

Making carbon markets work for small forest owners

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Abstract

Small forest owners have a wide variety of forest types, age class distributions, forest sizes and management strategies making it awkward, if not impossible for them to participate in carbon markets. The key issue is that the focus of forest-based systems for sequestering carbon is largely on creating permanent stores of carbon on defined areas of land with a one-off payment to the forest owner for the carbon. From a forest management perspective, this focus leads to either continued production of timber only if the forest area is sufficiently large to create an effectively permanent carbon pool, and otherwise a cessation of harvesting if the forest area is too small. Combined with a payment system for carbon that is generally based on matching a specific buyer and seller of carbon using a one-off payment to the forest owner, this creates a carbon market that is too inflexible to attract any but the largest land or forest owners. This paper presents an alternative system for marketing sequestered carbon - carbon banking. Carbon banking treats sequestered carbon in the same way that a financial institution treats capital. In essence, forest owners 'deposit' carbon, in exchange for an annual payment, and those who need carbon offsets 'borrow' carbon by making an annual payment. The role of the carbon bank is to aggregate deposits of carbon and use these to meet various demands for carbon. The carbon bank provides an opportunity for small forest owners to participate in carbon markets because payments are based only on current carbon sequestered. It also allows participants in the carbon market to receive current value for carbon rather than what effectively represents the capitalised value of the future benefits of sequestering carbon, thus removing some uncertainty about locking into the wrong value for carbon.

Keywords: carbon markets, non-industrial forests, carbon sequestration, small-scale owner

Introduction

Forest carbon trading systems have emerged as an important effort to mitigate the effects of greenhouse gas emissions through the sequestration of atmospheric carbon (van Kooten and Sohngen, 2007; Chomitz, 2000; Sedjo *et al.*, 2001; Marland *et al.*, 2001a; Marechal and Hecq, 2006). Examples of forest carbon markets include the Chicago Climate Exchange (Chicago Climate Exchange, 2008), the New South Wales Greenhouse Gas Abatement Scheme (NSW, 2008), and the New Zealand Emission Trading Scheme (Ministry for the Environment, 2007). With the development of carbon markets, for many forest owners, carbon sequestration in trees is potentially an important non-timber source of income. However, the way that forest carbon trading systems have developed creates particular constraints that limit participation in carbon trading schemes for many forest owners, particularly small owners. The purpose of this paper is to outline the characteristics of current forest carbon trading schemes, highlight the effect this has on participation in carbon trading, and to propose an alternative structure that would provide more opportunities to take advantage of this ecosystem service for a wider range of forest owners.

Constraints Imposed by Current Carbon Trading Schemes

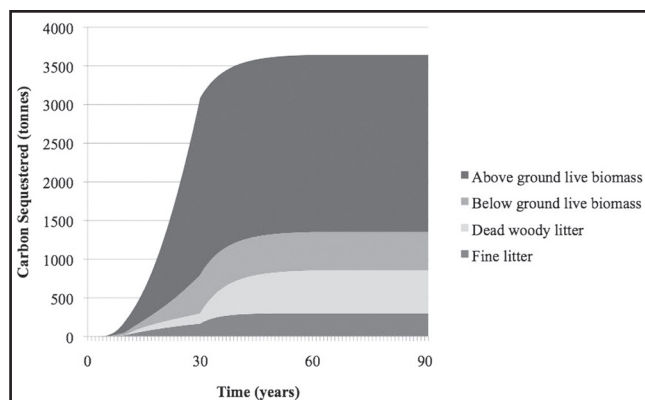
Current carbon trading schemes define a number of key characteristics for a forest carbon asset that influences the type of forest owner that can effectively participate in these schemes. In particular, there are two important constraints that emerge from current carbon trading schemes. One constraint arises from the definition of the underlying forest asset that forms the carbon reservoir, and the other arises

from how the price of carbon is determined.

Defining the Forest Asset

Trading is always done in terms of CO₂ equivalence but the actual carbon is stored in various pools, including trees or soil. As such, a mechanism is required for converting any of these to a measure of carbon that meets the specific definition of a carbon asset. Generally, this will involve a calculation of CO₂ equivalence, specification of the length of time the asset is under contract, and specification of the forest management that results in the CO₂ equivalence (Ellis, 2001; Chomitz, 2000; Hamburg, 2000; Chomitz and Lecocq, 2003). It is the definitions of CO₂ equivalence that constrain many forest owners from participating in carbon markets.

The common approach to carbon trading either requires or assumes that sequestered carbon is provided by an entity that has a large enough forest area under management to provide a stable reservoir of carbon over the usual cycle of growth and harvest for individual forest stands so that the sequestered carbon is 'permanent'. This is analogous to the constant level of growing stock found in the classic normally structured forest estate model. In addition, a forest owner selling credits is typically required to undertake a long-term commitment to maintain a forest. For example, in the New Zealand Permanent Forests Sinks Initiative the commitment is for perpetuity, although there is an option to exit after 50 years (MAF, 2007), and the NSW Greenhouse Gas Abatement Scheme the commitment is for 100 years (State Forests NSW, 2004). There are also restrictions on forest management. This may be in the form of a commitment to long-term forest estate plan that governs harvest volumes and reforestation activities. It may also



Source: Bigsby (2009). Based on a normally structured 30 hectare plantation harvested on a 30 year rotation using sequestration data from Paul *et al.* (2008).

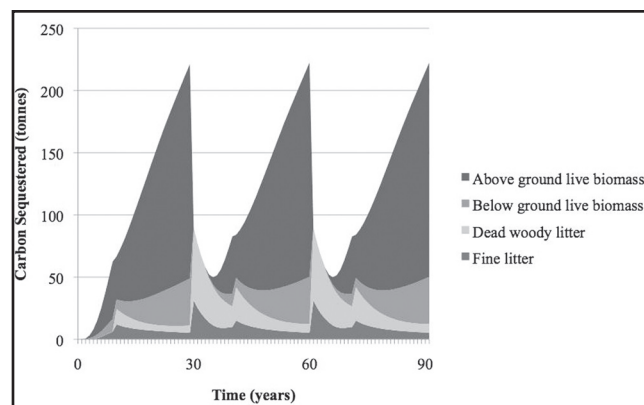
Figure 1: The preferred forest structure in carbon trading is one where the forest is normally structured and maintains a relatively steady pool of carbon.

place restrictions on the species chosen, or the silviculture options available to the forest owner. In some cases it may even require a change in the harvesting system from clear fell to continuous cover harvest systems (MAF, 2007).

If the constraints created by current carbon trading schemes are combined, the implicit 'optimal' forest owner for participation in carbon markets is either a large scale forest owner that has a normally structured forest with constant annual harvest, or a forest owner who will never harvest. . For example, Figure 1 shows outcome of an afforestation project where the trees are managed on a 30-year rotation. After 30 years the forest has a steady state reservoir of carbon. The forest structure shown in Figure 1 is essentially the preferred forest structure for carbon markets and similar approaches have been used as the basis of forest carbon projects (Sedjo *et al.*, 2002). As an indication of this requirement, the list of carbon funds and projects included in the World Bank's Carbon Finance Unit shows that projects are expected to yield 50,000 tonnes of CO₂ equivalent per year (Carbon Finance, 2008).

The constraints however have major implications for small forest owners. Figure 2 shows the same type of afforestation as in Figure 1, but in a structure that is more typical of small forest owners where they do a single planting that is harvested after 30 years then replanted. This results in a cyclical pattern of 'temporary' sequestered carbon rather than a steady state (Paul *et al.*, 2008; Ellis, 2001; Cathcart, 2000). The cyclical, temporary nature of the carbon storage in these forests means the effective exclusion under current carbon trading systems of all forest ownership that does not provide the normally structured forest in Figure 1.

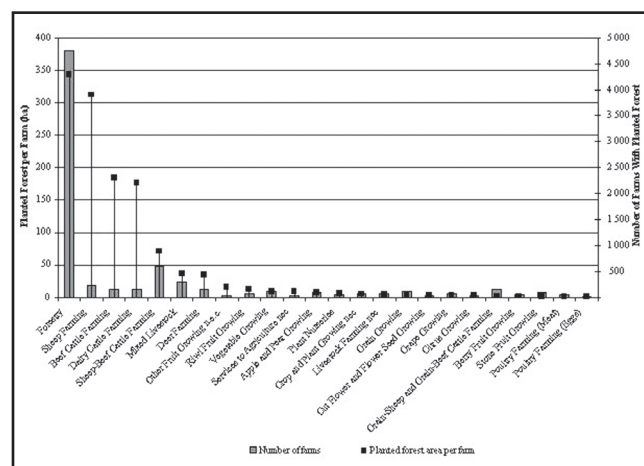
The potential for small forests to contribute to carbon sequestration is significant. There are roughly 15 million private forest owners in European Union, with an average forest size of 13 hectares (EU, 2006). Of the forested land in the U.S., 38% is private, non-corporate forest (USDA,



Source: Bigsby (2009). Based on sequestration data from Paul *et al.* (2008)

Figure 2: Typical forest structure with small forest owners is one where the forest is not normally structured and the carbon pool fluctuates significantly as harvests take place.

2008) and in some regions average size of forest ownership is small. For example, the average size of private forests is 4 ha in Massachusetts and 9 ha throughout New England (Kittredge, 2005). In 2002 in New Zealand, there was 1.8 million hectares of planted forest on 15,000 properties, of which about 192,000 hectares was on 10,700 properties that did not define themselves as primarily forestry (MAF, 2002). As can be seen in Figure 3, the largest number of properties with planted forests were those that identified as being primarily forestry, with an average forest size of 380 hectares. However, there were also 3,900 sheep farms with an average of 19 hectares of planted forest, 2,300 beef farms and 2,200 dairy farms with an average of 12 hectares of planted forest, and 890 sheep-beef farms with an average of 48 hectares of planted forest. These same four farm types also had about 370,000 hectares of mature native bush and 590,000 hectares of native scrub or regenerating native bush in 2002 (MAF, 2002). In addition to existing forest, much of the land that afforestation can take place on is under agricultural land uses where the average farm size is not very large. Since some mix of agricultural and forestry is often the optimal



Source: MAF (2002)

Figure 3: Planted Forest by Farm Type

land use, this further reduces the potential size of areas for afforestation on any particular land ownership.

Lastly, a forest owner who has not committed to one particular permanent land use or silvicultural prescription is also excluded from the system. Not considering more than one rotation of a plantation, or a desire to have flexibility in rotation age, harvesting intensity, spacing or species, precludes these forests from being considered as part of the carbon market. In addition to issues related to the size and structure of forests for small land owners there are the additional issues of time frame of commitment, loss of management flexibility and risk of forest (and carbon) loss (Ellis, 2001). While many of these latter issues are common to a range of forest owners, they may be amplified for small forest owners.

The Price of Carbon

Another feature of the forest carbon market is that the payment for carbon is typically a single, upfront payment for permanent (at least notionally) ownership of the carbon. For both buyers and sellers of carbon credits a key issue is uncertainty about the future price of carbon. Carbon trading is done through new and evolving markets that must reflect changing legislation, sequestration technology and climate change science, and thus there is significant price risk in the future (Williams *et al.*, 2005; Katila and Puustjärvi, n.d.). Forest owners are exposed to the risk that future price changes make their future liability for forest losses higher than what the carbon was sold for. Carbon buyers are also faced with the uncertainty of when to purchase carbon since markets are only just developing and current prices may not reflect true value for carbon, leaving them in a situation where they have paid too much for their carbon credits and have to write down their value.

For the forest owner, an important risk is that a forest is a biological asset that is subject to the risk of catastrophic disturbance from natural dangers such as wind or fire (Ellis, 2001; Sedjo and Marland, 2003; Dutschke, 2002), as well as being susceptible to pests and diseases that can injure or kill trees. Any of these events can reduce the carbon reservoir and expose the forest owner to a liability for the carbon they have sold but no longer hold. In addition, since the initial carbon payment reflects a particular silvicultural regime (eg. rotation length, harvesting intensity, species, stocking), any change to silviculture will potentially change the amount of carbon sequestered and force the forest owner to compensate with credits purchased elsewhere. The same would apply for a change of land use out of forestry.

Temporary Credits, Carbon Rental, and Carbon Banking

An important component of how forest sequestration has been defined is in the concept of 'permanence'. Essentially, behind the concept of permanence is the notion

that once sequestered, the same carbon must continue to be held in the same location and form as when it was first sequestered. For some, this notion of permanence means that only the sequestration of the same carbon molecules can be considered to be permanent (e.g. underground injection of CO₂), while for others the concept of permanence extends to something like a pool of carbon sequestered in a forest under some steady-state management regime with a formal contract that requires the forest owner to permanently follow that management regime. In either case, it is possible to identify a specific location or area with a quantifiable amount of sequestered carbon.

An alternative concept to permanence is that of 'temporary' sequestration. Temporary credits are created when there is an explicit recognition that the credits have a finite life (e.g. a project) or where there is uncertainty about the permanence of the sequestered carbon (Marland *et al.*, 2001; Dutschke, 2002; Chomitz, 2000; Sedjo *et al.*, 2002; Marechal and Hecq, 2006). In temporary sequestration, the location and form of a specific carbon molecules or pools of carbon are not important, only the aggregate number of molecules sequestered. In other words, one carbon molecule in a particular location and form is substitutable for another.

The difference between permanent and temporary sequestration is analogous to the concepts of strong and weak sustainability. Weak sustainability focuses on sustainable flows rather than the source of the flow, while strong sustainability focuses on sustainability of a specific resource (Pezzey and Toman, 2002a; 2002b). Permanent carbon credits can be thought of as 'strong' sequestration, with a focus on continued sequestration of the same carbon molecules or pools. Temporary credits, with substitution of carbon molecules and pools, can be thought of as 'weak' sequestration. Weak sequestration through the use of temporary carbon credits is still important in the wider context of climate change and should be valued in carbon markets. Temporary pools of carbon help to postpone the effects of climate change, allowing time for the development of new technology to replace technology that emits CO₂ emitting or to permanently sequester CO₂. It also bypasses the problems of perpetual insurance in permanent forestry projects, makes additionality easier to validate, and imposes fewer sovereignty constraints than permanent credits.

Three practical approaches have been identified to deal with temporary carbon sequestration (van Kooten and Sohngen, 2007; Ellis, 2001; Sedjo and Marland, 2002; Marland *et al.*, 2001b).

- Use a conversion factor to translate years of temporary storage to a permanent equivalent storage (ton-years).
- Issue Temporary Carbon Emission Units (TCER) for a temporary carbon offset credit that needs to be continuously replaced by the purchase of new TCERs as the old ones expire.
- Use the market system by renting carbon for a finite

period of time at which point the renter would have to renew the rental agreement or find replacement carbon to rent.

The first two approaches will still lead to a project-based approach to forest carbon sequestration that would create problems for many forest owners (e.g. Marechal and Hecq, 2006). The carbon rental approach however, provides a number of opportunities for developing carbon markets for a wider variety of forest owners. It makes intuitive sense to purchase and sell carbon credits if the sequestration is permanent but to rent if it is not, or to rent when there is unequal responsibility for sequestration or an unwillingness of some parties to make long-term commitments given the uncertainty or form of control over emissions (Marland *et al.*, 2001; Sedjo and Marland, 2003; Chomitz and Lecocq, 2003; Kerr, 2003). The combination of the requirements for the typical physical forest asset (forest estate) and how carbon is priced (permanent ownership) means that current approaches for carbon markets resemble that of a broker (Figure 4).

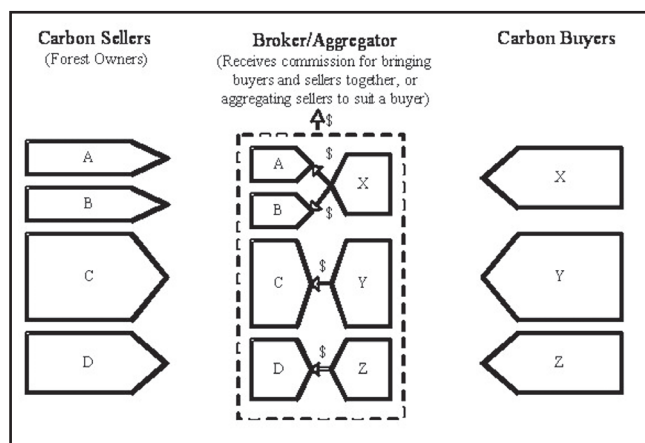


Figure 4: The Carbon Brokering System

The job of the broker is to match specific sequestration requirements of buyers with the owners of corresponding carbon reservoirs. The broker is paid for facilitating the trading of carbon but does not take ownership of the carbon in any sense. This also means that the broker must find buyers and sellers with the same transaction size requirements, or find ways of aggregating sellers or unbundling buyers to meet market needs. The current system of carbon trading, while facilitating the development of a market for forest carbon for some forest owners, still leaves a significant part of the potential forest carbon reservoir outside the system. While some size and structure issues have been addressed through aggregation or pooling of smaller forests in different schemes, a number of issues remain. The first issue is that there is many forests where the ownership is too small or too fragmented to ever approximate the scale or forest structure required for current carbon trading.

Carbon Rental

The concept of carbon rental to accommodate carbon sequestered in biological assets such as forests and soils has been explored by a number of authors (Sedjo *et al.*, 2001, 2002; Marland *et al.*, 2001; Sedjo and Marland, 2003; van Kooten and Sohngen 2007; van Kooten, 2004; Sohngen and Mendelson, 2007; Lewanowski *et al.*, 2004; Tavoni *et al.*, 2007; Cacho and Lipper, 2007, Kerr, 2003; Dutschke, 2002). The essence of the carbon rental concept is to apply capital market concepts to payments for carbon. For example, the current carbon market system uses a single, upfront payment that is essentially the purchase of an infinite period of carbon sequestration services provided by the carbon asset.

The rental concept requires the single payment to be converted to an annual rental payment for carbon (sequestration) services. This can be derived from the carbon purchase market in the same way that bond yields and prices are determined in financial markets or property prices and rentals are determined in the real estate market (Marland *et al.*, 2001; Sedjo and Marland, 2003; van Kooten, 2004). A capital value (CV) for an asset can be determined from its annual yield (y) and the interest rate (r) (Biggsby, 2009).

$$CV = \frac{y}{r} \quad (1)$$

Since we already have a Carbon Capital Value for (CCV) from existing carbon markets and interest rates from financial markets, the terms in Equation 1 can be rearranged to solve for an Annual Carbon Rental (ACR).

$$ACR = CCV \times r \quad (2)$$

With the development of carbon rental market the ACR could also be derived directly from a (future) carbon rental market. The carbon rental market should reflect the same time preferences as financial markets, resulting in a similar upward sloping 'Yield' or rental curve (Figure 5). Longer commitments on the part of both carbon borrowers and lenders will require higher annual payments to compensate for the reduced flexibility or increased security. The differential between borrower and lender yield curves, similar to financial markets, provides the return to the intermediary.

The carbon rental approach in Equation 2 has been used in models incorporating the economic value of sequestration, but these models also assumed the existence of some type of institution where the rental agreements could be arranged (Sun and Sohngen, 2007; Sohngen and Mendelsohn, 2003; Tavoni *et al.*, 2007; Cacho and Lipper, 2007; Lewandrowski *et al.*, 2004, Ellis, 2001). What is missing is the type of institution or market that would facilitate rental of carbon.

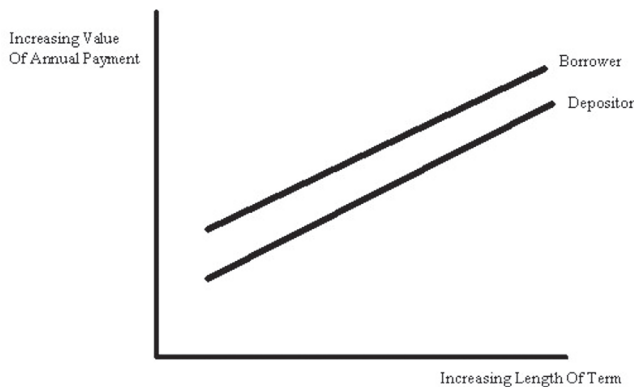


Figure 5: Carbon Rental 'Yield' Curve

Carbon Banking

One way of facilitating carbon rental is carbon banking (Biggsby, 2009). The use of the term 'carbon banking' in this paper is different than other authors who use the term to refer to a process of 'banking' credits under the Kyoto protocol during an interim period to be used during the commitment period (e.g. Parkinson *et al.*, 1999; Bosetti *et al.*, 2008). The basic idea behind carbon banking is to create a carbon market that is analogous to a capital market and which functions similar to a financial institution. Carbon banking uses a number of key aspects of financial institutions. First, in financial markets capital is not 'purchased', but rather is just 'rented' through the use of interest payments for the use of capital. Second, in financial markets, depositors with varying amounts and commitment periods create a pool of capital that can be separately loaned to borrowers, also with varying amounts and commitment terms. A similar concept for carbon markets has been outlined by Eusola and Weersink (2006), although their approach is more akin to developing a bond market by focussing on a minimum 5-year time periods for rental agreements.

The basic structure of an institution that could facilitate this market (the carbon bank) is shown in Figure 6. A key element of the bank is how carbon is characterised, or how the deposits denoted by A through G in Figure 6 are created. The carbon assets on deposit during a year are measured on an annual basis that can change from year to year, rather than being a single long term, steady state figure. This allows the carbon in the forest to change as the processes of harvest and regeneration take place, land use changes occur or natural disasters take place.

A 'deposit' of carbon happens when a forest owner registers their forest for a defined period of time. The initial carbon deposit is determined and subsequent carbon deposits will need to take into account changes to factors such as area and stocking. As with other carbon accounting systems yield tables, growth models, annual or periodic measurements, or some combination of these can be used to establish initial carbon levels and subsequent changes. The forest owner will be paid an annual amount based on the minimum carbon sequestered throughout that year.

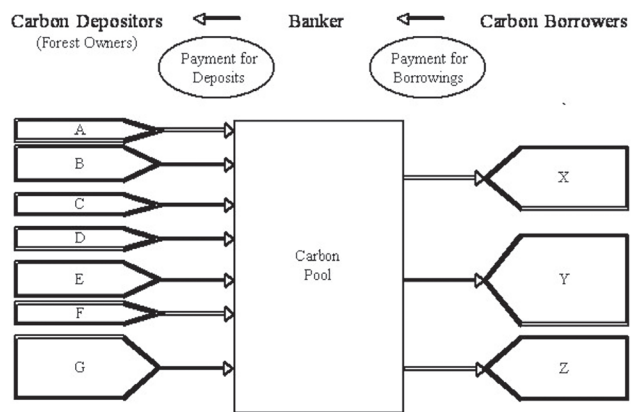


Figure 6: Carbon Banking - The bank creates a carbon pool by taking deposits from carbon owners in exchange for an annual payment and then loans the carbon to borrowers who pay an annual rental.

The deposits of a number of forest owners create a carbon pool at the bank. There will be annual 'withdrawals' due to net harvest reductions and catastrophic events, for example fire or insect damage, as well as annual 'deposits' through new forest owners registering forests and net forest growth. The net balance creates a pool of carbon that the Carbon Bank can loan out. Unlike a financial institution, there is no credit multiplier. The carbon bank can only loan out the physical carbon assets it has on deposit. In fact, the carbon bank would likely be subject to a 'reserve requirement' to account for unexpected reductions in the carbon pool during a year that means it will always have a loan portfolio that is smaller than its deposits. Chomitz and Lecocq (2003) suggest that an appropriate portfolio of sequestration projects might maintain 80 to 90 percent of carbon over the long term, implying a 10 to 20 percent reduction in what can be loaned out. The Forest Resource Trust in Oregon uses a reduction of 20 percent to create what is called an insurance pool against unanticipated withdrawals (Cathcart, 2000). For those who need carbon, it is 'borrowed' for a specified period of time at a given rate per unit of carbon per year. This can be structured similar to a loan agreement.

Conclusion

The development of carbon banking provides a number of advantages over the current broker-based system for trading carbon. In particular, it adds a significant degree of flexibility to forest owners, allowing almost any forest owner to potentially be involved in the carbon market. The flexibility includes reduced financial risk due to catastrophic loss since annual payments are based only on sequestered carbon in that year, and a reduction in carbon through some type of catastrophe means only that there is no payment for the carbon, rather than a potentially significant liability for replacement of the carbon as in the current system. Flexibility also includes the ability to change forest management since the carbon bank does not place the same long-term management constraints as the current system, allowing forest ownership to change, whether that

is through family succession or sale, and not impinging on the new owner to pursue their own plans.

An important difference between carbon banking and the current system is the annual payment structure. In the current system, the forest owner gets an upfront payment and no further income. Over time, the maintenance of the forest for carbon becomes tied to a past payment, and may become more of a liability because it is less relevant to the interests of the current management. With carbon banking, there is a positive incentive for forest owners to maintain forests because current payments rely on the presence of the forest in the contracted state.

Another advantage of an annual payment is that no party is locked into one value of carbon. At present, both parties are forced to take a position on the price of carbon in a rapidly developing and dynamic market, leaving the potential for either party to suffer significant financial losses. Carbon banking removes this risk by allowing the rate at which carbon is paid for to fluctuate according to the market and the term of the sequestration. Transaction costs can be a significant part of project based carbon sequestration (Cacho and Lipper, 2007). The use of a carbon bank should however reduce transactions costs associated with the carbon market by reducing the number of parties who are involved and having a single agency dealing with both lenders and borrowers.

There are some issues that will need to be addressed to facilitate carbon banking. One is that there will likely need to be the creation of appropriate carbon assets through the creation of a right to the carbon. An example of how this can be done is the New Zealand Forestry Rights Registration Act, which facilitates the creation of tree ownership that is separate from the land. In principle, this type of legislation should be able to be extended to the carbon contained in trees or in the soil. Another issue is verification of the carbon sequestered and the cost of verification. Obviously, payments based on annual levels of sequestered carbon will require an annual audit or in the case of forest or management changes, a re-measurement. This could be addressed using some type of trade off between the level of accuracy or detail in measurements and a discount from the maximum potential value (Hamburg, 2000; Chomitz, 2000; Marland *et al.*, 2001). This type of trade off is typical in any inventory system and should be easy to implement in this context. Given the context here, the payment might be discounted to represent the lower bound of measurement error for whatever system is used, similar to what has been suggested for the New Zealand PFSI (PFSI Team, 2007). However the measurement is done, forest owners must weigh up the relative costs and returns of accuracy versus the cost of measurement.

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