Sustainability Science for Public Policy:
Watershed Management, REDD+, and Bypassing the Resource Curse

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In Pursuit of SD

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- **Emerged from the felt need to employ appropriate science and technology in the pursuit of sustainable development.**

"3rd wave" of sustainability science

- **Transdisciplinary organization of environmental and resource management questions**
- **Adapts scientific knowledge to specific problems but also develops new methods for dealing with the dynamical, spatial, behavioral, and interactive complications of resource systems under pressure from humankind.**

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OBJECTIVE

- **How to do it?**
- **Provide prototypes in the area of forest/watershed management.**

A REDD+ Strategy for Global Cooperation and Greener Forests

To deforest is human, to ERR divine.

SEARCA ADSS
January 4, 2011

Status of world cooperation

Stalemate. **Developed and developing cos. blaming each other (Stern 2009).**

Copenhagen bust up!

- **BRICs and developing countries insist that developed countries should go first.**

- **But without developing countries, serious mitigation would be a losing proposition**
  - **Incomplete participation => leakage, costly mitigation.**
- **With climate change, developing countries experience a disproportionate of the adverse effects (Tol 2005).**

Cancun 2010 – Shelved emission reduction treaty; formulate Adaptation Framework.

Win-win incentives for developing countries

What developed countries can offer developing countries to achieve broader cooperation?

Integrated three-part incentive package

- **Extension of a cap and trade to forest carbon (first step)**
- **Appropriate mitigation allowances**
- **Financial and technical adaptation assistance**

REDD+: a developing country strategy for mitigation

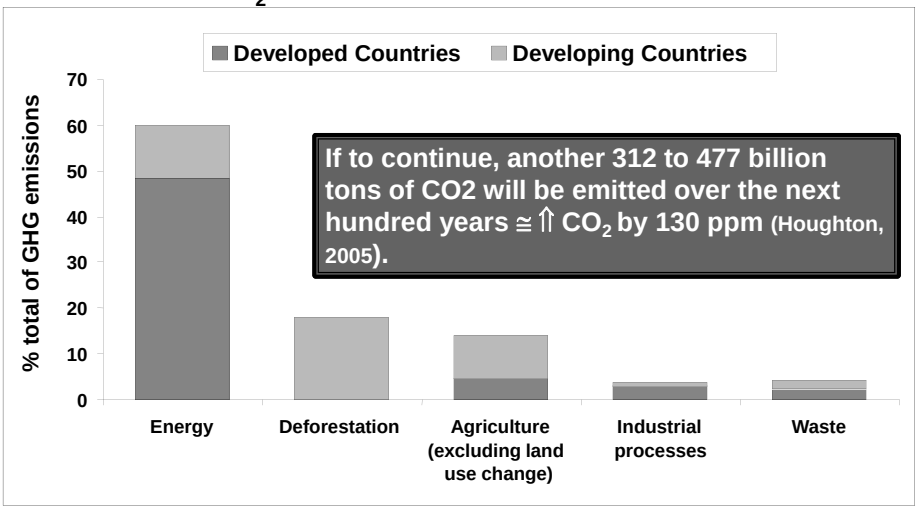
Reducing Emissions from Deforestation and Degradation plus conservation and carbon enhancement (REDD+) – currently conceived as a means to finance forest conservation.

The Genesis of REDD+

- **RED : Reducing emissions from deforestation (COP11, 2005)**
- **REDD : and degradation (COP13, 2007)**
- **REDD+ : plus conservation and enhancement (COP14, 2008)**
- **REDD++: plus all transitions in land cover that affect carbon storage (includes AFOLU and REALU)**

Importance of REDD+ to global cooperation

- **Forest in developing countries are sources, sinks, and reservoir of CO_2.**



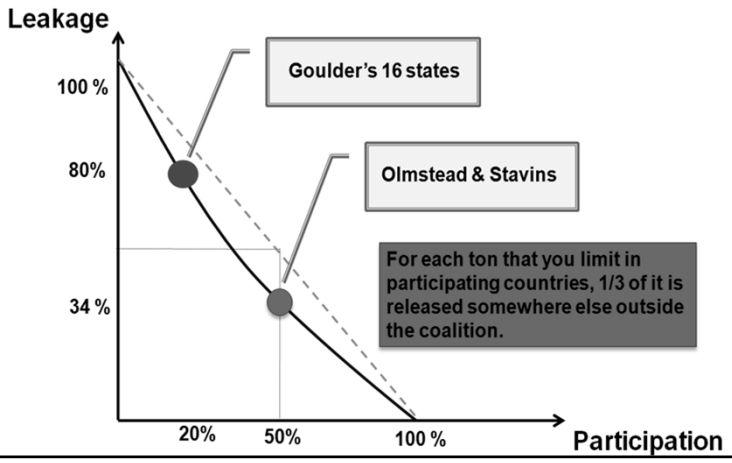
Sources: World Resources Institute 2007; World Development Report 2008

Cont'd: Importance of REDD+ to global cooperation

- **REDD+ can be an impetus for better forest policies**
  - **National forest policies had limited success in curtailing deforestation and promote conservation.**
- **REDD+ will be less effective if treated as a separate program**
  - **May suffer the same fate as it CDM precursor**
    - **Conceptual and measurement requirements are especially acute for forest mitigation policies.**
      - **Controversies surrounding forest offsets would be even greater.**

Cont'd: Importance of REDD+ to global cooperation

- **REDD+ can potentially reduce leakage and make mitigation less costly**



Research questions

- **For an exogenous path of carbon prices, what should be the efficient path of REDD+?**
- **How can the path be implemented in a win-win fashion?**

REDD+ proposals need Economics!

- **32 REDD proposals differ accdg. to scope, scale, financing, & distribution (Parker 2009). But all based on some form of historical baseline.**
- **"Stock-flow" approach of Cattaneo 2008 – no economic rationale for two instruments.**

Many REDD proposals, but lacking economic foundations and integration between forest emissions and sequestration and between forest and conventional emissions.

Single control variable: the amount of carbon emitted

Fallacy: proposition that emissions require one policy instrument and stock maintenance and enhancement (sequestration) require another.

Changes in carbon stock (= Area x Carbon/Area)

Changes in:	**Reduced negative change**	**Enhance positive change**
Forest area (ha)	Avoided deforestation	Afforestation and reforestation
Carbon density (carbon/ha)	Avoided degradation	Forest restoration and rehabilitation (carbon stock enhancement)

Resolving this conceptual issue will remove one of the barriers to greater cooperation.

Designing REDD+ program: Baselines against which benefit is measured

- **Don't reward actual reduction. That rewards profligate deforestation and would not serve as a solid basis of cooperation.**
- **Rather reward reduction beyond the nationally efficient level of forest emissions.**
  - **Big reward is the enhanced rents from being able to implement efficient forestry.**

How to do it?

Underpinnings of forestry resource economics:

- **Faustmann's formula - solution to the rotation problem to get the max PV of the stream of income**
  - **Benefits from timber (Hyde 1980, Chang 1983)**
  - **Timber and non-timber (Hartman 1976, van Kooten et al., 1995)**
- **"mining the forest" - renewable resource in the spirit of C. Clark**
  - **Berck (1979 1981) – pioneer**
  - **Lyon (1981) and Lyon & Sedjo (1983) - time path of the price of timber**
  - **Gan et al. (2001) - optimal forest stock**

Solutions are equivalent! - Anderson (1976)

Efficiency based approach to REDD+

Forest dynamics: Appealing to Faustmann

Objective: To specify a model of efficient forest dynamics that can be solved with and without carbon prices

Problem of the forester:

$$\underset{T}{\text{Max}}\ \pi_F = \frac{\tilde{p}Q(T) - c}{e^{\delta T} - 1}$$

Solution: cut when T satisfies

$$\tilde{p}Q'(T) = \delta[\tilde{p}Q(T) - c] + \delta\pi$$

- **LHS - marginal value of waiting or the additional benefits from postponing the harvest of a particular cohort by *dt*.**
- **RHS - marginal cost of waiting consisting of two terms:**
  - **the interest forgone by not harvesting the stand cohort**
  - **the forgone land rental payment that the landowner could have earned for renting the land after the harvest**

Efficiency based approach to REDD+

Forest dynamics: Incorporating carbon prices

Problem of the forester:

$$\underset{T}{\text{Max}}\ \pi_c = \frac{B_w + B_c}{1 - e^{-\delta T}}$$

$$\pi_c = \frac{[p - v\alpha g(1-\beta)]Q(T)e^{-\delta T}}{1 - e^{-\delta T}} + \frac{v\alpha g\left[Q(T)e^{-\delta T} + r\int_0^T Q(t)e^{-\delta t}dt\right]}{1 - e^{-\delta T}}$$

- **B_C – benefits from carbon sequestration**
- **B_w – value of timber taking into account the externality cost when carbon is released**

Efficiency based approach to REDD+

Forest dynamics: Incorporating carbon prices

Solution:
cut when T_c satisfies

$$[(p + v\alpha g\beta)Q'(T) + v\alpha gQ(T)] = \delta\pi_c$$

- **LHS – marginal benefit of delaying harvest; summation of the value of harvested timber and sequestered carbon**
- **RHS – opportunity cost of delaying harvest; forgone rental payment including sequestration**

First-best efficiency: Subsidize sequestration, tax emission

Translating carbon fraction in terms of carbon stock implies subsidizing net carbon sequestration, i.e. carbon stock now minus carbon stock a year ago

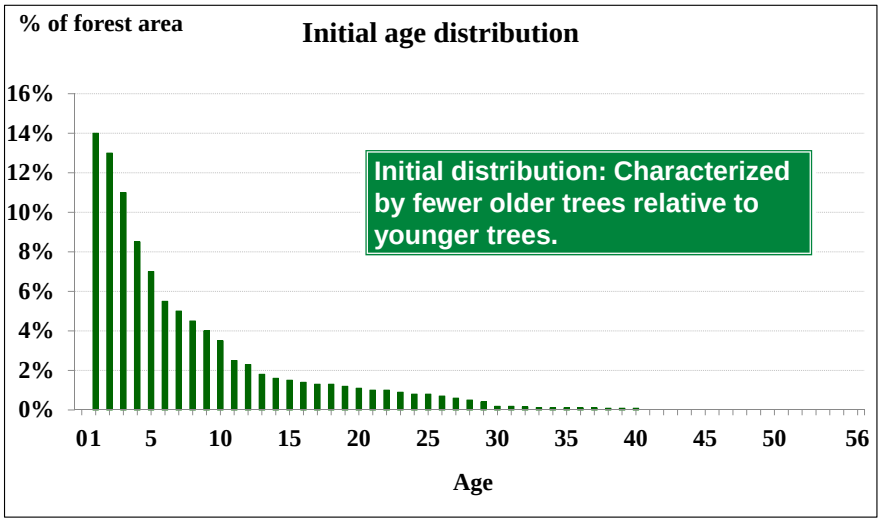
$$s_i = v(C_i - C_{i-1}) \quad \text{where } C_i > C_{i-1}$$

For the case in which carbon stock is depleting emissions are positive and a tax on emissions is implied

$$t_i = v(1-\beta)(C_i - C_{i-1}) = -s_i \quad \text{where } C_i < C_{i-1}$$

- **There is no need for separate instruments nor is there a need for a separate incentive for maintaining stock.**
- **There is only one control variable – the amount harvest, and only one instrument is required – subsidy (with positive and negative values)**

Illustration: Highly degraded forest of a developing country



Numerical simulation

Merchantable volume per hectare (in m^3) of the representative species

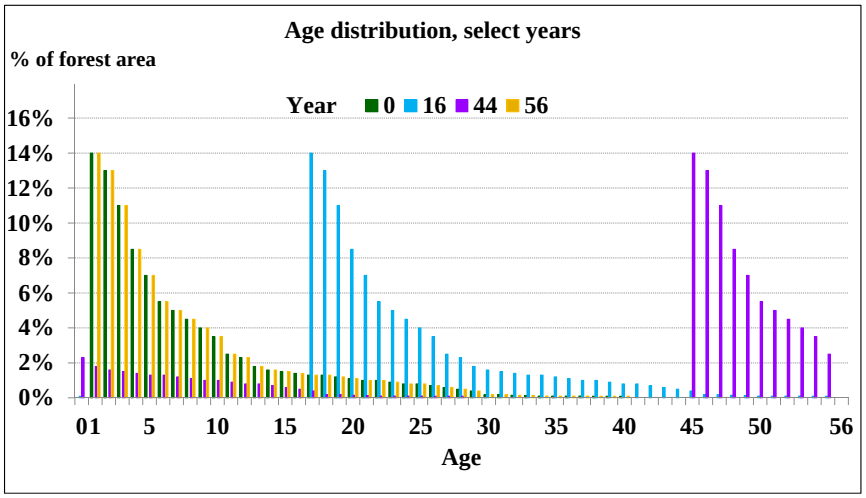
Age	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Vol	5	38	99	173	248	316	373	422	463	498	530	559	585	608

- **Parameters:**
  - $\tilde{p}$ = \$69.50/m^3
  - c = \$40/m^3
  - δ =.05
- **Stand volume:** $Q(t) = e^{a-b/t}$

Solution: Optimal t = 56 years

Result 1

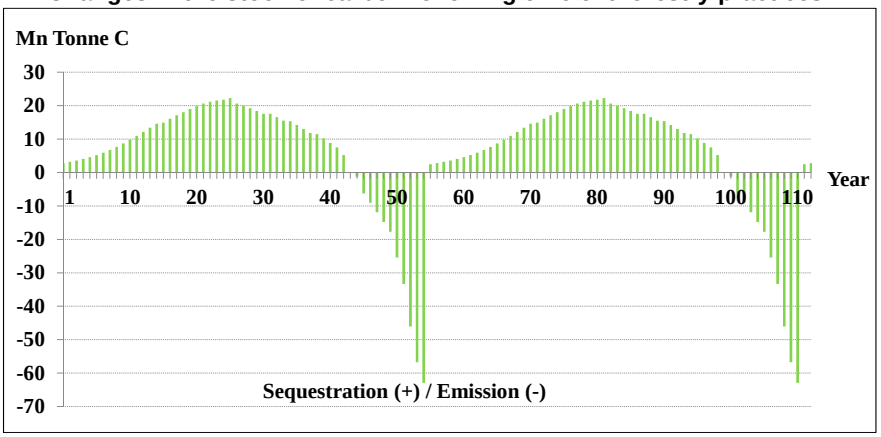
Forestry cycles: age distribution (after harvest) repeats every 56 years.



Result 2

Efficient forestry practices without carbon prices are congruent with negative emission permits, i.e. a sequestration requirement.

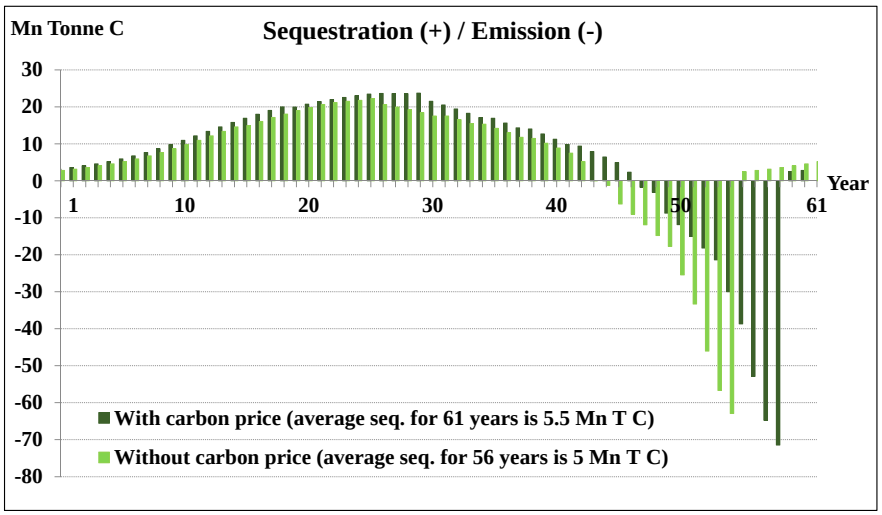
Changes in the stock of carbon following efficient forestry practices



Note: Authors' calculation using conversion factors from IPCC (2006).

Result 3

Carbon pricing does increase the level of sequestration.



Note: Authors' calculation using conversion factors from IPCC (2006).

What do we learn so far?

- **Initial endowment of carbon permits does not affect incentives regarding deforestation and degradation.**
- **Granting entitlements on the basis of historical carbon emissions are unnecessary**
  - **Serve only as a bribe to induce countries to join the agreement in the first place**
- **Expensive proposition, given that induced sequestration is likely to be small.**

Alternative:
Incentivize developing countries to join the coalition by backstopping efficient national forestry policies.

ERR: Efficient REDD+ Reforms

To deforest is human, to ERR divine.

- **Management support for implementation of efficiency reforms**

  Benefits
  - **augmented flow of forest products**
  - **amenity values such as decreased flooding and sedimentation, increased disaster resiliency, improved recharge groundwater aquifers, stream flow, and irrigation capacity**

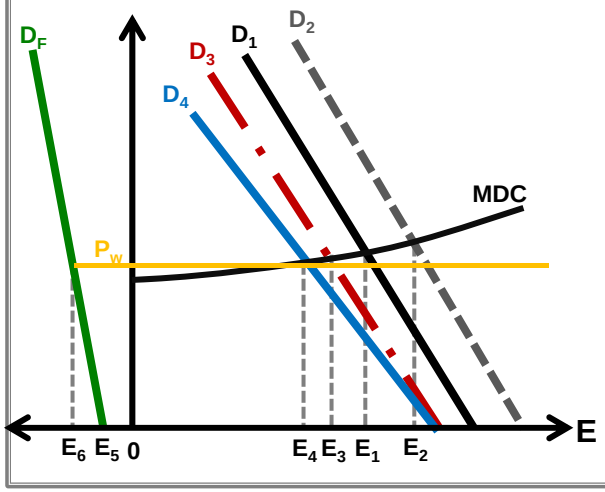
- **Carbon trading**
  - **Permit entitlements - based on efficient harvesting in the absence of carbon price.**
  - **A highly degraded forest would have negative entitlements.**
  - **Using this baseline, a developing country earns carbon credits which can be sold in the market at the world price of carbon if its sequestration is greater than the baseline.**

Should then be viewed as catalysts to shift from inefficient governance (e.g. open access) to appropriate property rights and pricing policies.

4 Broad efficiency reforms

- **Pricing institutions**
  - ***P* = *MOC*, where *MOC* consist of the cost of harvesting (*c*) and the marginal user cost (*MUC*).**
- **Incentives selection on contracts**
  - **To discourage rent-seeking, logging concessions can be auctioned to the highest bidder.**
  - **Enforcement: post a performance bond in an amount sufficient to cover possible damages**
- **Organizations**
  - **Nuclear estates provide an institutional instrument by which to capture the advantages of both large and small operations.**
- **Tenure security and nature's user fees**
  - **Whether private property, common property, or some other hybrid form is used (e.g. nuclear estates with long-term leases), there is a distinct advantage in formalizing the arrangement, i.e. maintaining a government registry of property, including common property.**

Integrating forest policies with conventional mitigation



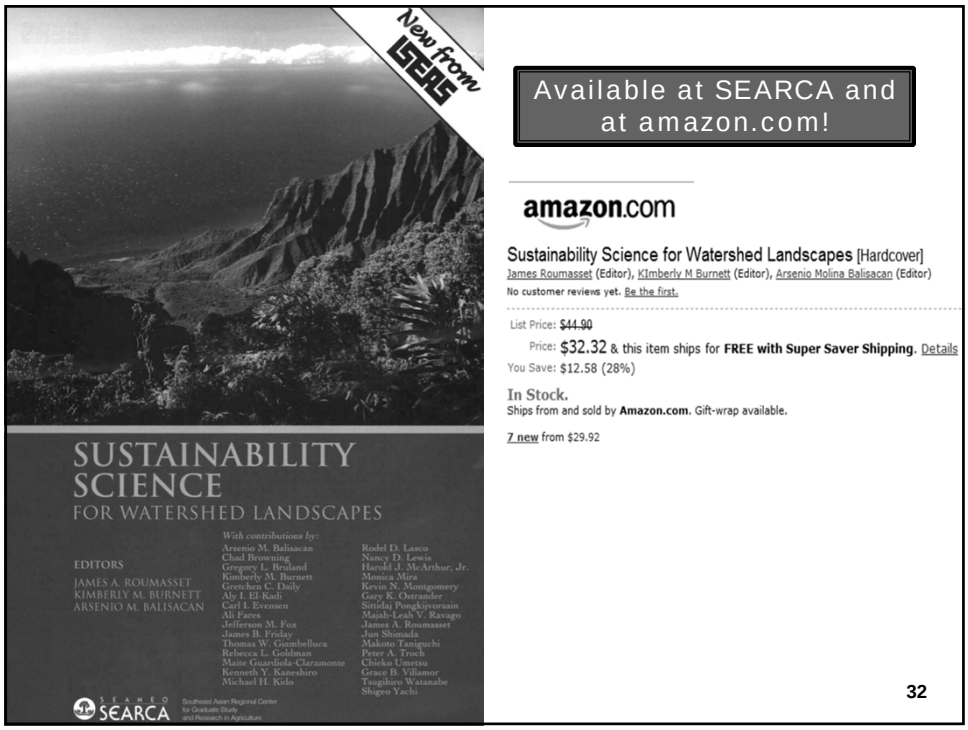
D_1: demand for industrial emissions
D_2: with inefficient forest harvesting
D_3: (D_1+E_5) with efficient forest harvesting
D_4: (D_1+D_F) with carbon pricing
D_F: demand for efficient forest emissions
MDC: marginal damage cost
P_w: world price of carbon
E: emissions

Conclusions

- **Efficient carbon emissions are positive for industry but negative for forests. Positive entitlements for forest emissions are unnecessary.**
- **The first priority should be moving towards efficient forestry practices. Financial, technical, and administrative assistance for efficient forestry will make a large difference in sequestration and will also provide an inducement to join the coalition of mitigating countries.**

Conclusions

- **Economic surplus in developing countries will be even larger in a fully integrated mitigation and adaptation program where conventional and forest emissions face the same carbon prices, and where developed countries are paying developing countries for adaptation.**
- **Integrating REDD+ and adaptation assistance into an integrated world agreement would be cost effective for developed countries as well by lowering the price of carbon and decreasing the cost of mitigation.**



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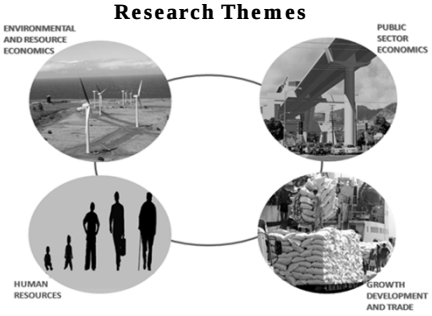

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Salamat po!

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Will be on the job market in May 2011