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Carbon offsets from afforestation and the potential for landowner participation in Ontario

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Introduction

Climate change is perhaps the greatest environmental policy challenge of the 21st century. Recent warming of the climate system is now accepted to be "unequivocal" and "very likely" due to the observed increase in atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHG) (IPCC 2007). In addition to the need for aggressive action to reduce fossil fuel consumption – the largest contributor to increases in GHGs in the atmosphere – a range of complementary activities can help to mitigate climate change by reducing emissions or *sources* of these gases, and/or increasing the *sinks* that remove these gases from the atmosphere.

Afforestation, or the planting of trees on previously non-forested lands, is one means of reducing atmospheric CO_2 levels and mitigating climate change. Trees function as relatively cost-effective biological carbon (C) sinks, removing CO_2 from the atmosphere through the process of photosynthesis, and converting this atmospheric form of C into plant biomass. Carbon sequestration in biomass is one of many benefits of planting trees; others include maintaining ecosystem resilience by protecting ground and surface water quality and quantity, controlling erosion, and creating wildlife habitat, as well as economic and recreational benefits (Freedman and Keith 1998).

Most (72%) of the approximately 1.26 million ha of marginal agricultural land available for afforestation in Ontario is located in the south and is privately owned (Parker et al. 2000, OMNR 2002, Bird and Boysen 2007). Therefore, the potential for afforestation to contribute to climate change mitigation efforts in Ontario depends on the willingness of landowners to commit their land to growing trees (Cherry 2001, Bird and Boysen 2007). Studies of the afforestation potential in Ontario have demonstrated that opportunities to enhance afforestation activities are significant but require appropriate incentives (Bird and Boysen 2007, ArborVitae et al. 1999). For example, if planting costs are subsidized for landowners, over 300,000 ha of private land in Ontario would be available for afforestation (Bird and Boysen 2007).

As C markets emerge, it is anticipated that afforestation projects will generate C offsets and provide a new revenue stream for landowners enrolled in afforestation projects (EOMF 2003). Most emerging domestic and regional emissions trading systems, including the Western Climate Initiative (WCI 2008), Canada's proposed offset system (Government of Canada 2008) and an Ontario system under discussion (Government of Ontario 2008), propose to include afforestation as a permissible offset activity. Protocols are being developed for quantifying, monitoring, and reporting the amount of C in afforestation projects to verify and support the sale of offset credits. These credits can be banked or sold to major regulated industrial GHG emitters under the auspices of developing cap and trade markets and are seen by industry as a cost-effective method of meeting some of their emissions reductions targets. Private landowner participation in afforestation programs will be influenced by potential financial return from the sale of C offset credits relative to other land use opportunities.

Afforestation is anticipated to be an important component of Ontario's broader provincial efforts to achieve significant GHG emissions reductions to combat climate change (Government of Ontario 2007). Evaluation of the relative contribution of afforestation in meeting future reductions targets depends upon analysis and validation of proposed C quantification and afforestation protocols as well as understanding the feasibility and constraints to the participation of private landowners in afforestation projects and future C markets. This note presents: (1) the results of efforts to test a proposed afforestation protocol[4] for use in Ontario and (2) a summary of two regional workshops designed to solicit input from private landowners about basic features of afforestation programs needed to increase their willingness to plant trees and participate in a future C market.

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[4] The Ontario protocol is currently in draft form but contains accepted C accounting methods and is largely consistent with other existing afforestation protocols (IPCC 2000, Jenkins et al. 2003, Alberta Environment 2007).

Methods

The testing of the draft afforestation protocol consisted of two primary components. In the first component, technical aspects of C accounting methods were examined using tree planting data from recent afforestation projects and enabled us to: (1) characterize the average size of individual afforestation projects in southern Ontario, (2) forecast C storage and offsets generated by these projects, and (3) identify needed improvements in the C accounting component of the protocol.

The C accounting methods described in the draft afforestation protocol were tested using data gathered from recent afforestation projects in eastern (in the South Nation River Conservation Authority watershed) and south-central Ontario (in the Credit Valley Conservation Authority watershed). This information included data on the tree species, number of trees, and area planted, as well as the site preparation, planting, and tending methods used. These data were used to derive forecasts of total carbon (C) (tonnes ha^{-1}), annual total carbon increment (tonnes C ha^{-1} $year^{-1}$), and total carbon offset (tonnes CO_2 equivalent[5] [CO_2e] ha^{-1}) stored in living tree biomass over time for 30 individual private landowners. These calculations depend on knowledge of the projected total merchantable stem volume associated with a given species and plantation age. For this analysis, the relationship between tree stem volume and age for individual tree species or species groups was derived from several literature sources that contained regionally relevant growth and yield information (e.g., US EPA 2007). Stem volume was converted to estimates of total tree volume and total carbon contained in the tree stem, branches, and roots using allometric relationships and biomass expansion factors contained in the draft protocol. The potential financial return from C offsets that may be generated by afforestation was demonstrated by forecasting C offsets for 20-, 40-, and 60-year-old plantations using actual data from tree planting projects of the workshop attendees. This exercise also served to identify issues with of the proposed C accounting procedures and enabled an independent evaluation of the practical feasibility of the monitoring requirements of the protocol.

The second component of this effort involved conducting two workshops with private landowners to discuss opportunities and potential barriers to their participation in tree planting programs and future C markets. Each workshop began with a series of short oral presentations describing the role of afforestation in Ontario's efforts to mitigate to climate change, basic features of tree planting programs, an introduction to the operation of cap and trade markets, an overview of basic C accounting methods, and discussion of forest C storage and offset potential of the tree planting activities of the individual landowners. These presentations were followed by facilitated discussions of key features of afforestation programs as they influence landowner participation, including aggregation, encumbrances, ownership issues, and incentives. The results of these discussions are summarized below.

Results

Quantifying potential C offsets using data from existing afforestation projects in southern Ontario demonstrates that a potential revenue stream is available to landowners. On average in the plantations assessed, C storage amounted to approximately 5.7 t CO_2e per hectare per year (t CO_2e ha^{-1} $year^{-1}$) over an initial 20-year period. Carbon offset values[6] of $20 per t $C0_2$e may generate revenues in the order of $115 ha^{-1} $year^{-1}$, from which costs for measurement, verification, aggregation, and project administration must be subtracted.[7] Actual C storage may be higher or lower than these estimates depending both on the inherent growth rate of the species planted, and site characteristics and management actions that influence tree growth rates (Parker et al. 2009).

Results of the analysis also demonstrate that planting projects in southern Ontario are typically small – commonly in the range of 2 to 6 ha. For example, in a 5 ha plantation planted with a mix of species, C offsets over 20 years may total about 530 t CO_2e (106 t CO_2e ha^{-1}) with potential revenues of $10,600 ($2100 ha^{-1}) over a 20-year period (Table 1).[8]

Table 1. Carbon storage, offsets (CO_2e), and credits at year 20 for a single landowner with a 5.0 ha plantation in South Nation River Conservation Authority area. Total C values are presented for total area and per hectare.

Species	Number planted	C storage (tonnes)	CO_2e (tonnes)	C credits ($)
Jack pine	1000	15.2	55.8	1116
White pine	5500	83.7	306.9	6138
White spruce	3000	36.8	134.8	2697
Red oak	500	8.8	32.3	646
Total	**10,000**	**144.5**	**529.8**	**10,597**
Total per ha	**2000**	**29.0**	**106.1**	**2118**

Note: An assurance factor of 0.10 was applied to the C values above to account for potential C reversals (Alberta Environment 2007) such as fire and disease.

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5 CO_2 equivalent (CO_2e) is a standard unit that expresses the energy trapping properties of any greenhouse gas and the length of time it remains in the atmosphere relative to that of CO_2. This standardized measure allows for comparison of greenhouse gases normalized for their global warming potential. For carbon stored in tree biomass, 1 kg C is equivalent to removal of 3.667 kg CO_2 from the atmosphere.

6 Carbon offset values of $20 per t $C0_2$e (the anticipated price of offsets in a regulatory offset system by 2015).

7 These costs are unknown and depend on how projects are aggregated.

8 This assumes the same value of $20 per t CO_2e and does not consider costs for measurement, verification, aggregation and project administration.

Summing the results from multiple local plantings of several species covering about 60 ha, we estimate that a group of landowner planting projects could potentially store 6100 t $C0_2$e over a 20-year period or 310 t $C0_2$e year^{-1}. It is anticipated that offset credits will be traded units of 10,000 t $C0_2$e or more. Therefore, it will be in the best interest of landowners to join together in order to participate in the carbon market. For example, where planting projects encompass 2 to 6 ha, 950 to 600 projects would be needed to produce enough offset credits for sale on the market.

The generally small scale of tree planting projects in southern Ontario illustrates the need for some type of aggregating organization or partnership to support the participation of landowners with small holdings in the C offsets market. Aggregation has the potential added benefit of simplifying the process and reducing the costs of afforestation projects by providing landowners with technical services such as forest inventory, monitoring, verification, and data management. As well, aggregators may assist with combining diverse C offset project activities being pursued by landowners (i.e., combining afforestation, forest management and agricultural offset activities). Landowners expressed a clear preference to work with existing entities such as local co-op structures and planting agencies with which they share history and trust, and that are familiar with the local and regional tree planting projects. For large sales of C offsets in tradable units, even further aggregation may be required, which may best be done by an organization capable of brokering large trades. Other points that emerged from these discussions included the need for certainty that aggregators will remain in operation over the long-term and the desire for flexible agreements (e.g., timeframe, choice of species, management approach, transferability, exit conditions) capable of meeting the specific concerns and objectives of individual landowners.

Landowners have various motivations for planting trees. Some landowners view tree planting in economic terms (e.g., enhanced property values, tax benefits, and future returns from harvest), while others plant trees for broader societal benefits based on a conservation and environmental ethic and to meet recreation and inheritance value objectives. In almost all cases, the potential sale of C offsets earned through tree planting is a value-added element and appears not to be a primary motivator for most landowners to become involved in afforestation. Clearly, a successful afforestation program will need to be inherently flexible and structured to accommodate differences in objectives among landowners.

To have a tradable, economic value in the carbon market, C stored by afforestation projects must remain permanently sequestered in the trees for a designated period. This period of C permanence is determined by the length of the afforestation project agreement. This is an important feature of afforestation programs since it has a significant influence on the level of participation by private landowners. Experience in other jurisdictions has revealed that some agreement criteria, such as the need to sign some type of conservation easement, may reduce landowner participation. Discussions with landowners suggested that perpetual easements are a significant deterrent to their participation in offsets projects. The key concern with such encumbrances is that landowners are hesitant to commit their land to a specific use for extended periods because land use opportunity costs and landowner objectives can change dramatically over relatively short periods of time, particularly in rural areas close to expanding urban centres.

Incentives to landowners are necessary to stimulate afforestation on private land (Bird and Boysen 2007). To be attractive to landowners, financial return from afforestation at minimum needs to be comparable to other land use opportunities. Return on investment based only on revenues from offset credit sales will likely not be high enough (i.e., at the assumed rate of $20 per t CO_2e) and would need to be supplemented by the sale of wood and/or tax allowances as partial compensation to cover investment costs. Competition from other forest-based activities such as economic opportunities from planting of trees to supply the developing wood pellet market may also reduce interest in afforestation programs.

Given the variety of different arrangements that exist for tree planting on private land, ownership of the saleable C offsets may differ among partners in these agreements. Equitable, shared ownership is preferred when financial assistance for tree planting is received from an external source, but with recognition that many of the additional costs and liabilities beyond plantation establishment (e.g., management and silvicultural costs, property tax payments, etc.) are typically borne by the landowner. As such, shared ownership and distribution of revenue from sale of C offset credits should favour the landowner. Again, as for other issues of importance to landowners, flexibility in the ownership structure to accommodate changes in price levels of C offsets and landowner objectives will be a key component affecting participation in afforestation programs.

Conclusions

Data from tree planting projects in southern Ontario indicates that as carbon markets emerge a potential revenue stream is available to landowners. The development of an offsets market that includes afforestation projects can help to stimulate interest in afforestation efforts in Ontario. Landowners have diverse interests and motives for tree planting including economic returns, broader societal benefits, and personal objectives. In most cases, the potential sale of C offsets is a value-added element and not a primary motivator for the landowners involved. To be successful, afforestation and C offset programs in Ontario will need to be designed to accommodate the needs and concerns of private landowners with small land holdings.

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Compensation des émissions de carbone grâce au reboisement et possibilité de la participation des propriétaires fonciers en Ontario

La présente note décrit les résultats de deux ateliers régionaux qui avaient été organisés pour analyser un protocole proposé afin de déterminer la quantité de carbone qu'il serait possible de faire absorber par la plantation d'arbres en Ontario. Ils avaient aussi été organisés pour obtenir les points de vue des propriétaires fonciers privés au sujet des éléments de base des programmes de reboisement, le but étant d'accroître leur bonne volonté de planter des arbres et de participer à un futur « marché carbone » (sorte de bourse où sont échangés les droits d'émissions de CO_2). Les données issues de travaux de plantation d'arbres dans chacune des deux régions dans le Sud de l'Ontario ont été utilisées pour relever les éléments des mécanismes de comptabilisation du carbone qu'il faudrait améliorer et pour évaluer la faisabilité des règles liées au contrôle. Les résultats montrent qu'un marché de compensation des émissions de carbone qui comprend des travaux de reboisement peut aider à encourager la plantation d'arbres en Ontario. Les propriétaires fonciers ont des intérêts et motifs divers pour planter des arbres, dont les avantages d'ordre financier, les avantages pour la société et les objectifs personnels. Dans la plupart des cas, la vente potentielle de crédits de carbone est un élément à valeur ajoutée et n'est pas une mesure incitative primaire pour les propriétaires fonciers qui participent. Le reboisement et les programmes de compensation des émissions de carbone en Ontario devront être conçus pour répondre aux besoins et aux préoccupations des petits propriétaires fonciers privés.

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