

RIVERS IN JEOPARDY: A VILLAGE COMMUNITY'S RESPONSE TO THE DESTRUCTION OF THEIR UPPER WATERSHED FORESTS IN THE MAE SOI VALLEY CATCHMENT, NORTHERN THAILAND

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ABSTRACT

Forest clearance in the upper watershed of the Mae Soi catchment led to severe soil erosion and the subsequent drying up of streams to the valley. In a self-help community effort, the lowland villages are restoring their forests, using native species and encouraging natural regeneration by laying tanks and water pipes on the vertical ridges of the catchment and establishing strict measures against fire.

Seeds are collected locally so trees grown are genetically suited to local conditions and germinated in local soil to retain mycorrhizal associations. The survival of planted seedlings proved poor on slopes subjected to repeated cultivation and lack of research prevented the adoption of more successful methods. Reforestation here was best carried out by allowing natural regeneration to take place with judicious planting of proven hardy species. Later seed collection has concentrated on species formerly dispersed by animals now extirpated from the area.

After 8 years, forest cover has been sufficiently restored to establish perennial flow of the Mae Soi River, together with the return of much wildlife. However, because of a long-standing conflict involving rights of settlement in forestlands, fires are deliberately lit to destroy reforestation efforts every year. The ultimate success of the project lies in the resolution of the current conflicts on watershed management.

INTRODUCTION

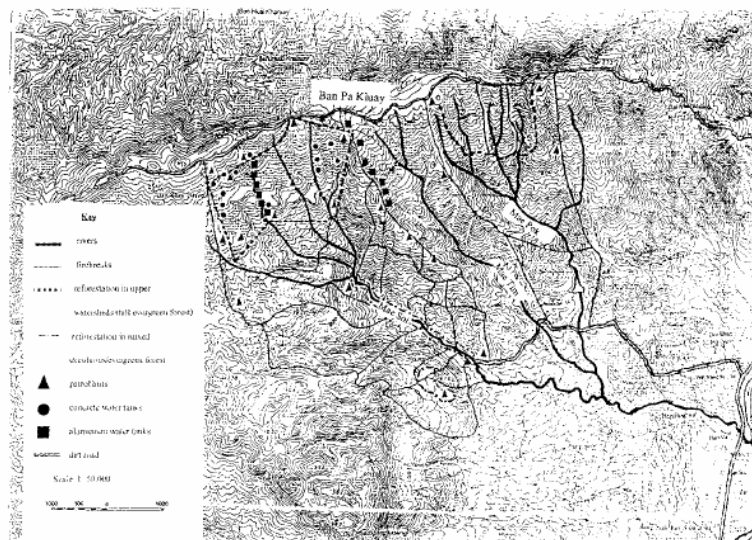
Destruction of upper watershed forests in northern Thailand is being caused by unsuitable land practices. The result is not only loss of forest resources but also soil erosion, siltation of reservoirs and the drying up of streams and rivers. Local people who depend on forest and water resources for their livelihoods are experiencing increasing hardship.

The Mae Soi valley catchment lies 74 km southwest of Chiangmai in the rain-shadow of Doi Inthanon, Thailand's highest mountain. Elevations range from 270 – 1,600 m above sea level. The upland area gives rise to three rivers, the Mae Soi and its two tributaries, the Mae Pok and the Mae Tim which are used to irrigate cultivation in the valley. The rivers flow into the Mae Ping, one of the four tributaries of the Chao Phraya, which together form Thailand's major river system.

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Destruction of the lowland forests of the Mae Soi catchment began in the 1940's with logging, followed by cattle-grazing and felling for charcoal-burning. However, while the headwater (upper watershed) forests remained intact, the rivers still flowed and were able to sustain the traditional cultivation of three annual crops in the valley. In the 1970's, migrant opium-growing peoples moved into the headwater forests, setting up the village of Ban Pa Kluay. With the help of foreign development aid aimed at opium eradication, the forests were soon being cleared for large-scale commercial production of cabbages. With the loss of the headwater forests, the streams to the valley began to dry up and the lowlanders could no longer grow enough food to feed their families.

Appeals to local authorities failed and the desperate villagers turned to their traditional centre of recourse, the monks. Phra Ajahn Pongsak, in the course of his 36 years as a forest monk, had come to understand how all life depends upon forest health and, together with the villagers, set up the Mae Soi Valley Project in response to their problems.



Map 1 The Mae Soi Catchment

The project works on two levels: first by arousing awareness of the importance of forest conservation through demonstration of their functions, and second, by launching rural development and forest conservation programmes. The first of these programmes is aimed at providing a living that does not depend on forest-degrading activities by the construction of an irrigation system of small reservoirs and feeder canals to create some 20 sq km of viable land for cultivation in the valley. The second programme is aimed at restoring the original forest ecosystems and so re-establishing the streams to the valley.

FOREST RESTORATION: METHODS AND ACTIVITIES

1. Upper Watershed Sites

Investigation by Ajahn Pongsak and village leaders proved that 21 km² of the headwater forests had been cleared at varying times, mostly between 1977 and 1984, noting history and vegetation cover. Priority sites for reforestation were identified, i.e. those where forest regeneration was not taking place due to competition from invasive weeds, notably *Imperata cylindrica*, lack of seed trees and poor soils due to repeated cultivation and irreversible changes in soil structure after annual fires.

Activities undertaken following the survey

1.1 Construction of nurseries

Four nurseries were constructed, 2 in the lowlands and 2 in the uplands, water being piped in from nearby streams or head-waters.

1.2 Seed Collection

It was observed that the pioneer species appearing on the poorest soils colonised by *Imperata* were legumes, small herbs and then shrubs such as *Pueraria thomsonii*. In more level, moister places, a number of species were regenerating naturally, many of them oaks and false chestnuts. As these had been an important component of the former climax forest, the first seed collections concentrated on the Fagaceae, together with legumes. Fagaceae collected included *Quercus semiserrata*, *Castanopsis tribuloides*, *C.acuminatissima*, *C.diversifolia*, an unidentified *Lithocarpus* species, whilst legumes collected were *Archidendron clypearia* and *Dalbergia fusca*. Several species of Magnoliaceae were present in the remnants of the original forest and an abundant source of *Michelia champaca* was found, which was added to the initial seedlings raised in the upland nurseries.

Seed collection in later years concentrated on those trees providing food for wildlife – flowers or fruits – in order to attract back former animal species now extirpated from the area. Besides the oaks and false chestnuts, *Helicia nilagirica* is proving particularly useful in attracting small rodents (Muridae), squirrels (Sciuridae) and porcupines (Hystricidae). This tree species is able to withstand drought and full exposure to sunlight, unlike species with large fleshy fruits, which seem to require greater shade and moisture. Other food tree seeds collected were *Artocarpus lakoocha*, *Melia toosendan*, *Turpinia pomifera*, *Phoebe cathia*, *Garcinia cowa*, *G.xanthochymus*, 3 *Ficus* species, *Eugenia albiflora* and *Choerospondias axillaris*.

In addition, more than 300 seedlings of *Prunus cerasoides* were provided by the Royal Forest Department.

1.3 Germination

Fagaceae: It was found that only fruits very recently fallen to the ground or actually picked ripe off the trees germinated. Approximate germination success rates of viable seeds were as follows:

<i>Quercus semiserrata</i>	over 90 %
<i>Castanopsis tribuloides</i>	70-80 %
<i>C. acuminatissima</i>	70-80 %
<i>C. diversifolia</i>	60-70 %
Unidentified <i>Lithocarpus sp.</i>	over 95 %

Leguminosae: Seeds were soaked for 24 hours before sowing. Approximate germination success rates were 50-60% for *Dalbergia fusca* and 70-80% for *Archidendron clypearia*.

Michelia champaca: Ants attacked arils surrounding the seeds, so the arils were removed before sowing the seeds. Subsequently a success rate of 80 % germination was achieved.

Helicia nilagirica: No treatment was required before sowing. The germination success rate achieved was nearly 100%, since most seeds collected were already sprouting.

With the exception of *Eugenia albiflora*, where 70 – 80 % of seeds collected germinated, germination of food tree seeds was very poor. Notable amongst them have been all *Ficus* species and those having fleshy fruits with hard stones, all important components of the forests we hope to restore. Using methods suggested by FORRU and research by Dr Kate Hardwick, we hope to be more successful next year.

After the treatment specified, all seeds were sown straight into plastic bags 18 x 6 cm filled with forest soil so as to retain the mycorrhizal associations. Upland and lowland nurseries have 2-3 workers each (depending on number of seedlings to be cared for), one supervisor on the ridges and one overall supervisor.

1.4 Planting

1.4.1 Site preparation: Weeds are removed in metre-wide strips, 2 metres apart, the strips running across (rather than vertically) the slopes to minimise erosion. Where *Imperata* is present, care is taken to dig out the full rhizome mass and any tree saplings already established naturally are left to grow. Tree seedlings have been planted at 2 m x 2m spacings in all the experiments at Mae Soi to date. However, 3 trial plots of 1.6 ha (10 rai) each are being prepared for this year's planting where holes will be dug 1.5 metres apart, using 30,000 Fagaceae seedlings presently being raised in the nurseries.

1.4.2. Planting methods: After weed removal, holes are dug to about 20 cm deep. When planting, the most humus-rich top soil is used to fill the hole first and the seedling placed in a small depression in order to conserve moisture as Mae Soi being in a rain-shadow, has less rainfall than the neighbouring catchments. The cut weeds are then piled around the seedlings as mulch. Many planting methods have been tried.

With or without bag removal: we were advised that seedlings would suffer root damage when removed from their plastic bag containers and the first plantings were a mixture of those planted wholly in bags, some in bags which were split along the sides and the bottoms cut off and some removed completely from the bags. Survival and growth rates were measured for comparison over 3 years and proved decisively that unless rainfall was

heavy enough to promote rapid growth, root development was too slow to break through the bags to allow the seedlings to survive the long dry season (Table 1).

Table 1

Seedlings planted in May 1990 and 1991. Figures below show survival rate by October 1994 in 3 plots			
	Plot A	Plot B	Plot C
Planted entirely in bag	12 %	none planted in this way	
Planted with bag cut open	none planted	56 %	27 %
Planted without bag	none planted	64 %	40 %

Direct seeding: An abundant masting of *Quercus semiserrata* in 1991 encouraged us to try direct seeding of this species. Their survival rate generally proved greater than those raised in the nurseries where tap roots tended to break through the bags and become damaged.

With fertiliser: Fertiliser NPK 16/20/0 was used for the first time in May 1999 and was placed at the bottom of holes before planting the seedlings. Monitoring of any improved performance has not yet taken place.

1.5 Maintenance

Weeding trials have been undertaken and the optimum timing appears to be once at planting time at the beginning of the rainy season and again about a month before the end of it so that vegetation cover over the young trees can help to conserve soil moisture during the dry season.

1.6 Survival of planted seedlings

Besides the bag trials mentioned above, we found that survival rate (apart from those destroyed by fire) depends on soil moisture and correct shading for the species grown. The plots shown in the table above were all on slopes of soils that could hold little water, being largely lateritic. The highest rate of survival was 64%. On the other hand, a fairly level plot at the base of the slopes planted with 4 species of Fagaceae, *Helicia nilagirica*, *Eugenia albiflora* and a *Cinnamomum* species performed much better. Heavy rain had followed a day after the planting and of the 150 trees monitored, only 5 died, showing a survival rate of 96% after 2 years.

1.7 Encouragement of natural regeneration

On exposed slopes of poor soils, monitoring of random areas showed that the trees that established naturally were far hardier than those planted. Careful planting of proven hardy species - *Parkia leiophylla*, *Helicia nilagirica* and *Quercus semiserrata* – in between naturally regenerating trees promises better results, although the introduction of further drought-tolerant species attractive to wildlife would enrich and hasten the process.

Mixed deciduous/evergreen forest in the lowlands

When Ajahn Pongsak first visited this area in 1970, the forest was thick and largely undisturbed. Since then, however, illegal logging removed most of the economic hardwoods such as *Tectona grandis*, *Xylia xylocarpa* var. *kerrii*, *Afzelia xylocarpa*, *Hopea odorata* and *Pterocarpus macrocarpus*. Patchy burning, but no cultivation, followed logging. The present forest consists mostly of bamboo – *Thyrsostachys siamensis*, *Dendrocalamus strictus* – and a few large trees of non-economic value remaining along the streams.

2.1 Seed collection

Initially, a collection was made of all tree species mentioned above except *Hopea odorata* as there were no suitable riparian planting sites. An abundant fruiting of *Mangifera caloneura* allowed us to include it in the first plantings. Later collections concentrated on food trees for wildlife: *Mangifera caloneura*, *Irvingia malayana*, *Terminalia chebula*.

2.2 Germination

With all seeds soaked for 24 hours germination success rates were as follows:

<i>Tectona grandis</i>	70 – 80 %
<i>Xylia xylocarpa</i> var. <i>kerrii</i>	70 – 80 %
<i>Afzelia xylocarpa</i>	over 90 %
<i>Pterocarpus macrocarpus</i>	none
<i>Irvingia malayana</i>	70 – 80 %
<i>Terminalia chebula</i>	70 – 80 %
<i>Mangifera caloneura</i>	80 – 90 %

Germination failure of *Pterocarpus macrocarpus* may lie, like the Fagaceae, with the timing of seed collection. More research needs to be undertaken in this area.

2.3 Planting

After disturbance such as logging in this forest type, bamboos are generally the first to establish themselves, followed very gradually by the former tree species should seed sources be still available. Our plan in these lower forests is to speed up succession and at the same time introduce food trees to attract wildlife and so try to re-create an approximation of the original ecosystem.

To this end, seedlings have been planted in gaps between bamboo clumps, starting by the sides of the streams where the soil is most moist. As the trees grow, the moisture spreads with their roots, which at the same time help to control bank erosion. The bamboo at first provides essential shade for the growing trees but as these become larger, the outer culms of the bamboo clumps are cut away to allow more sunlight to reach the ground. We find this to be particularly necessary for teak; *Xylia* and *Afzelia* are more able to withstand considerable shading.

2.4 Weeding

None is needed as there is very little groundcover

2.5 Growth and survival

Performance has been high in these moist soils of fair humus content.

2.6 Return of Wildlife

The return of wildlife to these forests in the last 2 years has been marked. A rough bird census in April 1999 listed over 30 species including a Wreathed Hornbill (*Rhyticeros undulatus*) at 600 m and 3 flocks of Jungle Fowl (*Gallus gallus*). Populations of porcupines Common Wild Pig and Common Barking Deer (*Muntiacus muntjac*) have all increased though sadly 14 of the latter were killed this year by hunters. Jackals (*Canis aureus*) have been seen as well as the tracks of Leopard Cat (*Felis bengalensis*). A troop of macaques (*Macaca nemestrina*) was seen fighting off a python (*Python reticulatus*). Other animals reported by villagers include squirrels, Slow Loris (*Nycticebus coucang*), hares (*Lepus peguensis*), pangolin (*Manis javanica*) and many snakes including *Chrysopelea paradisi* and *Ancistrodon rhodostoma*.

3. Fire

The greatest danger, however, to successful reforestation in Thailand is fire. Villagers set fire to the forest to clear the floor of slippery leaves and to drive animals out while hunting, to expose ground mushrooms especially *Astreus hygrometricus* and to force new leaf flush of *Sauropus androgynus*, a popular wild vegetable.

At Mae Soi, though, while fires are lit for the above reasons, the main cause arises from a socio-political conflict. In the last 40 years, opium-growing peoples have been migrating into Thailand fleeing war and unrest in neighbouring countries, some of them acting as Communist infiltrators. The Royal Projects were set up to win over their loyalty by first giving economic aid and later by introducing them to alternative cash crops in response to increasing drug problems in the West. Many international agencies set up similar projects and hill tribe development programmes followed, set up by NGO's.

Since Sukothai times, 700 years ago, upper watershed forests where the headwaters of rivers are formed in Thailand, have never been cleared for cultivation. They have been left undisturbed. The indigenous forest-dwelling tribal peoples, understanding the functions of different forests, rarely settled higher than mid-catchments. However, opium in the tropics cannot grow at altitudes lower than 1,000 m and the recent tribal migrants were forced to settle illegally in the upper watershed forests, and clear them for cultivation.

For the last 15 years, the development NGO's – presently numbering over 420 – citing human rights, are directing a movement to secure land rights for all settlers in forest lands regardless of site, whether in National Parks, Wildlife Sanctuaries or 1A classified watersheds. In the Mae Soi catchment, this movement and world sympathy with tribal rights has created misunderstanding and hostility between highlanders and lowlanders. Problems have remained unsolved through the intervention of third parties. At the beginning of the project, the Hmong of Ban Pa Kluay agreed to settle in the valley in a site that the lowlanders found for them, and of which they approved. A foreign aid agency working with the Hmong at the time, however, not understanding the threats that the

Hmong presence posed to water resources and wildlife, persuaded them to stay in the highlands, accusing the lowlanders of probable duplicity against them. Since then, human rights campaigners have reinforced this misunderstanding with accusations of racism against tribal people. Feelings have run high and have led to annual deliberate firing of the Mae Soi forest restoration, the most serious being in 1998, when over 1600 ha of the forests were burned.

3.1 Protective measures against fire

Protective measures against fire have had to be very rigorous and comprise the following:

Firebreaks: over 30 km of firebreaks 5 m wide are constructed every year and maintained from January to the first rains, which sometimes do not fall until June.

Patrols: each year 12 temporary huts are built to shelter 3 villagers each to watch for fires and maintain the firebreaks on a 5-day rota. The rota operates from January – June. Two fire-fighting teams of 45 village volunteers each, acting in turn, are alerted by radio of any fires that cannot be dealt with by the patrols. These are backed up an emergency team of 30 men when needed.

Equipment used (assembled over time as needs dictated):

- a) Pipes and storage tanks: pipes have been laid along vertical ridges from the nearest headwaters leading to storage tanks placed at intervals along the pipelines.
- b) 3 radios, 2 with the patrols on the ridges, 1 in the valley - for fire watchers in the highlands to alert fire fighting teams below.
- c) Bamboo alerts for each patrol – bamboo sections which when struck produce a resonance loud enough to alert neighbouring patrols, who then assemble at the site of the fire.
- d) 3 vehicles: a motorbike to contact fire-fighting teams in the villages; a 6-wheel truck for transport of fire fighting teams from the valley to ridges of the catchment and a 4WD pick-up truck to carry portable pumps and hoses to fire sites
- e) Lace-up shoes, rather than rubber-thonged sandals, for walking through hot ashes.

Fires have been repeatedly lit throughout the dry season in the 13-year course of the project. The above measures, gradually implemented over the years, have effectively protected the growing forests so that by 1996, nine years after the start of the project, the Mae Soi ran as a perennial stream, the only one out of nine in the District of Chomthong to do so. The fires of 1998 put a temporary arrest to the flow, but as there was little change in the soils, stream flow resumed after the first rains. Lowlanders are now able to make a living from lamyai (*Dimocarpus longan*), mango and tamarind orchards and cash crops such as chilli and *krachiep* (*Hibiscus sabdariffa*).

Two-thirds of project funds are spent on fire protection. If fires were eliminated from the catchment, the forests might be able to regenerate naturally, with the succession being speeded up with judicious planting. Costs would be comparatively low. But the issue of land rights and forest management in the highlands is still far from settled and fires will continue to destroy efforts at reforestation either to gain more land for cultivation or in protest for land rights.

RESEARCH NEEDS

The most pressing research needed, is clearly fire control, particularly the use of controlled burning techniques². These would include besides experimentation into different methods, the seasonal timing of such burns as well as their frequency. Other information which the project presently lacks, such as more reliable methods of wildlife monitoring³ and the germination of important species e.g. *Ficus* and *Pterocarpus macrocarpus* is available and will be sought. However, a further study of drought- tolerant species suitable for high altitude slopes of poor soils would be most useful.

POSSIBLE APPLICATIONS OF THE MAE SOI PROJECT

The project's activities have encouraged the other 8 subdistricts of Chomthong and neighbouring catchments as far as Mae Chaem and Lampang to form associations for the protection of their upper watershed forests. Ajahn Pongsak, by promoting awareness of the environment, has motivated village communities to help themselves and this promises to produce a model of environmentally sound development at very modest cost. However, more widespread education about the functions of Thailand's high-altitude forests is needed before general sustainable management of forest and water resources is assured. Until this is effected and the understanding acted upon, the success of attempts to restore the crucial upper watershed forests of northern Thailand and the river sources to which they give birth, will continue to be uncertain.

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J. F. Maxwell, who made a botanical survey of the catchment and identified species collected; Dr Kate Hardwick, who initiated and set up the monitoring system; Dr Oy Kanjanvanit, who has given much helpful information and comment; and most particularly of all, Dr Steve Elliott, who has given his time so generously as consultant on activities,

² Discussion groups subsequently responded to this need see Part 7 proposal 3.2.

³ See Part 7 proposal 1.4

editor of written work and initiator of research work on many aspects of our reforestation programme.

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QUESTIONS AND COMMENTS

Rick Burnette

Given the present tension between lowland and upland communities, how can hill-tribe people participate in forest restoration activities?

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The Hmong villagers were invited to become involved as part of the Tambon (District) Council. They agreed that destruction of the forests was drying up rivers and that they would resettle voluntarily, if provided with suitable land to settle on. They also agreed to help with reforestation, but each time they have agreed to move to the valley, a 3rd party has intervened to discourage them from doing so.