Causes and pathways of tropical deforestation

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Interannual variability in rates of deforestation

Evolution of the Mean Rate of Gross Deforestation in Amazon (km²/year)

Mean rate of Gross Deforestation (km²/ano) * Decade Mean

* Relative to the area of remaining forest
** Data from 1993 and 1994 refer to an estimate of the mean rate of gross deforestation for the period 1992-1994
*** The mean rate of Gross Deforestation for 1998 is based on analysis of 46 TM/Landsat scenes from that year
Causes of tropical deforestation

Proximate causes

- Infrastructure extension
  - Transport (roads, railroads, etc.)
  - Markets (public & private, e.g. sawmills)
  - Settlements (rural & urban)
  - Public Service (water lines, electrical grids, sanitation, etc.)
  - Private Company (hydropower, mining, oil exploration)
- Agricultural expansion
  - Permanent Cultivation (large-scale vs. smallholder, subsistence vs. commercial)
  - Shifting Cultivation (slash & burn vs. traditional swidden)
  - Cattle Ranching (large-scale vs. smallholder)
  - Colonization (incl. transmigration & resettlement projects)
- Wood extraction
  - Commercial (state run, private, growth coalition, etc.)
  - Fuelwood (mainly domestic usage)
  - Polewood (mainly domestic usage)
  - Charcoal production (domestic & industrial uses)
- Other factors
  - Pre-disposing environmental factors (land characteristics, e.g. soil quality, topography, forest fragmentation, etc.)
  - Biophysical drivers (triggers, e.g. fires, droughts, floods, pests)
  - Social Trigger Events (e.g. war, revolution, social disorder, abrupt displacements, economic shocks, abrupt policy shifts)

Underlying causes

- Demographic factors
  - Natural Increment (fertility, mortality)
  - Migration (in/out migration)
  - Population Density
  - Population Distribution
  - Life Cycle Features
- Economic factors
  - Market Growth & Commercialisation
  - Economic Structures
  - Urbanization & Industrialization
  - Special Variables (e.g. price increases, comparative cost advantages)
- Technological factors
  - Agro-technical Change (e.g. in access/improvement)
  - Applications in the wood sector (e.g. mainly wastage)
  - Agricultural production factors
- Policy & Institutional factors
  - Formal Policies (e.g. on economic development credits)
  - Policy Climate (e.g. corruption, mismanagement)
  - Property Rights (e.g. land races, titling)
- Cultural factors
  - Public Attitudes, Values & Beliefs (e.g. unconcern about forest, frontier mentality)
  - Individual & Household Behavior (e.g. unconcern about forests, rent-seeking imitation)
Meta-analyses of case studies:

• Synergetic combinations of multiple factors at different spatial & temporal scales.

• At short time scales: mostly individual and social responses to new opportunities and constraints created by markets and policies, and mediated by local institutional factors.

• At longer time scales: also demographic factors: population increase & decrease, breakdown of extended families, migration.
• development of the *forest frontiers* by weak state economies

• *institutions in transition* from communal to private land ownership

• *loss of entitlements* to environmental resources (e.g. due to *encroachment* by other land uses) leading to an ecological marginalisation of the poor

• *urbanization* followed by changes in consumption patterns and in income distribution

• *new economic opportunities* linked to new market outlets, changes in economic policies, or capital investments

• inappropriate *policy intervention*

• *macroeconomic shocks* and structural adjustment policies
Cluster of inter-related factors with direct or indirect, intended or unintended impacts on forests

- national demand for land
- policies to develop the forest frontier
- capital investments in logging and agricultural activities
- population movements
- the commodification of the economy
- development of urban markets
- infrastructure expansion
### Driving forces of tropical deforestation by scale of influence

**n = 152 cases**

<table>
<thead>
<tr>
<th>Scales</th>
<th>All factors (range)</th>
<th>Demographic factors* (n=93)</th>
<th>Economic factors (n=123)</th>
<th>Technological factors (n=107)</th>
<th>Policy and institutional factors (n=119)</th>
<th>Cultural or socio-political factors (n=101)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local</strong></td>
<td>2 - 88%</td>
<td><strong>88%</strong></td>
<td>2%</td>
<td>23%</td>
<td>4%</td>
<td>16%</td>
</tr>
<tr>
<td><strong>National</strong></td>
<td>1-14%</td>
<td>1%</td>
<td>14%</td>
<td>3%</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Global</strong></td>
<td>0-1%</td>
<td>-</td>
<td>1%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Several scales: global to local interplays</strong></td>
<td>11-94%</td>
<td>11%</td>
<td><strong>82%</strong></td>
<td><strong>74%</strong></td>
<td><strong>94%</strong></td>
<td><strong>77%</strong></td>
</tr>
</tbody>
</table>

* 6 cases of ‘population pressure’ (unspecified) could not be attributed to scales.

*Lambin and Geist (2003)*
Latin American (especially Amazonia) pathway of deforestation

- a phase of extraction and harvesting of timber plus initial colonization,
- generally followed by the establishment of colonists with a greater access to capital,
- competition to define or redefine the rules of land and capital access takes place, frequently involving violent conflict,
- winners and losers: those increasing land holdings and those pushed/pulled onwards to expanding the agricultural frontier further, where land is still cheap,
- for the winners: large-scale land conversion to pasture follows since cattle provides the largest economic rewards, given market conditions and/or government subsidies,
- this, in turn, drives up land prices, leading to further land consolidation.
Forest transition in Denmark

Source: Mather et al., 1998.
Forest cover trends, Jitai Basin / Jiangxi, SE China

Source: Zhao Shidong et al., 2001.
Forest transition

Area

transition

cropland

forest cover

triggers positive feedbacks negative feedbacks

Time
Two processes of forest transition

**Economic development path:** Economic development has created enough non-farm jobs to pull farmers off of the land, thereby inducing the spontaneous regeneration of forests in old fields

**Forest scarcity path:** A scarcity of forest products has prompted governments and landowners to plant trees

Rudel et al. 2005
Halting deforestation?
... or accelerating the forest transition?
Policy implications

No universal policy for controlling tropical deforestation.

Find the right balance and the correct mix of factors most suitable for a particular region.

Many factors that are among the causes of deforestation are also part of the solution,

   e.g., land-use policies, economic development, institutional arrangements, transportation infrastructure.
Policy packages should always include:

1. Improving **governance**, fighting corruption,

2. **Decentralizing** forest management with a concomitant increase in the local capacity to enforce law,

3. Developing **public participation** in environmental planning,

4. Designing creatively **new institutional instruments** (including market-based ones).
Difficulties

- Weak state **control** on forests: globalisation, economic priorities
- Difficult to **attribute** reduced deforestation to state policies: complex causal clusters, inter-annual variability, forest transition
- **International leakage:** international trade in forest and agricultural products
- **Permanence** of avoided deforestation: no quick fix to deforestation, forest transition linked to economic modernization
- **Multiple users** of forests: winners & losers, markets for forest services with *local* value
- **Measurement uncertainties:** consistency of time series, forest degradation & fragmentation