Ton-Year Accounting

Rational for Permanence

- Permanence is one of the issues that needs to be addressed to ensure the efficacy of forestry carbon as a mitigation strategy.
- As mentioned in Section 7 of the FPP, the Reserve requires that credited GHG reductions and removals be effectively "permanent."
- In forestry projects it is a requirement that projects must result in long-term changes in terrestrial carbon storage and CO_2 concentrations in the atmosphere.
- Permanence must be resolved if forestry carbon is to be adopted on a wider scale than it is at present
- Re-release of carbon stored in forestry projects could result in reversing the climate benefits of projects, and could even increase global emissions.

Permanence

A way to assure that sequestration offsets exist on the same plane as fossil fuels reductions.

- Perpetuity = straightforward approach
- Problems with Perpetuity:
  - Impossible to guarantee that a project will operate in perpetuity
  - May not be desirable in the long term: conflicts with future land use, questions of sovereignty
  - Due to decay pattern of CO2, mitigation efforts do not need to run in perpetuity
- Needed: A mechanism for forest/sequestration credits to be compared on a consistent and equal footing with permanent, GHG avoidance credits.

Permanence- Proposed Solutions

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- Temporary or Rental credits
  - Liability for replacement
    - With developer?
    - With buyer?
  - Other issues:
    - competitiveness of forest offsets (prices, contracts, contingency, etc)
    - market maturity
    - market liquidity
    - compatibility with C&T programs
- Buffer Pool
- Equivalence based credits
  - Social Cost of Carbon: damage function and discount rate
  - Ton-Year Accounting: function of C storage and time

Social Cost of Carbon

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- Damage: expected damage over a given impact horizon
- Discount Rate: needed in order to determine Net Present Value and time value of money
- Issues
  - Based on economic assumptions, carbon cost estimates that are evolving
  - Final curve highly dependent on discount rate chosen, much debate exists
- Complex, difficult to explain; yields similar curve as a ton-year accounting system

Why 100 years?

CLIMATE ACTION RESERVE

- For CAR's Forest Projects, this requirement is met by ensuring that the carbon associated with credited GHG reductions and removals remains stored for at least 100 years.
- The definition of "long-term" to ensure permanence varies substantially and there is no consensus regarding a minimum timeframe for project duration.
- The choice of a time horizon is a policy decision, not a scientific one.
- One hundred years as time horizon is in the order of magnitude of the lifetime of CO_2. Furthermore, it is consistent with the Kyoto Protocol's adoption of the IPCC's GWPs (Article 5.3) based on the effects of GHGs over a 100-year time horizon (Addendum to the Protocol, Decision 2/CP.3, para. 3) for calculation of the Absolute Global Warming Potential (AGWP) for CO_2.

Challenges of 100 years

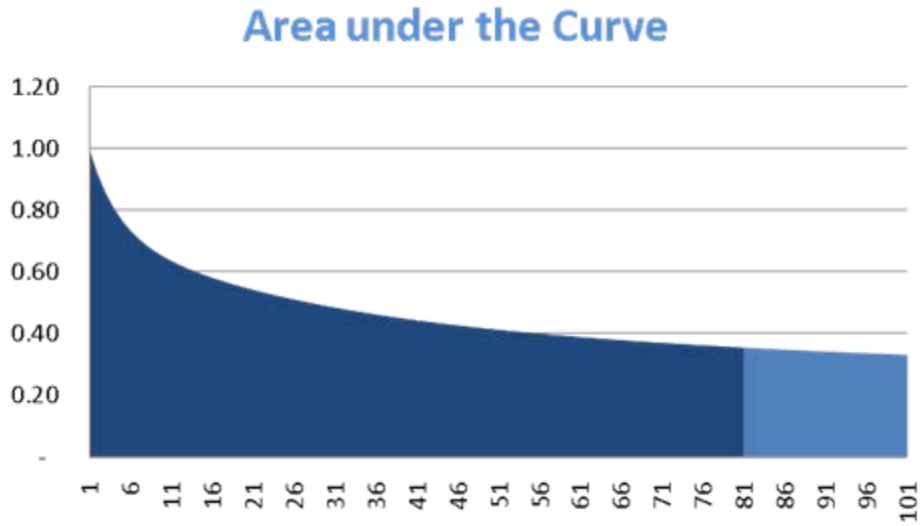
CLIMATE ACTION RESERVE

- Liability
- Inter-generational
- Too far to think about
- Fears of expenses of long-term monitoring

Ton-Year Accounting

- The Special Report on Land Use, Land-Use Change, and Forestry; prepared by the IPCC (2000); describes the ton-year approach for dealing with the lack of permanence of sequestered carbon.

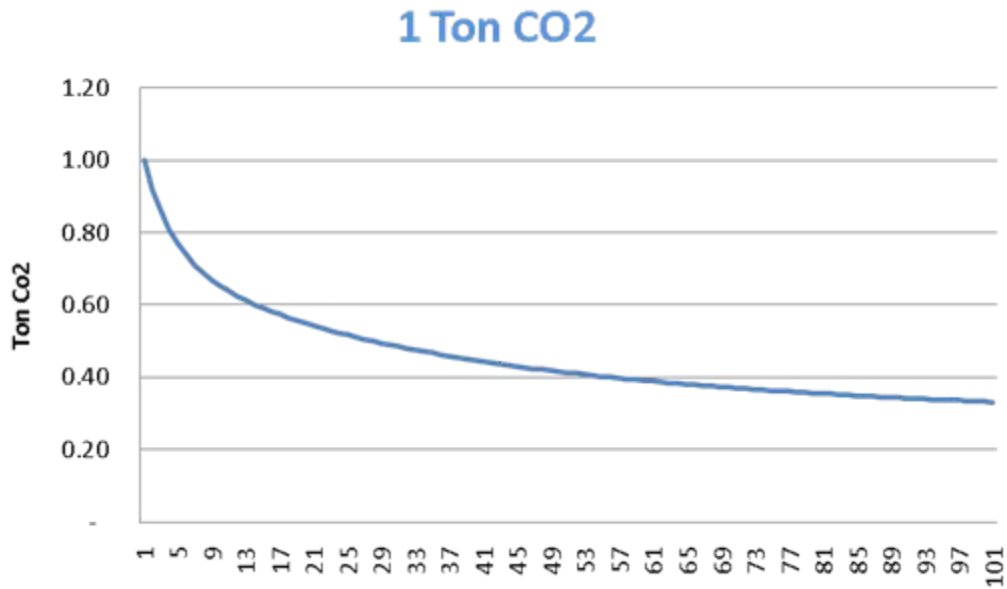
- To calculate ton-years, a comparison is made between the area under two carbon emission pulse curves, one curve being for the baseline scenario and the other for the project scenario, using a defined time horizon.



Carbon Cycle

- For our calculations we decided to use the Bern carbon cycle model used to calculate GWPs in the Second Assessment Report (SAR) (Joos et al., 1996

$$F\ [CO2\ (t)] = 0.175602 + 0.137467\ exp(-t/421.093) + 0.185762\ exp(-t/70.5965) + 0.242302\ exp(-t/21.42165) + 0.258868\ exp(-t/3.41537)$$



Ton Year

- 100 Year Permanence = 46 Tonne Years and can be Proportioned by Year

Year Since Reduction/Removal was Created)	CO2 Tonnes Permanent in Given Year	Sum of Permanent Tonne Years by Year	Percentage of 46 Tonne Years
-		-	0.00%
1	0.3324	0.33	0.74%
2	0.3334	0.67	1.48%
3	0.3344	1.00	2.22%
4	0.3355	1.34	2.96%
5	0.3365	1.67	3.71%
6	0.3376	2.01	4.46%
7	0.3387	2.35	5.21%
8	0.3399	2.69	5.96%
9	0.3410	3.03	6.72%

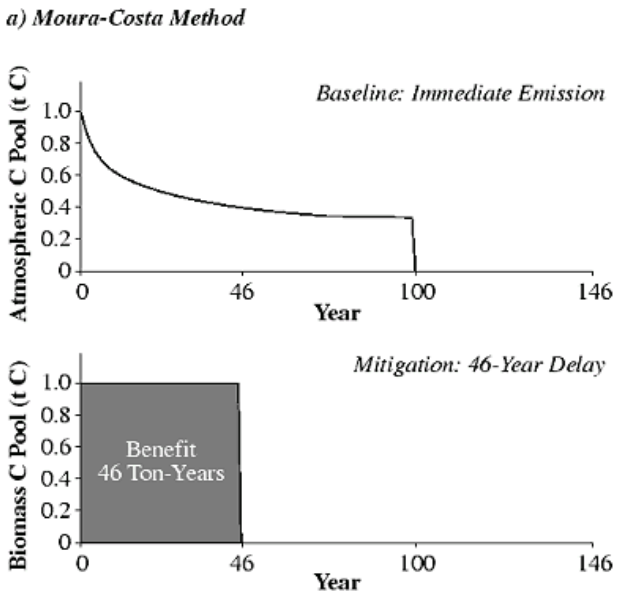
98	0.8578	44.18	95.83%
99	0.9203	45.10	97.83%
100	1.0000	46.10	100.00%

Different Approaches

There are a couple of different methods for calculating ton-years.

Moura-Costa: calculates ton-years assuming that the carbon stored in trees is fixed. The benefit is by the larger area that would be described by a rectangle representing carbon stock in plantation biomass over the life of a mitigation project.

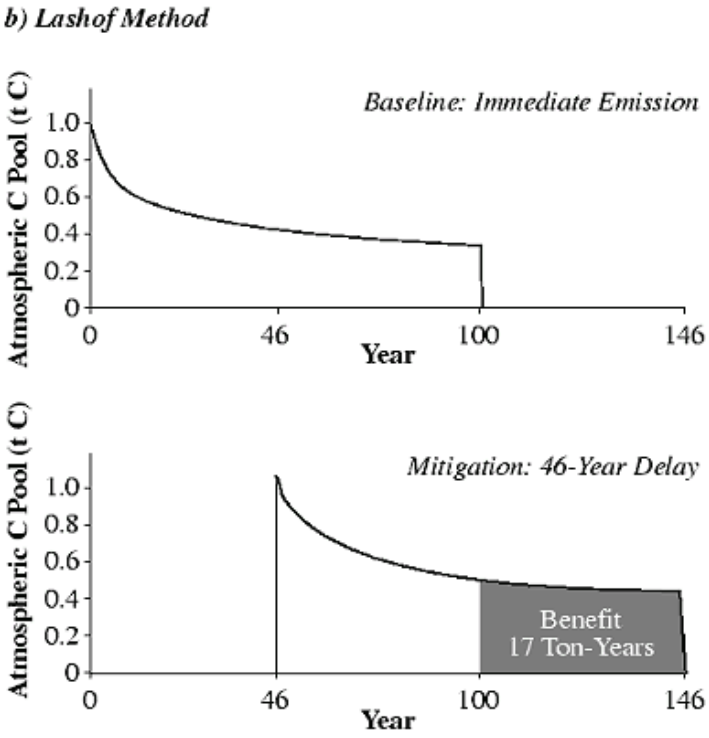
A carbon sequestration project with duration of 46 years can be analyzed as a removal of 1 t CO2 in year zero followed by emission of 1 t CO2 in year 46.



Different Approaches

b. Lashof Method: Calculates ton-years by assuming that carbon in the atmosphere is removed by natural processes and it is represented as the carbon cycle curve.

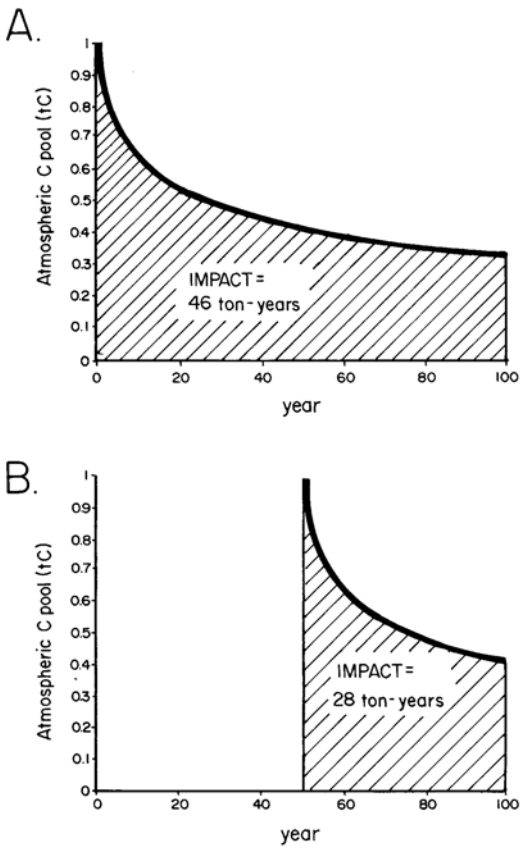
The benefit is represented in this approach by the area of the tail of the second curve that is pushed beyond the end of the time horizon as a result of the delay in emissions.



More about Ton-Year acct.

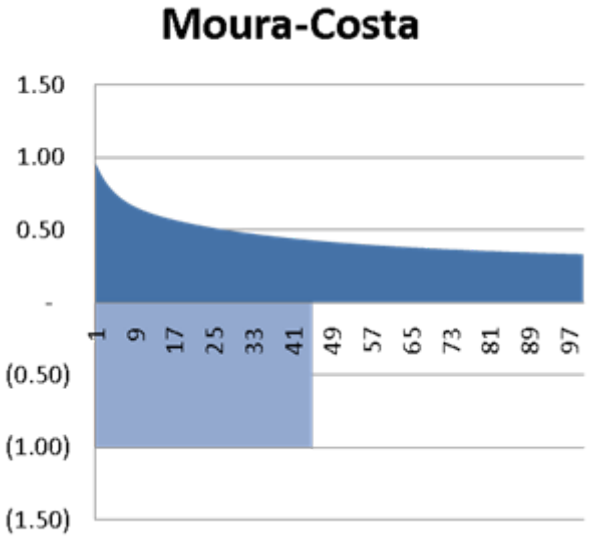
i.e.

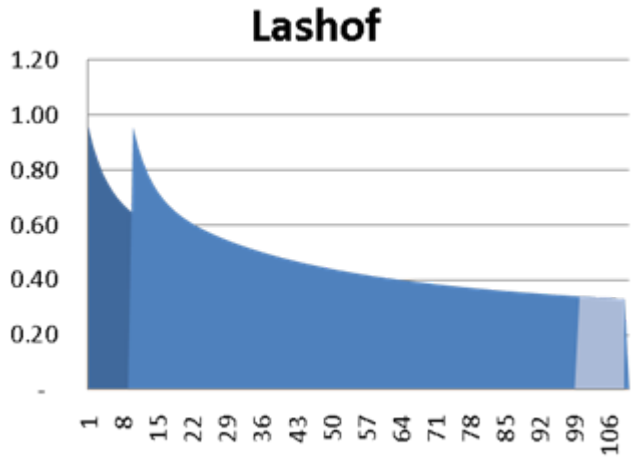
The net reduction in atmospheric CO2 from this project would be the difference between the integrated effects of these two curves. The result is a reduction in atmospheric burden of 17 ton-years (the difference between the integrals of the two curves within the 100-year time horizon: 46 ton-years - 29 ton-years), or 37 percent of the effect of a "permanent" removal (or avoided emission) (Fearnside et al., 1999).



Comparison

year	Area under curve	Mourna-Costa	Lashof
1	0.96	2.19%	0.73%
2	1.85	4.37%	1.45%
3	2.68	6.56%	2.18%
4	3.47	8.74%	2.91%
5	4.22	10.93%	3.65%
6	4.94	13.11%	4.39%
7	5.64	15.30%	5.12%
8	6.32	17.48%	5.87%
9	6.98	19.67%	6.61%
10	7.62	21.86%	7.36%
11	8.25	24.04%	8.11%
12	8.87	26.23%	8.86%
13	9.47	28.41%	9.61%
14	10.07	30.60%	10.37%
15	10.66	32.78%	11.13%
16	11.23	34.97%	11.89%
17	11.80	37.15%	12.66%
18	12.36	39.34%	13.42%
19	12.92	41.52%	14.20%
20	13.46	43.71%	14.97%





Reversal Liability and Crediting - I

CLIMATE ACTION RESERVE

If liability for reversal could be covered for 100 years, full value of reduction/removal would be awarded when reduction/removal is created (Year 0)

Year in Which Reduction/ Removal was Created)	Baseline (Tonnes CO2e)	Project Activity (Tonnes CO2e)	Total Removals /Reductions (Tonnes CO2e)	Annual Removals/ Reductions (Tonnes CO2 e)	Sum of Reductions/Removals under Tonne Year Accounting (Tonnes CO2e)	Project Years					
						0	1	2	3	4	5
-	10,000	14,000	4,000	4,000	-	-					
1	10,000	14,000	4,000	-	73	73	-				
2	10,000	14,000	4,000	-	96	96	-	-			
3	10,000	14,000	4,000	-	120	120	-	-	-		
4	10,000	14,000	4,000	-	144	144	-	-	-	-	
5	10,000	14,000	4,000	-	168	168	-	-	-	-	-
97	10,000	14,000	4,000	-	3,756	3,756	-	-	-	-	-
98	10,000	14,000	4,000	-	3,810	3,810	-	-	-	-	-
99	10,000	14,000	4,000	-	3,864	3,864	-	-	-	-	-
100	10,000	14,000	4,000	-	4,000	4,000	-	-	-	-	-

Reversal Liability and Crediting - II

CLIMATE ACTION RESERVE

With liability managed with a contract to a term of 30 years, the 30-year tonne year value can be awarded.

Year in Which Reduction/ Removal was Created)	Baseline (Tonnes CO2e)	Project Activity (Tonnes CO2e)	Total Removals /Reductions (Tonnes CO2e)	Annual Removals/ Reductions (Tonnes CO2 e)	Sum of Reductions/Removals under Tonne Year Accounting (Tonnes CO2e)	Project Years					
						0	1	2	3	4	5
-	10,000	14,000	4,000	4,000	-	-					
1	10,000	14,000	4,000	-	73	73	-				
2	10,000	14,000	4,000	-	96	96	-	-			
3	10,000	14,000	4,000	-	120	120	-	-	-		
4	10,000	14,000	4,000	-	144	144	-	-	-	-	
5	10,000	14,000	4,000	-	168	168	-	-	-	-	-
27	10,000	14,000	4,000	-	779	779	-	-	-	-	-
28	10,000	14,000	4,000	-	811	811	-	-	-	-	-
29	10,000	14,000	4,000	-	843	843	-	-	-	-	-
30	10,000	14,000	4,000	-	875	875	-	-	-	-	-

Contracts

- No contract. If there is no contract for 30 years the project would be credited yearly and no upfront amount would be received
- Sign a 30 year renewable contract: During the first 30 years of the Project, the aggregator assumes the responsibility for all the avoidable reversals. The aggregator and forest owner should sign a contract where the details are stipulated in order to achieve the permanence of the project during this period of time.

  If this happens, forest owner would get the corresponding ton-year credits for 30 years in the first year (ex-ante). Contracts could be renewed every time verification occurs and credits could be paid up front.

Key Points

CLIMATE ACTION RESERVE

- Flexible instrument
- You can have a credible project on a shorter term than a 100 years
- Credits are provided as long as the liability for project reversals is covered.

- On the downside, since only a proportion can be credited you don’t get a big payment upfront.

Next Steps

- Test the assumptions in the financial model.
- Further review of Moura Costa method to see if it could be scientifically justified.