



# Degradation of Forest Ecosystems

NREM 612

Dr. Bruland



**I. Definitions:** >250, forester, geographer, legal, etc.

*A. What constitutes a forest?*

1. Sometimes clear boundaries bet. forest & non-forest, otherwise gradual transitions
2. **Convention on Biodiv. 2001 Def:** Ecosys in which trees are **predominate** life forms
3. **FAO 2000 Def:** Ecosystems dominated by trees (perennial woody plants > 5 m @ maturity) where crown cover >10%, area >0.5 ha





## B. Forest Types (low → high human dom.)

1. **Conservation/Reserve**: Forest w/ minimal modification, harvesting, utilization



Monteverde Cloud Forest Reserve, Costa Rica



2. **Agroforestry**: Deliberate assoc. of forests w/ crops, livestock, or other types of products (i.e., honey) to result in more diversified prod. system



Agroforestry system (alder + avocado w/ corn & beans)  
in Caserio Los Frutales, Guatemala

3. **Silvopasture**: combines trees w/ forage & livestock prod. Trees managed for timber & provide shade, shelter for livestock



Silvopastoral system with cows, slash pine, & bahia grass in SE US



4. **Slash-&-Burn** (shifting ag, swidden): Patches of primary forest logged, burned, converted to ag or pasture, left fallow to regenerate (doesn't always reforest)



Slash-&-burn in Central & South America



5. **Plantation**: System managed intensively for maximum productivity/\$ w/ techniques such as clear cut, selective logging



C. **Deforestation**: imprecise term associated w/ varying degrees of degr.

1. conversion of forest to another LU, or long-term reduction in canopy cover below 10% (MEA 2005)

a. current rate: 13 mi ha yr<sup>-1</sup> (FAO 2005)





## II. Historical Losses & Current Status of Forests

A. 8,000 years ago global forest area ~ **6.2** bi ha (**47%** cover)  
(Billington et al. 1996)

1. Stone axes made ~3000 BC in Africa, Europe, N. America  
(Hogan 2010)

2. Humans often portrayed as pitted against forests (Putz & Redford 2010)

a.

3. Since mid 19<sup>th</sup> cent., deforestation sharply ↑, driven by ↑ pop. & industrialization (Hogan 2010)

a.

4. Currently ~ **3.9** bi ha of forest (**30%** cover) (FAO 2005, Bonan 2008)

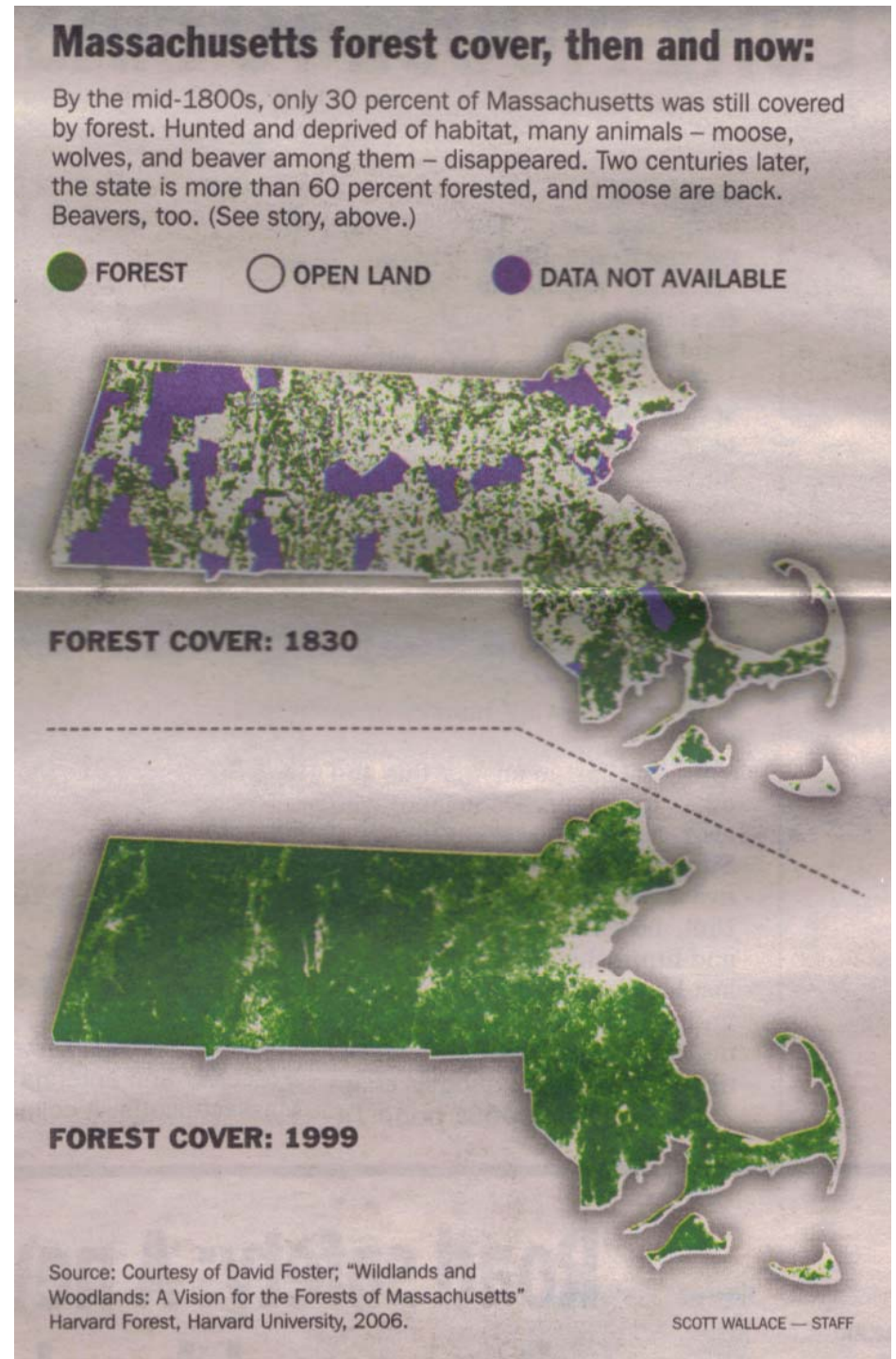
5. Loss rates vary by continent?

a.

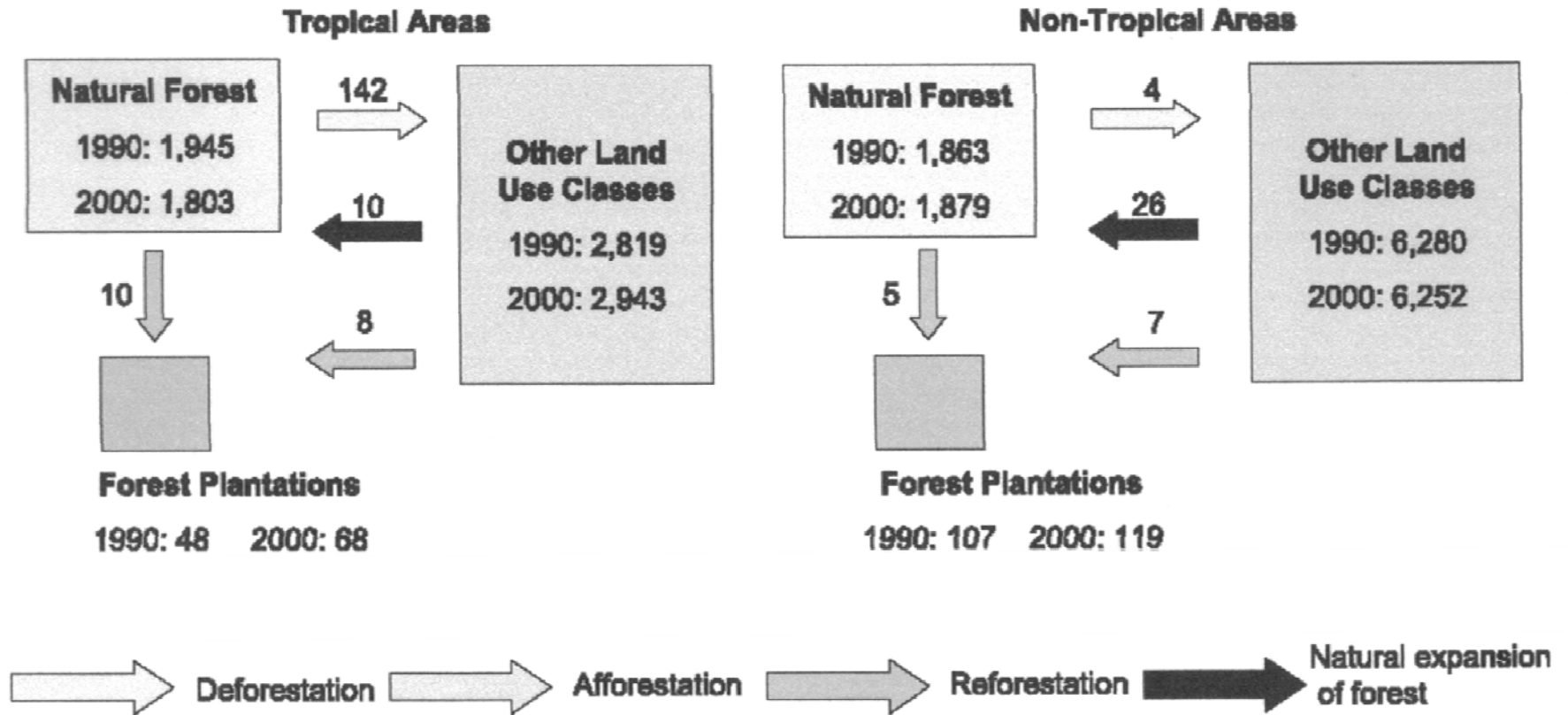
<b>Continent/ Country</b>	<b>Overall % Loss</b> (Lomborg 2001, Pimentel 2001)	<b>Current % Cover</b> (FAO 2001)
Europe	50-70	37
USA	30- <b>50?</b>	26 (N & Cent Am)
South America	20-?	51
Asia	50	28
Africa	24-?	22



- 6. Loss rates vary by forest type
  - a. Temperate/Boreal forests ↑ in last 40 yrs
- 7. Tropical forest ↓ in last 40 yrs
  - a. 350 million ha deforested, 500 million ha degraded (Lamb et al. 2005)



# Major Change Processes & Rates of Change in Tropical & Non-Tropical Forest Area from 1990-2000



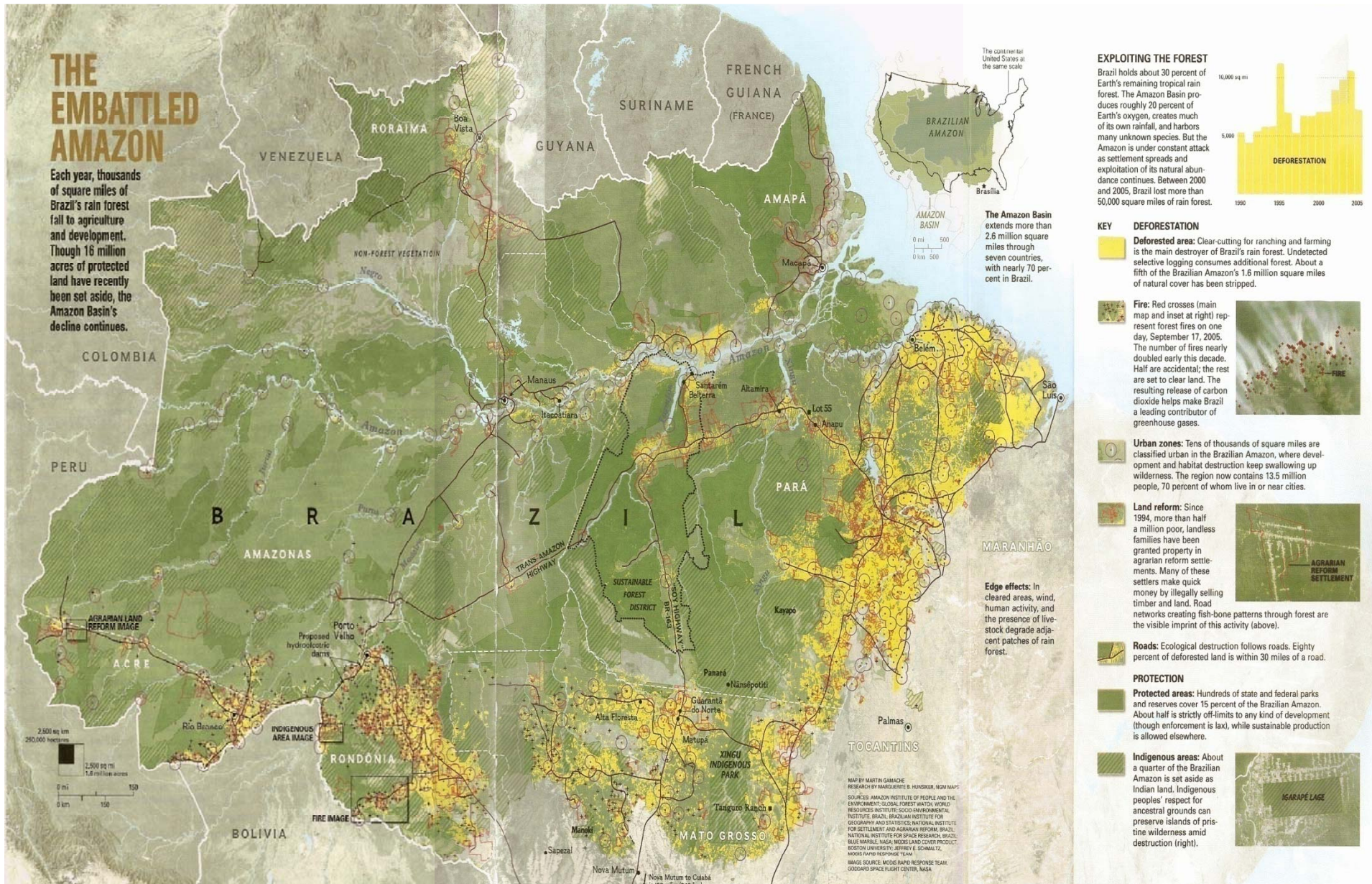
(FAO 2001, MEA 2005)



B. > **50%** (2.1 billion ha) of world's forests are located in 5 countries

*Which countries are they?*

- 1.
2. 3 countries have >**90%** forest cover (i.e., Micronesia)
3. 64 countries have <**10%** forest cover (i.e., Haiti)



(National Geographic, Jan. 2007)



### C. Forest are major pool of C

*How many metric tons (mt) in a Gt?* **10<sup>9</sup>**

1. Temp. forests: net sink of  $0.7 \pm 0.2$  Gt C yr<sup>-1</sup>
2. Trop. forests: net source of  $1.6 \pm 0.4$  Gt C yr<sup>-1</sup>  
(Lomborg 2001)

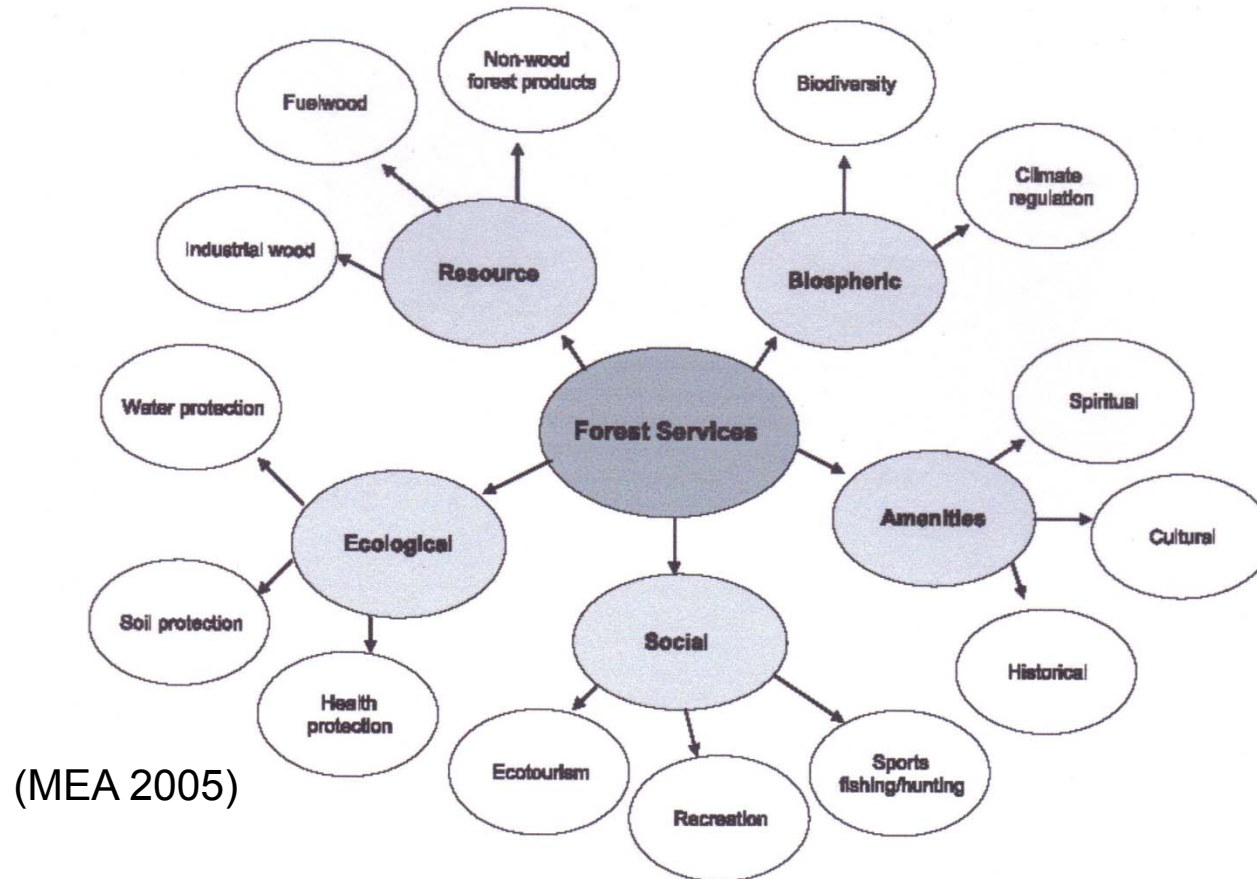
<b>Forest Pool</b>	<b>N&amp;D 1997</b>	<b>IPCC 2001</b>	<b>FAO 2005</b>
Biomass (Gt C)	330	337	283
Soil (Gt C)	660	787 (upper 1 m)	355 (upper 0.3 m)

## D. Ecosystem Services

1. Forests provide \$4.7 trillion (US) yr<sup>-1</sup> in eco services or

a. **\$969 ha<sup>-1</sup> yr<sup>-1</sup>** (Costanza et al. 1997)

a. includes valuation of non-timber products





### III. Causes of Forest Degradation

#### A. Natural factors

##### 1. Fires, hurricanes, tsunamis, volcanoes, glaciers



## **B. Human-Induced factors**

### **1. Pop pressure:** ↑ deg, conversion of forest

#### a. Collection of fuelwood (FW):

- i.  $\frac{3}{4}$  of world's FW burned in dvping countries (FAO 2006)

#### b. People forced to travel farther from home to collect

- i. **Fuelshed**



c. Improved infrastructure:

- i. New roads, railways, canals open prev. inaccessible forests
- ii. power lines bring electricity

2. *Often high poverty & uncertain land tenure in trop. forests*

**3. Economic:** Provide 3.3 billion m<sup>3</sup> wood yr<sup>-1</sup> (MEA 2005)

a. Wood → valuable market commodity

i.

b. Forestry contributes 2% of world's GDP, > \$600 bi US (Chiras 1998, Lomborg 2001)

i. 10 million people employed in forestry, cons. (FAO 2005)

c. Gov'ts offer subsidies to timber companies **OR** reverse timber cos. pay \$\$\$ to gov'ts → *CORRUPTION*

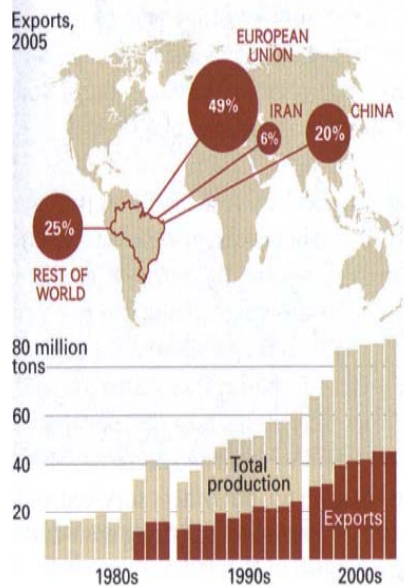
i.

c. Conversion to ag/pasture

i. growing markets for beef, soybeans drive defor.

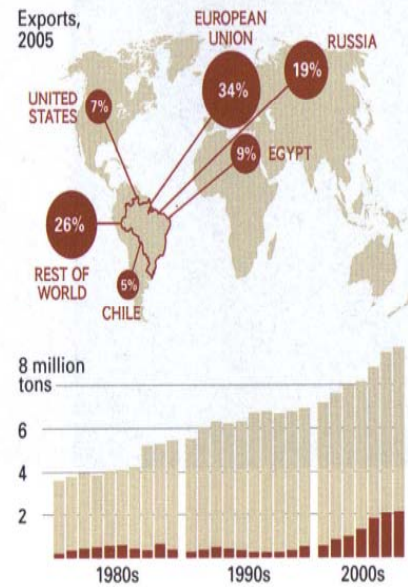
ii. US farmers switch to corn for biofuels, ↑ soy demand, encourage expansion of Brazilian soy farms into Amazon

**WORLD DEMAND FOR BRAZIL'S PRODUCTS**



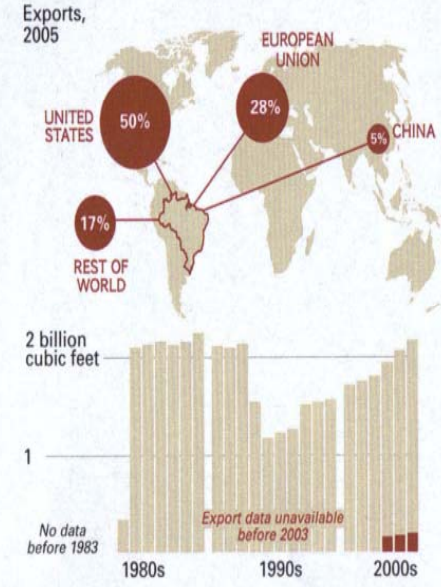
**SOY**

Soybean production in the Brazilian Amazon soared after heat-tolerant varieties were introduced in 1997. Brazil may soon lead the world in soybeans, surpassing the U.S.



**BEEF**

The world's largest exporter of beef since 2004, Brazil now supplies nearly every country, including emerging markets such as Algeria, Romania, and Egypt.



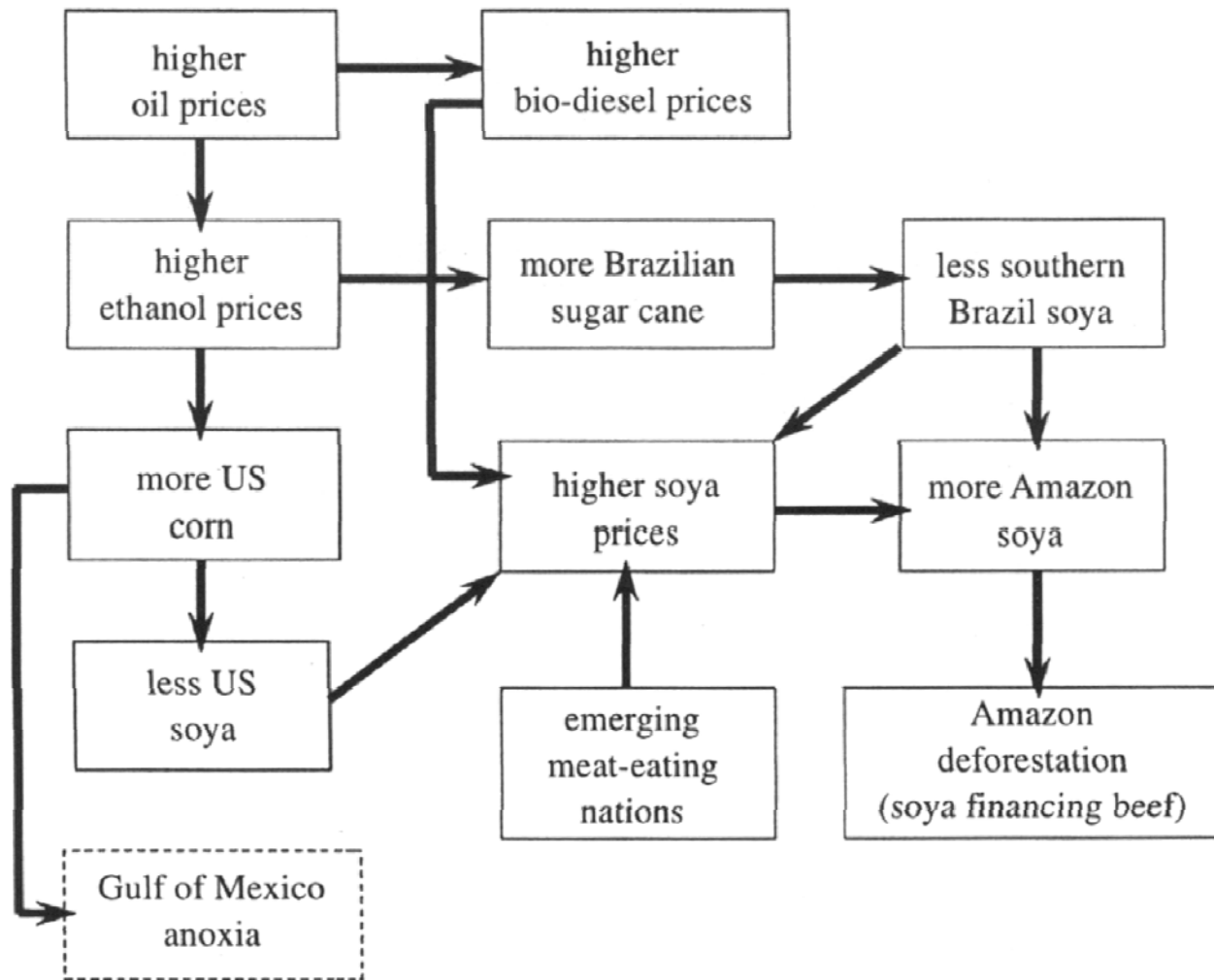
**TIMBER**

Demand for Brazilian hardwoods in Europe, the U.S., and Asia has been growing in recent years. Most timber from the Amazon Basin is taken illegally and stays in Brazil.

(National Geographic, Jan. 2007)



# Economic connections among US ethanol production (corn), Brazilian ethanol production (sugar), & Amazon deforestation



(Nepstad et al. 2008)

### 3. Political

#### a. Nationalization of forests

#### i. **Nepal 1957.** *What happened?*



b. Land settlement schemes

i. Defor. assoc. w/ loss of aboriginal peoples, expansion of settlers

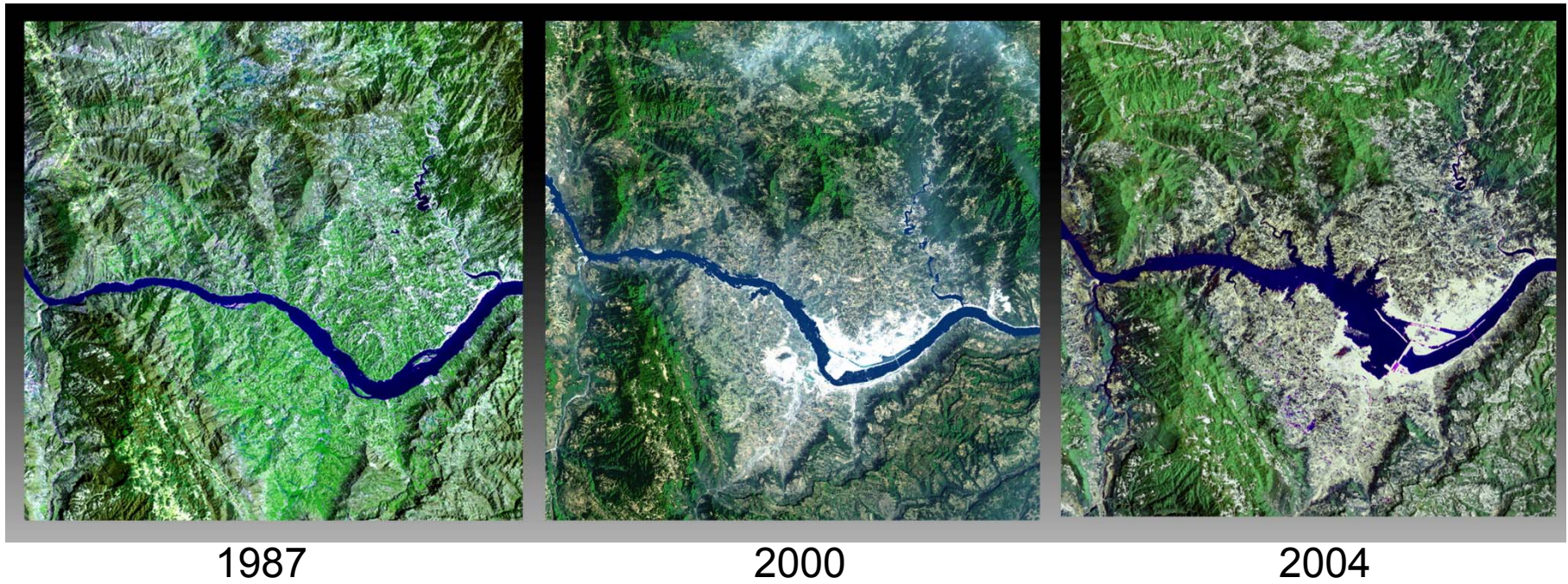
*In 1960 what country moved capital 900 km inland from coast to new location?*



## 4. Hydroelectric dams

- a. Often destroy forests w/ rich alluvial soils, high biodiversity

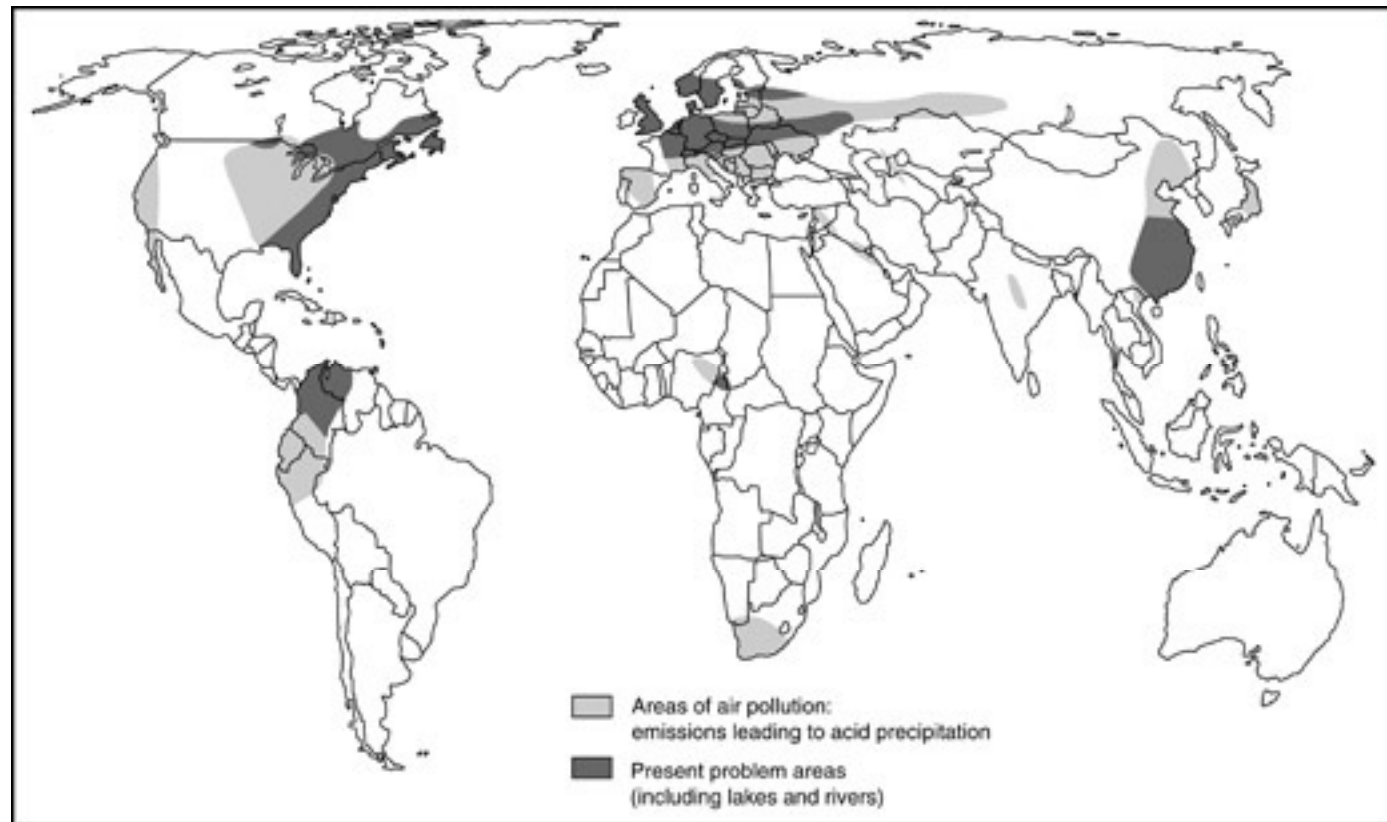
*Where has this occurred?*



## 5. Acid deposition

a: *What regions are suffering?*

i. Sierra Nevada, Appalachians, Scandinavia, Balkans



(Kaufman & Franz 1993)

### **III. Effects of Forest Degr.**

- A. Loss of biodiversity
- B. Landscape fragmentation
- C.  $\Delta$ s in climate, hydrology, water balance, streamflow
- D. Changes in BGC, C release, C storage, nutrient flux
- E.  $\uparrow$  erosion, sediment export



#### IV. Forest Policies:

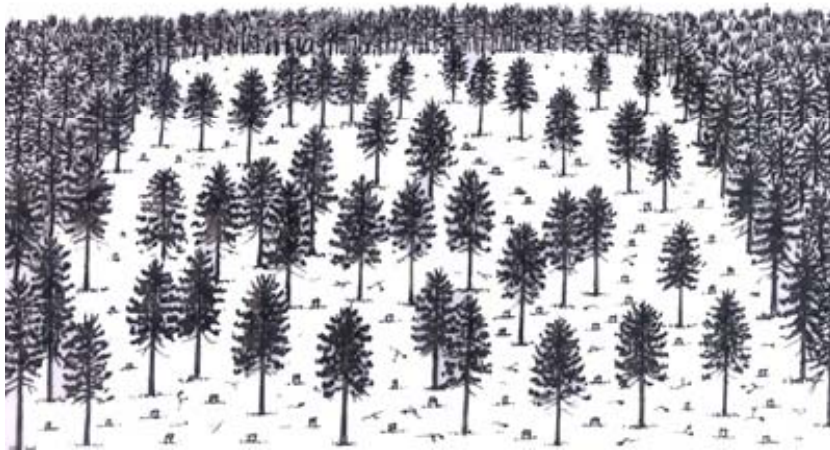
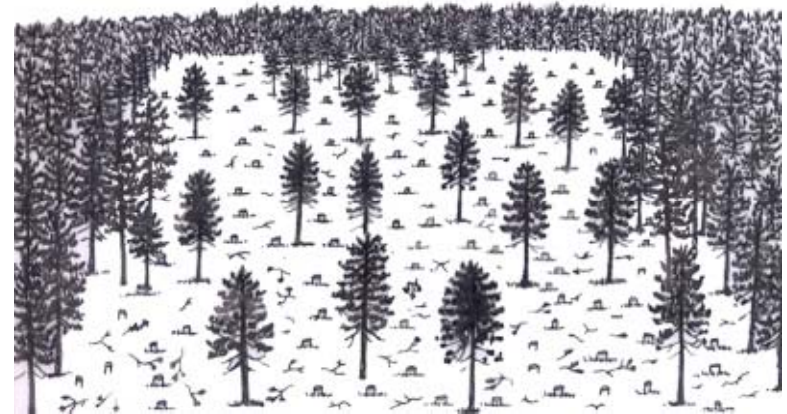
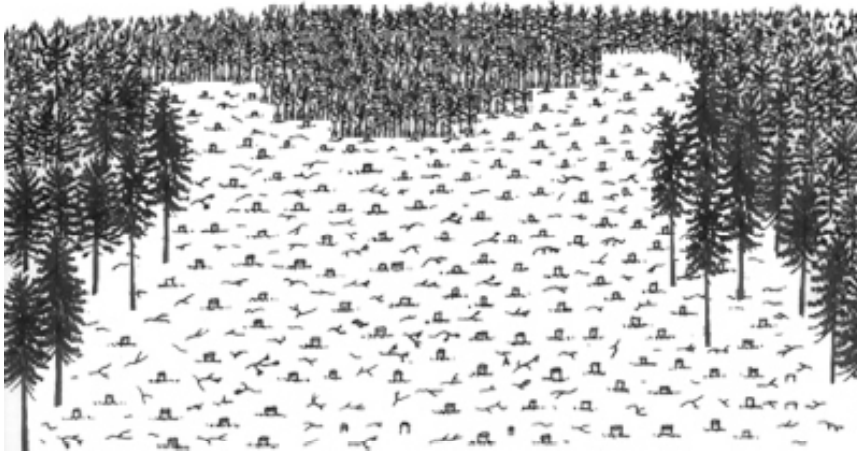
- A. **Sustainable yield**: Manage in way that won't ↓ long term yield; not necessarily sustainable
- B. **Multiple-use**: USFS, balance uses i.e. timber prod., recreation, & flood control
- C. **Current debate**: How to harvest w/ least impact?
  1. Intensively harvest smallest possible area
  2. Less intensively harvest large area

**OR**

*Which do N&D 1997 say is better option & why?*

## V. Management Options

A. Harvest Methods: clear cut, seed tree, shelterwood, selection



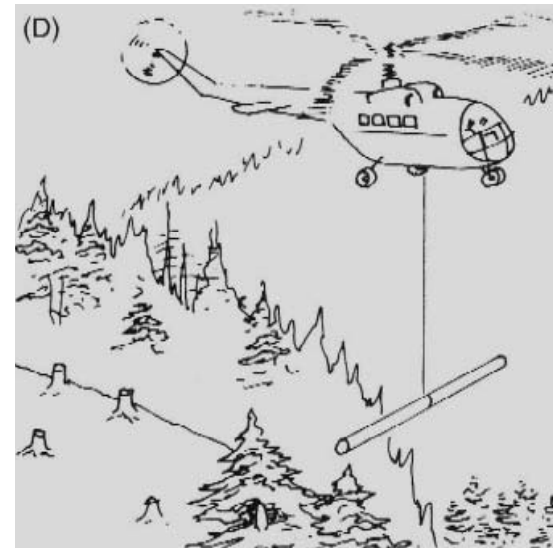
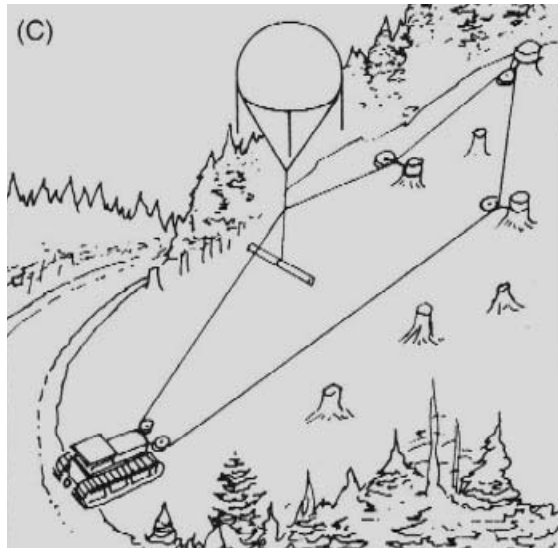
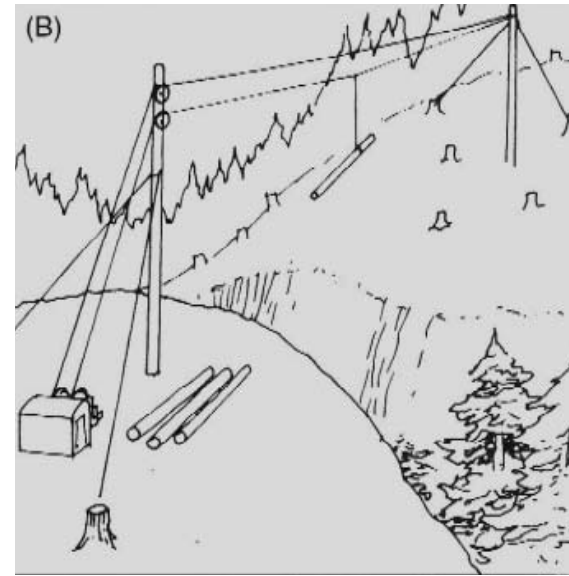
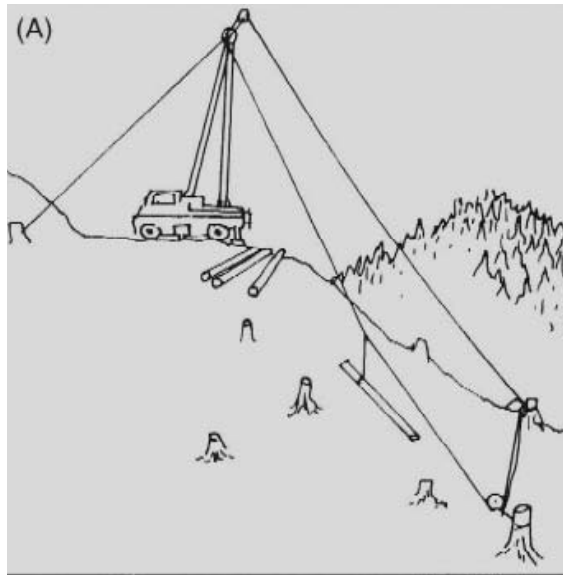


B. Harvest Equipment: animal vs mechanized, feller bunchers, tire vs track, helicopter, etc.

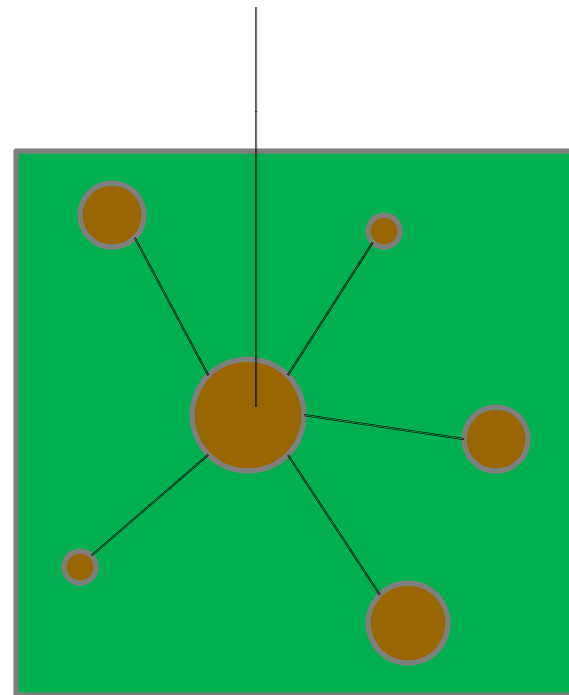
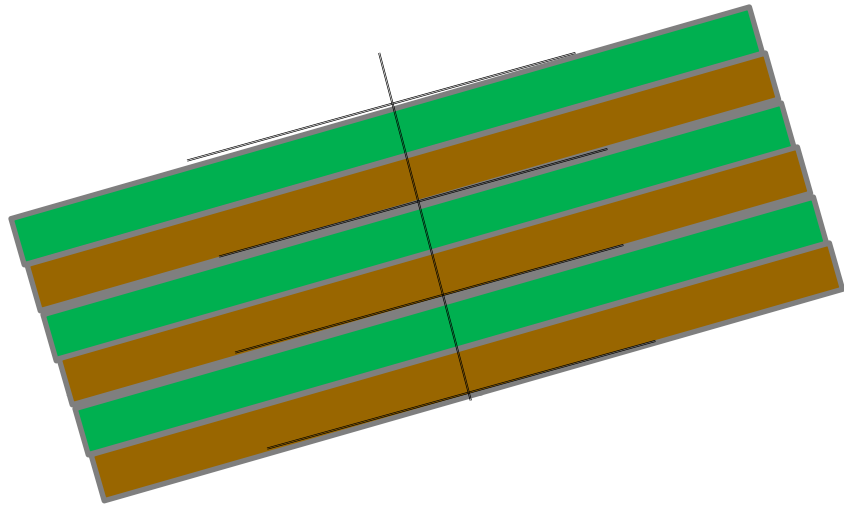




C. Log Transport Systems: high lead, skyline, balloon, helicopter



## D. Patterns of harvest



## VI. New Trends in Forest Mgmt/Policy (Agrawal et al. 2008)

### A. Decentralization of Mgmt:

1. ↑ recog. of local communities need for forest products & role in mgmt

### B. Role of logging companies in forest concessions:

1. Gov't provide companies timber rights in exchange for \$\$\$;

### C. ↑ importance of forest certification:

1. Indep. body provides assurance to consumers that forest product suppliers meet sustainability criteria
- 2.
3. 7% of world's forests currently certified,



## VI. Forest Scenarios

- A. Primary temperate forest w/ high-value timber
- B. Secondary tropical forest w/ low-value timber
- C. Primary tropical forest w/ high-value timber

*What method of harvest would you allow if any?*

*What equipment, what log transport system, what harvest pattern?*

*What other strategies would you recommend to minimize degradation & foster restoration?*