Land Modeling Using GCOMAP:
Deforestation, transaction costs, and regional disaggregation

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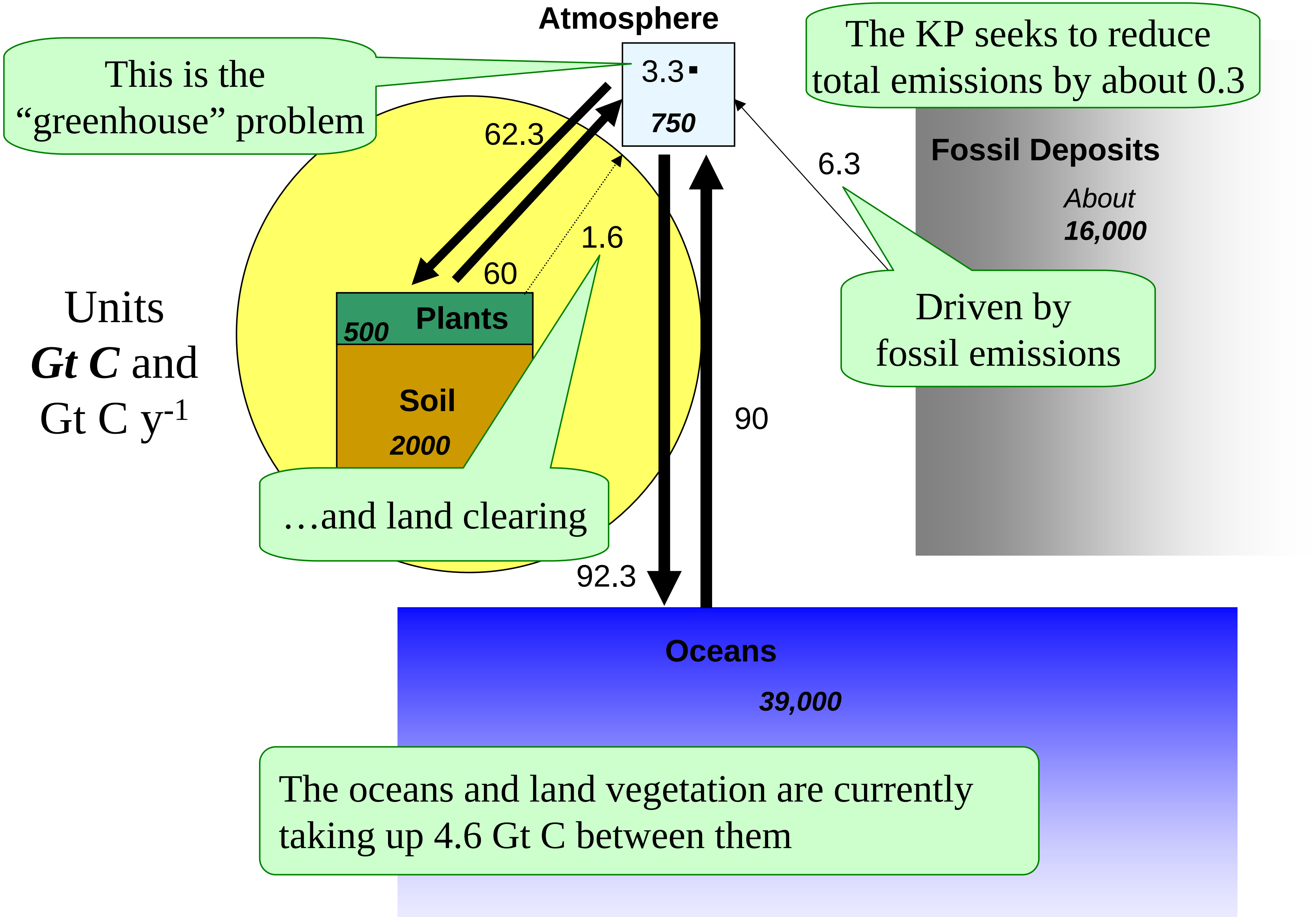
No Guinea Pig

- GCOMAP is a partial equilibrium model
- Requires data on reference case land planting and gross deforested area scenarios
- IMAGE runs provided change in total forest area but not the above information
- So, no guinea pig for the time being

Contents

- **Background on emissions from forest sector**
- EMF-21 GCOMAP Results
- Impact of
  - Transaction costs
  - Variation in deforestation baseyear estimates
  - Alternative disaggregation of land classes
- Conclusions

Human Activities are Perturbing the Carbon Cycle



This is the “greenhouse” problem

The KP seeks to reduce total emissions by about 0.3

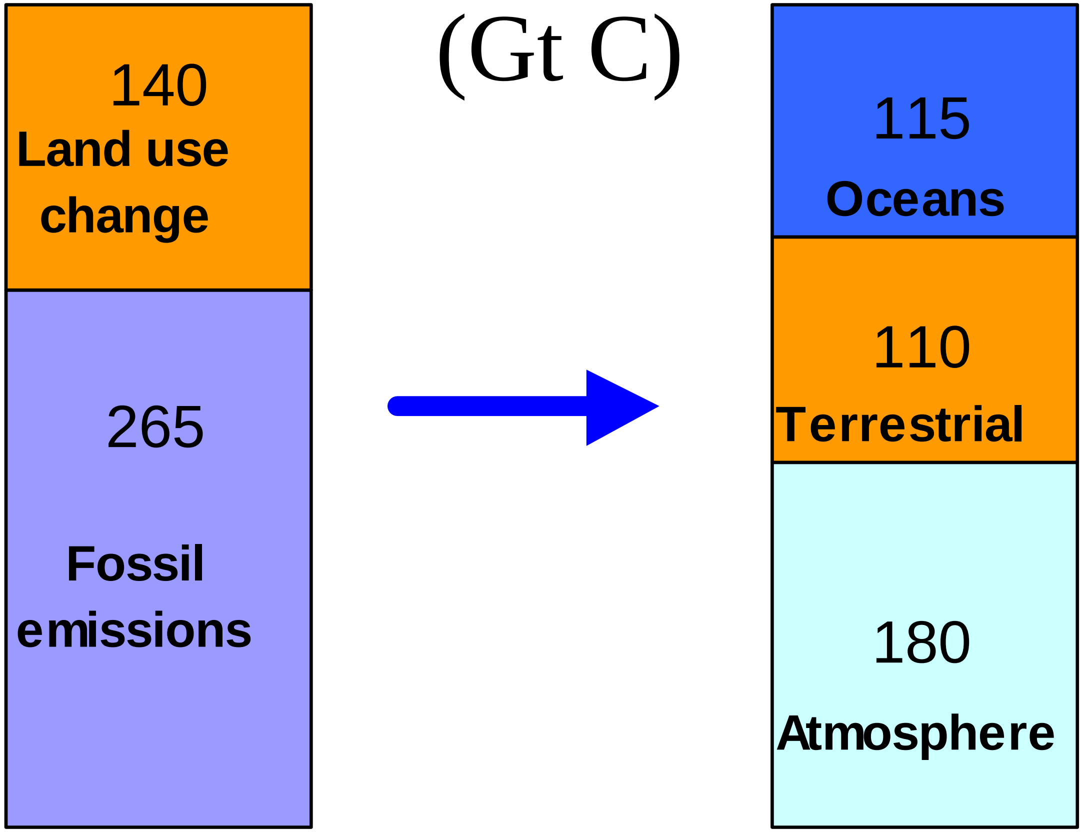
Driven by fossil emissions

…and land clearing

Units
Gt C and
Gt C y^{-1}

The oceans and land vegetation are currently taking up 4.6 Gt C between them

Emissions and uptakes since 1800 (Gt C)



140 Land use change

265 Fossil emissions

115 Oceans

110 Terrestrial

180 Atmosphere

***Table 1**: Global carbon stocks in vegetation and soil carbon pools down to a depth of 1 m.*

Biome	**Area**	**Global Carbon Stocks (Gt C)**		
	(10^9 ha)	**Vegetation**	**Soil**	**Total**
Tropical forests	1.76	212	216	428
Temperate forests	1.04	59	100	159
Boreal forests	1.37	88	471	559
Tropical savannas	2.25	66	264	330
Temperate grasslands	1.25	9	295	304
Deserts & semi-deserts	4.55	8	191	199
Tundra	0.95	6	121	127
Wetlands	0.35	15	225	240
Croplands	1.60	3	128	131
World total	15.16	466	2011	2477

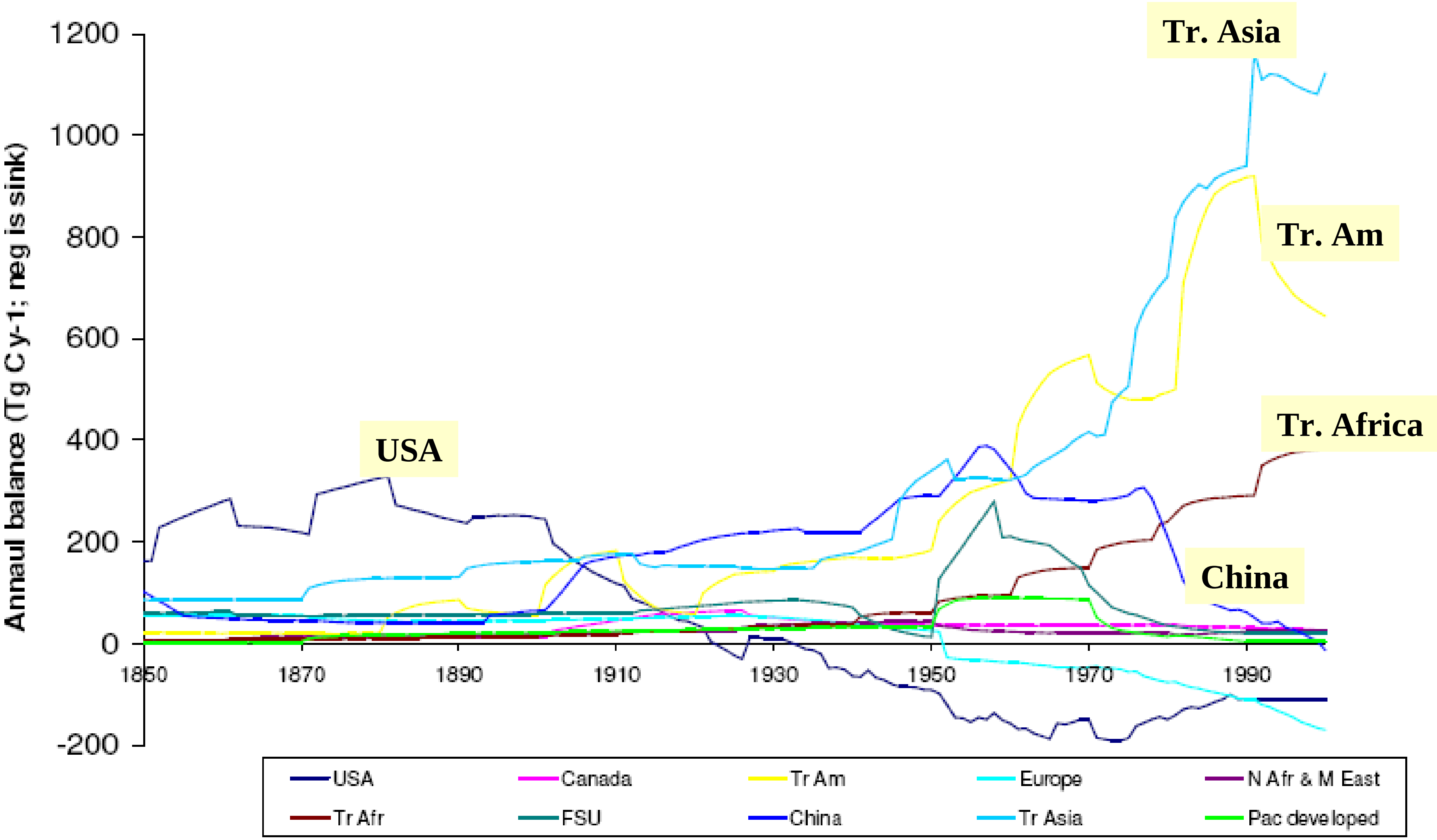
50%

84%

26 %

81%

Carbon balance of the land use change and forestry sector by region
Positive Values = Emissions Source



Source: Houghton (2003)

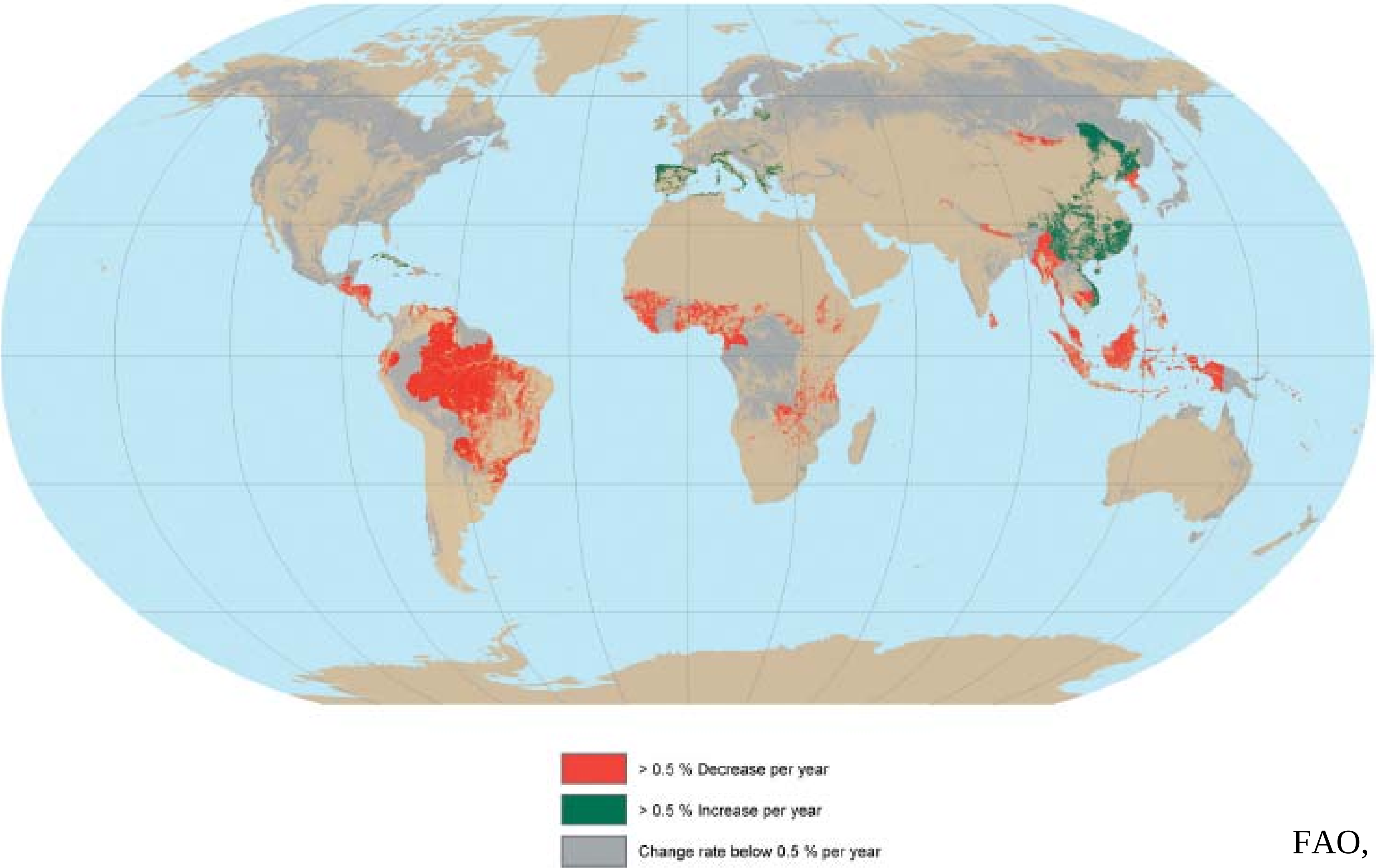
The Atlantic Monthly, April 1995 v275 n4 p61(15)

An explosion of green. (reforestation of eastern U.S.)(Cover Story) *Bill McKibben.*

Wood was used for everything--it was the cornerstone of the economy in the same way that petroleum is today. What iron existed was smelted using wood charcoal; to produce a thousand tons of iron a year, a furnace needed 20,000 or 30,000 acres of forest, MacCleery writes. A square forty-acre field required 8,000 fence rails. In the latter half of the nineteenth century, when barbed wire began to replace wood, there were more than three million miles of wooden fence in America. Railroads soon claimed the wood freed up by wire fencing; at the turn of the century the demand for railroad cars, ties, fuel, bridges, trestles, stations, and telegraph poles was taking a quarter of the nation's timber production. Steamboats burned wood for fuel until the Civil War, consuming a fifth of all the wood sold for fuel in 1840. In the second half of the nineteenth century forest cover in many areas of the East had fallen from 70 percent to 25 percent or less. Eventually the profligate cutting left lumbermen little choice but to move west: there were few mature forests left to take. Loggers moved from New England to New York, Pennsylvania, the Great Lakes, and the South.

Areas with high net change in forest area between 2000 and 2005

- Global forest cover -- 3,952 million ha, about 30 percent of the world’s land area
- Net forest area loss was 7.3 million ha/yr compared to 8.9 million ha/yr in the 1990s



FAO, 2006

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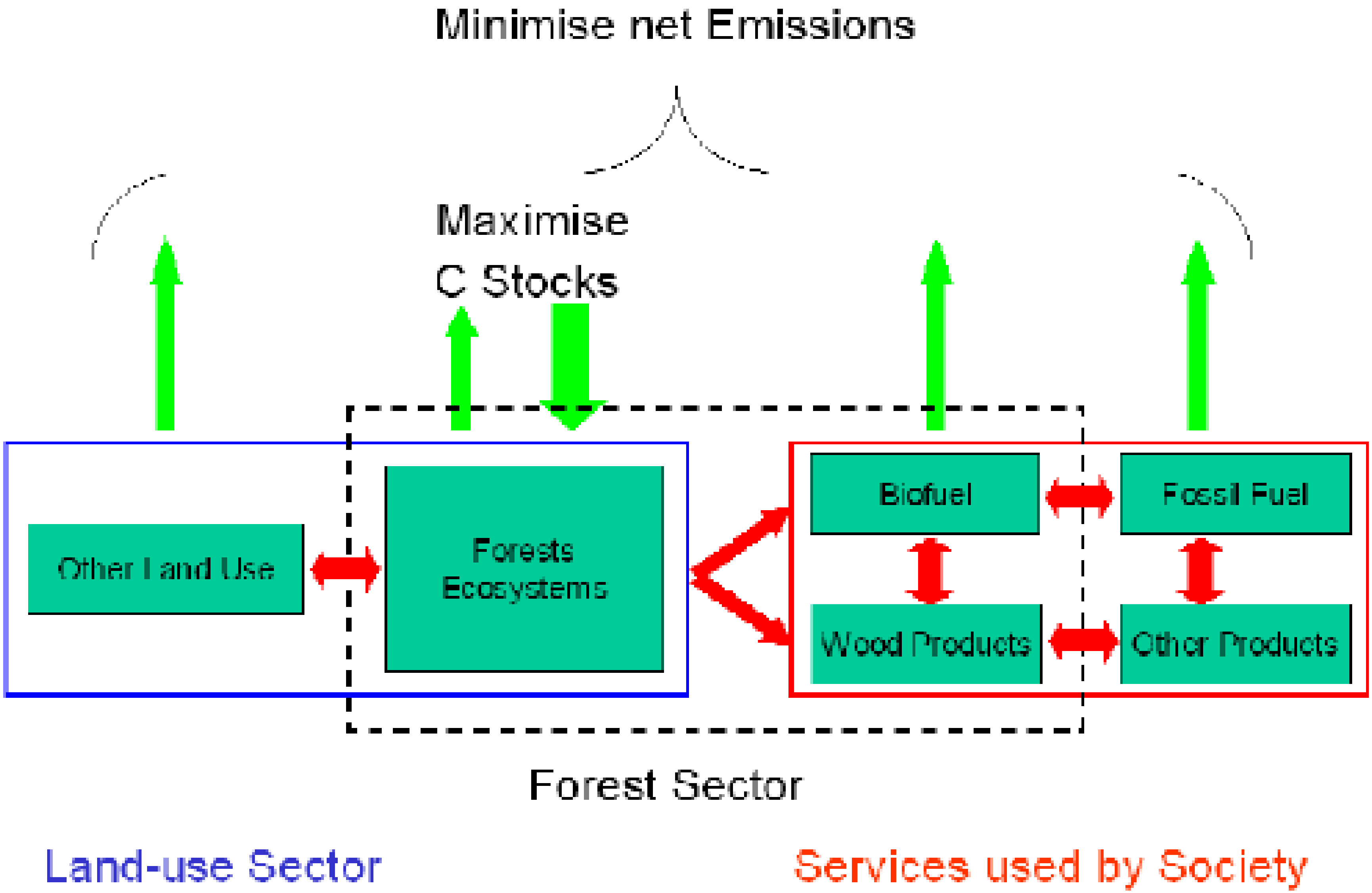
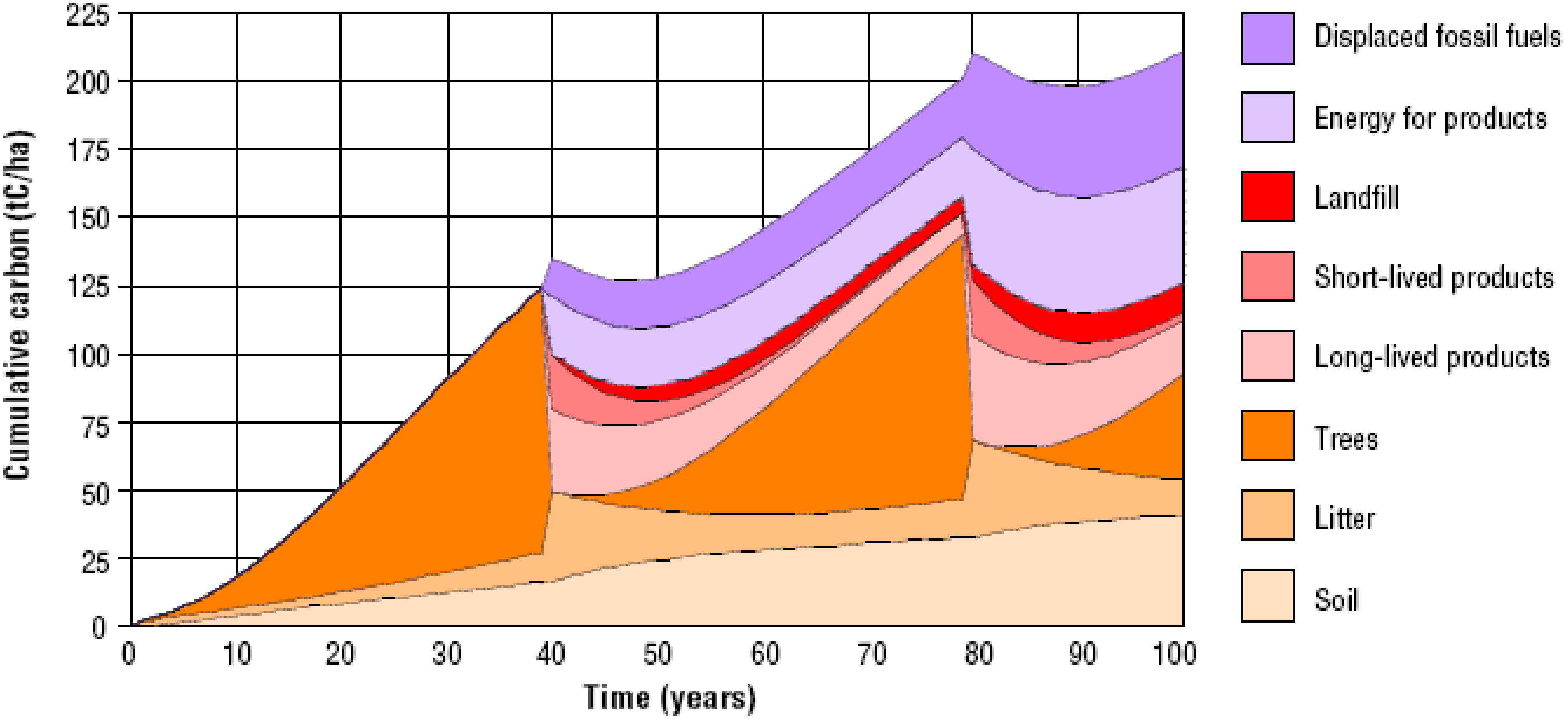
Mitigation strategies aimed at maximizing carbon storage in forest ecosystems

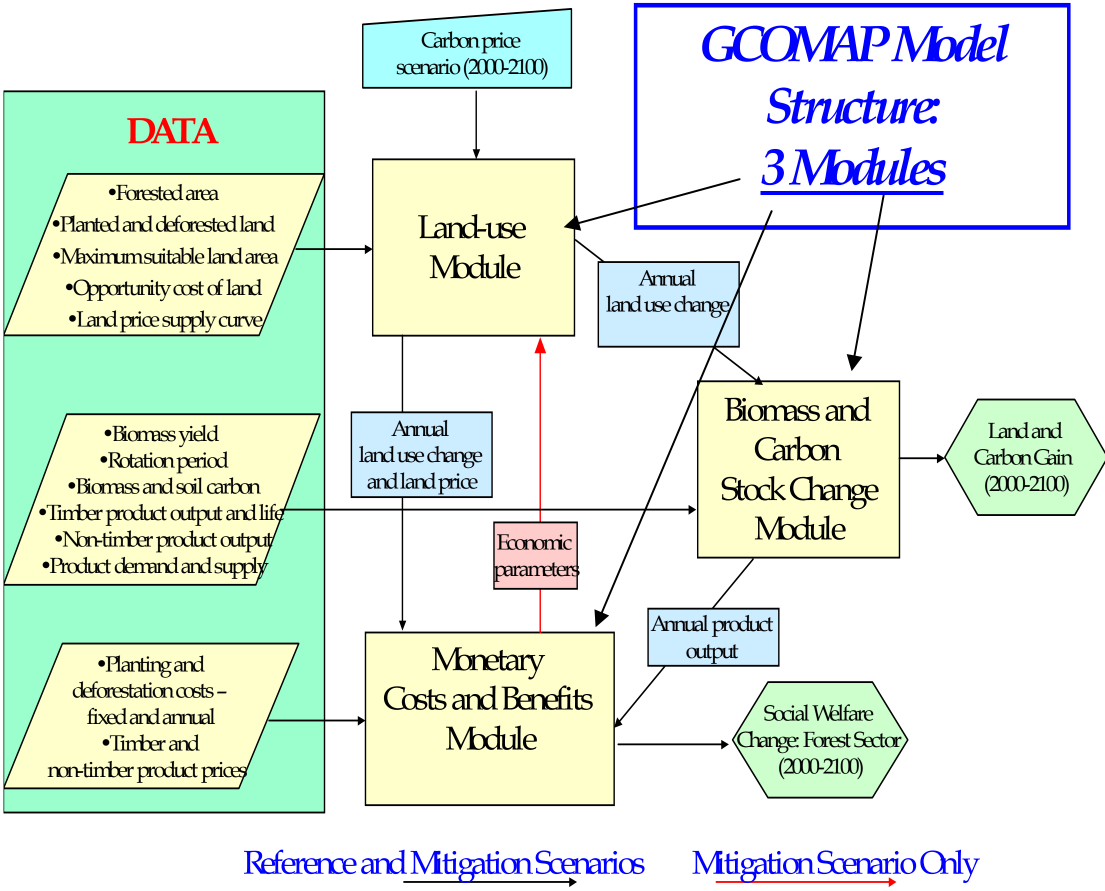


Carbon Balance for a Hypothetical Forest Management Project



Global Forestry Carbon Mitigation Potential Using GCOMAP: A Dynamic Partial Equilibrium Model

- **Since 1990, LBNL has developed bottom-up models to estimate forestry sector mitigation costs and potential for the tropics.**
- **GCOMAP was developed using this expertise, and uses these data combined with global and OECD data**
- **Model represents forest sector market dynamics; based on investment theory, and assumes perfect foresight**
- **Includes 10 regions, a deforestation and 2 forestation options, and tracks carbon in 6 pools annually**



GCOMAP Model Structure: 3 Modules

DATA

•Forested area
•Planted and deforested land
•Maximum suitable land area
•Opportunity cost of land
•Land price supply curve

•Biomass yield
•Rotation period
•Biomass and soil carbon
•Timber product output and life
•Non-timber product output
•Product demand and supply

•Planting and deforestation costs – fixed and annual
•Timber and non-timber product prices

Carbon price scenario (2000-2100)

Land-use Module

Annual land use change

Annual land use change and land price

Economic parameters

Biomass and Carbon Stock Change Module

Land and Carbon Gain (2000-2100)

Annual product output

Monetary Costs and Benefits Module

Social Welfare Change: Forest Sector (2000-2100)

Reference and Mitigation Scenarios

Mitigation Scenario Only

Deforestation Rate: Historical and Projected

- Global deforestation 17 Mha/yr in 1990s; 13 Mha/yr in 2000-05 (FAO)
  - –India and China: deforestation declined to zero
  - –Brazil: widely fluctuating deforestation rates
  - –Africa 1990-00 deforestation rate increased, unlike in other regions
  - Deforestation rate is projected to increase to 2020 before declining
- Rest of tropics: Deforestation rates are projected to continue declining

Region	**Change in Deforestation Rate (%/yr)**	**Deforestation Rates (% / year)**				
	1990 –00	**2000**	**2020**	**2040**	**2050**	**2100**
Africa	+ 0.026	0.80	1.29	0.78	0.65	0.26
Rest of Asia	- 0.005	1.03	0.82	0.60	0.52	0.12
Central America	- 0.011	1.19	0.97	0.75	0.65	0.37
South America	- 0.030	0.40	0.26	0.21	0.20	0.13

The deforestation rate gives the percent decline in the forest area per year

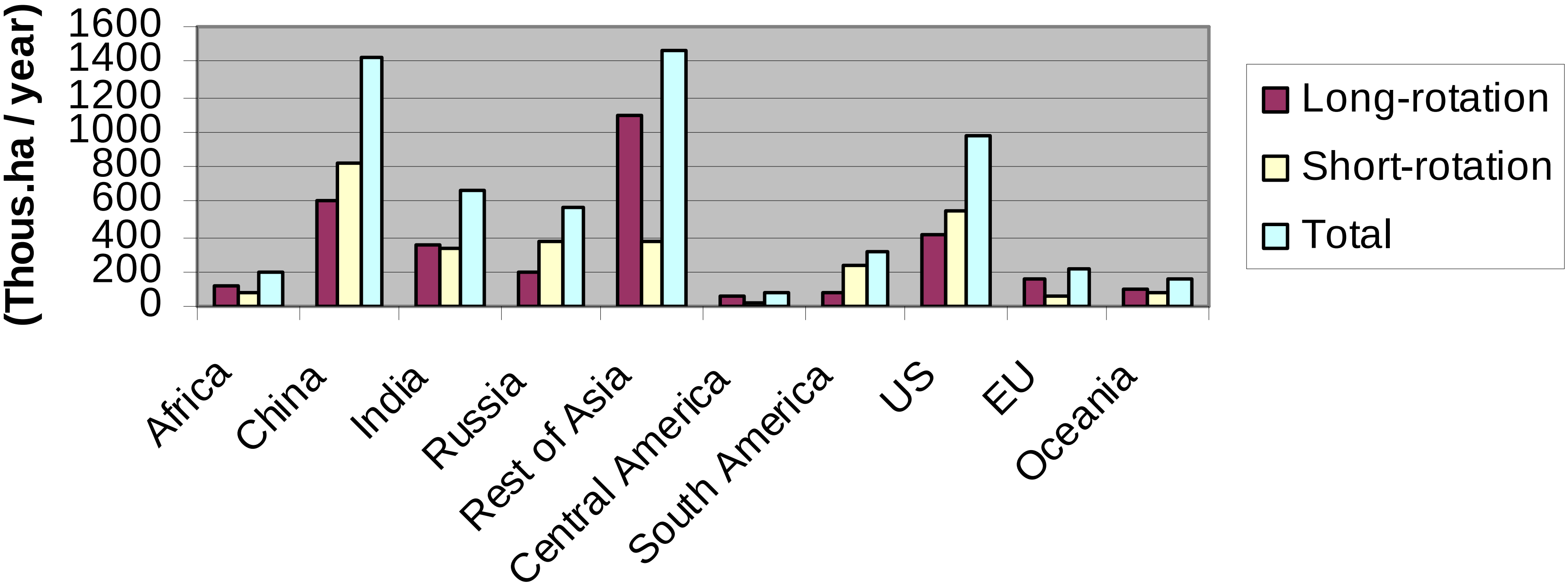
(-) rate is an annual decline in the deforestation rate

Based on FAO 2001 – Forest Resource Assessment-2000; Kaimovitz 1996 Livestock and deforestation in Central America in 1980s and 1990s; Barraclough and Ghimire 2000. Agricultural Expansion and Tropical Deforestation

Key Data Inputs

Historical Afforestation Rates

(Data for each region for periods varying from 1975 to 2000)



Source:
FAO 2001 – Forest Resource Assessment-2000, and
FAO 2000 – The Global Outlook for Future Wood Supply from Plantations
US – Moulton et al., 1996: Tree Planting in the United States

Results – Global land area and carbon gain* across scenarios

Mitigation Options : Long and short rotation forestry, and avoided deforestation

Scenario[b]	Carbon Price ($/t C)		Land Area Gained (Mha)		Carbon Benefits Gained (Mt C)	
2010 C Price + Annual Increase	**2050**	**2100**	**2050**	**2100**	**2050**	**2100**
1. $5 + 5%	**35**	**404**	**190**	**662**	**13,570**	**70,145**
Forestation			68	163	5,554	33,162
Avoided deforestation			122	499	8,034	37,105
2. $10 + 5%	**70**	**807**	**327**	**880**	**24,917**	**96,496**
Forestation			108	231	10,123	47,849
Avoided deforestation			219	649	14,796	48,835
3. $10 + 3%	**33**	**143**	**212**	**555**	**15,628**	**50,905**
Forestation			52	77	4,934	16,358
Avoided deforestation			160	478	10,694	34,547
4. $20 + 3%	**65**	**286**	**363**	**819**	**28,582**	**79,559**
Forestation			75	135	8,917	28,575
Avoided deforestation			288	684	19,665	50,985
5. $100 + 0%	**100**	**100**	**537**	**866**	**47,252**	**78,970**
Forestation			83	56	13,587	17,245
Avoided deforestation			454	810	33,665	61,725
6. $75 + $5	**275**	**275**	**664**	**1081**	**63,300**	**113,208**
Forestation			192	146	25,675	38,422
Avoided deforestation			501	959	37,625	74,786

Notes: a) Gained amount refers to the cumulative difference between a mitigation scenario and the reference case scenario by 2050 and 2100

b) All carbon prices are zero until 2009, and begin with the stated value in 2010

Results – Global land area and carbon gain* across scenarios

Mitigation Options : Long and short r eforestation

Higher the carbon price, larger the gained land and carbon amount, but

Scenario [b]	Carbon Price ($/t C)		Land A		ained (Mt C)	
2010 C Price + Annual Increase	**2050**	**2100**				**2100**
1. $5 + 5%	**35**	**404**	**190**	**662**	**3,570**	**70,145**
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Results – Global land scenarios

Mitigation Options : Long ar leforestation

Higher the carbon price, larger the gained carbon amount, but carbon price paths starting low and rising produce majority of carbon after 2050 and vice versa.

Scenario [b]	Carbon Price ($/t C)				Gained (Mt C)	
2010 C Price + Annual Increase	**2050**	**2**			**0**	**2100**
1. $5 + 5%	**35**				**0**	**70,145**
Forestation					4	33,162
Avoided deforestation			122	499	8,034	37,105
2. $10 + 5%	**70**	**807**	**327**	**880**	**24,917**	**96,496**
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Results – Global land ar   oss scenarios

Mitigation Options : Long and s   led deforestation

Avoided deforestation accounts from 51% to 78% of gained 2100 carbon depending on the carbon price and path.

Scenario [b]	Carbon Price ($/t C)				nefits Gained (Mt C)	
2010 C Price + Annual Increase	2050	2100			2050	2100
1. $5 + 5%	**35**	**404**			**13,570**	**70,145**
Forestation					5,554	33,162
Avoided deforestation			122	499	8,034	37,105
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Forestation			83	56	13,587	17,245
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Forestation			192	146	25,675	38,422
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Notes: a) Gained amount refers to the cumulative difference between a mitigation scenario and the reference case scenario by 2050 and 2100

b) All carbon prices are zero until 2009, and begin with the stated value in 2010

Carbon price to virtually stop deforestation (i.e., C price > opportunity cost) varies across the tropics

- Carbon price to halt deforestation depends on opportunity cost of land and products
  - Timber products fetch higher prices than land or other products
  - Higher the timber revenue higher the carbon price required to slow or avoid deforestation
- Feasibility of stopping deforestation complicated by many barriers.

Region	Carbon price to virtually stop deforestation ($/ t C)
Africa	$ 39
Central America	$ 127
South America	$ 147
Rest of Asia (Asia without China and India)	$ 281

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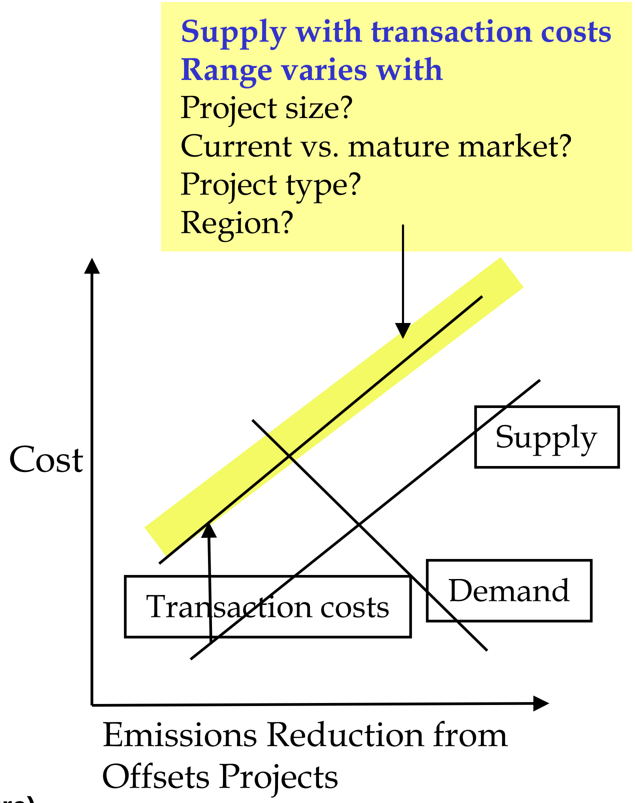
Transaction Costs Influence Supply of Traded Carbon

- Project search costs – Identification and stakeholder consultation
  - May be spread over many projects
- Feasibility studies costs – engineering, economic, and environmental assessments
  - GHG Baseline estimation and establishing additionality
- Negotiations costs – obtaining permits, negotiating and enforcing contracts for fuel supply, arranging financing
  - Marketing GHG credits, carbon contracting and enforcement
- Insurance costs – project risk insurance
  - GHG credit insurance (Difficult to get or too expensive today)
- Regulatory approval costs (GHG)
  - Project validation and government review (May include both domestic and international validation costs)
- Monitoring and verification costs (GHG) – During project implementation
  - Monitoring including equipment cost, verification and certification (Spread over many years of project life)

- Data Set 1: (26 projects)
  - The Nature Conservancy (Forestry) -- Bolivia, and Brazil
  - Indian Institute of Science (Forestry) , LBNL (Household woodstoves)
  - Oregon Climate Trust (Forestry, energy efficiency, renewable energy)
  - Natural Resources Canada (Forestry)
  - Trexler and Associates (Methane, large power plants, energy efficiency, carbon capture)
- Data Set 2: (13 projects)
  - Ecofys (renewable energy)
  - Ecoenergy (bagasse cogeneration)
- Data Set 3: (50 projects) –
  - Swedish AIJ Programme (Energy efficiency and renewable energy)
- Data Set 4: (10 projects)
  - Global Environmental Facility (Transportation, energy efficiency, renewable energy)



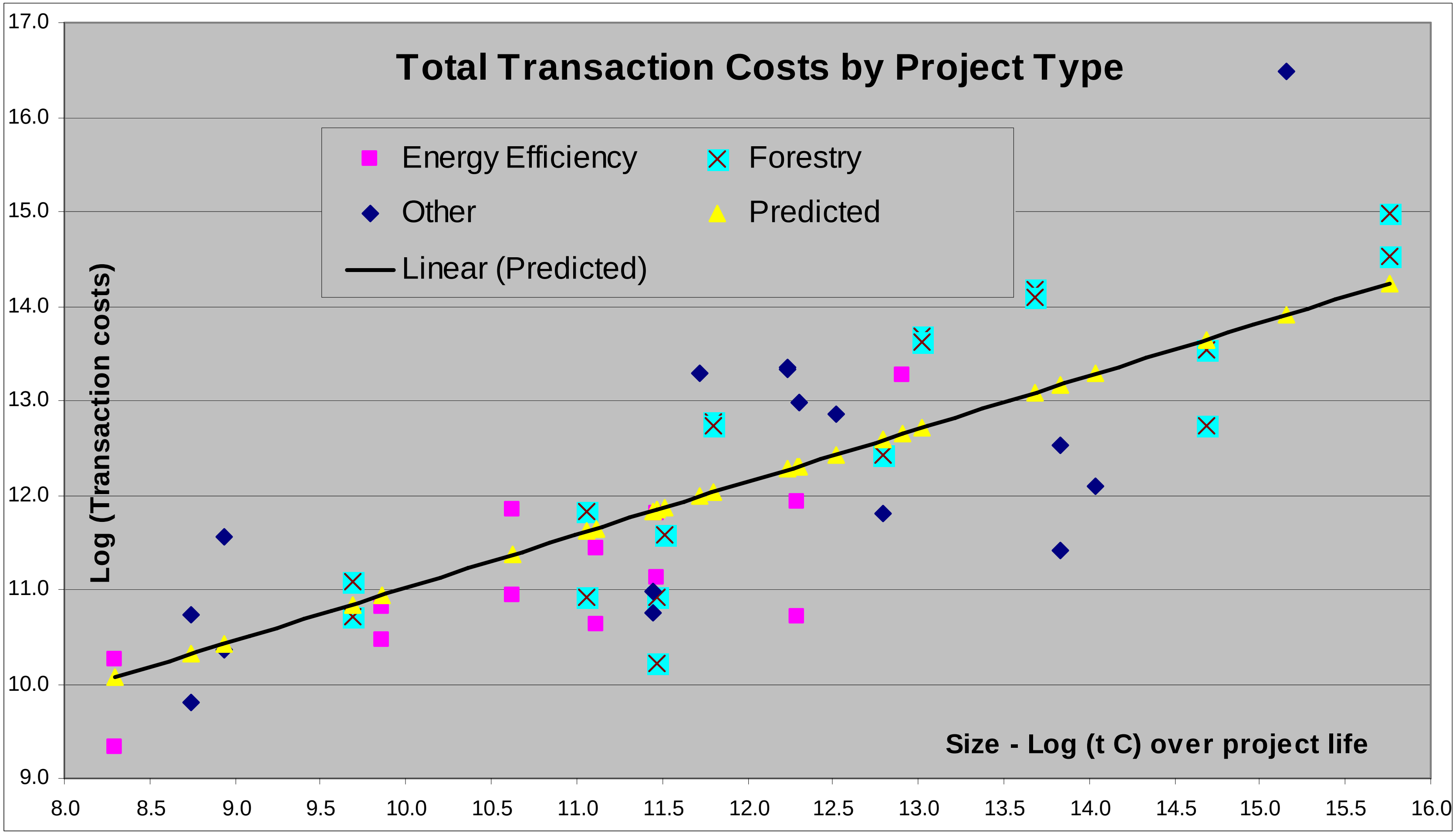
Supply with transaction costs
Range varies with
Project size?
Current vs. mature market?
Project type?
Region?

Key Findings: Regression Analysis of Transaction Costs of Multiple Types of Offset Projects

Dependent variable:	Log (Total Transaction Costs (USD))
	(Standard error in parenthesis)
Independent variables:	
t C (log)	0.56** (0.08)
Forestry	-1.04** (0.40)
Energy Efficiency	-0.59 (0.36)
Multiple objectives	-0.34 (0.30)
S. America	0.75* (0.45)
Asia	-0.24 (0.41)
Mature	-0.49* 0.27
Constant	6.08** (1.00)
R2	0.69
N	48

*Statistical significance at the 10% level
**Statistical significance at the 5% level

- **Statistical analysis to determine significant influence on costs of**
  - **Project Size**
  - **Multiple benefits**
    - **Technology demonstration, social development, other environmental benefits**
  - **Forestry, energy efficiency dummies**
  - **Regional dummies – Asia and Latin America**
  - **Mature vs. nascent markets**
- **Transaction costs range from:**
  - **$0.11/t C for larger to $15/t C for smaller projects**
  - **Range from 1% to 19% of project costs for forestry projects**

Total Transaction Costs by Project Type
Energy Efficiency
Forestry
Other
Predicted
Linear (Predicted)
Log (Transaction costs)
Size - Log (t C) over project life
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
8.5
9.0
9.5
10.0
10.5
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12.0
12.5
13.0
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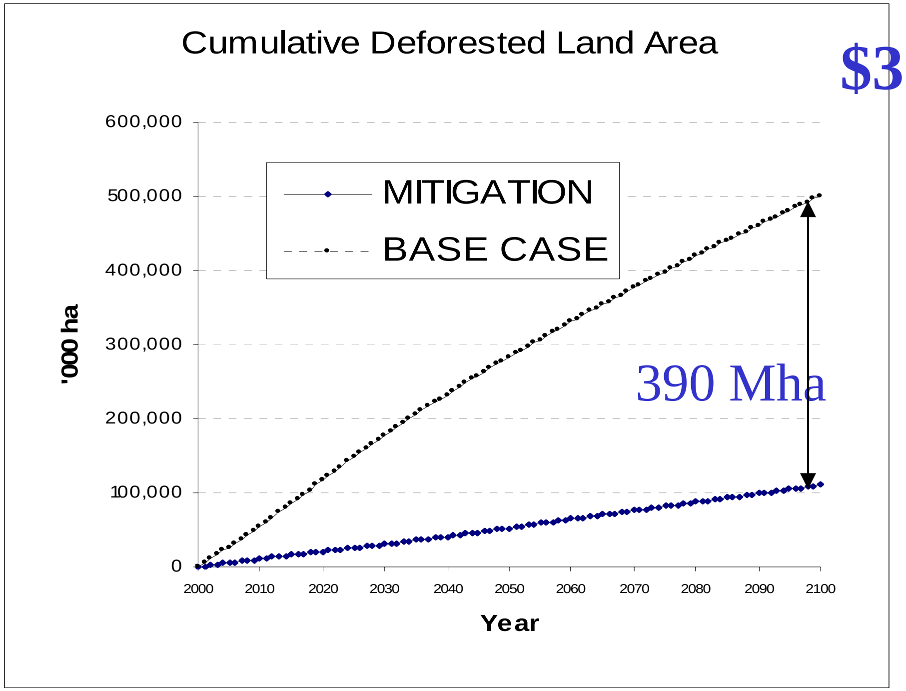
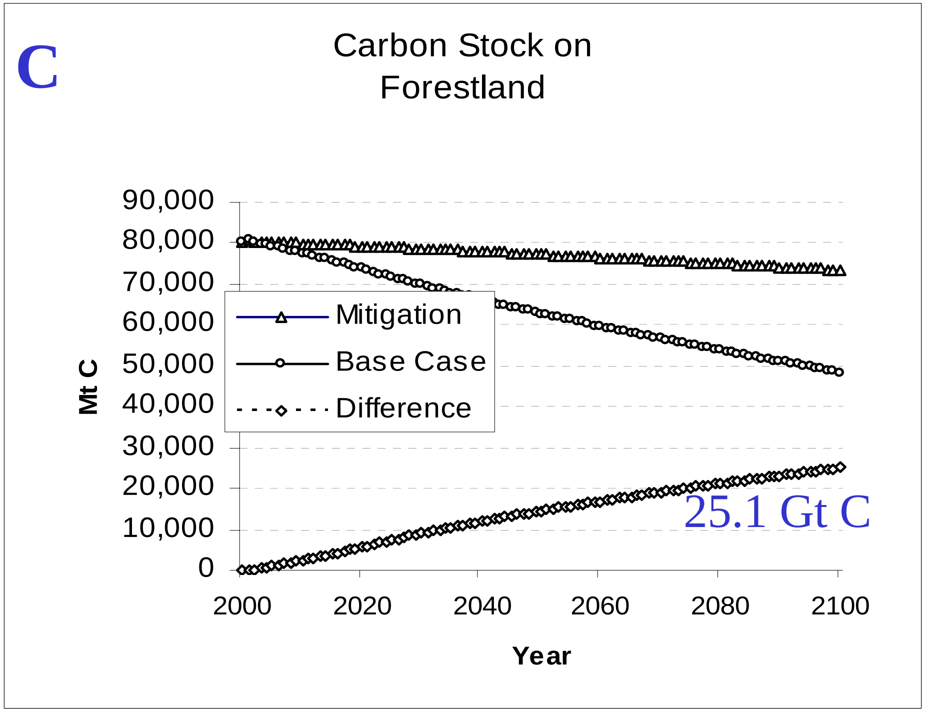
14.0
14.5
15.0
15.5
16.0



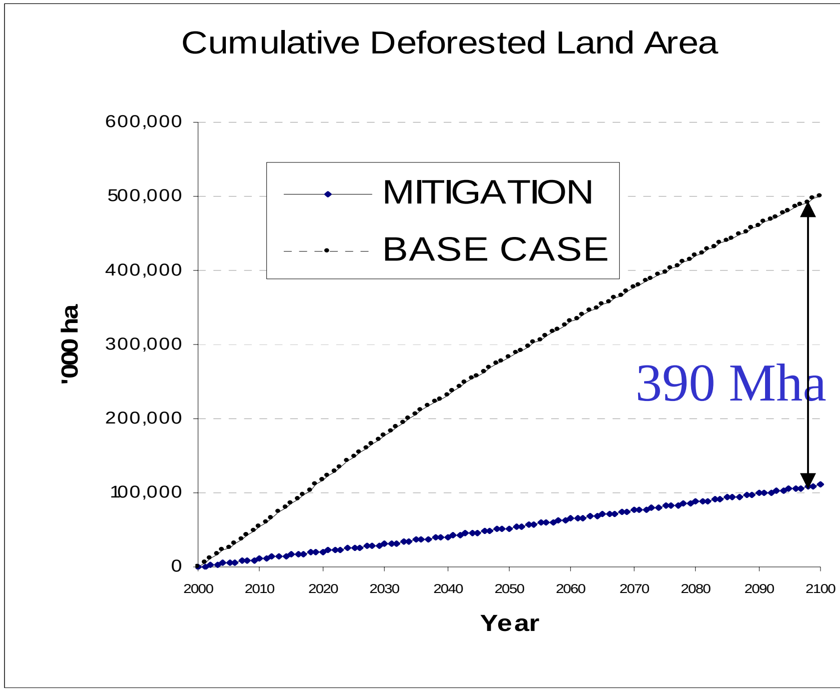
$30/t C

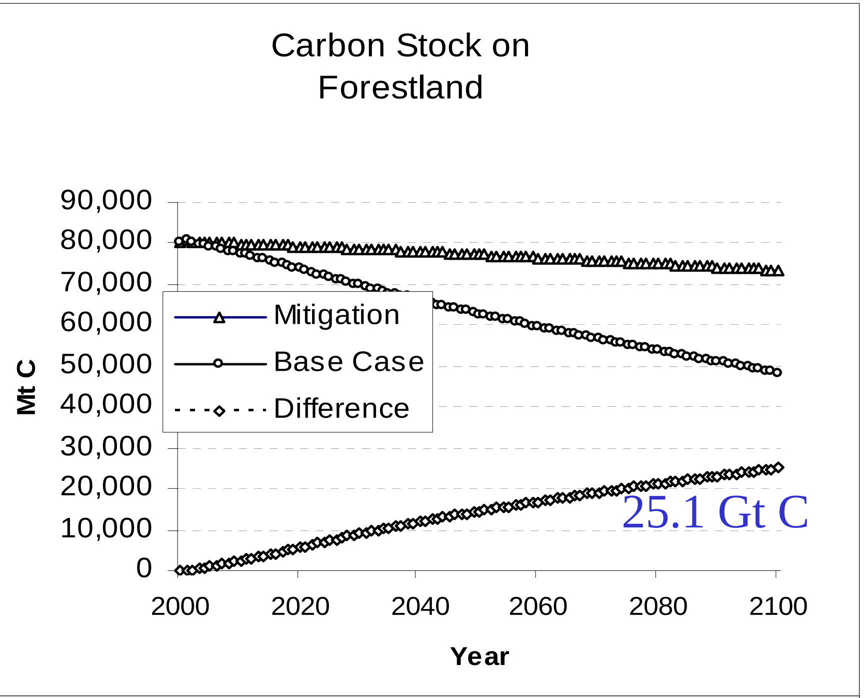


Africa

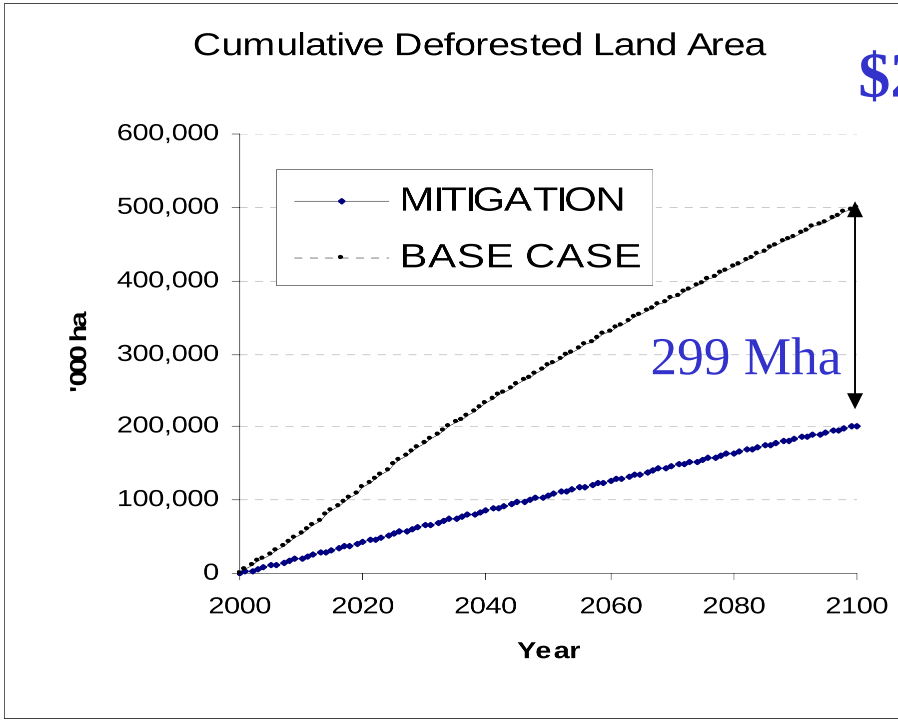
- 2000 deforestation rate: 0.80% per year
- Future deforestation rate:
  - Increases gradually to 1.29% by 2020 and then declines to 0.26% by 2100
- Carbon price: Constant $30 per t C
- Theoretical carbon price to virtually halt deforestation: $39 per t C

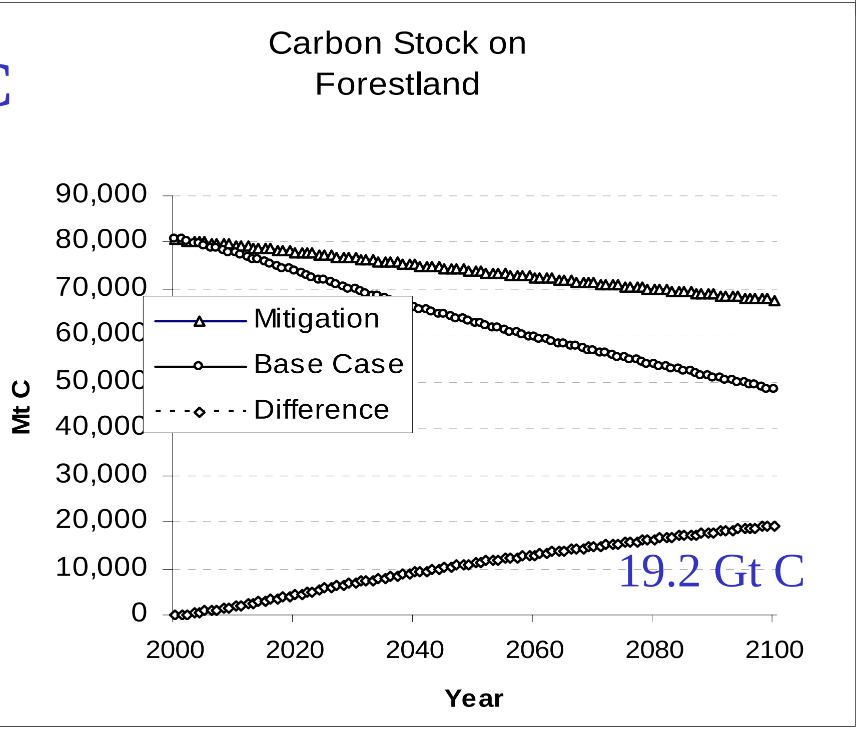
$30/t C


Cumulative Deforested Land Area
600,000
500,000
400,000
300,000
200,000
100,000
0
'000 ha
MITIGATION
BASE CASE
390 Mha
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year


Carbon Stock on Forestland
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Mt C
Mitigation
Base Case
Difference
25.1 Gt C
2000
2020
2040
2060
2080
2100
Year

$23/t C


Cumulative Deforested Land Area
600,000
500,000
400,000
300,000
200,000
100,000
0
'000 ha
MITIGATION
BASE CASE
299 Mha
2000
2020
2040
2060
2080
2100
Year


Carbon Stock on Forestland
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Mt C
Mitigation
Base Case
Difference
19.2 Gt C
2000
2020
2040
2060
2080
2100
Year

Alternative Reference Case Run: Africa Taking transaction costs into consideration

- Assuming a transaction cost of $7 per t C
- Hence an effective carbon price of $23 per t C
- Cumulative avoided deforestation:
  - Land area: 299.2 Mha
  - Carbon: 19.2 Gt C
- Net reduction in avoided deforestation due to transaction cost
  - Land area: 390.4 - 299.2 = 91.2Mha (23%)
  - Carbon: 25.1 - 19.2 Gt C = 5.9 Gt C (24%)

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EMF 21 Case: South America
Deforested Area and Forest Carbon Stock

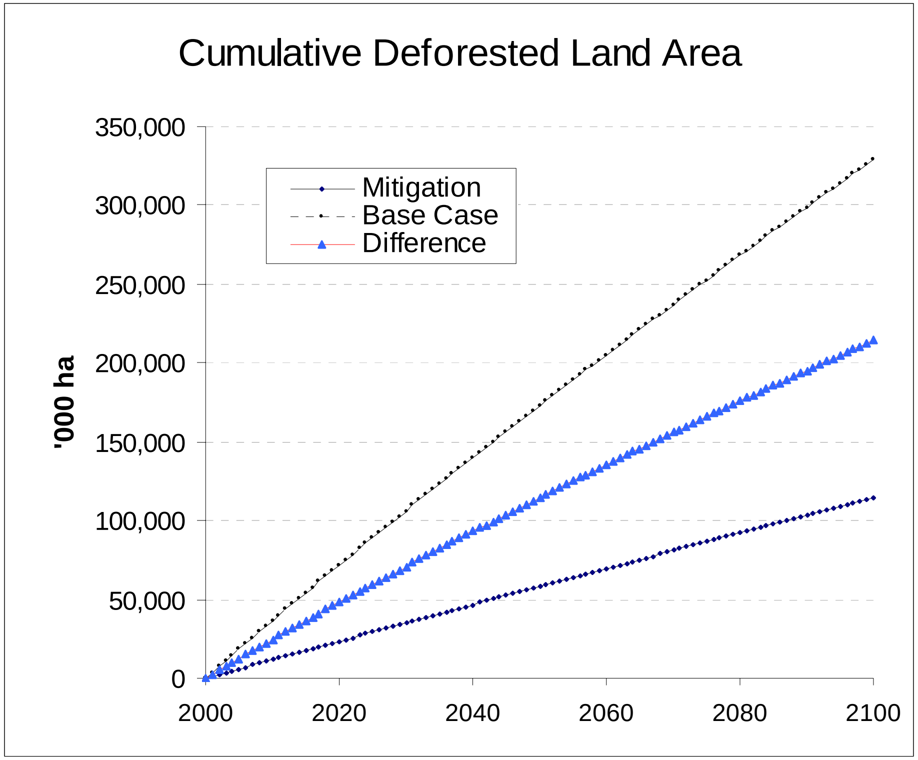
Constant carbon price: $100/t C (2000-2100)

Base year deforestation: 3.7 Mha

EMF-21 (2100):

Reference case deforested area: 329 Mha

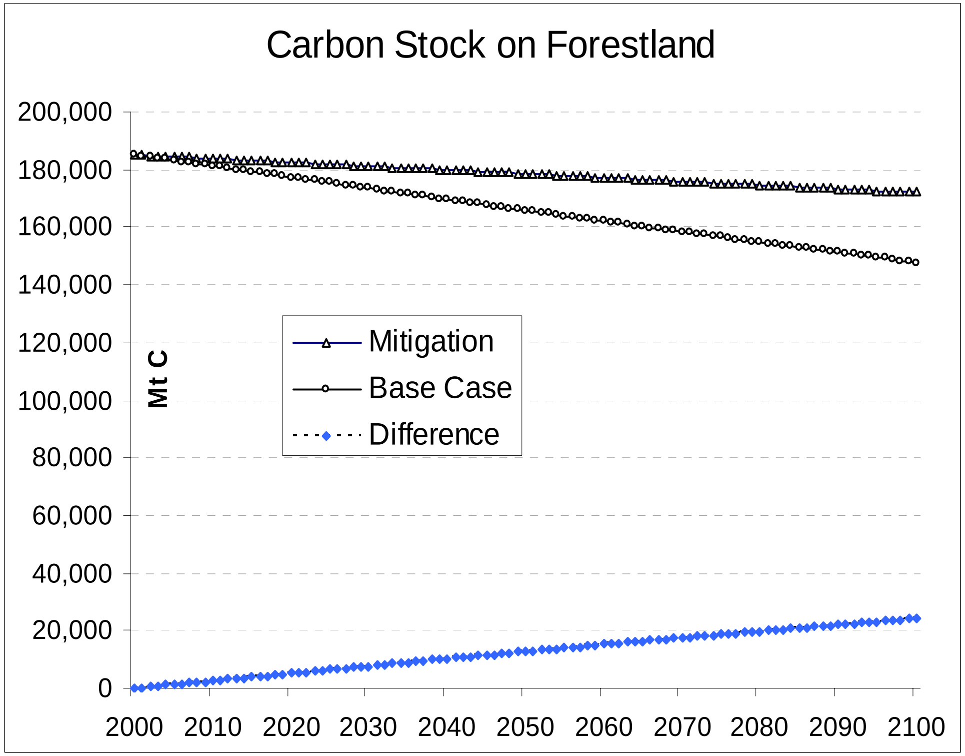
Avoided deforested area: 215 Mha



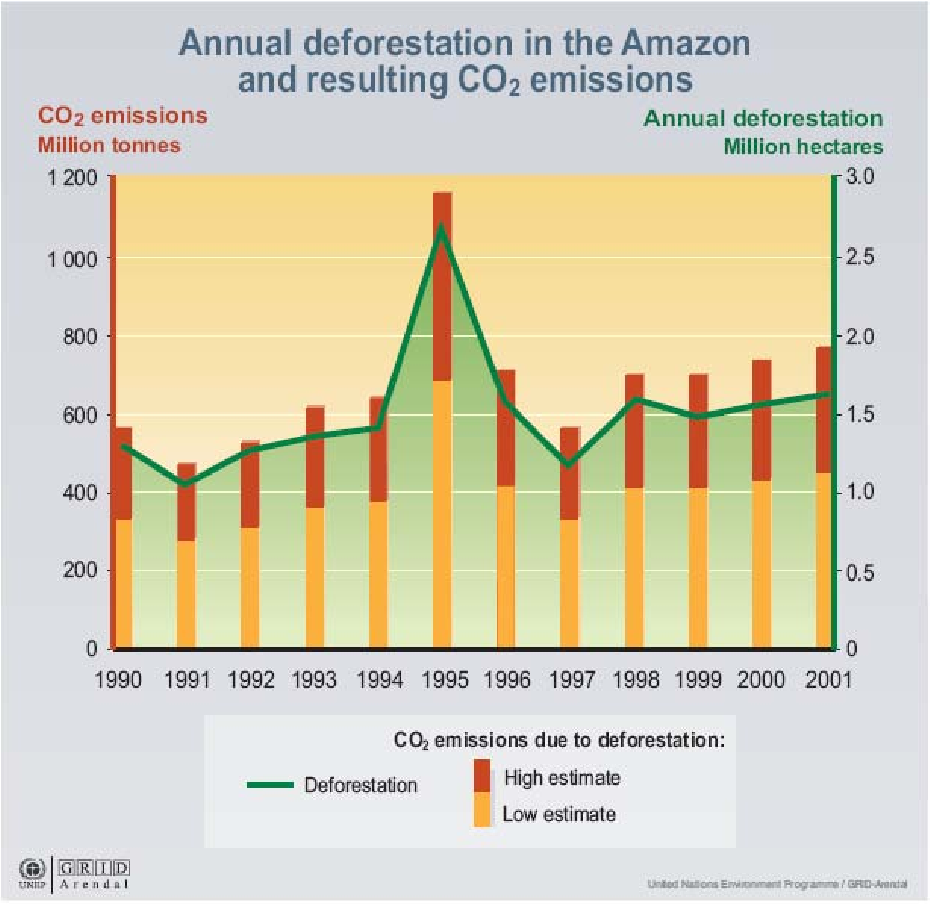
EMF 21 (2100):

Reference case carbon stock: 148 Gt C

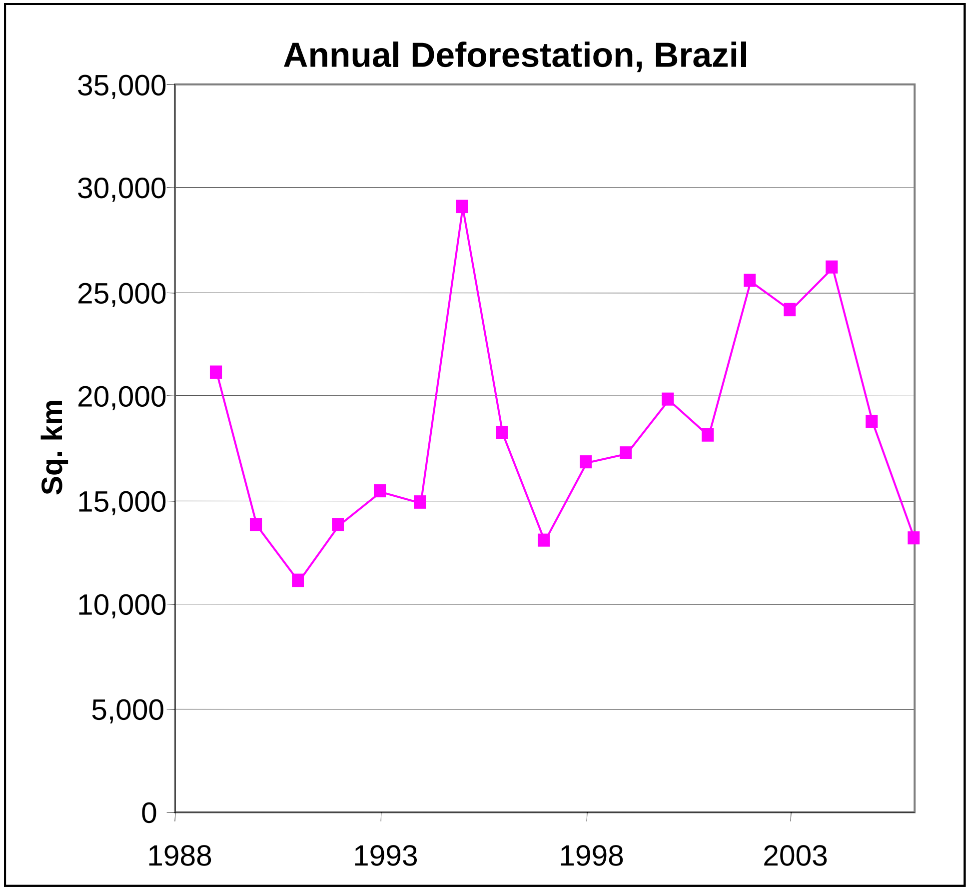
Avoided carbon emissions: 24.3 Gt C



Brazil Annual Deforested Area



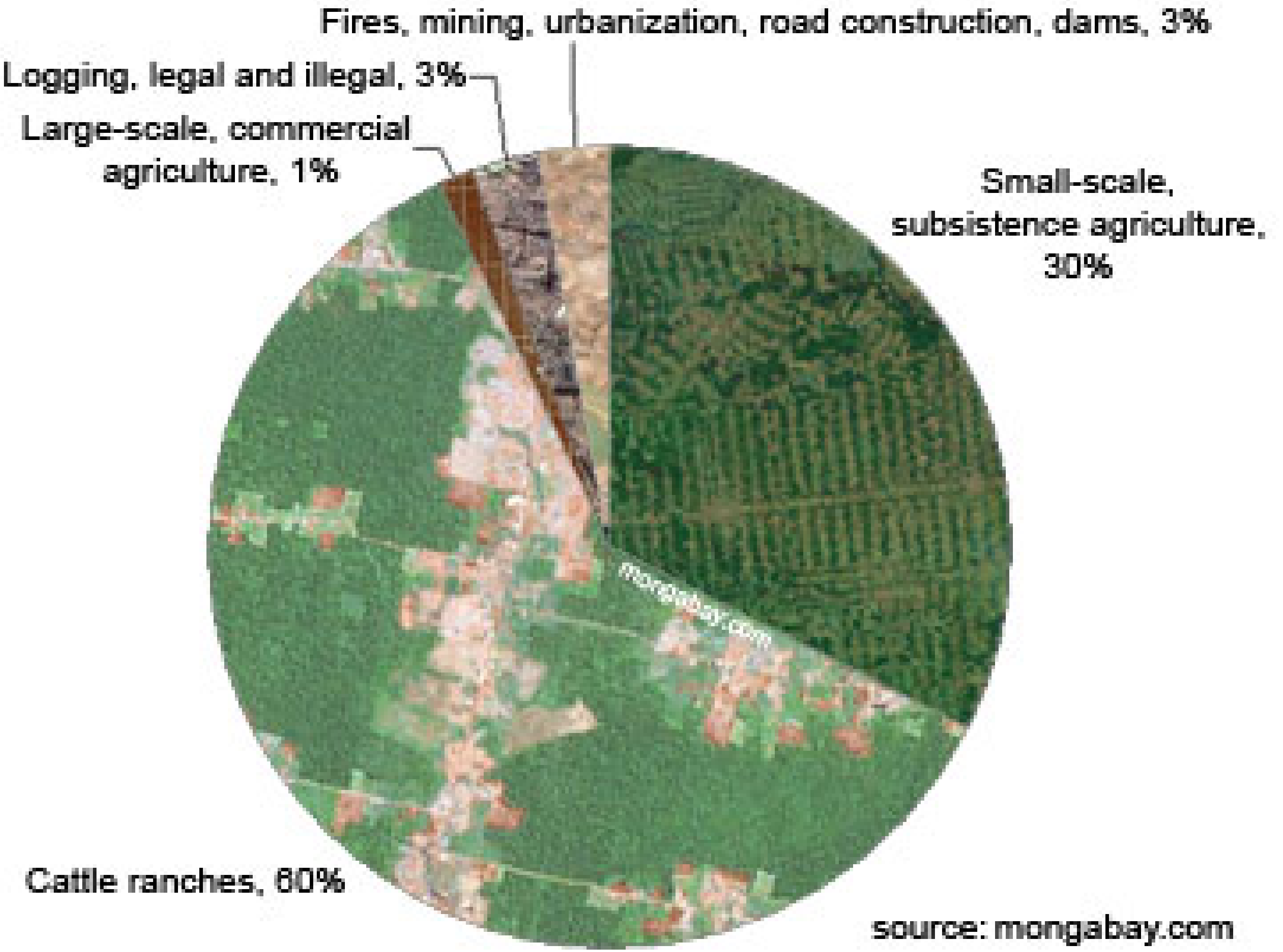
Sources: UNEP 1999; La Rovere 2000; Cramer 2004.



Source: INPE, Brazil

How to model sharp fluctuations in base year deforested area?

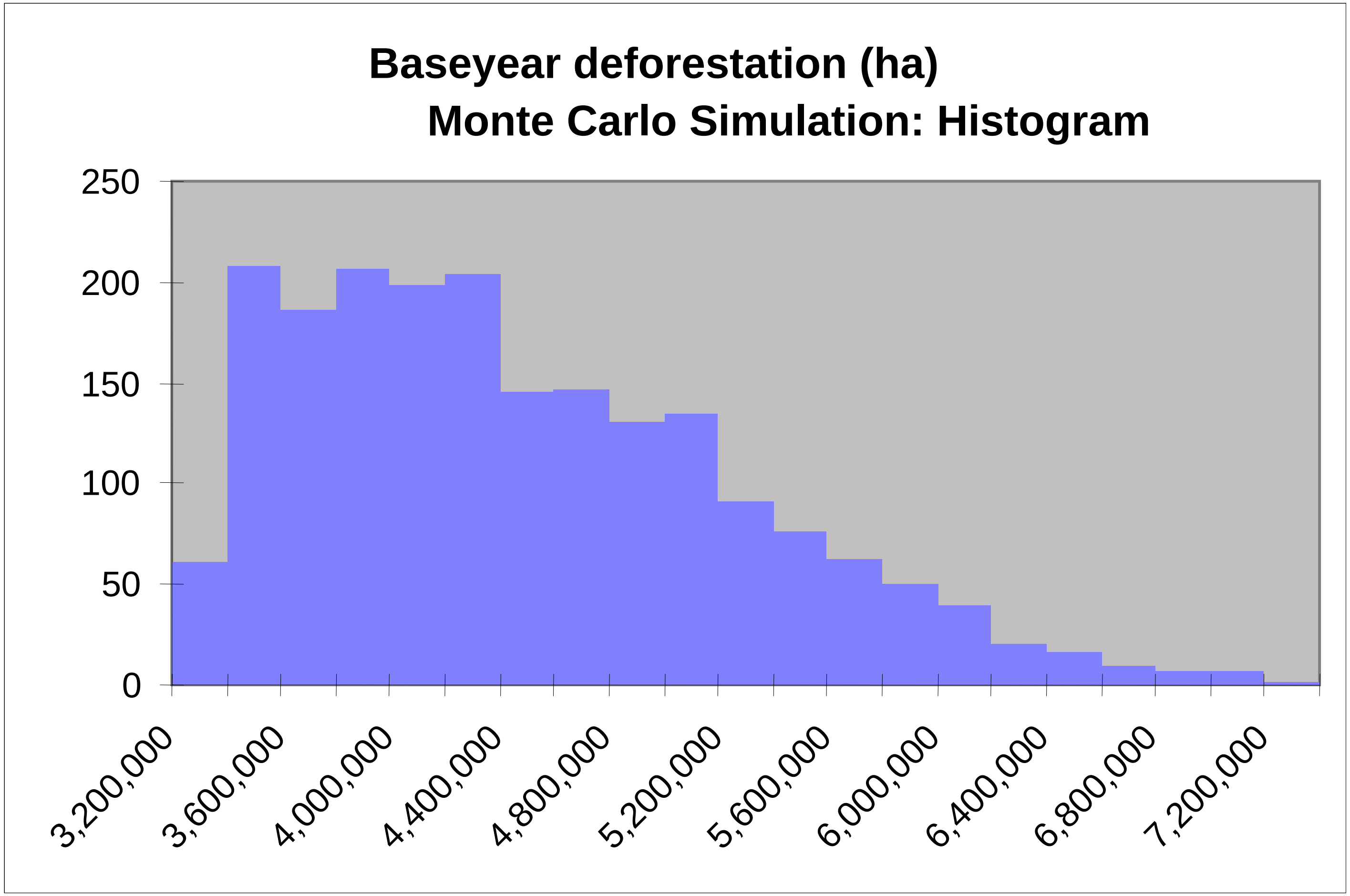
Causes of Deforestation in the Amazon, 2000-2005



source: mongabay.com

Alternative Reference Case: South America Base Year Deforestation

Mean Area in Reference Case: 3.7 Mha



Alternative Reference Case: South America Deforested Area and Forest Carbon Stock

Constant carbon price: $100/t C (2000-2100)

Base year deforestation: 3.1 – 7.0 Mha Range; Smoothed Triangular Distribution

Annual deforestation rate – Single rate changing over time

2100:

Avoided deforested area – 275 Mha (base case)

Avoided deforested area range – 153 Mha

-- 5%: 191 Mha (-31%)

-- Mean: 254 Mha,

-- 95%: 344 Mha (+25%)

2100:

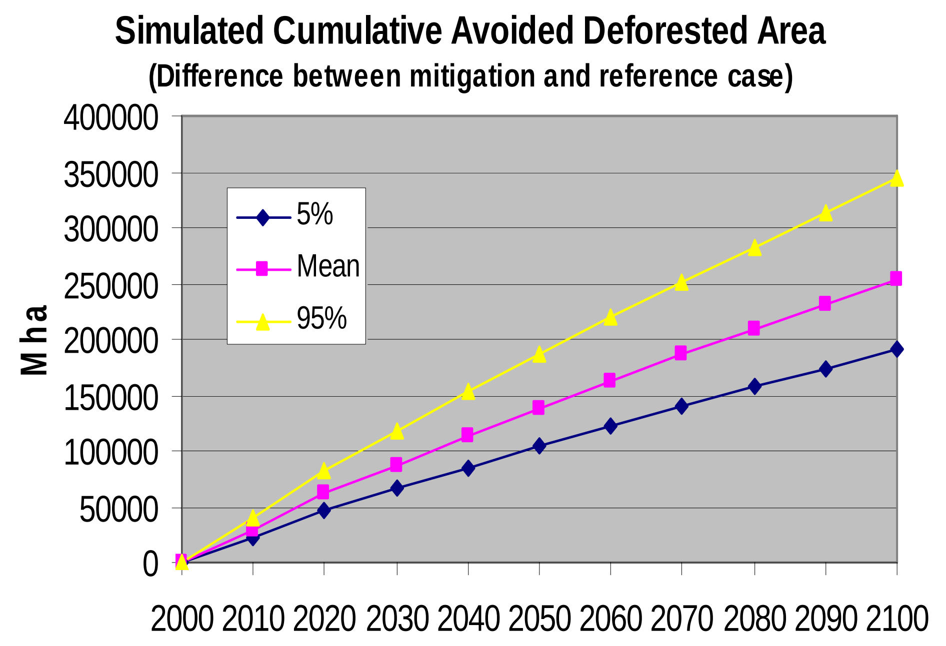
Cumulative carbon gain – 24.3 Gt C (base case)

Cumulative carbon gain range – 17.3 Gt C

-- 5%: 21.6 Gt C (-11%)

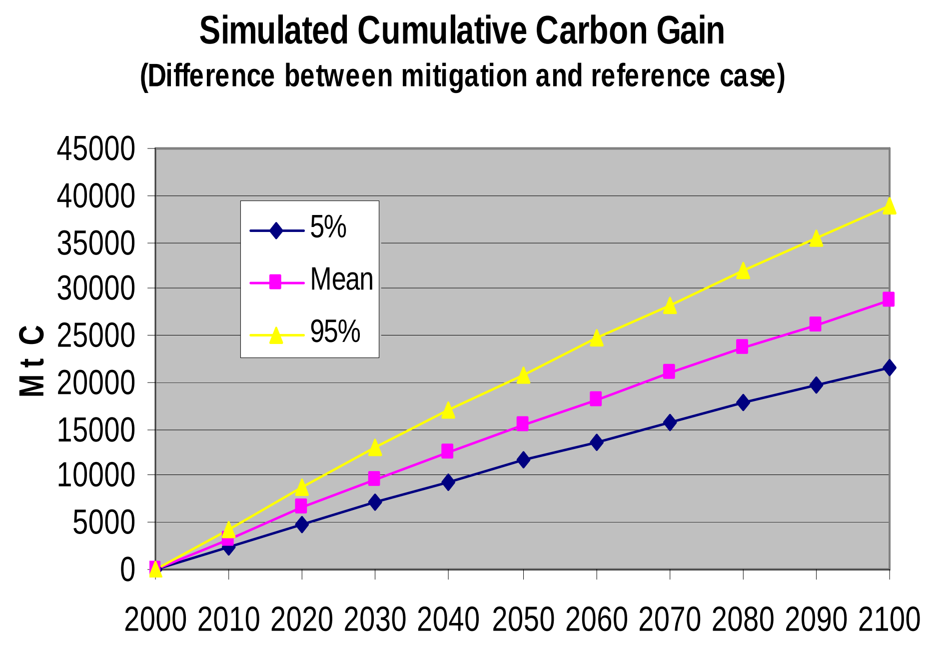
-- Mean: 28.8 Gt C

-- 95%: 38.9 Gt C (+60%)



Simulated Cumulative Avoided Deforested Area

(Difference between mitigation and reference case)



Simulated Cumulative Carbon Gain

(Difference between mitigation and reference case)

Alternative Reference Case: South America Deforested Area and Forest Carbon Stock

Constant carbon price: $100/t C (2000-2100)

Base year deforestation: 3.7 Mha (3.1 – 7.0 Mha Range; Triangular Distribution

Annual deforestation rate – SD increases from 100% to 400% by 2100

2100:

Avoided deforested area – 275 Mha

Avoided deforested area range – 203 Mha (33%)

-- 5%: 173 Mha;

-- Mean: 259 Mha

-- 95%: 376 Mha

2100:

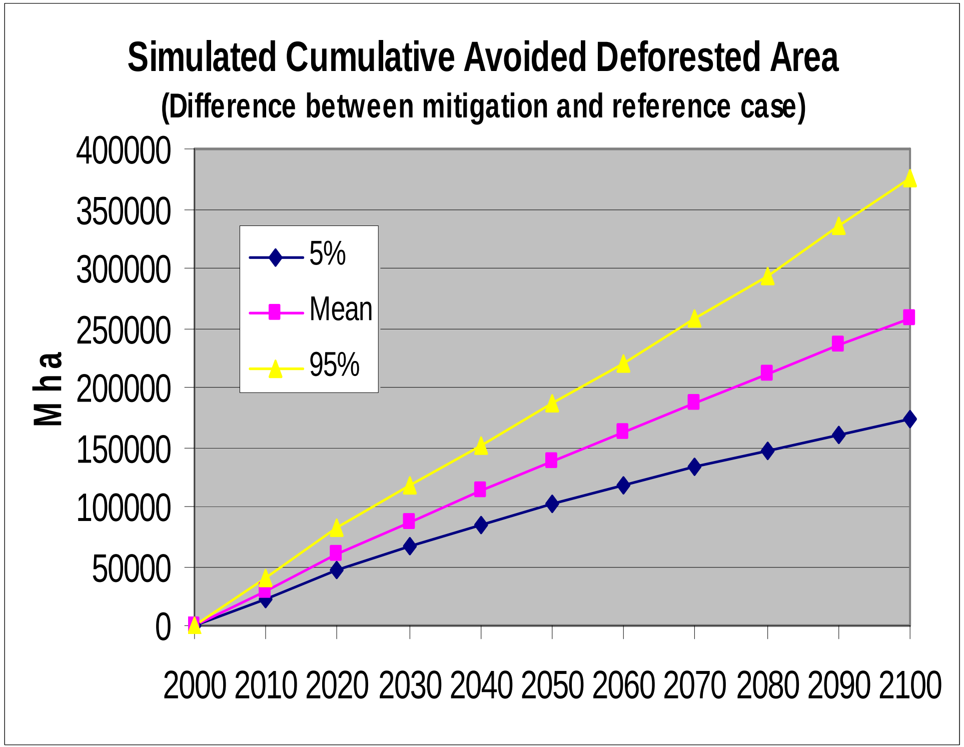
Cumulative carbon gain – 24.3 Gt C

Cumulative carbon gain range – 22.8 Gt C (26%)

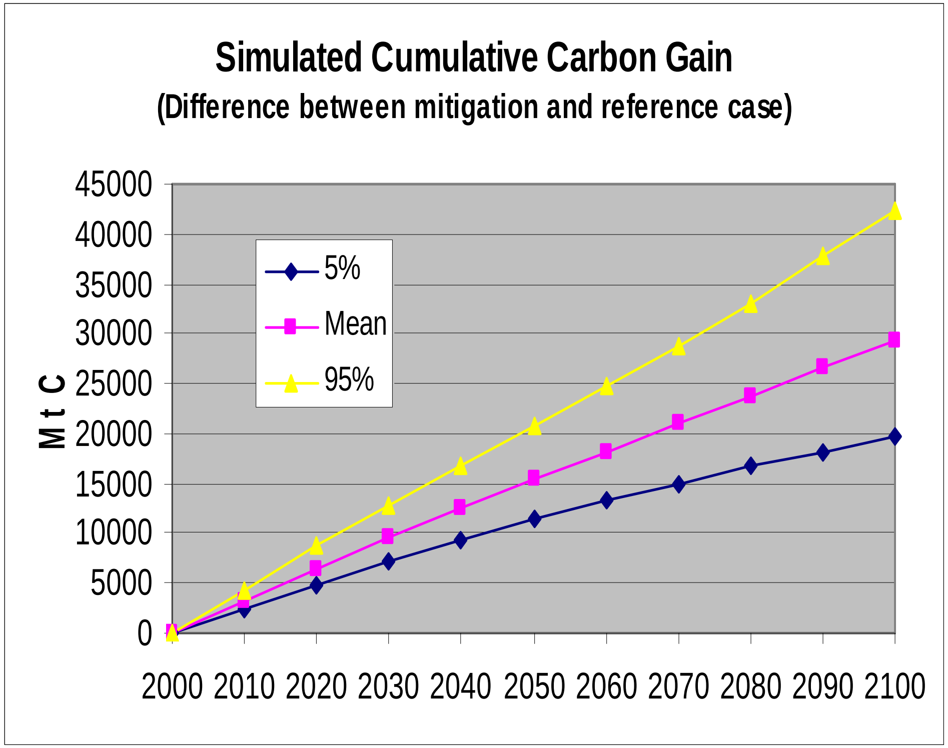
5%: 19.6 Gt C;

Mean: 29.3 Gt C;

95%: 42.4 Gt C


Simulated Cumulative Avoided Deforested Area

(Difference between mitigation and reference case)


Simulated Cumulative Carbon Gain

(Difference between mitigation and reference case)

Alternative Reference Case: Global Implications
Deforested Area and Forest Carbon Stock

Constant carbon price: $100/t C (2000-2100)

2100: Four regions – South and Central America, Africa and Rest of Asia

Avoided deforested area – 866 Mha

Avoided carbon emissions – 61.7 Gt C

If the above findings hold for the other three regions:

Considering only baseyear deforested area probability distribution --

Avoided deforested area range – 562-1013 Mha

Avoided carbon emissions – 54.8 – 98.8 Gt C

Considering baseyear deforested area and future deforestation rate probability distribution –

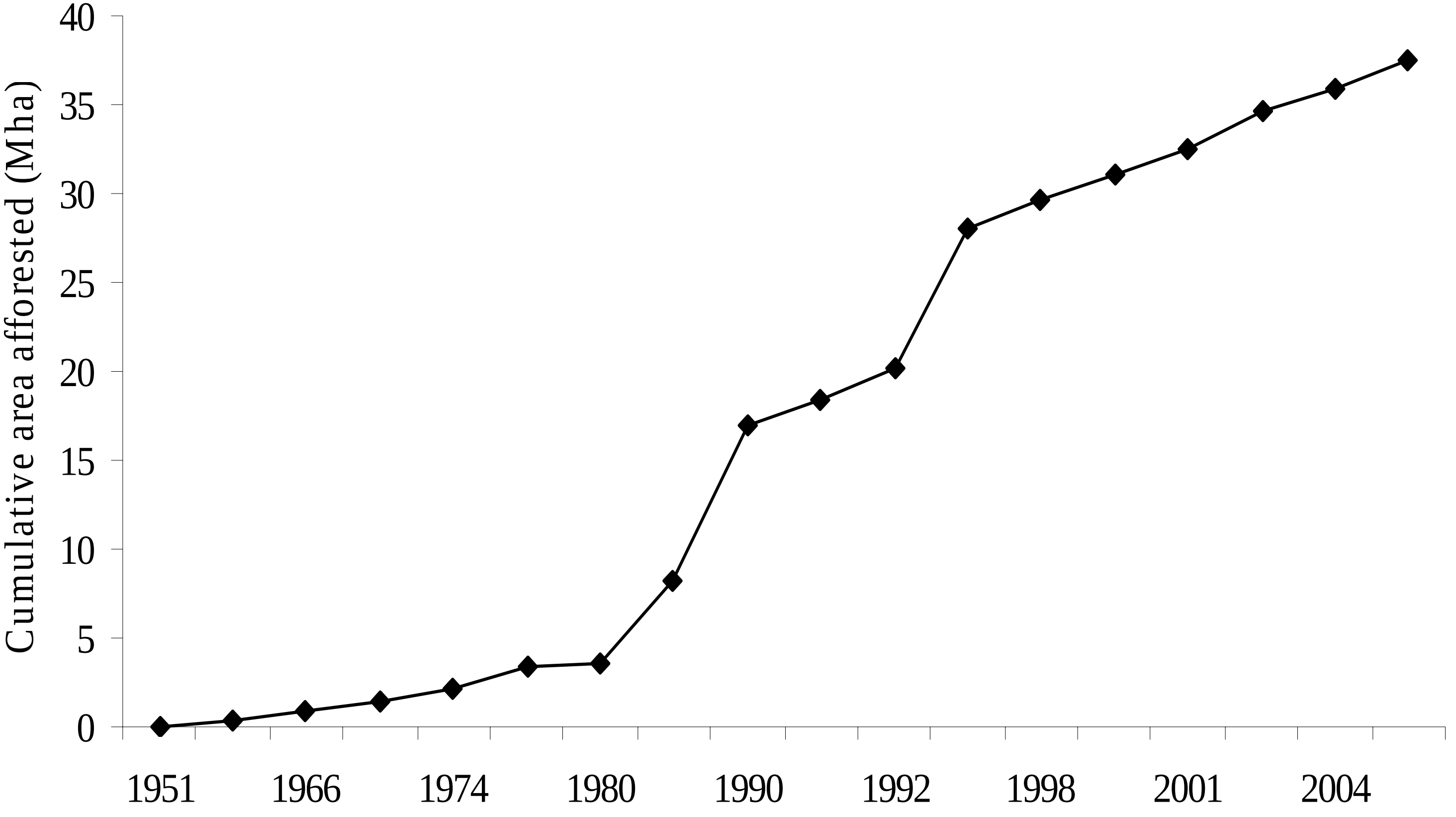
Avoided deforested area range – 510-1107 Mha

Avoided carbon emissions – 49.8 – 107.6 Gt C

Contents

- Background on emissions from forest sector
- EMF-21 GCOMAP Results
- Impact of
  - Transaction costs
  - Variation in baseyear deforestation estimates
  - **Alternative disaggregation of land classes**
- Conclusions

Cumulative area afforested in India for the period 1951 to 2005



Wasteland categories, their features and technical potential area

Wasteland category	Features	Technical potential area ('000 ha)
Gullied and /or ravinous land (Shallow-<2.5m deep)	Extensive network of gullies formed generally in deep alluvium and entering nearby river (along river courses), flowing much lower than surrounding table lands	1,056
Gullied and /or ravinous land (Medium-<2.5-5m deep)		583
Gullied and / or ravinous land (Deep->5m deep)		375
Land with scrub	Occupies high topographic conditions – with little vegetation	16,222
Land without scrub	Occupies high topographic conditions – with no vegetation	3,858
Shifting and cultivation area (Abandoned)	Land as a result of cyclic felling of trees and burning of forest for growing crops. Results in extensive soil losses and land degradation; Abandoned – if no cultivation at present	1,181

Degraded Forest - Scrub Dominated	Degraded forest land with crown cover lost and dominated by scrub vegetation, with root stock or seed source present in some locations	12,249
Degraded pastures/ grazing land	Mainly in Rajasthan, Haryana etc. Results from continuous grazing coupled with drought and famine; loss of ground cover leading to low moisture storage	1,939
Degraded land under plantation crop	Degraded land, where plantation crop raised has been harvested and currently with no tree crown cover	215
Mining Wastelands	Lands deteriorated as a result of mining activity	160
Industrial Wastelands	Lands deteriorated as a result of large-scale industrial effluent discharge	20
Total		**37,858**

India trends ('000 ha)

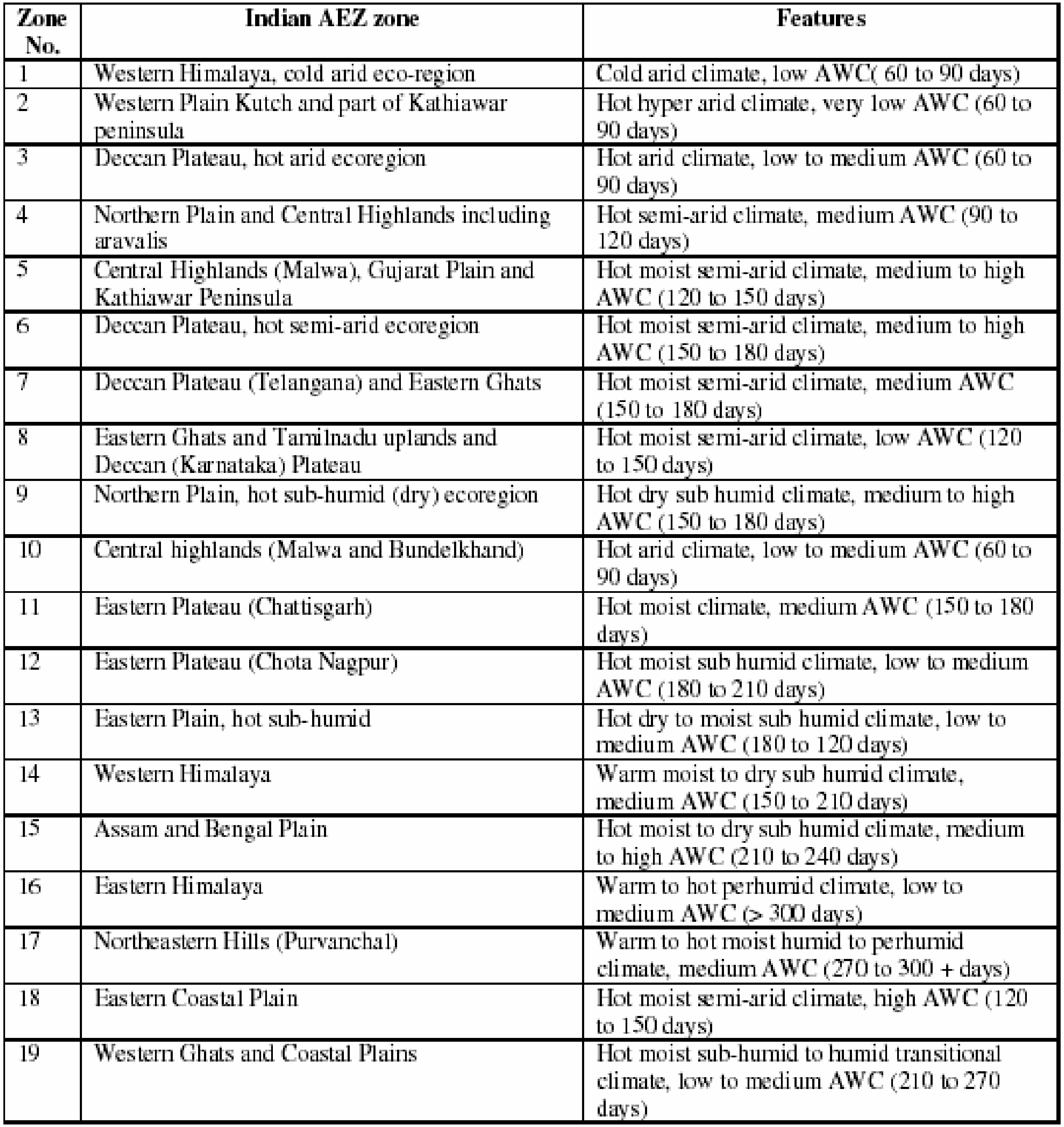
Year	Long-term fallow[1]	Current fallow	Net sown area
1960-61	11,180	11,640	133,200
1970-71	8,760	11,120	140,270
1980-81	9,920	14,830	140,000
1990-91	9,660	1,370	143,000
1999-2000	10,110	1,480	141,230

[1] *All fallow lands other than current fallow*

Agro-ecological Zone (AEZ)

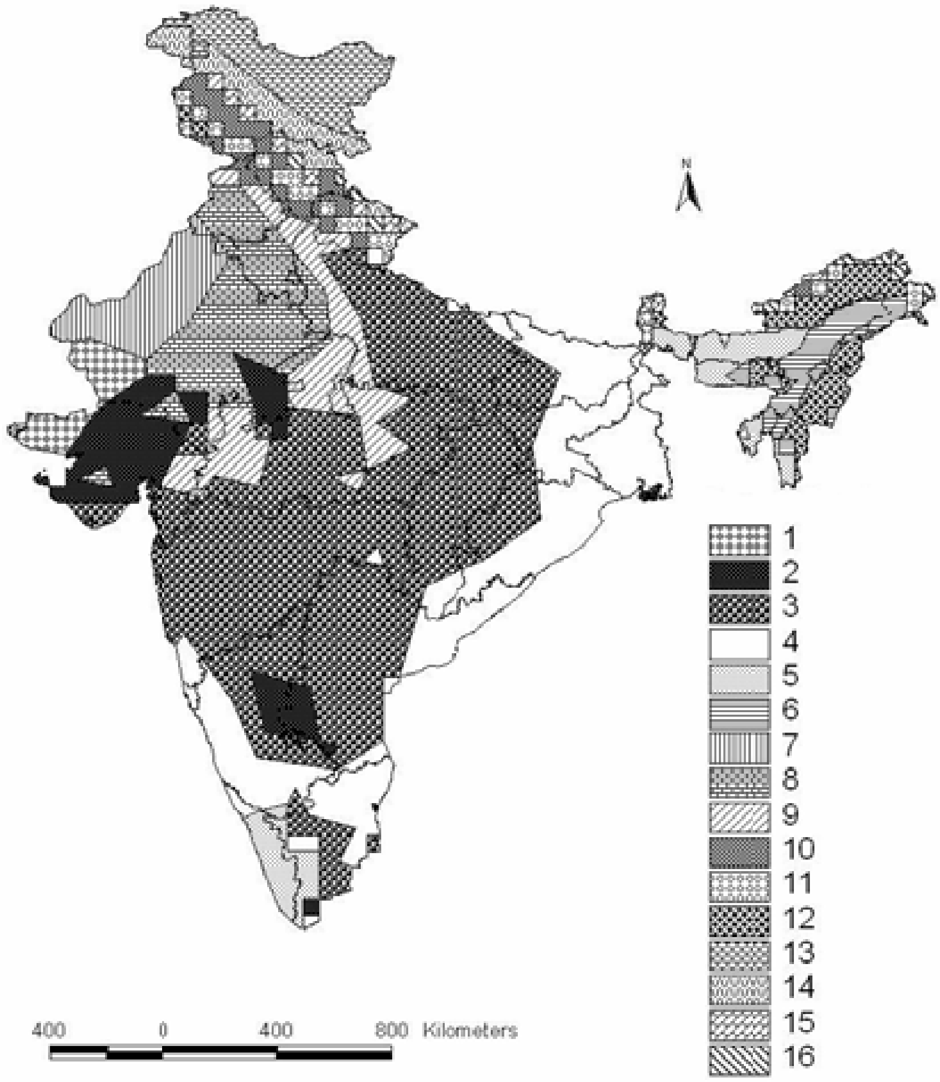
- The AEZ categorization is based on the Length of the Growing Period (LGP) concept, which is derived from climate, soil and topography data with water balance model and knowledge of the crop requirements (Sehgal et al., 1992 and FAO/IIASA, 1993).
- LGP refers to the period during the year when both soil moisture and temperature are conducive to plant growth.
- India has categorized its geographic area into 20 AEZs.

Features of Indian AEZs

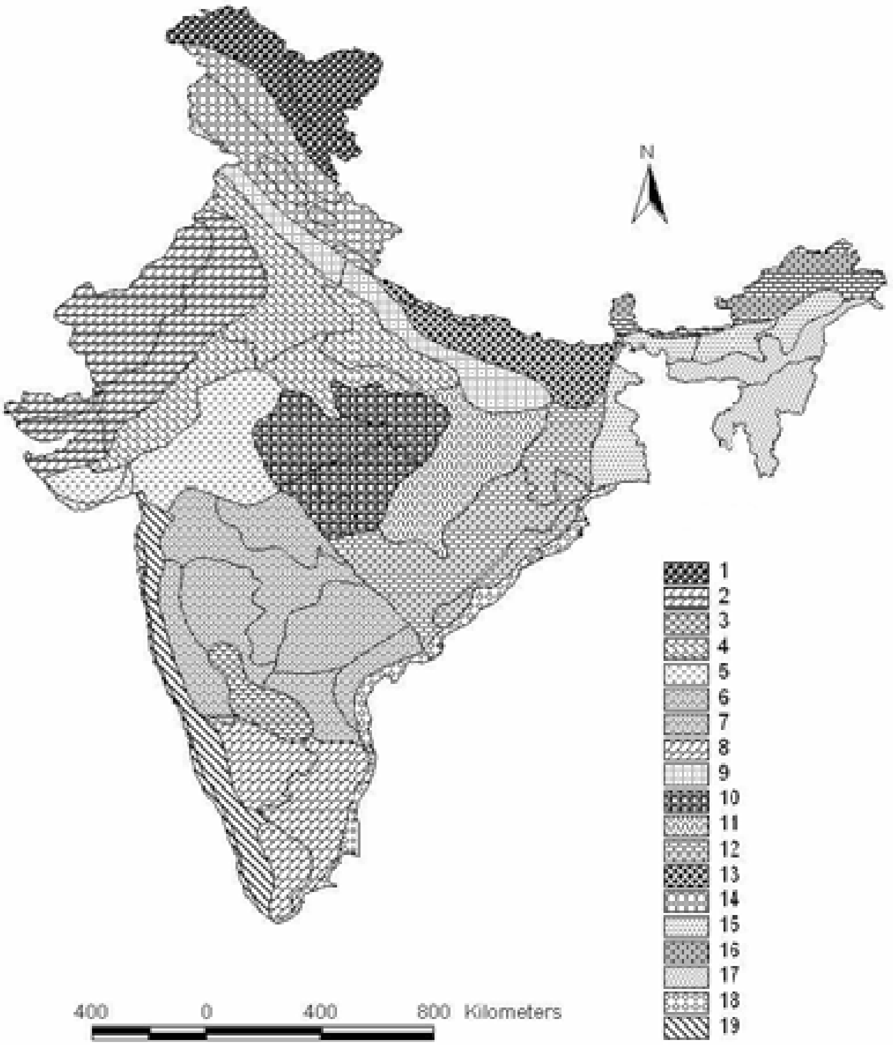


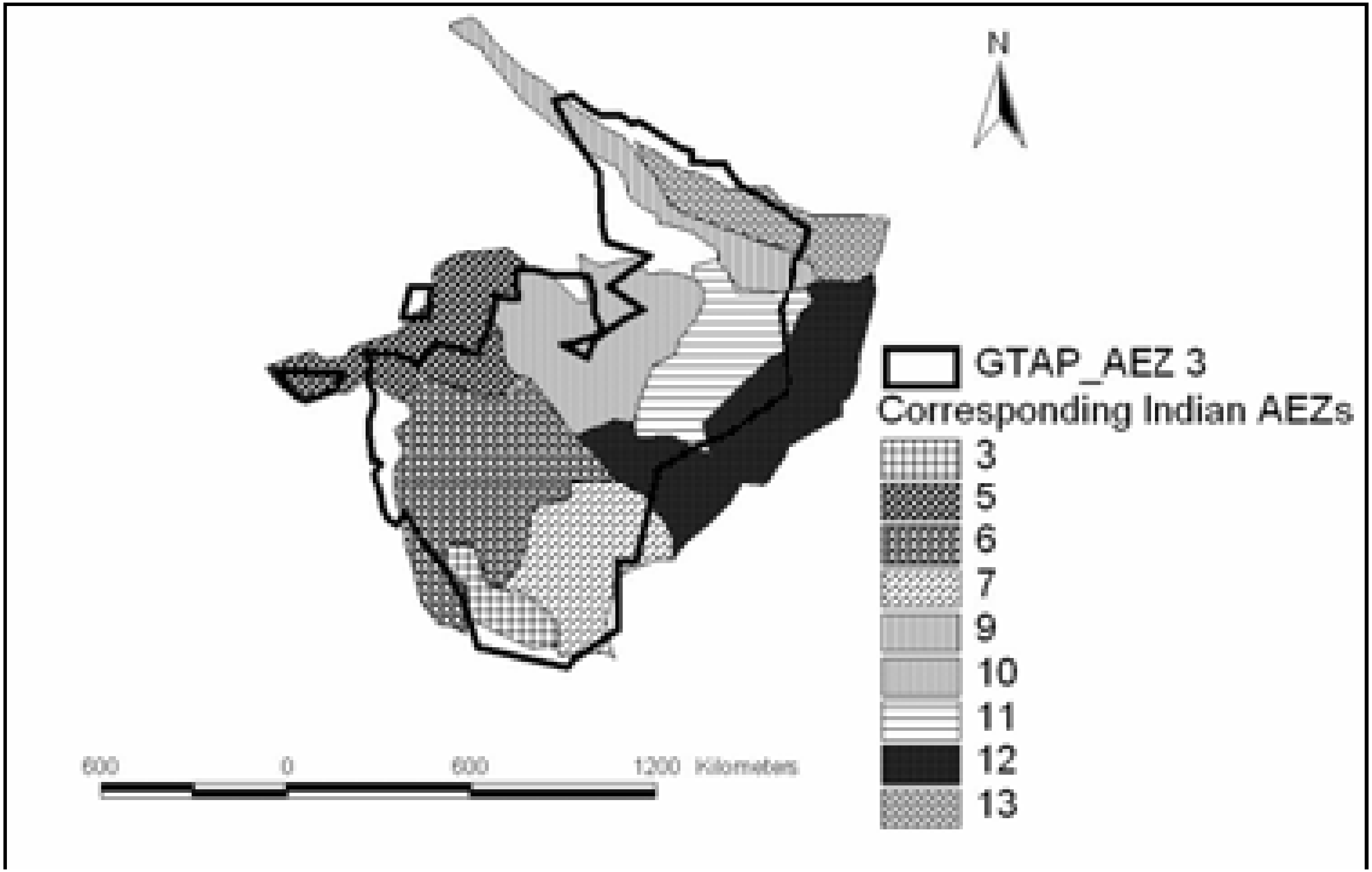
Zone No.	Indian AEZ zone	Features
1	Western Himalaya, cold arid eco-region	Cold arid climate, low AWC(60 to 90 days)
2	Western Plain Kutch and part of Kathiawar peninsula	Hot hyper arid climate, very low AWC (60 to 90 days)
3	Deccan Plateau, hot arid ecoregion	Hot arid climate, low to medium AWC (60 to 90 days)
4	Northern Plain and Central Highlands including aravalis	Hot semi-arid climate, medium AWC (90 to 120 days)
5	Central Highlands (Malwa), Gujarat Plain and Kathiawar Peninsula	Hot moist semi-arid climate, medium to high AWC (120 to 150 days)
6	Deccan Plateau, hot semi-arid ecoregion	Hot moist semi-arid climate, medium to high AWC (150 to 180 days)
7	Deccan Plateau (Telangana) and Eastern Ghats	Hot moist semi-arid climate, medium AWC (150 to 180 days)
8	Eastern Ghats and Tamilnadu uplands and Deccan (Karnataka) Plateau	Hot moist semi-arid climate, low AWC (120 to 150 days)
9	Northern Plain, hot sub-humid (dry) ecoregion	Hot dry sub humid climate, medium to high AWC (150 to 180 days)
10	Central highlands (Malwa and Bundelkhand)	Hot arid climate, low to medium AWC (60 to 90 days)
11	Eastern Plateau (Chattisgarh)	Hot moist climate, medium AWC (150 to 180 days)
12	Eastern Plateau (Chota Nagpur)	Hot moist sub humid climate, low to medium AWC (180 to 210 days)
13	Eastern Plain, hot sub-humid	Hot dry to moist sub humid climate, low to medium AWC (180 to 120 days)
14	Western Himalaya	Warm moist to dry sub humid climate, medium AWC (150 to 210 days)
15	Assam and Bengal Plain	Hot moist to dry sub humid climate, medium to high AWC (210 to 240 days)
16	Eastern Himalaya	Warm to hot perhumid climate, low to medium AWC (> 300 days)
17	Northeastern Hills (Purvanchal)	Warm to hot moist humid to perhumid climate, medium AWC (270 to 300 + days)
18	Eastern Coastal Plain	Hot moist semi-arid climate, high AWC (120 to 150 days)
19	Western Ghats and Coastal Plains	Hot moist sub-humid to humid transitional climate, low to medium AWC (210 to 270 days)

1 A: Global GTAP



1B: Indian AEZ




N
GTAP_AEZ 3
Corresponding Indian AEZs
3
5
6
7
9
10
11
12
13
600
0
600
1200
Kilometers

Socio-economic potential land for mitigation activities and allocation of land for SR, LR and NR according to GTAP and Indian AEZ land classifications

	Zone	Technical potential ('000 ha)	Socio-economic potential ('000 ha)	Allocation of socio-economic potential to different options (‘000 ha)		
				Short rotation	**Long rotation**	**Natural regeneration**
GTAP	*WL scenario*[1]					
	1,7,8	9,443	6,610	4,363	2,247	
	2	2,837	1,986	1,311	675	
	3	13,683	9,578	3,161	1,628	4,789
	4	5,045	3,532	1,166	600	1,766
	5,6	1,729	1,210	799	412	
	9	3,203	2,242	1,480	762	
	10 to 16	5,683	3,978	2,625	1,352	
	Total	**41,623**	**29,136**	**14,905**	**7,676**	**6,555**
	WL+LF+MC scenario[2]					
	1,7,8	41,703	11,839	7,814	4,025	
	2	15,276	3,308	2,183	1,125	
	3	101,193	21,121	6,970	3,591	10,560
	4	30,834	7,437	2,454	1,264	3,718
	5,6	13,981	2,367	1,563	805	
	9	10,361	3,279	2,164	1,115	
	10 to 16	16,277	4,366	2,881	1,484	
	Total	**229,625**	**53,717**	**26,029**	**13,409**	**14,278**

Socio-economic potential land for mitigation activities and allocation of land for SR, LR and NR according to GTAP and Indian AEZ land classifications (continued)

INDIAN AEZ	***WL scenario*[1]**					
	1&14	6,103	4,282	2,826	1,456	
	2	2,027	1,419	468	241	709
	3,6,7	3,723	2,606	1,341	691	574
	4,9,13	9,953	6,967	4,598	2,367	
	5	2,345	1,641	1,083	558	
	8&19	5,040	3,528	1,164	600	1,764
	10	1,989	1,392	919	473	
	11&12	4,807	3,365	1,110	572	1,682
	15,16,17	5,242	3,660	1,211	624	1,826
	18	394	276	184	94	
	Total	**41,623**	**29,136**	**14,905**	**7,676**	**6,555**
	***WL+LF+MC scenario*[2]**					
	1&14	21,326	5,072	3,348	1,725	
	2	22,837	5,359	1,841	1050	2,541
	3,6,7	32,821	7,256	2,588	1,234	3,489
	4,9,13	56,458	11,974	7,903	4,028	
	5	8,468	2,629	1,735	894	
	8&19	28,142	6,707	2,213	1,140	3,215
	10	11,605	3,225	2,129	1,096	
	11&12	22,253	5,588	1,844	950	2,655
	15,16,17	21,147	5,038	1,662	997	2,378
	18	4,568	869	766	295	
	Total	**229,625**	**53,717**	**26,029**	**13,409**	**14,278**

[1] *technical potential includes all wastelands suitable for A&R*

[2] *technical potential includes all wasteland area, all fallow land area (current as well as long-term fallow) and net cropped (Sown) area*

Cumulative additional area (‘000 ha) brought under A&R during 2005-2025, over the baseline scenario, under two C-price cases for GTAP and Indian AEZ land classifications

Land classification	Scenario	Cumulative additional area brought under A&R, 2000-25 (‘000 ha)	
		US$50 C-price	US$100 C-price
GTAP	WL scenario	1,964	3,662
	WL+LF+MC scenario	3,209	6,425
Indian AEZ	WL scenario	2,048	3,475
	WL+LF+MC scenario	4,967	7,322

Summary and Conclusions

- Transaction costs could significantly affect level of deforestation if carbon price is low
- The uncertainty in baseyear value can change carbon stock maintained by reducing deforestation by -11% to +60% if Brazil distributions hold globally
- India results:
  - Disaggregation approaches can result in widely varying estimates of carbon stock.
  - Taking climate impact into consideration reduces mitigation potential by almost 50%