Chapter 9

Use of Native Plant Species and Indigenous Knowledge for Rehabilitation of Degraded Mountain Ecosystems

Xu Jianchu & Tong Shaoquan
Yang Qixiu
and **Qiu Xuezhong**

The Present Situation of the Uplands

Uplands are defined by Sajise and Baguinon (1982), in both biogeographic and cultural terms, which refers to mountainous areas, its biological components, and agricultural practices. The degradation of land in mountain ecosystems is mainly caused by ecologically destructive human activities. The loss of vegetative cover, excessive runoff, soil erosion, and sedimentation in the uplands may have a significant impact on the ecological functions in the lowlands.

Yunnan is a typical mountainous province in southwest China with a range in elevation from 6,740masl in the northwest to 76.4masl in the southeast. Uplands, or the mountainous areas, account for 94 per cent of a total area of 383,000sq.km. Of this area, 150,000sq.km. have slopes greater than 25 degrees, 196,000sq.km. have between eight-degree and 25-degree slopes, and there is a land area of 34,000sq.km. with below eight-degree slopes. Water bodies (lakes, rivers, etc) make up 2,800sq.km. of the total area. There are five famous rivers: the Lancang Jiang (or Mekong), Nujiang (Salween), Changjiang (Yangtze), Yuan Jiang (Red River), and Nanpan Jiang (Pearl River) in the province.

Poverty and environmental degradation have become an inevitable part of the socioeconomic and ecological landscapes in the uplands. There are about seven million people living below poverty line in Yunnan, mainly distributed throughout the remote and marginal uplands at present. Degraded lands, including forestlands, account for 42 per cent of the total land area in Pupiao township and 31 per cent of the total land area in Baoshan municipality (Table 1).

Table 1: Land Use in Pupiao Township and Baoshan Municipality

Category		Pupiao Township		Baoshan Municipality	
		area (ha)	per cent (%)	area (ha)	Per cent (%)
1.	Farming land	4691	19	96660	20
	Paddy field	1364	6	32831	7
	Rain-fed upland	3210	13	63413	13
2.	Forest land	15014	60	247805	51
	Good forest	7514	30	201640	42
	Degraded forest	7500	30	46165	9
3.	Permanent Garden	44		6241	1
4.	Pastureland	1285	5	4926	1
5.	Wasteland (degraded land)	2871	12	108296	22
6.	Settlement	590	2	10340	2
7.	Road	201	1	3231	1
8.	Waterbody	302	1	7492	2
	Total	24997		484992	

(Data source: Baoshan Land Bureau Statistics 1994)

Rehabilitation of Degraded Uplands

The resources' management agencies are often structured in terms of key sectoral categories (e.g., forests, agriculture, animal husbandry, and water). Thus, the resource management approaches are also formulated into technical areas which often ignore critical social, cultural, and economic factors and the interrelations between all the different factors. Government planning often causes administrative contradictions between sectors resulting in "poverty of the state". By regulation, any felling from different title lands has to be approved by the local forest bureau. The degraded land, called "wasteland", in Yunnan is considered suitable for reforestation by the forestry department, however it may be designated for grazing to raise more cattle by the animal husbandry department or for fruit-tree plantation by the agricultural department.

Approaches to Restoration

The existing approaches to restoration in Yunnan are as follow.

Plantation

There are many plantation initiatives within the province, such as the *Eucalyptus* Reforestation Project, supported by the World Bank. The programme has many advantages, e.g., fast-growing *Eucalyptus* can provide the materials needed by various industries such as plywood and essential oils. The trees also provide fuelwood, and the extension required for such monocultures is comparatively simpler.

However, this programme has its disadvantages, mainly ecological deterioration factors, particularly in degraded mountain ecosystems. Such programmes also require high investment and are highly market dependant. Degraded mountain ecosystems are usually also areas of low biodiversity.

Air-seeding

The advantages of air-seeding are that large areas can be covered quickly and require low labour input. However, this method is very dependant on natural conditions, such as soil pH, the fertility aspect, and need for strong protection from stray animals and human disturbance. The method is only suitable for a few species, such as pine trees, and is expensive.

Natural Regeneration

Natural regeneration is a low-cost method of natural succession with high biodiversity and better ecological functions, and it can provide multiple products for the local people. But it is a lengthy process and requires local institutions for social fencing and products are sometimes considered of `low value' as they are high in biodiversity but not economical.

Overall, the government forest department is the major implementing agency for reforestation. According to the present reforestation rate, it is very difficult to recover targetted areas within a predictable period of time because of the constraints of lack of well-trained manpower and continual investment.

Use of Native Plant Species and Indigenous Knowledge on Them for Rehabilitation

Whilst degradation of ecosystems is often caused by human activities, solutions to degradation can also be found by human species. Native or endemic plants are more adaptive to the local biophysical environment than introduced or exogenous plants. Exotic or exogenous plants alter the biotic composition of natural

ecosystems, thereby changing the biodiversity, ecological processes and functions, and nutrient cycling. Thus, emphasis on the use of local species may prove to be a better option.

Likewise, indigenous people are more familiar with their environment and, therefore, more aware of the local problems than outsiders. They often lack opportunities in terms of land tenure, capital input and other services. Thus, applying indigenous information to rehabilitation is not only more appropriate but also saves time and expense.

Criteria for Selection of Species for Rehabilitation of Degraded Lands

Plant species' selected for rehabilitation of degraded lands should meet the following criteria.

They must be adaptive to extremely degraded habitats, low fertility soils, dry climates, and thin soil layers and they must be competitive to invasive plants.

They must be fast-growing to produce a high yield of biomass for habitat restoration to create sound conditions for succession by other species of organisms. Propagation and maintenance of such species must not require complex techniques and inputs. The species must be multipurpose, e.g., nitrogen-fixing and useful for fuelwood, fodder, and timber. They should contribute to the conservation and enrichment of soil, particularly on sloping uplands. Ideally they should be perennial and tolerant to constant harvesting, for example, fuelwood species should coppice vigorously after cutting. They must be economically and socially acceptable to the local people.

Methods for Identifying Useful Plant Species

Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) can serve as powerful tools for the inventory of native useful plant species and the documentation of indigenous technical knowledge, which could be used for rehabilitation of degraded uplands.

The types of RRA and PRA methods being used in the field include key informant interviews, semi-structured interviews, formal or informal interviews, and casual or focus-group interviews. Group discussions are very useful for obtaining systematic, holistic, and more accurate information on vegetation changes, deforestation, and indigenous taxonomy, such as land races, useful species, habitats, and ecosystems, in order to discover *emic* and *etic* distinctions; species' usefulness ranking and scoring – valuing the usefulness of biotic species by their criteria and categories; transect walks – walking with informants through an area; observing, asking about, and discussing important species (plants, birds, reptiles, and mammals) in different land use zones; resources, problems, and opportunities; resources' mapping; and vegetative profiling – a sketch map to show resources' availability (forest products and non-timber forest products), vegetative cover, land use, and its changes. The vegetative profiling can be used, for example, to show the structure, composition, and function changes in different components of the ecosystem; quantification – often using short questionnaires and local measures to know where, what, when, and how many resources are available; different trees and crops to be planted; diagraming -- product-flows; seasonalities (rainfall, production); social relations; traditional knowledge analysis – indigenous practices and institutions for water and soil conservation and resources' access; and participatory planning and monitoring – in which indigenous people prepare their own action plans on rehabilitation and sustainable upland resources' management.

Secondary data, such as a list of local fauna and flora, vegetation maps, and other publications (often called triangulation), is used to supplement or verify the information obtained.

Suitable Indigenous Species Available for Rehabilitation Work

Nitrogen-fixing Trees
Albizia mollis
Atylosia scarabaeoides
Bauhinia variegata
Bauhinia faberi var. microphylla
Caesalpinia decapetala
Cajanus cajan
Crotalaria assamica
Flemingia macrophylla

Soil Conservation and Bank Stabilisation Species
Agave americana
Contoneaster spp
Ficus tikoua
Musella laciocarpa
Pueraria lobata
Vitex negundo

Fruit Trees and Cash Crops
Diospyros kaki
Phyllanthus emblica
Punica granatum
Zanthoxyllum bungeanum

Fast-growing Timber and Fuelwood Trees
Betula alnoides
Camptotheca acuminata
Melia azedarach
Schima wallichii
Toona ciliata
Toona sinensis
Trachycarpus fortunei
Trema orientalis

Indigenous Technical Knowledge for Rehabilitation and Upland Resources' Management

On the basis of work carried out by the project to study the indigenous knowledge on local plant species, the project has come up with a detailed profile of plant species (Annex 1). Here, the use of various species by the people of Pupiao is given.

Terracing

Terracing is commonly practised by indigenous people for conservation of soil and water resources on sloping uplands. Natural barrier and rock-wall terraces can be found locally. Palm trees, *Vitex, Agave,* and other multipurpose plants are often planted on the beaches of terraces. Water storing or harvesting ponds are prepared for watering crops, particularly vegetables, during the drought season.

Non-timber Forest Products' Harvesting

Non-timber forest products provide local farmers with additional income. Edible mushrooms are quite a marketable product. Even pine cones are collected for fuelwood.

Live Fencing

Multipurpose species, such as *Vitex, Agave,* and palm, are planted along the sides of the paddy fields, uplands, and in home gardens for fuelwood, fibre, edible vegetables, and cash income. The thorny species, *Caesalpinia decapetala,* is planted for ornamentation and fencing out animals.

Crop Rotation and Cover Crops

Rotating food crops and legume cash crops is a good way to maintain soil fertility. Grains are usually planted first and alternated with legumes (soyabean, mung bean, peas, and peanuts, etc). Sweet potatoes are suggested as the best crop for the uplands, because they provide year-round cover, minimising soil erosion.

Indigenous Agroforestry

Combinations of perennial crops, for example, fruit trees and annual crops, are the indigenous agroforestry methods for efficient use of land resources. In Baoshan, many fruit species, such as chestnuts, walnuts, and *diospyros*, have been planted on terraced uplands for many generations.

Lessons Learned from the Baoshan Pilot Project

The work undertaken by the project at Baoshan has shown that the costs for the introduction of exogenous species and/or tree plantation are higher than the costs for work undertaken through the use of local species. And the survival and growth rates of native species are better than those of exotics. Natural regeneration can be achieved through the establishment of proper social fencing. Tenure security is a key component for land rehabilitation.

Reference

Sajise, P.E. and Baguinon, N.T., 1982. 'Upland Development: A Critical Resource Management Issue'. In Kamis Awang Al (ed) *Proceedings of [a] Workshop on [the] Ecological Basis for Rational Resource Utilisation in the Humid Tropics of Southeast Asia*. Malaysia: University Pertanian Malaysia.

Indigenous Plant Species' Profile

1. **Scientific name:** *Agave americana*
Local name: *laobzuang*
Description
Site requirement: It requires deep soil and is drought-tolerant.
Uses: It is a very important local fibre crop. *Agave* is commonly planted along the sides of the fields for bank stabilisation and soil erosion control. It is also a medicinal plant.
Propagation: Sucker separation

2. **Scientific name:** *Albizia mollis*
Local name: *yeheshu*
Description: It is a deciduous tree and attains a full height of 13m.
Site requirement: It is native at elevations from 1,300m to 2,800m.
Uses: The wood is quite hard and suitable for furniture. It grows fast with a beautiful crown, often planted along roadsides.
Propagation: Seeds should be pre-treated, soaked in hot water for a while, then submerged into warm water for 24 hours.

3. **Scientific name:** *Atylosia scarabaeoides*
Local name: *manbenchongdou*
Description: It is a legume vine.
Site requirement: It is a pioneering species for land cover. It is adaptive to drought-tolerant uplands.
Uses: It can be planted in loose sloping uplands to produce more biomass for land cover and soil improvement. The leaves are used for medicines.
Propagation: Seeds can be sown directly on upland fields.

4. **Scientific name:** *Betula alnoides*
Local name: *huapishu*
Description: It is a deciduous tree, attaining 16m in height, and yielding fruit in August and September.
Site requirement: It is native in mountainous broad-leaved forests at elevations of from 700m to 2,100m.
Uses: It provides good timber for housing and furniture. The bark is used for tannin extract.
Propagation: It is often recommended as a reforestation species, however, it is very difficult to reproduce the seedlings. Seeds should be stored and sowed in a well-prepared nursery for the coming year.

5. **Scientific name:** *Bauhinia variegata*
Local name: *baihuashu*
Description: It grows to a height of 15m.
Site requirement: It can be found from 750m to 1,900m in the valley, on sloping lands, and in sunny scrub areas.
Uses: The timber is hard and good for wood carving. Flowers and young bean pods are edible. Roots and flowers can be used for medicine. It is also planted for ornamental purposes and for fuelwood.

Propagation: Seeds should be pre-treated by soaking in warm water for several hours before sowing into a seedbed for reproduction of seedlings.
Note: Same as *Bauhinia faberi var. microphylla*

6. **Scientific name:** *Caesalpinia decapetala*
Local name: *tianliba*
Description: Climbing shrub with thorny branches.
Site requirement: It is adaptive to various conditions from stony uplands to water-logged stream sides.
Uses: Large volume of yellow flowers which have ornamental purposes. It is planted for live fencing alongside home gardens and agricultural fields. The seeds have medicinal value.
Propagation: Seeding.

7. **Scientific name:** *Cajanus cajan*
Local name: *mudou*
Description: It is a shrub or small tree from 1-5m tall.
Site requirement: It is a drought-tolerant upland crop and widely adaptive to different soil conditions. It can be planted at elevations of 1,500m. It does not tolerate water-logging and requires full exposure to sunlight to bear fruit.
Uses: The beans are nutritious and a tasty food source. The stem and branches are used for fuel, thatch, and basket fibre. The leaves provide excellent green manure for nitrogen-fixing.
Propagation: No pre-treatment of the seeds is required. It is usually directly sowed in the furrows.
Management: It is often intercropped with cereal crops. To manage as a perennial, cut stems at 50cm above ground.

8. **Scientific name:** *Camptotheca acuminata*
Local name: *xishu*
Description: It is a deciduous tree with a beautiful crown.
Site requirement: It usually requires loose soil.
Uses: It is often planted for industrial pulpwood and fuelwood because it is a fast-growing tree. The extracted compounds from seeds and bark are used for cancer medicines.
Propagation: Seeds are collected in October/November and sowed in the coming spring.
Management: Care from pest damage.

9. **Scientific name:** *Contoneaster* spp
Local name: *xunzi*
Description: Evergreen shrub, 1m in height.
Site requirement: It is widely adaptive to mountainous areas and soil conditions. It can be found at elevations of from 1,000m to 4,000m.
Uses: Fuelwood, ornament
Propagation: Cutting and sowing.

10. **Scientific name:** *Crotalaria assamica*
Local name: *dajushidou*
Description: Shrub attaining 1-2m in height.
Site requirement: It can be found both in drought-ridden uplands and water-logged fields.
Uses: Nitrogen-fixing for green manure.
Propagation: Direct sowing.

11. **Scientific name:** *Diospyros kaki*
Local name: *shizi*
Description: It is a deciduous tree with many horticultural varieties.
Site requirement: It is adaptive to temperate areas. It requires a well-drained deep soil with high humus content at pH 6-7.8.
Uses: High-value fruit tree commonly planted in the Yunnan uplands.
Propagation: Cleft grafting.

12. **Scientific name:** *Ficus tikoua*
Local name: *dishiliu*
Description: Stolon vine
Site requirement: It is adaptive to a wide range of elevation and soil conditions. It is drought tolerant.
Uses: Land cover for soil erosion control and bank stabilisation. Fruit is edible.
Propagation: Cutting and marcottage (air layering) in the rainy season.

13. **Scientific name:** *Flemingia macrophylla*
Local name: *yang wei dou*
Description: *Flemingia* is a shrub, attaining 2-3m in height. It has a deep root system and produces dense foliage.
Site requirement: *Flemingia* is moderately drought-tolerant and requires about 1,000mm/yr rainfall and not longer than a six month dry season. It is adaptive to a wide range of soils and elevations. It thrives on acid or infertile soils and heavy clays. It can also survive water-logging and occasional flooding. It can be planted at elevations of 2,000m but has been found to do best at about 700m. It is somewhat fire-resistant.
Uses: Flemingia is primarily grown as a source of mulch. The leaves decompose slowly, helping to suppress weeds while improving soil conditions. It provides a long-term release of nutrients to the soil as a green manure and is also used in contour planting to control soil erosion. Young leaves can provide an alternative source of fodder during the dry season but digestibility and palatability are not high. It can also provide small amounts of fuelwood.
Propagation: Seeds can be pre-treated, either by soaking in water for two days, immersion in boiling water for three - 10 seconds, or immersion in hot water for one minute. *Flemingia* is usually directly sown into contours or hedgerows.
Management: Check seeds carefully for insect damage before planting. Do not intercrop with *kadios* because *Flemingia* is an alternative host for the podfly pest. Wood can be harvested by coppicing after two years.

14. **Scientific name:** *Glochidion arborescens*
Local name: *pangshu*
Description: It is small tree, usually attaining 5m-8m in height.
Site requirement: It is a pioneering tree, drought-and-infertile-tolerant. It is native in sunny areas at elevations of from 830 to 2,000masl.
Uses: Fuelwood, bark for tannin extract and seeds for oil extract.
Propagation: Sowing seeds.

15. **Scientific name:** *Melia azedarach*
Local name: *kulian*
Description: It is a deciduous tree, attaining 30m in height and one metre in DBH, fast growing.
Site requirement: *Melia* has no specific requirements for soil. It is drought and water-logging tolerant, and can grow very fast even in infertile soil. It can be planted both in the uplands and lowlands, even in an air-polluted environment.

Uses: It provides popular timber for furniture, tools, and housing. No termite attacks. The root skin is a very useful medicine.
Propagation: Seeds can be harvested in November and December. Seeds should be pre-treated by soaking in water for two or three days. Seed sprouts in the nursery usually take 40 to 50 days.
Management: Usually no insect damage. Some crops can still be planted under the canopy since there is little shadowing.

16. **Scientific name:** *Musella laciocarpa*
Local name: *dibajiao* (ground banana)
Description: Ground banana is perennial with a short stem about 0.6m in height.
Site requirement: It is a native species from central and western Yunnan province. It is planted at elevations of from 1,000m to 2,000m. It requires sunny uplands.
Uses: It is a popular forage plant for pigs. Young leaves/shoots are edible in some places of Yunnan. It is also suitable for bank stabilisation and soil erosion control.
Propagation: Sucker separation.

17. **Scientific name:** *Phyllanthus emblica*
Local name: *ganlanguo*
Description: Shrub, 3m in height.
Site requirement: It is native from sea level, 300m to 2,250m in sub-tropical and tropical uplands. It likes the sun and is a drought-and-infertility-tolerant species.
Uses: Seeds can be used for oil extract. Fruits are rich in vitamin C and edible. Bark and leaves are used for tannin extract as well as for medicinal use.
Propagation: Seeds are collected from healthy mother trees with bigger fruits and soaked in warm water for 48 hours before sowing.

18. **Scientific name:** *Pueraria lobata*
Local name: *matenghu*
Description: *Pueraria* is a legume vine with expanded roots, widely distributed on grass and scrub lands.
Site requirement: It is a drought-and-infertility-tolerant species.
Uses: It can be used for fibre and paper-making. The roots are an important starch source for the local people and commercial drinks are also made from the plant. The plants as a whole can be used for medicinal purposes.
Propagation: It can be reproduced by root cuttings and seeds.

19. **Scientific name:** *Punica granatum*
Local name: *shiliu*
Description: It is deciduous fruit tree, but evergreen in the tropics.
Site requirement: It can grow at elevations of 2,500m. It is also drought-tolerant compared to other fruit trees. It requires sandy soil with a pH range of 4.5-8.2.
Uses: High-value fruit tree, often planted in the home garden and uplands.
Propagation: Cutting and young stem separation. The process of direct sowing is also used sometimes.

20. **Scientific name:** *Schima wallichii*
Local name: *maomaoshu*
Description: *Schima* is an evergreen sun-like tree. It is native at elevations of from 100m to 1,600m, the highest being 2,600m in northwest Yunnan. It can be planted with pine trees. It easily sprouts after repeated cutting.

Site requirement: *Schima* is a very important pioneering species recommended for reforestation in degraded uplands. It is drought-tolerant and requires acid red soil and a warm sub-tropical climate (more than -5°C).
Uses: It can be used for timber and fuelwood. *Schima* trees form a natural green belt and are fire-protective.
Propagation: Seeds can be collected from 20 year to 50 year old middle-aged mother trees in January and February. Dry seeds should be sowed within 50 days. Careful preparation of the nursery and shallow soil cover are very important for seed sprouting.

21. **Scientific name:** *Toona ciliata*
Local name: *hongchun*
Description: *Toona* is a semi-evergreen or deciduous tree.
Site requirement: *Toona* is usually planted in the valley or at low elevations.
Uses: *Toona* is a very popular tree for timber. The timber is very good for housing, furniture, and indoor uses.
Propagation: Seeds can be sown in well-prepared seed beds.

22. **Scientific name:** *Toona sinensis*
Local name: *Xiangchun*
Description: It is a deciduous tree called 'Chinese mahogany'.
Site requirement:
Uses: The timber is excellent for furniture and boats, also for housing, bridges, and agricultural tools. The young tips are edible. They are fragrant and a popular vegetable. The skin can be used for fibre.
Propagation: Seeds can be harvested in October and sown early next year. Roots can also be buried for propagation.
Management: Young seedlings should be planted in well-drained lands.

23. **Scientific name:** *Trachycarpus fortunei*
Local name: *zongbaoshu*
Description: Palm, an evergreen tree.
Site requirement: It is commonly planted south of the Yangtze River.
Uses: The sheath-fibre is widely used for ropes, boat cable, carpets, bedpads, raincoats, and brush. The palm is also ornamental. The timber can be used for handicrafts. The young female B is used as an edible vegetable in Baoshan and Yunnan province. The sheath-fibre is used as grain store cover for protection from rodents.
Propagation: The young seedling is shade-tolerant, therefore seeds can be sown in forest ground. The young seedlings grow very slowly. When seedlings have 5-8 leaves after four or five years, they can be transplanted in the fields.

24. **Scientific name:** *Trema orientalis*
Local name: *duiminshu*
Description: The *Trema* is a shrub or tree, attaining 2-10m in height, distributed from 1,000m to 3,800masl.
Site requirement: It is a pioneering tree for degraded uplands and requires sunny areas. It is drought-and-infertility-tolerant.
Uses: It is a fast-growing species and useful for fuelwood. The bark is used for medicine and pulpwood, the leaves as food for animals.
Propagation: Seeds.

25. **Scientific name:** *Vitex negundo*
Local name: *latagun*
Description: It is a shrub, 1-3m in height.
Site requirement: It is native at elevations of from 100 to 2,200masl. It is adaptive to a range of soil conditions from drought uplands and water-logged streams.
Uses: It is a very important source of fuelwood. It is used also for bank stabilisation and soil erosion control. A long period of flowering provides a good source for honey bees. The leaves are used as medicine for wounds.
Propagation: Cutting and direct sowing.

26. **Scientific name:** *Zanthoxyllum bungeanum*
Local name: *huajiao*
Description: The Chinese pepper berry is a small thorny tree.
Site requirement: It is widely tolerant to a range of elevation and soil conditions, but it grows better on deep fertile soil. It is commonly planted in the uplands and in home gardens.
Uses: It is a very popular spice in southwest China with high market value.
Propagation: Seeds should be pre-treated and soaked in warm soapy water to remove wax.