Land Use, Nature Conservation and the Stability of Rainforest Margins in Southeast Asia

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Zu Inhaltsverzeichnis

Policy Options for Stabilising the Forest Frontier: A Global Perspective

Sven Wunder

1 Introduction

The purpose of this paper is to summarise different research results about the impact of macro-level factors and "extra-sectoral" policies on tropical forest cover. Specifically, we are interested in the forest margins – i.e. the spatial transition zone between tropical forests and converted land uses. What are the policy factors that accelerate frontier expansion, and which ones tend to slow it down? The term "extra-sectoral" refers to all the things that happen outside of forests and forestry, yet nevertheless have a significant effect on forests. For instance, how do changes in international trade and a country's balance of payment affect deforestation? What does it mean for pressures on forests that a country drastically devalues its currency? What is the role of population growth?

In answering these and other questions, we will mainly draw on published and ongoing research carried out by the Center for International Forestry Research (CIFOR), which the author of this paper is affiliated to. For most of a decade, CIFOR has carried out a tropics-wide research programme on the "underlying causes of deforestation". The empirical results from this programme are the main source of knowledge for this paper. We will supplement this knowledge with other selected empirical studies that demonstrate how these macro factors and policies eventually "trickle down" to the forest. But the main objective is to synthesise the "big picture". Readers interested in the specific case studies that shape this "big picture" are referred to publications describing the underlying studies.

A key hypothesis is that what happens to tropical forests is more determined by events outside the forest arena than by what happens inside the forest sector. In other words, the extra-sectoral impacts will often be more important than, say, the new forest law, the participatory tree-planting project or the environmental education programme that is implemented in the forest margins. That does not mean that the latter type of intervention is useless. What it does mean is that some macroeconomic and extra-forestry factors tend to set the scene for success or failure of the projects and strategies of forest-margin stabilisation strategies, so that the promoters of these strategies need to have a realistic vision about the direction and proportions of impacts. In some cases, the macro-decision makers should also explicitly take into account how forests are affected before they make their "extra-sectoral", macro-level choices.

2 Definitions: Deforestation and Forest Degradation

2.1 Deforestation

Many different deforestation definitions exist, but in this paper we employ the terminology used by the United Nations Food and Agricultural Organization (FAO 2000a). According to FAO, a forest is an area of a minimum 0.5 ha size, covered by a tree canopy of at least 10%, with trees that can reach more than 5m height, subject to the constraint that the area should not be under an alternative (e.g. agricultural or urban) use. Deforestation would thus be any change in conditions that means the area no longer qualifies as a forest. In the majority of cases, deforestation occurs because the area's tree canopy-cover is reduced to less than 10% by converted land uses. This conversion can be permanent (e.g. urban expansion) or temporary (e.g. shifting cultivation). This means that we identify deforestation with a radical removal of tree cover - in most cases a conversion to other land uses.

Note that this definition does not say anything normative about whether deforestation is good or bad. Although much deforestation research is driven by a legitimate concern about the rapid loss of tropical forests, the desirability of these land-use change processes has to be assessed separately, based on a subsequent analysis of the costs and benefits of forest loss to different stakeholders at variable levels of aggregation.

2.2 Frontier Deforestation

Obviously, there are different means and ways to get rid of a forest. In this paper, we are particularly interested in frontier deforestation - the process of moving into large blocks of previously continuous forests. This transition zone is also often referred to as “forest margins”. The process of frontier deforestation and advancing forest margins has to be distinguished from the clearing of forest remnants in pre-established agricultural or in peri-urban areas. Both types of forest loss have important implications, but for two reasons we have a special interest in the forest-frontier margins. First, the conservation of frontier forests has been given special weight from a biodiversity point of view (Bryant et al. 1997). Second, there is evidence that once forests are fragmented, they disappear more rapidly in incremental processes that are harder to stop (Mertens and Lambin 1997; Rudel with Horowitz 1993). In terms of attacking root causes of tropical forest loss, it thus makes sense to have a special interest in forest frontiers and rainforest margins.

What does frontier deforestation look like in spatial terms? The top row of Figure 1 shows three different forms of frontier deforestation. First, large clearing for commercial purposes can appear as a geometric shape, for instance in the case of the expansion of soybean production in lowland Bolivia and Brazil (Kaimowitz and Smith 2001). A second type is the corridor shape, which is often found from settlement and agricultural activities around new roads, such as the logging roads being built into the humid forest zone of Cameroon (Mertens and Lambin 2000).

Finally, a third frontier-clearing prototype is the fishbone pattern, known from directed settlement programmes (such as Indonesia's *Transmigrasi*), where land is allocated to settlers in strips along a road or a settlement nucleus.

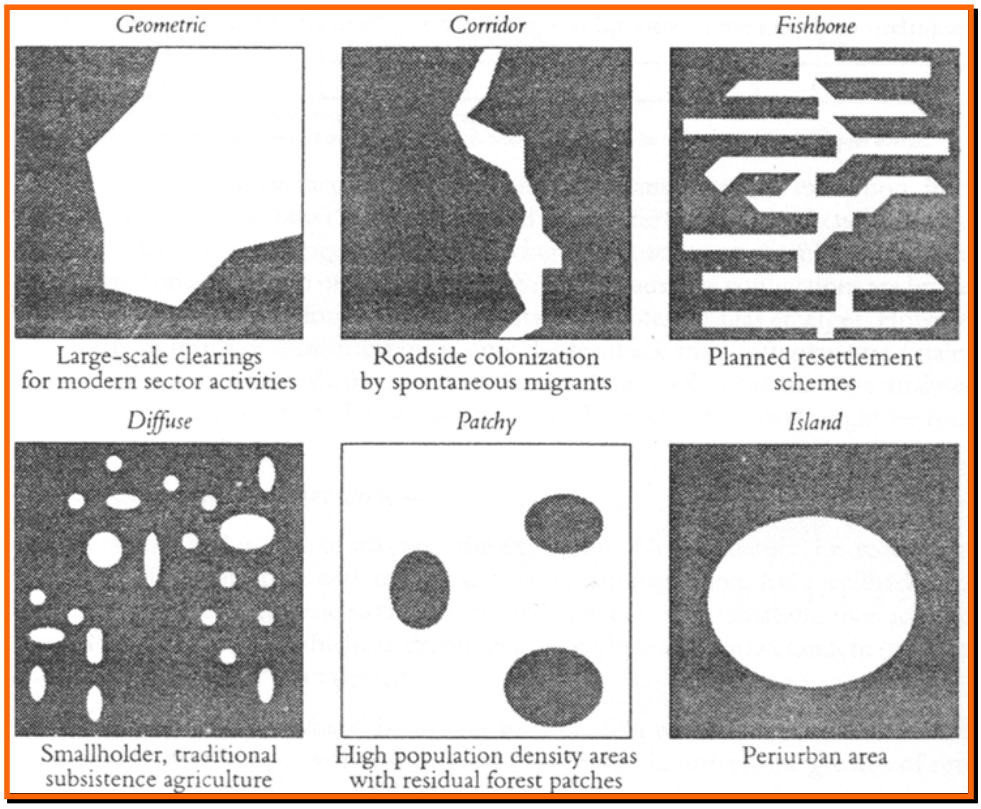

Fig. 1. Six spatial forest--non-forest patterns (Mertens and Lambin 1997)

2.3 Forest Degradation

Besides deforestation, there are also numerous forest degradation processes – a residual category of interventions that significantly affect forest quality and structure, but do not deprive an area its status as a forest. Notably, this includes selective logging, which reduces forest canopy-cover, but normally not below the 10% minimum threshold. On the other hand, clear-cut harvesting for pulp harvesting would usually been seen as deforestation, to the extent that they fully eliminate the

canopy cover.[1] Other examples of forest degradation include repeated exposure to fire, over-extraction of firewood or over-grazing (both mostly in dry forests), or over-harvesting of bush meat -- also called *defaunation*, and especially important in Central Africa.

Deforestation and forest degradation not only differ in their physical impact on forests; they also tend to be dissimilar processes in economic terms. Deforestation is often an investment in future uses of the converted land, since there usually is a non-trivial cost of preparing the land for alternative uses before the benefits from conversion can be reaped. On the other hand, the forest-degradation processes described above often tend to be more associated with a "cashing in" of rents through the over-harvesting of various forest products – i.e. producing an economic benefit here and now, but probably less in the future.

3 Theoretical Framework

Browsing through the literature on deforestation, one can distinguish between three main approaches to the phenomenon of deforestation: 1. The impoverishment approach; 2. The neo-classical approach, and 3. The political ecology approach (see Wunder 2000: Chapter 2 for further discussion). These schools differ substantially as to what they identify as the main drivers, agents and mechanisms behind forest loss, as shown in Table 1 below.

The impoverishment approach points to a combination of poverty and demographics as the main mechanism responsible for forest loss, creating a vicious circle of environmental degradation driven by the growing number of smallholders. Obviously, population growth plays a prominent role here; low labour absorption at the frontier and a low pace of technological innovation mean that Malthusian scenarios dominate. Shifting cultivation for subsistence uses under growing population pressures is an applied scenario of this type, leading to both reduced fallow periods and dwindling forest resources.

Neo-classical analysts rather see the ill-defined forest property rights as the main evil: an open or quasi-open access to forestland at the frontier encourages smallholders and large investors alike to open up the forest and claim land rights afterwards. Agents are not so much forced by deterministic and vicious circles; they rather react to opportunities in a rational and optimising way, even when they happen to be poor. Labour supply tends to be flexible; if there are good rewards to forest colonisation and conversion, people will have more children and, notably, migrants will come in from outside to fill job opportunities.

[1] In FAO's use of the terms, that would only hold if the area is not *intended* to be reforested after the clear cut. In a critique of the FAO concept, it is argued that intentions and predictions about post-clearing land uses in the tropics are extremely uncertain, making the FAO definition highly speculative (Wunder 2003).

Table 1. Three Deforestation Schools

School Questions	Impoverishment Approach	Neo-classical Approach	Political ecology Approach
What main, single factor is responsible for deforestation?	'The growing number of poor'	Open-access property rights	Capitalist investors crowd out peasants
Who is the principal deforestation agent?	Smallholders	Various agents	Capitalist entrepreneurs
What is driving the dynamics of deforestation?	A gradual push with deterministic, vicious circles	Optimising agents react to pull incentives	Capitalist pull, land expulsion and smallholder push
What impact have demographics and labour absorption	Labour absorption is low. Labour abundance boosts deforestation	Labour mobility is high and labour supply is very elastic	General labour scarcity at the frontier causes deforestation
What effect has a rise in the peasant's farm output prices?	It causes lower farm production and less deforestation	It causes higher farm production and more deforestation	It causes lower farm production and less deforestation

Source: Wunder (2000)

The political ecology approach points specifically to externally driven processes, e.g. large capitalist farmers or ranchers, as the main agents of deforestation. This can either be directly through their additional land demand, or by disrupting local land-use systems and by crowding out small farmers, who hence are pushed further into the forest. In other words, according to this school, the rich deforest for greed while the poor mostly do so for need. Normally, population growth is a subordinate factor in this picture.

Obviously, the three schools take competing approaches to the explanation of deforestation, but this does not necessarily mean that any one of them is universally more correct than the others. Forest-loss processes differ across the tropics, and one will find examples from different parts of the world that fit any of the three schools, as we will see below. On the other hand, as shown in the last row of Table 1, some of the predictions by the three schools are directly opposed, allowing us to test their relevance directly.

Consider that a small forest-margin farmer producing cocoa as his main cash crop is suddenly facing higher cocoa prices that substantially increase his revenues. What would be the impact on deforestation? In the political ecology and especially the immiseration approach, smallholders that are better off would need to produce less to make the same money - or they would be able to feed more mouths without having to push into new forest areas for cultivation. The assumption is that they only produce a certain "target revenue", which is sometimes also called a "full belly" economy – so to say, you only work until your stomach can be filled up with food. The opposite reaction occurs under the neo-classical standard economic assumptions of profit maximisation and unlimited wants. Farmers faced with a higher profitability in cocoa will allocate more labour, capital and land to cocoa to take maximum advantage of the price boom. This means normally that they will deforest more, rather than less.

4 Economic Models of Tropical Deforestation

The book “Economic models of tropical deforestation” (Kaimowitz and Angelsen 1998) was a state-of-the-art review of a range of different types of models explaining forest loss in the tropics. Most of the literature in this field is from the 1990s. The 133 models reviewed included *analytical models* (25), *household empirical models* (17), *spatial regression models* (9), *regional regression models* (20), *computable general equilibrium models* (14) and *global regression models* (38). The advantage of this synthesis is that it gives us a global snapshot of "what matters" in terms of economic incentives for land-use changes.

The countries under analysis ranged from the larger forest countries to some with limited forest coverage. Most frequently represented were Brazil (12), Costa Rica (6), Ecuador (5), Mexico (5), Indonesia (7), Philippines (4), Thailand (5), Cameroon (3) and Tanzania (4). In general the quality of data is lower the larger the coverage. Household models tend to have good-quality data as the scientist is in control of the data collected, just like spatial regression models where data often

come from remote sensing imagery. On the other hand, global regression models used national deforestation estimates, generally based on FAO forest assessment or yearbook data that exhibit a number of insecurities and serious problems (Rudel and Roper 1997; Grainger 1996; Matthews 2001).

In analytical terms we should generally make a distinction between:

- Sources and agents of deforestation – who deforests, for what purpose?
- Immediate causes of deforestation - the agents' decision parameters.
- Underlying causes of deforestation - broader contextual changes.

4.1 Effects of Price Changes

As a main result, the synthesis shows that higher agricultural prices in most cases stimulate more forest clearing. Farmers react positively to the opportunity of more profitable cultivation, compared with other alternatives. Hence, they increase their income by cultivating more land themselves, or newcomers will be attracted. This picture thus favours the neo-classical approach, at the expense of the political-ecology and impoverishment school.

Second, according to the model results changes in relative prices between agricultural products can also alter the balance between land uses, which affects deforestation. In particular, if farmers produce both *land-extensive*[2] food crops and *land-intensive* cash crops, and choose mainly between these two livelihood options in their land use, than a rising relative price of food crops over cash crops will tend to cause higher deforestation.

Third, higher timber prices can also stimulate deforestation, although the evidence is weaker than for agricultural commodities. This happens because better prices tend to stimulate a more rapid harvesting rate, which indirectly opens up forested areas for conversion, mainly through road building (see below).

4.2 Factors Affecting Costs

Policies and other interventions that favour agriculture will in most cases cause higher deforestation. Higher agricultural productivity, lower input prices, lower land prices, and lower transport costs are among the most important factors identified (Kaimowitz and Angelsen 1998). In most places, deforestation is thus fairly well explained by expanding agriculture (Andersen et al. 2002 ; Barbier 2001).

Road building near or into forest areas is the single most important factor causing deforestation. It lowers transport costs for both timber and agricultural products, so that these commodities can "pay their way out" to the marketplace. By making viable a series of economic activities and enabling more intensive human

[2] "Land-extensive" here means with a *high* input of land per output unit, "land-intensive" the reverse.

settlement, roads are thus often the first but decisive step towards forest conversion.

Higher rural wages, or higher labour opportunity costs in terms of new employment options, will reduce deforestation. This is because forest clearing is a particularly labour-intensive activity. The effect will be particularly strong when forest-based options constitute an "employment of last resort", which people turn to in periods of economic crisis when alternative, better remunerated employment options become scarce.

Fertiliser subsidies that make purchased fertilisers cheaper can in some cases reduce deforestation, and their withdrawal can increase it. This is an exception to the general pattern of agricultural subsidies promoting forest loss. It applies especially in contexts where slash-and-burn is a prime cause of deforestation, and where the main importance of forests is as a source of nutrient inputs into agriculture. Cheaper alternative fertilisers will then tend to reduce conversion for that purpose.

4.3 Land Tenure

We remember from last section that the neo-classical approach pointed to insecure land tenure as a key factor behind deforestation. But Kaimowitz and Angelsen (1998), as well as other empirical studies (e.g. Wunder 2000), find land-tenure security to be an ambiguous factor vis-à-vis the determination of forest loss. This is a controversial issue, where probably more research is needed. People who have insecure tenure and access rights can only plan for limited time periods; the more long-term the benefits, the less secure is it that the land user with insecure rights can reap them, and the less (s)he will be inclined to invest in the land.

In general, (more) secure tenure will help the land user adopt long-term profitable solutions. In some circumstances, that will favour forest management, but in many cases it will not. It depends on whether forestry is actually the long-run most profitable option - or whether that is cattle ranching, oil-palm estates, soybean fields - or even to sell the land to other parties. Depending on the socio-economic context, secure tenure seems to have a more positive effect on tree planting and agro-forestry than on natural forest management. Trees take time to grow, so the decision to allocate land almost per definition requires control over the land until harvest. But there is nothing in and off itself that makes sure that more secure tenure leads to more forests in the landscape; especially examples from Latin America show the opposite because pastures for cattle ranching often are the most rewarding and convenient land-use option in the long run.

One factor to consider is thus what land uses are favoured by secure tenure, but another one is the process by which this secure tenure is established in the first place. Forest clearing is often seen as a sign of active occupation - "the land is being worked" - that discourages others from taking possession. On the other hand, forestlands are often seen as "idle" territory inviting invasion. This means that deforestation often helps establish property rights (“homesteading”) – whether by informal tenure recognition among a group of land-colonising settlers, or by the

process of getting formal land tenure through a state agency controlling that land has actively been cleared. Homesteading thus promotes "excessive", speculative deforestation - beyond what can be explained by a pure economic rationale. People may in some cases clear forests simply to obtain control over the land, regardless of what is the most profitable land-use option.

5 The Role of Agricultural Technology

Forests and agriculture are generally the most extensive land uses in the tropics, and they tend to compete for land with forestry. Hence, higher agricultural land demand becomes the main driver of forest loss. Nonetheless, the balance between recipient sub-sectors of new agricultural land is quite different between tropical continents:

- Cattle-ranching heavily dominates land-use change in Latin America: most deforested lands end up as pastures in land-extensive ranching systems.
- In Central Africa and in South Asia, extensive swidden systems for food crops (plantains, tubers, etc.) require large land areas for crops and fallows.
- In Southeast Asia and West Africa, logging of highly priced timbers has played a larger role in opening up forest frontiers. In Southeast Asia, much land has subsequently been converted to cash and estate crops (oil palm, cocoa, coffee, etc.).

It has been argued that the Green Revolution with its drastic increase in the productivity of staple crop production has saved a lot of forests, and that further rises in yields will be necessary if the remaining wildlands in the tropics are not to be sacrificed (Borlaug 2002). The logic of the Borlaug hypothesis would seem similar to that of the impoverishment political ecology approach: if prime agricultural areas can produce higher yields, then production need not expand into marginal lands. But how precisely is the relationship between technological innovation and forest loss at different scales and under variable scenarios? A workshop held in Costa Rica in 1999 brought together a range of case studies around this topic, published later in a book (Angelsen and Kaimowitz 2001). This section will present some main results, and compare them to the model outputs from last section.

As a general observation, technological advances in agriculture, as well as the introduction of new profitable crops, will tend to make agriculture more profitable. So, in a given location, region or country, technological progress will usually cause higher deforestation, just as higher output prices do. This is what one would expect from neo-classical reasoning, with upward sloping producer supply curves (see above). However, several specific scenarios can change the picture, depending on factors such as farmers' production functions and output markets (see Angelsen and Kaimowitz 2001 for technical details). Let us look broadly at the factors separating the two cases:

Q.1. Under what circumstances do new technologies or products *reduce* forest clearing?

1. **When labour-intensive techniques/ products are being introduced in forest-scarce regions**. In these cases, some labour that might otherwise have deforested forest fragments will be absorbed by the use of new techniques that are applied to relatively large cultivated areas.
2. **Shifts in dual systems towards the sedentary, more land-intensive type**. Imagine a dual production system, with on the one hand productive, fertile, irrigated prime agricultural areas in the lowlands, and on the other marginal, rainfed uplands with low yields. If new technologies are only applicable to the prime areas with best conditions, this will reduce output prices and diminish forest pressures in marginal zones (Jayasurya 2001). This process has driven forest regrowth in many marginal zones of developed countries.[3]
3. **Introduction of high yield varieties (HYVs**) of cereals and other staples, which have an inelastic demand, will lower food prices. So, if the output market is limited and/or demand is highly price-elastic, then an increased production will trigger lower agricultural prices, which tends to reduce deforestation.

Obviously, the second and third cases represent the Borlaug hypothesis, underlining the role of scale. Let us return for a moment to our cocoa farmer from above, and assume that (s)he successfully introduces a new cocoa high-yield variety, which has been developed in that particular region. Consider three scenarios:

- **A:** The farmer sells his cocoa to the world market, and no other producer regions adopt similar yield-improving techniques. Hence, our farmer and his colleague innovators can sell unlimited additional cocoa at the same price. That provides farmers with good extra earnings, and they would be inclined to clear forest to plant more of the new variety.
- **B:** Assume now, alternatively, that sales go via middlemen with large accumulated stocks, so that the latter would only buy the additional cocoa at a reduced price. In that case, producer gains and incentives for new cocoa-led deforestation would be lower.
- **C:** Finally, suppose that all cocoa farmers in the world adopt the new yield-enhancing technique at the same time. That would flood the market with cocoa supplies and, depending on the demand elasticity of chocolate consumers, lead to a fall in world-market cocoa prices. This price fall would ultimately also reduce the incentives to expand cocoa production into the forest margins.

In other words, the Borlaug hypothesis remains valid at the aggregate world-market level - or when markets are restricted by policy or by transport costs. Yet, when innovations occur at a lower scale, with access to external markets that fix output prices, then it is likely that technological progress raises local land demand and increases local pressures on forests.

[3] See e.g. Mather and Needle (1998) and Rudel (2001)

Q.2. In which cases would new technologies or products *accelerate* forest clearing?

The first general answer is that, more often than not, new technologies will increase deforestation. The second is that this is in particular likely to happen when one finds:

1. Labour-saving or -displacing products or techniques (e.g. mechanisation of crop cultivation, ranching, soybean introduction), combined with a flexible supply of capital. Part of the redundant labour will here be "set free" to expand into the forest margins;
2. Eradication of plant and animal diseases is a powerful tool to make production across-the-board more profitable (just like a price increase does), and thus also stimulates land demand and forest conversion;
3. Export booms with products that demand large initial immigration of labour, which subsequently is "set free" under bust periods to expand into the forest;
4. Forest margins with a high population density, high population growth and/or flexible immigration of labour.

Note that in all the cases illustrated above, forestland is mainly to be considered as an available reservoir of land, which will accommodate fluctuations in the demand for new agricultural lands. Perhaps the strongest result is the fourth observation. It implies that if one has an agricultural frontier with a flexible labour supply - probably a condition valid for most tropical frontiers - almost no matter what type of technologies you introduce and safeguards you take, higher profitability will go hand in hand with higher deforestation. That is a somewhat uneasy message to send to the managers of Integrated Conservation and Development Projects (ICDPs) who aim to make both the environment and local people better off simultaneously by means of improved agricultural systems. Yet, this picture is consistent with the problematic practical results of most ICDPs (Gilmour 1994), and hence a revision of the overly optimistic Brundtland-report view on "win-win" options related to commodity production in tropical forests (Angelsen 1997; Fisher 2001; Wunder 2001a).

6 Comparing Macro-Economic Links

After a short general introduction, this section will highlight how factors and policies at the national level "trickle down" to the forest level. The section will draw mainly on CIFOR country-comparative work specifically on long-run land-use changes in eight tropical oil countries (Wunder 2003). The primary cases here were Cameroon, Venezuela, Gabon, Ecuador and Papua New Guinea, with secondary studies on Indonesia, Nigeria and Mexico. We will also draw on comparative CIFOR research about the forest implications of policy responses to macroeconomic crisis and to structural adjustment in Indonesia, Bolivia and Cameroon (Kaimowitz et al. 1998; Ndoye and Kaimowitz 2000; Sunderlin et al. 2001).

6.1 The General Picture: Economic Growth and Poverty

In the 1950, Simon Kuznets found that income inequality was rising in the early stages of an economic development process, while being reduced again in the later stages (Kuznets 1955). This pattern of an inverted U-curve over development phases has come to be known as the "Kuznets curve". More recently, scholars have also tried to look out for an Environmental Kuznets Curve (EKC), testing whether also the environment "has to get worse before it can get better" by means of economic development. While the pattern seems to fit some "brown" environmental problems (such as industrial emissions) fairly well, there has only been meagre support for an EKC on deforestation. In developing countries, economic growth is correlated with multiple sources of absolutely higher land demand, and even the *rate of* deforestation among developing countries does not seem to go down systematically in later stages of economic development (Culas and Dutta 2002). Consequently, it is unlikely that tropical countries can economically 'grow their way out' of high deforestation scenarios - except in particular cases where urban sectors and the service economy have a very dynamic role (see below). In that special case, they come to resemble more the case of developed economies at very high income levels; countries that grow crops in specialised high-yield systems and can afford to import the bulk of the most land-demanding commodities from other countries.

By the same token, poverty and its reduction over time have an ambiguous effect on deforestation (Reardon and Vosti 1995; Angelsen 1997). On one hand, poverty alleviation typically is associated with higher labour (opportunity) costs, which tends to reduce both forest clearing and degradation. On the other hand, when people get less poor they also start to consume more protein-rich foodstuff like meat and dairies, which has an impact on forests. They may also save more money, which alleviates their capital constraints vis-a-vis investments requiring forest clearing. As we will see below, the aggregate impact of poverty alleviation on forests depends on the relative weight of these different factors.

6.2 The Role of Trade and Foreign-Exchange Inflows

Both the forthcoming book on eight specialised oil and mineral exporters (Wunder 2003) and aggregate-level statistical comparisons of this group with tropical non-mineral exporters (Mainardi 1998; Sunderlin and Wunder 2000) confirm two basic facts. First, oil- and mineral-rich countries in the tropics on average retain a greater share of forest cover and, second, they tend to lose these remaining forests at a slower pace.

The core reason is that they have an abundant inflow of foreign exchange from mineral exports, which allows for higher government spending levels that attract people to the cities. At the same time, a more appreciated real exchange rate makes both agriculture and timber extraction less competitive than in non-mineral countries. This under-development of agriculture and forestry has a protective impact on forests, especially if the accompanying policies also come to have a fa-

vourable impact on forest conservation. Hence, the development path of these countries becomes more urban-based. Road building into forested areas and other rural development policies become widely neglected. The urban population still consumes resources that leave an "ecological footprint" on forests, but peri-urban cultivation systems tend to be more land-intensive than those practised by a rural-based population. In most cases, at the national level, urbanisation is unambiguously good for forest conservation.

Conversely, from the research on crisis and structural adjustment we know that the opposite scenarios of foreign-exchange scarcity and currency devaluation often lead to an increased emphasis on land- and forest-based resources and a "re-ruralisation" of the economy, which eventually also increase pressures on the forest margins. One factor is that relative prices make farming and logging more profitable, hence land users expand these activities to additional land. Another one is that urban employment declines, making low-remunerative rural-based activities the default option to secure livelihoods. Finally, a third general pattern is that crisis and sharp price fluctuations induce risk-reducing diversification strategies, e.g. in rural areas a larger portfolio of crops is grown by farmers so as to be prepared for unexpected income shortfalls. All these three effects increase pressures on forests.

6.3 What Policies Hurt Forests?

Not only the external condition created by trade and foreign exchange inflows matter; the domestic policy responses are also crucial in determining the net deforestation outcome. The forthcoming book on tropical oil and mineral exporters (Wunder 2003) identified the following ten major fields where national policies would *accelerate* deforestation.

1. Rural road building (or improvement) through/ near forests

Those countries that had strong rural road-building programmes (e.g. Ecuador and Indonesia) also had high deforestation, confirming the micro impact of roads from above.

2. Large gasoline subsidies

Not only roads reduce transport costs; cheap fuel has similar (though reversible and non-spatial) effects of enabling agriculture or timber harvesting from remote areas. Fuel subsidies thus accelerate forest clearing.

3. Large government spending at the frontier

Providing social infrastructure (schools, health services) in frontier areas helps to attract migrants and strengthens colonisation, and is thus conducive to deforestation.

4. Currency devaluation

In the macroeconomic sphere, devaluation is a powerful tool to change relative prices and production incentives. If agriculture and timber harvesting are a tropical country's main trade-exposed sectors, then making them more competitive through sharp and repeated devaluation will accelerate deforestation.

5. Generous forest concessions

A government that generously allocates land to concessionaires on favourable terms in an aggressive attempt to attract investors will tend to face more rapid extraction rates. Thus, forest areas are also being opened up more rapidly for conversion.

6. Import protection of land-extensive sectors

Generally, protectionism has ambiguous impacts on deforestation. Yet, we can safely say that import protection of certain land-extensive sectors like cattle ranching and dairy farming in parts of Latin America or slash-and-burn produced food crops in Central Africa hurts forests. These protected sectors then over-extend into marginal soils with very low returns. Protected domestic timber sectors can also be highly wasteful in their use of wood resources when lack of import competition induces them to become inefficient.

7. Subsidised credits for these land-extensive sectors

If the government provides specific subsidised credits for the mentioned sectors, this will further over-expand them, at the expense of forests.

8. Resettlement into forested areas

'Transmigration'-type programmes (like in Indonesia) where people are resettled from densely populated areas out into the forest, under the slogan of "bringing people with no land to a land with no people", will obviously accelerate deforestation.

9. "Homesteading" land-tenure rules

Land-tenure agencies often allocate property rights to settlers only if they can prove that they open up and convert 'unproductive' forestland. As explained above, this fosters speculative forest clearing beyond of what is mandated by production motives.

10. Abandon all family-planning programmes in favor of a pro-natalist strategy

There is no doubt that population growth tends to accelerate forest loss, since more people need more land to satisfy their needs. Population growth is a "slow driver", working indirectly, time-lagged and correlated more clearly at aggregated scales. It also does not open up the forest margins on its own,[4] but it is very important as a "fuel" to empower and to upscale the deforestation triggers.

6.4 What Policies Protect Forests?

Conversely, what policy package has *de facto* worked in the eight tropical oil countries as an effective protection of the forest margins? Most of the points listed here are a direct reversal of the above-mentioned factors that accelerate forest loss. The applied "macro-policy conservation recipe" looks like this:

[4] Rudel with Horowitz (1993) assert that, rather than causing frontier deforestation, rural population growth is more instrumental in eliminating forest fragments in pre-established agricultural zones.

1. Neglect the rural road network
2. Spend all the oil money in the cities
3. **Sell gasoline at its 'normal' price**
4. Keep over-valued exchange rates
5. **Tax logging companies heavily**
6. Heavily tax export agriculture
7. **Liberalise food imports**
8. Resettle people out of the forest to near roads
9. Waste budgets on agro-industrial 'white elephants' and ignore rural smallholders
10. Create a business environment where few people find it worthwhile to produce

First, compared to the previous "reverse" list, some factors merit additional explanation. Regarding (5), the implication is that if governments are able to capture the bulk of stumpage values, the rate of timber extraction will be slower, which will also reduce some of the conversion that is enabled by logging roads and other "opening-up" effects. For (7), more food imports will reduce the size of domestic land-extensive cultivation, and possibly increase overall efficiency in the use of resources. (8) indicates that some resettlement programmes, notably in Central Africa, have actually curbed deforestation, because they have moved people *out of* remote forested areas and into roadside settlements with typically more land-intensive agricultural production. (9) refers to the fact that an inefficient use of public funds in agricultural parastatals and misguided mega-projects has come to benefit forests because these activities never accomplished to clear the land they originally had planned to. Likewise, (10) notes that if a general rent-seeking mentality surges, as occurred in the oil countries, then the lack of entrepreneurial spirit will become a serious obstacle to any type of commodity production, which obviously also relieves pressures on forests.

Second, we should note that of these *de facto* effective conservation policies, only one - taxation of logging operations (5) - originates in the forestry sector itself, whereas another one - resettlement (8) - affects forested area directly. All the other measures are "extra-sectoral" - they were "blind" strategies of "conservation by chance", with measures originally designed to achieve completely different goals.

Third, we could ask the question how this set of policy recommendations likely would be received by development decision-makers - say, the Minister of Planning or a World-Bank team helping to design a structural adjustment programme and a poverty-reduction strategy. Probably, only three out of the ten components (the ones in **bold** in the Box) would earn positive marks vis-à-vis a list of "good development policies". These would be the elimination of gasoline subsidies (2), an effective taxation of logging rents (5) and a more liberal food-import regime (7). All the other measures, from urban policy biases to semi-corruptive practices and excessive interventions, would be perceived as having negative impact on economic development and poverty alleviation - some of them in a decisive way. This indicates that the hard trade-offs between tropical forest conservation and

economic development do not only occur at the micro-intervention level (see above), but also when we look at the big policy decisions at the macro level.

7 What Does This Mean for Indonesia?

7.1 Screening the Main Deforestation Drivers

We will now turn to a brief examination of policies and deforestation causes in a single country, Indonesia. We will do that by comparing the pattern of policies and macroeconomic development over the last decades with that of land-use change and forest loss. Initially, as mentioned above the model synthesis by Kaimowitz and Angelsen (1998) also included seven models for Indonesia. By looking at the main deforestation factors identified in these models, we can obtain at least a preliminary idea about what factors have driven forest loss in that country. The main factors found to cause higher forest loss over time or space in these models fall into the three domains of agriculture, logging and infrastructure:

Agriculture
- high output prices and/or low input costs
- high productivity and/or good soil quality

Logging
- high timber prices and/or low timber extraction costs
- the type (and terms of operation) of logging concessions

Infrastructure
- low transport costs (e.g. rural road density, type, maintenance)

From this set of factors, we can already make some observations vis-à-vis the three schools of deforestation from Section 2, Table 1:

- Commercial incentives have been the dominant drivers. Although some factors (such as soil quality) can also be subsistence-driven, most relate to markets.
- "Neo-classical" (and possibly "political ecology") explanations are more relevant than "immiseration". The deforestation-accelerating effect of higher productivity/ output prices/ lower input costs clearly shows that farmers react to "pull" incentives.
- The impoverishment mechanism of a vicious circle whereby a poor and increasing population is pushed to convert new forests to grow food crops is less relevant for the last three decades in Indonesia. If one increases agricultural profitability at the forest margin, one should thus expect forest loss to go up in Indonesia, not down.
- Logging has had a larger deforestation role than in most other countries. It has helped to open up forest frontiers. The sector has probably also quite often pro-

vided the basic capital for alternative land uses, e.g. oil-palm companies that have depended on harvesting timber profits first to then finance investments in the estate crops.

7.2 New Order Policies and Development Strategies

In spite of the financial crisis and political turmoil accompanying President Suharto's downfall, for his three decades of "New Order" period as a whole, Indonesia's economic development record has been impressive. Policies have been characterised by:

1. Macroeconomic policies widely praised for their prudence, continuity and timeliness (Gelb and Glassburner 1988; Bevan 1999b).
2. An economic strategy of openness to 'mobile' capital both of foreign and Chinese-Indonesian origin. Relatively liberal rules for capital movements and other measures to attract investment (Winters 1996).
3. A competitive real exchange rate - including the active use of currency devaluations (Warr 2000), favouring the exports of urban labour-intensive industries (textiles, electronics, etc.), cash and estate crops, and forest-based industries - with the consecutive rise of timber in the 1970s, plywood in the 1980s, and pulp & paper in the 1990s (Barr 2001: Chapter 2).
4. As a result of 1., 2. and 3., a remarkably high per-capita growth in national income and private consumption, turning Indonesia from an extremely poor country in the late 1960s to a middle-income economy in the 1990s.
5. Significant policy attention to rural development, agriculture and food security - including massive increases in rice productivity (Scherr 1989).
6. As a result of 4. and 5., major long-run progress in rural and urban poverty alleviation and also in non-income welfare (higher life expectancy and primary education enrolment, reduced child mortality, etc.)(Hill 1992; Sunderlin 1993; World Bank 1999b).
7. Aggressive land-use policies opening up forest margins through generous timber concessions, transmigration programmes and rural road construction.

7.3 Forest Lost and Converted

Turning now to the forest sphere, Indonesian deforestation figures are notoriously uncertain (Sunderlin and Resosudarmo 1996). A handful of remote-sensing based studies exist, but variable forest definitions and coverage make the estimates very difficult to compare. Nonetheless, in the following we give some rough numbers on both measured forest loss and its converted uses over the last two decades. These are based on estimates from Forest Watch Indonesia/ Global Forest Watch (FWI/GFW 2002), a consultancy report comparing a variety of sources (Muhamad 2002) and a synthesis of additional statistics on cropped areas (Wunder 2003: Chapter 9):

Deforestation between 1980-2000:	**about**	**30**	**million ha**
Conversion 1980-2000:			
Estate-crop and perennials expansion		12+	million ha
Forestry expansion (pulp harvest and plantations)		3÷	million ha
Food-crop expansion (incl. swidden)		7-8	million ha
Total converted uses 1980-2000:	**about**	**22-23**	**million ha**

As indicated by the ranges and +/÷ signs, these figures are subject to great uncertainties. Deforestation figures depend on the assumption regarding the differences in definitions and coverage (see above). The expansion of estate and cash crops is underestimated, as some of the minor crops are not accounted for. Forestry expansion is probably over-estimated, as some of the areas harvested by clear cuts have been put into cash and estate crops, and thus are double-counted. In addition, both natural forests and forestry plantations are “forests” in FAO terms, so converting one to the other should not count as deforestation.

Still, it seems worthwhile to get the guesstimates down on paper, allowing for an explicit discussion of the proportions. Even the rough figures show that perennial and estate crops make up more than half of converted land use. They also seem to indicate an inconsistency between deforestation and alternative uses. As by far most of Indonesia's "default" vegetation cover is tropical forest, we would expect deforestation and converted land use to approximately match. But the total conversion of about 22-23 million ha falls about 25% short off the alleged deforestation figure. The numbers don’t add up in Indonesia!

One possible explanation is that forest clearing ‘runs ahead’ of conversion because of the economic attraction to harvest timber and pulp resources, combined with a lack of capital to put the cleared land under alternative uses. Ecological processes could also play a role, like *alang-alang* (imperata) grassland invasions and repeated fires that come to convert forests into "wastelands". But part of the discrepancy could also be explained by outright errors in land classification leading to overestimated deforestation figures.

Returning to the policy aspects, the tentative figures confirm the suspicion from above that commercial "neo-classical" motives have clearly been dominating in the Indonesian deforestation case: cash- and estate-crop expansion has been much more important in quantitative terms than the increase in food-crop areas.[5]

What role have macroeconomic policies played for the outcome of accelerated forest loss? Did forest loss contribute to economic development - or was it even a necessary condition? This is not the place to analyse these complex questions in detail. One can cast doubt on whether the policies of generous large-scale timber concessions contributed much to the positive macroeconomic outcome. The wood-

[5] Even many so-called "food crops" are actually major cash generators for their producers, reflecting the growing importance of national markets. This further reinforces the vital role of commercial processes.

based industries generated much foreign exchange and accumulated capital for re-investments in other sectors, but the direct employment effects were limited and often local people in rural areas were expelled from their land, in the way it is described in the "political ecology" literature. On the other hand, much of the expanding cash and food crops were owned by smallholders, helping to appreciably consolidate the rural economy and alleviate poverty - much more than in countries with marked urban policy biases (see above). The development of labour-intensive agriculture was an effective motor for poverty alleviation, but it had a deforestation cost. Many of the policy measures were good for the macro-economy - and even for the majority of poor Indonesian people, but most elements were also bad news for forest conservation. This underscores the notion from last section of important policy trade-offs at the macroeconomic level.

8 Conclusion and Policy Recommendations

Agriculture is the great land-use competitor of tropical forests, and by far most deforestation occurs in order to increase farmlands. Hence, most policies and interventions that favour the expansion of agricultural production also come to decrease forest area – at least that is true for the type of forest-abundant agricultural frontier areas and forest margins that we have been concerned with in this paper. In some cases, agricultural expansion is driven by an increasing poor population growing food crops with land-extensive swidden cultivation (impoverishment approach). In others, it is the emergence of new market opportunities that drives the process (neoclassical approach). In a third set of cases, it is the clashes between these two processes that provide the main impetus (political ecology approach). Independent of what the dynamics are, there are normally strong underlying factors, most of them outside the forest sector, that enable and empower the conversion of forests to alternative uses.

Notably, even agricultural ‘intensification’ that increases per-hectare yields can accelerate forest loss. Intensification is still often seen as an area- and forest-saving factor, but that effect is highly context- and scale-dependent. The assumptions certainly hold for widespread intensifying innovations that reduce the total market price through their general supply-boosting effect. Yet, where adoption is limited, innovators increase production but prices remain high, so they will in most cases scale-up their now more profitable production. Hence, they will tend to deforest more, rather than less. Almost any agricultural investment in frontier areas with flexible labour supply promotes deforestation. So, it is hard to design agricultural programmes in these regions without a negative effect on remaining forest. In providing policy recommendations as to what could be done *strictly with the aim to stabilise the forest margins*, we were able distinguish between those factors that directly affect land extensification through a spatial effect, and those that work through the macro-level context.

8.1 Reduce Land Extensification

- Stop building or improving roads in remote rural areas near tropical forests!
- Don't give subsidised credits and inputs to "land-hungry" production sectors!
- Don't give out overly generous forest concessions to the timber companies!
- Stop rewarding deforesting squatters with secure land rights!
- Stop moving and/or directing people into forests!
- Stop financing development projects in the forest margins!
- Use instead resources and incentives in favour of other areas (e.g. pre-established "prime" agricultural zones, urban areas, peri-urban agricultural systems)!

The last two recommendations will appear controversial, and need qualification. They do certainly not imply that it is *impossible* to design forest-margin projects that through institutional fine-tuning and micro-adjustment of interventions will be successful in stabilising land demand at the forest margin. But it is very difficult to do so, and among the many projects that have tried to achieve it, the majority have failed. One does not have to be an Economics Nobel Laureate to predict that when you spend money in the forest margins – be it on health, education, R&D, value added activities and especially on agriculture – in the medium run these investments will have spin-offs that tend to attract more people and foster economic development. But more people and more development both mean in most cases more local land demand. That land is usually made available by converting forests. This is a serious risk that even the most well-intentioned forest-margin project will face.

8.2 Create a Conservation-Conducive Macro-Level Context

- Promote high urban labour absorption to keep people from migrating to the frontier!
- Avoid excessive economic fluctuations through careful adjustment policies!
- Avoid that currency devaluation makes agriculture and logging overly attractive!
- Don't provide subsidies to make fuel cheaper!
- Liberalise food and timber imports!
- Reduce population growth as an important long-run driver!

As for the spatially explicit recommendations above, many of them are deeply problematic from a development perspective. Unfortunately, many 'good' development policies (for economic growth and poverty reduction) are bad for forest conservation. Conversely, some 'bad' development policies come to protect forests. These *de facto* conservation successes are the result of 'blind' strategies and unintentional side-effects from macro policies. In particular, non-forestry (extra-sectoral) policies prove to be much more important for forests than forest policies proper. This part of the picture is not very encouraging.

Still, among the above-mentioned policy tools and interventions, there are some 'win-win' options that are promising for both forest conservation and economic development. Generally, the removal of subsidies with 'perverse' forest impacts (fuel, cheap agricultural inputs) has such a potential. Forestry-sector reform in developing countries can potentially help to capture (and distribute more fairly) timber stumpage values while also slowing down the "opening up" of forest frontiers. Speculative land-tenure arrangements caused by "homesteading" rules could be eliminated, and provide some social benefits at the same time. Import liberalisation in the timber and food sectors could reduce forest loss while increasing economic efficiency and (arguably) fostering national development in the long run.

Yet, it becomes clear from the above that the interface between forest conservation and (local or national) development in the tropics exhibits more trade-offs than synergies. A logical consequence from that diagnosis is that one should experiment much more with direct compensations for environmental services, i.e. rewarding local land users for forest conservation yielding benefits to outsiders (related to watershed, tourism, carbon-storage and biodiversity). Only if they are compensated in a *quid pro quo* for their opportunity costs of conserving the forest will they take these external benefits into account in their land-use decisions. Although experiences in the tropics with these schemes are incipient, they are certainly expanding (Landell-Mills and Porras 2002; Pagiola et al. 2002)– and they are badly needed as applied conservation tools in a world where tropical forests continue to recede.

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