# DEFORESTATION MECHANISMS : A SURVEY[1]

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This paper presents a critical review of various analysis about the underlying cause(s) of deforestation and under what mechanisms deforestation takes place. All these analyses are categorized into four groups, i.e. Neo-Malthusian, government-failure, microeconomic and macroeconomic approaches. Certain forms of deforestation, as long as they bring net development benefits and satisfy both social cost-benefit analysis and economic efficiency criteria, are generally economically desirable. Nonetheless economic criteria alone cannot provide decision-makers basis for deciding whether a deforestation project is desirable. Biophysical and political criteria need to be taken into account simultaneously.

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## INTRODUCTION

Unlike deforestation of temperate forests, where most causes are internal to the forestry system, tropical deforestation involves many external forces (Vanclay, 1993). Tropical deforestation is a very complex socio-economic process that may stem from a complex interaction between many factors. As most countries in the tropics are developing nations, these external factors often intertwine with the development process to single out a specific factor(s) that influence(s) tropical deforestation. Moreover, there exists a certain degree of disagreement among economists about the directional impact which each of these factors, and/or their interactions, have on deforestation. Thus, there are no straightforward answers as to how social and economic factors such as social values, religious belief, property rights, contract period and timber prices influence deforestation.

This paper presents a critical review of various analysis about the underlying cause(s) of deforestation and under what mechanisms deforestation takes place. All these analyses are categorized into four groups, i.e. Neo-Malthusian, government-failure, microeconomic and macroeconomic approaches. Before proceeding further, however, a discussion on how deforestation is defined and on whether deforestation is undesirable economically is presented.

## WHAT IS DEFORESTATION AND IS IT UNDESIRABLE ?

In principle, the term “deforestation” refers to a process where forests are cleared by human activities or destroyed by natural disasters, and then converted into other land uses or left as abandoned land. In this study, we shall be concerned mainly with deforestation resulting from human activities.

Rudel and Horowitz (1993, p.5) define deforestation as the clearing of more that 40 per cent of tree standings from a primary forest for logging or land-use conversion. It is apparent however that the “40 per sent” threshold does not have any ecological meaning. For example, if a black of 2,000 hectares in a 10,000-hectare primary forest zone has bee cleared, does it mean that deforestation is not taking place because only 20 per cent of the forest is cleared? One may also arbitrarily choose another threshold

depending on his or her preferences. Conservation lobby groups may favour a lower threshold, while the timber industries a higher one. For these reasons Rudel and Horowitz's definition is not adopted here.

Because forest biomass is basically a capital stock, Deacon (1994) sees deforestation as "a change in land use from a more capital intensive to less capital intensive activity" (p.415). Given this vies, Deacon defines deforestation as "a reduction in the land area covered by forests" (p.415). Deacon acknowledges, however, that not all types of deforestation can be associated with declining capital intensity. Conversion of forests into highly irrigated and mechanized farming, for example, may even increase the value of the land capital.

Myers (1991, p.4) proposes a broader definition of deforestation. Taking into account the ecological functions of a forest, Myers defines deforestation as "the complete destructions of forest cover through clearing for agriculture of whatever sort … It means that not a tree remains, and the land is given over to non-forest purposes … Decline of biomass and depletion of ecosystem service are so severe that the residual forest can no longer qualify as a forest … is included". Thus, deforestation occurs if either one of the following conditions are met. Firstly, all trees have been removed and the land is converted into agricultural or other non–forest uses, Secondly, the remaining trees no longer qualify as a forest, regardless of their proportion to the initial forest cover.

For micro-level studies, especially those reliant on primary data collection, Myers' definition is more practical that Deacon's. Data collectors with reasonable forestry knowledge could sensibly identify whether a parcel of forest has been deforested or not by looking at the forest's present condition. On the contrary, for macro-level studies such as an inter-country analysis, Deacon's definition seems to be more suitable. Analysts can use readily available forest statistic and estimate the deforestation rate. Nonetheless, country-specific date on forest cover and deforestation rates vary considerably from one set of statistics to another. As a consequence, Deacon's definition should only be used with caution.

Because this thesis is concerned mostly with deforestation done by farmers, empirical data are collected using a micro-level household survey. Interviews are undertaken

with farmers living in the forest frontier. To facilitate the field survey and analysis, Myers' definition of deforestation was than adopted.

Economists, especially those who favour weak conditions for sustainability (see Tisdell, 1997a)[2]. In general are willing to tolerate certain forms of deforestation. This is because under the weak conditions for sustainability, the substitution of man-made capital for natural resource stock is a suitable means for achieving sustainable development (Tisdell, 1997a). As a consequence, certain forms of deforestation are seen as acceptable conversions of natural resource stock into man-made capital, provided that they bring net development benefits and satisfy both social cost-benefit analysis and economic efficiency criteria. In other words, not all forms of deforestation can be regarded as economic "bads". Deforestation projects that increase the long-term social welfare of the community, such as constructions of dam, road and irrigation canals, are generally desirable under these weak conditions of sustainability.

For this group of economists, it is then important to distinguish between excessive deforestation and measured conversion of forests for development purposes. The former is undesirable, while the later is acceptable as long as negative externalities such as species extinction are compensated for. See for example Byron (1994), Kaimowitz *et al.* (1997) and Mendelsohn (1994). This means, deforestation is acceptable if it satisfies the feasibility criteria applied in a social cost-benefit analysis (SCBA). Unfortunately, many deforestation projects may appear to satisfy the while in fact they do not. In the case of a logging project, for example, conventional SCBA implicitly assumes that negative externalities will be offset by benefits flowing from reinvestment of logging taxes. As a consequence, these externalities are not counted in the cost-side of the analysis. Price (1990), however, argues that this assumption does not necessarily hold because not all revenues from deforestation are available for reinvestment, or if available, are not reinvested. This is one of the many arguments put forward by economists who favour strong conditions for sustainability, which the author will discuss later.

[2] There exist several different concept of sustainable development in the literature (Tisdell,1999). Among the most commonly used concepts is the Tietenberg's criterion, which says that a development process is sustainable if it ensures is that the per capita income of future generations is no less than that of current generations (Tietenberg,1988).

Some economists justify deforestation because they consider it economic ally efficient. Making analogy to Clark's bio-economic modal of extinction[3], Swanson (1994) categories deforestation into an economic activity called "stock disinvestment" or "resource mining". It refers to the liquidation of high-valued-but-with-low-growth resources. To liquidate the forests for their high value and to invest the funds in assets with higher growth rates are then seen as economically efficient.

Ecologists generally disagree with these "apologetic" views of some economists, especially on the basis of species extinction and environmental depletion arguments. Their disagreement is supported by economists who favour strong conditions for sustainability (Tisdell, 1997a). Here it is argued that given the current level of natural resource depletion, further conversion of natural resources into man-made capital and consumption purposes may threaten the income or welfare of future generations. Thus, this group of economists tends to favour a lower level of man-made capital relative to the natural resource stock. As a consequence, deforestation is seen as a waste of natural resource stock, whereas conservation is strongly desirable. See Tisdell (1990 and 1997a) for an extensive review about this debate.

A further complication arises if a deforestation is followed by the development of a long-fallow agroecosystem such as monospecies agroforests . The question raised is then, whether or not such a form of deforestation is desirable economically and ecologically. A reasonable approach to assess this situation is perhaps to use Conway's resilience property (Tisdell, 1999). But as Tisdell (1999) points out, one should not only take account of "whether or not a system returns to its original equilibrium, but …should also consider how long it takes to return to that equilibrium, and its actual path during disequilibrium" (p. 37).

In conclusion, it can be said that there is no straightforward answer to determine whether or not deforestation is desirable. While it is true that deforestation projects do to some extent improve the level of social welfare of society, in some come cases forest conservation (as opposed to deforestation) can even bring greater and more sustainable economic benefits (Tisdell and Xiang, 1996). Also, it should be noted that

[3] Clark's (1973) model is in fact related to the extinction of animal species. It builds upon the assumption of an open access regime, which implies that a resource will be model, bioeconomic equilibrium is extinction because resources with high price-cost ratio and low growth rate will be harvested until the point of extinction

the Hartwick's rule for reinvesting rents from resource extraction, as assumed in the conventional SCBA, is not a recipe for sustainability (Tisdell,1997b). As a consequence, economic criteria alone cannot provide decision makers with sufficient basis for deciding whether a deforestation project is desirable. Biophysical and political criteria also need to be taken into account in this case (Kaimowitz *et al.,*1997).

## ECONOMIC MECHANISMS OF DEFORESTATION

### Neo-Malthusian Approach

Under the Neo-Malthusian approach, population pressure is seen as the underlying cause of deforestation. While many agree to this argument (see for example Sandler, 1993, and Vanclay, 1993), only a few have presented a plausible mode of action or tested this hypothesis empirically. One example is Deacon (1994), which shows that deforestation is associated with population growth five years earlier. Surprisingly, the results also show that if higher and lower-income countries have the same rate of population growth, the former would exhibit a higher deforestation rate.

It is, however, still too premature to draw firm conclusions from the study. This is because the results are clouded by a number of technical and empirical deficiencies. For example, doubts arise over the accuracy of the results because the 1985 data on forest cover for about one-third of the 129 countries analysed are actually estimated from a regression between *total forest and forest* and *woodland area.* Data expansion to about a half of the total observations actually available can only produce "estimates" It is unfortunate that Deacon presents no regression results for the 84 countries where the data are *actually* available, so that a comparison can be made.

Also, if high income countries are exclude from the analysis, the regression coefficient for the 1975-80 population growth declines from 0.1860 to 0.1247. Its significance level "drops" to above the 10 per cent level. Thus, the inclusion of high-income countries alters the results considerably. Because low deforestation rates in these countries can be attributed to many factors (e.g. higher income and better law enforcement), it raises serious doubt about the importance of population growth in the modal.

Question also arises as to whether Deacon's choice of dependent variable, $D_i$ , is the best proxy for deforestation. Defined as the change in the log of forest area between *t* – 1 and *t* in country i the formal form for $D_i$ is $D_i = log\,(A_{i,t-1}) - \log\,(A_{i,t}), or\ e^{Di} = A_{i,t-1}\ / A_{i,t,}$ where *A* is the land area identified as forests. There are of course some other alternative forms for $D_i$, such as $e\overline{Di} = (A_{i,t-1} - A_{i,t,})/(A_{i,t-1} + A_{i,t,})$ or $\tilde{D}_i = log(A_{i,t-1} - A_{i,t,}) - log(A_{i,t-1} + A_{i,t,})$. Obviously, var $(\tilde{D}_i) \neq$ var ( $D_i$ ). Hence, use of $\tilde{D}_i$ might yield different results.

All criticisms above are not intended as a repudiation of Deacon's results, nor of the hypothesis that population pressure induces deforestation. Rather they highlight the enormous difficulties faced when one tries to obtain satisfactory econometric results from an inter-country analysis. Date on forest cover and deforestation rates are often incompatible from one country to another, making the analysis even harder. For this reason, one should not overlook micro-level studies, which despite their "local" scope may enable researchers to better understand haw deforestation occurs.

## Government Failure

The term "government failure" refers to misdirected policies that result in unintended deforestation and the inability of government institutions to preclude preventable deforestation. In this section, two forms of government failure frequently discussed in the deforestation literature, namely log export bans and corruption, are reviewed.

### *Log-export bans and timber princes*

Log export bans are probably the most commonly cited "misdirected" policies. Developing countries impose the bans as a means to promote the development of their export-oriented processing industries. The policy is thought to have increased deforestation because it forces domestic timber prices to decline.[4] The most common

[4] Another effect the bans have on timber market is that they restrict is that they restrict the amount of logs available for international supply. This in turn leads to the collapse of the Japanese plywood industry in the 1970s and 1980s, for example, is associated partly with log-export ban imposed by its major supplier, i.e. Indonesia. Other evidence suggests that Japan, South Korea and Taiwan had already recognized that

explanation is that, lower domestic prices encourage wasteful logging, diminish processing efficiency, and as a result, increase deforestation rates. This view can be found in Reppeto and Gillis (1988) and in a number of the World Bank's reports cited by von Amsberg (1994). Note that implicitly, and without any justification, these studies use logging as a synonym for deforestation. There is however ample evidence throughout Asia and the world that many areas have been deforested without ever having been commercially logged, and conversely, many areas have been commercially logged but are still quite reasonable (but not pristine) forests.

Another explanation is that, lower timber princes reduce the value of standing timber, and thus lead to a reduction in forest owners' profit. At one point, timber prices become low enough to make alternative land uses (e.g. agriculture) economically more profitable. This will then encourage conversion of standing forest into other land uses (Vincent, 1990). This view, however, assumes away the most common situation where the forest owner is a government forestry agency, which rarely behaves as a profit maximizing owner and is rarely interested in converting reserved forests to agriculture.

Contrary to the above view, there are those who argue that lower domestic prices can in fact discourage deforestation. This is because, as lower prices reduce profits from logging operation (assuming a constant logging cost), loggers have less incentives to continue their operations. Moreover, given that logging costs usually increase with increased remoteness of the areas to be harvested, lower timber princes may even act as a deterrent to the harvesting of remote forests.

Von Amsberg (1994) reconciles these conflicting views by distinguishing two different types of forest, i.e. unmanaged-and managed-forests. Unman-aged forests include old-growth and secondary forests that have not been logged until they are mature for harvest. Managed forests include forest plantation and other forests established for periodic harvests. Making use of the classical von Thunen's land-use modal, the results show that because unmanaged forests are seen as timber storage, the profit-maximizing response to lower timber princes is to leave the forests unlogged until the prices rise to a more profitable level. Thus, lower timber princes discourage the logging of unmanaged forests

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their comparative advantage had radically changed, and had already decided to phase out the wood industries based on imported logs (Byron, 1990).

Managed forests, on the contrary, are seen as inputs for timber production. Reductions in timber princes will result in lower amounts of land allocated for development of the forests. While this does not in any way mean a higher deforestation level, it is obvious that lower timber princes lead to lower forested areas.

All these analyses are however concerned mainly with the supply side of log export bans, with little attention given to the dynamics of domestic log demand. The complex effects of the price elasticity of domestic log demand, for example, are not extensively discussed. Also ignored are possible impacts of factors such as the ratchet effect, where in the short-run producers' response to a price decline is to increase supply in order to compensate for lost revenues. And if a dynamic modal, instead of a static one, is employed, the results might be more complex than those reported by the above studies. Because these speculations can only be confirmed by a thoroughly designed dynamic or general equilibrium analysis of log export bans and their impacts, such an analysis is beyond the scope of this study, and the author will not elaborate further on this topic.

It is however worth noting that in many cases, deforestation is related to household demand for farm land, rather than to demand for timber. As a consequence, timber prices may have little, if not zero, effects on the rate of this form of deforestation.[5] Because a large portion of the global deforestation rate can be attributed to farm household activities (Myers, 1981,1991; Sandler, 1993; Singh, 1994), this factor may have undermined the effects of timber prices on deforestation rate, if the relationship between timber prices and deforestation rate *does* exist.

### *Corruption*

In addition to forest clearing by farm households, another major cause of deforestation is unsustainable logging practices. Citing a report from a Papua New Guinean Commission of Inquiry, Vanclay (1993) argues that unsustainable logging is only a symptom rooted from more serious problems such as corruption and greed.

[5] This is because farmers do not sell timber from the cleared land. Instead they use the timber as raw materials for farm building and/or as fuelwood for their own consumption

Corruption makes bureaucrats and government institutions unable to perform their supervisory duties effectively. In theory such a failure, combined with the concession holders' decision myopia, could lead to excessive logging. Analytical proof for this point is provided by Walker and Smith (1993). Using a sequential-decision model, Walker and Smith defines a concession holder's annual decision problem as "whether or not to remain in compliance with the terms set in the logging contract" (p.388). Assuming that the contract terms are consistent with sustainable logging regime, compliance means the adoption of "sustained-harvest" by the logger, while on the contrary, noncompliance means a "liquidation-harvest".

The results show that with a zero detection probability, at a discount rate of 5 to 15 per cent, and with a contract length of 2 to 20 years, concession holders tend to violate the terms of the contract throughout its entire period. If detection probabilities fall below a given threshold that ensures compliance to the contract (for example, the threshold at a 5 per cent discount rate and a 10 year-contract length is 0.1238), it is economically rational for concession holders to choose liquidation harvest.

Given these results, to minimize deforestation governments need to determine the most cost-effective inspection policy, that is, a policy with the highest probability for the successful detection of contract violations at the lowest possible costs. If a country is plagued by rampant corruption, government institutions tend to fail to perform such a policy. This is because resources that should have been used to make these institutions better-equipped with staff, equipment and operational budget are diverted into personal uses by the corrupt officials. And if a contract violation is detected, the corrupt officials often turn a blind eye on it, in return for personal favours offered by the violating companies. Following Walker and Smith's results, it can be inferred that since corruption makes inspection policy ineffective, logging companies become more inclined to adopt unsustainable logging.

Empirical evidence that show the link between corruption and deforestation are however difficult to obtain. Not only because to prove corruption involves complex judicial proceedings, in many developing countries corruption are so widespread, implicating executive, judicative and legislative officials that it is almost impossible to expose even a tiny portion of the problem. With such limited information available,

analysts cannot perform an accurate study on the effects of corruption on deforestation.[6]

Despite this limitation, we present as an indication the case of deforestation in Indonesia. Transparency International, an anti-corruption body, rank Indonesia among the ten most corrupt countries from a group of 54 countries it surveyed in 1996, alongside India, Russia and China (Pitman, 1996). In the forestry sector, examples of corruption include the allocation of logging concessions to military, political and business elites without transparent procedures available for public scrutiny. They also include some forms of collusion between logging companies and bureaucrats responsible for logging supervision. Under such an environment, and worsened by the lack of technical capacities vis-à-vis the vast areas of logging concessions to be supervised, detection policy has become minimal. As a result many logging companies are involved in "illegal logging". Current estimates show that the actual levels of logging may exceed 40 million cubic meters per year (mcm/y), well above the reported log production of about 32 mcm/y (World Bank, 1994). Given the current consensus, that to be sustainable the rate of log harvest in Indonesia should be set at 31.4 mcm/y, declining to 25 mcm/y in year 2000, this illegal logging clearly threatens the long-term sustainability of the country's forest resources.

## Microeconomic Approach

The microeconomic approach attempts to provide explanations on how, under various forms of market failure, an agent's economic behavior leads to deforestation. The frequently cited forms of market failure are poorly defined property rights, poorly designed logging contracts and undervaluation of forest benefits, either at the local, regional or global level. Many of these works follow the classical work of Gordon (1954) and Hardin (1968) on common property resources.

[6] Analysts often use subjective corruption data collected from surveys amongst business persons and economic leaders with business experience in each of the countries surveyed. These data are available from, for example, World Competitiveness Report, Business International and various reports published by Transparency International. Ades and Di Tella (1997) show how corruption is defined differently from one survey to another, and between surveys conducted by the same agency in different years. Such inconsistencies indicate that data on corruption are still far from adequate.

### *Property rights and the tragedy of the commons*

Many point to the poor definition of property rights as the main form of market failure that causes deforestation (Barbier *et al*., 1991; Deacon,1994; Hodson *et al*., 1995; Mendelsohn, 1994; Mendelsohn and Balick, 1995; and Sandler, 1993). In this case the contrast between properly defined rights (whether in the form of fee-simple ownership, or recognized and established common property rights) on the one hand, and the absence of defined rights ("open access") or contested claims to property rights on the other hand, is often highlighted.

Following Hardin's (1968) "tragedy of the commons", the conventional wisdom is that forests held under common property will almost certainly be severely deforested. Gordon's (1954) and Clark's (1973) models of open access over-exploitation in the fishery sector provider the basis for later works conducted under this wisdom. In general these models suggest that under an open-access environment, the bio-economic equilibrium is extinction (See also Clark, 1976, 1990). With an open-access, anyone can utilize the resources often at a very low cost. Thus, no one has the incentives to control over exploitation and/or to maintain the quality of the resources. Individuals can also use the resources to satisfy their needs with no regards being paid at the damages inflicted upon other, both in the present and future periods. Such a view has led many to argue that the first-best solution to the open access problem is to establish a secure property rights (e.g.Mendelsohn,1994).

The poor definition of property rights also increases long-term risks and uncertainty for forest users. Deforestation produces higher short-rum income and consumption for the users, while on the contrary, sustainable forest utilization requires that some, may be a large, portion of these short-rum benefits be sacrificed in return for a stream of *expected* future income and consumption. As the future is full of uncertainty, poorly-defined rights make the users increasingly uncertain whether or not, at a given rate of time preference, their foregone short-run benefits will be compensated for in long-rum. Under such a risky environment the users become more inclined to over-exploit the forests.

Moreover, the poor definition of property rights discourages the establishment of long-term forest investments such as timber plantation. The users feel insecure because

there are some probabilities that they will be evicted from their land by other users or government officials. Mendselsohn (1994) shows that even at a very low probability of eviction, the destructive agricultural practices are found to be economically more attractive than sustainable forest harvest.

The above discussion obviously underlines the importance of property rights for forest management. Some analysts go even further by claiming that “no conservation strategy is likely to succeed without the recognition of properly defined property rights” (Hodson *et al*., 1995, p.1321). In this case, Hodson *et al*. associate exclusively the term “properly-defined” to “fee simple (private) ownership” or “a conditional ownership (e.g. utilization contract) with enforceable strings to ensure that the forests are to be preserved” The underlying assumption for this argument is that only these kinds of ownership guarantee minimum risks for investors. However, there is ample evidence throughout Asia of effective long-term, sustainable and equitable forest management as managed common property. It is the confusion between open access and a managed commons that has led Hodson *et al.* to make the demonstrably false claim that common ownership is a recipe for natural resources “to be harvested so intensively that they will decline to less-than-viable populations” (p. 1320), unless they have “ extraordinary powers of reproduction”. Thus, while it is true that for an open access resource “there is little reason to expect a commercial incentive to preserve the use of the land as rain forest” (p.1320), this must not be extended to managed commons.

One example which clearly repudiates the claim that any resources held in common property would always be over-exploited is the existence of *hutan adats* within the Kerinci-Seblat National Park area in Indonesia. A *hutan adat* is a commonly owned and managed forest considered to be sacred by a traditional society (e.g. a tribe). Members of the society are allowed to collect non-timber products from the forest and to do hunting or fishing. But nobody is allowed to clear to the forest. The continuing existence of *hutan adats* for decades indicates the capacity of local society to utilize common forests sustainably. Berkes and Folke (1992) cites some other examples, including communal land tenure in Torbel, Switzerland and common land management in Hirano, Japan. Pinedo-Vasquez *et al.* (1990) show how a Northeast Peruvian community manages communal forests sustainably by putting self restrictions on forest harvests.

Outside the forestry sector, other resources such as water, grazing lands, fish catch and wildlife have also been sustainable utilized under common property rights (Feeny *et al*., 1990). An example for this is the traditional *Subak* irrigation system in the island of Bali, Indonesia, where common water resources are shared and utilized sustainably.

From these examples, some analysts appear to have under-estimated the capacity of traditional social controls (e.g. religious values, customs and taboos) to ensure sustainable utilization of common resources. This may stem from economists' failure to recognize the role of cultural capital as a basis for guiding a society toward sustainable uses of natural resources (Berkes and Folkes, 1992). In this case the term "cultural capital" refers to "factors that provide human societies with the means and adaptations to deal with the natural environment and to actively modify it … includes the wide variety of ways in which societies interact with their environment" (Berkes and Folkes, 1992, p.2). Included in this term are religious values, ethics, customs, taboos, traditional knowledge and social/political institutions. Note however that cultural capital is not a static concept. It may change significantly due to rapid economic and technological changes. If the changes lead to the adoption of more exploitative uses of common resources, than the above positive impacts of cultural capital will not materialize. Nonetheless, one should not under-estimate the potential role of cultural capital in ensuring sustainable uses of common resources.

### *Logging contracts and follow-on farmers*

Deforestation may result from establishment of permanent farms by follow on farmers on abandoned logging plots. Walker (1987) argues that this form of deforestation is caused by suboptimal contract length. Assuming constant prices and linear costs, Walker shows that if the length or the logging contract is less than the number of plots to be harvested (termed as "the time constrained case"), logging companies have no incentive to exercise exclusionary rights. They will tend to abandon their logging plot and let follow-on farmers move in. Evidence from large logging companies in Indonesia and Columbia indicate that the companies do exhibit the time-constrained case, and hence have little incentive to exclude follow-on farmers. In the later work, however, Walker and Smith (1993) appear to be in favor of a shorter contract period because it discourages short-run liquidation harvest.

Intuitively, whether or not concessionaires have incentives to prevent follow-on farmers needs not necessarily be influenced by contract length. Concessionaires might not care whether follow-on farmers arrive if they are not required to prevent it by the state who actually owns the forest. As in a lease, the maintenance of the capital asset is the landlord's (owner's) responsibility. It would unrealistic to expect the tenant to care for someone else's property if he or she is not required to.

One may argue if the contract length is long enough *and* the logging giver a relatively high return, concessionaires may find it beneficial to prevent follow-on farmers. But again, it is not contract length *per se* that induces the concessionaires to do so. The high financial returns from logging also play a rote here. And if the returns from logging are not high enough. The incentives to prevent follow-on farmers might disappear unless the concessionaires are required to do so by law.

What clearly emerge from this discussion is that there is no simple straightforward answer about the directional impact of the length of logging contract on deforestation. As with the earlier discussion on property rights, security of tenure is a necessary but not sufficient condition for sustainable forest management. Even with secure tenure, ownership, a long term contract or lease, many managers may well decide that raid liquidation of the asset is the optimal strategy, especially if they do not bear the social and environmental external costs of their decisions.

### *Undervaluation of the full benefits of a forest*

Humans can derive a variety of economic and non-economic values from a forest. *Direct-use value* refers to the commercial values of forest products, including timber, fuelwood, and non-timber products (NTPs) such as fruits, rattan and resins. *Indirect-use value* involver various environmental benefits such as global ecological services (e.g. carbon sequestration), protection of watershed area, conservation of land and water resources, exports of energy and nutrients, and various amenities that support ecotourism. *Option value* refers to the future use of biodiversity as potential sources for biological and medicinal inventions. Existence value is associated with a community's willingness-to-pay to keep the existence of a forest, regardless of whether or not they actually utilize the resource.

Nevertheless, humans often put greater emphasis on the direct-use value of a forest, and undermine the other values. In addition to lack of knowledge, poverty and ignorance, such a bias stems primarily from controversy as to how these benefits are distributed among various sections of the world community. For farmers in poverty, for example, forests are seen mainly as a source of fertile land and fuelwood. As they do not directly enjoy the other benefits of a forest (e.g. a forest's option value), they tend not to internalize companies, who view forests mainly from their timber value.

The fact that it is difficult, and sometimes controversial, to quantify the full benefits of a forest can only favour this undervaluation. Direct-use value is probably the easiest one to measure. Attempts to measure the other values, however, have so far yielded unsatisfactory results. In the case of indirect-use value, controversies arise from difficulties in estimating intangible externalities. For example, it remains unclear how to measure the economic benefits of carbon sequestration and to determine what section(s) of the global community actually enjoy these benefits[7]. Measurement of option value is also hampered by the high risks and uncertainty involved in scientific inventions. The absence of "actual" market makes estimates of willingness to pay, and hence existence value, highly subjective and hypothetical. Such an undervaluation could then result in tropical forests being over-exploited for their direct value only.

The undervaluation of tropical forests also reflects a "collective action problem" (Sandler, 1993). While tropical forests produce global public goods (e.g. biodiversity and carbon sequestration),the onus for preserving the forests often fall into the countries where the forests are located. Unfortunately these countries usually have limited financial capability vis-à-vis their huge needs for development funding, and are often plagued by rampant corruption and inefficient bureaucracy. It is then unrealistic to expect these countries alone to conserve their forests, without global cooperation (Gluck *et al*., 1997).

### Macroeconomic Approach

The macroeconomic approach attempts to establish the link between foreign debt and deforestation. The main hypothesis is that, faced with high level of indebtness,

[7] An example of work in this area is Adger *et al*.(1995), which attempts to measure the full benefits of Mexican forests. While the study is obviously a commendable attempt, one can dispute the accuracy of the results that show almost ninety per cent of the benefits are enjoyed by the global community.

developing countries may adopt various debt servicing schemes that increase deforestation. In general these schemes include any export-promotion and import-reduction programs related to the liquidation of forests, such as the promotion of timber products export and the subsidization of forest conversion to agricultural land to increase (reduce) agricultural exports (imports).

Gullison and Losos (1993) test this hypothesis on nine Latin American countries for the period of 1976-1985. If the hypothesis is true, level of foreign debt should increase export of timber products. And because Latin American forests are converted mostly into cattle ranches (Myers, 1981), debt should lead to increased export of beef. Initial evidence suggests a very strong correlation between the log of foreign debt and the log of deforestation ($r$ = 0.75). But after the data were adjusted by population level, the correlation disappeared. Gullison and Losos also find no evidence that foreign debt induce deforestation through increased exports of timber products and beef. The fact that earning from forest product exports form only a tiny portion of Latin America's long-term debts(1.00 and 0.43 per cent in 1980 and 1985, respectively) casts further doubt on the hypothesis.

Other authors suggest indirect links between debt and deforestation. The World Resources Institute (1992) argues that debt repayments, which often constitute a large portion of national budget, reduce investments in environmental programs. As funding for programs such as forest conservation and reforestation shrink, the level of deforestation increases. A high level of debt is also thought to worsen poverty, resulting in increased deforestation. Because spending in environmental programs has traditionally been very low, Gullison and Losos (1993) question whether budget cuts in these areas can significantly increase deforestation. However, Gullison and Losos produce no evidence to show that cuts in forest conservation and reforestation budgets do not increase deforestation. Thus, their doubt is more of intuition rather that built upon solid empirical results.

Despite this lack of empirical evidence, there is compelling argument to question whether budget cuts caused by debt repayment do increase deforestation. If the cuts are across-the-board, the net effect might not necessarily be increased deforestation. As spending for projects such as road and dam construction decline, less forested

areas are then converted. Hansen (1989) shows that because debt payments reduce capital investment, they could actually lower the level of deforestation.

In relation to poverty as an intermediate variable between foreign debt and deforestation, the argument is neither clear nor convincing. Economists remain divided as to whether poverty is a cause or a result of large foreign debt. As for its effect on deforestation, in some cases poverty even act as a deterrent to deforestation. As an example is a case reported in Northern Madagascar, where after acquiring adequate capital, poor farmers move from subsistence farming to cash crop cultivation, resulting in higher rate of deforestation (Gullison and Losos, 1993).

Notwithstanding the above criticisms, Kahn and McDonald (1995) find a positive link between debt and deforestation, even after the date are adjusted by population or real GNP in US dollar. Building their model on the hypothesis that foreign debt induces myopic behavior (because it affects social discount rates), Kahn and McDonald show how optimal level of deforestation changes according to changes in production inputs and competing uses of GNP. A 10 per cent reduction in total or relative debt service is shown to reduce deforestation by 1.7 to 3.1 per cent.

However, as the models exhibit a very low explanatory power (Adjusted $R^2$ = 0.286-0.310), while at the same time Kahn and McDonald recognize that the results are correlative (rather than causative), the result raise more questions than they answer. For example, can one rule out the possibility that the positive correlation between debt and deforestation is a mere coincidence? Why does the evidence gathered so far point to no causative relations between foreign debt and exports of timber and agricultural products? And given that the link between debt, poverty and deforestation is still unclear, under what mechanisms could debt lead to increased deforestation?

These puzzles lead to serious questioning over the merit of the debt-for-nature swap to reduce deforestation. Proponents of the swap build their argument on the perceived link between debt and deforestation. It seems that more empirical evidence are required to prove their case. These puzzles, however, need not necessarily derail North-South cooperation to arrest deforestation rate. Viewing tropical forests as global public good, many have modeled the need for global cooperation to preserve the resources, including financial transfers to compensate property rights (Sandler,1993)

and equal protection of old-growth forests between developed and developing nations (Kohn, 1995).

Another study that can be grouped into the macroeconomic approach, yes it does not deal exclusively with the level of foreign debt, is Capistrano and Kiker (1995). The study test the hypothesis that forest depletion is affected by macro-scale economic factors arising at the global and national levels. Data on 45 countries from 1967 to 1985 are analysed. The results show that real exchange rate devaluation, debt service ratio, food self-sufficiency, per capital income and export prices of forestry and agricultural outputs are significant regressors for forest depletion, while population pressure and the ration of arable land to rural population are show to have ambiguous effects.

These results, however, should be interpreted with caution. Capistrano and Kiker use "the area of tropical broadleaved forest industrially logged" as the indicator for deforestation and overall forest depletion. But as discussed before, commercial logging cannot be used automatically as a synonym for deforestation. Thus, it is the "area of industrial logging", which does not always mean "the level of deforestation", that the authors actually use as the dependent variable. With this in mind, the result that variables such as export princes of forestry products are shown to be statistically significant should come as no surprise.

## CONCLUSION

Certain forms of deforestation, as long as they bring net development benefits and satisfy both social cost-benefit analysis and economic efficiency criteria, are generally economically desirable. Nonetheless economic criteria alone cannot provide decision-makers basis for deciding whether a deforestation project is desirable. Biophysical and political criteria need to be taken into account simultaneously.

This paper presents a critical review on various analyses of the cause(s) and mechanisms of deforestation. The author categories these analyses into four general groups, i.e. Neo-Malthusian, government-failure, microeconomic and macroeconomic approaches. Excluded from this survey are micro-level evidence, such as that

deforestation is often associated with farmers' capital accumulation behavior, and poverty it a deterrent to, not a cause of, deforestation.

## REFERENCES


Ades, A and Di Tella, R. (1997), "National champions and corruption: some unpleasant interventionist arithmetic", *The Economic Journal*, 107(43): 1023-1042

Adger, W.N., Brown, K. Cervigni, R. and Moran, D. (1995), "Total economic value of forests in Mexico", *Ambio*, 24(5): 286-296.

Barbier, E. Burgess, J. and Markandya, A (1991), "The economics of tropical deforestation", *Ambio,* 20 (2): 55-58.

Berkes, F. and Folke, C. (1992), "A system perspective on the interrelations between natural, human-made and cultural capital", *Ecological Economics*, 5: 1-8.

Byron, R. N. (1990), "Forest products trade in newly industrializing Asia", in Anderson, K. and George, A. ( eds ), *Australia Agriculture and Newly Industrialising Asia: Issues for Research,* Australia-Japan Research Foundation, Australia National University, Canberra, pp.221-239.

Byron, R.N. (1994), Policy research for tropical forests. Mimeo. A discussion paper presented at the Centre for Policy and Implementation Studies. Jakarta, 22 February 1994.

Capistrano, A.D. and Kiker, C.F.(1995), "Macro-scale economic influences on tropical forest depletion*", Ecological Economics,* 14: 21-29.

Clark, C.W. (1976), *"Mathematical Bioeconomics: the Optimal Management of Renewable Resources* (1st ed), John Wiley and Sons, New York.

Clark, C.W.(1973), "Profit maximization and the extinction of animal species", *Journal of Political Economy*, 81(4): 950 -961.

Clark, C.W.(1990), *"Mathematical Bioeconomics: the Optimal Management of Renewable Resources* (2nd ed. ), John Wiley and Sons, New York .

Deacon, R.T.(1994), "Deforestation and the rule of law in a cross section of countries", *Land Economics,* 70 (4): 414-430

Feeny, D., Berkes, F., McCay, B.J. and Acheson, J.M. (1990), "The tragedy of the commons: twenty two years later", *Human Ecology*, 18: 1-19.

Gluck, P., Tarasofsky, R., Byron, R.N., and Tikkanen, I. (1997), "*Options for strengthening the international legal regime for forests.* A report prepared for the European Commission by EC, EFI, IUCN and CIFOR. EFI, Joensuu, Finland.

Gordon, H.S (1954), "The economic theory of a common-property resource: the fishery, *Journal of Political Economy*, 62: 124-142.

Gullison, R.E. and Losos, e.c. (1993), "The role of foreign debt in deforestation in Latin America", *Conservation Biology,* 7(1): 140-147.

Hansen, S (1989), "Debt for nature swap: overview and discussion of key issues", *Ecological Economics*, 1: 77-93.

Hardin, G. (1968), "The tragedy of the commons", Science, 162: 1243-1247.

Hardin's, G. (1968), "The tragedy of the commons", *Science,* 162: 1243-1247.

Hodson, T.J., Englander, F., and O'Keefe, H. (1995), "Rain forest preservation, markets, and medicinal plants: issues of property rights and present value", *Conservation Biology*, 9(5): 1319-1321.

Kahn, J.R. and McDonald, J.A. (1995), "Third-world debt and tropical deforestation", *Ecological Economics,* 12: 107-123.

Kaimowitz, D., Byron, R.N., and Sunderlin, W. (1997), *Public policies to reduce inappropriate tropical deforestation. Mimeo.* Centre for International Forest Research (CIFOR), Bogor, Indonesia

Kohn, R.E. (1995), "Salvatore model with equiproportional preservation of forests", *Open Economies Review*, 6: 63-79.

Mendelsohn, R. and Balick, M. (1995), "Private property and rainforest conservation", *Conservation Biology*, 9 (5): 1322-1323.

Mendelsohn, T. (1994), "Property rights and tropical deforestation", *Oxford Economic Papers,* 46: 750 -756.

Myers, N (1981), "The hamburger connection: how Central America's forests become North America's hamburger", *Ambio,* 10(1): 3-8.

Myers, N (1991), "Tropical forests: present status and future outlook", *Climatic Change,* 19: 3-32.

Pinedo-Vasquez, M., Zarin, D. and Jipp, P (1990), "Use-values of tree species in a communal forest reserve in northeast Peru", *Conservation Biology*, 4: 405-416

Pitman, J. (1997), "Kicking the kickbacks", *The Australian*, June 13, 1997, p.27.

Prince, C. (1990), "Deforestation and economic criteria", *Project Appraisal*, 5(3): 159-166.

Repetoo, R. and Gillis, M. (1988), "*Public Policies and the Misuse of Forest Resources,* Cambridge University Press.

Rudel and Horowitz, B (1993), "The Changing Geography of Tropical Deforestation, Columbia University Press, New York.

Sandler, T. (1993), "Tropical deforestation: markets and market failures", Land Economics, 69(3): 225-233.

Singh, K.D. (1994), "Tropical forest resources: an analysis of the 1990 assessment", *Journal of Forestry,* 92(2): 27-31

Swanson, T.M. (1994), "The economics of extinction revisited and revised: a generalized framework for the analysis of the problems of endangered species and biodiversity losses", *Oxford Economic Papers,* 46: 800-821

Tietenberg, T. (1988), *Environmental and Natural Resource Economics*, 2nd ed., Scott Foresman and Co., Glenview, IIIinois.

Tisdell, C.A and Xiang, Z. (1996), "Reconciling economic development, nature conservation and local communities: strategies for biodiversity conservation in Xishuangbanna, China", *The Environmentalist*, 16: 203-211.

Tisdell, C.A. (1990), "Ecological economics and the environmental fulture", *Discussion Paper in Economics*, No 28, April 1990, the University of Queensland, St Lucia, Brisbane.

Tisdell, C.A. (1997a), "Weak and strong conditions for sustainable development: clarification of concepts and their policy application", Economics, *Ecology and the Environment Series*, Working Paper No 11, April 1997, the University of Queensland, St Lucia, Brisbane.

Tisdell, C.A. (1999), "Biodiversity*, Conservation and Sustainable Development : Principles and Practices with Asian Examples,* Edward Elgar, Cheltenham, UK.

Vanclay ,J.K. (1993), "Saving the tropical forest : needs and prognosis", *Ambio,* 22(4) : 225-231.

Vincent, J.R. (1990), "Don't boycott tropical timber", *Journal of Forestry,* 88(4): 56.

Von Amsberg, J. (1994), "Economic parameters of deforestation",*Policy Research Working Paper* No. 1350, the World Bank, Washington.

Walker, R.T. (1987), "Land use transition and deforestation in developing countries", *Geographical Analysis*, 19(1): 18-30.

Walker, R.T. and Smith, T.E. (1993), "Tropical deforestation and forest management under the system of concession logging: a decision theoretic analysis", *Journal of Regional Science,* 33(3): 387-419.

Wibowo, D.H and Byron, R.N. (1999), “Deforestation mechanisms: a survey”, *International Journal of Social Economics*, 26: 455-474.

Wibowo, D.H., Tisdell, C.A. and Byron, R.N. (1997), “Deforestation and capital accumulation: lessons from the Kerinci-Seblat National Park, Indonesia”, *Asia Pasific Journal on Environment and Development,* 4(1): 11-28.

World Resources Institute (1992), *World Resources 1992-1993*, Oxford University Press, Oxford.