Accounting System Considerations: CO_2 Emissions from Forests, Forest Products, and Land-Use Change

A statement from Edmonton*

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meeting together in Edmonton, Alberta, Canada on 28-30 July, 1997
have agreed on this statement of principles relative to reporting
emissions of greenhouse gases
from forestry, forest products, and land-use change.

With continuing concern about the accumulation of greenhouse gases in the earth's atmosphere, there is increasing interest in accounting for the sources and sinks of these gases and in exploring for ways to slow the atmospheric accumulation by decreasing sources or increasing sinks. Also, as interest in mitigating climate change builds, there is an increasing tendency to assign credit for providing greenhouse gas sinks and debits for greenhouse gas sources. The United Nations Framework Convention on Climate Change, for example, asks each country to provide estimates of its greenhouse gas sources and sinks and to adopt plans to stabilize or reduce its net of emissions. Increasingly this kind of accounting of credits and debits is being applied at smaller scales as, for example, various sub-national states and provinces estimate their net emissions and the US adopts a program whereby corporations, small businesses, or even individual citizens can report their emissions and emissions-reduction efforts. The international program of Joint Implementation will permit investor countries to take credit for emissions reductions achieved through sponsored programs in host countries. Pressure is building for a binding system of national emissions reductions and this will be a primary focus for an international gathering in Kyoto, Japan in December, 1997.

In this atmosphere of emissions credits and debits, of distinguishing between "my" emissions and "your" emissions, we should be clear about the accounting rules. Which emissions will appear in my account and which in yours? Our concern here is in an accounting framework for estimating and accounting for CO_2 emissions related to the harvest and use of forest products. We suggest that there are five principles that should be recognized in an accounting strategy: accuracy, simplicity, scale independence, precedence, and incentives. By "accuracy" we mean that the accounting framework should produce an accurate estimate of what emissions occur and in whose account they appear. We use "simplicity" in the context that Albert Einstein had in mind when he wrote that things should be made "as simple as possible, but not simpler"; recognizing that for reasons of data and expertise one might be obliged to accept an accounting that is less complete than would be desired. "Scale independence" reminds us that a methodology adopted for use by countries should be equally appropriate if applied to groups of countries, states, or even corporations or projects. "Precedence" calls to mind that strategies adopted in apparently similar situations elsewhere may provide a frame of reference that is accepted by users and expected by observers. Finally, we recognize that the system of accounting for credits and debits may provide a set of incentives and disincentives for behavior and that the system will be counter-productive if it fails to provide incentives for the desired behavior. We enlarge on these principles below and discuss two alternative approaches for assessing CO_2 emissions related to the harvest and use of forest products.

Accuracy

To ensure accuracy we need a clear and complete description of the system to be accounted for. We need to know that all items will be accounted for and that none will be multiply counted. If we use a set of subsystems, we need to be sure that they fully describe the whole. We should include CO_2 emissions from gasoline combustion in the account of the vehicle user, regardless of where the fuel was produced, because this is the point at which the CO_2 is discharged into the biogeochemical cycling of carbon. But, should the same be said of biological systems? Should a biological "source" be separated from the corresponding biological "sink"? We suggest that forests and forest products are part of the biogeochemical cycling of carbon, that the system of concern is as shown in the figure below, and that this figure is an appropriate system description at any chosen geopolitical scale.

Simplicity

A suitable accounting strategy for national (or sub-national) greenhouse gas emissions must be sufficiently simple that it can be used by national teams in most nations. At the same time, we should not reduce the procedures to the lowest common denominator of technical ability or data. In this sense the procedures might be simplifiable so that where expertise or data are presently inadequate to do a full accounting, simplifying assumptions can be made. This is not merely a detail. An accounting system may be "simplifiable" so that it recognizes limited access to data and/or expertise, but a system description that is too simple does not accurately characterize the system of concern.

While CO_2 emissions from gasoline should appear in the accounts of the vehicle user, we doubt that accounting should be carried to the point that individuals must show as a source for the CO_2 they respire while credits for providing a CO_2 sink go to the farmer who produces the vegetables that provide their metabolic energy. It makes sense to recognize that there is an inherent linkage between the vegetable garden and the vegetable consumer. We need not be concerned about the spatial specifics unless we are concerned in biogeochemical details that might distinguish a CO_2 sink at a farm in Brazil from a CO_2 source at a dinner table in the USA, or if we have reason to believe that there is a large and growing storage of vegetables somewhere in between.

Scale Independence

Global commitments to accounting for greenhouse gas emissions and reducing net emissions are being made by countries. Actions to assess and reduce emissions will occur at the local, corporate, or project level. We need accounting strategies that are equally appropriate at all scales. One can argue that imports and exports of wood products are not an important contribution to a given nation's greenhouse gas emissions. At the corporate or project level, however, imports and exports of wood products can be a very important component of the greenhouse gas balance.

Precedence

There is an established and appropriate tradition that emissions of pollutants are accounted at their source. We preserve this precedent in reporting emissions of CO_2 from gasoline in the account of the vehicle user rather than in the account of the fuel producer.

Should we do similarly when we consider emissions of C that can be recycled, C that is already part of the biogeochemical cycle, C that is potentially removed from the atmosphere at one site and returned at another, C that is cycled as in the vegetables above? It is instructive to consider fuel ethanol produced from corn, a system that lies somewhere between the human diets and fossil fuels discussed above. If CO_2 emissions are to be counted at the point of fuel ethanol combustion we must surely give credits to the farmer who raised the corn, thus removing CO_2 from the atmosphere. If this approach were adopted, the farmer could get CO_2 sequestration credits if the corn is used to fuel automobiles but not if the corn is used to feed people. Energy produced from tree biomass is similar, the linkage between CO_2 removal from and return to the atmosphere seems compelling. To maintain the connection, we should account for all C transfers. The forest owner who produces biomass sustainably and uses it for fuel has no net effect on atmospheric CO_2. If biomass production and biomass use are not by the same party, or even in the same country, the linkage between the two should still be fully accounted, as in the figure below. The principle of simplicity suggests that we acknowledge the inherent cycling of C and include neither the sink nor the source of CO_2 when vegetables are consumed, when fuel ethanol is consumed, or when other renewable biomass fuels are consumed as well. Time, however, is an important consideration, a tree takes years to grow but can be burned in a day. In any of these cases annual inventories of emissions would require recognition if any stockpiling or withdrawal from stocks occurs. Stockpiling does occur when the purchaser of wood experiences an increased store of durable wood products; i.e. when the receipt of wood products exceeds their oxidation and sale. Withdrawal from stocks occurs, for example, when harvest from a forest exceeds the net annual increment of growth.

Incentives

An accounting strategy can provide incentives and disincentives for behavior. From the perspective of the atmosphere, if a tree is grown by party A and then sold to and burned by party B, no net emissions of CO_2 , when averaged over time, will have occurred. The discussion above suggests that the accounts of both Party A and Party B should show no net emissions. In effect, we have measured the C balance for each party and neither has accumulated nor lost C. We have included all C transfers across the system boundaries, as described in the figure. An alternative accounting strategy would be to ignore the transfer of carbon from Party A to Party B, to account only the transfers of carbon between the respective parties and the atmosphere when they actually occur as CO_2. This accounting would show Party A to have, over time, a net sequestration of CO_2 while Party B provides an identical source of CO_2 to the atmosphere. This procedure treats the CO_2 emissions as we would CO_2 from fossil fuel, while separating the biological emissions from the corresponding biological sinks. For the sake of discussion we call the first approach discussed above the "stock change" method and the later approach the "CO_2 flow" method. *(Footnote: These names have been inherited from earlier discussions and are used here to maintain the continuity of the discussion, even though we recognize that they are inaccurate. Alternative names should be sought because the current names do not accurately characterize and distinguish the methods employed.)* The distinction is really one of system boundaries and, if properly executed on a global basis, both methods would provide an accurate account of net emissions to the atmosphere. But, it must be recognized that the stock change method reports where carbon is being stored on the ground, not the physical location at which CO_2 is removed from or released to the atmosphere. Geographically explicit carbon or CO_2 fluxes can be used in the process of calculating stock changes, but this need not necessarily be the case. Stock changes can also be assessed by estimating the stock at different times. In its final reporting the stock change method reports the net change in biological carbon stocks regardless of the nature of the associated fluxes. The CO_2 flow method, on the other hand, seeks to report the geographic location at which wood and wood products are oxidized and carbon is fixed by forest growth, the physical location at which flows to and from the atmosphere (i.e. across the atmosphere's system boundary) actually occur. If we dismiss as impractical and unnecessary the prospect of a geographically explicit accounting of emissions and sinks related to agricultural products (and the associated animal and human respiration), it does not seem important that the accounting system for emissions from forest products and renewable biomass fuels also does not provide a geographically explicit inventory of CO_2 flows to and from the atmosphere. The stock change method does report a geographically explicit inventory of changes in biologically active carbon pools related to forest products and renewable biomass fuels.

The two accounting strategies described in the preceding paragraph do produce a different distribution of credits and debits. It behooves us to examine these differences and the incentives and disincentives they are likely to provide as we seek to minimize net emissions of CO_2. We note that the simple act of participating in an accounting exercise promotes education and understanding. Greater understanding of the nature and magnitude of emissions should enhance appreciation of what is implied in trying to minimize net CO_2 emissions.

The table below uses six simple cases to illustrate that the choice of accounting methodology can result in a significantly different distribution of credits and debits. For the sake of simplicity, these cases involve only 2 countries. Three quick observations from the table are appropriate: 1.) in each case the CO_2 flow and stock change methods yield the same result at the global level (country A + country B), 2.) the stock change method differs from the 1995 IPCC prescribed methodology largely in that it gives credit for C stored in long-lived wood products whereas the IPCC methodology assumes that there is no net change in wood product stocks, and 3.) using the CO_2 flow method a party conducting forest harvest without replanting accounts no CO_2 emissions to the extent that harvested material is transferred to another party.

The most striking observation from the table is that in every case the CO_2 flow method provides a disincentive (negative values in the table) for the use of imported, harvested, renewable wood products. Even in case 2.1, where party A reports zero CO_2 emissions after burning self-produced biomass fuel, Party A would be better off (receive credit for 1 unit of sequestration) if the biomass were sold to Party B (case 1.1) rather than using it himself. There are, of course, strong incentives (positive values in the table) to grow forest products, but purchase and/or use of wood products is uniformly discouraged by the CO_2 flow method. The stock change method, on the other hand, provides disincentives (negative values) only for deforestation. Sequestration credits are acquired when the store of C in wood products is increased.

Our conclusion is that a stock change accounting strategy (based on a clear and consistent description of the system boundaries and of the various parties) serves the interest of simplicity, as defined above, while suffering no decrease in accuracy; is consistent with accounting precedents; provides an appropriate set of incentives for the behaviors that we would hope to encourage; and is scale independent. We suggest also that a stock change method is more amenable to simplification in those cases where a country is limited by data or expertise. Such a country could choose to ignore the change in C stocks, for example, in durable wood products or in landfills. A CO_2 flow method, on the other hand, requires all of the details. For example, the C in wood products exported by country A would never appear in the global account (see, for example case 1.1 above) if the importing country was unable to account for the fate of imported materials.

TABLE: Credits and debits for CO_2 emissions with different accounting methods

	1995 IPCC method			**CO_2 flow method**			**Stock-change method**		
Case	Country A	Country B	A+B	Country A	Country B	A+B	Country A	Country B	A+B
1.1	0	0	0	+1	-1	0	0	0	0
1.2	0	0	0	+1	-0.5	+0.5	0	+0.5	+0.5
2.1	0	---	---	0	---	---	0	---	---
2.2	0	---	---	+0.5	---	---	+0.5	---	---
3.1	-1	0	-1	0	-1	-1	-1	0	-1
3.2	-1	0	-1	0	-0.5	-0.5	-1	+0.5	-0.5

Negative numbers represent a CO_2 source (net emission to the atmosphere)
Positive numbers represent a CO_2 sink (net uptake from the atmosphere)

Case 1: Country A manages its forest with no net carbon stock changes and exports 1 unit of harvested wood to country B where it is: (case 1.1) burned to produce energy or used as a short-lived product with immediate oxidation or, (case 1.2) put into long-term storage, so that wood product stocks increase by 0.5 unit (there is an assumed oxidation rate from these stocks of 0.5 units). Country B has no forest.

Case 2: Country A manages its forest with no net carbon stock changes and uses 1 unit of harvested wood itself either: (case 2.1) to produce energy or short-lived products with assumed immediate oxidation or, (case 2.2) to produce long-lived products, so that wood product stocks increase by 0.5 unit.

Case 3: Country A harvests its forest without regrowing it (deforestation) and exports 1 unit of harvested wood to country B where it is: (case 3.1) burned to produce energy or used as a short-lived product with immediate oxidation or, (case 3.2) put into long-term storage so that wood product stocks increase by 0.5 unit.

FIGURE: System definition for estimation of CO_2 emissions from forestry, forest products, and land-use change.

The figure illustrates how the various carbon stocks are related and how carbon is transferred from one stock to another. The change in any carbon stock is the difference between inputs and outputs and each stock has its own dynamics. An estimate of emissions from any part of the system requires consideration of all transfers with other parts of the system, including the atmosphere, and with other parties. Solid arrows represent transfers to and from the atmosphere while dashed arrows represent transfers to and from other parties. "Direct loss" includes losses due to disturbances such as fire and insects. "Litter fall" includes transfers due to disturbance. "Decay and combustion" includes waste decomposition and burning of industrial waste and fuelwood.