Bamboo in the High Forest of Eastern Bhutan

A Study of Species Vulnerability

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PREFACE

This case study from eastern Bhutan depicts clearly how policies that ignore traditional forest and species' management systems, that have evolved – and worked well – from generation to generation do so at the risk of the disappearance of not only sustainable, locally acceptable management and harvesting systems, but also at the risk of species disappearing.

This document provides rich information about bamboo resources in Bhutan, the geophysical conditions, main species, use and management. It is illustrated with sketches and photos. Bamboo comprises a number of fast growing species, important resources for housing, tools, and containers. The commercial demand for bamboo doubled from 1991 to 1997 in Bhutan. Bamboo is a good alternative non-timber forest species. Ridam, the traditional management of forest resources, a generic long-standing method for protecting mountai forest resources, needs to be supported and improved. The study also provides highlights of factors affecting the sustainability/vulnerability of bamboo which are of interest for future discussion.

The work by Messerchmidt, Temphel, Davidson and Incoll should put us on alert as species disappear throughout the Himalayas, and poverty encroaches on hard working hill and mountain dwellers.

Chen Guangwei
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ICIMOD

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ABSTRACT

Bamboo is an important alternative forest resource harvested from the high forests of eastern Bhutan. A study was conducted to determine the significance of bamboo in the local subsistence and commercial economies, with particular attention to factors affecting the vulnerability of species (risk of extinction). The importance of indigenous knowledge and of the traditional system of forest resource protection are described, along with recommendations for linking them with scientific management. Field observations indicate that the bamboo in the forest of the Khaling-Kharungla Forest Management Unit (FMU) of Tashigang District, Bhutan, is under some threat from factors related to commercial demand, forest management, certain seasonal conditions, timber harvesting, forest grazing, and open (increased and uncontrolled) access by road. To improve analysis of the data, a vulnerability assessment scale was adapted from the literature and modified for further clarity and rigour. It is introduced here as a 'Rapid Plant Vulnerability Assessment Scale'. Thirteen categories of potential threat are ranked on the scale, several of which are new to this analysis and were added to determine the level of threat (low, moderate or high) more accurately. It is concluded that the bamboos of Khaling-Kharungla are vulnerable to a moderate to high degree, and that remedial action (better overall management) is needed.

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INTRODUCTION

During the winter of 1998-99, research was carried out in eastern Bhutan to ascertain the vulnerability of indigenous bamboo species to commercial exploitation, with special attention given to the local sociocultural context and the role of bamboo in the traditional economy. The work was carried out through the Third Forestry Development Project (TFDP) in Bhutan's northeastern-most district of Tashigang (Tashigang 'Dzongkhag'). The TFDP has operated since 1994 in the region, bringing forest management and social forestry expertise to six districts that make up the eastern region[1]. This study represents part of the project's mandate to apply social forestry principles and practices to the sustainable management of tree and forest resources.

The forests of eastern Bhutan

The forest ecology of Bhutan is complex, with 11 distinct forest types represented nationwide. Nine types are found in the six eastern districts[2].

The bamboo vulnerability study was carried out in the predominantly Cool Moist Broad-leaved Forest (2,000–2,900m) of Khaling-Kharungla. This forest blends into a Warm Moist Broad-leaved Forest below 2,000m, and into alpine scrub above and outside of the study area. The high broad-leaved forest is described as a mixture of deciduous and evergreen species (e.g., *Quercus* spp, *Rhododendron* spp, *Castanopsis, Schima, Daphniphyllum, Symplocos, Exbucklandia, Acer, Persea, Alnus*). It is further characterised by a dense undergrowth of bamboos, shrubs, ferns, climbers, and many epiphytes.

Alternative forest resources in eastern Bhutan

Alternative (non-timber) forest resources (AFRs) are important in both the subsistence and commercial economies of eastern Bhutan. AFRs are defined as the **raw materials from a forest** that, taken together, fit neither the standard definitions of **non-wood** or **non-timber forest products** (NTFPs), nor of **minor** forest products. Rather, many of these raw materials are woody, are of major significance in the local economy and, technically, they remain as

[1] Eastern Bhutan's highest, coolest, and most northerly districts are Tashigang, Mongar, Yangtse, and Lhuentse; the lowest, warmest and most southerly are Pemagatshel and Samdrup Jongkhar. The region is bordered by China (Tibet) on the north, and by India on the east and south (Arunachal Pradesh and Assam states, respectively).

[2] The nine forest types of eastern Bhutan are: (1) Tropical Lowland Forest (also called Sub-tropical Forest), below 700m, and (2) Warm Broadleaf Forest (Lowland Hardwood Forest), 1,000–2,000m. These two are dominated by a variety of tropical and sub-tropical species: e.g., *Acacia catechu, Bombax ceiba, Duabanga grandiflora, Ailanthus grandis, Schima wallichii, Terminalia* ,and associates. (3) Chir Pine Forest, 900–1,800m, *Pinus roxburghii* in open stands, associated with lemon grass. (4) Evergreen Oak Forest, 1,800–2,600m, in which *Acer campbellii* and *Castanopsis* dominate, with *Quercus* and *Pinus wallichiana*. (5) Cool Moist Broadleaf Forest, 2,000–2,900m, *Quercus* and *Rhododendron* spp. with *Castanopsis* and other species, in association with bamboos, shrubs, and ferns, and so on in the understorey. (6) Broadleaf/Conifer Mixed Forest, 900–3,000m, *Pinus wallichiana* on southern aspects intermixed with *Pinus roxburghii* on eastern aspects. (7) Blue Pine Forest, 1,800–3,000m, *Pinus roxbhurghii (P. excelsa)* with *P. bhutanica*, intermixed with *Quercus* and *Rhododendron* spp. (8) Mixed Conifer Forest, 2,000–2,700m, *Picea, Tsuga, Larix* (sub-alpine and, in places as cloud forest bearded with mosses and lichens). (9) Fir Forest, 2,700–3,800m, *Tsuga* and *Betula* blending into alpine scrub at the highest elevations (*Juniperus, Rhododendron*, and others). (Based on MoA 1998; Grierson and Long 1983; and Noltie 1994; see also TFDP 2000: Ch.4)

resources until well after harvesting when they become, after a certain amount of processing, value-added products for marketing (Messerschmidt and Hammett 1998, 1994).

There are many types of AFRs in eastern Bhutan. Some of the most important found in the eastern dzongkhags include medicinal plants such as 'chirata' (*Swertia chirata*) and 'pipla' (*Piper* spp); traditional paper-making resources, locally 'shu-gu' (*Daphne* spp); essential oils (especially the aromatic 'citral' distilled from lemon grass – *Cymbopogon flexuasus*); many bamboos (known locally as 'shi' ; species of the genera *Arundinaria, Bambusa, and Dendrocalamus*); and a variety of other plants harvested for their food values, fibres, resin, turpentine, and ornamental qualities.[1]


Plate 1: Bamboo mat roofs of Khaling village

Bamboos are widely distributed throughout Bhutan. Thirteen genera and 28 species have been recorded nationwide (Pradhan and Rinchen 1996, Stapleton 1994a, b). They occur in many sizes, at virtually all elevations, and are used widely for basket and mat-making, containers, hats and rain wear, fencing, roofing (see Plate 1), and construction of houses and huts, as well as for religious flag poles and water channelling (bamboo pipes).

Three species are found in the study area: *Borinda grossa* (Yi) Stapleton, *Thamnocalamus spathiflorus* (Trin.) Munro, and *Chimonobambusa callosa* (Munro) Nakai. These species are the focus of our study. In a later section we describe their botanical attributes and discuss traditional use and management, as well as their commercial values.

THE BAMBOO STUDY

Study objectives

The objectives of the study were as follow.

- To determine traditional and current relationships between the bamboo resources and human inhabitants of the area; most importantly, the **role of bamboo in the local economy and in commercial enterprise and the impacts of commerce on the resource.**
- To identify and record **traditional uses, indigenous knowledge, and local resource management systems** related to forests generally and bamboo specifically.
- To determine the **vulnerability of bamboos to commercialisation and other outside influences** (timber logging, grazing, roads, and so on), using a **Rapid Plant Vulnerability Assessment Scale** adapted with modifications from a previous example in the literature.

[1] There are two main studies of AFRs in Bhutan (FAO 1996 and Dorji 1995). Several more specific works are also available, including on the medicinals *chirata* (Pradhan et al. 1998) and *pipla* (Pradhan et al. 1999), *shu-gu* or *Daphne* for paper-making (Hadorn and Wangda 1999, *cf.* Messerschmidt 1988), citral or lemongrass oil (RNR-RC 1998), and varieties of 'shi' or bamboo (Stapleton 1994a,b).

- To consider ways to promote **participatory management** of the resource considering the rights and responsibilities of all relevant stakeholders.

Research timing and methods

The research was conducted during the dry winter months at the height of the traditional annual bamboo harvesting season. A combination of expert, semi-structured, and focus group interviews (rapid appraisal methods) was used (see Plate 2), coupled with on-site observation of the resource in the forest and of roadside bamboo mat production. Discussions were held with a variety of local decision-makers, forestry officials, traditional forest users, and bamboo harvesters. These included the sub-district administrator (the 'Dasho Dungpa'), divisional foresters, forestry extension officers, forestry operations' staff, village leaders (including the 'gup', or headman), and local residents (men and women) who identified themselves as contract cutters, mat-makers, and end users. The villagers interviewed were residents of the village of Wamrong in Lumang Block ('geog') and Khaling (Khaling Block) of Tashigang District (see Figure 1). We also reviewed the field notes of colleagues associated with the project,[4] and pertinent documents such as the Khaling-Kharungla forest management plan and operational plan (Chamling 1996, DFO 1997).[5] To guide the fieldwork, data analysis, and write-up, a topical checklist was prepared by the research team.[6]

Plate 2: Bamboo cutters' focus group meeting with the research team

DESCRIPTION OF THE STUDY AREA[7]

Physiological context

Area location

The Khaling-Kharungla Forest Management Unit (FMU) is located in the south of Tashigang District, between 27º 12' N. Latitude and 91º 31' and 91º 38' E. Longitude (Topo Map No. 78M/12), at elevations of from 2,000 to 2,900m. The National Eastern Highway transects the unit, linking Tashigang with Pemagatshel and Samdrup Jongkhar districts further to the south, and with all other districts of Bhutan to the west and southwest.

[4] Besides the field notes of John Davidson (plant ecologist), the observations of Rebecca Pradhan (botanist) and Tandin Wangdi (plant taxonomist) are also reflected in the descriptions and findings presented here.

[5] In the Bhutanese system, an operational plan which describes the capital and infrastructural investments in roading and logging for each FMU is written following closely the recommendations of a comprehensive management plan. When the FMU Management Plan was written (Chamling 1996), Khaling-Kharungla fell within the Mongar Forest Division. It now falls within Tashigang Forest Division, created in 1998. We have made the correction in this paper.

[6] Much of the study was conducted using rapid rural appraisal (RRA). An RRA topical checklist prepared to guide the field work was modified in the field to reflect on site realities and new knowledge. On RRA methodologies, see Grandstaff and Messerschmidt 1995; McCracken et al. 1988; Messerschmidt 1995.

[7] The source of the following description is Chamling 1966, combined with more recent field work and observation.

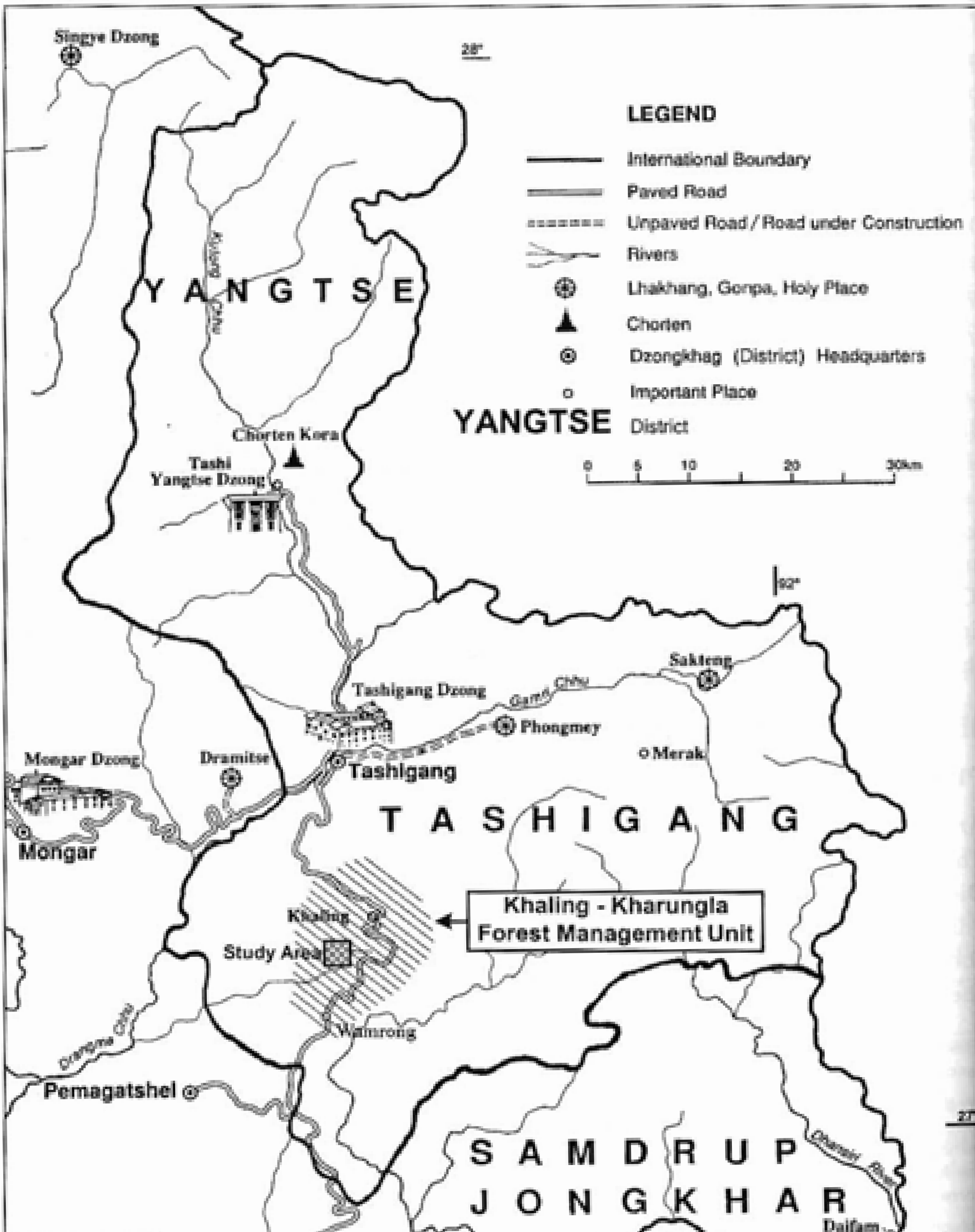

Figure 1: Location of Study Area

The total FMU land area is 7,277ha under various forested and non-forested (agricultural) land uses, including both production and protection forestry under the FMU management and operational plans. Table 1 shows current land-use classes.

Table 1: Land-use Classes in Khaling-Kharungla Forest Management Unit		
Land-use classes	Area (ha)	%
Forested land		
hardwoods	4421.63	68.88
Pines	250.91	3.91
Scrub	685.12	10.67
Bamboo	**119.57**	**1.86**
Shifting cultivation (tseri)	676.97	10.55
Logged	138.62	2.18
in plantation	13.03	0.20
Blank	113.00	1.76
A. Sub-total	*6,418.85*	*88.21*
Non-forested land		
under cultivation	779.54	90.89
as pasture	78.18	9.11
B. Sub-total	*857.72*	*11.79*
TOTAL (A+B)	**7,276.57**	**100.00**
(Based on Chamling 1996: Table 1)		

Topography, rainfall and soils

The terrain is moderate to steeply sloping and mountainous with deeply incised valleys. The elevation ranges from 1,200 to 3,200m over the whole of the forest unit. Slopes are very steep at higher elevations, becoming more gentle in the middle and lower parts. Within the FMU, 47 % conforms to Slope Class-I (0–45%), 44% to Class-II (45–75%), and the remaining 9 % to Class III (75–100%) and Class IV (>100%).

Rain is the most common form of precipitation in the FMU, with light snowfall in winter. The annual rainfall ranges from 250 to 500cm. The wettest months are May to September – the summer monsoon; the driest are November through January – the bamboo cutting season.

Soils under the hardwood forests are generally well drained sandy loams with a thick layer of humus, generally shallow, ranging from 10-60cm in depth.

Forest types

The Khaling-Kharungla FMU encompasses both cool and warm broadleaved forests, moist and dry, respectively, depending on the local rainfall regime. The cool moist broadleaved forest (most relevant to the bamboo study) ranges from 2,000 to 2,900m. Trees of the family *Lauraceae* and the genus *Exbucklandia* are most abundant, with *Quercus* spp, *Rhododendron* spp, *Castanopsis indica*, *Acer*, *Betula*, *Lindera*, and *Symplocos* spp. This forest is also characterised by dense bamboo thickets, shrubs, climbers, and epiphytes.

Human and animal impacts

In 1996, when the management plan was prepared, there were 205 households within the FMU, with an average of seven persons per household. The total population was 1,435 inhabitants. The local population growth rate is estimated at 2.5% per annum, assuming no significant urban drift effects.

In addition to harvesting bamboo and other AFRs, the main traditional uses of this forest are timber cutting and livestock grazing. In the subsistence economy, the need for timber is small, mainly for new house construction and repairs. For new construction, every Bhutanese house owner holds a traditional right to cut up to 25 or 30 trees in hardwood (up to 50 in conifers); for house repairs owners are allowed three to five trees every five years. Divisional Forest Office (DFO) staff do the marking, though traditionally the house owner makes his own choice. In the study area, in any one year, only one or two new houses are constructed and a few are repaired. Even adding the occasional construction or repair of a schoolhouse, other public buildings, or a bridge, the impact of traditional timber cutting is small. It is our observation that the greatest potential threats to the bamboo resources are from commercial logging (based on road access) and livestock grazing.

Commercial logging

Commercial logging operations, managed by the Forestry Development Corporation of Bhutan, began at Khaling-Kharungla in 1998. According to the FMU Operational Plan (DFO 1997), altogether 20 cable lines ('skylines') are planned for harvesting timber over the 10-year plan period. Each line is approximately 1,000m in length, running perpendicular to the slope.

A forest access road is being constructed, linked to the National Eastern Highway near Wamrong (see Figure 2). The access road is expected to reach a distance of 8km during the first 10 years of logging operations. By mid-2000, 2.4km of this road had been completed. Road access facilitates the harvesting of timber and also opens up the resource to other AFR harvesters and contractors from outside the area. A small experimental plantation has been established for regeneration of some of the main species (*Exbucklandia*, *Acer*, and others), and trial plots have been established to determine the best means of regeneration after logging (Davidson 2000).

Livestock grazing

Livestock grazing has a significant effect on the condition of the forest, including the bamboo resources. Inventory records and field observation show that most parts of the FMU are

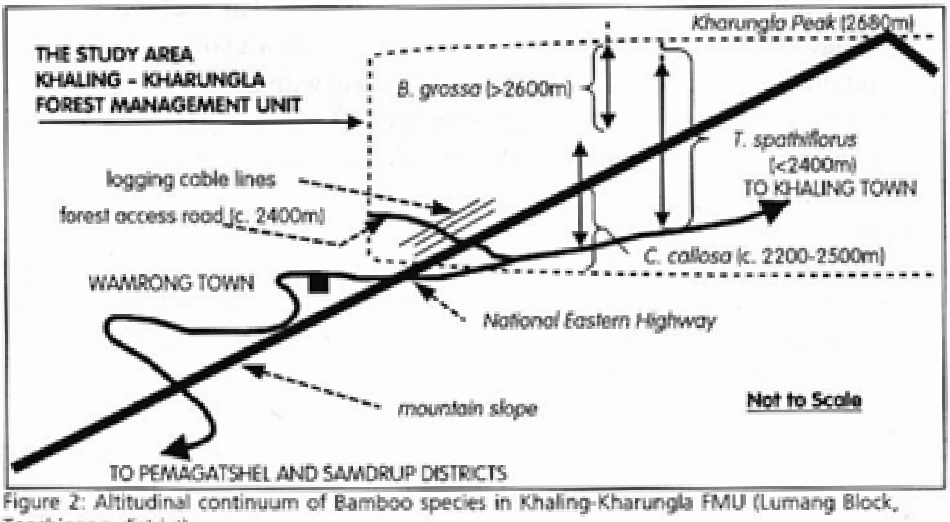

Figure 2: Altitudinal continuum of Bamboo species in Khaling-Kharungla FMU (Lumang Block, Tashigang district)

grazed by local cattle, with a small influx of migratory cattle and sheep during winter months. As the cattle are left to roam freely in the forest, some damage to tree and bamboo regeneration occurs, mostly from browsing and trampling of seedlings.

Local cattle husbandry plays a vitally important role in the traditional household economy of Bhutan. Most local cattle are kept for draught and milking purposes. The 1996 survey reports 8,152 livestock (or 8,016 livestock units) within the Lumang and Khaling Blocks. Some of these are from seasonally migratory herds of both cattle and sheep belonging to the Brokpa ethnic people who reside in the nearby highland valleys of Merak and Sakteng (in Sakteng Block, Tashigang District).

The heaviest grazing season is from September to May when an estimated total of 3,628 livestock (1,964 livestock units), local and migratory, are pastured here.[8] Under free-ranging conditions, approximately two hectares (5 acres) of natural forest area is needed to support one livestock unit, or approximately 0.5 livestock units per hectare (Chamling 1996; Dorji 1993; Gyamtsho 1992)[9].

The FMU Management Plan reports that the <u>local</u> resident animal population appears (arguably) to pose little or no threat to the forest ecosystem. However, more recent observations of tree regenerative capacity and possible displacement of grazing wildlife forms indicate that the combined grazing pressure arising from migratory herds and local animals is beginning to threaten the ecosystem. This competition has precipitated conflict between local and migratory cattle grazers[10,11].

BAMBOO SPECIES, CONDITION AND USE

Species and distribution

All three species of bamboo occurring within the FMU (*B. grossa*, *T. spathiflorus*, and *C. callosa*) are found in sequence along the altitudinal continuum as shown in Figure 1. A synopsis of species type, habitat ,and utility is given in Table 2.

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[8] From observations more recent than 1996, these figures seem low.

[9] In a recent study in all FMUs of eastern Bhutan, Yonzon (1998) recorded the relative frequency of encounters of humans and cattle. He found the frequency of human encounters to be 15 %, and of cattle to be almost 20%. The cattle encounters were 10 times above the frequency of native mammals and large-sized birds. (Wild boar were the third highest frequency; they are well known for the damage they inflict on both forest and agricultural lands.) See also Davidson et al. 1999.

[10] The Brokpa (from a Tibetan term, 'brog-pa' (meaning nomadic livestock herders), are members of a relatively small ethnic group (with an approximate population of 3,000) who inhabit the high mountain valleys of Sakteng and Merak in north-eastern Tashigang District. Their livelihood is based on transhumance livestock husbandry with yak, cattle, and sheep, coupled with limited highland farming. In summer they reside at their home base in the villages in the high valleys of Sakteng and Merak. In winter, whole families of Brokpa migrate down to warmer regions with their cattle and sheep. At Khaling-Kharungla they have established long-standing economically symbiotic relationships with local residents, conducting trade and doing manual labor such as carpentry, wood cutting, and weaving bamboo mats while awaiting warmer weather to return home.

[11] Further discussion of traditional forest and pasture resource use and tenure in the Himalayas, including Bhutan, are found in FAO n.d.; Gyamtsho 1992; Miller 1988; Miller and Craig 1997; Richard and Miller 1998; Ura 1993a,b; Wangchuk 1998.

Table 2: Bamboo species, habitat and utility at Khaling-Kharungla	
Borinda grossa (Yi) Stapleton. Local name: shi	
Habitat and altitudinal sequence	***Utility to humans and animals***
Occurs above c. 2,600m (up to c. 3,200m). Clump-forming thornless, frost-hardy bamboo growing up to 10-12m in height. Distinguished by its long, finely-grooved thin-walled internodes up to 50cm long and 4.5cm in diameter.	High utility. Extensively harvested by locals and contractors. Most important local non-timber forest resource. - Mature culm (2nd season): mats for roofing, huts and temporary shelter, fencing and farm protection, household implements, walking sticks - Immature culm (1st season): cords, fibres (coarse 'rope'), baskets, winnowing trays, butter churn spindles, arrows - Tender shoots: human consumption, cattle feed (illegal); browsed by wild animals - Leafy portions: brooms, padding
Thamnocalamus spathiflorus (Trin.) Munro. Local name: shi-za	
Overlapping and below *B. grossa*, above c. 2,400m (grows naturally up to c. 3,500m). Clump-forming, thornless, frost-hardy, growing to about 5m tall. In distinction to *Borinda*, the culms are smaller, brittle, and have swollen nodes with fewer branches.	Little utility to either subsistence or commercial economy - Shoots and leaves: important food and concealment for wildlife - Young shoots, tender culms and leaves: heavily grazed by cattle in early winter
Chimonobambusa callosa (Munro) Nakai. Local name: ra-shi	
Found at c. 2,000 – 2,500m elevation. Distinguished from the others, above, by the growth of solitary shoots from long-spreading rhizomes and by a ring of thorns around the culm nodes. Slightly frost-hardy with relatively thick-walled culms up to 6m tall and 4cm in diameter. (In the study area, a good example of its development can be seen in the electricity line corridor and lower bamboo hauling track.)	Little utility to either subsistence or commercial economy - Mature culm: 'wattle and daub' wall construction, mats and baskets - Young shoots: grazed by cattle

Borinda grossa is a clump-forming thornless, frost-hardy bamboo up to 10-12m in height, occurring above 2,600m elevation in the study area. This bamboo is distinguished by its long, finely-grooved, thin-walled culm internodes of up to 50cm long and up to 4.5cm in diameter[12] (see Figure 3).

Thamnocalamus spathiflorus overlaps with *B. grossa* above about 2,400m in elevation. It is most likely of the subspecies *spathiflorus*, since the culm sheath is symmetrical on the culms examined. This is also a clump-forming, thornless, frost-hardy bamboo growing to about 5m tall. In distinction to *Borinda*, the culms of *Thamnocalamus* are smaller, brittle, and have swollen nodes with fewer branches[13] (See Figure 4).

Chimonobambusa callosa is found from 2,000m to 2,400m elevation. It is easily distinguished from the other two by the growth of solitary shoots from long spreading

[12] *B. grossa* is synonymous with *Fargesia grossa* (Yi), and also with *Borinda chigar* and *Borinda emeryi* (Stapleton) (Masman 1995; Watson and Dallwitz 1992).

[13] In Chamling (1996), *Thamnocalamus spathiflorus* is mis-identified as *Yushania pantlingii*, a species common elsewhere in eastern Bhutan. This was probably due (in part) to the fact that local residents lump *T. spathiflorus* among those species which they refer to as 'maling' or 'malingo'. Our identification was keyed and verified in the field by the plant ecologist (J. Davidson).

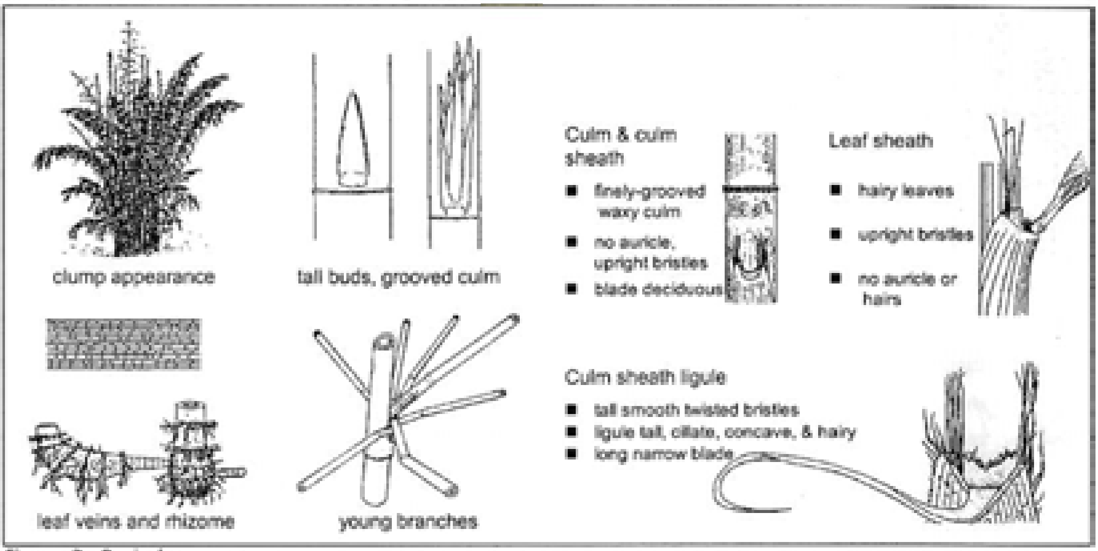

Figure 3: *Borinda grossa*

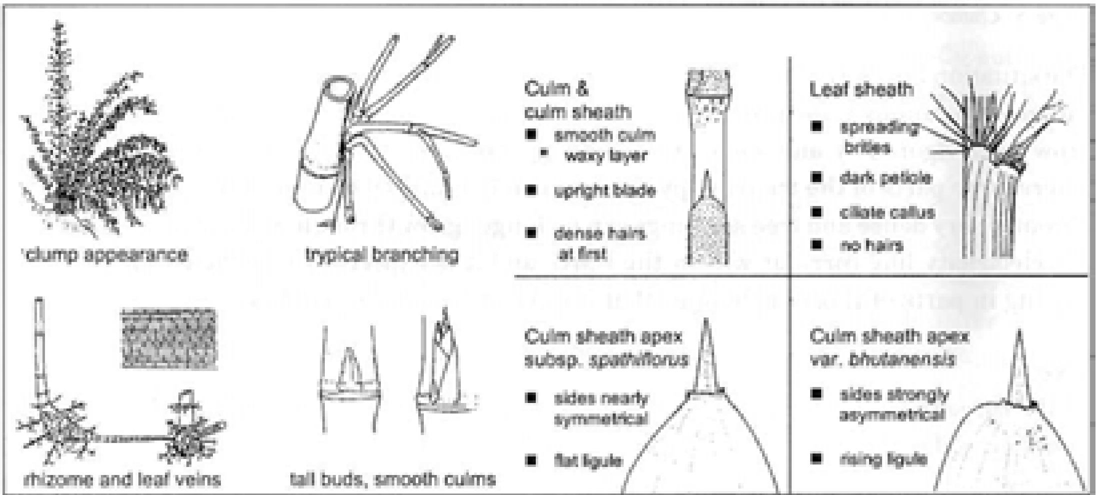

Figure 4: *Thamnocalamus spathiflorus*

rhizomes and by a prominent ring of sharp thorns around the culm nodes. This species is slightly frost-hardy with relatively thick-walled culms up to six metres tall and four metres in diameter. In the study area, the best development of this species can be seen along the electricity line corridor and the lower part of the walking track (the 'bamboo trail') which runs from the top of the FMU down across the forest road to the nearby highway and village of Wamrong (see Figure 5).

Condition

When bamboos such as *B. grossa* and *T. spathiflorus* grow in clumps, tree seedlings usually regenerate in the gaps between the clumps. However, in this FMU, most such tree regeneration is grazed by cattle and does not survive except for unpalatable *Symplocos* species.

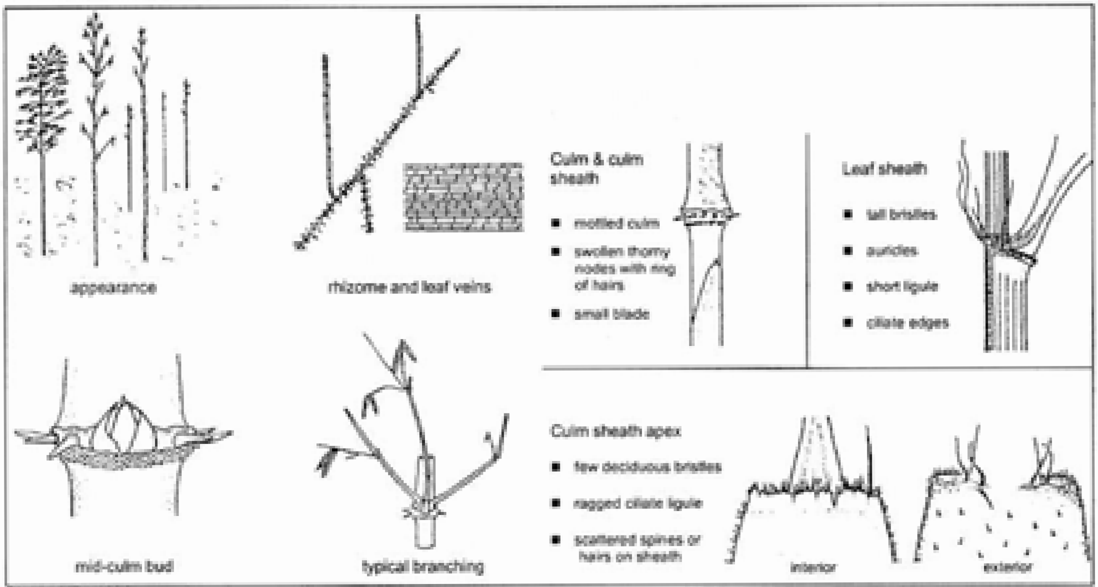

Figure 5: *Chimonobambusa callosa*

The situation is different for spreading genera like *C. callosa*. Under undisturbed conditions the mature canopy trees prevent sufficient light, reaching the ground for this bamboo to grow very vigorously and some tree seedlings can grow through the bamboo. However, where large parts of the tree canopy are completely removed by clear felling, the *C. callosa* becomes very dense and tree seedlings can no longer grow through it. This is the case along the electricity line corridor within the FMU, and it is expected to be the result of future logging in parts of those cable lines that impact on *C. callosa* patches.

Use

Of the three species of bamboo, *B. grossa* is the most important economically. It is found in quantity and is the most heavily used for making a variety of mats for house roofing and fencing, and for the wattle and daub of house and hut construction. The other two species have little commercial value and only minor utility in the local economy.

The harvested clumps

All of these bamboos are fast-growing, with short-lived aerial parts and long-lived rhizomes that continually renew themselves vegetatively. Periodically, the species are re-invigorated by a flowering and seeding cycle during which the previous vegetative generation completely dies out. The precise timing of flowering and seeding has not been determined[14].

The normal growth pattern is for a new culm to emerge during the monsoon and reach maximum height extension by the onset of the dry winter season. During the second year, the culm wall becomes hard and dense, and branches and leafy crowns become pronounced.

[12] Local informants indicate that the local bamboos flower every five to nine years, but we were unable to verify this.

By the third year the culm is in decline and beginning to decay, becoming dark brown to black. Eventually, by the fourth or fifth year, the culm falls and or breaks off and decays on the ground. New culms come up in their place.

Culms are harvested during the second year. Harvesting is selective; only the straightest, smoothest, and largest culms are chosen. They are cut 20-50cm above the ground level by a single downward diagonal blow from a 'patang', the Bhutanese man's traditional machete-like knife.

Clumps that have many culms harvested tend to develop matted rhizomes which restrict subsequent new growth. In an ideal situation, the rhizomes should be allowed more space to grow by using various techniques for removing part of the clump (cross, crescent pattern, and others).

Socioeconomic aspects

Utility

Because of its level nodes, thin walls, and long internodes, *B. grossa* is easily split into strips for mat-making. This species is the most important alternative (non-timber) forest resource in the FMU and it is harvested and used extensively.

During the cutting and mat-making season (mostly from mid-October through December, but extending to April), *B. grossa* cuttings can be observed being dragged in bundles down the bamboo trail to the road where they are laid out, pounded flat, split, and woven into mats. Mats are used locally in house construction, roofing and fencing, and for household implements. Rough cords ('coarse rope') as well as baskets, hats, winnowing trays, and a few other items are made from the fibres of the immature, first season culms. The tender shoots of *B. grossa* are eaten by people and sometimes heavily browsed by domestic cattle, sheep, and wildlife. The leafy portions are sometimes cut to make brooms and for padding under heavy back loads (especially when the heavy bamboo culms are dragged down from the high forest).

In addition to its importance in local subsistence, *B. grossa* has considerable commercial value. Since 1979, commercial harvesting permits have been issued from the Divisional Forestry Office to contractors, some of whom come from a distance away (such as from Samdrup Jongkhar and Pemagatshel districts in the south, near the international border with India), as well as locally from towns and villages within Tashigang District.

Note that, despite the life form stamina and great utility of the resource, in this generally humid environment the lifetime of bamboo products is limited. Bamboo mats, for example, have poor long-term durability, because in this humid environment they are attacked by insects and fungi much more rapidly than some timber products. The typical mat roofing lasts for three years.

Compared with *B. grossa*, the culms of *T. spathiflorus* are small and brittle and not widely used. The shoots and leaves provide important food and concealment for wildlife. In the study area young shoots, tender culms, and leaves are heavily grazed by cattle in early winter.

The culms of the thick-walled *C. callosa* are inflexible and brittle; and the presence of nodal thorns makes them unpleasant to handle. Virtually the only use observed has been to fabricate wall panels in house and hut construction, a style of 'wattle and daub' where the culms are split and loosely woven, then covered on both sides by cement or clay for durability. The only other *C. callosa* parts of any use are the tender shoots that are browsed by cattle.

Commercial value

Bamboo contractors hire local villagers to cut and deliver bamboo culms to the roadsides. There, the culms are split and woven into roofing mats and fencing material of commercial value. The rate paid for cutting, dragging, splitting, and weaving is Nu 50 to 60 per day (the standard day labourer's wage is the same for man or woman)[18] (see Plates 3, 4, 5 and 6)

Plate 3: Bamboo culm haulers in the high forest

Plate 4: Bamboo culm haulers in the high forest

Plate 5: Bamboo culm haulers in the high forest

Plate 6: Bamboo culm haulers in the high forest

[18] Ngultrum (Nu) 40 = US $1.

A skilled mat weaver can complete four mats in a day, after cutting and hauling the resource to the roadside and splitting the culms (Plate 7) . A finished mat consumes, on average, 15 to 18 culms (about one adult dragger's head-load, Plate 8). Finished mats measure approximately 2 x 5m and sell for Nu 50 to 60 each.

Productivity is measured in 'truckloads' of 150 mats each. One commercial truckload has a market value in the range of Nu 7,500 to 9,500 at current prices, depending in part on how far away the mats are delivered. The volume of cutting under commercial permit is shown in Table 3. The figures show that 684,660 culms were extracted under commercial permits from the forest between 1991 and 1997, increasing steadily each season. The sale of finished mats brings a good profit for contractors compared to logging and firewood cutting, for example.

Table 3: **Supply of bamboo by commercial permit, 1991-1997**

Year	Annual cut by government permit (culms)
1991	62,570
1992	85,670
1993	88,500
1994	75,550
1995	123,750
1996	120,545
1997	128,075*
Total	684,660

*In 1997, an additional 3,000 culms were cut for making mats for a VIP visit. This was an extraordinary, non-commercial purpose, was managed by the government, and required no commercial permits; hence, they are not counted here.
Source: Forestry records, Range Office Wamrong, Tashigang District

It is clear that the commercial value of the bamboo is high, and also that it has important economic benefits for local residents who participate in commercial cutting and mat-making.

Subsistence value

Bamboo mats for roofing and fencing are ubiquitous across Bhutan, and especially so in the eastern dzongkhags where natural bamboo resources are abundant. Traditionally, house roofs are constructed of mats, and some less substantial houses and huts use bamboo mats for wall construction. There are several varieties of mat, identified by the tightness of the weave. Split bamboo is also used to make a variety of other products, as already noted. Hence, the demand for bamboo in this subsistence economy is high.

Plate 7: Splitting culms by the roadside

Plate 8: Weaving a mat

During the most intense bamboo harvesting season (October to December) some local families depend almost totally on this work for employment and cash income. During the dry winter season, men and teenage boys enter the high forests to cut the culms. They – and women and girls in some locales[16] – may be seen dragging the raw material, the harvested culms, down to the roadsides. There, the culms are split and flattened to make them pliable for weaving. For some local families, seasonal income earned from the bamboo harvest and mat-making is considerable, although precise cash totals earned from this work are difficult to calculate.

BAMBOO MANAGEMENT

Bamboo harvesting in this FMU is managed in two ways, by government permits and by traditional rules. The locally, long-standing traditional management system of Khaling-Kharungla, however, has collapsed in recent years, especially after the national highway was built and the more recent construction of the forest road, both of which have given easy access to outsiders, thus raising the commercial value of local bamboo.

The government permit system

In 1979, the Divisional Forestry Office introduced a system of permits for cutting bamboo to contractors seeking access to the bamboo resources of this FMU. Since then, all commercial harvesting has been conducted under this system. (Illegal local cutting goes uncounted.) The permit fee is 8 Nu per 100 culms.

According to the local Forest Range Officer, a permit can be issued for cutting up to 1,000 culms at a time, at the rate previously noted, 8 Nu per 100. But, while the government system controls access and has increased the commercial value of bamboo, it has also contributed to the demise of a pre-existing protection system by ignoring local tradition.

The local protection system

Traditionally (before 1979), an indigenous conservation system called 'ridam' was practised by local villagers, the original users of this forest. Ridam is well known in eastern Bhutan as a generic, long-standing method of protecting mountain forest resources. It sets down strict and locally unique rules about seasonal access and closure (Box 1). As long as the forest remained relatively undisturbed by commercial pressures or other imposed changes (outside of traditional practices), ridam worked well as a protection system. It has the potential to be reinstated, perhaps with modification, thus recognising the local people's important role in a more participatory management process.

At Khaling-Kharungla, bamboo harvesting was traditionally carried out only by local users, mostly from mid-October through December (extending less intensively up to April).

[16] At Wamrong (Lumang Block) it is customary for women, including older girls, to work alongside men in cutting and dragging bamboo out of the forest. In Khaling, by comparison, it is customary only for men and boys to do this work.

Box 1: Ridam

('ri' = 'mountain' + 'daam' = 'restricted, prohibited')

'Ridam' is an indigenous practice in eastern Bhutan that strictly prohibits people from entering or using a designated mountain forest area during specified periods each year. The concept is bound by both place and time and is firmly fixed in local cultural practice and belief. In the past, ridam at Khaling-Kharungla was observed during the 7th to 9th months of the Bhutanese calendar (mid-August to mid-October). During these two months, all access to the forest was strictly prohibited; and forest-based activities such as timber cutting, fuelwood collection, bamboo harvesting, collecting medicinal plants, herding, and hunting were totally banned.

Local people believe that, if ridam is broken, the guardian deities of forest and farm will cause crop damage by sending violent storms (rain, hail, wind). As this is the main harvest season, storm damage to crops is especially feared (and not uncommon).

As is typical with such long-standing local traditions, the practice of ridam has had a noticeable positive effect on the environment, as well as on the local socio-economy. For one, it provides a period of rest for both young wildlife and plants (e.g., bamboo, grass, trees) to mature relatively undisturbed by humans during the late warm, wet monsoon growing season. For another, it effectively focuses villager attention on the important activities of agricultural field management and harvest. As ridam was observed in the high forest of Khaling-Kharungla during two of the most busy months of the agricultural cycle, this taboo served to focus farmer attention on farming, well away from the forest.

According to local informants, ridam at Khaling-Kharungla was diligently observed until recently. The breakdown of ridam began with the opening of the National Eastern Highway in 1962, which increased outside access to local resources. The traditional system further eroded after 1979, the year the forest department imposed their control over harvesting forest products with the introduction of a permit-for-cutting system. Both of these events opened access to forest resources to outside entrepreneurs, unfamiliar and unconcerned with ridam. Village leaders complain that they have been powerless to stop strangers from contracting locals to harvest forest products throughout the year, in ignorance of tradition.

In Buddhist Bhutan, there are many such beliefs and traditional practices affecting the natural environment – trees and forests, streams, lakes and mountains, and wildlife. Local practices like ridam encourage respect for nature and discourage resource abuse. They typically have a strong hold on local people and promote a cautious attitude towards the environment.

For further discussion, see TFDP 2000, Ch.4: 'The Environment in Bhutanese Culture'; also Choden 1996.

Throughout the rest of the year, access was discouraged (though not entirely closed), until the seventh to the ninth months of the Bhutanese calendar (mid-August to mid-October) when access was strictly forbidden. During these two, crucial months, according to the rules of ridam, access by villagers to the entire forest for any purpose was entirely prohibited. These months correspond to the most important season for new bamboo growth; thus the ridam closure contributed to the well-being of young and vulnerable bamboo, as well as other flora and fauna of the forest.

Ridam has, until recently, been followed at Khaling-Kharungla since time immemorial, because of the local belief that breaking the rules would bring destructive storms with serious damage to field crops. One important result was the focusing of villagers' attention on agriculture, away from all forest-based activities. Another was the imposition of a rest period on the forest, protecting young plants and animals during the crucial and most vulnerable season for maturation.

The traditional ridam system began to break down at Khaling-Kharungla from 1962 onwards, but markedly after 1979 when the government permit system was imposed. The permit system ignores the rights of local leaders to regulate access to the forest and has encouraged relatively uncontrolled access to bamboo resources by outside contractors who know or care little about local custom or belief. As a result, ridam is now regularly violated, with concerned villagers and their leaders virtually powerless to act. Some villagers remember that, for a few years after 1979, there were, indeed, crop-damaging storms. In time, however, this disincentive to breaking the rules was ignored. In discussions with local leaders, they voiced their desire to reinstate ridam by seeking a more active participatory role in forest management planning[17].

Resource working circles

A variety of activities involving people's participation in the management of resources, including bamboos, is discussed in the FMU Management Plan. The plan describes a system of 'working circles', defined as areas for special resource management, each following a set of recognised and agreed-upon objectives. The most common objectives are production and protection. Production typically deals with commercial timber harvesting, while protection is usually concerned with biodiversity and watershed conservation.

While the classical definition of production and protection working circles focuses largely on the technical and commercial aspects of timber extraction, the definition for working circles in Khaling-Kharungla FMU does take into account some of a complex set of local socioeconomic considerations. This is the entry point for the application of social forestry concepts and practices, although they have not yet been implemented. (One objective of this study is to encourage more attention to resource management planning and implementation.) The working circles planned for all FMUs under the Third Forestry Development Project typically include community-oriented objectives, alongside scientific research objectives, although these have often not been fully implemented.

The plan divides the FMU into two management classes and several types of working circle, with most emphasis on harvesting hardwoods (logging), as follows[18].

- **Production**: two **production working circles**, including a **hardwood working circle** of 3,804.39ha in three blocks (at Khaling, Kurchilo, and Bephu villages) and a **community working circle** with a jurisdiction of 1,261.42ha in one block (near Brekha village). A **bamboo working circle** is to be taken up (in future) under the community working circle at Brekha.

[17] Wangchuk (1998: 85, after Talbot and Lynch 1994; Guha 1989) observes that "The process of increasing state regulation generally changes the relationship between the resource availability and the communities from a customary one to a formal one." State appropriation "has generally shown negative effects" on indigenous knowledge and traditional practices. "The process tends to favour fragmentation of the community ...and the erosion of social bonds... [by impacting] the social organisational capability and local resource management institutions at the community and household levels. It influences the perception of the sustainability of the forest resources traditionally used by the local communities."

[18] Note that areas within a working circle can either overlap or be non-contiguous, and that working circles may overlap with one another.

- **Protection**: a single **protection working circle**, with a 2,210.76ha jurisdiction, lying within the Khaling and Kharungla blocks. This includes a 603.77ha site designated as Sherubtse College Nature Study Area.[19]

Discussion

Silvicultural management of bamboo has never been practised in eastern Bhutan despite its importance as a widely used alternative forest resource. The 1996 FMU Management Plan points out the significance of bamboo in the local subsistence economy, but it does not fully recognise the growing importance of its commercialisation[20]. Due to heavy commercial demand in recent years, however, harvesting of the main local species, *B. grossa*, is under pressure with the very real risk of overexploitation leading to a marked degradation of the most easily accessible parts of the forest. The little degradation noted in the 1996 plan, including a growing shortage of mature *B. grossa* culms, is described as being due to uncontrolled cutting "in an unsustainable and haphazard manner," presumably by local cutters. To aggravate the situation even further, the plan continues, annual migratory cattle herders from nearby Merak and Sakteng have "carelessly and recklessly cut down the young culms and shoots of all sizes and age classes, while grazing their cattle." This perception, in turn, fuels the ethnic conflict between the local villagers and Brokpas over access and use of the forest (Chamling 1996: 42).

Local irritation with the Brokpa is complicated by the fact that their form of transhumance is a traditional activity, one which quite literally defines them culturally – as "underlying all aspects of Brokpa life" (Wangmo 1990: 55). Hence, it is not easily changed nor revoked.

More recent conflicts have arisen over the building of the forest access road and logging. In early 1999 and again in 2000, logging operations within the FMU were temporarily closed down after local villagers complained of their lack of involvement and petitioned the new Tashigang District Commissioner (the 'Dasho Dzongdag') to halt them. The villagers listed several complaints, including damage to agricultural lands caused by construction of the logging access road. An underlying cause of their complaints, however, is the loss of local control over access to the forest by outsiders and breakdown of the traditional rules of ridam.

The FMU Management Plan anticipated some of these causes of conflict, but totally ignores the indigenous ridam system. To their credit, the writers of the plan described several management options of considerable importance, such as participatory resource management, including training and demonstrations in bamboo silviculture and management for resident bamboo harvesters and transhumance livestock grazers alike. To date, however, no decisive action has been taken either in forming a bamboo working circle or the broader community working circle through which these social forestry objectives could be put into effect.

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[19] Sherubtse College, for the liberal arts and sciences, is Bhutan's only institution of higher education. It is located a few miles from the study area, at Kanglung, in Tashigang District.
[20] The 1996 plan says that only "a small quantity is commercially traded" (Chamling 1996:41).

What appears to be needed is a combination of the following:

- better information about bamboo as an alternative forest resource and how it responds to harvesting;
- better information on the level of bamboo resource use and economic demand under both subsistence and commercial conditions;
- more attention to the complex issues of traditional tenure, including knowledge and management systems governing forest resource access, especially by local residents and migratory herders;
- consideration of ways to adapt both traditional and scientific systems to bamboo resource management; and
- a higher level of mutual respect and understanding between all resource stakeholders (old and new), enabling accommodation and encouraging compromise among them using established conflict resolution criteria and tools.[21]

Our initial findings indicate a serious and growing threat to the bamboo resources of Khaling-Kharungla FMU. These findings are based on rough field observations and discussion. To determine the magnitude of the threat more analytically, however, we also applied a plant vulnerability assessment and ranking system that was adapted with modifications from an earlier example in the literature.

SPECIES VULNERABILITY

Potential threats to the bamboo resource

Species' vulnerability is a measure of the increased risk of extinction as a result of unsustainable harvesting or other perturbation(s). A standard definition of sustainable forest management describes it as "the process of managing forest to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment" (ITTO 1992a,b, 1998; see also Mankin 1998; Wijewardana 1998).

While most definitions of sustainability in this context refer to harvesting, other actions (or inaction) can also lower sustainability and raise species' vulnerability. The sustainability of a species implies that the impact of anything that affects its natural condition is so low or minimal that the species is not threatened with extinction. Thus, the low vulnerability of a species indicates that it is probably sustainable – assuming that existing conditions remain in a relatively steady state. For example, if the bamboos of Khaling-Kharungla are considered not to be highly vulnerable to extinction, then they can be harvested indefinitely at current rates and in current conditions (i.e., provided that the harvest rate is adjusted to result in negligible impact on the structure and dynamics of the plant populations being exploited or on the surrounding ecosystem; cf Peters 1994).

[21] On conflict resolution in forestry, see FTPP 1998.

We now ask – Do the current conditions, trends, and practices concerning the exploitation of bamboos from the FMU augur well for the sustainability of the species? Or, is the resource vulnerable to extinction?

Several threats to the sustainability of bamboo became apparent during the fieldwork. In addition to the commercialisation of bamboo, they include the construction of roads, imposition of the government permit cutting system, commercial logging, and livestock grazing. But, because our intuitive conclusions from the field show insufficient rigour to satisfy most scientific management planners, we sought a more analytical (and, if possible, quantitative) approach. To improve the analysis we adapted a vulnerability assessment system from the literature (Wild and Mutebi 1996), modifying it to allow a more quantitative mode of analysis. By this means, we gain a clearer appreciation of the various threats to bamboo, and of their severity. From the analysis that follows, a planner can make relatively more precise predictions and plans to manage and maintain plant resources and surrounding ecosystems sustainably; and can take remedial action where required.

The result of our analysis is summarised in the 'Rapid Plant Vulnerability Assessment Checklist' in Table 5. The checklist is based on a set of categories within which specific threats to a species are discussed and scored (ranked). This system identifies the most important trends.

To begin the vulnerability ranking process, we have defined and discussed thirteen categories of potential threat. Note that there is partial overlap between some categories.

A discussion of factors affecting the sustainability/vulnerability of bamboo

In the following discussion, the bold definitions in quotation marks that introduce ten of the 13 categories (Nos 1 to 7 and 10 to 12) are derived from Wild and Mutebi (1996). For more clarity, some additional descriptions have been paraphrased, with slight modifications from the original. To the original list we have added three new categories (Nos. 8, 9, and 13) that broaden and strengthen the analysis. The definitions that introduce these three new categories are our own. Our ranking of relative vulnerability is shown in parentheses for each category in the discussion, as they appear in Table 5.

Natural conditions and species' life

Life form and provenance

(1) Reproduction and longevity (LOW vulnerability)

> **"Long-lived, slow-reproducing species are more vulnerable than short-lived, fast-reproducing ephemeral species."** (Life form refers to the ecological characteristics of a species, such as growth rate, reproduction, and longevity.)

Observations: The data indicate that the most likely bamboo life form vulnerability at Khaling-Kharungla may occur in the sexual stage, when the plants flower and die. The most serious problem occurs as seedlings come up and are eaten by cattle. Traditional cutting and harvesting are not as critical as grazing during the seeding stage after flowering (July to September). If a generation of seedlings is eaten, there is no other source for growth and regeneration. Our data indicate that this is not the case to date and that regeneration has been ample.

A further risk may occur if the resources are very heavily harvested, limiting the number of shoots available to bear flowers.

(2) Habitat (NIL)
"Species with very narrow habitat requirements are likely to be rarer and more vulnerable."

Observations: None of the bamboo species studied has a very narrow habitat; therefore there is no vulnerability in relation to habitat specificity. These are frost-hardy species, and there is plenty of room for them to flourish. Furthermore, the habitat of the most highly-valued species, *B. grossa*, is not seriously affected by logging (which occurs below it in elevation).

(3) Growth Rate (LOW)
"Slower growing species will be more vulnerable to use."

Observations: The growth rate of all three species is fast. They grow approximately two metres per month in their first year. Mature size is achieved in about five months during the first season and growth in height is finished by October. In the second year they grow branches and more of a crown, and they thicken and become more lignified (harder, stiffer). Under ideal circumstances, therefore, growth rate should not be affected.

(4) Abundance and Distribution (LOW)
"Abundant widely distributed species are less vulnerable to overuse."

Observations: These three bamboo species are widely distributed throughout Bhutan (in and out of the study area). In eastern Bhutan they flourish throughout the same elevational ranges and rainfall regime, in the same forest type (cool broadleaf), and also within conifer forests.

Use and demand

(5) Parts Used (MODERATE)
"The part used significantly affects sustainability... If a certain size, age, or quality of a plant is used, the remaining population may ensure the survival of the species. But there is a risk that ecological assessments may indicate a higher availability than the more selective resource user assessment and lead to an overestimate of supply."

Observations: The parts used significantly affect sustainability, based on harvest index (the ratio of useful parts to biomass). In general, the moderate use of fruits, nuts, or leaves of plants has the least impact, while the use of twigs, branches, bark, stems, and roots, in that order, has more impact on longevity and reproduction. Consistent use of the whole plant leads to local extinction.[22]

If care is taken in the pattern of selection and use of the bamboos, by size, age or quality, and by time and season, the remaining population may endure, survive, and procreate. The term 'care' implies reliance on rational management, whether indigenous or scientific (noting that many indigenous management systems are scientifically sound), or some combination.

(6) Demand (MODERATE)

"The level of demand has a major impact on the plant. Demand is made up of two factors – the quality harvested and the frequency of harvest."

Observations: The demand on a resource is also influenced by a number of other factors, some of which may be entirely out of the control of local people or scientific managers. They include human population growth and a consequent change in need and demand, levels of supply (resource quantity and availability), resource access (easy or difficult), seasonality, permit systems, available substitutes, market tactics, and so on. Demand, of course, tends towards selecting the best of the resource, which, if harvested in excess, may influence the quality of future regeneration.

While bamboo mats are in great demand throughout eastern Bhutan, local informants observed that the pressure on the resource (hence its vulnerability) may fall off somewhat with the recent introduction of strong plastic-coated tarpaulin material. It is thought that the placement of tarpaulin sheets with mats repels moisture and fungal infestation, increasing durability and lifespan of the mat for up to three years. If this is the case, demand for bamboo mats should decrease commensurately, assuming that other factors (like population growth) do not interfere. The long-term effect of this substitute on demand, however, has yet to be determined.

Frequency of bamboo harvesting to meet demand is, therefore, not a serious issue, unless it leads to immense over cutting, or to harvesting during the most vulnerable season for young plants (July to September). So far, this appears to be only a moderate threat.

(7) Substitutes (LOW)

"The availability of substitutes affects species' vulnerability by reducing demand."

Observations: The typical eastern Bhutanese house roof is covered by 25 mats. The cost of roofing a typical house at Wamrong or Khaling, including materials, labour,

[22] In the coppicing species of *Daphne*, for example (in the harvesting of which the bark is stripped and used for making traditional paper), it has been determined that removal of bark down into the rootstock increases vulnerability (decreases plant survival), while removal of the bark down to a point a few centimetres above ground level reduces overall vulnerability, allowing regrowth by coppice (Messerschmidt 1988 and personal observation).

and so on, is conservatively estimated to be Nu 2,000.[23] By comparison, a corrugated metal roof on the same house would cost around ten times that amount, or about Nu 20,000. Where a mat roof lasts about three years, a metal roof lasts up to 12 years for the best quality (Table 4).

Table 4: **Comparative prices for house roofing in communities near Khaling-Kharungla FMU**

Roofing material	Approximate cost*	Duration
Bamboo mats	Nu 2,000	3 years
Corrugated metal	Nu 20,000	7 to 12 years (varies by quality)
Other (e.g., wooden shingles or shakes – though not locally available)	n/a	4 years (softwood) 12 years (hardwood)

*Given an average size house, the costs in column 2 include the roofing materials plus labourers' wages, meals and refreshment.
Source: Field notes

Thus, in the short run, the difference in immediate cost of mats over corrugated metal roofing provides an important economic incentive to favour continued use of bamboo mats. For the majority of local people, mat roofing is the only option, as metal roofing materials are prohibitively expensive since enough cash or savings to purchase them is not easily acquired. Local people say that because bamboo mats are easily accessible and relatively inexpensive, bamboo is their first choice among the options. There are also aesthetic and cultural considerations which favour bamboo mats over metal roofing materials (although these are not often voiced).

As noted earlier, commercially available plastic-coated tarpaulin sheets have come into use recently in association with bamboo mats, potentially lengthening the period of use of the mats. We have no firm data, however, on the incidence of tarpaulin usage, nor of the actual increased lifespan of mats.

Similarly, but to a much smaller extent, corrugated metal roofs may also reduce the need for matting. So far, however, the number of metal roofs in the area is low, although an increase in their use has recently been noted at Khaling town.

Social, cultural and economic effects on a species

Basis of management

(8) Traditional management – presence: low, absence: high (HIGH)
"Traditional management, if based on indigenous knowledge of a resource (and has sound scientific utility; often it does), reduces resource vulnerability."

Observations: In many communities of users, there are individuals ('local experts') who have intrinsic knowledge about species' reproduction, longevity, and seasonality, and of the parts and products used. This knowledge exists at Khaling-Kharungla where,

[23] This figure of Nu 2,000 is derived from the following calculation: 25 mats x Nu 50 each + salary for 7 days' labour @ Nu 50/day + 3 meals and refreshments. The house owner typically hires six or seven labourers, and together they usually accomplish the task in one long day

in the past, it has been used to inform traditional management decisions, particularly resource protection (under ridam), harvesting practices, product design, supernatural sanction, and other sociocultural and economic aspects of the species, its use, and its environment.

Indigenous knowledge tends to be holistic, and although it may not be expressed (by the locals) in scientific terms, the richer or greater (robust, long-lasting) it is, the more likely it is to have real scientific management value (see DeWalt 1994; Duffield et al. 1998; Grenier 1998; Ortiz 1999; Warren et al. 1995). Traditional management often promotes species' protection over silvicultural management. At Khaling-Kharungla the indigenous ridam system was used to restrict access and use of the species on a seasonal basis, backed up by belief in supernatural sanction. Such systems tend to enhance species'sustainability and reduce vulnerability.

However, when commercial pressures or other outside influences impinge, and harvesting demands on a traditionally protected resource increase, indigenous knowledge and traditional management systems tend to break down. Outside pressures often undermine their utility, respectability,and efficacy, whereupon local tradition is lost (and it, like the resource it was meant to protect, also becomes vulnerable).

During the field research, local bamboo harvesters and mat-makers were engaged in focus group discussions and expert interviews, but precisely how much they know and the quality of their knowledge (i.e., depth of understanding) is still uncertain and needs further study. Some knowledgeable people expressed the belief that the bamboo has been over cut and its accessibility diminished (they must go further into the forest to find it, compared to the past). They now feel that some areas should be periodically closed to harvesting combined with reinstatement of the indigenous ridam system of protection.

Since 1997, a simple rotational system has been imposed by local leaders at Khaling-Kharungla. For example, at the time of our study the bamboo resources in Khaling Block (near Brekha and Bephu villages) were closed to cutting. After a few years, we were told, the ban would be switched over to Lumang Block (near Wamrong town). Local leaders also expressed a desire to see both the rotational access scheme and the indigenous ridam system incorporated into an amended FMU Operational Plan.

It is questionable, however, if rotation will make any difference. The resource in the reserved area will not be used; hence, an increasing proportion of culms will become old. The only perceivable advantage would be that, if flowering occurred in the reserved area during a closed year, there would be a full flowering, compared with limited flowering on residual shoots in areas where cutting was allowed. (Reservation does not affect total supply, only its age.) Apart from that, the only effect would be to limit supply to that available from the unreserved area; but this, in turn, may lead to over-cutting in the open areas. (A better solution might be to allow cutting within both areas, i.e., over the whole resource, in a more controlled manner; or, possibly, to time closures to correspond with the species' years of sexual reproduction).

Finally, it is interesting to note that the ridam-imposed seasonality fits neatly with the biology of the plant. The most naturally vulnerable time for young shoots is the summer season which was traditionally closed to harvesting.

(9) Scientific management – presence, low; absence: high (HIGH)

"Where reasonable policy is in place and sound scientific management is practised, based on objective and in-depth scientific knowledge, the vulnerability of a species should decrease."

Observations: This dictum assumes that good management policies exist, that scientifically-informed guidelines are followed, and both policy and management are based upon in-depth understanding of a species under various conditions of use or abuse (and that no contradictory socioeconomic or political tradeoffs are imposed). Where neither scientific management nor traditional management exist (the current situation in regard to the bamboos of Khaling-Kharungla), vulnerability increases dramatically.

Commercial effects and other outside influences on a species

Harvesting and commerce

A number of outside conditions and demands tend to affect the vulnerability of a species in terms of reproduction and longevity, parts and products used, and the decisions and tradeoffs that go into policy and management decisions. They include the following (Nos 10-13).

(10) Seasonality – as related to use and demand (HIGH)

"Demand may be reduced if harvesting is restricted to seasons."

Observations: Some species are highly vulnerable if critical seasonality is ignored. Care must be taken with species like bamboo not to harvest them during the flowering or seeding seasons. Traditional and scientific management practices usually take seasonality into account, restricting human access accordingly.

Bamboo harvesting is conducted during the dry winter season when agricultural field work is at a minimum, access to the forest is easier, there are no leeches (which inhibit human access), new seedlings are at least risk, the weather is dry, and the mats can be made under dry conditions (limiting fungal infection).

Vulnerability based on seasonal harvesting can be more complicated than this, however. If the issue is expanded to all seasonal perturbations which impact on bamboo life form vulnerability, then there is cause for concern. In the past, no access to the forest was allowed during the season of highest life form vulnerability, July to September; while, today, human access to the forest is uncontrolled and cattle grazing is unregulated.

(11) Response to harvesting – as related to life form (MODERATE)

"The ability of a species to regrow or increase its growth rate as a response to harvesting affects its vulnerability."

Observations: Over-harvesting, under commercial pressure or in the absence of good knowledge of a species' life form, can have devastating effects and may lead to local extinction. Thus, ability of a species to regrow or increase its growth rate as a response to harvesting directly affects its vulnerability.

In the study area, all bamboo species reshoot vigorously and grow well after cutting. For next year's harvest, young shoots are preserved with little harvesting.

Local people mostly harvest second year shoots, and take some care not to damage younger ones. But, our informants also said that some cattle grazers allow their animals to browse freely and cut the tender shoots for fodder (though illegal). Nonetheless, the remaining population of bamboos should ensure survival of the species.

A risk does occur, however, in the year before flowering and seeding. That is, if everything is cut down including second and third year culms, the plant cannot flower or seed. If management ensures that some culms are left, vulnerability is minimised. So far, this is uncertain, but it looks as if harvesters take some care in the matter, knowing that future resource availability depends, in part, on their watchfulness and constraint.

(12) Commercialisation – as it affects intensity of use and demand (HIGH)

"The ability of a species to regrow or increase its growth rate as a response to harvesting affects its vulnerability."

Observations: As a resource comes under the pressure of commercialisation, expanding away from subsistence use, unsustainable demand (hence, vulnerability) increases. Rational management (whether on traditional or scientific principles, or a combination of both) can ameliorate this pressure, increase a species' sustainability, and reduce its vulnerability.

The commercialisation of bamboo products in the study area is a relatively recent phenomenon. From 1979 onwards, the contract permit system rapidly opened up the resource to market-driven commercialisation. Currently, many of the dealers who contract locals to extract bamboo come from outside the local area.

As noted earlier, the overall production and sale of local bamboo products is measured in 'truckloads' of 150 mats each. Villagers estimate that the equivalent of 20 truckloads of finished mats are for local consumption, against nine for commercial use. At first glance, this may not seem like a great increase or serious threat. Based on a dramatic recent rise in commercial output since the permit system was introduced, however, we now calculate an increase of nearly 50% commercial truckloads over local consumption. The increase is, in fact, even higher because some local non-contract cutters sell mats independently to commercial buyers.

Currently available data show that between 1991 and 1997, 684,660 culms were extracted under commercial permits (Table 3). The average annual cut during this period was 97,809 culms. Since 1994, however, commercial demand increased to an average cut of

124,123 culms per year. Thus, the annual commercial cut more than doubled from 1991 to 1997 (a 105% increase). This, in turn, indicates a considerable threat, hence high vulnerability of the species from this factor.

(13) Other factors – as they relate to access and intensity of use (HIGH overall)
"In each circumstance in which a vulnerability assessment takes place, other interactions may occur to affect species vulnerability."

Observations: Some examples are **road access** which may increase product off-take, as well as **grazing, logging, mining, burning,** and **recreational activities**, that may expose a species to other threats which endanger the remaining growing stock. Each such factor should be carefully examined, although assessing their individual effects is largely a judgment call on the part of the observer. Different perturbations may be identified in relation to other species. Resource vulnerability may be potentially high in relation to some or all of them.

Roads (HIGH)
"Roads increase access, hence vulnerability."

Observations: Local roads include the National Eastern Highway (open since 1962) and the forest access road (started in 1997). Road access has increased bamboo vulnerability from commercialisation, attracting contractors and opening up markets where none existed before.

Road access coupled with the implementation of a commercial contract permit system since 1979 and local population growth has raised demand, with a consequent decline in resource availability. Informants are quick to point out that prior to the road there was less demand and more abundance of bamboo. As demand increases, vulnerability is increased.

Grazing (HIGH)
"Uncontrolled grazing increases vulnerability."

Observations: The key variable is the presence or absence of effective control over herders and livestock. Herders often cut leafy branches for fodder and allow their cattle free range to browse in the bamboo areas. Herds of sheep also graze in parts of the FMU area during the winter. How much sheep grazing affects the vulnerability of the species, or even if they graze the bamboo thickets, is not known.

Grazing of established vegetatively reproducing bamboo clumps seems to have little impact on survival of bamboos. The vulnerability of bamboo to grazing comes when the seedling production cycle takes place. Since the vegetative generation dies off following seedset, the survival of the bamboo relies solely on successful germination and growth of the seedlings. If these are all eaten by cattle or sheep, the bamboo will quickly disappear and will probably be replaced by aromatic broadleaved weeds and unpalatable trees like *Symplocos* spp.

Grazing of young culms, while not killing the clump, will mean that those culms will not be available for harvest in the following year.

Logging (MODERATE)
"Logging, to the degree that it impinges on the resource in question, increases species' vulnerability."

Observations: Logging impact in the study area is limited by the fact that the most important bamboo species, *B. grossa*, grows at altitudes above the existing and potential logging cable lines. (The first two skylines are largely in bamboo but it is the little used species of *C. callosa* that is present. The next three skylines reach the lower side but do not extend up into the more useful *B. grossa*. Cable lines planned for installation past the first five are not yet open and fall outside the study area.

Our basic conclusion is that logging should not be a problem in a direct sense, and only indirectly given that the forest road is opening up the area to easier access. The FMU Operational Plan should be amended to be sure that *B. grossa* is not adversely disturbed in any cable lines; there is little timber of any commercial value associated with it. The least important species, *C. callosa*, may be induced to grow down into the cleared logging areas, thus with no obvious vulnerability. (The presence of *C. callosa* in harvested cable lines, however, will make it very difficult to successfully plant and maintain broadleaved tree seedlings as prescribed in the FMU Management Plan.)

Other potential threats (NIL)
"Other vulnerabilties must be examined on a case by case basis."

Observations: Other potential threats in the study area may include alternative land-use practices such as slash-and-burn agriculture ('tseri'), the permanent conversion of forest areas into agricultural production, the uncontrolled harvesting of associated species other than timber, as well as hunting, burning (forest fire), mining, and recreational activities. We detected no threatening activities among these options.

Based on the above discussion, we can rank the thirteen categories on the 'Rapid Plant Vulnerability Assessment Checklist' (Table 5). The ranking proceeds as follows.

1. Potential threats are ranked categorically by placing a check mark in the appropriate column. (In column A, nil or no vulnerability, the rank is 0. In B, low vulnerability, the rank is 1. In C, moderate vulnerability, the rank is 2 and, in D, high vulnerability, the rank is 3). Note that there are no 'killer' categories; in extreme cases of threat check column D.
2. Count the checkmarks in each column and multiply by the value indicated for each column. Enter these totals where indicated.
3. Add together the total values from each column to produce an overall score.

Table 5: Rapid Plant Vulnerability Assessment Checklist				
For each category, rate species' vulnerability by marking with a check '✔' in the appropriate column, then sum up the columns for the overall score.				
Column	A	B	C	D
Category	NIL 0	LOW 1	MODERATE 2	HIGH 3
Natural conditions and life effects on a species				
Life Form and Provenance				
(1) Reproduction & Longevity		✔		
(2) Habitat	✔			
(3) Growth Rate		✔		
(4) Abundance & Distribution		✔		
Use and Demand				
(5) Parts Used			✔	
(6) Demand			✔	
(7) Substitutes		✔		
Sociocultural and economic effects on a species				
Basis of management				
(8) Traditional Management				✔
(9) Scientific Management				✔
Commercial effects and other outside influences on a species				
Harvesting and commerce				
(10) Seasonality				✔
(11) Response to Harvesting			✔	
(12) Commercialisation				✔
(13) Other Factors				✔
Column Totals:	0	4	6	15
GRAND TOTAL (Sum of columns A,B,C,D)				25
less than 13: low vulnerability **14 to 26: moderate vulnerability** **more than 27: high vulnerability**		Overall assessment of bamboo vulnerability in the Khaling-Kharungla Forest Management Unit, eastern Bhutan: MODERATE TO HIGH ✔		
Adapted with modifications from Wild and Mutebi 1996				

A score of 0 to 13 implies low vulnerability and is no cause for alarm. A score of 14 to 26 indicates moderate vulnerability and remedial actions to reverse the trend may be necessary. A score of 27 to 39 reveals high overall vulnerability and a high probability of extinction unless immediate action is taken to halt or reverse the trend.

Using this ranking system, we assess the vulnerability of bamboo species of Khaling-Kharungla FMU in eastern Bhutan at an overall rank of 25: **moderate to high**.

References

Chamling, K.D. (1996) *Management Plan for Khaling-Kharungla Forest Management Unit, Tashigang Dzongkhag (1996-2002)*. Khangma (Bhutan): Project Facilitation Office

Choden, J. (1996) 'Ree-daam: A Practice Linking Religion and Nature.' In *Druk Forestry News* 11: 17. Thimphu (Bhutan): Ministry of Agriculture, Forestry Services Division

Davidson, J. (2000) *Ecology and Management of the Broadleaved Forests of Eastern Bhutan*, TFDP Field Document FD00/7. Khangma: Third Forestry Development Project

Davidson, J.; Moktan, M.; Gyeltshen, J.; Pradhan, R; Wangdi, T. (1999) *Observation on Regeneration of the Broadleaved Forests of Eastern Bhutan*, TFDP Field Document FD99/13. Khangma: Third Forestry Development Project

DeWalt, B. (1994) 'Using Indigenous Knowledge to Improve Agriculture and Natural Resource Management.' In *Human Organization* 53(2): 123-131

DFO (1997) *Operational Plan for Khaling-Kharungla Forest Management Unit, Tashigang Dzongkhag*. Tashigang (Bhutan): Divisional Forest Office

Dorji, J. (1993) *Estimation of Grazing Animal Feed Requirements in the Kingdom of Bhutan*, a Background Paper for Bhutan's National Environmental Strategy. Thimphu: National Environmental Commission

Dorji, T. (1995) *Assessment of Non-timber Forest Resource Utilization in Eastern Bhutan*, TFDP Field Document 8. Khangma (Bhutan): Third Forestry Development Project

Duffield, C. et al (1998) 'Local Knowledge in the Assessment of Resource Sustainability. In *Mountain Research and Development*, 18(1): 35-49

FAO (n.d.) *Livestock Numbers and Cattle Culling Policy*, Consultancy Report. Thimphu: Food and Agriculture Organization of the United Nations

FAO (1996) *Non-wood Forest Products of Bhutan*, RAP Publication 1996/6. Bangkok: Food and Agriculture Organization of the United Nations

FTPP (1998) 'Integrating Conflict Management Considerations into National Policy Frameworks'. In *Proceedings of a Satellite Meeting to the 11th World Forestry Congress, 10-13 October 1997, Anatalya, Turkey*. Rome: Food and Agriculture Organization of the UN/Forests, Trees and People Programme

Grandstaff, T.B.; Messerschmidt,D.A. (1995) *A Manager's Guide to the Use of Rapid Rural Appraisal*. Bangkok: FAO/UNDP, FAO/FARM Programme and Suranaree University of Technology

Grenier, L. (1998) *Working with Indigenous Knowledge*. Ottawa: International Development Research Centre

Grierson, A.J.C.; Long, D.G. (1983-1991) *Flora of Bhutan*, 2 Vols. Edinburgh: Royal Botanical Gardens, Kew

Guha, R. (1989) *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya*. New Delhi: Oxford University Press

Gyamtsho, P. (1992) 'Forests and Livestock: Conflicts and Synergisms.' In *Proceedings of the workshop on Forest Inventory and Management*, 4-10 May 1992, pp 141-145. Lamé Gompa, Bumthang, Thimphu: Ministry of Agriculture, Department of Forests

Hadorn, C.; Wangda, P. (1999) *Traditional Papermaking in Bhutan: Demand and Supply.* Yusipang (Bhutan): Ministry of Agriculture, Research Extension and Irrigation Division, Renewable Natural Resources Research Centre

ITTO (1992a) *Criteria for the Measurement of Sustainable Tropical Forest Management*, ITTO Policy Development Series 3. Yokohama (Japan): International Tropical Timber Organization

ITTO (1992b) *Guidelines for the Sustainable Management of Natural Tropical Forests*, ITTO Policy Development Series 1. Yokohama (Japan): International Tropical Timber Organization

ITTO (1998) *Criteria and Indicators for Sustainable Management of Natural Tropical Forests*, ITTO Policy Development Series 7. Yokohama (Japan): International Tropical Timber Organization

McCracken, J.A.; Pretty, J.N.; Conway, G.R. (1988) *An Introduction to Rapid Rural Appraisal for Agricultural Development.* London: International Institute for Environment and Development

Mankin, W.E. (1998) 'Defining Sustainable Forest Management'. In *Tropical Forest Update* 8(3): 7

Masman, W. (1995) *Borinda.* <www.bodley.ox.ac.uk/users/djh/ebs/borinda.htm> (accessed April 2000)

Messerschmidt, D.A. (1995) *Rapid Appraisal for Community Forestry: The RA Process and Rapid Diagnostic Tools.* London: International Institute for Environment and Development

Messerschmidt, D.A. (1988) 'Success in Small Farmer Development: Paper-making in Pang and Nanglibang, Nepal'. In *World Development*, 16(6): 733-750

Messerschmidt, D.A.; Hammett, A.L. (1998) 'Local Knowledge of Alternative Forest Resources: Its Relevance for Resource Management and Economic Development'. In *Journal of Sustainable Forestry*, 7(12): 21-55

Messerschmidt, D.A.; Hammett, A.L. (1994) 'Villager Collection and Marketing of Alternative Forest Resources (AFRs) and AFR Importance for Farm Forestry Planning and Management.' In J. Sowerwine et. al. (eds) *From Farmers' Fields to Data Fields and Back: A Synthesis of Participatory Information Systems for Irrigation and Other Resources*, pp 17-33. Sri Lanka: International Irrigation Management Institute and Nepal: Tribhuvan University, Institute for Agriculture and Animal Sciences

Miller, D.J. (1988) 'Wildlife Management and Problems with Livestock Grazing in the Himalaya'. In *Bhutan Journal of Animal Husbandry*, 10: 72-81

Miller, D.J.; Craig, S.R. (eds) (1997) *Rangeland and Pastoral Development in the Hindu Kush-Himalayas*, Proceedings of a Regional Experts' Meeting, November 5-7 1996, Kathmandu, Nepal. Kathmandu: International Center for Regional Mountain Development

MoA (1998) *Biodiversity action plan for Bhutan.* Thimphu: Royal Government of Bhutan, Ministry of Agriculture

Noltie, H.J. (1984) *Flora of Bhutan*, Vol 3, Part 1. Edinburgh: Royal Botanic Garden Kew.

Ortiz, O. (1999) 'Understanding Interactions between Indigenous Knowledge and Scientific Information'. In *Indigenous Knowledge and Development Monitor,* 7(3): 7-10

Peters, C.M. (1994) *Sustainable Harvest of Non-timber Plant Resources in Tropical Moist Forests: An Ecological Primer*. Washington DC: World Wildlife Fund, The Nature Conservancy and World Resources Institute, and Biodiversity Support Program/USAID

Pradhan, P.M.; Moktan, M.R.; Legha, P.K. (eds) (1999) *Perspective on Conservation and Sustainable Use of Pipla (Piper species) in Bhutan.* Khangma (Bhutan): Ministry of Agriculture, Research Extension and Irrigation Division, Renewable Natural Resources Research Centre-East

Pradhan, R, Rinchen (1996) *Preliminary Report on Bamboo and Cane of Lower Kheng, Zhemgang Dzongkhag*. Thimphu: Royal Government of Bhutan, Ministry of Agriculture

Richard, C., Miller, D. (1998) 'Grazing Commons of the Hindu-Kush Himalaya and Tibetan Plateau: Constraint or Opportunity?', A Paper Presented at the Conference on Strategic Consideration on the Development of Central Asia, Urumqi, Xinjiang, China, September 13-18, 1998. Kathmandu: International Center for Integrated Mountain Development (unpublished)

RNR-RC (1998). *Impact of Lemongrass Distillation on Socioeconomy and Environment in Eastern Bhutan*, RNR-RC/East Technical Document 13. Khangma: Renewable Natural Resource Research Center/East

Stapleton, C.M.A. (1994a) 'The Bamboos of Nepal and Bhutan'. In *Edinburgh Journal of Botany* 51(1): 1-32, (2): 275-295, (3): 301-330

Stapleton, C.M.A. (1994b) *Bamboos of Bhutan*. Edinburgh: Royal Botanical Gardens, Kew for the Overseas Development Administration (U.K.) and the Royal Government of Bhutan

Talbot, K., Lynch, O.J. (1994) *Workshop on Strategies for Effectively Promoting Community-based Management of Tropical Forest Resources: Lessons from Asia and Other Regions*. Washington DC: World Resources Institute

Temphel, K.J., Messerschmidt, D.A., Davidson, J., Incoll, W.D. (1998) *Bamboo Utilization Study at Khaling-Kharungla FMU, Tashigang Dzongkhag, Eastern Bhutan*, TFDP Field Document FD98/16 (rev. Feb. 1999). Khangma (Bhutan): Third Forestry Development Project

TFDP (2000) *Social Forestry in Eastern Bhutan: A Study of the Third Forestry Development Project, 1994-2000*. Khangma: Third Forestry Development Project

Ura, K. (1993a) 'Gambling for Sustainability – Local Institutions for Pasture Management in Bhutan'. In *Forests, Trees and People Newsletter,* 22: 12-17.

Ura, K. (1993b) 'The Nomad's Gamble: Pastoralists of Northern Bhutan' In *South Asia Research,* 13(2): 81-100.

Wangchuk, S. (1998) 'Local Perceptions and Indigenous Institutions as Forms of Social Performance for Sustainable Forest Management in Bhutan', PhD dissertation. Fortwissenschaftliche Beiträge 20. Zürich: Eidgenössische Technische Hochschule, Departement Wald- und Holzforschung

Wangmo, S. (1990) 'The Brokpas: A Semi-nomadic People in Eastern Bhutan'. In *Himalayan Environment and Culture,* pp 141-158. Simla, Himachal Pradesh (India): Indian Institute of Advanced Studies

Warren, D.M. et al (1995) *The Cultural Dimension of Development: Indigenous Knowledge Systems*. London: Intermediate Technology Publications

Watson, L., Dallwitz, M.J. (1992) *Grass Genera of the World*. <http://biodiversity.uno.edu/delta/> (version: 18 August 1999, accessed April 2000)

Wijewardana, D. (1998) 'Criteria and Indicators for Sustainable Forest Management'. In *Tropical Forest Update* 8(3): 4-6

Wild, R.G., Mutebi,J. (1996) *Conservation Through Community Use of Plant Resources*, People and Plants Working Paper 5. Paris: UNESCO

Yonzon, P. (1998) *Monitoring Wildlife in the Forest Management Units of Eastern Bhutan*, Consultancy Report, TFDP Field Document FD98/19. Khangma (Bhutan): Third Forestry Development Project

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