

The effects of urbanization on Doi Suthep-Pui National Park

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Abstract

This paper explores the changing relationship between Chiang Mai city and Doi Suthep (doi=mountain), since before the city's foundation nearly 700 years ago. Doi Suthep has great spiritual, cultural and religious significance for Chiang Mai's citizens. It features prominently in several legends, which symbolize the triumph of civilized city-dwellers over savage, forest-dwelling hunter-gathers. The spiritual significance of the mountain probably arose as a result of Chiang Mai's early citizens' dependence on it for water, timber and other forest products.

Today, however, this relationship is changing. The mountain still plays a vital role in Chiang Mai's economy, no longer as a provider of essential natural resources, but as a tourist attraction. The mountain remains an important water catchment area and is also important for wildlife conservation, due to the high biodiversity of its forests and the presence of many rare species. It has a long history as a site for scientific research and as an outdoor laboratory for students. For all these reasons, Doi Suthep was made a national park in 1981.

However, in the rush to profit from tourism, the mountain's forests and wildlife are being destroyed. The effects of the city on Doi Suthep are i) direct encroachment of urban sprawl on to the mountain; ii) construction of infrastructure (roads, resorts etc.) often to meet the needs of mass tourism; iii) expansion of agriculture, stimulated by the proximity of Chiang Mai as a growing market for agricultural produce and iv) an increase in hunting, which has resulted in the extirpation of all large mammal species.

In contrast, increased development in the city has brought with it the economic prosperity needed to fund conservation, as well as an affluent middle-class, which has formed conservation organizations, such as the For Chiang Mai Group, which actively campaign for the conservation of Doi Suthep.

INTRODUCTION

In a little over a year's time Chiang Mai's citizens will celebrate the 700th anniversary of the foundation of their city by King Mengrai in 1296. Throughout this period, a very special relationship has developed between the city and Doi Suthep, the mountain which dominates Chiang Mai to the west. For Chiang Mai's earliest inhabitants, their very survival may have depended on the mountain and its forests. Timber from the forests would have been used to construct the first houses. The early citizens would also have relied on Doi Suthep for clean water. Up until about a hundred years ago, the city's drinking water came from the stream called Huaykaew ("crystal stream"). An aqueduct carried its waters from the waterfall near

Wat Palad, on Doi Suthep's lower slopes, over the city walls at the north-west bastion called Hua Lin ("head of aqueduct"). During times of hardship, such as droughts and famine, when agriculture failed, the early citizens of Chiang Mai may have turned to the mountain as a source of food. Even today, it is common to come across people collecting bamboo shoots, chestnuts, mushrooms and wild vegetables on the mountain. Chiang Mai's early citizens might also have relied on the mountain for their health, since a great many medicinal plants grow there and are still collected today. It is, therefore, hardly surprising that Chiang Mai's inhabitants bestow on Doi Suthep great spiritual, cultural and religious significance.

ANCIENT LEGENDS

The spiritual significance of the mountain extends back even before the foundation of the city. The guardian spirits of Chiang Mai, Pu Sae and Ya Sae, originated about 1,300 years ago when the area was occupied by the Lawa tribe, the earliest known inhabitants of Chiang Mai area. They were probably forest-dwelling hunter-gatherers; head hunters, possibly even cannibals. Legend has it that the Lord Buddha, while travelling in this region, persuaded Pu Sae and Ya Sae to forswear their cannibalistic traditions. Their son, Wasuthep (Sudeva Rikshi), went even further. He gave up all meat for the rest of his life, became a monk and lived for many years as a hermit in a cave on Doi Suthep. In fact, the name of the mountain, "Suthep" is probably derived from his name.

Today the spirits of Pu Sae and Ya Sae are believed to roam the lower slopes of Doi Suthep and every year, at the beginning of the rainy season, these spirits are honored in an elaborate ceremony, which combines elements of Buddhism and Lawa religious beliefs, involving the sacrifice of a young male buffalo. By keeping alive this tradition, perhaps Chiang Mai's citizens are acknowledging their historical dependence on the natural resources of Doi Suthep, which played such a vital role in the city's foundation.

Another ancient legend, in which Doi Suthep features prominently, also involves a Lawa chieftain called King Luang Virangka who lived on the lower slopes of the mountain, near the present-day airport. He fell in love with Queen Chamadevi, a Mon queen who, more than 1,000 years ago, founded the Kingdom of Haripunchai, based at Lampoon, 26 km south of Chiang Mai. The Mon were a civilized, Buddhist, pale-skinned race and Queen Chamadevi refused to marry the Lawa chieftain because he was a dark-skinned, uncivilized cannibal. The Lawa chieftain tried every means to win over the Mon queen, but to no avail. Eventually he lost patience and stormed Lampoon city with his army, only to be defeated by the Queen's twin sons mounted on a magical elephant. Eventually the Queen called a truce, at which she promised to marry King Virangka if he could throw a javelin from the summit of Doi Pui (the uppermost peak on Doi Suthep) to anywhere within the walls of Lampoon - a distance of about 30 km. King Virangka accepted the challenge and was allowed three attempts. On the first attempt his javelin landed very close to, but just outside, Lampoon city walls. This astonishing feat so terrified the Queen that she decided to sabotage his efforts by sorcery. She made an enchanted hat out of her undergarments and sent it to King Virangka, as he rested before his second throw. King Virangka accepted the gift, but no sooner had he put it on than the hat sapped away his supernatural strength. His second throw went just 5 km, landing at Mae Hia. So distraught was the Lawa chieftain that he threw his javelin high into the air, tore off his shirt and allowed the falling weapon to pierce his chest—dying literally of a broken heart. His body was laid to rest somewhere near the summit of Doi Pui.

What both these legends symbolize is the triumph of a civilized rice-growing nation over a savage hunter-gather society: in short, the victory of city over forest.

CHANGING VALUES

Today Doi Suthep still plays a vital role in Chiang Mai's economy, no longer as a provider of natural resources, but as a tourist attraction; tourism being the province's most important industry. Nearly a million tourists visit the mountain each year, to see Phra That temple, the King's Palace and hill tribe villages. Furthermore, Doi Suthep is of great importance for wildlife conservation, scientific research and education, due to its high biodiversity and the presence of rare species. It also remains an important water catchment area (still providing water to much of the western side of the city). For all these reasons the mountain was made a national park on 14th April 1981.

FORESTS AND WILDLIFE

There are two basic types of forest on the mountain: deciduous forest below about 1,000 m elevation and evergreen forest above. The deciduous forest is further divided into two kinds; deciduous dipterocarp-oak forest in the driest areas and mixed evergreen-deciduous forest along streams and gullies.

In the deciduous dipterocarp-oak forest, the common trees include members of the Dipterocarpaceae (e.g., *Dipterocarpus obtusifolius*, *D. tuberculatus*, *Shorea siamensis* and *S. roxburghii*) and Fagaceae (e.g., *Lithocarpus sootepensis* and *Quercus kerrii*).

Many trees of the deciduous dipterocarp-oak association support large numbers of epiphytes (plants growing on, but not penetrating another plant) including ferns (e.g., *Drynaria rigidula* (Polypodiaceae)) and orchids (e.g., *Cymbidium simulans* (Orchidaceae)). One of the most curious, however, goes by the Latin name of *Dischidia major* (Asclepiadaceae). Growing on tree branches, epiphytes face many problems, one of which is a shortage of nutrients because they are not rooted in soil. *Dischidia major* obtains nutrients by means of a close relationship with ants. Some of its leaves are swollen and hollow and ants are somehow attracted to build their nests inside. The debris from the ants' nests is rich in nutrients and *Dischidia major* grows nodal roots into the ants' nests to absorb the nutrients.

The ground vegetation includes many deciduous perennial grasses (e.g., *Apluda mutica*, *Arundinella setosa* etc.), sedges (e.g., *Rhychospora rubra*, *Carex continua* etc.) and other assorted herbs such as *Curcumophora longifolia* (Zingiberaceae), *Geniosporum coloratum* (Labiatae) and *Liparis sutepensis* (Orchidaceae).

One of the most interesting mammal species of the deciduous dipterocarp-oak association is the Burmese ferret-badger (*Melogale personata*), which is still quite common on Doi Suthep, though rarely seen, because it is active only at night, spending the daytime in a burrow. It feeds on birds' eggs, snails and lizards. Its black and white coloration warns of an

unusual defense mechanism. When threatened, it sprays a foul-smelling liquid into the face of the predator from a gland near its anus.

In mixed evergreen-deciduous forest, the trees are generally taller (15-20 m high) than those of the deciduous dipterocarp-oak association and the canopy more or less closed except during the dry season. One of the most characteristic trees is *Dipterocarpus costatus* (Dipterocarpaceae), easily recognized by its long, straight, light grey trunk, compact crown and grey-green foliage. A great number of tree species grow in the mixed deciduous association, none of which approach dominance and many have very beautiful flowers e.g., *Bauhinia variegata* (Leguminosae, Caesalpinioideae) and *Metadina trichotoma* (Rubiaceae).

Amongst the ground flora, are many interesting species, including *Amorphophallus krausei* (Araceae). A great many woody climbing plants (lianas) grow in mixed deciduous association (e.g., *Spatholobus parviflorus* (Leguminosae, Papilionoideae)).

Above about 1,000 m elevation, evergreen forest contains a very wide range of tree species. Although no species become dominant, trees of the families Magnoliaceae (e.g., *Talauma hodgsonii* and *Michelia champaca*) and Fagaceae (e.g., *Castanopsis armata* and *Quercus lanata*) are characteristic. The canopy is dense and consequently, the undergrowth consists mainly of tree saplings and shade-tolerant shrubs, such as *Phlogacanthus curviflorus* (Acanthaceae).

The evergreen forest on Doi Suthep is home to several species of parasitic plants, which absorb nutriment from the roots of other plants, rather than carrying out photosynthesis themselves. One of the most curious groups of parasitic plants on Doi Suthep is the genus *Balanophora*. So peculiar is the structure of these plants, that early botanists thought at first that they were some form of mushroom. Closer examination, however revealed the male and female parts of flowering plants. They form large tubers on the roots of several plant species. *Balanophora* spp. are exceedingly rare, but on Doi Suthep, four species are present.

Doi Suthep's evergreen forest provides an important stop-over for birds, during their annual migrations. Many birds stop to feed there, before resuming their travels (e.g., grey nightjar (*Caprimulgus indicus*), slender-billed oriole (*Oriolus tenuirostris*) and orange-flanked bush-robin (*Tarsiger cyanurus*). Thus, Doi Suthep is important not only for local birds but also for birds which may nest in distant countries. Some of Doi Suthep's more colorful resident bird species of the evergreen forest include iridescent green pigeons (*Treron* spp.), barbets (*Megalaima* spp.) and leafbirds (*Chloropsis* spp.), orange and black minivets (*Pericrocotus* spp.) and broadbills (e.g., *Serilophus lunatas*) and tiny blue fly-catchers (*Ficedula* spp.).

The evergreen forest is home to many squirrel species e.g., the belly-banded squirrel (*Callosciurus flavimanus*) (easily recognized by a bright orange patch on its abdomen), and it is a last refuge for Doi Suthep's remaining larger animals, including stump-tailed macaques (*Macaca arctoides*), common palm civets (*Paradoxurus hermaphroditus*), leopard cats (*Felis bengalensis*), porcupines (*Hystrix brachyura* and *Atherurus macrourus*) and barking deer (*Muntiacus muntjak*). The slow loris (*Nycticebus coucang*) may also still survive there.

BIODIVERSITY

Despite centuries of disturbance, Doi Suthep still retains a remarkably diverse flora and fauna. Over the past few years, information on all of Doi Suthep's vascular plant species, based on the collections of J.F. Maxwell, have been entered into a computer database at CMU Biology Department Herbarium. The database now holds information on 2,092 species (including 13 new records for Thailand). To put this figure in perspective, it is about 50 % more species than the entire flora of Great Britain, an area 1,000 times larger than Doi Suthep. The richest habitat is mixed evergreen-deciduous forest, with 1,135 species (or 54 % of the park's flora), even though this forest type covers only 18 % of the park's area.

A survey carried out by staff and students of the Biology Department, Chiang Mai University found that Doi Suthep's deciduous forest has the highest tree species richness (about 90 per hectare, of dbh \geq 10 cm) of any other deciduous tropical forest in the world, so far surveyed (ELLIOTT *et al.*, 1989a). Such a unique genetic resource is of world-wide importance and deserves the strongest possible protective measures.

Animal species include at least 326 birds (ROUND, 1984), 500 butterflies (PINRATANA, 1977-85), 300 moths (BANZIGER, 1988), 61 mammals (CONSERVATION DATA CENTRE, pers. comm., ELLIOTT *et al.*, 1989b), 28 amphibians and 50 reptiles (NABHITABHATA, 1987); all in a national park which covers just 261 km².

RARE SPECIES

Doi Suthep is a last refuge for many rare species. Fifty of Doi Suthep's orchid species have been declared by the International Union for the Conservation of Nature as endangered, threatened or rare. Seven of them are found nowhere else in the world (BANZIGER, 1988), including *Dendrobium parvum* Seid., a species new to science, discovered on Doi Suthep by J.F. Maxwell in 1987. Two of Doi Suthep's parasitic *Balanophora* spp. (*B. abbreviata* and *B. fungosa*) are threatened with extinction (BAIN & HUMPHREY, 1982). In 1958 K. Larsen discovered a curious violet, saprophytic plant *Sciaphila thaidanica* on Doi Suthep (LARSEN, 1961). Since then, however, there have been no further records of this strange Doi Suthep endemic.

The crocodile salamander (*Tylostrotion verrucosus*), an amphibian, is endangered with extinction. It lives only high-altitude ponds, and in Thailand it is found in only four localities, one of which is Doi Suthep (BEAVER, 1982). At least 22 of Doi Suthep's bird species are rare or threatened with extinction, including the giant nuthatch (*Sitta magna*), silver pheasant (*Lophura nycthemera*), wedge-tailed green pigeon (*Treron sphenura*), Jerdon's Baza (*Aviceda jerdoni*), fire-capped tit (*Cephalopyrus flammiceps*), 5 species of thrush (*Turdus* spp.), rufous-faced warbler (*Abroscopus albogularis*), pygmy blue flycatcher (*Muscicapella hodsoni*) and Tristram's bunting (*Emberiza trastrami*) (CONSERVATION DATA CENTRE, pers. comm., BAIN & HUMPHREY, 1982). BAIN & HUMPHREY (1982) list two of Doi Suthep's mammal species as threatened with extinction, viz. the leopard cat (*Felis bengalensis*) and the white-bellied flying squirrel (*Petinomys setosus*).

SCIENTIFIC RESEARCH

The high biodiversity of Doi Suthep has attracted scientists, since the turn of the century, making Doi Suthep's forest one of the most intensely studied in Thailand. One of the first scientific expeditions to the mountain was that led by the German botanist, Dr. Carl Hosseus in 1904 (HOSSEUS, 1908). Shortly afterwards Dr. A.F.G. Kerr, an Irish physician and botanist stationed in Chiang Mai, collected several thousand botanical specimens from Doi Suthep and many plant species are named after him (JACOBS, 1962, KERR, 1911). The collections of Hosseus and Kerr contain several hundred previously unknown species, some of which are endemic and a few have never been collected since (MAXWELL, 1988). Later studies of the vegetation were carried out by OGAWA *et al.* (1961), KUCHLER & SAWYER (1967), SAWYER & CHERMSIRIVATHANA (1969), BEAVER & JINOROSE (1974) and CHEKE *et al.* (1979). MAXWELL (1988) provides the most recent account of the vegetation of Doi Suthep.

Transport up Doi Suthep for early explorers was basic. COCKERALL (1929) wrote: "When the day came, early in February, to ascend Doi Sutep, we were taken in an automobile to the foot of the mountain, where we found awaiting us a group of men with chairs on poles, to convey us up the steep slopes" He described Doi Suthep as "a veritable paradise for botanists" and it remains so to this day.

Doi Suthep has also been important as a field site for the study of birds (DEIGNAN, 1945; DICKINSON & CHAIYAPHUN, 1967; ROUND, 1984; BEAVER & SRITASUWAN, 1985), reptiles and amphibians (NABHITABHATA, 1987) and insects (MALICKY, 1987; BANZIGER, 1985; BANZIGER & FLETCHER, 1988). Such a long history of scientific study is of immense value in providing base-line data, against which long term change, whether natural or man-made may be compared.

Doi Suthep is of crucial importance to the science of taxonomy, the naming and classifying of organisms (BANZIGER, 1988, 1989; MAXWELL, 1989). Because of its long history of scientific research, many species were first named from specimens collected from Doi Suthep. Such specimens are known as type specimens, and the locality from where they were collected as the type locality. Scientists wishing to confirm identification of organisms must compare their specimens with the type specimen. In the event of a type specimen being destroyed, scientists must return to the type locality and search for a specimen matching the description of the type specimen. Doi Suthep is the type locality of at least 279 vascular plant species (CMU Biology Department Herbarium Database) and 60 animal species (BANZIGER, pers. comm.).

Doi Suthep's high biodiversity is potentially of great economic value. In particular, its high tree species richness could play an important role in forest restoration projects. Compared with other regions of Thailand, the north has suffered least from deforestation. Even so, between 1961 and 1985, the region lost 28 % of its forest (TDRI, 1987). In Chiang Mai Province alone, the area of deforestation doubled in the ten years between 1975 and 1985 from 323,458 ha to 651,302 ha (GRID, 1988). At this rate, there will be little forest left in about 10 years.

Doi Suthep, with its many tree species, suited to a wide range of soil and climate conditions, could provide a valuable seed source, for the use of native tree species in forest-restoration

projects. However, in order to restore natural forest ecosystems to degraded areas within national parks and wildlife sanctuaries, a much better understanding of how such ecosystems function is needed and this will require a great deal of research. At the Biology Department, Chiang Mai University we are carrying out some of that research, using Doi Suthep as our study site (ELLIOTT *et al.*, 1994). We have studied the annual cycles of leaf, flower and fruit production of trees growing on the mountain (ELLIOTT, PROMKUTKAEW & MAXWELL, 1994) and investigated which soil and climatic factors determine the distribution of different tree species.

A generous grant from Riche Monde (Bangkok) Ltd. has enabled us, in co-operation with the Royal Forest Department, to build a new Forest Restoration Research Unit (FORRU-CMU) near Doi Suthep-Pui National Park Headquarters. The unit will carry out research to determine the most effective methods to propagate as many native forest tree species as possible, for forest restoration projects.

DOI SUTHEP'S EDUCATIONAL VALUE

As well as providing a natural laboratory for scientists, Doi Suthep is an outdoor classroom for university students and school children. It is ideally situated near to Chiang Mai University campus, and is of vital importance in providing material for demonstration purposes during lab sessions for biology classes and a convenient site for field trips for ecology and environmental science students. As well as Chiang Mai's two universities and many schools, community groups such as the YMCA also use Doi Suthep as a base for educational camps. As Chiang Mai becomes more urbanized, school children are becoming increasingly more detached from nature. However, the school children of Chiang Mai are more fortunate than most city children, in having a national park nearby, where they can study zoology and botany or learn about human dependence on nature.

IMPACT OF CHIANG MAI CITY ON DOI SUTHEP

The rapid expansion of Chiang Mai, as a city and a tourist centre, has had four main detrimental effects on Doi Suthep:

- i. direct encroachment of urban sprawl on to the mountain;
- ii. construction of infrastructure (roads, resorts etc.), to meet the needs of mass tourism;
- iii. expansion of agriculture, stimulated by the proximity of Chiang Mai as a growing market for agricultural produce and
- iv. an increase in hunting of animals and collection of plants for the horticulture trade.

The urban sprawl of Chiang Mai spreads right up to the foot of Doi Suthep and in many places it crosses the boundary of the national park. Fueled by the phenomenal increase in land prices since the late 1980's, all kinds of underhanded methods are used to obtain land ownership documents within the national park for development and speculation. Buildings within the park include Forest Department facilities and privately owned development projects. In addition, no fewer than 39 government agencies (TV transmitters, agricultural research stations, police and army posts etc.) lay claim to about 10 km² of the park. A draft management plan for Doi Suthep-Pui National Park, compiled by staff of the Faculty of

Forestry, Kasetsart University in 1988, listed 7 settlements occupied mostly by Thais and 6 hill tribe villages, including Huay Kaeo, Mae Hia Nai, Mae Hia Nork, Nong Quai, Ban Pong, Mae Sa, Pah Hah, Doi Pui, Chang Khien, Taad Mork, Mae How, Mae Lod and Mae Sa Mai.

In 1964 a survey recorded 369 people living inside what was to become Doi Suthep-Pui National Park. They were permitted to stay for the remainder of their lives, but were not allowed to sell their land. Only 148 people insisted on staying, but they were soon joined by immigrants, arriving in droves, to cash in on the tourism boom. By 1981, the number of people living in the park had increased to 1,956, and by 1988, the population had exploded to 13,694. Government officials advocate a pragmatic approach to the problem, by bringing encroachers to court on a case-by case basis, rather than employing draconian measures to expel them all. However, such legal battles are lengthy and complicated, due to ambiguous or forged land rights documents, often obtained with the connivance of corrupt officials. Several thousand such court cases would have to be fought to remove all encroachers from the park. Between 1987 and 1991, only 67 were successfully prosecuted and ordered to leave.

Many development projects, which encroach into the national park, have been constructed, to profit from the tourism boom. Most are along the Mae Rim-Samoeng Road, which cuts through the northern part of the national park. They include the Ton Dong restaurant (km 9), Mae Sa Elephant Camp (km 10), Pong Yang Garden Village (km 14) and part of Erawan Resort (km 15).

Another form of tourism infrastructure, which has caused great damage to the park, is the construction of new roads and the upgrading of dirt tracks into tarmac roads. This has three main adverse effects:

- i. construction activities damage the vegetation, thus further degrading the forest and increasing soil erosion, causing siltation of water courses,
- ii. improved access facilitates activities, which damage the forest e.g., hunting, collecting butterflies and orchids for sale, rubbish dumping, tree felling etc., and increases the risk of forest fires and
- iii. the sense of wilderness, sought by many people who walk in the forest, is destroyed.

The irony is that most tourists themselves do not want new roads and resorts in the national park. A survey conducted in 1989-1992 (ELLIOTT, 1992) found that one in five foreign tourists and one third of domestic tourists visit Doi Suthep during their stay in Chiang Mai. Altogether nearly a million tourists visit the mountain each year, generating 2 million baht income to the national park and incalculable revenue to hotels and other businesses in Chiang Mai. Nearly seventy per cent of Doi Suthep's visitors go to see Phra That temple, but walking along forest trails and visiting waterfalls are also very popular (with 66 % and 63 %, respectively, of visitors engaging in these activities). Surprisingly, touring by motor vehicle was one of the least popular activities, so expansion of the road system cannot be justified as satisfying the demands of tourists. Most visitors were satisfied with the present road system within the park, and saw no need to expand it. Also, the majority disagreed with the idea of constructing a hotel or cable car within the park. Tourists were clearly aware of environmental degradation on Doi Suthep. Seventy-seven per cent thought that the park had been spoilt by

garbage, 69 % complained about deforestation and 58 % felt that the park had been spoilt by too much tourism development. Any further degradation of the mountain could, therefore, have serious consequences for Chiang Mai's tourism-based economy.

The rapidly increasing human population living in or near Doi Suthep, coupled with the growth of Chiang Mai as a market for agricultural products, has led to a huge expansion of agriculture within the national park. This has also been encouraged by several government agricultural research stations situated inside the national park, which promote new crops and cultivation methods. About 44 % of the park is now covered by agriculture.

Urban sprawl, tourism development and agricultural expansion have all contributed to forest destruction on Doi Suthep. Nearly 60 % of the park has been deforested.

However, even where the forest survives, there are few large animals due to hunting. Roads now enable hunters to reach previously inaccessible areas and hunting is growing as a recreational pastime for city dwellers. Hunting is responsible for the disappearance of all large mammal species (except barking deer, *Muntiacus muntjak*) from Doi Suthep, including gibbons (*Hylobates lar*), bears (*Ursus thibetanus*), sambar deer (*Cervus unicolor*) and wild boar (*Sus scrofa*). All of these species were common on the mountain just twenty years ago. Hunting has also exterminated at least ten bird species including all species of hornbills (formerly five hornbill species were present (DEIGNAN, 1945; ROUND, 1984)) and vultures. Even now, hunting continues unabated. The sound of gunfire may be heard almost anywhere on the mountain. Hunters' platforms and the remains of wildlife barbecues are commonly found. With the extermination of all large animals from the park, hunters now turn their attention towards the smaller animals: squirrels and song birds. In several areas, where once the forest echoed with the sound of bird song, there is now an eerie silence. The hunting on Doi Suthep is not carried out for subsistence, but merely for sport.

The loss of some animal and bird species may be of crucial importance to the survival of the forest as a whole. Many birds, bats and flying squirrels are important pollinators of trees. Many seeds are unable to germinate unless they have passed through the digestive tract of a hornbill or gibbon. Many tree species rely on animals to disperse their seeds well away from parent trees, for their seedlings to establish. If key seed-dispersing animal species disappear, the trees will be unable to reproduce. As the older trees die, they will not be replaced with younger ones and slowly the forest will become poorer in tree species.

Plants are also threatened by unscrupulous collectors. Two species which have disappeared from Doi Suthep in recent years include *Mussaenda sandariana* (Rubiaceae) (COCKERRELL, 1929), collected for its ornamental value and *Psilotum nudum* (Psiloaceae), which is of great scientific interest, since it is the most primitive of vascular plants found in Thailand (MAXWELL, pers. comm.). Perhaps the saddest loss, however, has been that of the fabulous lady's slipper orchid (*Paphiopedilum callosum*), which was probably removed from the park by collectors for the horticulture trade (BANZIGER, 1988).

CONCLUSIONS

Although Doi Suthep has lost several species, it still retains a diverse flora and fauna of great scientific and educational value. Doi Suthep must now serve many functions. As well as being a refuge for wildlife, it is a religious and cultural centre, a watershed protection area, a tourist attraction, a site for recreation, education and research, as well as providing a spectacular backdrop to the city of Chiang Mai. With so many different demands made upon such a small area, it is hardly surprising that conflicts of interest arise. However, such conflicts must be resolved if Doi Suthep's forest and wildlife are to survive. Ways must be found to:

- i. prevent further destruction or deterioration of the surviving forest areas;
- ii. restore the natural forest ecosystem where they have been destroyed or degraded;
- iii. prevent hunting of all animals and collection of rare plants and insects;
- iv. re-introduce extirpated species such as gibbons and hornbills and
- v. by education, increase local people's appreciation of Doi Suthep's wildlife and gain their support for the conservation objectives of the national park.

How can the development of Chiang Mai city contribute towards achieving these objectives? Firstly, all conservation activities require funding and without economic prosperity, there would be no funds available to finance conservation. There can be little doubt that Doi Suthep contributes significantly to the tourism industry in Chiang Mai, but there needs to be a mechanism, by which more of the wealth generated by tourism goes towards conservation.

In some areas, tourism development within the park is actually helping to bring back the forest. Around one of the Hmong villages, Ban Doi Pui, the development of the tourist trade has led to a decrease in the villagers' dependence on agriculture, and the forest is returning on abandoned fields. The villagers themselves have also planted native forest trees, to restore the watershed above their village.

Secondly, with the development of the city has come a better educated and affluent middle class, with greater appreciation of the mountain's cultural and conservation values. This has led to the formation of several community groups, which actively campaign for better protection for the national park. One of the best known of these is the For Chiang Mai Group, which came together when a consortium of developers proposed constructing a cable car from Chiang Mai Zoo, to carry tourists to Phra That Temple. They campaigned successfully to have the project shelved, and also ran a productive workshop, which brought together the various groups with an interest in the park's management.

The University is also playing its part. As well as the Forest Restoration Research Unit, the University is planning to build a conservation centre near the base of the mountain. The centre will provide exhibitions and audiovisual shows on the mountain's cultural and conservation importance.

Attempts are also being made to restore forest by tree planting. For the last two years students, villagers and government officials, with sponsorship from companies, have joined together to plant tree seedlings in deforested areas. The national park has established a nursery near Doi Pui to mass produce seedlings. More than 500 rai have been planted so far

and 200 rai per year will be planted over the next few years. However greater monitoring is needed, to determine if such tree-planting initiatives really are effective at restoring the forest.

Nearly 700 years ago, timber and water from Doi Suthep played a vital role in the founding of Chiang Mai city. Today the people of Chiang Mai are finally beginning to pay back their debt to this sacred mountain.

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