Permanence Discounting for Land-Based Carbon Sequestration

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Presentation Topics

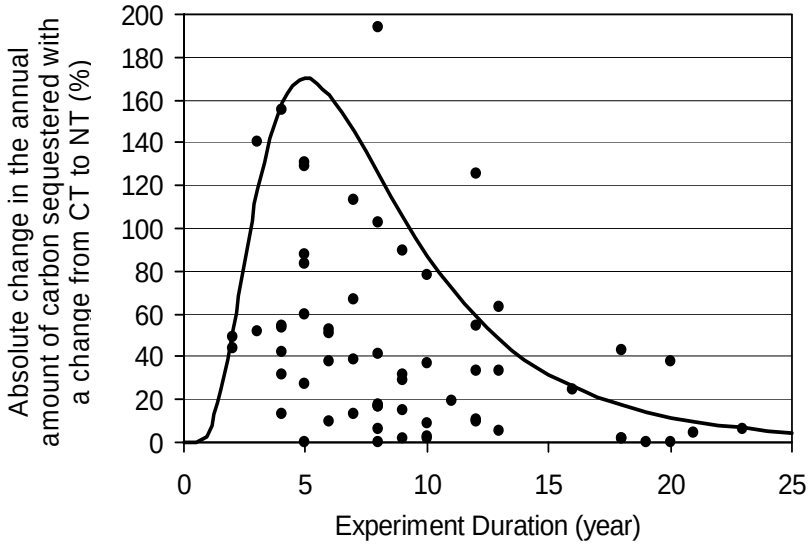
- Why worry about permanence in a carbon sequestration context
- Market comparison with other prospects possible need for Grading standards
- Discuss permanence discount and empirical magnitude of permanence discount
- Discuss Uncertainty and uncertainty discount
- Why include less than permanent items

Why is Permanence an Issue

- **Volatility of sequestered carbon** - sequestered carbon can be rapidly released back to the atmosphere on reversal of practices, fire etc.
- **Saturation /New Equilibrium** - differential rates of accumulation over time and a long run decline to a near zero rate of net sequestration
- **Sustainability of Practices** – crop rotations and herbicide resistance plus land diversion
- **Contract duration and liability terms** - project payment terms, liability and duration influence offset value including leasing
- **Uncertainty** – how much carbon is sequestered and retained (not entirely a permanence issue but closely related)

Saturation/ New Equilibrium of Sequestration in Ag Soils and Forests

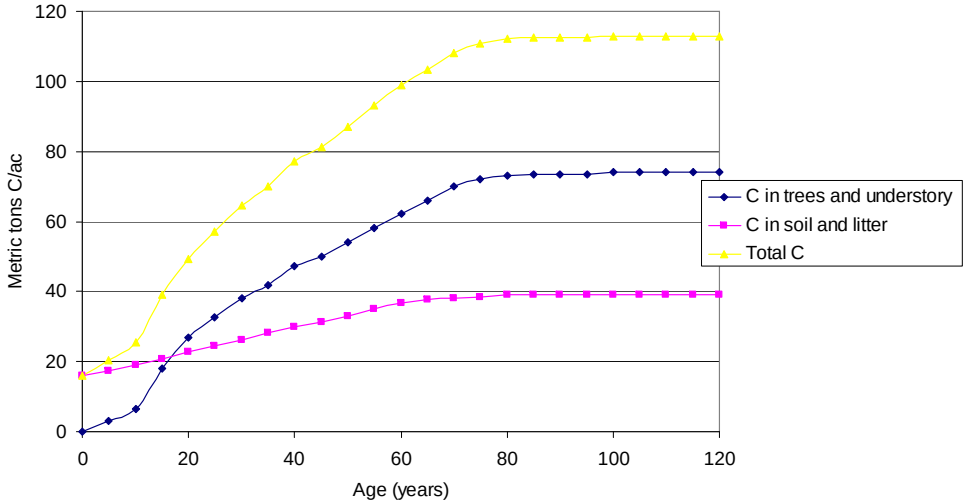
Soil C sequestration over time after a change from conventional to zero-tillage operations



West and Post 2002 Soil Organic Carbon Sequestration by Tillage and Crop Rotation: A Global Data Analysis Soil Science Society of America Journal 66:1930-1946 (2002)

Note saturation by year 20

Figure 2. Cumulative Carbon sequestration in a Southeastern U.S. pine plantation
Source: Data Drawn form Birdsey (1996)



Birdsey et al, USFS, FORCARB

Note saturation by year 80

Permanence and The Price of Carbon

- The question is if such items are allowed whether the **permanence** concerns associated with sequestration may alter the value or quantity of the resultant carbon offset in the market place
- **Offsets are not fungible** – from an offset purchaser's point of a view, an impermanent sequestration asset may be worth a different amount than permanent offset
- General concern price may differentiate based on permanence characteristics like a **grading standard**

Fungibility

- **Grading standard**

  #2 Yellow corn, CD plywood, Long staple cotton

- Receive a **price premium/discount** depending upon product characteristics and consumer cost of using

- GHG offset (especially carbon sequestration) may have consumer cost effects being not fully claimable due to **permanence (plus additionality, leakage, and uncertainty)**

Smith, G.A., B.A. McCarl, C.S. Li, J.H. Reynolds, R. Hammerschlag, R.L. Sass, W.J. Parton, S.M. Ogle, K. Paustian, J.A. Holtkamp, and W. Barbour, Harnessing farms and forests in the low-carbon economy: how to create, measure, and verify greenhouse gas offsets, Edited by Zach Willey and Bill Chameides, Durham, NC: Duke University Press, 229 p, 2007.

McCarl, B.A., "Permanence, Leakage, Uncertainty and Additionality in GHG Projects", Paper developed as input to book Quantifying Greenhouse Gas Emission Offsets Generated by Changing Land Management, A b ook developed by Environmental Defense, 2006.
http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1149.pdf

How to derive Permanence Discount?

- **Permanence discount can arise in terms of a**
  - **Price discount where like three grades of gasoline one needs to pay more for a more permanent item**
  - **Quantity discount where the saleable quantity is reduced to a quantity that one can permanently count on or is discounted for its impermanent terms**

- **Either way one gets less than would be paid for a more permanent asset like capturing methane from a landfill or a manure lagoon and immediately burning it up**

Kim, M-K., B.A. McCarl, and B.C. Murray, "Permanence Discounting for Land-Based Carbon Sequestration", Ecological Economics, vol. 64, issue 4, 763-769, 2008.

How to derive Permanence Discount?

- **Effective price (*PE*) today for impermanent offset – carbon sequestration**
  - Equivalent Price = $\frac{\text{Cost of impermanent}}{\text{Quantity received}}$
- What is cost --
  - Quantity of offsets over time times carbon price
  - Plus if leasing the cost of obtaining replacement credits when the contract expires
  - Plus cost of maintaining practice that is not related to carbon (ie money to maintain practice and monitor carbon
- Note last two terms zero for permanent assets as GHG is destroyed

How Big is the Discount?

- **Agricultural soil carbon sequestration**
  - 25 year lease with 100% buyback – approximately **49%** price discount
  - Maintenance cost at $5/acre – approximately **36%** price discount
- **Afforestation**
  - Harvest year 20 without reforestation – **52%**
  - Harvest year 20 with reforestation – **23%**
  - Harvest year 50 without reforestation – **20%**
  - Harvest year 50 with reforestation – **7%**

Carbon Sequestration and Uncertainty

- Quantity of land-based carbon sequestration is subject to uncertainty - buyers may incorporate uncertainty in their offering prices
- Uncertainty is used to describe
  - Phenomena such as statistical variability, lack of knowledge or surprise
  - Lack of confidence in a single value
- This paper presents an empirical confidence interval based uncertainty discount approach
- Then we apply to an East Texas case

Kim, M-K., and B.A. McCarl, "Uncertainty Discounting for Land-Based Carbon Sequestration", Journal of Agricultural and Applied Economics, forthcoming, 2009.
http://agecon2.tamu.edu/people/faculty/mccarl-bruce/papers/1121.pdf

Issues on Uncertainty– Shortfall Penalty

- Purchaser of carbon credit faces risk of having the quantity sequestered falling below the claimed level (shortfall penalty)
  - Example: US SO_2 trading - penalty for excess emissions of SO_2 is set at \$2000/ton × annual adjustment factor which is 3-5 times offset price
  - Substantial interest on behalf of the purchaser directed toward ensuring that the potential offset credits acquired can be safely relied upon to exceed the environmental commitments

Sources of Uncertainty

- Climate and other factors like pests, fire etc.
- Aggregation induced sampling error at a regional scale
- Carbon pool measurement error, and
- Inter-temporal variation in the duration and permanence of carbon sequestered in the future

Uncertainty Issue (3) – Appropriate Distribution

- **Site level -** Carbon distribution for a year highly variable according to a Canadian soil scientist I once heard talk**.** **But site level is not right basis**

- **Spatial aggregation -** aggregation of multiple sites (or farms) generating carbon credits
  - A contract for 100,000 tons may require 800 US farms of an average farm size of 500 acres

- **Temporal aggregation -** multi-year contracts with the same group of carbon credit suppliers
  - Project commitments spanning over a number of years expected due to the slow change characteristics of carbon

Empirical Risk

Within one year

Region	Sorghum	Rice	Soybean
Brazoria county, TX	21.4	14.2	23.1
TX crop reporting district 9	17.0	7.4	18.1
State of TX	10.4	7.5	15.6
US	8.8	5.2	7.0

Over 5 years

Region	Sorghum	Rice	Soybean
Brazoria county, TX	5.1	5.3	8.7
TX crop reporting district 9	2.9	2.3	5.4
State of TX	3.3	2.2	3.9
US	1.3	2.0	2.5

Moral : Aggregation over time and geography reduces risk
Don’t use numbers from crop modelers

Empirical Uncertainty Discount

- The uncertainty discount from a confidence interval approach
- Discount = Multiplier * Relative risk * Carbon/Yield relation

- We get a CV of 6.3% resulting in the **uncertainty discounts of 10.2% for a 95% confidence level and 7.9% with a 90% confidence level**

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Do we include items that are not permanent

- Contract terms like leasing and liability can handle non permanent characteristics
- Trading is designed to allow cheaper offsets to be used than can be developed by the initial emitter. So the question is are these impermanent items cheaper despite permanence?
- Many things are impermanent
  - Policies that reduce fossil fuel use leave the resource in the ground as a potentially volatile source of emissions
  - CCS is impermanent as it puts items in places where they could be released from and which requires maintenance/monitoring costs
- Sequestration strategies may provide a bridge to a lower cost emission reducing future where CCS or other things can be cheaply used
- Sequestration has other benefits in water quality, erosion and is non competitive with food in some ways

Implications and Conclusions

- Permanence and uncertainty discounts indicate the amount that the offset **price would be reduced** to reflect the alternative characteristics of the offset
- Permanence considerations could substantially affect the **terms of trade** for (potentially) temporary carbon sequestration and permanent emission reductions
- Temporary storage may be a wise interim strategy to get carbon reductions that are relatively cheap and able to be implemented in the short run while the backstop technologies evolve (**bridge to the future**)
- Permanence and uncertainty shows purchasers of carbon credits would be at risk of not meeting their abatement obligations. Hence, the quantity of land-based carbon credits may need to be discounted to avoid the liability of shortfalls
- Application of our theoretical approach suggests that the project level uncertainty discounts fall in a neighborhood of 5% to 10%