in utility and industrial sectors, specifically by implementing the latest technologies from developed countries. Capital constraints were the greatest barrier to implementing alternative energy sources, although capital flows under the CDM are designed to help alleviate that difficulty. Also, cogeneration using non-conventional fuel sources provided a significant window of opportunity for compromise between inexpensive fossil fuel use and capital-intensive renewables.[xx]

Conventional development is recognized to bring a host of environmental problems, many of which are not eliminated directly by the CDM. Brazil, India, and China identify development priorities, under which environmental concerns are addressed, yet economic priorities continue to dominate development objectives.[xxi] Many environmental "cobenefits" arose naturally from land-use and forestry projects included under the CDM. "Cobenefits" included improved air and water quality, enhanced soil preservation, flood protection, electrification of rural and remote areas, and increased employment. "Moreover, through careful project selection and prioritization, the level of cobenefits could be deliberately enhanced rather than incidentally generated." (WRI, 1999:4)

Brazil had the greatest opportunity to implement forestry carbon sequestration projects because of its natural environment. Projects are required to address not only project structures but also ingrained social, political, and economic forces working against forest conservation. The natural environment of Brazil lends itself easily to plantation growth of sequestration projects and protection of natural sinks. Plantations have been largely limited by capital constraints while the protection of natural sinks has been limited by a combination of issues. "Curbing deforestation...would require addressing pervasive economic structural problems and a program broad enough to eradicate, not merely relocate, illegal logging. Government-supported concession schemes could be instrumental in providing large-scale reduced-impact logging opportunities." (WRI, 1999:8-9) The major cobenefits of forestry projects in Brazil included soil preservation, improvements in water quality and availability, and protection of biodiversity. Plantations were one of the cheapest offset markets in terms of carbon prices, yet yielded some negative effects such as the impact of the use of chemicals on the natural environments and impact on soils. Sustainable forestry management was slightly more expensive and yielded a higher level of environmental and development benefits for Brazil.

WRI's research on the implementation and effects of the CDM on Brazil, India, and China demonstrates that GHG reductions and sustainable development are mutually advantageous goals.[xxii] The valuation of cobenefits will play a key role in determining increased value of individual projects, providing an increased incentive to invest in more expensive projects that may have longer-term sustainable development goals. Also, the location of projects will have a significant effect on the local and regional environmental quality while the carbon reduction credits are insensitive to location. Governments and investors will have to examine how location affects investment. It remains to be seen how the CDM or the countries themselves will balance the twin objectives with the shared and individual goals of the governments and investors.

VIII. The Growing Market for Tradable CO_2 Emission Permits

While the Kyoto accord poses a threat to the traditional production processes of numerous industries reliant on the release of CO_2 emissions into the environment, investors in forests and agriculture are optimistic for the creation of new markets for tradable carbon permits. In return for paying farmers and foresters for carbon stored in biomass, polluting firms may receive carbon credits towards their reduction in CO_2 emissions. Large investment could flow into rural agricultural areas where carbon-absorbing crops are grown. The January 22, 2000 edition of *The Economist* reports, "Growing such crops as switchgrass not only absorbs carbon, but also produces a fuel that some power plants can use instead of oil, coal, or gas. Techniques that keep greenhouse gases trapped in the soil, such as injecting seeds rather than tilling, have already lead to lucrative contracts" (65). Pacific Power, Delta Energy, and Tokyo Electric Power Company have invested in forest sinks in Australia. The State Forests of New South Wales have established a system of measurement and trade for the carbon dioxide stored in trees. In return for tradable emission credits, the firm pays for the planting and management of forests on local farming lands near Sydney. Talk exists of creating an electronic market for carbon credits, and insurance policies are even being developed in case a forest sink burns down.

In Europe, some organizations offer the opportunity for individuals to account for "personal carbon emissions" to offset the estimated annual three tons of CO_2 emissions that each person on earth, on average, is responsible for. Future Forests, a British organization, will plant and manage the 15 trees it figures must be planted per person to account for the carbon of a lifetime, all for a small fee. (Americans are responsible for one quarter of the world's emissions, approximately 20 tons of CO_2 per year per American. According to the Future Forests estimates, each American would require closer to 105 trees.) Criticism of individual offset programs revolves around the future displacement of problems associated with developing countries' consumption rather than addressing the pollution problem at the source of production. Large corporations investing in such individual offset programs include Mazda, Formula One racing teams, and Mercedes-Benz.

IX. Other Carbon Sequestration Projects

The cost of separating CO_2 from smokestack emissions would boost the cost of electricity an estimated 50 percent.[xxiii] The high cost of separation technology has historically been the biggest barrier to action. Only when the cost of utilities reflects the full-cost of externalities such as human health and environmental degradation will separation technologies seem less expensive in the long-run. In Norway, "carbon taxes" instituted in the early 1990's make carbon release more expensive than storage alternatives. Norway's Statoil company has built an $80 million facility to separate CO_2 from natural gas and inject it into a well 1000 meters below the seafloor of the North Sea. The facility, built in 1996, has already paid for itself, and Statoil plans to use it for another 18 years.[xxiv]

In recent years, oil companies have been pumping CO_2 into reserves underground to increase pressure and boost oil production.[xxv] This extends the life of the oil fields as well as storing the CO_2. Large geologic reserves exist around the world, including numerous reserves in the American West, which scientists believe CO_2 can be pumped into for indefinite storage.

X. The Evolution of Private Markets for Carbon Sequestration Projects

A market for private companies to begin developing carbon sequestration projects is emerging. Increased public acceptance of global warming as a threat and government action slowed by bureaucracy and politics provide an opening for private markets to meet the demand for carbon offsets. In the absence of a regulatory body to monitor project standards, private companies managing CO_2 offset projects will have to create standards that exceed those slowly emerging from international negotiations to ensure long-term validity and reliability. Private companies will have to accept the liability of uncertain performance and potential environmental risks associated with agricultural products to ensure consumer confidence that the CO_2 offsets paid for will be delivered.

Private markets have the unique opportunity to develop significant consumer markets where research has been incomplete. Establishing the validity of carbon offsets as a consumer product will set a precedent for increased production by governments and NGOs. In the short-run, private entrepreneurs may develop a market for consumers to buy their offsets to ease their consciences without altering unsustainable behavior and consuming habits. However, in the long-run, for projects to be viable, they will have to address the production process to determine the carbon content of consumer products by reinvesting in renewable energy sources and developing substitutes to goods produced in unsustainable ways.

Simply buying forests to set aside for carbon sequestration shifts demand to other susceptible areas without addressing the demand which makes forests vulnerable. Stability, longevity, and security of the forest products market, including the allocation of land for trees as a source for timber products, will ensure a constant supply of products to meet consumer demand without threatening other forest and CO_2 projects. In this sense, tree farms and CO_2 projects that preserve forests in perpetuity are complementary industries, not competitors. Realization of the significant role of tree farms to the security of CO_2 sequestration projects is significant in choosing lands for projects.

Collateral environmental benefits will create much of the initial value in carbon sequestration forest projects. While quantifying and marketing the carbon sequestered in trees is a relatively new and emerging market, realizing the value of wildlife conservation and environmental integrity is well-established. The forests will experience a shift from pressures for commercial exploitation while creating financial security for investment. In the event of a crisis, the forest can be harvested to raise funds. The forests will be managed for long-term preservation, also providing the benefits of conservation, biodiversity, and increased natural resistance against diseases and wildfire.

While being free of commercial pressure, forests would also be free from human pressures as human populations will not live on lands managed privately for carbon sequestration. However, such forests will provide employment opportunities to engage local people profitably in conservation efforts. The Oxford-based Carbon Storage Trust will establish a fund to endow the forests in perpetuity as carbon stores.[xxvi] The interest will be reinvested into the community in return for care and management of the reserve. Also, certain management regimes will generate firewood. browse, and/or sustainably harvested wood products to benefit the local people and economy.

Management regimes will vary depending on the type of forest and the local needs. Companies investing in sites eligible for carbon sequestration projects are not under the same constraints as investors in land for forest product production. Trees sequester carbon regardless of the quality of wood for making forest products. The same trees that make poor-quality lumber or wood products sequester carbon as well as other trees (ignoring differences for species and age).[xxvii] Companies have the opportunity to buy up land estimated as poor-qulaity for commercial forestry at low prices, avoiding competition between commercial and carbon sequestration forestry to not be competitors.

Problems unique to forestry projects for carbon sequestration inevitably arise. The displacement of land-use and timber economies is one such problem. Displacement of money invested as part of aid packages, grants, or commercial investments is a second problem. Also, special consideration must be given to evaluation of commercial agricultural land for forestry development. If a project displaces agricultural production to less productive lands, increasing the conversion of other lands for agriculture, the project cannot claim to be a net carbon sink.

A second problem unique to forestry sequestration projects is ensuring the long-term security of the carbon sequestered. Inevitably, adverse circumstances will arise creating pressure to log secured forest projects. In developed countries, with established legal and land tenure systems, land purchases are likely to remain valid.[xxviii] Also, price is likely to reflect the opportunity cost of retaining the land for other uses and reflect adequate information about accepted markets. Finally, developed economies are often characterized by service industries and secure sources of food, fuel, and shelter exist, eliminating the need to provide forest resources for a local population. Consequently, forest projects in developed countries may only involve buying the land and planting, although generally at a higher cost and with greater scarcity.

The developing countries do not have such securities built into existing systems. The concept of land ownership may not be familiar in some societies, legal systems do not guarantee title enforcement, and prices may not reflect full information, resulting in potential for moral claims against land titles.[xxix] Also, subsistence lifestyles are offered few alternatives in economies with support tied directly to the land. Establishing forest projects in developing countries involves securing greater support of the local populations, including communicating the value of conservation as well as ensuring alternative means of support for subsistence lifestyles. Clearly, securing carbon sequestration in perpetuity is an involved process with uncertain outcomes.

The establishment of suitable project criteria is essential to prevent a variety of serious unintended consequences from carbon permitting and offset programs. The impact on the commercial forest products industry has the potential to be dramatic. Producing timber products from carbon storage forests would impact the expected future prices. Also, increased supply would require an associated increase in demand for wood products. Suggestions for the proposal have included creating a market for durable goods produced in sequestration forests, creating a larger mass of wood sequestering carbon.[xxx] This is a weak argument for sequestration for two reasons. First, wood products are rarely durable and once timber has been cut, it fails to sequester further carbon, the point of creating sequestration forests. Second, displacing the commercial timber industry is not the goal of carbon sequestration projects. In fact, the separate goals of securing forests for sequestration and designating land for commercial production of timber are complementary. Carbon subsidized product would replace commercially produced carbon. Securing separate production lands make sequestration land not a threat to the commercial industry, preventing hasty management decisions. Also, forest products from sequestration projects and products produced on sustainably managed and harvested forests would not be easily discernable to the average consumer. Managing forests for sustainable goods production is far different from managing for climate benefits. Sequestration projects that competed for environmental or moral superiority would hurt their own chances of success, as eventually forests designed for sequestration would be logged. Separate forests are needed for commercial production and sequestration.

Offering carbon subsidizes to encourage sustainable forest management practices and as an incentive to halt deforestation also have unintended effects. The incentive for commercial producers to demonstrate bad practices would be created, showing that the shift to sustainable practices has been large, deserving larger subsidies. This is similar to problems created in average cost regulated industries having the incentive to demonstrate higher average cost to receive a higher regulated cost.[xxxi] It would also discourage sustainable practices out of a company's own commitment to responsible production, ideally a shift that companies are making in the 21st century in response to consumer demand for responsibly produced goods. Secondly, all timber lands will become threatened for deforestation if land owners can now be paid to not harvest, something they may never have intended to do in the first place.[xxxii] Interfering with the market mechanism which reflects the full cost of timber production is not an effective long-term solution to deforestation or poor production standards.

Entering carbon sequestration permits into a competitive market without any regulation or standards creates many of its own market problems. Companies need to be held accountable for the very long-term, a difficult guarantee to make in a market with inadequate resources to deal with uncertain outcomes. The marketing of offsets must demonstrate realistic pricing and performance in order to prevent fraud from companies making guarantees they are not able to back up. For example, the Carbon Storage Trust ensures its offset through a diverse portfolio of sequestration projects, local support, non-displacement of other aid packages, and reinvesting returns in the local community and in a cash fund to create new projects if some should fail. Ultimately, carbon sequestration projects will have to be judged on their environmental soundness, as endorsed by independent environmental groups and NGOs, not on price. However, in the early stages, sound financial investment insurance is necessary to gain validity and reliability.

XI. A Case Study in the Private Market for Carbon Offsets: The Carbon Storage Trust, Oxford, UK

The Carbon Storage Trust of Oxford, UK is a commercial organization trading and marketing CO_2 offsets. In a market largely unregulated and relatively new, the Trust has developed four key objectives to create validity and longevity in their program.[xxxiii] The first is establishing standards, which the company will do independently, higher than any expected governmental regulation, to ensure long-term validity as the market develops and comes under increased scrutiny. An Environmental Steering Committee will serve as an independent body to supervise projects and endow the long-term liability of guaranteeing storage. The Environmental Steering Committee will monitor standards and rule over conflicts of interest between non-commercial environmental components and commercial components. The second objective is to determine priorities, recognizing that carbon offsets are a means to an end of developing renewable energy and energy efficiency policies. Forestry offsets will be used to fund the development of renewable energies as a means to reduce carbon emissions from the source. Meeting long-term obligations to ensure the storage of carbon indefinitely is the third objective of the Trust. This includes the ability to replace and develop projects. The final objective is to establish credibility with consumers and industry. The inclusion of independent experts and NGOs is intended to assure the credibility of the Trust by monitoring projects and ensuring the upholding of standards.

The Carbon Storage Trust evaluates project criteria to ensure long-term security for the carbon stored. When the Trust funds projects, it must ensure it is not displacing other invested money in the form of aid packages, grant schemes, or as part of straight-forward commercial investments.[xxxiv] Projects must not shift CO_2 emissions elsewhere. Projects do not reduce emissions if they have not eliminated global demand for the forest product or the equivalent amount of land for production. Projects should avoid preserving carbon on good agricultural land due to economic consequences of shifting food production demand elsewhere. Finally, while the endowment ultimately underwrites the security for long-term storage, all local economic factors need to be assessed to ensure the highest probable success before investing. This includes engaging local organizations and community groups, evaluating the relationship between the project and the local people, and evaluating issues of cultural land tenure.

The Trust has adopted a working definition of perpetuity as "...until levels of anthropogenic greenhouse gases in the atmosphere have started to fall sustaniably and substantially." (Carbon Storage Trust, 12) Recognizing that perpetuity is almost an impossibly long time, and that an established priority is the shift to sustainable energy sources, the sequestration projects are created with the expectation of being one step in meeting a larger goal. The Trust's strategy consists of three components: diversity, sustainable use, and income in perpetuity.[xxxv] Diversity includes projects in a variety of countries, all with secondary goals other than carbon sequestration such as land rehabilitation, conservation, and social benefits. Sustainable use involves community access to sustainably produced forest products such as firewood and select forest products, thus contributing to local incomes. Finally, income in perpetuity involves putting an amount of the income collected by offsets equal to the economic return that could otherwise be derived from the land into an Endowment Fund. This fund will be invested to create income into perpetuity and used to encourage local communities to protect the forests rather than consume them. The cost of this endowment is essentially the cost of storage. Surpluses will be set aside to replace failed projects, if needed.

XII. The Department of Energy's Voluntary Reporting of Greenhouse Gases 1997[xxxvi]

The United States Department of Energy (DOE) has collected reports on current carbon sequestration projects worldwide in a Voluntary Reporting of Greenhouse Gases 1997 Report. A total of 302 projects were reported by 74 entities. Projects by electricity suppliers were the most commonly reported, with forest projects a close second. Only 38 of the 302 projects were forest preservation yet accounted for 76% of the sequestration reported for 1997. Seventy-one percent (224/302) of the projects included tree planting in the forms of afforestation, reforestation, urban forestry, and woody biomass production or agroforestry.

All but one of the 172 afforestation and reforestation projects reported to the DOE were domestic. American Forests, a nonprofit conservation organization, and American Electric Power Inc.(AEP), a large investor-owned utility, accounted for 74% of projects reported in 1995, but by 1997 afforestation and reforestation projects had increased by 50%. The UtiliTree Carbon Company initiated two large-scale domestic programs. The Western Oregon Carbon Sequestration Project is an afforestation project on non-industrial timberland, with long-term management contracts requiring the sites to remain forested for a minimum of 65 years. The Mississippi Valley Bottomland Hardwood Restoration Project is a pilot program of 80 acres with potential of expansion to 70,000 acres. Its goal is to determine the feasibility of sequestration through restoration of bottomland hardwood forest on marginal farmland in Louisiana. A number of electric and gas companies are experimenting with reforestation on company lands.

The unique nature of urban forestry projects make quantification of carbon sequestration difficult. Urban forestry includes tree planting in all urban and suburban settings. Planting trees next to buildings provides the potential to not only sequester carbon in that one tree, but to reduce energy consumption in that building by providing shade in the summer and protection from wind in the winter. Models to estimate the amount of carbon sequestered by the tree often fail to reflect the energy consumption reduction services provided by the trees. Often the emission reduction from consumption reductions are many times bigger than the sequestration itself.

Forest preservation projects reported to the DOE were primarily foreign (33 of 38), in contrast to afforestation and reforestation projects which were almost 100% domestic. The Noel Kemph Mercando Action Project in Bolivia involves the preservation of 634,286 hectares of land on the southern and western boundary of the Noel Kemph Mercando National Park. The program was reported by AEP, PacifiCorp, and BP America. The project consists of 3 parts: 1) carbon dioxide emission reductions through the cessation of logging activities and the protection of forest land from conversion to agricultural use, 2) protection, regeneration, and preservation, and 3) leakage prevention. A reported one million metric tons of carbon dioxide reductions through sequestration or reduced emissions were accounted for in 1997. The Rio Bravo Carbon Sequestration Pilot Project in Belize includes the purchase of 14,400 acres of endangered forest threatened with conversion to agriculture. This project was started in 1995 and is jointly undertaken by a partnership between Cinergy Corporation, DTE/Detroit Edison, PacifiCorp, Wisconsin Electric Power Co., the UtiliTree Carbon Company, the Nature Conservancy, and Programme for Belize, a Belizean nongovernmental organization. Domestic forest preservation plans include maintaining forested buffer zones around plants and including forest preservation as a component of afforestation and reforestation projects.

Modified forest management projects to increase carbon sequestration were reported in Malaysia. Reduced-impact logging techniques such as pre-cutting of vines, directional felling, and planned extraction of timber on properly constructed and used skid trails are combined to reduce logging damage by a goal of 50%.[xxxvii] Also, AEP initiated selective harvesting of upland central hardwood and bottomland hardwood stands to improve growing space relationships and maximize growth rates. DTE conducted similar thinning on previously unmanaged woodlots to increase sequestration.

XIII. The United States' Position on the Kyoto Protocol[xxxviii]

The White House Annual Economic Report published February 10, 200 by the President's Council of Economic Advisors acknowledges the significance of climate change in the 21st century. The report discusses the Clinton Administration's stance on the Kyoto Protocol. It will not send the treaty to Senate for ratification until emissions limits are also set for the major developing countries and clearly outlined emissions permit-trading system is included, similar to the SO_2 emissions trading system included in the 1990 Clean Air Act Amendments. The report finds that trading allowances would have no meaning unless emissions limits are set globally. To prevent the stifling of economic growth, the Economic Report suggests limits that are indexed to growth, such as a ratio of GHG emissions to Gross Domestic Product (GDP). With the leapfrogging of technology, developing countries do not need to go through the same stages of technological development, allowing them to adopt limits without interfering with economic growth. The report advocates reliance on incentives and market-based policies, sitting their success in the past in US environmental policy and acknowledging the dramatic cost savings in emissions reductions.

XIV. The World Bank's Prototype Carbon Fund

The World Bank launched its Prototype Carbon Fund (PCF) on January 18, 2000. It will serve as a mechanism to transfer the capital and technology directed at global GHG reductions from developed to developing countries. The PCF has been established with funds from both governments and private companies and will attempt to make the market for emission reductions outlined in the Kyoto Protocol a reality. Emissions reductions will be independently verified and certified, and reductions will be transferred to contributors in reduction certificates rather than cash.[xxxix] Eventually these emissions reductions will be used against Annex1 countries' reductions commitments under the Kyoto Protocol. Participating governments include Finland, the Netherlands, Norway and Sweden. Private corporations contributing are the electric power companies of Tokyo, Chubu, Chugoku, Kyushu, Shikoku, and Tohoku, the trading houses Mitsubishi and Mitsui, and Electrabel, an electric utility company in Belgium. The World bank will act as a broker for emission prices between buyers and sellers, ensuring technology gains and profits from reduction credits in developing countries and lower-cost emission reductions in developed countries.

Meanwhile, the European Bank for Reconstruction and Development (EBRD) and the Dexia Group launched an equity investment fund to reduce greenhouse gas emissions in central and eastern Europe. Projects in this region primarily are classified as energy-savings, developing in areas such as district heating, public lighting and industry sectors. The Dexia Group is a European banking group that finances services for local governments and public service facilities. In return for financial contributions, investors will receive equity returns and emissions reductions credits that can be used if the Kyoto Treaty is ratified. The EBRD and Dexia Group see in eastern and central Europe, as they transition from centrally planned to market economies, lower cost opportunities for energy savings projects to be developed and credited.

XV. Conclusion

Global warming is increasingly being accepted as the most significant environmental, economic, and political issue facing the 21st century. The acknowledgment of the need for collective action by the global community is significant in taking the first steps towards mitigating global climate change through an international agreement such as the Kyoto Protocol. Innovative and unprecedented approaches to the situations contributing to global warming are an essential aspect on any successful international agreement. The Clean Development Mechanism is one such approach, and although inherently coupled with many unintended side effects and influences, it is a necessary step in exploring new solutions to age-old problems. Included within mechanisms such as the CDM are smaller approaches to mitigating global warming, such as forest sequestration projects, that will collectively make up the larger impacts. The significance of the smaller projects and their contributions to determining successful projects for each country with different development objectives cannot be underestimated. The potential for international cooperation and collective thinking is immense and will truly determine the development and success of the global community in the 21st century.

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[xxvi] Carbon Storage Trust, 10
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