

A policy breakthrough for Indonesian farmers in the Krui damar agroforests

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In January 1998, Djamaloedin Soeryohadikoesoemo, Indonesia's Minister of Forestry from April 1993 to March 1998, signed an historic decree that established – for the first time in Indonesia – an official precedent for community-based natural resource management. Based on the minister's concept for a distinctive forest-use classification, 'Kawasan dengan Tujuan Istimewa' (KdTI), the new decree recognizes the legitimacy of community-managed agroforests on a significant area of State Forest Land.

This decree recognizes the environmental and social benefits of an indigenous land use system (damar agroforests), the role of indigenous institutions in ensuring the sustainability of this natural resource management system, and the rights of smallholders to harvest and market timber and other products from trees they planted. While the new KdTI area still is part of the State Forest Land, this classification is unprecedented in that:

- it sanctions a community-based natural resource management system as the official management regime within an area of the State Forest Land;
- it allows local people to harvest timber from within the State Forest Land;
- it allows limited harvesting of timber from within a watershed;
- it devolves the management responsibility of State Forest Land to a traditional community governing structure; and
- these rights are provided without a time limit.

The first KdTI area is in the heartland of the Krui damar agroforests in Lampung Province on the Indonesian island of Sumatra. Through a process developed by the Krui people a century ago, these agroforests begin with land clearing and planting of upland rice, which is followed by a succession of treecrops, including coffee, fruit trees, various timber species and damar (*Shorea javanica*), which produces resin as well as timber. Managed by a succession of farmers, these agroforests develop over a period of decades into complex, multi-strata agroforestry systems that replicate a number of forest functions, including biodiversity conservation and watershed protection. Satellite images indicate there are approximately 55 000 ha of these mature agroforests in Krui. The new KdTI area covers 29 000 ha of damar agroforests at various ages that fall within the State Forest Zone, with the balance being on private land.

At the invitation of the Indonesian Minister of Forestry, ICRAF and NGO partners the Tropical Nature Foundation of Indonesia, and the Family of Nature and Environment Lovers-Lampung worked closely with Forestry Department counterparts to identify and develop workable options for implementation of the Minister's KdTI concept in Krui. This effort benefited greatly from previous research on the ecological, social and economic functions of the Krui agroforests conducted by the Institut français de recherche scientifique pour le développement en coopération

(ORSTOM) scientists, some of whom are seconded to ICRAF in Southeast Asia. Subsequently, a research consortium grew that includes the 2 Indonesian NGOs, the University of Indonesia, the Centre for International Forestry Research (CIFOR) and the ICRAF/ORSTOM team. Results of research by this 'Krui Team' helped local farmers gain official recognition by documenting the myriad benefits of the damar agroforests as a resource management system. Since 1995, the research consortium has been working with Krui farmers to literally place their agroforestry systems on the map and to articulate the environmental and economic benefits of their system. Research and community organizations produced numerous maps and detailed descriptions and analysis of the Krui agroforests. In March 1997, the consortium conveyed requests from village leaders to the Minister of Forestry to begin a dialogue with government about the status of their lands. In June the consortium helped organize field visits from key government officials as well as a 2-day workshop to present research results and discuss the status of the land. The results of these activities were reported to the Minister of Forestry and, 6 months later, the ground-breaking decree was signed.

At least 7000 families in the KdTI area will benefit directly from the decree's official recognition of their rights. If this pilot effort is implemented successfully, the KdTI prototype may be applied in numerous other locations in Indonesia, with benefits for hundreds of thousands of households through poverty alleviation, improved resource management and reduction of social conflict. Indeed, this can be viewed as an effort by Minister Djamaloedin to address human rights issues arising from conflict over forestlands as well as the pursuit of environmental objectives and poverty alleviation. Until this decree was issued, the Krui agroforests were at risk because of the uncertainty of farmers' tenure status in the State Forest Land. A forestry company held the government-awarded right to manage this area, including the right to harvest an estimated 3 million commercially valuable trees planted by local people, who could legally be fined or jailed for establishing and managing their agroforests. In addition, local farmers expressed growing concerns over the uncertainty of their rights on the damar agroforests they planted and are currently managing. Many damar farmers adopted a 'wait and see' strategy and chose not to plant damar and fruit trees until they would know for sure that they will be able to harvest the benefits of their work. This uncertainty clearly endangered the very future of a system that is renowned worldwide as a rare example of successful and sustainable system for management of forest resources by a local community. Thanks to this new decree, damar farmers and their agroforests in the KdTI area should now be safe from such threats.

The Krui experience has gained the attention of researchers working on similar problems as far away as Cameroon. African scientists visited the Krui agroforests as part of the activities of the Alternatives to Slash-and-Burn Programme and expressed interest in the way the new policy will implemented in the hope that a similar process can be explored in Cameroon.

Damar agroforests in Krui (West Lampung, Sumatra)¹

¹ The following article is made up of parts of the article *“Formal recognition of farmer’s rights as a pre-condition for the re-building of productive and durable community forests in Indonesia: the damar agroforests in Krui, Sumatra”* (G. Michon, H. de Foresta, Kusworo, and P. Levang), under press for C.Zerner Ed.: People, Plants and Justice.

Kebun damar: between forest and garden

Driving westwards from the peneplain along the Sumatra highway -a mosaic of dry fields and pepper plantations- through the Barisan range -a succession of reddish hills extensively degraded by pioneer coffee growing- one suddenly enters another country: a land of trees that stretches all along the quiet descent to the Indian Ocean. The human mark on this forest landscape is not immediately obvious: some clearings bearing hill paddy, few patches of fallow vegetation. Elsewhere, a venerable jungle dominated by large trees.

The area covers some 100 000 ha divided between a long coastal plain -130 km from the provincial border in the North to the southern Cape Cina in the Sunda Straits- which widens from north to south, and a steep hilly and mountainous area culminating over 2,000 m high. It stretches over three administrative subdistricts².

Wherever possible, irrigated ricefields -and associated permanent villages- have been established along the coastal plain, but the rude topography and the relatively low quality of the inland soils have limited the possibilities of further permanent agricultural food production. The hills have long remained the domain of a classic agroforestry rotation: mosaics of temporary rice fields and coffee plantations with secondary, fallow vegetation. But for about a century or so, this traditional pattern of forest conversion to agriculture has evolved into a complex system of forest re-development: planting valuable fruit and resin-producing trees in their swiddens, Pesisir farmers have managed to create a new forest landscape entirely tailored to their needs. This man-made forest, though forming an almost continuous massif, is made up of a succession of individually evolved gardens, that the farmers name from the dominant tree species: the damar³ (Torquebiau 1984; Michon and Bompard 1987; Michon and Jafarsidik 1989).

Damar gardens in the Pesisir represent totally original examples of sustainable and profitable management of forest resources, entirely conceived and managed by local populations. Originality lies in the ecological mastery of the main economic resource, the forest tree, not through conventional domestication which usually concerns modification of plant characteristics to achieve adaptation to a cultivated ecosystem, but through an almost total reconstruction of the original forest ecosystem in agricultural lands. Success is due to the proven reproducibility of the system over the long term as well as to its economic results and to its social bases. Today, more than 80% of the damar resins produced in Indonesia is provided not by natural forests, but by the Pesisir damar gardens. Among the 70 villages scattered along the coast, only 13 do not own damar gardens⁴ (Dupain 1994). Productive gardens presently cover at least 50,000 ha (estimation based on field experience and satellite image analysis), the main center of cultivation being located around the city of Krui, where hills are almost totally covered with a mature damar forest. Yearly damar production was estimated around 8,000 tons in 1984 (Bourgeois 1984) and reached 10,000 tons in 1994 (Dupain 1994). New gardens are still being established in the northern and southern subdistricts.

Damar gardens can be analysed as a forest, and indeed, biologically, they constitute a forest in its own, a complex community of plants and animals and a balanced ensemble of biological processes reproducible in the long term on its own dynamics. For common observers, they can easily be mistaken -and they have often been- for a natural forest. But they definitely have also been established not as a forest but as an agricultural production unit on an agricultural territory. They are part of lands that are agriculturally claimed by local people, they are managed mainly as

² Population density ranges from 100 p/sq.km in the central district where available space for agriculture is saturated for more than 30 years, to less than 20 p/sq.km in the south where land can still be easily appropriated. From the ancient times until recently, the main communication links with regional centers (Bengkulu, Teluk Betung, Batavia/Jakarta, Singapore) were established through direct maritime connections, and several small harbors were scattered along the coast, with an important market center at Krui, in the central district. Recently, the old road to the east, through the central Barisan range -and through the national park- has been rehabilitated, a provincial road to the north has been completed and another is being developed to the south.

³ "Damar" is a generic term used in Indonesia to designate resins produced by trees of the Dipterocarp family.

⁴ these are mainly villages territory of which lies on the sandy sediments of the coast and which specialized in coconut growing, as well as new transmigration villages in the south and several former "clove villages" in the north

an agricultural enterprise. Occupying this vague interface between “agriculture” and “forest” -at least with the conventional perceptions of agriculture and forest that modern science has promoted-, they fully deserve the name of agroforests (Michon 1985; de Foresta and Michon 1993).

A tree plantation modelled as a forest

While damar trees are clearly dominant in mature gardens, representing about 65 % of the tree community and constituting the major canopy ensemble, damar gardens are not simple, homogeneous plantations. They exhibit diversity and heterogeneity typical of any natural forest ecosystem, with a high botanical richness, a multi-layered vertical structure⁵ as well as specific patterns of forest dynamics.

Plant inventories in mature damar agroforests have recorded around 40 common tree species, and several more tens of associated species, either large trees, treelets and shrubs, liana, herbs and epiphytes. Important economic species commonly associated with damar are mainly fruit trees: they represent 20 to 25 % of the tree community. In the canopy, durian and the legume tree *Parkia speciosa* associate with the damar trees. In the sub-canopy ensembles, langsat is the major species with, to a lesser extent, mangosteen, rambutan, jacktree, palms like the sugar-palm *Arenga pinnata* or the betel-palm *Areca catechu*, and several water apple species -*Eugenia spp.*-, as well as trees producing spices and flavorings (*Garcinia spp.* fruits of which are used as acid additives in curries, *Eugenia polyantha* the local laurel tree). The last component -10 to 15 % of the tree community- is composed of wild trees of different size and of various nature, which have naturally established and are protected by farmers either because they do not present adverse effects on planted trees, or because of interesting end uses. These species mainly include bamboos and valuable timber species (Apocynaceae, Lauraceae, etc). Non-tree species characteristic of a forest ecosystem (Zingiberaceae, Rubiaceae, Araceae, Urticaceae) have colonized the undergrowth of gardens, where they contribute to maintain a favorable environment for the development of seedlings of the upper layers trees.

Management of mature gardens is centered around the harvest of resin and that of fruits. Labour allocated to routine garden maintenance is mingled with labour devoted to resin harvest, and the tempo of harvests is determined by labour requirements for wet rice cultivation. Work in the gardens is postponed at time of rice harvest or of ricefield preparation, so that tree gardening never competes for labour with subsistence agriculture.

Once established, the damar plantation evolves with minimum human inputs. The silvicultural process in damar gardens is not conceived, as in conventional forest plantations, as a mass treatment applied to a homogeneous, even-aged population of trees, but aims at maintaining a system which produces and reproduces without disruption either in structural or in functional patterns. Natural processes are given the major role in the evolution and shaping of the cultivated ecosystem. Global continuity is ensured through a balanced combination between natural dynamic processes⁶ prevailing in tree population and appropriate management of individual trees of economic species. As natural decay of planted trees is predictable, farmers can easily foresee and plan their replacement. The main task of the gardener is to regularly introduce young trees in the garden plot in order to constitute and maintain an uneven-aged pool of replacement trees. In a well managed garden, the size of the replacement pool ensures the sustainability of the productive stand.

2 / Between plantation economy and forest use: the economic and social values of damar gardens

Damar gardens have been established by farmers in a perspective of commercial production, and the economic management of the damar gardens is basically closer to that of an agricultural

⁵ tree stands in damar gardens show a mean density of 245 trees/ha (record of all trees over 20 cm in diameter on eight 4000m² randomly selected plots) and a mean basal area of 33 m²/ha. These quite high figures, associated to a well balanced diameter class distribution, are really close to structural patterns found in natural forests [Michon, 1985 #16; Wijayanto, 1993 #18].

⁶ pollination, fructification and production, seed dispersion and germination, seedling and sapling development, gap colonization, water and nutrient cycling

smallholder plantation than to that of a forest. However, some functions of the damar gardens still relate to the former harvested forests that complemented rice swiddens in ancient production systems.

Damar garden as an enterprise

Damar trees represent the main source of household cash income, and damar collection is far more lucrative than other agricultural activity in the region (Mary 1987; Levang 1992). Resin is harvested on a regular basis: individual trees are usually tapped from once a month to once every 2 weeks. A single villager can harvest a mean of 20 kg of resin a day. In the central subdistrict villages, mean harvests are between 70 and 100 kg per family per month. Resin sale represents a regular income allocated to day-to-day expenses⁷: purchase of additional foods, weekly costs for children schooling. Five days of work in damar gardens are usually enough to ensure a month subsistence for the whole family (Levang 1989; Levang 1992). For those who do not own permanent ricefields, the damar income also allows to purchase some rice and thus complements dry rice culture where it still exists. However, the damar income is usually not sufficient to raise important funds nor for hoarding.

The damar activity also generates a series of associated activities: harvest, transportation from the field to the village, stocking, sorting and transportation to wholesalers in Krui. Harvest, transportation and sorting are carried-out either by the grower himself or by members of his family, or by specialized agents who are paid employees. Independent entrepreneurs ensure resin stocking in the village. These activities raise significant additional income for the village⁸ and allow those who do not own a damar garden to benefit from damar production (Bourgeois 1984; Mary 1987; Levang 1992; Nadapdap, Tjitradjaja et al. 1995).

As in many other places in Sumatra, the contribution of the fruit component to household economy has been increasing in recent years because of the growing importance of urban markets and of the recent major improvements in the road network. For the last productive years, marketing of the major commercial fruits, durian and langsung, has allowed to multiply the global agroforest income by two (Levang 1992; Bouamrane 1996). However, due to high irregularities in fruiting seasons⁹, income from fruits cannot be fully integrated in household daily budget planning. It is still mainly used for exceptional or "luxurious" expenses¹⁰.

Damar gardens constitute one of the most profitable smallholder production system in Sumatra (Table 1, from (de Foresta and Michon 1997)). They globally ensure reasonable levels of life quality, including high-schooling of children which is given top priority in most villages of the area. In addition, they can be managed -and used accordingly whenever needed- as a safety assets: a garden, or part of it consisting of several selected trees, can be "pawned" through special agreements called *gada*¹¹ (Mary 1987; Lubis 1996) that allow any family to overcome difficult

⁷ In the 11 villages "less concerned" by the damar activity, resin production and processing makes-up 45% of the mean household cash income. In the remaining 46 "damar villages", it represents between 70 and 100%. The production of 1993 generated regional gross value estimated at Rp 6.5 billions (US \$ 3.25 million) for Pesisir farmers from the sale of the damar only, to which Rp 5.3 billions (US \$ 3.25 million) have to be added as additional value generated by trade and Rp 2.7 billion (US \$ 2.65 million) for related wages, which makes a total of Rp 14.5 billion (US \$ 7.25 million) of regional gross value for the whole Pesisir villages. To this should be added Rp 542 million (US \$ 271 000) of profit margins made by the 9 Krui traders (Dupain 1994).

⁸ the sale value of the resin itself represents only less than half (44,5%) of the total income provided by resin production in villages, related activities accounting for the largest share (Mary 1986; Levang 1992)

⁹ due to adverse climatic conditions, there has been no fruit season in the area from 1992 to 1994

¹⁰ house repair, purchase of furniture, chainsaw or satellite dish, wedding ceremonies, or any festive activity

¹¹ "Pawnbrokers" (any villager with funds available can become a pawnbroker) may provide loans of several thousand rupiah for one garden for an undetermined period (at least one year). Tree production serves as yearly interest for the creditor, who for the whole period of pawning can use the garden for his own convenience, except for selling or transforming it. The agreement ends as soon as the gardens owner refunds all the money to the creditor or when he claims the profits made by the creditor are sufficient.

periods without resorting to selling trees or land¹², which is considered as one of the worse things that might happen to a family.

Indeed, in accordance with an agricultural conception of resource management, damar gardens also represent a patrimony. Born from a strategy of land property creation, fruit of a labour invested for a distant term, which will benefit mainly to future generations, the damar garden constitutes an inalienable lineage property (Mary 1987; Nadapdap, Tjitradjaja et al. 1995). In the very particular social and institutional context of the Pesisir, where families are defined mainly by their land assets, this notion of lineage patrimony defines the agroforest not only as the source of living of a household, but also as the land foundation of a lineage.

Damar gardens as a useful forest

On another hand, damar gardens fulfill a role equivalent to those of natural forests in forest villages economies.

Wild resources associated with damar trees support a whole range of gathering activities that are more typically linked with natural forest ecosystems -hunting, fishing, and harvesting of plant products- and provide important complementary subsistence resources for households. These include various non commercial fruits, vegetables and spices, firewood as well as other plant material and timber for housing purposes¹³.

Damar gardens also represent, as does any natural forest, a source of products that are potentially marketable commodities at a larger scale: timber, rattan, medicinal and insecticide plants can be harvested for sale whenever needed or if market conditions are considered as interesting¹⁴. As new markets are developing, some of the traditional subsistence products have actually emerged as new commodities. Timber presently stands as the major “new” commodity that might even revolutionize the management of damar gardens¹⁵ (Petit and de Foresta 1997). Damar gardens have taken over the essential role traditionally devoted to natural forests in household economy: a place opened to subsistence gathering and extractivism and used opportunistically, according to the family’s immediate needs. This forest function also appears in some of the egalitarian social attributes of the gardens -through product exchanges, sharing and donations¹⁶- and open right for harvesting¹⁷. This creates important networks of reciprocity that act as a counterpart of merchant networks created through agricultural activities, and that help maintain a social balance between well-endowed people and resourceless.

In replacing natural forests by damar agroforests, villagers’ aim was to amplify commercial strategies linked to the forest ecosystem. This is a widespread dynamics all over Indonesia: slash and burn practices are usually not targeted to staple food production only, but, primarily, to the establishment of income-generating agro-ecosystems (Pelzer 1978; Scholz 1982; Dove 1983; Weinstock 1989). Here, and this is one of the main originalities of the land conversion process in the area, though converting natural forests into a commercial plantation, Pesisir farmers also

¹²bank credit is still uncommon and uneasy in villages.

¹³thatching material from palm and *Garcinia* leaves, rattan and other liana, fibers from tree bark, bamboo. For timber production, damar and fruit trees appear as important as wild species

¹⁴the most valuable but also less predictable extractive commodity in the damar gardens is rattan: rattan cane harvest is subjected to the profit/failure dynamics of local buyers, and rattan fruits once appeared as a valuable product. This important economic unpredictability constitutes the main impediment to the development of rattan harvesting into a real garden production.

¹⁵as other sources of timber in the area are vanishing, the economic potential of damar timber is increasing. However, timber harvesting and marketing regulations, taxes, bribes and police harassment, constitute major impediments to the development of timber production as an integrated production of damar gardens

¹⁶Poor people, and children for their weekly schooling needs, can harvest resin fallen on the ground, they are even allowed to collect resin from the lowest tapping holes. Valuable fruits are traditionally shared by the family, and, in season, distant relatives may come and join for a durian party or leave with a basket full of *langsats*, which is considered as a valuable practice for keeping family cohesion

¹⁷Useful garden products such as firewood, sugar palm sap, small fruits, medicinal plants, can be collected in privately-owned gardens by whoever needs and asks for it

managed to restore a whole range of economic products and functions originally offered by the forest. Forest conversion did not go along with a radical process of biological simplification, rather it restored plant and animal diversity through cultivated, preserved and spontaneously established species. Specialization did not entail economic reductionism, rather, it restored the whole range of economic choices present in a natural, untransformed ecosystem. In a perspective of integrated conservation and development programme, this preservation of existing and potential economic diversity might appear as important as that of biodiversity.

Building on forest resource: species domestication or forest reconstruction? or how the control of a forest resource leads to appropriation of a forest

Damar story in the Pesisir constitutes a highly original example of spontaneous appropriation of a forest resource -the damar tree- by local farmer communities. It was achieved as the wild resource itself was vanishing (Michon, de Foresta et al. 1995; Michon, Foresta et al. 1996). If human history is rich in examples of natural resource appropriation through cultivation to achieve domestication, the originality of the damar example is that, while cultivating this particular forest resource, villagers have achieved the global restoration of a forest in the middle of agricultural lands (Michon 1996). Biologists will argue that the damar agroforest is far from a natural, pristine tropical forest: though close to it, damar gardens can not totally replace the natural forest ecosystem. But they represent a rather integral forest resource, which is, for local people, much more significant than a natural forest which escapes more and more their control and conservation of which is, for long and for external institutional reasons, out of their concern.

How cultivation techniques evolve into forest appropriation strategies

Reconstruction of a forest by Pesisir villagers was not planned as such. Rather, it appeared *a posteriori* as the consequence of a particular cropping system minimizing labour input and maximizing the use of natural production and reproduction processes of an artificial ecosystem dominated by trees. In that sense, it is the choice of particular cultivation techniques and patterns more than the initial selection of a given forest tree, that allowed true forest appropriation.

Technical appropriation of the damar resource: overcoming biological constraints, using biological advantages

The main ecological disadvantages of the selected forest species are typical of Dipterocarps: difficult natural regeneration, due to irregular and occasional flowering, lack of seed dormancy, and necessity of mycorrhizae association. But one important advantage has to be mentioned: unlike many Dipterocarp species, Shorea javanica appears to be rather light-tolerant, that made it suitable to cultivation in plots already cleared for agriculture.

Villagers solved the regeneration problem through a technology of “assistance storing of seedlings” (Michon and Bompard 1987; Michon and Jafarsidik 1989). The establishment of small nurseries, where the seedlings can be kept for several years and used whenever planting material is needed allowed to overcome fruiting irregularity and lack of seed dormancy. The mycorrhizae problem was avoided through a first phase of direct transplantation of seedlings from the forest to the plantation site.

Among other biological constraints is the long renewability rate of damar as a resource: it takes at least one generation -20 to 25 years- for a tree to attain a minimum tappable size. The economic consequence is that, for the first 25 years, a pure damar plantation would be of little, if any, use for the planter. This difficulty was solved through a strategy of crop succession starting from the ladang and planned over the medium term.

Integration of a forest tree in a farming system: the “ladang way”

Expansion and success of damar cultivation are indeed closely related to swidden agricultural practices (Michon and Bompard 1987; de Foresta and Michon 1994). It is through the *ladang*, and through its traditional crop succession structure that damar trees have been restituted in the landscape.

In the former dry land cultivation system, *ladang* were opened primarily for rice production, but some did not directly return to fallow. Instead, they were further transformed into either coffee or

pepper plantation¹⁸. The first damar trees were introduced in these successional *ladang* gardens, amidst coffee bushes and pepper vines, where they found a suitable environment to establish and further develop. After the abandonment of the coffee or pepper stand, damar trees were strong enough to grow along with secondary vegetation and overcome competition of pioneers. The subsequent fallow was a mix of self-established successional vegetation and introduced damar trees, which fully developed until reaching a tappable size, some 20 to 25 years after the plantation, but no more than 10 years after the plot abandonment. Damar plantation soon became a success story: everyone started to plant seedlings in his own *ladang* garden. Through this very simple cropping technique, after two decades, a traditional fallow land had changed into a managed tree garden including damar trees as well as other introduced fruit species and self-established trees, bushes and vines.

This process of establishment still prevails today in area which are being converted. Ecologically, the whole development of these successive crop mixtures imitates natural forest succession¹⁹, with all its ecological benefits: soil protection, microclimate evolution in accordance with successive component needs. Technically, it reminds a classic agroforestry process of forest plantation establishment -taungya system-, in which young seedlings of economic tree species start to grow in favorable, controlled conditions: here, maintenance of the coffee/*Erythrina* stand secures good microclimatic conditions -shade and humidity- favouring transplantation success and provides weed control during the first 4 to 15 years following seedlings' introduction.

Economically, this vegetation succession process is of tremendous importance as it makes-up the basis of a succession of harvestable commercial products, thus reducing the unproductive time span of the plantation to some 5 to 10 years. Costs of labour devoted to damar establishment are mingled with those devoted to rice and coffee cultivation on swidden fields. Cultivation of commercial tree crops does not compete for labour with subsistence agriculture. On the contrary, it allows to maximize returns on labour inherent to the swidden system -vegetation cutting and field maintenance- successively through coffee and trees.

Pesisir villagers have succeeded in what most foresters dream, but fail: establishing, maintaining and reproducing, at low costs and on huge areas, a healthy Dipterocarp plantation. This is still a unique example in the whole forestry world. And the best part of the story is that this success is inextricably linked to shifting cultivation, this agricultural system hold in contempt by foresters. The acceptance of the wild tree as a cultivated tree crop and the subsequent expansion of the plantation were allowed by the particular structure of the swidden production system, and *ladang* was at the very heart of this success.

In achieving the switch from "natural and sometimes protected" status of the damar tree in traditional extractivism systems to its adoption as a new crop in the farming system, farmers have clearly re-invented the common process of resource appropriation through (agri)culture. Indeed the control of the damar resource, based on the mimicry of natural forest processes which adapts the cultivated ecosystem to the plant characteristics, runs opposite to conventional domestication processes which emphasize modification of biological and ecological characteristics to achieve adaptation of the plant to a cultivated ecosystem (Michon 1996).

Further appropriation of the forest resource: restoring biodiversity

The plantation process that usually associates damar with fruit trees and leaves pioneer trees establishing naturally in the *ladang* garden basically recreates the skeleton of a forest system. But the real appropriation of forest richness and diversity is achieved through the free development of natural processes of diversification and niche colonization. As in any secondary vegetation dominated by trees, the newly maturing damar plantation provides a suitable environment and convenient niches for the establishment of plant propagules coming from the neighboring forests through natural dispersion. It also offers shelter and feed to forest animals. In this natural

¹⁸coffee or pepper and *Erythrina* as shade tree or living poles were coplanted with dry rice and vegetables, the productive plantation was maintained for 4 to 6 years for coffee, and up to 15 for pepper, and then returned to fallow

¹⁹rainfed rice as the first grassy phase, coffee/pepper as the early pioneer tree phase, subsequent secondary formation with young damar and fruit trees, and damar/fruit trees associated to various wild trees, as the mature phase

enrichment process, farmers merely select among the possible options offered by the ecological processes: favouring resources, through introducing economic trees and protecting their development, or tolerating non-resources development and reproduction as long as they are not considered as “weeds”. After several decades of such a balance between free functioning and integrated management, the global biodiversity levels are fairly high. As natural forests below 700-800 m asl are almost inexistant in the Pesisir, damar gardens constitute the major habitat for many plant species characteristic of lowland and hill dipterocarp forests that would otherwise have disappeared (Michon and de Foresta 1990; Michon and de Foresta 1995). The agroforest also shelters many animal species, among which some representants of highly endangered species like the Sumatran rhino or the Sumatran tiger²⁰ (Sibuea and Herdimansyah 1993; Thiollay 1995)

Seen from the planter’s point of view, while the introduction of economic species in the damar agroforest is intentional, global biodiversity reestablishment is “accidental”. But it is precisely this “accident” -the establishment of diversified flora and fauna as in any silvigenetic process- which reconstitutes the real forest aspect of the agroforest. These combined processes - the intentional and the accidental one- are essential for several reasons: they restore resources that otherwise would not have been conserved purposefully because they do not appear as important economic resources. But they also allow to restore biological and ecological processes which are determining in the functioning and reproduction of the agroforest as a forest ecosystem. In that sense, even those components which are not economic -or potentially economic- resources are not neutral. Non-edible fruit trees in the agroforest help supporting populations of fruit-eating birds, squirrels and bats, which are essential natural pollinators and dispersers of economic fruit species. Focusing on resources, one should not forget those “functional” resources which are not -and will never be- valued as commodities but are nevertheless essential: restoring diversity, either economic or biological, is meaningless if ecological processes are not maintained.

Damar gardens are certainly an interesting example of agroforestry association. But in the agroforestry context, they convey a totally new dimension: that of the association, not between trees and crops as in conventional agroforestry, but between the forest resource and the agricultural logic (Michon, de Foresta et al. 1995). It is above all the integration of forest resource management into the farming system which constitutes the success and the originality of the damar agroforest. Damar gardens offer new insights into the definition of technical, ecological as well as socio-economic and institutional bases for managing forest resources into farming systems. They open new perspectives for re-inventing forest common property resources through

²⁰*In order to assess biodiversity levels, comparative studies have been conducted between agroforests and related primary forests for several fauna and flora groups, including higher plants (from ferns to dicotyledons), birds, mammals and soil mesofauna.*

Soil mesofauna diversity levels (α and β diversity) are quite similar between forest and agroforest. None of the numerically important species of the forest population is absent in the related agroforest, however, because many species in that large group are rare species, results do not prove that all forest species exist in the agroforest (Deharveng 1992).

Bird richness in damar agroforests is 30% lower than in primary forest: respectively 96 and 135 species have been recorded in those two ecosystems. About 57% of the bird species found in the forest have not been encountered in the agroforest, whereas 40% of the agroforest species were not present in the forest surveys [Thiollay, 1995 #48]. Reduction of bird diversity can be related to biological factors (simplification of composition and vertical structure from forest to agroforest), but is probably mainly due to high hunting pressure (birds are caught for food, but also often to be kept in cages in the village or sold to outsiders, as bird keeping is more than a hobby in Indonesia).

As far as mammals are concerned, almost all forest species are present in the agroforest. Densities of Primates populations (macaques, leaf monkeys, gibbons and siamang) in the agroforest are quite similar to those observed for natural forests. Footprints of the rare Sumatran rhino have been recorded in the agroforest, less than 2 km from villages. This represents the first record of rhino in this part of Sumatra and allows to draw hypotheses on the usefulness of agroforests for the conservation of endangered animals as an important adjunct to protected forests (Sibuea and Herdimansyah 1993).

Global flora richness is reduced to approximately 50% in the agroforest. However, results have to be dissociated by biological groups, as they can be very different from one group to another. The largest loss occurs for trees (agroforest diversity merely represents 30% of the original diversity levels), which is quite understandable as economic intensification, and therefore selection operates mainly on trees. Epiphyte and liana richness in the agroforest is at least 50% of forest richness, whereas for undergrowth plants, it is much higher in agroforests than in natural forest (2 to 1), which should be related to the common abundance of this group in secondary forests as compared to primary forests.

an original agricultural perspective. They also bring new insights to the open debate about natural resource management by local communities. As a development strategy, the establishment of damar agroforest represents an interesting example of forest product management for commercial purposes which did not protect the forest as a whole -it entailed a total transformation of the original ecosystem- but preserved most of its resources and retained an important part of its biodiversity. The transfer of the forest resource from the natural ecosystem to the agroforest did not imply only a transfer of resources, structures and economic vocations, but also a guaranty of the renewability of these resources, structures and economic vocations. And this is an essential lesson for foresters who rarely attempt to manage the forest as a global ecosystem but still pretend devising “sound strategies” for managing the forest resources as renewable ones. In that respect, the agroforest should be considered as an ecological model of forest reconstruction of great potential for reforestation and land rehabilitation programmes. But agroforest is more than a biological duplicate of the forest. In the present political, institutional and socio-economic context in Indonesia, which appears quite unfavorable to long term maintenance of the forest itself, the whole process of damar agroforest establishment and development appears as an extremely original strategy of re-appropriation of forest resources by local populations, or, more than forest resources, of the traditional “forest resource” of peasant economies in the forest margins of Indonesia.

Forest farmers and foresters: from conflict to alliance?

Damar farmers have never been involved in official decision-taking processes regarding the planned development of lands they have actually and efficiently managed for centuries. Neither have they been really informed of these decisions that obviously may have profound implications for their future. On the contrary, after having worked hard and believed that they were developing their lands for their children and grandchildren, they suddenly learned, usually through rumors more than through clear explanations, that these lands belong to the State and that the State has in mind “better” projects for their development. Unsurprisingly, this chronic disinformation has led to the multiplication of conflicts between farmers and government-sponsored agents, which commonly translated into cheats on one side and power abuse on the other side.

Episode 1: the reserved forest

The forest reserve (BoschWeesen, or BW as it is still known locally) was established by the Dutch administration in 1937. Its borders have been decided after consultation with local people, and were in these times located far from the agricultural territory of villages. The status of this reserve has been upgraded to National Park in 1991 (Bukit Barisan Selatan National Park). As an old constraint on their territorial development, villagers are well aware of its existence and of its borders. However, they do not really fully agree with the legitimacy of the Park for flora and fauna protection. This disagreement gained importance in villages where land shortage problems were acute, but it is basically more conceptual than factual. The fundamental grievance of farmers against the ideology -and practice- of conservation forestry is that it values the forest more than humans and will always give the preference to wildlife and plants, would this entail important problems for local people²¹.

Due to land shortage in several villages, encroachment of *ladang* and damar gardens in the forest reserve, especially along the Krui-Liwa road, started as far as 1955. In the late 1960's, a tacit agreement was concluded between farmers and the forestry authorities, allowing several dozens of families to open land in the reserve and establish damar gardens (Mary and Michon 1987). But police and conservation guards continued to regularly visit the farmers to get “reward” for this agreement. This continuous annoyance conducted many families to leave the area at the

²¹Wildlife, especially elephants, constitutes another source of conflicts between villagers and the PHPA officers. For several years -in fact since the remaining production forest was logged-over and the related opening of roads attracted migrants who cleared large areas in the logged-over forest for coffee and pepper growing- elephants frequently come out of the national park, destroy the crops and attack farmers in their *ladang*, and now even in villages. Villagers require the right to carry guns in order to protect themselves, which is of course not accepted by the conservation guards.

end of the seventies. Today, in the Park where no ladangs have been opened for more than twenty years, the canopy has closed and only the exercised eye will distinguish the damar islands in the forest.

Episode 2: the production forest

Between the reserved forest and the Indian Ocean, the government granted concession rights covering 52 000 ha to a logging company, HPH Bina Lestari (Kusworo 1997) in 1981²². This company had formal rights to collect timber all over the three Pesisir subdistricts. Damar farmers did not know that their territory has been given for logging, as the company only logged timber in the extreme north and in the extreme south and did not dare to harvest timber planted by local farmers in their agroforests; had they done it, this would not have been considered as illegal, and farmers would not have had any right to claim for compensation²³.

The HPH left in 1991 as the area was divided according to the first officially recognized TGHK maps into conversion forest (7500 ha) in the extreme south, protection forest in small pieces distributed all along the western border of the National Park²⁴, and production forest (about 42 000 ha). The management of the production area was given to the state-run company Inhutani V and rumors quickly arose of an Inhutani project of industrial forest plantation for forest "rehabilitation" with large-scale Acacia planting, about to start in 1992. This fortunately never materialized, and is not likely to happen since the latest development of the "Krui case" in the Department of Forestry.

Between 1992 and 1996, the Forestry service materialized these maps by measuring the State Forest borders and by placing poles. During this period, damar farmers began to suspect that their lands were also claimed by the State. They were never directly informed of the legal consequences of their land being classified as Production or Protection Forest, and when they asked, the answer was always that nothing was changed, *at least for the time being*.

Episode 3: recognition? or re-appropriation? ambiguities of the forestry support

Since 1992, new developments occurred that induced changes in the attitude of foresters regarding the Damar enterprise of Pesisir farmers. Among the conjugated forces that pushed these changes are: the joined efforts of local and international researchers and NGOs to promote the "Krui case" as an outstanding example of reforestation and forest management by local communities²⁵, the politically-correct switch in the Department of Forestry itself towards allocating more support to forest communities, the -timid- acknowledgement by regional authorities of potentially important social troubles induced by repeated right violations and power abuse. This translated into a better taking of the originality and the value of the Pesisir system into consideration at various levels of forest and regional administration.

However, this recent support may be a double-sided sword for damar farmers: while many foresters in Jakarta perfectly acknowledge the value and the validity of the damar garden system, they just seem to forget acknowledging that it arose and worked perfectly well without them for something like a century.

The new deal: one for all, all for one, against the planters?

Forests -as well as non-forest- lands in the Pesisir represent the last "wild frontier" in the already overpopulated province of Lampung. Due to the proximity to Jakarta and to the on-going road

²²the Pesisir area is known in the Department of Forestry as Bina Lestari's forest

²³Under the same situation in the province of Bengkulu, other private foresters have concieniously logged damar gardens belonging to local people

²⁴these pieces of Protection Forest have no other rationale than a compensation for other areas in the province where previously designated protection forest has been declassified to make way for public and private development projects.

²⁵as a result of this joint effort, the prestigious National Kalpataru award for the environment had been given by the President of Indonesia to the "customary community of damar farmers in Pesisir, Krui" on June 5, 1997.

development, it is a tempting invitation for private speculators: estate developers and agro-industries. For the regional authorities, these potential investors represent highly interesting parties: besides being important tax payers -which farmers are not-, their investments would greatly increase the regional development index, and supposedly increase the level of industrial activities in the area (Kusworo 1997).

Since the early 1990's -after the completion of logging operations-, the district authorities have started allocating "private lands" as well as part of the logged-over forest lands²⁶ in the three Pesisir subdistricts to two oil palm companies: respectively 24,500 ha to PT Karya Canggih Mandiri Utama in the south, being developed since 1994, and 17,352 ha to PT Panji Padma Lestari in the north, starting in January 1996 -with an additional 4,500 ha in the south to the same company. Local farmers were not informed of these projects and started asking questions when they encountered field teams measuring land -among others, measuring their damar gardens and even their ricefields. They were not always given the right answer, however.

Local authorities specified that oil palm would be planted only on actually "empty" lands, though local farmers could also be invited to join with their own lands if they wish. They started campaigning to support the project, asking the village heads to speak highly of the economic merits of oil palm planting and to ensure farmers cooperation. But they also specified that no farmer should be compelled to give up his damar land for the company, that no damar tree should be felled without the consent of the owner. PT Karya Canggih Mandiri Utama soon applied its own conception of "inviting" farmers to join: after a formal convocation conveyed through the subdistrict head -*Camat*- to the village authorities, and given the subsequent lack of enthusiasm from damar farmers, they decided to use fake but positive farmers' signed approval in the place of true but negative ones, and started clear-felling damar gardens, under moon light as this is less visible than under bright morning light²⁷. Angry farmers started publicizing this blunt violation of their basic rights to the provincial assembly and to local newspapers.

Farmers in the northern subdistrict, aware of the hidden practices of the companies, started affirming and publicizing their resistance to the venue of PT Panji Padma Lestari even before it actually started measuring land (1996). The joint claims of farmers, NGOs and international research institutions asserting that replacing farmers' damar gardens by oil palm estates was neither ecologically defensible nor socially acceptable, and that the way this replacement was about to happen could clearly constitute a *cas d'école* of power abuse by economic and political elites, finally succeeded. In December 1996, the Ministry of Forestry asked PT Karya Canggih Mandirutama to suspend its activities and solve the current conflicts with local damar farmers, while in March 1997, the Provincial Governor asked PT Panji Padma Lestari to stop its activities.

Conclusion

The "agroforest framework" offers a good opportunity to escape the formal forestry context and to devise new forms of association between farmers, foresters and regional authorities concerning forest resources. Ecologically, economically, socially, the agroforest is not to be assimilated to a natural forest, and indeed, as long as this confusion between forest and agroforest is maintained, as long as local practices for management of forest resources in farming systems are ignored, the chances of survival of agroforests as a unique model of integral forest management will not cease to decrease. Agroforests, once recognized, open a totally new field for negotiations between foresters and local communities, a field favorable to institutional innovations where ancient conflicts could be solved-out without one or another party losing its face. In particular, it could allow to formulate new alliances between the conventional forestry sector and local communities, to propose new options for land or resource management and control, without destabilizing the

²⁶using the process of revision at the district scale of the TGHK as a way to declassify the targeted forest land.

²⁷farmers actually woke up and noticed that all their damar trees had been cut overnight.

existing forestry legislation. And it would be a pity not to take this as an opportunity to rethink, on a real field basis, the whole conventional context of forestry and agriculture.

References

- Anonymous (1995). Strengthening community-based damar agroforest management as natural buffer-zone of Bukit Barisan Selatan National Park, Lampung, Indonesia. Research Report, Lembaga Alam Tropika Indonesia (LATIN).
- Bouamrane, M. (1996). "A season of gold: putting a value on harvests from Indonesian agroforests." Agroforestry Today 8(1): 8-10.
- Bourgeois, R. (1984). Production et commercialisation de la résine "Damar" à Sumatra Lampung, Masters Thesis, E.N.S.A.M., Montpellier, France.
- Burkill, I. H. (1935). A Dictionary of the Economic Products of the Malaya Peninsula. London, Crown agents for the colonies. Millbank.
- Collet, O. J. A. (1925). Terres et peuples de Sumatra. Amsterdam, Elsevier.
- de Foresta, H. and G. Michon (1993). Creation and management of rural agroforests in Indonesia: potential applications in Africa. Tropical Forests, People and Food: Biocultural Interactions and Applications to Development. C. M. Hladik, H. Pagezy, O. F. Linaret et al. Paris, Unesco & the Parthenon Publishing Group: 709-724.
- de Foresta, H. and G. Michon (1994). "From shifting cultivation to forest management through agroforestry: smallholder damar agroforests in West Lampung (Sumatra)." APAN News. 6/7: 12-13.
- de Foresta, H. and G. Michon (1997). "The agroforest alternative to Imperata grasslands: when smallholder agriculture and forestry reach sustainability." Agroforestry Systems 36(1-3): 1-16.
- de Jong, W. (1994). Recreating the forest: successful examples of ethno-conservation among land-dayaks in central West Kalimantan. Communication to the International Symposium on Management of Tropical Forests in Southeast Asia, Oslo.
- Dove, M. R. (1983). "Theories of swidden agriculture, and the political economy of ignorance." Agroforestry Systems 1: 85-99.
- Dove, M. R. (1985). The Agroecological mythology of the Javanese and the political economy of Indonesia. Honolulu, East-West Environment and Policy Institute.
- Dove, M. R. (1993). "Smallholder Rubber and Swidden Agriculture in Borneo: A sustainable Adaptation to the Ecology and Economy of the Tropical Forest." Economic Botany 47(2): 136-147.
- Dunn, F. L. (1975). Rain-Forest collectors and traders: a study of resource utilization in modern and ancient Malaya. Kuala Lumpur.
- Dupain, D. (1994). Une région traditionnellement agroforestière en mutation: le Pesisir (A traditionally agroforestry area in mutation: Pesisir), Masters Thesis, CNEARC, Montpellier, France.
- Fried, S. T. (1995). Writing for their lives: Bentian Dayak authors and Indonesian development discourse, PhD Thesis, Cornell University, Ithaca, N.Y.
- Gillis, M. (1988). Public policies and the misuse of forest resources. Cambridge University Press.
- Gouyon, A., H. de Foresta, et al. (1993). "Does 'jungle rubber' deserve its name? An analysis of rubber agroforestry systems in southeast Sumatra." Agroforestry Systems 22: 181-206.
- Levang, P. (1989). Systèmes de production et revenus familiaux (Farming systems and household incomes). Transmigration et Migration Spontanées en Indonésie (Transmigration and Spontaneous Migrations in Indonesia). Departemen Transmigrasi - ORSTOM: 193-283.
- Levang, P. (1992). Pahmungan, Penengahan, Balai Kencana. Enquête agro-économique dans la région de Krui (Lampung), Research Report, ORSTOM/BIOTROP.
- Lubis, Z. (1996). Repong Damar: Kajian tentang pengambilan keputusan dalam pengelolaan lahan hutan pada dua komunitas desa di daerah Krui, Lampung Barat. Research Report, P3AE-UI and CIFOR.
- Marsden, W. (1783). The History of Sumatra. London.
- Mary, F. (1987). Agroforêts et Sociétés. Analyse socio-économique de systèmes agroforestiers indonésiens, Document E.N.S.A.M. - INRA.
- Mary, F. and G. Michon (1987). "When agroforests drive back natural forests: a socio-economic analysis of a rice/agroforest system in South Sumatra." Agroforestry Systems 5: 27-55.
- Michon (1996). "The agroforest model as an alternative to the pure plantation model for domestication and commercialization of NTFP's."
- Michon, G. (1985). De l'homme de la forêt au paysan de l'arbre: agroforesteries indonésiennes, U.S.T.L., Montpellier, France.
- Michon, G. and J. M. Bompard (1987). "Agroforesteries indonésiennes: contributions paysannes à la conservation des forêts naturelles et de leurs ressources." Rev. Ecol. (Terre Vie) 42: 3-37.
- Michon, G. and J. M. Bompard (1987). The Damar gardens (*Shorea javanica*) in Sumatera. Proceedings of the third round-table conference on Dipterocarps. A. G. J. H. Kostermans. Samarinda, UNESCO: 3-

- Michon, G. and H. de Foresta (1990). Complex agroforestry systems and conservation of biological diversity 1/ Agroforestry in Indonesia, a link between two worlds. In Harmony with Nature. An International Conference on the Conservation of Tropical Biodiversity, Kuala Lumpur, Malaysia, The Malayan Nature Journal. Golden Jubilee issue.
- Michon, G. and H. de Foresta (1995). The Indonesian agro-forest model. Conserving biodiversity outside protected areas. The role of traditional ecosystems. P. Halladay and D. A. Gilmour. Gland, Switzerland and Cambridge, UK, IUCN.
- Michon, G., H. de Foresta, et al. (1995). "Stratégies agroforestières paysannes et développement durable: les agroforêts à damar de Sumatra." Natures- Sciences- Sociétés 3(3): 207-221.
- Michon, G., H. d. Foresta, et al. (1996). Damar resins, from extraction to cultivation: an "agroforest strategy" for forest resource appropriation in Indonesia. Ethnobiology in human welfare. S. K. Jain. New Delhi, Deep Publication: 454-459.
- Michon, G., H. d. Foresta, et al. (1995). New face for ancient commons in tropical forest areas? the "agroforest strategy" of Indonesian farmers. 4th annual meeting of the International Association for the Study of Common Property Resources, Bodo, Norway.
- Michon, G. and D. Jafarsidik (1989). Shorea javanica cultivation in Sumatra: an original example of peasant forest management strategy. Management of tropical Rainforests. Utopia or chance of survival. E. F. Bruenig and J. Poker. Baden-Baden, Nomos Verlagsgesellschaft: 59-71.
- Momberg, F. (1993). Indigenous Knowledge Systems. Potentials for social forestry development: resource management of Land-Dayaks in West Kalimantan. Berlin, Technische Universität Berlin.
- Nadapdap, A., I. Tjitradjaja, et al. (1995). "Pengelolaan Hutan Berkelanjutan: Kasus Hutan Damar Rakyat di Krui, Lampung Barat." Ekonesia(2): 80-112.
- Padoch, C. and C. Peters (1993). Managed forest gardens in West Kalimantan, Indonesia. Perspectives on biodiversity. Case studies of genetic resource conservation and development. C. S. Potter, Cohen, J.I. and D. Janczewski. Washington, AAAS: 167-176.
- Peluso, N. L. (1983). "Networking in the commons: A tragedy for rattan ?" Indonesia 35(1): 95-108.
- Peluso, N. L. (1992). "The ironwood problem: (Mis) management and development of an extractive rainforest product." Conservation Biology 6(2): 210-219.
- Peluso, N. L. (1992). "Rich forest, poor people: Resource control and resistance in Java." Book Reviews 9: 115-127.
- Pelzer, K. J. (1978). Swidden Cultivation in Southeast Asia: Historical, Ecological, and Economic Perspectives. Farmers in the Forest. P. Kundstadter, E. C. Chapman and S. Sabhasri. Honolulu, The University Press of Hawaii: 271-286.
- Rappard, F. W. (1937). "Oorspronkelijke bijdragen: de damar van Bengkoelen (the damar of Bengkulu)." Tectona D1(30): 897-915.
- Sardjono, M. A. (1992). "Lembo culture in East Kalimantan: A model for the development of agroforestry land-use in the humid." GFG-Report 21: 45-62.
- Scholz, U. (1982). Decrease and revival of shifting cultivation in the tropics of south-east Asia - The examples of Sumatra and Thailand.
- Sevin, O. (1989). Histoire et Peuplement (History and population). Transmigration et Migration Spontanées en Indonésie (Transmigration and Spontaneous Migrations in Indonesia), Departemen Transmigrasi - ORSTOM: 13-123.
- Sibuea, T., Th. and D. Herdimansyah (1993). The variety of Mammal species in the agroforest areas of Krui (Lampung), Muara Bungo (Jambi) and Maninjau (West Sumatra). Keanekaragaman jenis Mammalia di daerah agroforest Krui (Lampung), Muara Bungo (Jambi) dan Maninjau (Sumatera Barat), Orstom and Himbio.
- Siebert, S. F. (1989). "The dilemma of dwindling resource: rattan in Kerinci, Sumatra." Principes 32(2): 79-97.
- Thiollay, J. M. (1995). "The role of traditional agroforests in the conservation of rain forest bird diversity in Sumatra." Conservation biology 9(2): 335-353.
- Torquebiau, E. (1984). "Man-made Dipterocarp forest in Sumatra." Agroforestry Systems 2(2): 103-128.
- van der Koppel, C. (1932). De economische beteekenis der Ned. Indische harsen (The economic significance of Dutch East Indies resins). Batavia, Kolff