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A VARIABLE MANAGEMENT SYSTEM FOR THE HILL FORESTS OF SARAWAK, MALAYSIA

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CALDECOTT, J. 1988. A variable management system for the hill forests of Sarawak, Malaysia. Malaysian forests are able to supply a number of non-wood products, including rattan, tourism revenue, wild meat and phytochemical and pharmaceutical products. These products can be incorporated within the variable management systems of 20-60 years proposed for these dipterocarp forests. This would maximise their long-term productivity with an increased range of outputs.

Key words: Hill dipterocarp forest - Sarawak - management - non-wood products.

Introduction

About 9.1 million *ha* of Malaysia's permanent forest estate has now been assigned indefinitely to the production of timber. These production forests are mostly of hill dipterocarp type, and a large proportion has already been harvested. As of 1983-1984, the unlogged portion amounted to about 1 million *ha* (35% of the original area) in Peninsular Malaysia, 1.5 million *ha* (56%) in Sabah and 4 million *ha* (74%) in Sarawak (Tang 1987).

Currently Malaysia (1986-1990) produces about 32 million m^3 of logs each year. This output from natural forests is expected to decline sharply by 1990's and Malaysia as a whole will experience a nominal deficit in log supply of nearly 8 million m^3 each year, relative to projected consumption at current prices (Baharuddin & Tong 1987). Forest plantations are being established in Peninsular Malaysia and Sabah, but there will be a shortfall in total supply of plantation material because plantations are not being established rapidly enough relative to the exploitation of natural stands (Groome 1987). Rubberwood production may offset the decline only marginally. Moreover, no feasible plantation programme is likely to convert more than about 10% of the remaining natural production forests in the permanent forest estate, and at least 8 million *ha* of natural forests will be managed indefinitely for wood production.

Logs are harvested in Malaysia in order to supply both domestic and export demand. A shortfall in log supply such as that predicted will cause either a contraction in domestic downstream processing, or a contraction in export revenue, or both, depending on where that shortage is directed. It is assumed, however, that domestic users will ultimately enjoy priority of access to indigenous log supplies, and that Malaysia will wish to be self-sufficient in tropical hardwoods. This means that wood production from the management of natural dipterocarp forests will have to be placed on a sustainable basis.

Although investments in downstream timber processing and forest plantation development are encouraged by the Malaysian Government through various taxation-based incentives (Chee & Soon 1987, MIDA 1987, Thornton 1987). To increase and diversify export earnings, forest plantation development is less strongly encouraged at present. The latter is urgently needed to help satisfy the demand for at least some kinds of wood-based products.

Certain problems of natural forest management are, however, not yet resolved. It is essential that the Malaysian dipterocarp forests are managed sustainably if domestic self sufficiency is to be fulfilled on a long-term goal. Tang (1987) recently has cast doubts on the sustainability of current management strategies applied to hill dipterocarp forests. Tang contends that, to achieve sustainable wood outputs, the management objectives should be consistent with the regenerative capabilities of the forests themselves. Since this requirement would generally imply a reduced log output, based on a downward revision of mean annual girth increments to be expected in hill forests, an extensive forest plantation system would be essential to compensate for lost wood production.

Tang (1987) goes on to propose a modified harvesting system for natural forests that would in principle allow both wood and non-wood forest products to be considered within a unified management approach. The present paper considers the implications of this, in the context of the perceived need to create additional sources of export revenue within Malaysia, and to generate sufficient cash-flow from regenerating production forests so sustainable management can become self- financing.

A variable management system for hill forests

The Selective Management System (SMS) and the 'modified' Malayan Uniform System (MUS) are the basis of hill forest management for timber production in the various states of Malaysia. The MUS relies on dipterocarp seedling growth to replace a commercial timber stand, and this is unrealistic in hill forests, where such seedlings are generally very patchily distributed. Modification of the MUS regeneration sampling techniques and preferred species lists, is said to be an inadequate response to managing the hill forests (Tang 1987).

The subsequent introduction of the SMS had not necessarily resolved the problem. This system in principle allows selection from among a range of management options (monocyclic or polycyclic harvesting, enrichment or conversion planting), based on a prefelling inventory (Tang 1987). In practice, however, polycyclic logging is usually involved, relying on the growth of adolescent trees between harvests, and this has been accompanied by the use of a cutting cycle which at 25-30 years is too short for adequate maturation of the stand to occur;

mean rates of annual increment in hill forests are generally both lower and less responsive to post-logging silvicultural treatment (Tang 1976).

Tang (1987) emphasized that outside of certain particularly rich stands, which are rare in hill forests, silvicultural treatment is either valueless or cost-ineffective, it may remove trees which the market may require later on, and therefore, it would be appropriate to allocate silvicultural effort only to those stands which will benefit from it. Elsewhere, management of hill forests should generally be assigned away from silviculture and towards three key activities: (i) prefelling inventory and management planning; (ii) closer control of logging operations; and (iii) monitoring the growth of residual stands. Of these, the first two would include detailed topographic mapping and tree-marking for both road and skidtrail layout and directional felling. Recent studies have established these activities significantly reduced damage to the residual stand (Chua 1986, 1987).

Tang (1987) concluded that a new management system is required for regenerating hill dipterocarp forests: one that is consciously adapted to real stocking, growth rates and site conditions, rather than relying on a blanket 25-30 year cutting cycle. In particular, the cutting cycle used should vary from 20 to 60 years depending on individual stand characteristics. This means that the longer cycle of 50-60 years should be used as a basis for determining annual coupe (or AAC) areas, with cutting regimes for individual blocks (or compartments) being determined to ensure that a new timber crop can develop within this period.

The new system would be based on a prefelling inventory and might be called a 'Variable Management System' (VMS) to reflect the range of management options to be used, including a variable cutting diameter limit, a variable predominant regeneration size class for the next crop, and a variable cutting cycle duration.

In practice, the overall effect of using the VMS would be that most Forest Department or equivalent resources would be allocated to the intensive management of more productive and accessible forests (perhaps 20% of the total), while all other areas would be managed with minimum intervention and 50-60 *y* cutting cycles.

The role of non-timber products

Existing management systems are concerned exclusively with the need to obtain a sustainable harvest of roundwood from hill dipterocarp forests. There are, however, a number of other, non-wood resources within such forests, and it would be appropriate to consider these if forests are to be managed with maximum economic efficiency (Burkill 1935). These non-wood resources are presently under-used commercially, even though some of them have the potential to contribute to a diversified and sustainable forest management system. Such resources include: antimicrobial agents, other pharmaceuticals, pesticides, food colourants, flavours and preservatives, dyes, seed oils, fruits, perfumes, latex, gums, waxes, resins and rattan canes.

The potential commercial significance of many such materials has undergone recent and fundamental change with the advent of new technologies and markets. Meanwhile, revenues from tourism, fisheries and wildlife harvesting should also be considered in this context as high-value rain forest products.

Recognition of the full extent and potential of this diverse but under-used resource base is of recent origin (*e.g.* Myers 1984), and a systematic description of all its features remains incomplete. Nevertheless, there is now strong evidence that these assets represent important opportunities for large-scale investment by the public and/or private sectors. This would justify finding a way to combine their management with that of wood resources, and this could be done by 'extending' the VMS to take non-wood resources into account. Examples of such assets, and ways in which their management might be integrated with wood production, are described below.

Rattans

Climbing palms or rattans, mainly of the genus *Calamus*, are commercially the second most important forest product (after timber) in Southeast Asia (see among others Dransfield 1979, 1984). The canes produced from rattan palms find uses in many marketable products in addition to their principle role in the furniture industry. A total of more than 150,000 tonnes of rattan cane is now consumed world-wide, with an overall value being greater than US$2,500 million per year.

The valuable species *C. caesius*, and others such as *C. optimus*, occur naturally on drier slopes in Malaysian hill forests and can be harvested sustainably from managed forests, or deliberately planted therein. Other locations such as those subject to occasional flooding, would be more appropriate sites for *C. trachycoleus*. There is also the opportunity to introduce exotic rattans for planting in particular locations.

Planting rattan commercially has been done in several territories. Rattans may contribute to hill forest management in several different ways:

a) Where natural forests are to be replaced with 'compensatory' tree plantations, rattans could be planted as a second crop.
b) In accessible areas rattan plantations could be established in suitable residual stands of natural forest. A high density of commercial rattans within a poor timber stand would justify exclusive use of that stand for rattan, rather than timber production.
c) In less accessible areas, enrichment planting of rattan seedlings in the residual stand may be justified without subsequent investment in maintenance beyond the first 3-5 years.
d) In many other areas periodic harvesting of naturally growing canes growing amongst the regenerating timber stand would be cost-effective.

Wild meat

A recent study of hunting in the interior of Sarawak drew attention to the actual and potential economic role of wild meat as an important non-timber forest product (Caldecott 1988). The study found that wild pigs (*Sus barbatus*) and deer provided 60-90% of a harvest of wild meat of 18,000 ±9,000 tonnes each year in Sarawak as a whole. This represented an average consumption of about 12 *kg* per person per year, and its replacement by domestic livestock and pond-fish would cost at least US$50 million. In rural communities, wild meat contributed about 40% of all meat and fish consumed, and a well-established commercial traffic in wild meat was valued at several million dollars annually, with a comparable value being attached to trade in certain riverine fish.

Ecological conditions such as food supply within hill forests directly control the number animals which may be harvested sustainably from each population, and this in turn is affected by forest management practice. In order to maintain the productivity of wildlife populations through habitat protection would involve minimizing damage to certain trees which are used as food sources by economically-important wild animals (see tree species lists in Caldecott 1988). For the management of wildlife populations under the proposed EVMS after the pre-felling inventory, the following options would be available:

a) Food trees could be incorporated within compensatory forest plantations.
b) In some relatively accessible areas, a high density of food trees within a rich timber stand would justify exceptional care during timber harvesting under a prolonged cutting cycle, in order to maximise wild meat productivity. Such areas could then be deliberately managed as hunting reserves for community use, commercial meat production, or for recreational hunting.
c) In other accessible areas, a high density of food trees within a poor timber stand would justify exclusive use of that stand for meat rather than timber production. The area would then be treated as a managed hunting reserve.
d) In certain remote areas, the presence of dense stands of trees which are particularly significant for mobile or migratory wildlife populations (*e.g.* oak forests for wild bearded pigs) would justify allocation of that stand to meat rather than timber production.
e) In most relatively inaccessible areas, the objective would be to minimize damage to food trees in general, as part of standard management procedure for each stand.

Tourism

Environmental tourism

Tourism development often relies on the clustering of diverse attractions within single regions, since this allows simplified access, collective marketing and coordinated exploitation (Tisdell 1984). Any forest area may contain features with special potential for recreation, including unusual forest formations, waterfalls, cliffs and viewing points. Special biological features may also occur, illustrated by the discovery of a new and spectacular species of the giant flower *Rafflesia* in Sabah, and these may also have potential significance in this context.

A simple check-list for use during prefelling inventories should help to identify those stands which might be able to contribute to later tourism development in the area concerned. Allocation of these stands to recreational use instead of timber production may be justified.

Specialist hunting and fishing tourism

Recreational hunting is a major phenomenon in many parts of the world and directly involves, for example, nearly 6.5 million people in the EEC (Anonymous 1986) and over 100,000 in Australia (Tisdell 1982). Similar figures apply to sport fishing. Because many people travel long distances and spend relatively large sums in order to hunt or fish, they contribute disproportionately to international tourism patterns and revenues. Malaysia could gain access to this market through the facilitation of international specialist tourist access to certain parts of the permanent forest estate, and this could therefore play a role in its long-term management.

Genetic and phytochemical resources

The great taxonomic diversity of tropical rain forests implies the extreme chemical richness which has recently begun to be documented (Janzen 1975, Rosenthal & Janzen 1979, Myers 1984). Thus, for example, a greater proportion of species contain alkaloids and other 'secondary compounds' than in any other kind of vegetation - and the average tissue concentration is also much higher. These secondary compounds include a wide range of chemicals derived from plant metabolism - for instance, cardiac and cyanogenic glycosides, terpenoids, glucosinolates, saponins, phytohaemagglutionins, proteinase inhibitors, flavonoids, and tannins.

Many important medicinal drug families have in fact originated in tropical forests (Elliott & Brimacombe 1986, Caldecott 1987, Plotkin in Anonymous 1988). Such drugs generate very large sums each year in sales revenue, but they are hard to identify in rain forests because the search must be conducted amongst a background of thousands of 'neutral' species and the chemicals they contain. The process can be simplified if forest-dwelling people are available as informants (*e.g.* Penans in Sarawak), since they will often have pre-screened the forest for useful materials. Information of this sort is routinely compiled by ethnobiologists (*e.g.* Perry 1980 for East and Southeast Asia, Quisumbing 1978 for the Philippines, and Chai 1975, 1978 and Pearce *et al.* 1987 for Sarawak).

Thus, for example, interrogation of the World Health Organization/University of Illinois NAPRALERT database in 1987 yielded about 358 Malaysian species of ethnomedical significance.

Tropical forest chemical products are hard to market for at least two reasons. Firstly, these products are often important as 'information' rather than as substances, since their role is usually to provide clues about the activity of new molecular families, which can then be explored and developed in a laboratory environment. Since information is highly portable, it is difficult to control access to this kind of forest product, and this is essential if it is to be sold. Thus, a country must be able to exert sovereign control over the information concerned until work is sufficiently advanced on each potential product that a valid international patent can be taken out (Yankey 1987).

Secondly, development of a product to this stage requires considerable investment, and more will be needed to bring that product to a marketable state. Once an international patent is secured, however, there is the option for this second, more expensive phase to be carried out by a private company under licence. Thus, if the country concerned cannot afford to market the product itself, at least it can expect to receive royalties for an extended period.

Analogous problems and opportunities apply to other plant products. A recent study in Cameroon (Thomas & Tobias 1987) identified numerous commercializable products in addition to potential pharmaceuticals, for example: molluscicides, insecticides, calorie-free sweeteners, spices, dyes, edible seeds and fruits, latex and resins.

Fruit resources

In the Malaysian context, fruit resources are represented by numerous underused species of *Mangifera* and *Citrus* (Jones 1985, Kostermans 1986, Lee 1987, Saw 1987, Bompard 1987), and edible seeds and perfumery products by engkabang and gaharu respectively. The two latter products serve to illustrate the potential value of rare components of the genetic resource base of hill dipterocarp forests.

Engkabang

These are the oil-containing seeds of certain species of *Shorea*, which are used in the manufacture of chocolate products. Because of the episodic nature of dipterocarp fruiting, the amount of engkabang produced varies greatly from year to year: in Sarawak, for example, from zero to more than 23,000 tonnes (Caldecott 1988b).

This pattern of production has discouraged investment in engkabang as a commercial crop. One variety of engkabang tree, a strain of *Shorea stenoptera* has been found in West Kalimantan which commences fruiting at less than three years of age, and flowers annually. All specimens appear to derive from one tree whose fruit was collected in 1940 (Anderson 1975).

Gaharu

This is a deeply fragrant woody material which is produced by certain trees when attacked internally by fungus, and is significant because of its high market value. It has been used in perfumes, incense and medicines in China, India and West Asia for more than a millenium (Burkill 1935). The trees concerned are: *Aetoxylon sympetalum,* a West Sarawak/West Kalimantan endemic, which produces the 'true' gaharu and which is now almost extinct; and *Aquilaria malaccensis,* a very rare tree of dipterocarp forests in northern Sarawak and elsewhere in Southeast Asia, from which most gaharu now derives. The process of harvesting gaharu usually involves the destruction of trees which look as if they might be infected, and there is a clear role for artificially propagating these trees and inoculating them with the fungus to secure long-term supplies in Malaysia.

The proposed EVMS could accomodate the use of genetic and phytochemical resources in several ways. Firstly, some resources will be secured as a side-effect of managing a stand for wild meat production, since they are represented by wild fruit trees which may later be domesticated. Further management of residual stands already assigned to this role would involve screening of surviving fruit trees for economic significance.

Secondly, certain trees - such as *Aquilaria,* and others with established ethnomedical significance - could be added to the list of trees for special treatment so that they would be recorded during a prefelling inventory and protected during logging. Such resources would then be available for later follow-up work.

Thirdly, where forest-dwelling people occur in or near areas to be placed under extended VMS management, or have recently been resettled therefrom, their ethnobiological knowledge should be reviewed. Standard techniques for collecting and processing such data are now available (*e.g.* Elliott 1986), and this would be a cost- and time-efficient way to identify genetic and phytochemical resources within the management area. These would then be available for further study.

Regardless of whether or not specific action would be required in any particular forest stand, the information obtained could contribute to an exclusive database under governmental control. This would be available to support long-term work leading to the patenting, production and marketing under licence of pharmaceutical and other phytochemical products.

Conclusions

Existing hill forest management practices in Malaysia need to be reformed if the permanent production forests are to be exploited efficiently and sustainably for wood outputs (Tang 1987). This would involve introducing a Variable Management System (VMS), which would rely on prefelling inventories to allow a choice of cutting regime with a cycle of between 20 and 60 years, depending on individual stand characteristics. This change would be accompanied by a reallocation of management resources on the basis of relative cost-effectiveness, and a strong plantation forestry programme to relieve natural forests of part of their wood-producing role.

It is here further argued that other kinds of forest productivity could also be managed under an 'extended' Variable Management System (EVMS). These are the various non-wood products, many of which have significant economic potential and which could therefore contribute to revenues from natural production forests.

It is relevant to ask how the benefits of using an EVMS would be realised, by whom and over what period? This is crucial, since without adequate incentives the extra investment which the EVMS would demand (in terms of prefelling fieldwork and foregone short-term timber production) would deter both the private and public sectors.

The key incentive for long-term management of any biological resource is long-term ownership of that resource. Moreover, this ownership has to be exclusive, not general, and applied at an apparopriate level of management. Thus, a managed hunting reserve needs to be either relatively small and controlled by one rural community, or relatively large and controlled by one company; multiple-ownership in each case would lead to competitive exploitation and damage to the resource base.

Therefore, in terms of efficient management, any one area of permanent hill forest ought to be assigned on a long-term basis to one and only one managing agency. In areas close to and readily accessible by a rural community, that community might well fulfil the role of such agency, but elsewhere private-sector companies would be involved. In the former case, community wellbeing would provide an incentive for proper management, while in the latter the salaries and careers of the managing personnel would be dependent upon maintenance of a sustainable harvest. The time-scale of ownership involved would be some multiple of the life-cycle of the timber harvest, since this is the crop with the longest rotation.

Thus, an effective duration of ownership for most hill forests would be based on multiples of the minimum sustainable cutting cycle, which appears to be on the close order of 60 years. In effect, then, the basic management unit of the proposed EVMS would be a company holding a 120-year timber harvesting licence for a large area of state land, renewable at mid-term subject to satisfactory fulfilment of terms, including maintenance of the forest in a state which allows a continued stable log harvest.

A model of clear relevance to this system is the Sabah Foundation, which was established in 1966 and holds a 100-year concession covering 973,000 *ha* of Sabah (Marsh 1988). It may be impossible now to make arrangements concerning such large areas elsewhere, but the incentive effect of so doing may nevertheless be simulated by making licences for smaller (but still large) areas renewable, or by combining small concessions into large, long-term management units. An important factor would be the requirement that the companies involved make substantial early investment in downstream wood processing facilities integrated with their concessions, and that indigenous wood processing is protected by high tariffs applied to log export.

The same concession-holding companies would be permitted to exploit all non-wood resources within their licensed areas for the duration of the licence, and with the same condition to be fulfilled regarding the continued productivity of the resources concerned. Such exploitation would be carried out by subsidiaries or venture-partners of the principle tenant, or by independant specialist companies acting with its permission. Government agencies would have a supervisory role throughout the tenure of the overall licence.

It would also be feasible for licences to be issued by government in respect of specified resources only, so that multiple complementary permits could apply simultaneously to one area. In this case, the responsibility of government to coordinate and reconcile the licensed activities would be of paramount importance, since no concession holder would have an interest in maintaining the productivity of resources other than those for which it holds a licence. In any event, government would also have an important role in applying appropriate financial incentives, particularly involving relief from taxation, in order to encourage investment into the non-wood sectors of the resource base.

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