Destruction of forest areas as a result of logging and harvesting in African or American dense tropical rainforests

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Photo 1.
Tropical forest logging road.
Photo Laurent, 1983.

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P. Biggins (Trans.)

RÉSUMÉ

LA DESTRUCTION DU COUVERT FORESTIER CONSÉCUTIVE À L'EXPLOITATION FORESTIÈRE DE BOIS D'ŒUVRE EN FORÊT DENSE TROPICALE HUMIDE AFRICAINE OU AMÉRICAINE

Il est devenu habituel de lire dans les médias des articles accusant l'exploitation forestière d'être le moteur principal de la disparition des forêts tropicales. Ce raccourci trompeur est imputable à une méconnaissance des réalités forestières, d'une part, et à un amalgame entre l'exploitation forestière et le défrichement agricole, d'autre part. L'objet de cet article rédigé par un praticien familier du contexte forestier tropical était d'évaluer l'impact de l'exploitation forestière sur les forêts denses tropicales humides, dans les deux continents africain et américain. Par souci d'exactitude, les phases de l'exploitation ont été distinguées : installation de la base vie, constitution du réseau routier de vidange des bois, réalisation des opérations d'exploitation proprement dites. Des scénarios ont été distingués en fonction de la richesse de la forêt, dont le volume récolté varie de 3 à 15 m^3/ha. Ces estimations confirment que la destruction du couvert forestier demeure si faible qu'à l'exception de situations radicales l'exploitation forestière ne constitue pas une menace pour le maintien durable des forêts tropicales. La mise en place des réseaux routiers et de pistes de débardage affecte de 4,5 à 5,5 % du couvert forestier. Les surfaces des trouées consécutives à l'abattage ne dépassent jamais 4 % du couvert, et restent inférieures à 2 % pour les forêts riches ou de richesse moyenne. L'exploitation forestière n'est donc directement responsable que de la destruction de 5,5 à 8,5 % du couvert forestier. Dans le cas de forêts riches, des exploitations forestières successives peuvent certes atteindre 12 à 16 % du couvert forestier. Mais c'est alors sans compter sur la dynamique de reconstitution de la biomasse opérant naturellement entre deux séquences d'exploitation. En Asie du Sud-Est où l'exploitation est plus intensive en raison d'un potentiel commercial très élevé, la reconstitution du couvert est acquise en 20 ans. Si la valeur économique d'une forêt dense tropicale humide diminue avec l'exploitation, ses valeurs biologique et écologique restent quant à elles sensiblement intactes.

Mots-clés : dégradation forestière, déforestation, piste forestière, chantier forestier, aménagement forestier, exploitation forestière, Afrique, Amérique du Sud.

ABSTRACT

DESTRUCTION OF FOREST AREAS AS A RESULT OF LOGGING AND HARVESTING IN AFRICAN OR AMERICAN DENSE TROPICAL RAINFORESTS

Articles in the media that point to logging as the main driver of tropical forest loss have become commonplace. However, this is a misconception that can be attributed to inadequate knowledge of actual forest conditions on the one hand, and to the conflation of logging and agricultural clearance on the other hand. This article, written by a practitioner with a thorough knowledge of the tropical forest context, sets out to assess the impacts of logging on dense tropical rainforests in Africa and South America. In the interests of accuracy, the article distinguishes between the different phases of a logging operation: establishment of the base camp, building of logging roads to ship out the timber and actual felling. Different scenarios are described according to the richness of forest environments, where harvested volumes vary from 3 to 15 m^3/ha. These estimations confirm that the destruction of forest cover is so low that, except in radical situations, logging is not a threat to the sustainability of tropical forests. Opening up road networks and logging roads affects 4.5% to 5.5% of forest cover. Clear-felled areas never exceed 4% of the forest cover and the figure drops to less than 2% in highly or moderately species-rich forests. Logging is therefore directly responsible for only 5.5% to 8.5% of forest destruction. Although the figure can rise to 12% to 16% in rich forest environments, it does not take into account the natural dynamics of biomass reconstitution between logging sequences. In Southeast Asia where logging is more intensive due to very high commercial potential, forest cover reconstitutes within 20 years. While the economic value of dense tropical rainforests declines with logging, their ecological and biological value remains virtually intact.

Keywords: forest degradation, deforestation, logging road, logging site, forest planning, logging, Africa, South America.

RESUMEN

DESTRUCCIÓN DE ZONAS FORESTALES DEBIDO AL APROVECHAMIENTO FORESTAL EN LAS SELVAS TROPICALES DE ÁFRICA O AMÉRICA

Se ha vuelto habitual leer en medios de comunicación artículos que acusan al aprovechamiento forestal de ser el principal impulsor de la desaparición de los bosques tropicales. Este falso atajo se debe al desconocimiento de las realidades forestales, por una parte, y a la amalgama entre aprovechamiento forestal y desmonte para fines agrícolas, por otra. El objetivo de este artículo, redactado por un especialista conocedor del medio forestal tropical, consistía en evaluar el impacto del aprovechamiento forestal en los bosques lluviosos tropicales de África y América. Para lograr una mayor precisión, se diferenciaron las fases del aprovechamiento: instalación del campamento, apertura de la red de caminos para la extracción de madera y operaciones de aprovechamiento propiamente dichas. Se contemplaron distintas situaciones según la riqueza del bosque, ya que el volumen recogido varía de 3 a 15 m^3/ha. Estas estimaciones confirman que la destrucción de la cubierta forestal permanece tan baja que, exceptuando algunas situaciones extremas, el aprovechamiento forestal no supone ninguna amenaza para el mantenimiento sostenible de las selvas tropicales. La creación de caminos y vías de saca afecta del 4,5 al 5,5% de la cubierta forestal. Las áreas de los claros de tala no superan nunca el 4% de la cubierta forestal y permanecen por debajo del 2% en los bosques ricos o de riqueza intermedia. Esto significa que el aprovechamiento forestal sólo es directamente responsable de la destrucción del 5,5 al 8,5% de la cubierta forestal. Aunque es cierto que, en el caso de los bosques ricos, los sucesivos aprovechamientos pueden afectar del 12 al 16% de la cubierta forestal, este dato no tiene en cuenta la dinámica de reconstitución de la biomasa que transcurre naturalmente entre dos períodos de aprovechamiento. En el sudeste asiático, con un aprovechamiento más intenso debido un potencial comercial muy alto, la reconstitución de la cubierta forestal se efectúa en 20 años. Si el valor económico de los bosques lluviosos tropicales disminuye con el aprovechamiento, los valores biológicos y ecológicos permanecen prácticamente intactos.

Palabras clave: degradación forestal, deforestación, pista forestal, campamento forestal, ordenación forestal, aprovechamiento forestal, África, América del Sur.

It is now commonplace in certain articles intended for the general public, or ecological journals, to accuse logging of being the driving force behind the disappearance of forest areas in the Tropics, and thereby responsible for the destruction of dense evergreen or semi-deciduous forests.

This claim, often made by people who have never seen logging in the Tropics at first hand, is contradicted by the facts.

Felling a few trees per hectare, usually fewer than 1 in 3, during a logging operation and constructing the corresponding skid runs, opening up less than one kilometre of road for 100 ha and only clearing land to establish the base camp and cross-cutting yards, tropical timber loggers have very little effect on the forest.

Anyone having flown over dense forest has been able to see that it is often difficult a few years later to distinguish between zones that were logged and those that were not.

Trees that are not felled because they are of no commercial value at a given time thus remain available for future logging and, while the economic potential of the forests has been tapped into, the disturbance of their "ecological value" remains extremely slight.

However, through the road network created, loggers develop the forest, facilitate its penetration and provide access to vast zones. Consequently, in all regions with a farming tradition, or subject to population pressure, slash-and-burn agriculture no longer remains confined to forest boundaries but spreads into the forests. As the soils rapidly become exhausted, clearing operations multiply. The fragmented forest will become seriously threatened and destined to rapid dismantling or disappearance.

Disordered and rampant land clearance leads not only to enormous economic and financial waste, but below a certain level of tree cover it also results in irreversible ecological consequences that are still difficult to grasp.

For example, it has been estimated that[1] in Côte d'Ivoire, the area of dense rainforests fell from 11.8 million ha in 1955 to 4.0 million ha in 1980, at an annual deforestation rate varying between 280 and 350,000 ha depending on the periods.

In addition, Clément[2] estimated in 1974 that in addition to the 41 million m^3 extracted from forests by logging between 1966 and 1974, 185 million m^3 (for 43 species) were isolated or destroyed by land clearance over the same period.

Who is therefore to blame? Loggers who, through the road network they construct, open up increasingly distant zones, which is an economic factor in a country's development, or farming through its uncontrolled and disorderly use of land, or even the Public Authorities, due to an absence of integrated silvo-agricultural land use and development plans?

Let us try and more effectively pinpoint what share of responsibility lies with tropical African loggers in the disappearance of forest areas.

1. Les ressources forestières de l'Afrique Tropicale – Projet d'Évaluation des Ressources, FAO, 1981.
2. Approche d'une actualisation des résultats des inventaires de 1966, Jean Clément, SODEFOR, 1974.

Forest penetration occurs on three levels:
- creation of the base camp,
- construction of the log haulage road network,
- the actual logging operations.

Moreover, the last two are very difficult to examine separately in the case we are interested in, as the density of the road network will depend on the choice of haulage method and the relief and richness of the forest, and vice versa. Let us therefore deal with them together.

Setting up the worksite base camp

For reasons of remoteness, in almost all cases loggers need to set up a base camp within the immediate vicinity of the concession awarded to them, or inside it.

The base will not only comprise a camp to house all the workers but also the buildings needed for the worksite to operate: offices, workshop, store, along with various social buildings: dispensary, school, cooperative.

The base is usually set up before work begins under the logging permit. Depending on local conditions, the possibilities allowed by the relief, and the production capacity of the worksite, the base may greatly vary in size from one logging site to another.

Based on experience, we shall adopt a land clearance of between 30 and 60 ha.

For a given base camp area, the degree of land clearance is inversely proportional to the area of the forest concession. For a base of 30 ha, 0.06% of the tree cover will be opened up for a permit of 50,000 ha, but only 0.03% for 100,000 ha.

By limiting permits to between 50,000 and 200,000 ha, the deforestation caused by installing the base will thus amount to 0.3 to 0.6‰ of the forest cover.

Photo 2.
Tropical forest base camp.
Photo J. Estève, 1983.

Deforestation caused by the construction of road networks and skid runs

The densities of road networks and skid runs are closely linked once the haulage method has been chosen.

Two methods predominate depending on forest richness and the relief conditions:

■ **direct haulage in one or two phases**, from the foot of the tree to the roadside loading area.

This haulage by a caterpillar-track or tyred tractor over short distances, of around 200 to 700 m, is usually reserved for average to rich forests and easy terrains.

The resulting high road network density – 10 to 12 km for 1,000 ha – is compensated for by the volume harvested per ha, 8 to 15 m^3, and by the relatively low cost of road construction.

The additional skid run system can be estimated at between 60 and 80 m per hectare.

■ **haulage in two successive phases**

• first haul by caterpillar tractor over short distances, 200 to 500 m maximum, from the foot of the tree to the intermediate cross-cutting yard in the forest,

• second haul by an articulated tyred tractor over distances that can reach up to 2 km, bringing out merchantable logs from the intermediate yard to the roadside loading area.

This haul, which could be equated, moreover, to a transport phase, helps to reduce the density of secondary roads, and thereby the cost of constructing the road network.

This method is generalized in the case of either poor forests, at 3 to 6 m^3 per hectare, where many kilometres of roads have to be constructed, or in the case of difficult terrains where the cost of constructing a km of road is high.

The road network density ranges from 5 to 8 km for 1,000 ha and the second haul skid run system between 6 and 30 km.

The additional first haul skid runs amount to 80 to 100 m per ha.

To calculate the areas deforested, we shall adopt the following basic hypotheses, verified by experience:

• formation width of a main road: 20 to 40 m depending on the quality and direction of the road. We shall take an average of 30 m,

• formation width of a secondary road: 20 m on average, but we shall only apply it to half the network, to take into account dry season roads under shade,

Photo 3.
Construction of a terrace near a forest base camp.
Photo J. Estève, 1983.

• width of first or second haul skid tracks: the length of a bulldozer blade, i.e. 3.2 m to 3.7 m depending on the models. We shall take an average of 3.5 m,
• roadside truck-loading landings: these landings are added to the deforested area for the different networks. They vary considerably in number and unit area from one worksite to another depending on the road system and the organization of the worksite. For the sake of simplicity, we shall consider an average value of 2,000 m² of landings for 100 ha logged.

The calculation of the deforested areas will be based on two typical examples identified in the field for each of these two haulage methods, namely:

■ **single-phase haulage**

• forest richness: 8-10 m³/ha (average forest)
– road network density: 10 km of roads for 1,000 ha, of which half is main roads and half secondary roads,
– density of skid run network: 80 m/ha.

• forest richness: 15 m³/ha (rich forest)
– road network density: 12 km of roads for 1,000 ha, of which half is main roads and half secondary roads,
– density of skid run network: 60 m/ha.

■ **two-phase haulage**

• forest richness: 5-6 m³ per ha (poor forest)
– road network density: 5.5 km for 1,000 ha, of which 2/3 are main roads and 1/3 is secondary roads;
– density of second haul skid run network: 5.5 km for 1,000 ha,
– density of first haul skid runs: 90 m/ha.

• forest richness: 10 m³/ha (average forest on difficult terrain)
– road network density: 6 km of roads for 1,000 ha, of which 2/3 are main roads and 1/3 is secondary roads,
– density of second haul skid runs: 12 km for 1,000 ha,
– density of first haul skid runs: 100 m/ha.

The formation of the networks and the corresponding deforestation percentages are summed up in the table I.

In fact, whatever the logging method adopted and the richness of the forest, the way in which installation of the different networks affects the forest cover varies little, between 4.5 and 5.5%.

It should also be noted that the importance given to the skid runs is overestimated. In fact, in order to limit the cost of opening up these runs as much as possible, the tractors carefully avoid and go around medium- and large-diameter trees.

Consequently, although the undergrowth is destroyed, the dominant storey remains unscathed and the forest cover does not disappear completely.

Forest canopy opening caused by tree felling

One last point remains to be examined: the size of the gaps created in the forest during tree felling operations.

As the tree falls, it wounds, flattens and crushes a certain number of stems lying in its direction of fall. Such stems are usually small in diameter, as the feller varies the felling direction according to the presence of large diameter trees, to avoid any risk of hanging.

Timber and windfall mostly arise from the canopy crashing to the ground, because the trunk slides over obstacles.

The sizes and shapes of tropical tree crowns vary considerably. However, it can be approximately estimated, depending on the species and the size of the trees, that they vary between 10 and 25 m in height and 15 to 35 m in width, and an average area of 250 m² can be adopted. Incidentally, almost all the damage caused in the undergrowth and dominated storey is caused by large branches.

Table I.
Formation of the networks and corresponding deforestation percentages

Logging method	**Single-phase haulage**				**Two-phase haulage**			
Forest richness	**8-10 m³/ha**		**15 m³/ha**		**5-6 m³/ha**		**10 m³/ha**	
	formation (m²)	% of cover	formation (m²)	% of cover	formation (m²)	% of cover	formation (m²)	% of cover
Road and track network for 1,000 ha	(5)		(6)		(3.67)		(4)	
Main roads (km)	150,000 (5)	1.50	180,000 (6)	1.80	110,000 (1.83)	1.10	120,000 (2)	1.20
Secondary roads (km)	50,000	0.50	60,000	0.60	18,300 (5.5)	0.18	20,000 (12)	0.20
Second haul skid runs (km)	- (80)	-	- (60)	-	19,250 (90)	0.19	42,000 (100)	0.42
First haul skid runs (km)	280,000	2.80	210,000	2.10	315,000	3.15	350,000	3.50
Landings	20,000	0.20	20,000	0.20	20,000	0.20	20,000	0.20
Total	**500,000**	**5.00**	**470,000**	**4.70**	**482,550**	**4.82**	**552,000**	**5.52**

Table II.
Canopy opening area and forest richness.

Forest richness (m^3/ha)	5	10	15
Number of trees logged	0.5 to 1	1 to 2	1.5 to 3
Canopy opening (m^2/ha)	62 to 125	125 to 250	190 to 375
Corresponding % of cover	0.62 to 1.25	1.25 to 2.5	1.9 to 3.75

It can therefore be reasonably imagined that only part of the crown will create a durable gap in the canopy. We have estimated it to be 50% of its area.

Depending on forest richness per hectare, the areas involved would amount to (table II).

The gaps caused in the forest cover after felling of the logged trees therefore always remain less than 4%, and are probably around 2% for a forest of average richness.

Recap

The following table III provides a recap of the different effects of timber logging on forest areas in African or American dense tropical rainforests.

Timber logging is therefore only directly responsible for the destruction of 5.5 to 8.5% of the forest cover. Yet these figures should be considered as maxima due to the relative and partial canopy opening caused by the construction of skid runs, which does not affect the dominant storey.

However, one might object that the general rule in average to rich forests is to proceed with several successive logging rounds, usually two or three, between 5 and 10 years apart (table III).

These successive logging rounds under the permit enable gradual use of the existing material depending on how transportation conditions evolve, and on trading conditions. Some species of lesser value or secondary choices that were not harvestable during the first round as they were not profitable, will become so thereafter.

In all, the volume removed may therefore reach 30 to 50 m^3 per ha in rich forests.

Deforestation due to roads and skid runs can be considered as a constant, because any resumed logging operations will make maximum use of the infrastructures created beforehand. Only a few additions will be made to the existing first haul skid runs, and given the overestimation of their importance in the previous calculations, this variation can be considered as negligible.

However, successive felling operations will proportionally increase the number and size of the gaps. For instance, for a second round harvesting 10 m^3 per ha, the corresponding canopy opening will be 2% on average, and it will be likewise for any third round.

The accumulation of these successive logging operations thus leads, in the case of rich forests, to total canopy opening that can reach 12 to 16%.

Of course, this accumulation presupposes that the forest does not evolve after the first harvest and at least partial reconstitution of the cover in the first felling gaps does not take place. Yet, on the contrary, it would seem[3], that windfall gaps in tropical rainforests lead to a rapid reaction of the environment, giving rise to a dynamic phase of biomass reconstitution. The principle whereby harm done by felling gaps is accumulated over time could therefore be judged pessimistic.

Consequences of commercial logging in the rainforests of Southeast Asia

The way in which logging affects the forest may be more brutal when it takes on a more intensive nature due to very high commercial potential, which is the rule in certain other tropical regions, especially Southeast Asia.

However, even under these extreme conditions, selective logging only leads to temporary disturbance of the environment, which is quickly cancelled out by restoration of the forest cover. This is, at least, what is revealed by the eyewitness accounts reported below.

3. Tropical Trees and Forests – An architectural analysis, F. Hallé, R. A. A. Oldeman, P. B. Tomlinson.

Table III.
Rate of cover destroyed depending on the logging method.

	Percentage of cover destroyed			
Logging method	**Single-phase hauling**		**2-phase hauling**	
Forest richness (m^3/ha)	8-10	15	5-6	10
Base camp installation Construction of road and track networks Felling gaps	0.03 to 0.06 5 1.25 to 2.5	0.03 to 0.06 4.7 1.9 to 3.75	0.03 to 0.06 4.8 0.62 to 1.25	0.03 to 0.06 5.5 1.25 to 2.5
Total	**6.28 to 7.56**	**6.63 to 8.51**	**5.45 to 6.11**	**6.78 to 8.06**

In a remarkable overview entitled: "Deforestation and its ecological implications for the rainforests of Southeast Asia", yet to be published, Professor E.F. Bruenig, from the Institute of World Forestry in Reinbeck, studies the effects of commercial logging on tropical rainforests and quotes two examples of the apparent destruction of this type of forest, its recovery, and the economic implications for the rainforests of Southeast Asia. He writes that:

- the extinction of species resulting from logging, contrary to what some scientists believe, seems to him to be "*most unlikely except perhaps in very large-scale exploitation of the complete phytomass which completely destroys the habitat for epiphytes and shade-plants*",
- as regards erosion, the hydrological properties and biological activity of the soil, Bruenig quotes Hamilton (Queensland, 1983) who feels that "*those portions that are logged rather quickly return to a pre-logging hydrologic regime as the forest regenerates and a full canopy is restored*",
- moreover, the same evolution was seen in the MAB International Pilot Project in the Amazon where clear-felling plots "*have shown only short-term initial losses which stopped as the original vegetation quickly redeveloped*",
- the same author then cites a striking example of a tropical rainforest in Kalimantan. He writes that:

"*Another example refers to the alluvial forest of great height on the banks of the Melinon and Terikan rivers. In the mid-19th century (Spenser, 1858) the vegetation of the land occupied by this forest was described by botanists as rice fields and young secondary growth.*

I visited the zone in question in 1958, with Spenser's book in my hand. At that time, the vegetation already looked like virgin forest and gave me the impression of being very old secondary forest. Twenty years later, the same place was sampled and considered as primary forest by some botanists of a recent Royal Geographical Society Expedition. (In other places) the natural succession after two years of dry-rice cropping produced a dense forest of over 20 m in height and about 150 t per hectare, in about 20 years".

Nonetheless, the author warns us "*However, deforestation on sites with lesser reproductive vitality will not be as quickly repaired, as shown by the vast areas of irreversibly degraded areas of white sand savannahs*".

The author concludes that the main two causes of true deforestation would appear to be:

- shifting cultivation and livestock farming and their slash-and-burn soil colonization techniques, often following in the footsteps of logging operations,
- the excessive use of farming land due to a lack of available areas, caused by structural and social reasons.

Conclusion

Although I never consulted Professor Bruenig about the conclusions he drew on the rainforests of Southeast Asia, they tallied with our conclusions regarding African or American dense rainforests, despite those in Southeast Asia being much more intensively logged.

Photo 4.
Installation of farming in a logged forest area.
Photo J. Estève, 1983.

It seems clear that, except in particular cases, the destruction or damage caused to forest areas by timber logging in dense tropical rainforests does not threaten the longevity of the forests and preserves the forest ecosystem.

The economic value of the concession will decline but, in virtually all cases, its biological and ecological value will remain largely intact.

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