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Renting Carbon Offsets: the Question of Permanence.

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This paper describes a system whereby carbon emission credits would be rented, rather than sold, when carbon is sequestered but permanence of sequestration is either not certain or not desired. Such a system recognizes that stocks and flows can be alternative descriptions of the same phenomenon, and that a stock need not exist in perpetuity to have an equivalent flow. Hence, temporary carbon offset credits can be traded in markets similar to those used for carbon emissions credits. This approach removes the necessity of using the awkward ton-year approach that has sometimes been suggested.

The Kyoto Protocol accepts the principle that sequestration of carbon in the terrestrial biosphere can be used to offset emissions of carbon from fossil-fuel combustion. A concern with carbon sequestered in the terrestrial biosphere, such as in forest ecosystems, is that it may lack permanence (see Sedjo and Toman on this website). Emission credits, as proposed for the energy sector, are based on the idea that a prevented emission is prevented forever, and emission credits might be traded among parties. For sequestered carbon that may subsequently be released to the atmosphere, the issue is a bit more complex, but still tractable. However, it would be advantageous to agree in advance as to the nature of the trading system to deal with temporary offsets and the assignment of liability within the trading system. A rental contract for emissions credits not expected to be permanent would establish continuous responsibility for sequestered carbon; credit would be assigned when carbon is sequestered and debits would accrue when carbon is emitted.

The rental proposal developed is similar to that offered by the government of Colombia except that it casts these temporary emissions credits into the traditional concepts of rental contracts, clarifies the opportunities for secondary transactions and explicitly allows for indefinite contract extensions. Such an approach would be consistent with the

Kyoto Protocol and its attempt to provide quantitative limits on greenhouse gas emissions.

Finally, the effect of renting carbon on an individual project basis should increase total global carbon sequestration. Although any individual project may be temporary, the aggregate effect of economic incentives for carbon sequestration will be to increase aggregate sequestration on a permanent basis. In a world where there are incentives (payment) for carbon sequestration services we would expect more sequestration to be provided at any future time than if no payments were being made.

INTRODUCTION

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC, 1998) has proposed a process for establishing quantitative, enforceable limits on the emission of greenhouse gases to the Earth's atmosphere. The Protocol provides that, within prescribed rules, countries can remove the greenhouse gas carbon dioxide from the atmosphere into living plants, sequester the carbon in the terrestrial biosphere, and use the sequestered carbon to offset some of their greenhouse gas emissions from other sources. Although the future of the Kyoto Protocol is clouded with the withdrawal of the US, the concepts developed are useful for the fulfillment of this agreement or the undertaking of another.

One of the more controversial elements of the Kyoto Protocol has been the use of terrestrial carbon sinks to meet carbon reduction obligations (Articles 3.3. and 3.4.). The possibility of using carbon sinks in the terrestrial biosphere has been recognized as a potentially powerful yet relatively low-cost tool to offset carbon emissions (**Can Carbon Sinks be Operational? An RFF Workshop Summary** Kauppi, Sedjo, et al 2001). However, carbon sequestration has been criticized on several grounds that need to be considered in establishing the rules for accounting (Schlamadinger and Marland, 2000). For biological systems including land use and forestry these include saturation, verification and permanence (**Can Carbon Sinks be Operational? An RFF Workshop Summary** Sedjo and Toman 2001). The fundamental issue that is unique to sequestration projects is the one of permanence, and this is the subject of the current paper.

Is it appropriate to treat carbon sequestration in the biosphere as the negative of emissions to the atmosphere if we cannot guarantee that carbon once sequestered will remain sequestered? In an ideal accounting system it would be possible to treat carbon flows in and out of the biosphere similarly to flows from fossil fuels: flows toward the atmosphere would be emissions and represented with a positive sign while flows from the atmosphere would be treated symmetrically and have negative sign.

We consider possible accounting rules for carbon that is sequestered in the biosphere when the permanence of that sequestration is in doubt. We argue here that permanence of sequestration is unnecessary, that there is value in delaying emissions regardless of the long-term fate of the sequestered carbon. We propose that if emissions reductions are

clearly permanent (e.g. fossil fuel is not burned), then emissions credits might be bought and sold. If emissions reductions are not clearly permanent (e.g. carbon is sequestered in a forest), then emissions credits might be rented instead. What is needed is to establish who is responsible if and when the CO_2 is released to the atmosphere. In this paper we develop an approach for renting emissions credits. We note that this approach is an alternative to the now widely discussed ton-year approach for dealing with sequestration that cannot be considered permanent.

Other systems for emissions trading, e.g. the US system of trading sulfur emissions and the trading of CO_2 emissions from fossil-fuel combustion under the Kyoto Protocol, differ in that they deal only with current year flows and do not confront the problem that decreasing emissions this year may result in increased emissions in some future year. For sulfur emissions there is no storage of sulfur with potential future release. Long-term commitment to storage is required for some other pollutants, such as radioactive wastes.

This paper addresses the design of an accounting system that accommodates the lack of permanence of sequestered carbon and yet allows inclusion of carbon sequestration projects. Finally, we note also that although any individual projects may be temporary, the aggregate effect of economic incentives for carbon sequestration will be to increase aggregate sequestration on a permanent basis.

LIABILITY - A FUNDAMENTAL ISSUE

The essential issue for permanence is liability. The Kyoto Protocol envisions a system whereby credits against emissions commitments can be achieved by sequestering carbon in the terrestrial biosphere. Carbon sequestration is a reversible process, however, and the Kyoto Protocol does not fully prescribe who is responsible if the sequestered carbon is subsequently released and the basis for the credits thereby lost.

If credit is given when carbon is sequestered, who then assumes the liability if the sequestered carbon is lost? The rental system described is such a transfer system, liability would reside with the activity host so long as a rental contract was in place but would revert to the buyer/renter of credits when the rental contract expired. With the proposed carbon rental system commitments would be made one contract period at a time. In this context a major role for insurance might be to cover the damages, i.e., assume the carbon liability, should the buyer/renter go out of business.

APPROACHES PROPOSED FOR ADDRESSING PERMANENCE

The absence of confidence of permanence for carbon sequestered in biological systems has generated some concern. A common approach has been either to acknowledge that the sequestration is likely not permanent, assess the environmental and economic benefits of limited-term sequestration, and allot credits in proportion to the time period over which carbon is sequestered, or to provide reasonable assurance of indefinite

sequestration. The first alternative has led to what has been called the ton-year approach (table 1), a conceptually straightforward approach in which activities would accrue credits for each year that a ton of carbon is withheld from the atmosphere and some quantity of ton-years would be equated with a permanent ton. For the second alternative, three mechanisms for providing reasonable assurance of indefinite sequestration: a.) provide partial credits according to the perceived risk that they will be maintained for a specified time, b.) link temporary sequestration projects with obligations for later action to assure permanence of the emissions reduction, and c.) tax sequestration credits to finance research and development into emissions-saving technologies (Chomitz 2000).

The "rental" approach suggested below is consistent with the first approach suggested above in that it recognizes the benefit of limited term sequestration. The rental approach differs in that it provides full credit at the time of sequestration in return for full liability if the sequestered carbon is later released,. Financial markets will allot values to emissions credits according to the time over which carbon is sequestered and there is no need to define a numerical equivalence between ton-years and permanent tons.

There are a variety of reasons, both environmental and economic, that it may be advantageous for some parties to acquire temporary credits and others to provide temporary credits for carbon sequestration, even when it is understood that the sequestration is not likely to be permanent. These reasons include, but are not limited to:

1.) It postpones climate change. Climate change and associated damage is lessened for every year that the carbon is sequestered.
2.) It buys time for technological progress. Every year that atmospheric CO_2 is restrained provides opportunity to develop or discover alternate ways to avoid greenhouse gas emissions.
3.) It buys time for capital turnover. It can be very inefficient financially to replace invested capital short of its planned lifetime.
4.) It may save money for reasons not already listed. If sequestration is inexpensive and "if the marginal cost of abating industrial emissions is declining, or growing more slowly, than the discount rate, temporary sequestration may be a good bargain" (Chomitz, 2000, p. 12).
5.) It allows time for learning to occur (e.g. Kolstad, 1993).
6.) It may not be possible to arrange for formal insurance for perpetuity.
7.) Hosts may be reluctant or unwilling to provide guarantees in perpetuity, seeing it as an unacceptable intrusion on opportunity or sovereignty.
8.) And, as suggested by Chomitz (2000), some temporary sequestration may turn out to be permanent.

The Special Report on Land Use, Land-Use Change, and Forestry, prepared by the Intergovernmental Panel on Climate Change (IPCC, 2000), describes the ton-year approach for dealing with the lack of permanence of sequestered carbon. In a ton-year system, credit would be awarded for the number of tons of carbon held out of the atmosphere for a given number of years and some equivalency factor would be defined to equate a specific number of "ton-years" with permanent sequestration.

Several approaches have been suggested for defining the equivalency factor, i.e. the number of ton-years that is to be equated with permanence (IPCC, 2000; Fearnside et al., 2000; Moura Costa and Wilson, 2000). Basically one would integrate over time the number of tons sequestered and convert this to tons of carbon emissions offset by dividing the equivalency factor, i.e. ton-years/f = permanent tons, where f is the equivalency factor. This paper agrees with Chomitz (2000) that there is no unique way to determine a conversion rate between ton-years and permanent tons and that the choice among a number of justifiable possibilities is thus a policy decision.

A RENTAL ALTERNATIVE

A rental approaches avoids many of the difficulties discussed above. Just as a space can be rented to provide for the temporary parking of a car, space could be rented for parking carbon. Payments would be made based on the amount of carbon parked and the time for which it is parked. Each period would involve a new carbon payment for that period, even if the carbon volume were unchanged. If carbon accrued on the parking site over time, the period payment for services would rise reflecting the carbon volume accrual (assuming the price per unit volume were unchanged). If the carbon were released, the rental payments would cease and the carbon emitter would once again bear the carbon liability and therefore need to find another storage place, either temporary or permanent, for the carbon.

From a financial perspective it is easy to shift between the value of an asset, e.g., the value of permanent credits, and the annual value (rental) of the services provided by that asset. Furthermore, in a world where carbon emission credits are commonly traded, the market would provide the value of a permanent carbon credit (the asset value). This would provide a base price from which the market could determine the annual rental values for carbon sequestration services. Also, the market would consider the additional costs associated with any extra monitoring (some monitoring would need to take place for sequestration projections whether temporary or permanent). Thus, the market could arrange rental contracts using information on the price of permanent carbon credits, the discount rate, and costs unique to quasi-temporary projects.

With the rental approach, like other investments, one would not expect the provision of indefinite services or full payment before the services were rendered. Contracts could be made for periodic payments, e.g., a payment each year based on the carbon serviced, perhaps with a provision for renewal. If longer contracts were desired, the evaluation of future values would probably be discounted, reflecting both the discount rate and the market's assessment of risk. Most of the advantages of temporary credits (e.g. credit for delaying emissions) rely on the credits being available early in the project life, i.e. at the time of actual sequestration.

Additionally, a rental system would provide symmetry. Debits and credits would both be accounted on a periodic (perhaps annual) basis and would be counted in the time interval

that the loss or gain of carbon occurred. This overcomes the ton-year problem when dealing with "temporary" debits.

There are a variety of ways that insurance programs might be used to provide reasonable expectation of permanent sequestration. However, with the rental system suggested here, the role of insurance would be substantially less critical and investors would have incentives to pay market rates for credits to protect their flow of future annual payments. Any insurance would be for defined contract periods and with better definition of risk. In this context a major role for insurance might be to cover the damages, i.e., assume the carbon liability, should the buyer/renter go out of business.

Even when permanent sequestration is not certain, it is possible to devise approaches to try to assure that impermanent sequestration is linked to a permanent net reduction in emissions. Since the payments for carbon services are made on a period basis, continuing the carbon services would result in continuing period payments for carbon sequestered earlier. Continuing payments provide continuing financial incentive to continue to provide sequestration services. Thus, while there is no initial commitment that the project is permanent, the investor has reasons to try to extend the period of sequestration. Permanence in a forest, for example, might be accomplished by establishing a steady-state forest on a previously unforested site. Once the steady state biomass (and carbon) is attained, the investor has a financial incentive to try to maintain the steady-state function, as the rent flow will be lost if the carbon parking service is discontinued. Van Kooten et al. 1995 have shown that at certain relative prices the maximum value of the timber asset would be attained by focusing solely on carbon sequestration and ignoring timber harvests entirely. Permanence might also be accomplished through a reserve of extra credits or through an obligation to replace temporary credits with permanent credits over time.

RENTING CREDITS: SOME ASPECTS

A traditional system for limited-term use of a capital asset involves a rental contract, and rental contracts seem ideally suited to transfer of emissions credits for carbon sequestration where permanence is either not guaranteed and/or not desired. A rental contract can allow the "buyer/renter" to enjoy the limited term benefits of the asset while the "seller/host" retains long-term discretion.

A principal feature of a rental system is that it behaves like a direct credit/debit system for the renter of credits. Credit is assigned when carbon is sequestered and debits accrue when carbon is emitted. The credits and debits are symmetric and instantaneous. The difference is that credit is leased for a finite term, during which someone else accepts responsibility for emissions, and at the end of that term the renter will incur a debit unless the carbon remains sequestered AND the lease is renewed.

At the end of the rental period the renter will have received some of the benefits listed above and can either renew the lease or incur the emissions debit and replace the credit

with one from another activity. We would argue as an analogy that a party renting a garage to park his car is able, at the end of the lease contract, either renew the release or find another place to park his car. The car driver might have used the rental term to either find a better lease agreement elsewhere, build his own garage, or make the decision to park his car on the street and suffer the damages. The car driver might have found another mode of transport and no longer need a garage.

At the end of the rental agreement the renter would incur an emissions debit and the host would be released from further liability. If the carbon remained sequestered the host could: a.) renew the lease, at newly re-negotiated terms, b.) lease the credit to another Annex B party, c.) retain the credit for its own use, or d.) set free the sequestered carbon if it had a higher use for the committed land. The emissions credit would in fact be used only one time, but it could be transferred among parties at any later time (so long as the carbon remained sequestered) if the first party incurred a current year debit and the new renter received a current year credit. To continue the metaphor, our car driver above would be looking for a new place to park his car but the garage would be available for another driver. And if the garage owner had become wealthy enough to purchase a new car, he could decline to renew the lease and use the garage for his own car.

A rental contract for emissions credits would establish continuous responsibility for sequestered carbon. The host country would have to accept short-term liability, over the duration of the rental contract (although the liability could be transferred to an insurance or bonding agent). The renter would need to have legal and financial recourse for provision of the contracted service, i.e. carbon sequestered. In fact, it is likely that the renter would ultimately absorb the cost associated with the risk of premature carbon loss. Presumably the value of rented credits would vary with the credibility and responsibility of the host.

Table 2 illustrates the flow of carbon and carbon credits for 2 potential accounting approaches (ton-years, and carbon rental) for a simple scenario. We consider that one ton of carbon is sequestered in the first year and that it remains in the terrestrial biosphere until being released in the eleventh year. We assume that 50 ton-years are taken to be equivalent to one permanent ton.

Our proposal is similar to that of Colombia except that we establish no expiration date. Expiration occurs when it occurs, and the implication is that the rent payments cease. The duration of rental contracts could be left to the discretion of the contracting parties. Thinking in terms of rental contracts also tends to make clear the opportunities for secondary transactions, a concept not addressed by the Colombia proposal. Describing the approach in terms of rentals helps bring the proposal into familiar financial terms and concepts. In the words of traditional property transactions it might also be appropriate to think in terms of easements.

One question posed with regard to rental credits involves the long-term commitments of corporations or other non-governmental organizations that engage in rental agreements for carbon emissions credits. These entities would essentially accept long-term,

unsecured obligations for carbon releases potentially many years after the use of the credits, and there is no assurance of their existence and responsibility by the time that the rental contracts expire. In fact it is governments that will likely be bound by international obligations, whether they be taxes or rations on emissions, and that must ultimately determine the extent to which they will choose to include rented credits as part of their reporting and long-term obligations. We cite student loans as an example where the US government backs long-term, unsecured obligations by students seeking to finance their educations. The US government ultimately backs these loans but imposes limits on the magnitude of individual obligations. Similarly, individual countries may choose to provide limits on the extent to which individual investors can use rented credits to contribute to meeting the national commitment.

CONCLUSIONS

Rental of carbon emissions credits should ideally bring benefits to both the renter and host. The attraction of rented credits for the renter would presumably be financial. Those in need of credits could buy permanent credits, rent temporary credits, or borrow money to purchase permanent credits as in taking a mortgage on the garage. Rented credits would provide revenue to the host. They would also, presumably, bring a flow of development and environmental values to the host. They would not, however, obligate the host beyond the negotiated rental contract, a matter that has been of considerable concern to potential host countries.

Finally, we note that the effect of renting carbon on an individual project basis should increase total global carbon sequestration. Although any individual project may be temporary, the aggregate effect of economic incentives for carbon sequestration will be to increase aggregate sequestration on a permanent basis. In a world where there are incentives (payment) for carbon sequestration services we would expect more sequestration to be provided at any future time than if no payments were being made.

REFERENCES

Bird, N., 1997. Greenhouse Challenge Carbon Sinks Workbook: A Discussion Paper. Greenhouse Challenge Office, Canberra, Australia, as cited in IPCC, 2000.

Blanco, J., and C. Forner, 2000. Special Considerations Regarding the "Expiring CERs" Proposal; paper prepared for presentation at the International Forum on Enhancement of Japan's Private Sector's Overseas Re-afforestation Cooperation, Fall, 2000. The Ministry of the Environment, Colombia, 17 pp.

Chomitz, K. M., 1998. Baselines for Greenhouse Gas Reductions: Problems, Precedents, Solutions. Development Research Group, World Bank, Washington DC, USA, 62pp, as cited in IPCC, 2000.

Chomitz, K. M., 2000. Evaluating Carbon Offsets from Forestry and Energy Projects: How do They Compare? World Bank Policy Research Working Paper 2357, New York, 25 pp., see http://wbln0018.worldbank.org/Research/workpapers.nsf/5ade973899c860868525673100 6834d5/d92de72e3c60be77852568f9004b40e3?OpenDocument

Colombia, Ministry of the Environment, 2000. Expiring CERs, A Proposal to Addressing the Permanence Issue, pp. 23-26 in United Nations Framework Convention on Climate Change, UNFCCC/SBSTA/2000/MISC.8, submitted 13 Sept., 2000, available at www.unfccc.de.

Dobes, L., I. Enting, and C. Mitchell, 1998. Accounting for Carbon Sinks: The Problem of Time, pp. 1-15 in L. Dobes (ed.) Trading Greenhouse Gas Emissions: Some Australian Perspectives, Occasional Papers no. 115, Bureau of Transport Economics, Canberra, Australia, as cited in IPCC, 2000.

Fearnside, P. M., 1997. Monitoring Needs to Transform Amazonian Forest into a Global Warming-Mitigation Option. Mitigation and Adaptation Strategies for Global Change 2: 285-302.

Fearnside, P. M., D. A. Lashof, and P. Moura-Costa, 2000. Accounting for Time in Mitigating Global Warming Through Land-Use Change and Forestry. Mitigation and Adaptation Strategies for Global Change 5: 239-270.

Intergovernmental Panel on Climate Change, 1995. Climate Change 1994: Radiative Forcing of Climate Change. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change, 2000. Land Use, Land-Use Change, and Forestry: A Special Report of the IPCC, Cambridge University Press, Cambridge, UK.

Kauppi, P., R. Sedjo, M. Apps, C. Cerri, T. Fujimori, H. Janzen, O. Krankina, W. Makundi, G. Marland, O. Masera, G-J. Nabuurs, W. Razali, and N. H. Ravindranath,

2001. Chapter 4. Technical and Economic Potential of Options to Enhance, Maintain, and Manage Biological Carbon Reservoirs and Geo-engineering; in Report of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, in press.

Kolstad, C. D., 1993. Looking vs. Leaping: The Timing of CO_2 Control in the Face of Uncertainty and Learning, pp. 63-82 in Y. Kaya, N. Nakicenovic, W. D. Nordhaus, and F. L. Toth (eds.), Costs, Impacts, and Benefits of CO_2 Mitigation, International Institute for Applied Systems Analysis, Laxenburg, Austria.

MacLaren, J. P., 2000. Trees in the Greenhouse: The Role of Forestry in Mitigating the Enhanced Greenhouse Effect. Forest Research Bulletin No. 219, Forest Research, Rotorua, New Zealand, 72 pp.

Marland, G., B. Schlamadinger, and P. Leiby, 1997. Forest/Biomass Mitigation Strategies: Does the Timing of Carbon Reductions Matter? Critical Reviews in Environmental Science and Technology 27: S213-S226.

Meinshausen, M., and B. Hare, 2000. Temporary Sinks Do Not Cause Permanenet Climatic Benefits. Manuscript distributed at the 6th meeting of the Congress of Parties to the UN Framework Convention on Climate Change, The Hague, The Netherlands, Sept., see www.carbonsinks.de.

Moura Costa, P., and C. Wilson, 2000. An Equivalence Factor Between CO_2 Avoided Emissions and Sequestration – Description and Applications in Forestry. Mitigation and Adaptation Strategies for Global Change 5: 51-60.

Richards, K. R., 1997. The Time Value of Carbon in Bottom-up Studies. Critical Reviews in Environmental Science and Technology 27: S279-S292.

Schwarze, R., and J-O. Niles, 2000. The Long-Term Requirement for CDM Forestry and Economic Liability. Journal of Environment and Development 9 (4): 384-404.

Schlamadinger, B., and G. Marland, 2000. Land Use & Global Climate Change: Forests, Land Management, and the Kyoto Protocol. Pew Center on Global Climate Change, Arlington, Virginia, USA, 54 pp., available at www.pewclimate.org.

Sedjo, R. A. and M.Toman, 2001. "Can Carbon Sinks be Operational." RFF Workshop Proceedings. RFF Discussion Paper 01-26, July.
http://www.rff.org/disc_papers/PDF_files/0126.pdf

Tipper, R., and B. H. de Jong, 1998. Quantification and Regulation of Carbon Offsets from Forestry: Comparison of Alternative Methodologies, with Special Reference to Chiapas, Mexico. Commonwealth Forestry Review, 77: 219-228, as cited in IPCC, 2000.

United Nations Framework Convention on Climate Change, 1998. The Kyoto Protocol to the United Nations Framework Convention on Climate Change, document FCCC/CP/1997/7/Add.1, available at www.unfccc.de.

Van Kooten, G.C., C.S. Binkley and G. Delcourt, 1995. "Effect of Carbon Taxes and Subsidies on Optimal Forest Rotation Age and Supply of Carbon Services," *Am. Journal Agric. Econ* 77: 365-374.

Van Kooten, G. C., A. Grainger, E. Ley, G. Marland, and B. Solberg, 1997. Conceptual Issues Related to Carbon Sequestration: Uncertainty and Time. Critical Reviews in Environmental Science and Technology 27: S65-S82.

TABLE HEADINGS

Table 1: A variety of values have been suggested for the conversion rate between ton-years of carbon sequestration and permanent tons of carbon emissions reductions.

Author	Ton-years Equal to 1 Permanent ton
Tipper and de Jong, 1998	42 - 50
Fearnside et al., 2000	46
Chomitz, 1998	50
Moura-Costa and Wilson, 2000	55
Bird, 1997	60
Fearnside, 1997	100
Dobes et al., 1998	150

Table 2: The flow of credits and debits for 2 different accounting alternatives when 1 unit of carbon is sequestered in year 1 and subsequently released in year 11.

Year	1	2	3	4	5	6	7	8	9	10	11
Carbon Sequestered	1										
Carbon Released											1
1. Ton-years earned											
credits	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	
debits											
2. Rental											
credits	1										
debits											1