

FOREST ECOLOGY ON JAVA: CONVERSION AND USAGE IN A HISTORICAL PERSPECTIVE

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Received January 1990

SMIET, A.C. 1990. Forest ecology on Java: conversion and usage in a historical perspective. The global scope of the discussion about conversion of tropical rain forest is new, but in some regions deforestation is an old problem. Environmental impacts of deforestation on Java have been noted 150 years ago and measures to mitigate these impacts have been debated for at least 100 years. The Javanese forests have diminished gradually by conversion until last century, when this process accelerated in line with population increase and in response to economic interests. Although many groups and individuals at the time called for a halt to forest conversion and proposed measures to retain and restore forest cover, colonial forest policy was slow in recognising other forest values besides timber production. It lasted until 1927 that forest policy actively pursued protection of hydrological resources by forest management and reforestation. Forest management for the protection of nature conservation values was not effective until 1967. Natural forests now cover only 7.6% of Java. Large areas of forest are degraded by past and ongoing use to fulfill local needs for forest products. Forest policy presently aims at finding a balance between on the one hand production, conservation and hydrological protection functions of the forest, and on the other hand the needs of the local population.

Key words: Forest ecology - forest conversion - forest use - forest degradation - deforestation - forest policy - human impact - Java - history

Introduction

Deforestation and disappearance of tropical rain forest claims world wide attention at the moment. It often appears as if this topic is new and under discussion for the first time. The global scope of the debate is certainly new, but at regional levels deforestation is an old problem which has in the past been the subject of heated discussion between government officials, private business and foresters. Deforestation and subsequent environmental impacts on Java have been noted 150 years ago and have influenced government policy for at least one hundred years.

The Indonesian island of Java is one of the most densely populated areas in the world. In 1987 the total population was 103,748,000 in an area of 132,187 km² (Java and Madura combined). The population density is 783 persons km² and the annual growth rate is 1.81%. Discussions on forest values and on the environmental effects of deforestation on Java (soil erosion, hydrological problems, nature conservation) started in the second half of the nineteenth century and were often accompanied by pleas to

maintain and improve forest cover (Junghuhn 1850-1854, Holle 1866, Schermbeek 1880, Cordes 1888, Ham 1894, Altona 1914). At present many authors, for example Harjono (1986), Repetto (1986) and Donner (1987), consider deforestation a result of high population pressure, and perceive the lack of forest cover as one of the main causes of erosion, flooding and water shortages.

This paper describes and analyses past forest use and management in relation to ever growing population pressure, with emphasis on the non-teak forests, meaning natural forest and non-teak plantation forests. While natural forests once covered the whole island, now they cover only 7.6% of the area. At present the total area administered as forest land is 30,130 km^2 or 22.8%, one third natural forest and two thirds man made plantations. The major problem confronting forest managers at present is forest degradation as a result of past and ongoing exploitation by the rural population; forest products as timber, firewood and fodder are much in demand to fulfill subsistence needs (Soekiman & Wahjoedi 1980, Wirjodarmodjo & Bratamihardja 1983). Without a historical perspective the present forest conditions on Java cannot be fully understood.

Natural forest is meant here in contrast with man made forest. It is not always untouched by anthropogenic influences, but it has originated as the climax vegetation under strictly natural conditions. The term forest refers to forest as vegetation type, while the term forest land refers to an administrative area not necessarily forested.

Forest use and forest conversion

Early history

Java has been populated by man and its hominoid ancestors for at least one million years. Bellwood (1985) suggests that Java was occupied by bands of small and gracile Australoid hunters and collectors unto the first millenium B.C. Then migrants arrived from Asia's mainland and gradually agriculture and settlements developed, probably at the expense of lowland forest in coastal areas. It is improbable that man had a profound influence on the forest until the beginning of our era.

In the first millenium A.D. the complex societies evolved which are associated with irrigated rice cultivation. This type of cultivation requires not only the skills of iron technology (tools) and animal husbandry (water buffalo), but also a sophisticated organisation to provide and distribute irrigation water (Bellwood 1985). Local population centres developed which later gave rise to a series of Hindu and Buddhist kingdoms in various parts of Java. Amongst other achievements, these highly developed civilisations have built the temples of Borobodur and Prambanan in the ninth century A.D. These temples lie about 40 km from the coast in south-central Java, illustrating the fact that cultivation (and hence forest clearing) had made inroads into the interior. During these centuries, large stretches of lowland forest must have

been cleared in the alluvial coastal plains and in the broad intervulcanic plains of the interior. Where irrigated rice cultivation was not possible, settlements were based on rain fed agriculture and shifting cultivation. Forest conversion was not limited to the lowlands, since sporadic settlement occurred in remote valleys and mountain plateaus to avoid political unrest and the frequent wars fought between the kingdoms in the plains. The many relics of Hindu temples on most mountains indicate frequent ascents to Java's highest peaks. It is not likely, however, that these religious activities caused disturbance to the montane forest, except perhaps in east Java, where, in contrast with ever wet west Java, the montane forest is highly susceptible to burning in the dry season. It is conceivable that the large areas of *Casuarina* forest, a fire-climax forest dominated by *Casuarina junghuhniana*, which presently clads the upper slopes of most mountains in east Java, had their origin from fires unintentionally started by Hindu pilgrims hundreds of years ago.

In the fourteenth and fifteenth century Islam spread rapidly throughout Java. To escape unrest many people fled to the mountains where they settled and maintained their traditional culture. Around 1300 A.D. the Dieng plateau in central Java was inhabited and largely deforested (Junghuhn 1850-1854). Other examples are the tribes of the Baduy and the Tengger people who settled in mountainous areas in respectively west and east Java in the fifteenth century, and have maintained their traditional values up to the present day. These occasions were probably the first where locally large scale clearing of montane forest took place to sustain rain fed agriculture.

The colonial period

The history of forestry in colonial Java has been described in some detail by Boomgaard (1988). The first European colonisers in the sixteenth and seventeenth century encountered many population centres along the north coast of Java and were compelled to trade with well developed political and economical structures. These early colonisers described large areas of teak forest (*Tectona grandis*) along the north coast of central and east Java. Altona (1923) estimated their total area at 1 to 1.5 million ha. The origin of teak on Java and of these forests has been much debated. Altona (1922 & 1923) presented evidence for the introduction of teak by Hindu migrants, probably as early as 200 A.D. He also proved that at least some of these extensive teak forests had been planted around 1600. To date, the debate on the origin of Javanese teak forests has not yet been completely resolved, but Boomgaard (1988) cites new evidence that supports Altona's views. If these views are indeed correct, it means that natural (lowland) forest had been replaced by teak forests at a large scale long before the start of the colonial period.

The teak forests were under heavy exploitation pressure throughout the sixteenth, seventeenth and eighteenth century. Many reports then warned

against continuous over exploitation, but the warnings went unheeded. Exploitation by the so called "blandong system" guaranteed traders and government officials a stable supply of cheap timber, even though the timber had to be extracted and transported from increasingly remote areas (Cordes 1881). Other trade products originating from the forests included rattan, bamboo, wax (from *Ficus* species), fibres for rope production (from *Arenga* spp.) and materials for medicinal purposes (Zwart 1937).

Large scale settlement and intensive cultivation of the Javanese uplands are a relatively recent phenomenon restricted to the last 200 years. Raffles (1817) estimates that 85% of Java was still "in a state of nature", presumably forest. Junghuhn (1850-1854) is the first author to describe forest clearing in the mountains and to show concern. He gives examples of large scale deforestation in several parts of Java, taking place in the years between 1785 and 1840. He cites exploitation for fuelwood and the conversion into coffee plantations or settlement areas as the most important causes of deforestation. Junghuhn is also the first author to describe large stretches of grassland, both in mountain and lowland areas, and to attribute their existence to deforestation and subsequent regular burning. Travelling all over Java and exploring all mountains, Junghuhn has given detailed descriptions of their respective vegetation cover. Although he does not give quantitative estimates, his work make clear that at the time the lower slopes of most mountains were cultivated, that the forest on some mountains had been cleared almost to the summit (Gunong Merbabu, Gunung Sindoro and Gunung Sumbing, all in central Java) and that the montane forests in east Java regularly suffered from man induced burning. In contrast, Junghuhn also gives vivid descriptions of lowland and mountain vegetation in an apparent undisturbed state.

Palte (1984) has studied the development of Java's uplands and distinguished three periods in which waves of settlers moved into the uplands and converted forest into cultivated land:

- the first period was between the end of the eighteenth century and 1830: people fled the system of forced labour and taxation imposed by the colonial regime. In the decades after 1830 the effectively organised colonial administration discouraged people from opening up new land;
- the second period lasted from 1860 - 1925: during this period government policy aimed at improving upland productivity and stimulated the conversion of forest into arable land. Rain fed agriculture and the cultivation of cash crops in estates (coffee, tea, rubber *etc.*) encouraged the settlement of farmers and plantation workers in all parts of upland Java. In 1915 the total area of estate plantations in the mountains of Java was estimated at 3,600 km^2 (de Graaf & Stibbe 1918). This wave of upland settlement diminished gradually after 1920, when suitable land became scarce and when the government started to enforce forest protection measures; and

- the third period lasted from 1942 until 1950; the enforcement of government policies collapsed under the Japanese occupation and, was followed by subsequent unrest with the independence struggle.

From the first half of this century many Forest Service reports indicate large scale forest abuses in all forested areas of Java. Local people frequently practice illegal cultivation on forest land. Theft of timber and fuelwood, grazing by domestic animals frequent man induced forest fires affect plantations and natural forest (Altona 1914, Jelen 1928, Burger 1930 and many others). This type of forest abuse reportedly resulted in degradation and disappearance of natural forest in gazetted forest areas. Between 1929 and 1940 the annual reports of the Forest Service reported the conditions of protected natural forest areas on Java in three categories: deforested, insufficiently forested and densely forested. These reports invariably link forest destruction to abuse by the local population, taking place in spite of protection efforts. Table 1 summarises these data and shows that, while the area of protected natural forests increased slightly (by assigning the protected status to hitherto unprotected areas, see policies), the proportion of dense forests declined to a mere two thirds of the total area. When the two categories of deforested and insufficiently forested areas combined, it appears that the natural forests were affected by abuse at a rate of around 20,000 *ha* *y*⁻¹.

Table 1. Natural forest conditions in protected areas between 1929 and 1940 (Annual Reports of the Forest Service)

Year	Total protected forested area (<i>ha</i>)	Deforested		Insufficiently forested		Densely forested	
		<i>ha</i>	%	<i>ha</i>	%	<i>ha</i>	%
1929	1,627,138	158,756	9.8	242,665	14.9	1,225,717	75.3
1931	1,660,408	162,174	9.8	293,554	17.7	1,204,680	72.5
1935	1,763,738	166,110	9.4	328,447	18.6	1,269,181	72.0
1940	1,858,680	203,829	11.0	413,534	22.2	1,241,317	66.8

The present situation

The present (1986) forestry situation on Java is shown in Table 2. Forest use and management problems are reviewed by Wirjodarmodjo *et al.* 1983.

Table 2. Present forestry situation on Java (BPS 1988)

Forest type	Area (<i>km</i> ²)
Natural montane forest	5,990
Natural hill forest	1,872
Natural lowland forest	2,128
Subtotal natural forest	9,990
Teak production forest	10,697
Non-teak production forest	9,443
Subtotal production forest *	20,140
Total forest land	30,130

* on Java production forest comprises only plantations

The presently remaining forests on Java are under strict supervision by the Forest Service. Every forest area now has a legal status and is managed accordingly. Administrative boundaries are fixed and marked in the field. Although there is locally still pressure to convert forest into arable land, it is unthinkable that this will happen, except in case of minor boundary corrections. Shifting cultivation has disappeared altogether. Local people, however, continue to use the forest, plantations as well as natural forest, to meet subsistence needs for timber, fodder and firewood. Also game hunting and collection of fruits, tubers and traditional medicine are commonly practised. Locally livestock grazing is a severe problem. Wood cutting for timber and fuelwood locally has a large impact on the forest: newly established plantations fail, older plantations suffer from wood theft (Wiersum 1978, Soekiman *et al.* 1980, Klop & Ogtrop 1985) and natural forests undergo a degradation process (Smiet 1989). Fires regularly affect forest lands in the dry season; they are often lighted intentionally for purposes of hunting or pasture improvement. It appears that marginal socio-economic conditions and the lack of alternative livelihood opportunities compel local people into forest use, whether legal or not (Nibbering 1989, Smiet 1989). Such uncontrolled use has already led to severely degraded forest land, not covered with trees any longer, but with grasses (*Themeda* sp., *Imperata cylindrica* etc.) or with shrubs (*Melastoma* sp., *Lantana camara*, *Eupatorium* spp.). The extent of such degraded forest land is now 80,668 ha (BPS 1988).

Forest management policy

Policies

Although government control had been firmly established on Java for many centuries, there has been no management policy on forests, which, with exception of the teak forests, were considered a nuisance rather than an asset. It was not until the second half of the eighteenth century that some local officials started to plant teak, spurred by the dwindling supply of timber from the over exploited teak forests. Governor Daendels initiated the first regulations on management and exploitation of the teak forest in 1808 (Boomgaard 1988). However it was not until the middle of the nineteenth century that management of the teak forests became effective. The blandong system had been abandoned by then and the supply of timber had dwindled, while the need for wood was growing with the increasing population and expanding infrastructure (railroads) and industry (sugar factories).

In 1849 the first professional foresters arrived and in subsequent years the Forest Service gradually came into being. All management efforts were aimed at production increase of the teak forests devastated by centuries of over exploitation. In the first Forest Law of 1865 all forests were declared government property and were divided into:

1. teak forests under controlled management;

2. teak forests not under controlled management;
3. all other forests.

The regulation aimed solely at the provision of a stable timber supply from teak forests. Management activities concentrated on planning and supervision of exploitation (which was in fact carried out by private companies), guarding against wood theft and replanting of clearcut areas (Cordes 1881). Neither in the law, nor in effect was there any attention for the natural forests. The second Forest Law of 1874 also emphasised production of teak timber and brought all teak forests under controlled management. However, this second law marked an important step forward by pointing to the values of natural forest. Based on the emerging views in Europe, mainly Germany and Switzerland, the regulation mentioned explicitly the climatological and hydrological values of montane forests and the threats of its conversion (Lugt 1930). Management activities in subsequent decades, however, were totally concentrated on production of teak and the expanding Forest Service continued to ignore natural forests. Overall government land use policy in this period was aimed at an increase of agricultural productivity and was based on the 1874 "Land Clearance Act" (Ontginnings Ordonnantie), which significantly stimulated conversion of natural forest into arable land.

The third Forest Law of 1897 was considered a step back with respect to the preservation of natural forest (Lugt 1930). The law emphasized the production function of natural forests in providing fuelwood for local industries (at the time there was an acute shortage of wood for the rapidly expanding railways and sugar industries) and legalised the large scale conversion of montane forest into plantations (which in effect had already taken place for many years). Forests were now divided into:

- teak forests, which were by now all under controlled management;
- non-teak forests to be preserved for reasons of production and protection of "climatological and hydrological values"; and;
- non-teak forests not to be preserved.

Forest management and the production of teak remained the first priority of the forest service. Very little attention was paid to forests of the second category and then only in so far production was involved. No guidelines were given for management of natural forests with respect to protecting their hydrological values.

There was no attention for the third category of forest. Although government property, these forests were considered worthless and its land was readily transferred to anyone interested: to local people for settlement and cultivation, and to entrepreneurs for exploitation or conversion into plantations. The annual reports of the Forest Service from this period virtually ignore natural forests and only mention their continuous decrease due to reclamation. It is not until 1912 that the first estimates are given: 940,000 *ha* of forest to be preserved and 1,486,300 *ha* of forest not to be preserved. This amounts to a total of 2,426,300 *ha* of natural forest.

The Forest Law of 1913 did not bring any significant changes in legislation with respect to non-teak forests. Although so far forest management policy appeared totally preoccupied with teak production, some foresters had recognised the negative effects of the ongoing deforestation in the mountains and attempted reforestation of denuded slopes in their districts. Until 1901 about 12,700 *ha* were reforested mainly in two districts (Lugt 1930). It was only after heavy pressure from lowland industries and agriculture, complaining about the shortage of wood and the erratic irrigation water supply, that the Forest Service undertook efforts to manage natural forests in which a thorough inventory was made of the needs for reforestation to improve the hydrological situation was Altona (1914), who examined the Brantas watershed in east Java. Altona recommended the reforestation of at least 10,000 *ha*, but Lugt (1930) had to conclude that in 1930 only about 1000 *ha* of plantations had actually been realised. A special "Reforestation Commission", sponsored by the sugar industry, finally succeeded in convincing the Forest Service that large scale reforestation was essential (Reboisatie Commissie 1931). Lugt (1933) gave an overview of reforestation efforts with non-teak species: until 1929 a meagre 62,502 *ha* had been planted, mainly with native species, such as *Altingia excelsa*, *Schima noronhae* and *Quercus* species.

The Forest Law of 1927 contained many regulations and guidelines for the preservation of non-teak forests. This was the first time that forest values, other than wood production, were explicitly taken into account in management guidelines. The Forest Service on Java was split into a branch for the exploitation and management of the teak forests and a branch for exploitation and management of the non-teak forests. This second branch was also made responsible for the delineation and management of hydrological protection forests and for reforestation of bare forest land. In 1938 this non-teak forest branch was again abolished in a reorganisation, but in the short time of its existence it carried out its task energetically. By 1940 a total of 128,393 *ha* of non-teak plantations had been established (Schuitemaker 1950) and 1,941,013 *ha* of non-teak forests had been delineated and gazetted.

Table 3 gives an overview of the non-teak forest reduction between 1898 and 1937. These figures include the areas of non-teak plantations established under the reforestation policy (see Reforestation). It appears that, in spite of reforestation efforts, about 2.2 million *ha* of natural forest has been reclaimed in the period between 1898 and 1937. This figure corresponds well with the land use data compiled by Palte (1984), who reported an increase in agricultural land use (smallholder and estate land) from about 3.2 million *ha* in 1898 to about 5.3 million *ha* in 1938. In 1937 all remaining non-teak forests on Java received a legally protected status and could not be reclaimed anymore. In subsequent years the area of non-teak forests increased slightly due to reforestation.

Table 3. The reduction of non-teak forests between 1898 and 1937, based on van der Haas (1898) and annual Forest Service reports

Year	Area of non-teak forest (ha)
1898	4,000,000
1911	2,426,300
1915	2,139,800
1919	2,258,760
1929	2,220,862
1936	1,821,055

The period between 1942 and 1950 was one of political upheaval. First came the Japanese occupation during the Second World War and then came the struggle for Independence. Forest management all but collapsed. When the Forest Service started to function again in 1951 many problems were encountered with forest destruction, illegal occupation of forest land, serious wood theft and uncontrolled grazing. It was estimated that approximately 500,000 ha of forest had been destroyed (Soesilo 1954) or about 17.9% of the total prewar forest land area of 2,800,000 ha (including teak forests). In the following years most occupied forest land was brought under government control. Forest cover was largely restored by reforestation (see Reforestation).

Nature conservation

Parallel with the pleas to halt deforestation for hydrological reasons, in the second half of last century voices were raised to conserve forest to protect rare species. In 1889 the first conservation area was established on the slopes of the Gunung Gede in west Java. In 1912 the Netherlands-Indies Society for Nature Protection was created by concerned civilians. The colonial government recognised the society officially in 1916 and assigned it an advisory role in all matters of nature conservation (Kies 1935). Management however, remained with the government, partly with the Forest Service and partly with the regional governments. Most nature reserves on Java were surveyed, proposed and gazetted before 1940, mainly on instigation by the society. Until 1967 management dealt with administrative matters only, and very little was done in the field. Consequently many conservation areas deteriorated and some disappeared altogether (MacKinnon *et al.* 1982). The Forest Law of 1967 gave the first firm legislative basis to nature conservation and assigned management responsibilities. In 1969 a special section of the Forest Service was set up to deal with administration, planning and management of conservation areas. In the following years this section has grown to a substantial organisation at Directorate-General level within the Forest Department with field offices and personnel throughout Java and elsewhere in the country. The main management problem in conservation areas on Java is disturbance by uncontrolled use, including tree cutting and poaching.

Reforestation

Large scale reforestation efforts on degraded forest land started in the 1920s. Until 1940 a total of 128,393 *ha* had been reforested, of which 95,000 *ha* in the period between 1920 and 1940 (Schuitemaker 1950). After 1950 the reforestation policy was resumed with new vigour and in the period between 1951 and 1985 an average of 20,000 *ha* of non-teak plantations were established per year (Departemen Kehutanan 1986). In contrast to the colonial period, the species planted now included *Swietenia macrophylla*, *Pinus merkusii* and *Agathis damara* as the most important species. These plantations were established in all areas where restoration of forest cover was deemed essential for reasons of watershed protection. Such areas included grassland, shrubland, abandoned estates and abandoned agricultural land all over Java. Besides protection the production of timber and pulpwood for commercial purposes was (and is) another important function of these plantations. The total area of non-teak plantations is at present 9,443 *km*² (Table 2).

Outline of present policy

The main policy guideline for forestry on Java is that at least 30% of the island's surface should be under forest cover. Enforcement of this policy would require an expansion of the forest area from the present 3 to 4 million *ha* (Table 2). Although actively pursued by the Forest Department, achievement of this long term goal is unlikely because of conflicting land use demands from other departments. This and other policies for forest development on Java are outlined by Wirjodarmodjo *et al.* (1983).

At present two agencies of the Forest Department are responsible for the management of natural forests on Java. The first is Perum Perhutani (State Forestry Enterprise), whose main task is to manage Java's plantation forests in a semi-commercial way. Another task is to manage 555,000 *ha* of natural forest as protection forest, which is mostly situated on the upper mountain slopes. Its management activities consist mainly of guarding and patrolling against illegal activities which may threaten the forest. The second agency is the Directorate-General of Nature Conservation (PHPA), responsible for the management of conservation areas, totalling 444,000 *ha* of natural forest on Java. These include some of the remnants of lowland forest (< 500 *m*; total 126,850 *ha*), while the remainder is mountain forest (> 1000 *m*). PHPA activities include, besides guarding and patrolling, also visitor management: guiding visitors and providing them information on conservation values. With respect to natural forest the management priority of both agencies is to maintain the *status quo*, one agency acting from a hydrological protection perspective, the other from a nature conservation perspective.

In dealing with the pressure from local people to exploit forest resources (see The present situation), both agencies experiment with various

methods. It has been realised that guarding and patrolling is not enough to deter people from entering the forest, if no alternatives are given to meet local needs for forest products (Soekiman *et al.* 1980, Wirjodarmodjo *et al.* 1983). Trials with buffer zone management, agroforestry and social success (Soekiman *et al.* 1980, Nibbering 1987, Wiersum 1982, Wirjodarmodjo *et al.* 1983). Also outside the forest land much attention is given to tree planting for multiple purposes: erosion control, reclamation of degraded land, soil improvement and provision of timber and fuelwood.

Deforestation in relation to population increase

An attempt to estimate the original forest habitats on Java has been made by MacKinnon *et al.* (1982). Three broad forest categories were distinguished: montane forest (altitude > 1000 m), hill forest (altitude 500 - 1000 m) and lowland forest (altitude < 500 m; includes fresh water swamp forest, mangroves, beach formations, lowland rain forest and monsoon forest). The respective surface area of each category was calculated compared to the corresponding areas of presently remaining forest, which were estimated by interpretation of satellite imagery (Landsat).

The difference between MacKinnon's estimates of presently remaining forest (Table 4) and the official statistics of forest land (Table 2) is probably caused by the fact that on Landsat imagery the distinction between planted forest and natural forest is not always clear. Since most planted forests border on natural forest this might easily lead to an over estimate of the latter. The overall decrease of 91.1% is entirely attributable to human factors such as forest exploitation, shifting cultivation and forest conversion into other land use types. Volcanic eruptions and earthquakes have locally destroyed some forest, but this is negligible compared to man's impact. Only 8.9% of the original natural forest is still left and most of this is montane forest (6,875 km²). Only 2.5% of the original lowland forest is presently left. The remaining lowland forest, not counting small isolated patches, has survived in three areas only, largely because some factors limited their suitability for cultivation: lack of water (Baluran in northeast Java), poor soil fertility and frequent water shortages (Blambangan in southeast Java) and destruction by natural disasters (Ujung Kulon in southwest Java, where settlements were wiped out by the Krakatau eruption of 1883). In all three areas cultivation has been tried unsuccessfully. At present they are the most important conservation areas on Java (MacKinnon *et al.* 1982).

Table 4. Reduction of natural forest habitats on Java; areas in km²
(after MacKinnon *et al.* 1982)

	Original natural forest (km ²)	Remaining natural forest (km ²)	Percent reduction %
Montane forest	12,130	6,875	43.3
Hill forest	10,990	2,149	80.4
Lowland forest	109,067	2,730	97.5
Total	132,187	11,754	91.1

No quantitative data are known about the population size of Java in the past. The first estimate from 1781 was about two million (Departemen Kehutanan 1986). In previous centuries the population growth had been curbed by disease outbreaks and wars. A reliable estimate is given by Raffles (1817) who organized a survey in 1815. He arrived at a figure of 4,615,270. Another reliable estimate for the nineteenth century (1847) sets the population at 9.5 million. Around the turn of the century there were about 30 million people, in 1950 50 million, in 1961 63 million and at present more than 100 million (BPS 1988).

In Figure 1 an attempt is made to depict the decrease of Java's forests over time. The figure covers the period from 1600 A.D. until the present situation as given in Table 2. The forest area in 1600 A.D. has been estimated and it has been assumed that up to then only lowland forest had been converted.

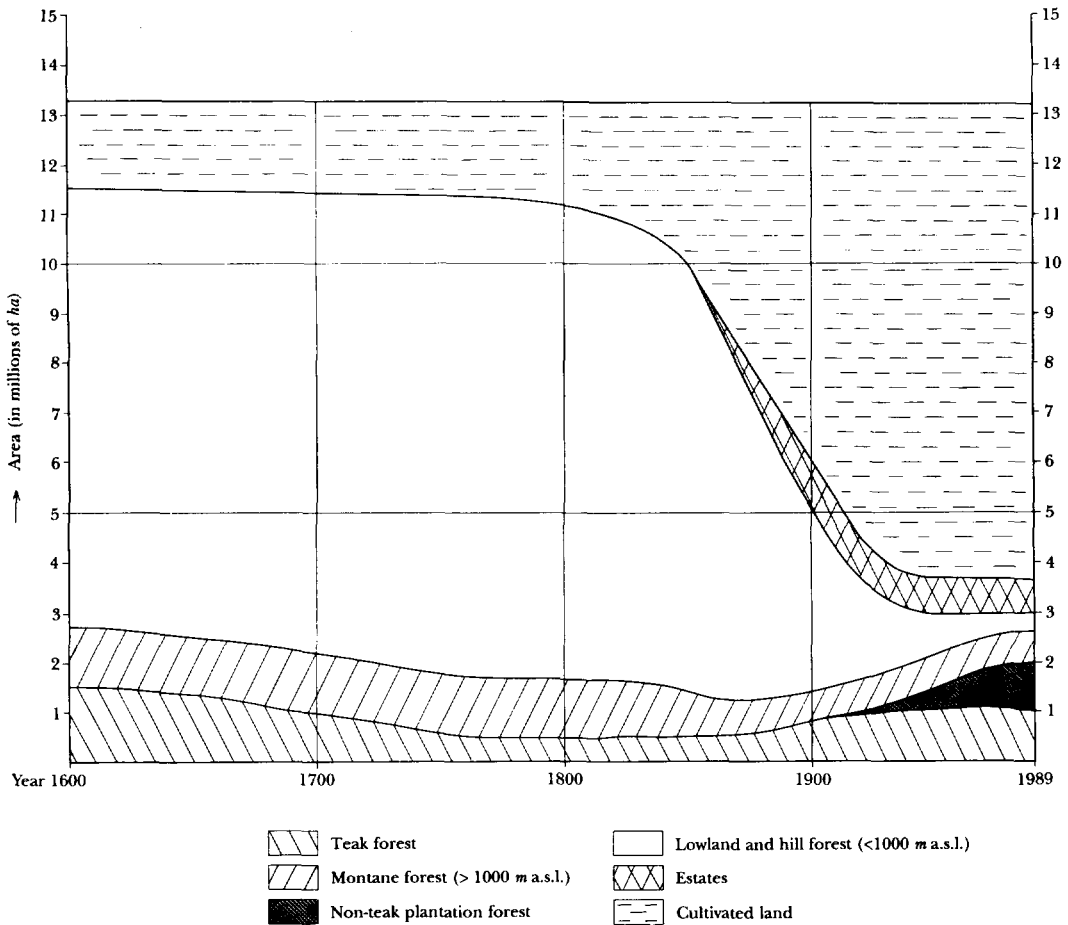


Figure 1. Decrease of forest land and change of forest types on Java from A.D. 1600 to the present

Discussion

Forest management in the colonial period was directed towards exploitation of teak forests only until the end of last century. Other aspects of forestry were largely ignored. Management policies throughout the history of Java can be described as policies guided by economic interests. From the sixteenth until the nineteenth century it was the pressure of traders to maintain a stable and cheap supply of timber. In the nineteenth century it was the demand for land by local people and by business for the growth of cash crops in estates. In the early part of the twentieth century conflicting interests arose, when farmers demanded a stable water supply for irrigation and industries needed wood. These demands originated from the environmental effects of deforestation (erosion, hydrological problems) and required a drastic change in forest management from exploitation-oriented to preservation-oriented. Management policy then tried to balance these conflicting interests by on the one hand allowing forest reclamation to continue, and on the other hand by undertaking reforestation efforts. It was not until 1937, when the area of natural forests had already dwindled to its present level of < 1 million *ha*, that a clear preservation policy was chosen that prohibited further forest reclamation. Vigorous reforestation efforts have since expanded the plantation forest area to about 2 million *ha* (teak and non-teak). In addition to wood production these plantations serve the watershed protection function, that was previously guarded by natural forest.

Forestry policy by the colonial government has in particular been influenced by the general notion that deforestation caused hydrological problems, although at that time the relation between forest cover and hydrological regime was far from clear. In the period between 1915 and 1930 Dutch scientists debated the value of reforestation efforts in restoring or maintaining the hydrological values of montane forest. One party maintained the view that hydrological values (quantity, quality and stability of river flow) were mainly determined by geological conditions and soil properties, while the other party propagated the "sponge theory" which regards forest cover as the best regulator of river flows. After much debate, hampered by the lack of data, the sponge theory was accepted. This and the creation of a non-teak forest branch of the Forestry Service formed the basis for the practical management of natural forest and for the establishment of forest plantations throughout Java to guard hydrological values. In view of the recent discussions about the influence of forests on hydrology, it now appears that the reforestation policy was a right one, albeit defended with the wrong arguments (see for example Hamilton & King 1983, and Smiet 1987).

Not much is known about the rate of deforestation on Java, but, as depicted in Figure 1, it was most likely a slow and gradual process until the beginning of the nineteenth century. Then the rate accelerated and reached a high at the end of the nineteenth century and the beginning of the

twentieth. Data in Table 3 suggest that between 1898 and 1911 about 1.5 million *ha* forest has been converted at a rate of about 3% per year. In the last 50 years the total extent of forest land has not changed significantly, although the population explosion on Java continues. This is caused on the one hand by the firm government commitment to maintain forest cover, and on the other hand by topographical factors such as the difficult accessibility and steepness of remaining forest areas, rendering the land unsuitable for other land use.

The forest area quotations in this paper need some scrutiny. All figures from before 1912 are rough estimates and are not based on comprehensive field measurements. Later the colonial Forest Service measured the extent of plantation forests accurately, but only estimated the extent of natural forest areas. The figure of 4 million *ha* of natural forest for 1898 reported by de Haas (1898) is rather crucial because it determines the decrease of natural forest as reported in Table 3. Also the figure of 4 million *ha* of natural forest corresponds with the available land use statistics as reported by Palte (1984). His data show that at the end of the nineteenth century a maximum of 6 million *ha* of land was cultivated, leaving 7 million *ha* for non-cultivation types of land use. Teak forest covered less than 1 million *ha* at that time. Assuming that other land use (built-up areas, fish ponds, lakes *etc.*) took up 2 million *ha* (in 1986 approximately 3 million *ha*; BPS 1988), about 4 million *ha* remains. Modern forest statistics are also not completely reliable: for the province of west Java, for example, various government agencies provide data on forest land use that are 10 to 20% lower than the official forestry data. The data used here are quoted from the government Statistical Office (Biro Pusat Statistik). They seem to correspond with the estimates of MacKinnon *et al.* (1982), based on interpretation of satellite imagery (Table 4).

A second issue related to the interpretation of forest statistics concerns the matter of forest quantity (extent of forest land) *versus* forest quality (vegetation type and structure). All quoted figures concern administrative forest land, but not all of this land was (or is) covered with trees. In the Kali Konto area of east Java, for example, it was found that of the 13,000 *ha* of natural forest land, in fact only 50% was covered with forest, the remainder being covered by shrub and woodland (Smiet 1989). Of the remaining forest 75% was classified as degraded (Smiet 1989). According to official statistics the extent of critical land inside forest land is now 80,668 *ha* (BPS 1988). In all parts of Java the remaining natural forest has been (and still is) subjected to human influences such as tree cutting, burning and grazing, but overall data on forest degradation are lacking.

Conclusions

Throughout history the forests on Java have gradually diminished by exploitation and conversion. Forest conversion began with population growth in the nineteenth century, and continued until 1937 when the forest area

approached its lowest level. Although the extent of forest land hardly changed between 1937 and present, the forests, plantations and natural forests alike, continued to be exploited, which has in the course of many years led to severely degraded forest stands. At present the forest areas on Java can best be described as "islands in a sea of crops".

All natural forest ecosystems on Java, although legally protected since 1937, have been subjected to a gradual process of degradation, which accelerated in periods of slack government control (1942 - 1950, 1960 - 1965). This degradation process is not new, since the Javanese people have always used forest products to fulfill subsistence needs: timber for construction, firewood, game hunting, collection of fruits and tubers, traditional medicine *et cetera*. Shifting cultivation has been widely practised in west Java, while man-induced fires have devastated montane forests in east Java for many centuries. Exploitation and fires continue to affect forests until the present day.

Population increase has certainly been the most important factor behind the large scale deforestation on Java. However, a second important factor has been (and still is) government policy. Up to 1850 the successive governments did not show any interest in forests other than the yields of teak forests. Until then deforestation was a spontaneous process, largely without government involvement. From around 1850 until 1928 the government actively stimulated forest conversion. Although the various forest laws since 1874 paid lip service to the protective functions of forest, government activities remained preoccupied with timber production and forest conversion. Between 1928 and 1937 forest conversion became strictly controlled and large scale reforestation efforts were undertaken. From 1937 until present the total extent of forest land has not changed significantly, which shows that a firm commitment to maintain forest cover actually works, in spite of a large population increase. Uncontrolled forest use remains a problem and forest policy now aims at finding a balance between on the one hand the production, conservation and protection functions of the forest, and on the other hand the needs of the local population.

Colonial foresters, with some exceptions, have been particularly slow in recognizing other forest values besides timber production. Concerns about deforestation were voiced, some as early as 1850, by individuals and groups from outside the Forest Service. It was not until 1927, with the formation of a special non-teak branch, that forest policy actively pursued the protection of hydrological resources by natural forest management and reforestation. With respect to nature conservation, the Forest Service left most planning and management activities to a private society and to regional governments. It lasted until 1967 before the Forest Service became effectively involved in conservation management.

It has been particularly in the field of nature conservation that the loss of Javanese natural forests have had great impact. Not only has the Javanese tiger gone extinct, the remaining natural forest conservation areas are so

small and isolated that the long term preservation of ecosystems (presently still with endemic forest-dependent bird, rhino and gibbon species) may be seriously questioned (MacKinnon *et al.* 1982).

Under the prevailing conditions on Java the greatest challenge for the Forest Service lies in developing a policy to accommodate the needs of local people with the requirements of sound forest management. The attention for agroforestry and buffer zone management is an important step in the direction of alleviating the pressure on the remaining forests in order to safeguard its multipurpose functions.

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