Diss. ETH No. 13678

Evolution of the forest uses and their impact on the forest structure with regard to sustainability in central Bhutan.

A dissertation submitted to the
SWISS FEDERAL INSTITUTE OF TECHNOLOGY ZURICH
for the degree of Doctor of Technical Sciences

presented by:
Christina Giesch
Dipl. Forest engineer ETH
born 08.12.1968
citizen of Lancy / GE

accepted on the recommendation of:
Prof. Dr. P. Bachmann, examiner
PD Dr. K. Seeland, co-examiner
2000

ACKNOWLEDGEMENTS

I would like to take this opportunity and express my sincere gratitude to all those who supported and helped me in the initial stage and preparation of this study, during the field work in Bhutan and in the final phase of compilation, analysis and redaction. My special thanks to the SDC who provided me a "bourse de jeunes chercheurs" to finance my field work and to the ETH for their financial support in Bhutan as well as in Switzerland.

I would like to thank Prof. Dr. Peter Bachmann to have given me the opportunity to carry out this research. During the years of assistantship and thesis, I have learned to appreciate him as employer and referee.

My special thanks to Dr. Klaus Seeland for his patient support and advises, especially in the initial phase of this thesis. Without his support, this study would most probably never have been conducted.

I am obliged to the RGOB for having given the necessary authorisations and support for the field work. My special thanks in particular to Lyonpo Khandu Wangchuk, Deputy Minister of the Ministry of Agriculture, to Lyonpo Kinzang Dorji, Secretary of the Ministry of Agriculture, Sherub Gyaltshen, Director of the Research, Extension and Irrigation Division, and to the staff of the Training Division. Many thanks to Dr. Lungten Norbu for his introduction to forestry research in Bhutan and his help, especially in the initial stage of the research. Further I like to thank the RNR-RC Jakar and staff as well as the Bumthang Dzongkhag administration for their kind support.

This thesis would not have been written without the help of the villagers in Dhur and my local staff. They are far to numerous to be all mentioned here, but I owe special thanks to Sangay Tshering for his work as interpreter, to Rinchen Tashi for his steadfast good mood, to Kunzang for the logistic support and to all my team for their excellent work and good spirit.

I am grateful to my friends, in Bhutan and Switzerland, for their patient support. Am'Lemo and her family provided me precious assistance at my arrival in Bumthang, which resulted in a sincere friendship later on. For their support in Bhutan, I'd like to thank the Helvetas' officers, in particular Guy and Corinne Morand who helped me out with a hot shower from time to time, Kunzang and Walter Roder as well as Thérèse and Ernst Jenni. My thanks to my parents, Pierre, Dominique, Carina, Helen, Dinesh and Nathalie who always stayed in contact with me and gave me faith to continue. My special thanks to Ruth and Günter Ronsdorf who were my most reliable support and sponsored part of the material needed for the field work.

TABLE OF CONTENT

LIST OF FIGURES

Chapter 5:

Chapter 6:

Chapter 7:

LIST OF TABLES

Chapter 2:

Chapter 3:

Chapter 4:

Chapter 5:

Chapter 6:

Chapter 7:

List of abbreviations

B.	Bumthangkha (local language spoken in Bumthang)
dbh	diameter at breast height
DFEO	District Forest Extension Officer
DFO	District Forest Officer
Dz.	Dzongkha (national language)
FMU	Forest Management Unit
FRD	Forest Research Division
FSD	Forest Services Division
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IFDP	Integrated Forest Development Programme
LUPP	Land Use Planning Project
MoA	Ministry of Agriculture
nfe	non formal education
no.	number
NTFP	Non Timber Forest Product
NWFP	Non Wood Forest Product
PLA	Participatory Learning and Action.
PP	Pre-Primary (education)
PRA	Participatory Rural Appraisal
REID	Research, Extension and Irrigation Division
RGOB	Royal Government of Bhutan
RNR	Renewable Natural Resource
RNR-RC	Renewable Natural Resource Research Centers
RRA	Rapid Rural Appraisal
SDC	Swiss Development Cooperation

SUMMARY

Bhutan remained closed to the outside world until the middle 20th century before starting its development under the impulse of its third king (1952-1972). Bhutan's situation is unique among the Himalayan countries: the population pressure is low and the natural surroundings are largely preserved. Indeed, depending on the definition of forest, the total forest cover is estimated to lie between 64.4% and 72.5% of the country's area. Yet considerable regional differences exist also within the country: whereas the forest cover seems to be increasing in the Central part, the forest cover decreases in the South and East of the country. Bumthang, an area of four valleys in Central-Northern Bhutan, is one of the regions in which the forest cover expands.

The aim of the present study is to analyse the impact of the traditional forest uses on the forest structure. It analyses the structure of the different forest types present in the study area and defines the use and management of different forest products which are used and managed traditionally by the rural population. Both forestry and sociological surveys were conducted, as one of the underlying hypotheses of the research is that the use and management of natural resources in general, and forest resources in particular, has to be approached by conducting investigations both of the actual resource use and the socio-cultural perception of the local resource users towards their environment.

With the help of the measurement of stumps recorded during an forest inventory, the tree species and tree dimension used for every forest product were identified. It was found that for every forest product a tree with specific characteristics was chosen.

On the average, the forest uses proved to be extensive and no impact on the structure of forest used traditionally by the villagers could be traced. The only forest product which has a significant impact on the forest structure is the extraction of blue pines to be used as beams, for which nearly all blue pines with a dbh around 30 cm are felled. The few blue pines with a bigger dbh were those which do not have the appreciated characteristics. The structure of the forests, in which the extraction of trees for beams takes place, is thus strongly affected. However, this has to be taken cautiously, as the extraction of trees for beams is concentrated on a few forest patches.

The traditional use and management of the forest products are strongly influenced by the living conditions under the feudal system (first half of the 20th century). The rural population had to do forced labour to such an extent that the time remaining to cultivate their own fields was scarce. Therefore the limiting factor for the management of forest resources was their labour capacities. On the other hand, in the perception of the villagers, the forest resources are plenty and thus there seems to be no need to manage them economically.This traditional management system was the response of the villagers to their environmental situation. Whether this system can be carried on or should be replaced by a more economical management of forest resources in the long run is what the final discussion is all about, as there is neither a single nor a simple answer to this question.

Zusammenfassung

Das Königreich Bhutan war bis Mitte des zwanzigsten Jahrhunderts von der Aussenwelt isoliert. Bhutan's Entwicklung begann während der Regierungzeit des dritten Königs (1952-1972). Die Situation von Bhutan ist einzigartig und kaum mit den anderen Himalaja Staaten zu vergleichen: in der Tat ist die Bevölkerungsdichte gering und, je nach Auslegung des Begriffes "Wald", bedeckt dieser zwischen 64.4% und 72.5% der Landesfläche. Es gibt jedoch nicht unwesentliche regionale Unterschiede. Die Waldfläche in Zentral-Bhutan scheint zu zunehmen, während sie sich in Süd- und Ostbhutan verringert. In Bumthang, einer aus vier Tälern bestehenden Region in Zentral-Nord Bhutan, scheint sich die Waldfläche auszubreiten.

Der Zweck dieser Studie ist, den Einfluß der traditionellen Waldnutzungen auf die Waldstruktur zu analysieren. Die Struktur der verschiedenen Waldtypen sowie die traditionelle Nutzung der verschiedenen Waldprodukte durch die ländliche Bevölkerung wird dargestellt. Es werden dabei sowohl forstliche wie soziologische Methoden angewendet. Eine der Haupthypothesen, die dieser Studie zu Grunde liegt, sagt aus, daß die Nutzung der natürlichen Ressourcen im allgemeinen und die der Waldnutzungen im besonderen, mit Untersuchungen sowohl über die aktuellen Nutzungen wie auch über die Wahrnehmungen der ländlichen Bevölkerung gegenüber diesen Ressourcen und Umwelt erfaßt werden müssen.

Durch Messungen an Wurzelstöcken während einer Forstinventur wurde für jedes Holzprodukt die verwendete Baumart und -größe identifiziert. Damit konnte belegt werden, daß für jedes Endprodukt eine spezielle Baumart mit eigenen Charakteristiken ausgewählt wurde.

Generell wurden die Wälder durch die ländliche Bevölkerung extensiv genutzt; ein negativer Einfluß auf die Struktur der Wälder konnte nicht festgestellt werden. Die einzige Waldnutzung, die einen Einfluß auf die Waldstruktur bewirkte, war das Entnehmen von Föhren für die Herstellung von Balken. In diesen Waldteilen wurden fast alle Föhren mit einem Brusthöhendurchmesser von ca. 30 cm entnommen. Die wenigen verbleibenden Föhren mit einem Durchmesser über 40 cm wurden nicht gefällt, da sie die gewünschten Eigenschaften für die Balkenproduktion nicht aufwiesen. Die Struktur jener Waldteile, in denen Föhren für Balken entnommen wurden, erwies sich als stark beeinträchtigt. Diese Tatsache muß jedoch relativiert werden, da nur einige wenige Waldstücke von dieser Nutzung mit negativen Auswirkungen betroffen sind.

Die traditionelle Waldnutzung ist stark beeinflußt durch die Lebensbedingungen unter dem Feudalsystem der ersten Hälfte des zwanzigsten Jahrhunderts. Die intensiven Fronarbeiten liessen der Bevölkerung nur wenig Zeit, ihre eigenen Felder zu bearbeiten. Der limitierende Faktor für die Waldnutzungen war somit die Arbeitskraft. In der Wahrnehmung der Bevölkerung gab es genügend Wald und deshalb schien es ihr nicht notwendig, ihn ökonomisch zu nutzen. Das beschriebene traditionelle Nutzungssystem wurde aus dem sozialen und natürlichem Umfeld der ländlichen Bevölkerung entwickelt.

Es steht zur Diskussion, ob langfristig das jetzige System so weitergeführt werden kann oder durch ein ökonomisch günstigeres System ersetzt werden sollte. Es gibt weder eine einzige, noch eine einfache Antwort zu dieser Frage.

Résumé

Le Bhoutan est resté coupé du monde extérieur jusqu'au milieu du XXème siècle avant de commencer son développement sous l'impulsion de son troisième roi (1952-1972). La situation de ce pays est unique au sein de l'Himalaya: la pression démographique est faible et l'environnement naturel est largement préservé. Selon la définition du terme forêt, celle-ci recouvre entre 64.4% et 72.5% de la surface totale du pays. Toutefois, il existe des différences régionales considérables: alors que la surface forestière semble être en augmentation dans la partie centrale du pays, elle est décroissante au sud et à l'est. Bumthang, un district comprenant quatre vallées dans le centre-nord du Bhoutan, est une des régions dans la quelle la surface forestière est en augmentation.

Le but de la présente étude est d'analyser l'impact des exploitations forestières traditionnelles sur la structure des forêts. Elle analyse la structure des différents types de forêts et définit l'utilisation et la gestion traditionnelles des différents produits forestiers par la population rurale. Les relevés on t été effectués sur la base de méthodes tant forestières que sociologiques. En effet, l'une des hypothèses fondamentales de cette recherche était que l'utilisation et la gestion des ressources naturelles en général, et des ressources forestières en particulier, doivent être étudiées aussi bien sous l'angle de l'utilisation actuelle des ressources que sous celui de la perception socioculturelle des utilisateurs de ces mêmes ressources.

Les essences forestières et les dimensions des arbres utilisés pour chaque produit forestier ont été identifiées à l'aide de mesures par placettes récoltées par inventaire. Les résultats démontrent que pour chaque produit forestier un arbre avec des caractéristiques particulières est sélectionné.

Globalement, l'utilisation des forêts est extensive et aucun impact sur la structure des forêts utilisées traditionnellement par les villageois n'a pu être prouvé. Seule l'exploitation de pins pour la production de poutres a un impact significatif sur la structure forestière. Dans ces forêts, tous les pins ayant un diamètre à hauteur de poitrine (dhp) d'environ 30 cm ont été exploités. Les quelques rares pins ayant un dhp supérieur à 40 cm ont été épargnés car ils n'avaient pas les caractéristiques requises. La structure des forêts dans lesquelles avait lieu la production de poutres était donc perturbée. Néanmoins, cet état de fait doit être relativisé puisque l'exploitation d'arbres pour la production de poutres est concentrée sur des surfaces forestières particulières.

L'utilisation traditionnelle et la gestion des produits forestiers ont été fortement influencées par les conditions de vies de la population rurale sous le système féodal (première moitié du XXème siècle). La population rurale devait alors accomplir des travaux forcés au point que le temps restant pour la culture de leurs propres surfaces agricoles était fortement restreint. La capacité de travail a donc été le facteur limitant pour la gestion des ressources forestières. D'un autre côté, dans la perception des villageois, la forêt est une ressource naturelle illimitée et il ne leur semble par conséquent pas nécessaire de la gérer économiquement. Le système de gestion traditionnel est la réponse des villageois à leur situation environnementale. Finalement toute la discussion est de savoir si ce système peut être conservé ou si, à long terme, il doit être remplacé par une gestion plus économique des ressources forestières. Il n'existe ni réponse unique, ni réponse simple à cette question.

1. Introduction

1.1 Background

A large part of our planet is mountainous. Indeed in a recent study, Kapos et al. affirm that 23.4% of the terrestrial area are covered with mountains[1] and that mountain forests represent 23% of the world's forest area [Kapos, Rhind et al. in print]. Forests play an important role in the balance of a mountain ecosystem. It is generally acknowledged that the forests reduce soil erosion and landslides and, further act as a "reservoir" releasing water gradually.

The Himalayas are the largest mountain complex of the world, covering more than one million square kilometres. They are relatively young mountains, which were generated 50 millions years ago by the collision of the Indian and the Eurasian continents. This process is by far not finished and the Himalayas still are rising at a rate five times faster than that in the Alps [Grujic 1999]. Due to its recent genesis and its morphological characteristics, this mountain system is especially fragile. Indeed within a short horizontal distance, the mountains reach heights of several thousands of meters — up to 7'000m or 8'000m — thus distinguishing these mountains with very steep slopes. Further the Himalayas are veritable barriers for the south-west monsoon and intercept large amounts of precipitation. The risk of erosion and landslides is therefore considerable, but the forests act as a natural shield and protect the ground from the direct impact of the precipitation and facilitate their absorption [Moench and Bandyopadhyay 1986]. Unfortunately the Himalayan forests have disappeared to a large extent, giving way to arable land.

Ives and Messerli have demonstrated that the process of deforestation is a much older phenomenon in the Himalayas than is commonly believed [Ives and Messerli 1989]. For example, the process of deforestation in the Pahar region of Nepal took place over centuries [Mahat, Griffin et al. 1986]. Peaks in the rate of deforestation occurred during the mid-18th century, when the House of Gorkha encouraged the conversion of forest to arable land — since land taxes were an important source of income for the State — and at the beginning of the 19th century, when a large amount of charcoal was required to smelt iron in order to supply the army with arsenals. The deforestation climaxed between 1890 and 1930, during the Rana Period, for the construction of temples and palaces. According to Mahat et al. the major conversions of forests to agricultural land had already occurred by the early 20th century [Mahat, Griffin et al. 1986]. In Sikkim also, the history of deforestation started a long time ago, mainly with an influx of Nepalese immigrants around 1770. The deforestation in the Himalayas climaxed several decades ago, but it is still going on on a smaller scale, due to the "nibble-effect" [Moench and Bandyopadhyay 1986].

1. Following areas were defined as mountains in this study: areas with elevations above 2'500m, areas between 1'500-2'499m with a slope superior to 2°, areas between 1'000-1499m with slope superior to 5° and areas between 300-999m with local elevations equal or superior to 300m.

The situation concerning forests and deforestation, however, varies greatly within the Himalayas. Bhutan, for example, has preserved a large area of forest. Indeed, depending on the definition of forest, the total forest cover is estimated to lie between 64.4% and 72.5% of the country's area [Wangchuk 1991]. Yet considerable regional differences exist also within the country: whereas the forest cover seems to be increasing in the Central part, it is shrinking at an increasing rate in the south and east of the country [Wangchuk 1997].

Bhutan's situation is unique among the Himalayan countries: its natural surroundings are largely preserved and the population pressure is still low. Indeed the population density is 3 to 4 times lower than in the surrounding Himalayan regions [Ives and Messerli 1989]. Bhutan's history is also unique: the country remained closed to the outside world until the mid-20th century and opened only hesitantly, so that the country's cultural identity remained largely preserved. Bhutan's development started only during the second half of the 20th century under the impulse of its third king. He replaced the former feudal system with a modern monarchy, creating a National Assembly and abolishing slavery and serfdom. A large part of Bhutan's population lived through these tremendous changes, adapting within a few decades from a subsistence to a market-oriented system. The changes affected also the traditional forest use system. With the Forest Act of 1969, the forests were nationalized. However most villagers still remember their traditional forest use system and, partly, still practice it.

Bumthang is one of the regions in Bhutan in which the forest cover seems to be increasing. Bumthang is a complex of four valleys in Central-Northern Bhutan at altitudes between 2'600m and 7'000m. The forests are with few exceptions coniferous and cover half of the area. Considering that another 23% of the district are composed of rocks and ice, the forest cover is substantial. In contrast to most regions in the Himalayas, the forest cover even seems to be expanding in these valleys. Pictures from the 1970's [F. Maurer, Helvetas, pers. com. 1996] and the presence of large areas of young blue pine forests are indicators for this natural reforestation. Several theories for its occurrence exist, e.g. drastic reduction of the population due to a smallpox epidemic, changes in agriculture, loss of agricultural land due to the limitations of land-holding or the introduction of the Forest Act, which limited felling and prohibited fires. The evolution of the forest cover during the last century unfortunately is not documented.

The area under forest in Bumthang is considerable, but it remains unclear why such a large forest cover has been preserved in this region, when deforestation has been common in other areas. It seems that the present human activities in this region have not affected the forest area, since this is even increasing. Possible explanations are that the rural population has a forest management system which allowed them to manage the forests sustainably or that their number is too low to allow them to reduce the forest cover effectively.

Some foresters in Bumthang are concerned about the impact of human activities on the forests. They confirmed that the forest area is increasing, but have been observing that the quality of the forests, especially the quality of the blue pine forests, is decreasing [G. Morand et D.Wyrsch, IFDP/Helvetas, pers. com. 1996]. So far, no study has been made to assess the quality of the forests and its evolution. The quality of the forests is defined here by the composition of the forest, in terms of species and age classes, further by the quality of the single stems. To be able to understand the evolution of the forest quality, the forest structure, as well as the impact of the forest uses on the forest structure, have to be

assessed. We further require knowledge about the activities which take place in these forests: the products the rural population extracts, their importance in terms of quantity and possible trends, as well as the processes of extraction.

1.2 Aim and objectives of the study

It is crucial to understand the processes taking place in these forests in relation to the human activities, in order to avoid mistakes which have occurred in other countries being repeated in this region. Still too little is known about the interrelationships of forests and population in Bhutan. It is hoped that the present study will make a contribution to this theme and answer at least partly the questions mentioned above.

The aim of the present study is to analyse the impact of the forest uses on the forest structure and to assess whether these uses affect the sustainability of the forests. It has to analyse what products, in what quantities and by what means are extracted by the rural population.

The objectives of the present study are:

- Analysis of the forest structure of forests traditionally used by the rural population;
- Analysis of the characteristics of the forest products traditionally used by the rural population;
- Analysis of the traditional forest management system and rationale of the rural population;
- Estimation of the quantities of forest products extracted and trends;
- Assessment of the impact of traditional forest uses on the forest structure;
- Assessment of the social context of these forest uses;
- Reflections concerning a sustainable forest management planning.

Worldwide, classical forestry has shifted towards social forestry in the past decades. This phenomenon has occurred in the developing as well as in the developed countries [Bachmann 1993a, 1993b, 1995]. Whereas, classical forestry was largely concerned with optimising wood production and therefore mainly technically oriented, the transition towards social forestry stressed the importance of the different forest functions and the social settings. The whole approach and perception of foresters and forestry was modified.

The present study is at the interface of classical and social forestry. It attempts to describe the traditional forest uses of the rural population in a case study in Central Bhutan, their evolution and their impact on the forest structure and sustainability, combining a forestry and a sociological approach. With knowledge of the forest activities and their rationale as well as their impact on the forest structure, suggestions can be made for a sustainable forest management taking into account the needs and the knowledge of the local population.

1.3 State of research

1.3.1 State of forestry research in Bhutan

Forestry research in Bhutan is a recent phenomenon. Indeed forest research only started in the late '70s, mainly carried out by various forestry development projects [Norbu 1997]. In April 1987, the Forest Research Division (FRD) was created as part of the Forest Department (FD — at present Forest Services Division, FSD) [Namgyel 1997]. The FRD was based in Taba, nearby Thimphu. The main objective of the FRD was to carry out basic and applied research in order to support better ways of forest management and forest utilization. The number of researchers in the FRD was extremely low — only 2 researchers in 1990-1991 — and the research activities were therefore limited to forest management. In 1990, a regional forestry research station was created under Helvetas /SDC as part of their Integrated Forestry Development Project in Bumthang. With the re-organization of the Ministry of Agriculture in 1993, forestry research joined the Research, Extension and Irrigation Division (REID) and formed together with Field Crops, Horticulture and Livestock the national Renewable Natural Resource (RNR) research programme. From this time onwards research in these four sectors — forestry, field crops, horticulture and livestock — were integrated and carried out in the four regional Renewable Natural Resource Research Centres (RNR-RC) located across the country — Yusipang, Bajo, Jakar and Khangma.

Since, in its beginnings, forestry research was carried out to support different forestry development projects, the majority of the research findings are difficult to access, as they are mostly concealed in reports. Rosset gave a comprehensive review of the research activities concerning temperate coniferous forests in Bhutan, comprising research on topics from climate, soils, forest types and silviculture up to some aspects of management [Rosset 1998].

Initially the main objectives of the forestry research focused on the subjects needed to support forest management, while only a few studies were conducted in the field of social forestry. A non-exhaustive list of interesting publications related to social forestry — in a broad sense — is given below:

- Sangay Wangchuk wrote his Ph.D. thesis on local perceptions and indigenous institutions as forms of social performance for sustainable forest management in Bhutan [Wangchuk 1997].
- Karma Ura gave an interesting account of the traditional pasture management of the nomads and, together with Gupta, an overview of traditional institutions and innovations [Gupta and Ura 1992; Ura 1993].
- Wagner (1994) made an ethno-botanical study in South-central Bhutan [Wagner 1994].
- Non Wood Forest Products were assessed by a few, but increasing, number of researchers [Dorji 1995; FAO 1996].
- Upadhyay studied the "tseri" shifting cultivation system in Eastern Bhutan, whereas the grass fallow shifting cultivation system was described mainly by Roder [Norbu, Wangdi et al. 1996; Roder 1990; Roder et al. 1992, 1993; Upadhyay 1995].

- In relation with a relatively recent project of GTZ in the field of social forestry, several reports were published presenting aspects of social forestry and results of RRAs [Kievelitz 1995; Maier 1996; Namgyel 1996].

1.3.2 State of sociological and anthropological research in Bhutan

The situation of sociological, socio-anthropological and ethnological research in Bhutan is similar, or even more embryonic, than research in forestry.

Several travel reports were published in the late 19th and early 20th centuries, giving accounts of the natural and socio-political scenarios [Atkinson 1882 (reprint 1980); Bailey 1924]. White, for example, witnessed the ascension of the first Bhutanese king, His Majesty Ugyen Wangchuk [White 1910, 1919].

Michael Aris wrote several books about the history of Bhutan, from its early history [Aris 1980, 1982] to the beginnings of the monarchy (late 19th and early 20th century) [Aris 1994]. Karma Ura described life under the feudal system in a historical novel [Ura 1995].

At a conference at the university of London, several aspects of developments in Bhutan — for example, language policies, architecture, decentralization — were presented [Driem 1993; Dujardin 1993; Ura 1993].

Pommaret wrote numerous accounts on Bhutan, mainly on religious aspects, as for example on the mountain deities and mediums [Pommaret 1995, 1996], and, under a pseudonym, on the temple festivals — Thimphu *tsechu*, Paro *tsechu*, Wangdiphodrang and Jampey *lhakhang* festival — [Wangmo 1982, 1983, 1986]. Further she wrote several articles for magazines and a guide book about Bhutan [Pommaret and Imaeda 1991].

Brauen gave an ethnological account of a village nearby the present study area [Brauen 1994].

1.3.3 State of research concerning description of the forest structure

Description of the forest structure has been a concern of forest researchers for many decades. Length profiles were used in Europe to describe the forests as early as 1923 [Köstler 1953; Knuchel 1923, 1944]. This method was also adapted for other geographical regions: Lamprecht for example used length profiles to describe tropical forests [Lamprecht 1954].

Leibundgut adapted length profiles to describe virgin forests [Korpel 1995; Leibundgut 1959, 1993]. An element of dynamics was thus introduced in the description of the forest structure. Indeed every length profile represents a development stage of the virgin forest. A whole sequence of length profiles in the different development stages reveals the natural dynamics of the virgin forests. Sansonnens used the same approach to compare structure, dynamics and composition of the homegardens in Indonesia and Sri Lanka [Sansonnens 1996].

The analysis of the forest structure was further used to describe or quantify human impact on the forests. In Eastern Nepal, Schmidt-Vogt characterized the forest types through length profiles and described human impact on the forests [Schmidt-Vogt 1989, 1993, 1997]. He interpreted the present forest structure as the result of human impact. Similarly, Irvine studied the structure and composition of fallow land in the Amazonian rain forest, demonstrating the impact of the indigenous succession management on the forest structure [Irvine 1989].

The measuring of length profiles is very time-consuming. Bürki therefore chose a simpler method to describe the forest: he differentiated forest structures by simply using inventory data [Bürki 1981].

1.3.4 State of research concerning sociological methods related to forests and trees

With the shift from classical forestry to social forestry, the need to comprehend the social settings, environmental perception, and indigenous knowledge related to environment arose [Brokensha 1980; Croll and Parkin 1992; Descola 1994; Dove 1994; Posey 1992; Seeland 1997; Warren 1995]. The need to assess the indigenous knowledge and the local perceptions of trees and forests became a subject of research in South Asia as well, as can be seen from the numerous publications and case studies [Clemens and Nüsser 1997; Duffield, Gardner et al. 1998; Ebner 1996; Gadgil and Vartak 1976; Gilmour and Fischer 1992; Linkenbach 1997; Maag 1994; Moench and Bandyopadhyay 1986; Norbu 1993; Sansonnens 1996; Schmidt-Vogt 1993; Seeland and Schmithüsen 1995; Wangchuk 1997; Wiart 1983].

The classical set of — rather technical — forestry methods were supplemented with sociological methods and sometimes, as Messerschmidt recommends, with socio-anthropological methods [Messerschmidt 1991]. The best-known methods are the RRA, which was developed in the '80s, the PRA and finally the PLA[2] [Chambers et al. 1994; Leurs 1996; Schönhuth 1998]. These methods were designed to obtain a set of data in a restricted time frame. Their originality resides in their approach, which puts the rural population in the centre of the research and admits their subjective perception. However these techniques, due to their expeditive character, are controversial [Hess et al. 1998; Schönhut 1996].

An approach involving long stays in the field certainly presents many advantages: there is more time for direct observations, and relationships based on mutual confidence can be build up with the local population. Whyte presented a set of field methods, extending from different observation methods to various verbal and visual techniques of asking questions [Whyte 1977]. However, even with longer stays in the field, the observations remain squattered and limited in time. Furthermore it remains questionable how far the presence of a participant observer also influences the social environment, and thus his own research findings [Whyte 1984, 1994].

1.4 Selection of the study area

The location of the research was chosen in Bumthang, a district in Central Bhutan, as it has conditions comparable to those of the mountain regions in Switzerland, with mainly temperate coniferous forests.

The choice of the study area was made taking into account the following criteria: forest types present in the area, composition of the population, accessibility, stage of development, and the presence of various institutions.

2. RRA: Rapid Rural Appraisal; PRA: Participatory Rural Appraisal; PLA: Participatory Learning and Action.

Ideally the forests had to present the whole range of forest types, from blue pine forests up to fir forests. Further it had to be used traditionally by the villagers, but not commercially. The population had to be mainly rural, which excluded the lower part of the Chhoekhor geog. The presence of different social groups was also favoured. Dhur, in Chhoekhor Toe — the upper part of the Chhoekhor *geog* —, fulfilled all these criteria. Indeed, all the main forest types were found, the population is rural and composed of several social groups.

The study area comprises three villages. The village of Dhur is located on a ridge between the rivers Yoleng Chu and Dhur Chu. It is divided in six parts: the lower village — Shikshay—, two middle villages — Hjawang, Khaisar —,the upper village — Gonpfey and the two bridges below the main village — Menchigang and Chutigang. The villages of Lusbi, on the other side of the Yoleng Chu, and Crongmanba, on the road to Kurjey, belong also to Dhur. These two villages do not have a *lhakhang* (temple) and have to attend the important ceremonies, as for example *Nuenath*, in the *lhakhang* of Dhur[3].

Figure 1-1: Gonpfey, the upper part of the Dhur village (2'950 m), view to the south-east, 1997.

3. In the present study the term of "Dhur" will always refer to the complex of the three villages — Dhur, Lusbi and Crongmanba. The term of ""village of Dhur" will refer to the main village composed by Shikshay, Hjawang, Khaisar, Gonpfey, Menchigang and Chutigang.

2. Bumthang and the forestry sector

2.1 Location

Bhutan can be divided into three geographical zones: the southern, the central and the northern zone. The lower southern zone (200-2'000 m) consists of the Sub-Himalayan foothills, covered with tropical forests, along the Indian border. The temperate central zone lies within the Inner Himalayas at 2'000-4'000 m. It is the cultural and historical heart of Bhutan. The Northern zone, with altitudes above 4'000 m, along the Tibetan border, is part of the Great Himalayas. The main valleys are oriented from north to south and are separated by ridges reaching up to 5'000 m.

Bumthang is located between latitudes 27°30'N and 27°45'N and longitudes 90°35'E and 91°55'E. It comprises parts of both the central and northern zone (see Figure 2-1). It has a total area of 2'714 km^2 [LUPP 1995]. Bumthang is one of the twenty *dzongkhags* (districts) of the country. It consists of a complex of four comparatively broad valleys (see Figure 2-2). Each valley is a *geog*[4] (sub-district): Chhoekhor, Chhumme, Tang and Ura.

The lowest altitudes are found in the southern part of the *dzongkhag* at approximately 2'500m and the highest altitudes are in the northern and north-eastern parts at 5'700-5'800m [LUPP 1994]

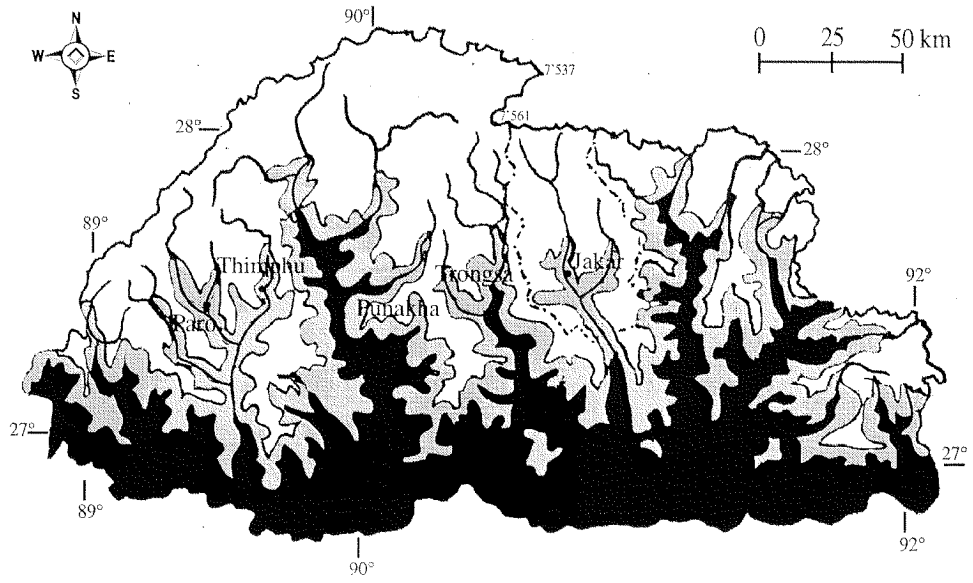


Figure 2-1: Map of Bhutan with the three zones: the black area represents the zone between 200 and 2'000m, the grey zone 2'000-3'000m, the white zone above 3'000m. The Bumthang dzongkhag is indicated with a doted line. Modified from LUPP [1994].

4. The spelling of the Bhutanese names might differ from one author to the other. In this study, the names were spelled, as far as possible, in the official "roman Dzongkha" [RGOB 1997]. The pronunciation of the "roman Dzongkha" however differs from the written form. Here should be pronounced "gewog". When no romanized spelling could be found, the term was written phonetically.

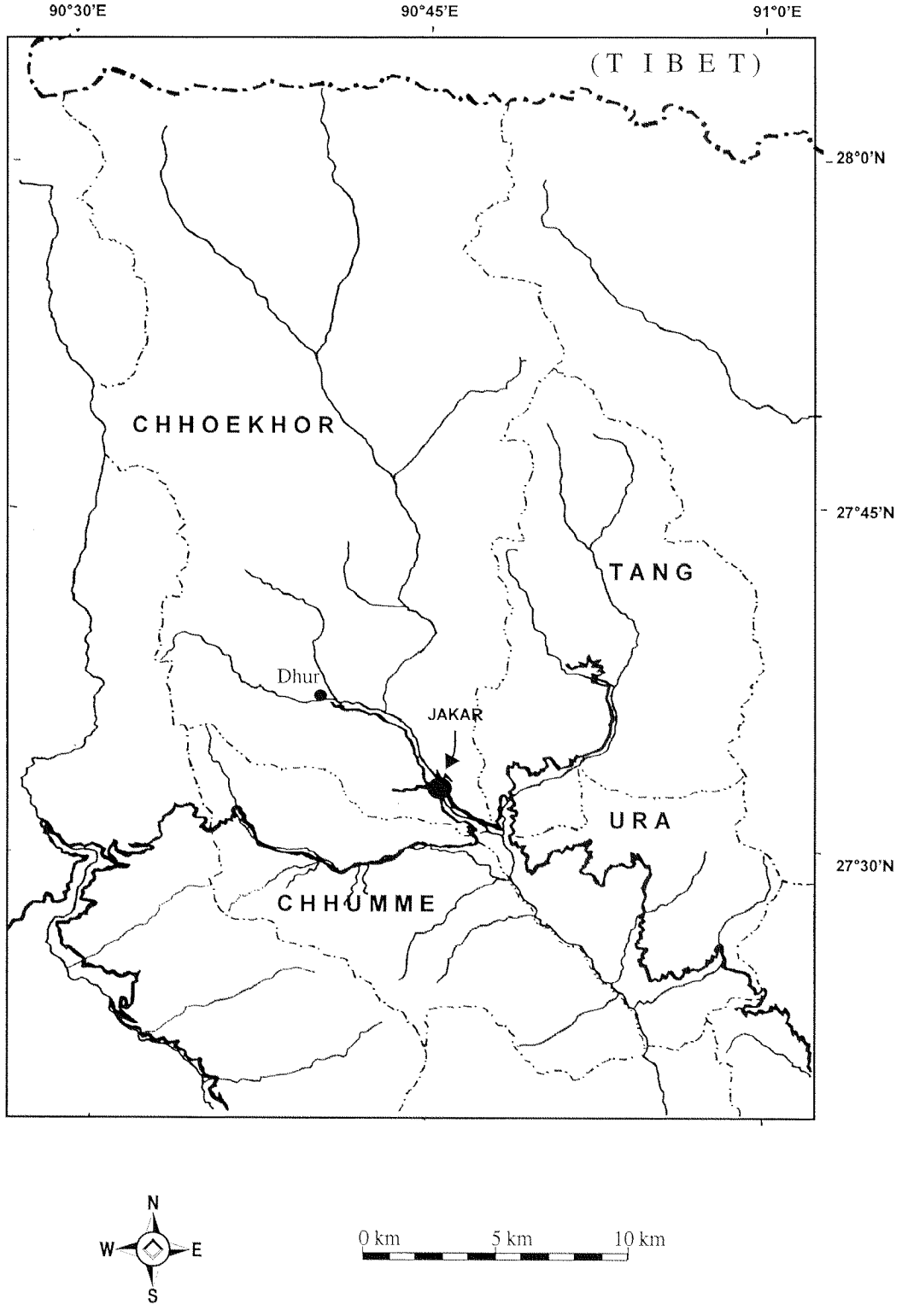


Figure 2-2: Map of the Bumthang dzongkhag. 1: 250'000. Source: LUPP 1997, modified: the contour lines and the land uses were not reproduced and only some names of the locations were reproduced.

2.2 The socio-economical conditions

2.2.1 Population

Demography

In 1993, Bhutan's population was estimated to be approximately 640'000 [Central Statistical Organization 1994]. That is a population density of 15.7 inhabitants per km^2, which is very low compared to those of the neighbouring countries: approximately 152 inhabitants/km^2 in Nepal and 283 inhabitants/km^2 in India [UNESCO 1997][5]. The population growth is estimated between 1.9 and 2.7% annually [UNDP, Human development report, 1992 in: Helvetas 1989; Central Statistical Organization 1994].

No official figures are available for Bumthang's population, but it can be roughly estimated at 1'300 households or 12'000 inhabitants. The population density (4.4 pers/km2) is therefore lower than the national average. The large northern part of the district is inhabited. Settlements can be found only at relatively low altitudes in the southern part of the *Dzongkhag*: permanent settlements can be found up to 3'000 m and the temporary settlements of yak herders up to 5'000 m. The only urban centre of the district is Jakar in Chhoekhor *geog*.

Population groups

The Bhutanese population can be broadly divided into three groups:

In the northern part of the country, along the Tibetan border, live groups of pastoralists. They are known as *bhzop* to the western Bhutanese and as *brokpa*[6] to the central and eastern Bhutanese. Both names are derived from the Tibetan word *drokpa* (*'brog-pa*) which means "herder" [Aris 1980]. The *brokpas* live mainly from yak herding and barter of their products.

The *brokpas* of Chhoekhor Toe[7] believe they are originating from Tsampa, the border region between Bhutan and Tibet and fled from the numerous wars which occurred in the region during Shabdrung Ngawang Namgyel's[8] reign. The *brokpas* are said to have then settled in the Northern part of Bhutan, from Lingshi to Merak and Sakten. The *brokpas* of Chhoekhor Toe proudly consider themselves as the original *brokpas*, since they preserved their own distinct language, *Brokkat* (*'sBrog-skad*) and customs. George van Driem indeed listed *Brokkat* as one of the Bhutanese languages, though it is spoken only by roughly 300 people [Driem 1993].

So far no anthropological survey was carried out in Bhutan. It can however be stated that the country is inhabited by many ethnical groups. The majority of these groups are of mongoloid feature and their language belongs to the Tibeto-Burman language family [Pommaret 1997]. The main population of Bhutan is concentrated in the central zone of the country. It is inhabited by various groups which can be classified according to their

5. The population density in Bhutan according to UNESCO is 38 inhabitants/km^2. This figure relies on an estimate of 1,7 million inhabitants in Bhutan and a country area of 47'000km^2. The population is definitely overestimated and the area of the country has been since then revised by LUPP.
6. The term of *brokpa* will be used in this document to designate the yak herders. This Bhutanese term as well as the following are listed in the glossary.
7. Chhoekhor Toe means „upper part of the Chhoekhor geog".
8. Shabdrung Ngawang Namgyel (Zhabs-drung Ngag-dbang rNamgyal) (1594-1651) unified Bhutan in the 17th century, built the first *dzong* at Simtokha and conferred the country its system of administration and law.

language. Three main groups can be distinguished: the *Ngalong* (*sNga-slong*, „the earliest risen"), *Sharshop* (*Shar-phyogs-pa*, „Easterner") and Bumthang. Since the three main languages are completely different and mutually incomprehensible, *dzongkha* (*rDzong-kha*, „the language of the *dzongs*[9]"), derived from the language of the *Ngalongs*, was declared the national language.

The *Ngalongs* are found in the western valleys. They are the descendants of Tibetans who immigrated from the 8th century onwards until the mid-20th century [Helvetas and SDC 1993]. The *Sharshops* are the largest group and found in the eastern part of the country. The *Sharshops* are of indo-mongoloid origin and probably among the oldest population group in the country [Helvetas and SDC 1989]. The third group of languages has its origin in the district of Bumthang. Modified forms of this language are spoken in the districts of Kheng; Kurtoe (*sKurstod*) and Tongsa (*Mang-sde-lung*) [Aris 1980; Driem 1993]. Further, some groups in Arunachal Pradesh (India), the *Mon-pa* of rTawang, have a language which is related to the Bumthang language.

In Bumthang, farmers call themselves *monpa*. The term *Mon* or *Monpa* is very confusing. Population groups called *monpa* can be found in a variety of places: in Bumthang (farmers), in Kheng (forest dwellers) or in Arunachal Pradesh (population groups). The confusion comes from the original meaning of this designation: „Mon is a general term used by Tibetans for many Himalayan regions inhabited by non-Indo-Aryans" [Aris 1994].

The southern part of the country is covered with dense forests. It is inhabited by the *Lhotsampas* and some small communities (Lepchas, Mon-pas, Toktop,...). The *Lhotsampas* (literally: inhabitant of the south) are probably the most recent settlers in Bhutan. They are of Nepalese origin and arrived in the late 19th and early 20th century.

In Bumthang, two main groups were found during the study period: the *brokpas*, seminomadic yak herders who are concentrated in the more northern settlements, and *monpas*, who are mostly farmers. In addition, Tibetans have settled in the regions and run most of the shops in the bazar of Jakar.

Social classes in the feudal system[10]

Nowadays, there are no distinct social classes. The different social classes presented below go back to the previous feudal system, during the reign of the first two kings (1907-1952). However some of these former social classes are still of importance to this study, since they have a direct impact on land ownership. During the field work, three main social categories were encountered.

The *khraebas* were the tax-paying households which had to pay the full taxes [Ura 1995][11]. In Dhur, the *khraebas* define themselves as the „hosts of the Shabdrung". During the 17th century, Shabdrung Ngawang Namgyel visited Bumthang. Those households who hosted the Shabdrung were therefore known as *khraeba*. One interpretation of this legend could be that the *khraebas* are the oldest families of a village.

9. The *dzongs* are fortresses acting as centres for both administration and clergy.

10. No comprehensive study on the social class system during the first half of this century could be found. However some indications were found here and there. Therefore, the explanations here rely mostly on the information given by the villagers during the field work.

11. Karma Ura designates this class as „*trelpa*". „*Khraeba*" is the phonetic transcription of the term used in Bumthang. Further in this document „*khraeba*" will be used.

The *szurbas* (or *zurpa*) are households which separated from the main parental household. The *szurbas* were subject to taxation, but much less than the *khraebas* [Ura 1995].

The *doebas* (or *drapas*) are landless farmers who had to rent or share-crop land [Guenat 1991]. A family of *doebas*, as well as their descendants, was subject to a landlord. Their living conditions, however, were better than that of the serfs (*zeeba* or *zaba*)[12].

Further, there are a few other groups: among the Brokpas are found the *yaktse* and the *naktse*. They were the keepers of the male and female yaks, respectively, of rich families, royal family or *dratshang*[13]. A group which is specific to Bumthang is the *dung* (*gDung*).

> "The only patrilineal noble families preserving a lay, as distinct from a religious, character to have survived the vicissitudes of theocratic and monarchic government in Bhutan are the so-called *gDung* who live where the language of Bumthang is spoken(..)" [Aris 1980].

On the contrary, there are plenty of families in the whole country which descend from famous religious teachers. The heads of such families are known as *chöje* (*Chos-rje*).

2.2.2 The economy

The majority of Bhutan's population live in rural area as subsistence farmers. The GDP (Gross Domestic Product) per capita of 478 US$ in 1995 [UNDP 1996] is relatively high compared to the neighbouring countries[14]. The main contributors to the GPD are agriculture and forestry (43% in 1993), but the shares of electricity (8%), transport (8%) and manufacturing (9%) are continuously growing [World Bank 1994]. The power sector is very important in Bhutan and is expected to grow rapidly with the construction of several hydroelectric plants in the country.

The situation in Bumthang is similar: the vast majority of the population is active as subsistence farmers or herders. The farmers who are settled near the road have the opportunity of growing cash crops (mainly potatoes and apples), selling their milk (to the Milk Processing Unit in Chhoekhor) or producing seeds (grass or vegetables). The traditional weaving of *yathras* (woollen cloth) has increased and provides a supplementary income to the households. Besides the subsidence farmers, a considerable number of men are monks living in the monastic communities. A small fraction of the population pursue other economical activities; e.g. they are in government service, run a shop or a restaurant, repair vehicles or are contractors.

2.2.3 Institutions and infrastructure

The *dzongkhag* (district) is administrated by a *dzongda* (district administrator) and his assistant the *dzongrab*. The *dzongkhag* is divided in several *geogs* which are headed by a *gup*. The *gup* is elected by the villagers and acts as link between the villages and the *dzong*. The *chhimi* is a national assembly member representing a geog. He is elected by

12. Serfdom was abolished in 1953.

13. Dratshang: monastic community [Department of education 1992].

14. Gross National Product per capita in 1995: 340 US$ in India, 240 US$ in Bangladesh, and 200 US$ in Nepal [UNDP 1998].

the villagers of the geog. The representative of a village is the *tshogpa*. He is elected by the villagers for a period of 3 years and is exempted from the government and the compulsory village work. The smaller villages do not have a *tshogpa*. *Chipon* or *liaison* are messengers who maintain the contact between *dzong* and villages. In the villages visited, the households usually act in turn as *liaison* for a year.

The national highway crosses the district from west to east with 122 km of motorable road. 41.5 km of feeder roads complement the road network. A hydroelectric station in Chhumme with a — theoretical — capacity of 3 x 0.5 MW provides electricity to parts of Chhumme and Chhoekhor *geogs*. A small number of micro-hydels supplement the power supply [Central Statistical Organization 1994]. At the end of 1992, the telephone and fax were introduced, complementing the post office and wireless station facilities.

2.2.4 The culture

Bumthang is an important religious and historical centre. Indeed there are nearly 100 temples (*lhakhangs* and *gompas*) in the region. Some of them are of greatest religious importance: the complex of Kurjey *lhakhang* — one of the most sacred places — where Guru Rimpoche left the imprint of his body while meditating, Jambay *lhakhang* is one of the 108 temples built by the Tibetan King Songtsen Gampo to subdue a female demon and Tamshing — founded by the saint Pema Lingpa of Bumthang — where some of the oldest paintings in Bhutan are [Pommaret and Imaeda 1991]. The religiosity of the place has also influenced the population. The slaughtering of animals and the rearing of pigs are condemned.

The present royal family originated from Bumthang. They are believed to be the descendants of Pema Lingpa [Aris 1994]. The palace of the first king is still to be seen in Wangdicholing. Several *dzongs* and impressive buildings can be found in this district (Jakar *dzong*, Lame Gompa *dzong*, Wangdicholing palace,...).

2.3 The environmental conditions

2.3.1 The geology and soils

The geology of the Bhutan Himalaya has still been little described and it is the, geologically, least known section of the Himalayas. Augusto Gansser wrote the most comprehensive document about the geology of Bhutan [Gansser 1983]. He divides the Bhutan Himalaya into five units: "The Subhimalaya with the Siwalik sediments. The Lower Himalaya with Late-Precambrian metasediments and marginal remnants of Gondwana rocks (..). The High Himalaya which cover with over 15 km thick thrust sheets the greater part of the country." the Tethys Himalaya and the Indus-Tsangpo zone or suture zone along the Northern border of Bhutan.

The geological underground of Bumthang is part of the central gneissic complex and described as a Thimphu formation which "is characterised by migmatites and biotite-granite-gneisses with thin beds of quarzite, quartz-mica schists, calc-silicate rocks and marbles, etc." [Economic and social commission for Asia and the Pacific 1991]. The valleys of

the Bumthang *chu* (river) are 'U' shaped and show the imprint of earlier glaciation [Bhargava 1995].

The soils of Bhutan fall into the broad category of "brown soils" [Kovda and Lobova 1971; Sargent et al. 1985]. Sargent differentiated the soils according to the forest types. In general their studies showed that the soil pH is neutral (mean pH 5.6 at 10 cm depth) and that the organic matter content is relatively high (in average >35%). In Bumthang the soils are ranging from clayey, impeded with a deep organic horizon and pH around 5 for the fir/hemlock/birch and hemlock/birch/maple forests, to rather sandy and well drained soils with pH around 6 for the evergreen oak, evergreen oak/blue pine and blue pine forests.

The soil survey of Bhutan undertook some studies in Bumthang, but the results have not been published yet. Researches in the project IFMP in Ura found mainly the following soil types: podzols, cambisols, stagno gleysols and spodi-dystric cambisols [Herbst 1993].

2.3.2 The climate

Due to the wide range of altitude, the climate in Bhutan varies from tropical to alpine, up to the zone of eternal snow. The most important characteristic of Bhutan's climate is the Southwest monsoon, which lasts from June to September, bringing in most of the annual precipitation. However, the extreme variable topography causes wide variations in the climatic factors, resulting in local climates.

There are several weather stations in Bumthang run by different organisations: Batpalathang, Lame Gompa, above Dhur, Hurchi forest, Ura and Geden. The oldest weather station still working was established in 1981, all the others in the late '80s and '90s. Therefore the meteorological data presented rely on a short period of measurements and have to be regarded cautiously. Further, little is known about the influences of the topography on the climate. The average daily temperature ranges from -2.6 °C in January to 12.1°C in July at 3'270 m (Hurchi) and from 3.7°C in January to 17.8°C in July at 2'650m (Batpalathang). The average yearly precipitation varies from 763 mm (at Batpalathang, 2'650 m) to 1'340 mm (Hurchi forest, 3'400 m) [Rosset 1998]. 70% to 80% of the precipitation falls in summer (June to September), whereas the winters are comparatively dry.

The climate of Chhoekhor is characterised by strong winds which blow from the lower to the upper part of the valley every afternoon. Griffith already noticed this strong diurnal wind during his visit to Bumthang [Griffith 1847, in: Schweinfurth 1983].

2.3.3 Land use

Bhutan is covered to a large extent by forests (64.4% or 72.5% with scrub forests). Agricultural land accounts for 7.7% and pastures for 3.9 % of the country's area.

In Bumthang (see Table 2-1), the forest covers half of the *dzongkhag* or, if scrub forest is included, 67%. The extent of the natural pastures (8%) and of the unproductive land (23%) are above the national average, for a vast part of Bumthang lies above the timber line.

Table 2-1: Distribution of the land use types in Bumthang. Source: LUPP 1995.

Land use	area in ha	% of total area
Agricultural land	5'631	2 %
Forest	134'685	50 %
Scrub forest	46'446	17 %
Natural pasture	21'406	8 %
Settlements	160	< 0.1%
Others (rock, glaciers,...)	62'265	23 %

The agricultural land comprises 2% of the district's area. The land is divided into several categories (see Table 2-2). *Pangzhing* is the largest represented type of agricultural land with 61.5%. *Pangzhing* is grass fallow shifting cultivation land, usually situated on slopes and cropped for 1-2 years with bitter or sweet buckwheat (*Fagopyrum tataricum, F. esculentum*), then left fallow for 6-20 years [Roder et al. 1992, 1993]. *Kamzhing*[15] is permanently cultivated land, used mainly for wheat, barley and in recent times potato [Guenat 1991].

Tseri is bush fallow shifting cultivation land usually found at lower altitudes (300-2'500m) [Roder et al. 1992].*Tshesa* are the kitchen gardens. Recently, orchards have been planted, mainly with apple trees.

According to the land register, the largest part of the land is recorded as *tsamdrog*. Tsamdrog is pasture land with grazing rights. Some forest can also be retained as *tsamdrog*. *Sogzhing* is a patch of forest where the people have usufructuary rights to collect litter, but have no rights over the trees or on the land.

Table 2-2: Distribution of the land according to the land record in Bumthang. Source: Survey of Bhutan, in: LUPP 1995.

Land type	area in ha	area in %
Pangzhing	3'765	61.5 %
Kamzhing	1'778	29 %
Tseri	458	7 %
Tshesa	103	2 %
Orchard	33	0.5 %
(Tsamdrog)	(26'792)	-
(Sogzhing)	(315)	-

15. *Kamzhing* is also called *Karzhing* (=wheat land). *Nazhing* (=barley land, irrigated) is included in this category.

2.4 The forestry sector

2.4.1 Forest types

From the '80s onwards several classifications of forest types have been published [e.g.: Grierson and Long 1983; Negi 1989; Sargent et al. 1985; UNDP and FAO 1984].

The most differentiated forest type classification — at least for the temperate forests of Bhutan — was proposed by Sargent et al. (see Table 2-3). They analysed LANDSAT 2 images and carried out a field survey with 63 transects to determine the forest types.

The forest types 1a to 3c in Table 2-4 are found in Bumthang. The distribution of the forest types depend not only on the altitude, but also on the local habitats.

Table 2-4 shows the relative importance of the different forest types according to the definition of LUPP. The most represented forest type is mixed conifer forest with 54% of the forest area. The mixed conifer forest comprise fir, hemlock and spruce (corresponds approximately to class 1a, 1b and 2b of Sargent). The fir forests cover 30% of the forested area (approx. class 2a). Finally blue pine forests (approx. class 3b and 3c) cover 16%.

Table 2-3: Distribution of the forest types in Bumthang. Source: LUPP 1995.

Forest type	area in ha	area in percent
Broadleaf (>80%)	33	< 0.1%
Broadl./conifers mixed	15	< 0.1%
Blue pine	22'015	16 %
Mixed conifers	72'175	54 %
Fir	40'438	30 %
Plantation	9	< 0.1%

2.4.2 Legislation

The **Bhutan Forest Act** was promulgated in **1969**. With this Act, all the forests, where "no person has acquired a permanent, heritable and transferable right of use and occupancy" [RGOB 1969], were declared as government reserved forests. The traditional uses were limited (e.g. the felling of trees requires a permit and marking) or even forbidden (e.g. the burning of pastures or the collection of torch wood). The Forest Act 1969 guarantees timber for bona fide use for the local population against payment of a royalty or a fee.

The Forest Act of 1969 was replaced in **1995** by the **Forest and Nature Conservation Act** [RGOB 1995]. This new Act remains within the same lines as the old one, but many ambiguities were clarified and the new Act is broader. Further, the Forest and Nature Conservation Act 1995 keeps a provision for social and community forestry. The Acts are complemented by royal commands and bylaws.

The draft of **Social Forestry Rules** has not yet been approved [RGOB 1993]. In the same way, the **National Forest Policy of Bhutan 1985** was never officially approved [RGOB 1985].

Table 2-4: Forest types of Bhutan (excluded for the tropical zone).
Source: [Sargent et al. 1985].

	Forest type	altitude	Main species
1a	Juniper/fir/spruce	3'720 ± 180	Juniperus pseudosabina, Picea spinulosa, Abies densa, Betula utilis, Rhododendron maddenii, R. lepidotum, R. anthopogon, Lyonia ovalifolia, Sorbus microphylla, Rosa sericea.
1b	Spruce/hemlock	3'250 ± 140	Picea spinulosa, Tsuga dumosa, Abies densa, Pieris formosa, Rhododendron arboreum, Rosa sericea.
2a	Fir/hemlock/birch	3'450 ± 270	Abies densa, Tsuga dumosa, Juniperus recurva, Betula utilis, Acer sp., Rhododendron arboreum, Viburnum nervosum, Rosa sericea.
2b	Hemlock/birch/ maple	3'130 ± 130	Tsuga dumosa, Juniperus recurva, Taxus baccata, Betula utilis, Acer sp., Mahonia nepalensis, Rhododendron arboreum, R. hodgsonii, R. falconeri, R. grande, Eurya cerasifolia, Hydrangea aspera, Gamblea ciliata.
3a	Evergreen oak	2'890 ± 210	Quercus semecarpifolia, Juniperus recurva, Rhododendron arboreum, Cotoneaster microphyllus, Symplocos ramossissima, Rosa sericea.
3b	Evergreen oak/ blue pine	2'800 ± 200	Quercus semecarpifolia, Pinus wallichiana, Tsuga dumosa, Rhododendron arboreum, Lyonia ovalifolia, Pieris formosa, Viburnum nervosum, Elsholzia fruticosa, Vaccinium sikkimensis, Eleagnus parvi-folia, Rosa sericea.
3c	Blue pine	2'810 ± 350	Pinus wallichiana, Quercus semecarpifolia, Rhododendron arboreum, Lyonia ovali-folia, Pieris formosa, Viburnum ner-vosum, Elsholzia fruticosa, Rosa sericea.
4	Deciduous oak	2'600 ± 440	Quercus griffithii, Pinus bhutanica, Rhododendron arboreum, Symplocos ramossissima, Lyonia ovalifolia.
5	Chir pine	1'880 ± 650	Pinus roxburghii, Castanopsis hystrix, Rhus semialata, Macaranga pustulata, Indigofera dosua.
6	Oak/laurel	2'430 ± 290	Michelia velutina, Quercus lamellosa, Cedrela sp., Castanopsis hystrix, C. tribuloides, Persea odoratissima, Neilia rubiflora, Ilex dipyrena, Daphniphyllum himalaense, Eurya japonica.
7	Warm temperate	1'840 ± 200	Shima wallichii, Exbucklandia populnea, Acacia pennata, Boehmeria ternifolia, Symplocus lucida, Persea sp., Sarcococca wallichii, Castanopsis indica, C. tribu-loides, Viburnum cylindricum, Zantho-xylum oxyphyllum, Daphniphyllum himalaense, Eurya japonica

Land ownership was formalized in 1953 with the establishment of the *thram* (land register) [Guenat 1991]. The **Land Act** was promulgated in **1978** [RGOB 1978]. This Act gave legal status to land property and limited land ownership to 25 acres per family. However, *tsamdrog* and *sogzhing* are not included in this restriction.

2.4.3 Institutions

The Forest Department was created in 1952. It is now integrated in the Ministry of Agriculture as the Forestry Services Division (see Figure 2-3). The territorial divisions are headed by DFOs (District Forest Officers). In some districts (e.g. Jakar) there are range offices with rangers and beat officers. Beat officers mark trees in both FMU (Forest Management Unit) — mainly for wood for the urban areas — and the remaining government forest — mainly for the rural area. Under the *Dzongkhag* administration are the DFEOs (District Forest Extension Officers) who act as the link between the villagers and the forest service.

The marketing of the forest products is done by the Forest Development Co-operation, FDC, (former BLC, Bhutan Logging Corporation). In 1998, the timber pricing policy declared a ban on the export of timber. Solely semi-finished and finished products are allowed to be exported.

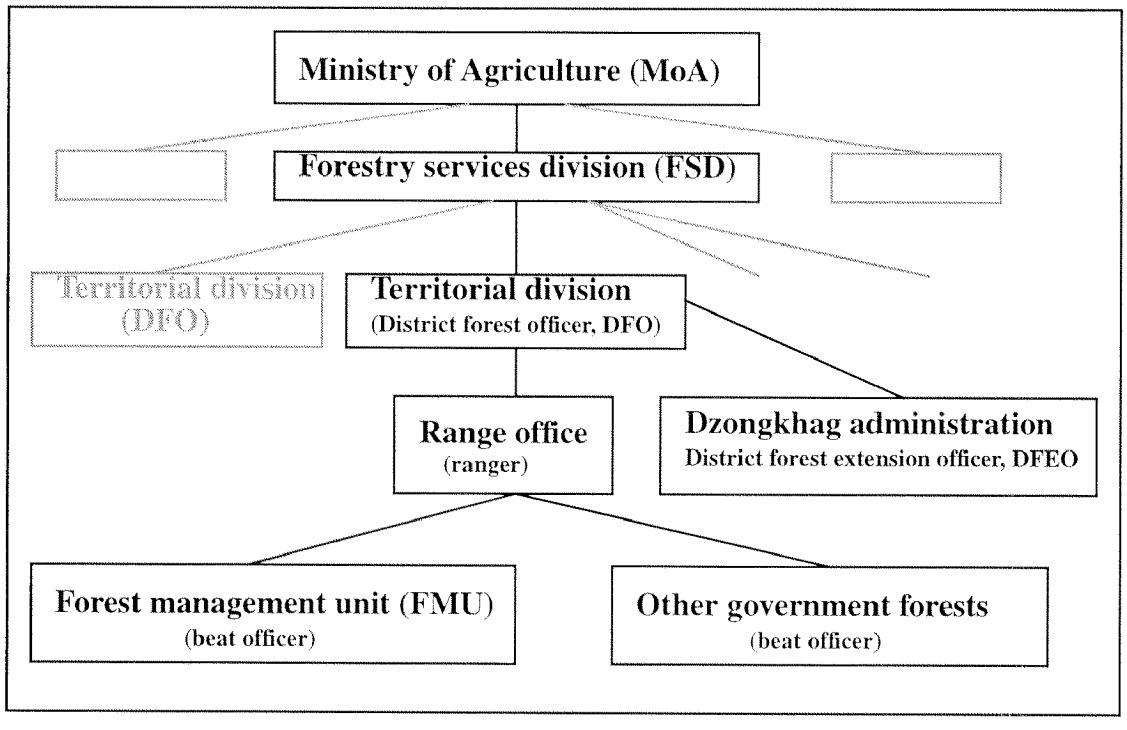


Figure 2-3: Structure of the forest service.

2.4.4 Forest products for the rural area[16]

The rural households are permitted free fire wood and construction wood at subsidised rates, provided it has registered land (land register: *thram*) in the village.

Firewood

The Forest Service used to mark trees for fire wood once a year. From 1999 onwards the Forest Service will mark trees for fire wood twice a year. The range office informs the *gups* on what day they will issue the permits in the village. The villagers have to be present in the village on the day announced to get their permit issued. The trees are sometimes marked on the same day or, more commonly, later on. Every household, independent of its size, gets the equivalent of one truckload (12m3) fire wood[17]. The trees are not measured, but their volume is estimated. After the marking, the villagers have to complete the felling of the trees within one month.

Construction wood

Construction wood comprises beams (*cham*), planks, shingles, poles, "*zim*" and "*dang-chung*"[18].

The forest service issues permits for construction wood once a year[19]. They inform the gups by letter 1-2 months in advance on what date the permits will be issued. The households have to obtain a form from the *gup* on which the villagers have to indicate how many trees and for what purpose they would like to have. It is the duty of the *gup* to check whether the person has registered land in the village. The villager has to deliver the form at the *Dzongkhag* administration. There an officer has to cross-check the validity of the thram[20] and the *Dzongda* has to approve the form. Then the villager has to show his form to the range officer. The range officer takes into account the quantity of wood the household has already obtained during the past years. Once the permit is issued the villagers have to fell the trees within 6 months.

The rural households are entitled to 100 trees for beams at a subsidised prices every 25 years: the first 50 trees cost 10 Nu[21] each (plus 0.75 Nu/tree for marking, rate 1999), the next 50 trees cost 30 Nu each (plus 0.75 Nu/tree for marking, rate 1999). If more trees are required, the household has to pay the market rate.

In 1999, the subsidised rates for the other products for the rural area were:

- Planks: 10 Nu/tree (max. 5 trees)
- Shingles: 10Nu/tree
- Poles: 6Nu/tree
- *Zim*: 6 Nu/tree
- *Dangchung*: 2 Nu/tree

16. The information presented below was provided by the range office in Jakar (April 1999).
17. From 1999 onwards, the households will get the equivalent of two truck loads (24m3) since the firewood will be given twice.
18. "*Dangchung*" and „*Zim*" are slim poles on the roof to hold the shingles. *Dangchungs* are laid from top to bottom and *Zim* across the roof.
19. Previously they issued permits throughout the year.
20. *Thram*: landholding register.
21. In 1998, 1 US$ was approximately equal to 37 Nu (*Ngultrum*), 1 Swiss Franc to 26 Nu.

3. Methodology

3.1 Survey of the forest structure

3.1.1 Indicator plots

One possible approach to surveying the structure of forests used traditionally by the rural population is the interpretation of indicator plots. In this study the description of the indicator plots partly assessed the important processes taking place in these forests. Further they provided a typical picture of every forest type. Lastly, measurement of the indicator plots allowed the verification of the characteristics which were to be measured, in a second step, during the forest inventory.

The indicator plots were chosen so that they ideally represented the image of a forest type. The selection was therefore subjective, depending on the perception of an average picture of a forest type.

One to two indicator plots were recorded for every main forest type — blue pine forest, blue pine forest with oak, forests on former agricultural land, hemlock forests, mixed hemlock and fir forests and fir forests. The approximate location of the indicator plots is shown in Appendix 1.The forest types were defined in the field according to the main tree species and the general aspect of the forests. They are based on the existing definitions of forest types [Grierson and Long 1983; Negi 1989; Sargent, Sargent et al. 1985; UNDP and FAO 1984], but since the present work was conducted on a smaller scale, the forest types had to be more detailed. For the further processing and analysis, however, similar forest types were grouped.

The indicator plots are based on the method of length profiles [Knuchel 1944; Korpel 1995; Lamprecht 1954; Leibundgut 1959]. However, to facilitate the measurements circular plots were chosen instead of rectangular ones: the position of a tree is easier to define in a circular plot as only the azimuth and the distance to the center need be measured. The plots were laid out with a radius varying between 25 m and 15 m depending on the relief and the visibility, which was often limited due to the dense undergrowth, especially bamboo.

First the surroundings and the indicator plots were described:

- Description of the immediate surroundings:
  - access to the area (easy, medium, difficult);
  - distance to the village (walking time: less than 30', 30'-60', 60'-90', more than 90');
  - visible infrastructure (record of footpath, hut/shed, fence, *chörten* (small shrine),...);
  - evidence of past or present forest use (presence of felled trees, lopped trees, candle trees, young forest patches,...).
- Description of the indicator plot:
  - altitude, exposition and slope;
  - vegetation on the ground: cover in % of herbaceous vegetation, bamboo and shrubs;

- description of the forest layers according to the brief formulas of forest description [Schütz 1990];
- height of the upper forest layer;
- determination of the forest type;
- determination of the intensity of the forest uses for every use (1: less than once per year, 2: every year, 3: more than once per year).

In a second step the regeneration growth — from 0.5 m height up to 7.9 cm dbh — was measured in a sub-plot of 1 m radius in the centre of the plot.

- measurements carried out on the regeneration (from 0.5 m height up to 7.9 cm dbh) in a sub-plot of 1 m radius in the centre of the inventory plot:
  - species;
  - dbh (if superior or equal to 1cm) or height class (between 0.5 m and 1.3 m in steps of 10 cm).

The measurements had to be done before measuring the trees in the indicator plot in order to avoid trampling the regeneration and to be able to measure intact section of regeneration growth. Measuring the regeneration growth in a sub-plot outside of the main plot was considered, but this alternative was rejected for two reasons: it is more time consuming to define the centre of the sub-plot outside of the indicator plot — since the dense undergrowth needs to be cut to allow measurement with compass and measuring tape — , further the surroundings of the regeneration sub-plot would not be defined in the same way when the regeneration is located in a sub-plot in the centre of the indicator plot.

In a third step the trees, stumps and logs in the indicator plot were measured in order to define on one hand the forest structure and on the other hand — through the stumps and logs — the forest uses.

- measurements carried out on the trees:
  - location of the tree through its azimuth and distance from the centre;
  - definition of the characteristics of the tree: species, dbh and layer;
  - special characteristics (e.g. forked, broken top...).
- measurements carried out on the stumps and logs:
  - location: azimuth and distance from the centre;
  - species, diameter and length;
  - determination of the purpose for which the tree has been felled (see Table 3-1) and approximately when.

The measurement of stumps and logs during an inventory is rather uncommon. Therefore no references could be found concerning criteria to determine for what purpose a tree had been felled. The experience with the indicator plots and the indications of the villagers allowed the definition of criteria for determining the purpose of felling a tree (see Table 3-1). Further it was possible to assess the extraction of bamboo through the presence of cut bamboo stems and the erratic presence of strips of bamboo, which are left over from the processing of simple ropes used to tow the extracted bamboo. The grazing in the forest could not be directly observed. The impact of browsing is perceptible only in intensely grazed areas, mostly on the forest fringes. The villagers indicated during the measurements whether grazing was taking place in the part of the forest being investigated.

In the Karakorum, Schickhoff recorded stumps and estimated their decay to demonstrate that the recent road construction had favoured deforestation in this area [Schickhoff 1997]. In the study area, however, no data was available about rotting processes of logs and

stumps in these forests. The estimation of the age of older stumps therefore had to be done with broad categories — 1 year, 2-3 years, 3-20 years, more than 20 years — and loss of their significance.

Table 3-1: Criteria to determine for what purpose a tree was felled.

Purpose	Criteria
Fuel wood	all the parts of a tree are removed.
Beams	presence of wooden chips resulting from the processing of the beam with the axe; the upper part of the tree is left lying.
Planks	presence of large wooden parts with bark which were split off, presence of damaged planks.
Shingles	most of the tree is left over; presence of wooden parts with bark resulting from the process of shingles.
Poles	absence of wooden chips or signs of further processing; sometimes the upper part of the tree was left over.
Torch wood	presence of chips of torch wood on the ground and/or on the stumps or log.
Inner bark	presence of peeled stems and strips of bark.

One of the major problems for the measurements of the indicator plots was the limited visibility within the plots. Indeed in young blue pine stands on former agricultural land, the number of trees limited the visibility to few meters. In other forest types, the dense bamboo undergrowth even limited the visibility to one-two meters. Therefore the radius of the plots had to be adapted, the undergrowth cut down or a topographically higher point had to chosen as the centre of the plot.

3.1.2 Processing and analysis of the indicator plot data

The indicator plots were intended, among other things, to illustrate the structure of the various forest types. Therefore the location of the trees was drawn with the help of charts. The indicator plot was presented once from a bird's eye view — with the trees represented by signs — and once in profile — with a set of stylised trees.

In the representation in profile, only a 10m wide strip was drawn, as the density of the trees inside the plots did not allow represention of all the trees. A chart which considered the inclination of the slope was used in the background to facilitate the positioning of the trees and then removed for the final version. The size of the trees as shown — height and diameter — is only indicative.

The characteristics of the indicator plot were calculated in the same way as those of the inventory (see 3.1.4 "Processing and analysis of the inventory data").

3.1.3 Inventory

In order to gather information about the forest types, composition and uses over a larger area, a two-phase forest inventory was carried out. In the first phase qualitative data was recorded and in the second phase dendrometric data, further some information was collected on the transect (see Figure 3-1).

In the first phase of the inventory, qualitative data were recorded in a grid of 50m by 200m. In total 735 records were made in the first phase (including the descriptive part of the indicator plots in the second phase). These data were used further to construct maps of the forest types and to locate the various forest uses. The following data were recorded in the first phase:

- First phase: qualitative data. Grid: 50m x 200 m. In total 735 records.
  - forest type;
  - description of the forest according to the brief formula of forest description [Schütz 1990];
  - vegetation on the ground: cover in % of herbaceous vegetation, bamboo and shrubs;
  - evidences of past or present forest use (presence of felled trees, lopped trees, candle trees, young forest patches,...).

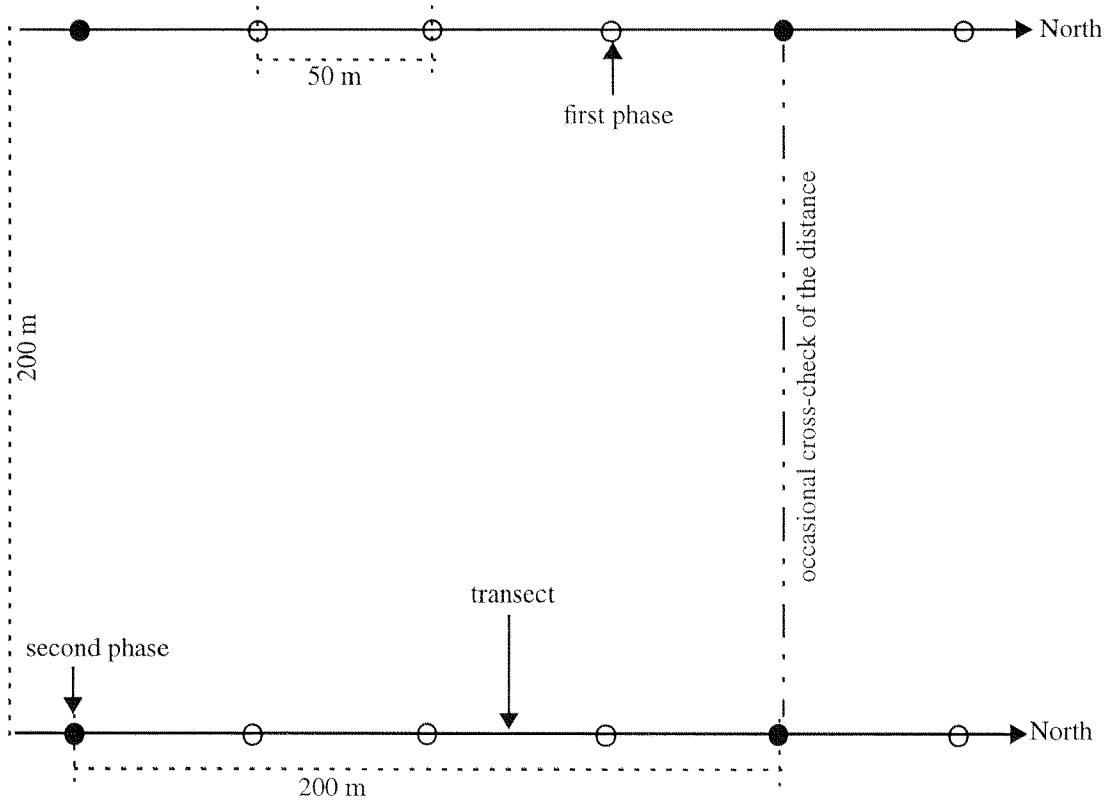


Figure 3-1: Two-phase inventory and transect.

In the second phase dendrometric data were recorded in circular plots of 5 ares with a grid of 200m by 200m. Most of the set of characteristics measured for the indicator plots seemed after the first experiences suitable for describing the forest structure and assessing

the forest uses. In contrast to the indicator plots, however, some simplifications were made. For instance, the location of the trees and stumps in the plot were not recorded.

- Second phase: dendrometric data. Circular plots of 5 a; grid: 200 m x 200m. In total 196 plots.
  - Description of the immediate surroundings:
    - access to the area (easy, medium, difficult);
    - distance from the village (walking time: less than 30', 30'-60', 60'-90', more than 90');
    - visible infrastructure (record of footpath, hut/shed, fence, chörten,...);
    - evidence of past or present forest use (presence of felled trees, lopped trees, candle trees, young forest patches,...).
  - Description of the indicator plot:
    - altitude (when possible);
    - vegetation on the ground: cover in % of herbaceous vegetation, bamboo and shrubs;
    - description of the forest layers according to the brief formula of forest description [Schütz 1990];
    - height of the upper forest layer;
    - determination of the forest type;
    - determination of the intensity of the forest uses for every use (1: less than once per year, 2: every year, 3: more than once per year).
  - measurements carried out on the regeneration growth (from 0.5 m height up to 7.9 cm dbh) in a subplot of 1 m radius in the centre of the inventory plot:
    - species;
    - dbh (if superior or equal to 1cm) or height class (between 0.5 m and 1.3 m in steps of 10 cm).
  - measurements carried out on the trees (dbh equal or above 8 cm):
    - definition of the characteristics of the tree: species, dbh and layer;
    - special characteristics (e.g. forked, broken top...).
  - measurements carried out on the stumps and logs:
    - location: azimuth and distance from the centre;
    - species, diameter and length;
    - determination of purpose for which the tree was felled (see Table 3-1) and approximately when.

Finally, special features — for example, infrastructure, streams and evidences of forest uses — were recorded along the transect. This information however showed to be too discontinuous to allow reconstruction of the footpaths or streams on a map.

- Transect between the plots:
  - visible infrastructure (e.g. record of footpath, hut/shed, fence, chörten,...);
  - natural features (e.g. cliffs, streams);
  - evidence of past or present forest use (e.g. presence of felled trees, lopped trees, candle trees, young forest patches,...).

Initially both the forests around Lusbi and those north from Dhur were to be measured in order to obtain data for different expositions, but the terrain north-west of Lusbi is very steep and covered with cliffs. Few measurements were taken, but the work then appeared to be too dangerous and the inventory in the forest around Lusbi was abandoned. A triangle of forest north of Dhur was inventoried (see Figure 3-2).

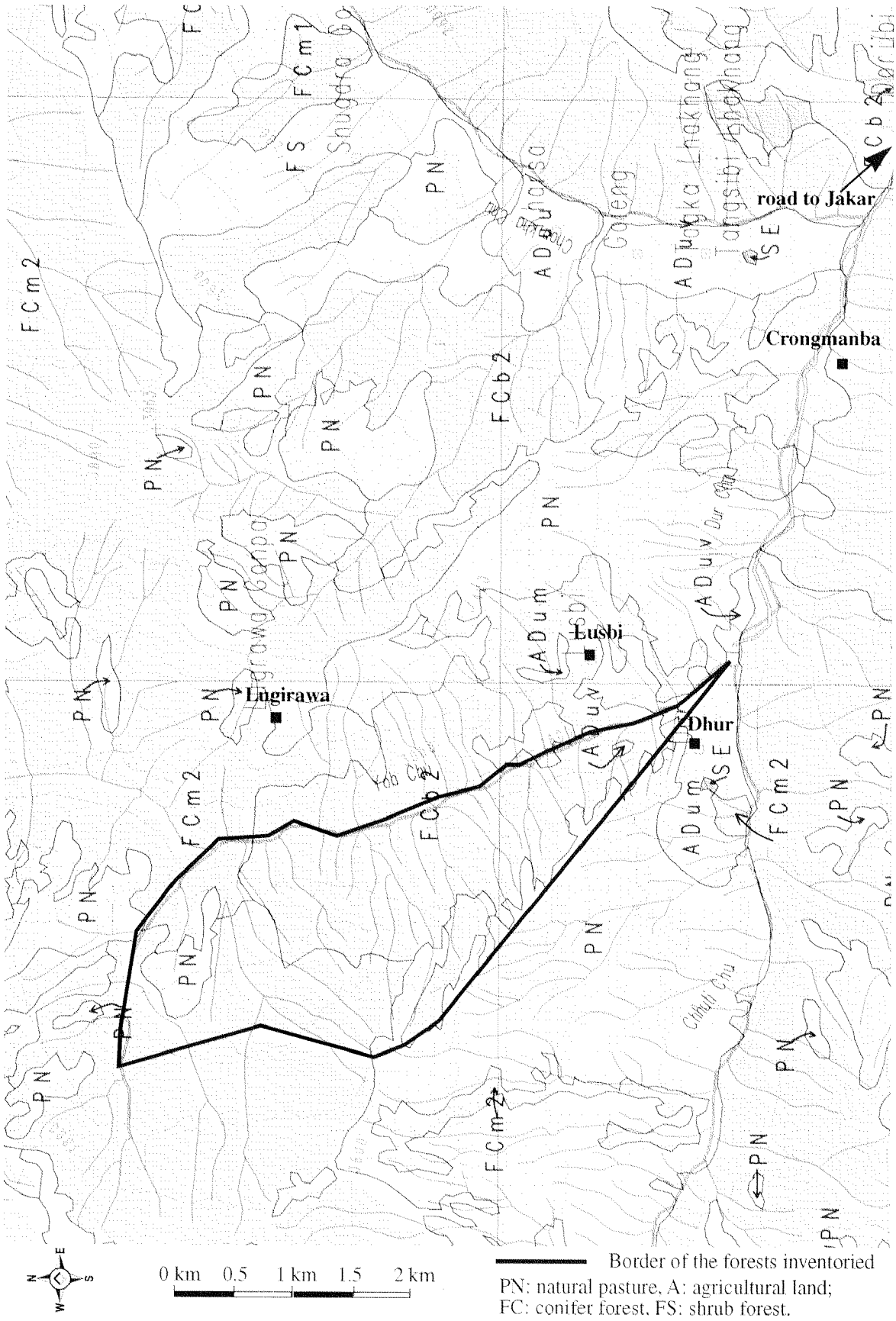


Figure 3-2: Map of the study area with the border of the forest inventoried. 1: 50'000. From LUPP 1995, modified: names and the border of the forest inventoried were added.

Natural features define the limit of this forest: the river Yoleng Chu in the lower part, the ridge to the south-west and the small river Gorsum Chu to the north.

Difficulties were encountered in measuring the altitudes. Indeed during the day, variations of pressure affecting the indications of the altimeter seemed to occur. During lunch break altitude differences up to 100m were recorded, thought the altimeter obviously was not excited!

Another difficulty encountered during the inventory was the dense bamboo undergrowth. , The way had to be cut free to allow measurements with the compass. On the average 1-2 people had to be employed to cut down the bamboo. On some occasions, the distance between two lines was cross-checked and adapted, but errors concerning the straightness of the lines can't be excluded.

3.1.4 Processing and analysis of the inventory data

Volume

The volume of standing trees was calculated according two different volume functions. The existing local volume functions were used for blue pine (*Pinus wallichiana*), Himalayan hemlock (*Tsuga dumosa*), East Himalayan spruce (*Picea spinulosa*) and East Himalayan fir (*Abies densa*). Bürgi had established these local volume functions on the basis of section-wise measurements of felled trees in three FMUs in Bumthang [Rosset and Rinchen 1997]:

- Blue pine: $V=0.0001521 * dbh^{2.520318}$
- Hemlock: $V=0.0002226 * dbh^{2.3765258}$
- Spruce: $V=0.000173 * dbh^{2.5010833}$
- Fir: $V=0.0005395 * dbh^{2.1905379}$

For the other tree species, the volume functions from the PIS (Pre-Investment Survey) for central and eastern Bhutan were used [Laumans 1994]:

- Oak: $V= (0.020144 + 4.292089*dbh - 0.894675 * SQRT(dbh))^2$
- Birch: $LN(V)= 2.460537 + 2.447069 *LN(dbh)$
- Maple: $V= (0.374246 + 4.759591*dbh - 1.89151 * SQRT(dbh))^2$
- Rhododendron: $V= (0.306492 + 4.31536*dbh - 1.749908 * SQRT(dbh))^2$

Maps

No forest stand map was available for the forest inventoried area, since the forest has not been commercially used to date. A unique set of aerial photographs was accessible, but it covered only the southern part of the area studied. Therefore it was not possible to conduct the proposed mapping of the forest types or to assess the evolution of the forest cover.

An attempt to produce a map with a GPS was made, but due to the mostly northern exposition of the forest, the GPS could not receive signals from a sufficient number of satellites.

Finally the maps of the forest stands (Figure 4-1) and of the forest uses (Appendix 8-16) were constructed from the information of the inventory data and verified with photographs taken from the opposite slope.

The sketch-map of the village of Dhur was elaborated with a compass and measuring tape.

3.1.5 Average age of trees on former agricultural land

Large tracts of blue pine forests are characteristic of the landscape in Bumthang. Many of these blue pine forests seem to be relatively young. The latter often grow on land suitable for agriculture. However the origin of the various young blue pine forests has not been assessed so far. Many hypotheses have been put forward to interpret this natural regrowth (see 1.1 "Background").

In the study area, the forest cover has increased over the past decades. In the forest inventoried, 17 young blue pine forests on former agricultural land were identified.

Measurements on these 17 areas were undertaken in order to discover the reasons and the time frame for natural regrowth. The following steps were taken to define the average age of the trees on former agricultural land:

- measurement of the area with compass and measuring tape in order to estimate the total area which got reforested naturally in the inventoried forest;
- full inventory of all trees with a dbh equal to or over to 8cm;
- random selection of ten to twenty trees, depending on the total number of trees;
- extraction of an increment core at 1.3 m above ground from the selected trees and measurement of tree characteristics (e.g. number of branches on the tree from the ground up to the point from which the increment core was taken);
- counting of the year rings with a microscope — a correction was made for missing pith;
- estimation of the age of the trees according to the number of year rings, the correction for missing piths and the number of branches counted below the place where the increment core was taken;
- the results were improved by estimating the age of the remaining trees by using their dbh and a regression over the dbh and age of the trees from which the increment cores were taken.

Further, enquiries were made to find the owner of the area in order to question him about his reasons for abandoning cultivation in this location.

3.2 Survey of the social context

3.2.1 Household Survey

One of the objectives of the present study was to assess the social context of the forest uses in order to get a better understanding of the processes in the interface between population and forests.

As mentioned in the introduction (see 1.3.2 "State of sociological and anthropological research in Bhutan"), little information is available about the population itself and its perception of the environment. Information which in other cases could be retrieved from national statistics and publications had to be collected.

To gather basic information about the population in the study area a Household Survey was carried out. The questions of the Household Survey are presented in Appendix 26. The Household Survey is a baseline survey covering all the households within the research area. In the study area, which comprises Dhur, Lusbi and Crongmanba, 82 households

were interviewed, which represented the totality of the population in 1997. Further 40 households in various villages in the two neighboring valleys — 20 households in the remaining part of Chhoekhor Toe and 20 households in Tang — which present similar social and natural conditions to those of Dhur, were interviewed in 1999 with the same set of questions. These additional interviews allowed differentiation between regional social features and local specificities.

The Household Survey was conducted with the help of a structured questionnaire. The interviews were carried out face-to-face, in the village or in the fields, with one or several household members. The compilation of these basic socio-demographic information therefore provided reliable first-hand data at the local level. The inquiry focused particularly on the size and composition of household units, the social group membership, the economic conditions of the household, the economic and social activities of the household and the local history.

The main topics of the questionnaire were:

- socio-demographic settings:
  - population group to which the household belongs;
  - composition of the household: age, sex, education level, occupation and residential status of every household member;
- economic conditions:
  - landholding in and outside of the village;
  - changes in the landholding;
  - user rights;
  - domestic animals: number and type of livestock, other animals;
  - houses: age of the house and available facilities;
- activities:
  - ranking of activities according to their importance;
  - ranking of activities according to cash income;
  - relationship within the village: concept of mutual help and compulsory work;
- history:
  - history of the village during the first half of the 20th century;
  - impact of the Forest Act of 1969 on the household;
  - economical changes in the household during the last decade.

3.2.2 Forest Resource Use Survey (FRUS)

The objective of the FRUS (Forest Resource Use Survey) was to obtain detailed information on the availability, past and present consumption, mode of acquisition, and future outlook of the local population on the management of wood and non-wood forest resources.

In Dhur, 79 households were surveyed. Three households out of 82 were absentees and thus do not consume any forest products in this area. As in the case of the Household Survey, 40 households in the two neighboring valleys — the remaining part of Chhoekhor Toe and Tang — were interviewed in order to distinguish local specificities.

A structured questionnaire was used for the FRUS (the questions are reproduced in Appendix 27). The interviews were carried out with one or several household members, in

the village or in the fields.The households were questioned about the quantities of forest products they used — during the past years and before the introduction of the Forest Act of 1969 — , the location — their own sogzhing, a villager's sogzhing or the government forest — of the forest product extraction and its price.

The following products were taken into consideration (see Table 3-2):

Table 3-2: Wood and non-wood products considered during the survey.

Wood products:	Non-wood products:
- fuelwood (trees and dry wood)	- bamboo
- beams	- fodder
- planks	- litter (ferns and pine needles)
- shingles	- incense
- poles	- edible plants
- torch wood	- medicinal plants

Further the households were questioned about some aspects of grazing. For every livestock type, the location — forest or pasture — duration in months and mode of grazing — free or watched over — were assessed.

The households were asked to identify the ownership of the different forest products in different locations — garden, sogzhing, government forest. Lastly, the households were requested to give their opinion on the current situation regarding the forest products.

3.2.3 Checklist in Cultural Ecology

Cultural ecology is defined here as the relationship between culture, social organisations and natural environment. Though a well established discipline, dating back to the 19th century, cultural ecology has gained importance during the late 20th century [Bargatzky 1986].

The Checklist in Cultural Ecology provides a methodology for developing an appropriate epistemological approach in cross-cultural and interdisciplinary research [Seeland 1989]. Its objective is to support the researcher's ability to develop meaningful research topics and relevant linkages between different scientific subjects, especially within non-European cultural settings. Being an on-the-job methodology it is highly context-oriented and has an applied orientation. The Checklist in Cultural Ecology contributed to the present study by giving a broader context to the forest uses in the area. The social science research techniques which were applied in the data collection with the help of the Checklist in Cultural Ecology were observations, interviews of key informants with semi-structured interview guidelines, group interviews, calendars and resource mapping [Whyte 1977; Whyte 1984; Whyte 1994].

The Checklist in Cultural Ecology comprises five steps to sketch the complexity of a resource use pattern.

The first step characterises the general social features of the research area: name and location of important social groups with their respective different socio-economic interests,

their traditional hierarchies and modern developments. Themes of this first step also included: definition and characteristics of the social groups, communities, institutions, hierarchies, concurrence between groups and foreign groups.

The second step identifies relevant cultural values, social and religious customs and taboos. Themes of this second step also included: traditions, customs, cultural values, gender specific work, religious rules, taboos and tolerance.

The third step looks at the natural environment in a cultural and ecological perspective and tries to define typical representations of society and culture within the local natural setting. For example: structure of the settlements, socio-cultural restrictions on uses, vegetation, crops, gathering of wild plants, game and hunting, rituals related to agriculture, landholding, ownership, inheritage, land use types and production types.

The fourth step emphasises the linkages between forest uses and social organisation at a particular time, predominantly in the past. These are, among others: relationship between population and flora, entitlements for plantations, significance of the location or age of a tree and exotic trees.

The fifth step identifies present problems and sensitive issues resulting from changes in society and in forest use and resource management.

The Checklist in Cultural Ecology gives the researcher a broader understanding of the socio-cultural context he/she is working in with the focus on the interface population and natural environment. Field work is always limited in time and one's presence in a particular place often discontinuous. Even though the field work extended over three years in the present study, the information gathered remains fragmentary and has to be treated cautiously.

The findings from the Checklist in Cultural Ecology were used on one hand to outline the questionnaires of the Household Survey and the Forest Resource Use Survey. Later on, on the other hand, the Checklist in Cultural Ecology was used to cross-check some results of the questionnaires. Lastly, it allowed the retrieval of further information, which was not made available through the surveys.

3.3 Linkage between the forestry and sociological methods

One of the underlying hypotheses of the research is that the use and management of natural resources in general, and forest resources in particular, has to be approached by conducting investigations both of the actual resource use and the socio-cultural perception of the local resource users towards their environment. These aspects are presented in Section 4. "The forest structure".

The forest types and the forest structure were traced by the indicator plots and the forest inventory. From the analysis of the forest structure, it was possible to assess indications of the impact of the forest uses on the forest structure.

The socio-cultural context presented in Section 5. "The social context of the forest uses" was assessed through sociological methods, mainly the Household Survey and the Checklist in Cultural Ecology. The perception of the natural environment by the villagers was traced by the Forest Resource Use Survey and the Checklist in Cultural Ecology.

The definition of the forest uses as well as the quantities and ownership were mainly assessed by the Forest Resource Use Survey. The type of tree required for every product, the location of the uses and the impact of the forest use on the forest structure was assessed through the forest inventory and partly by the indicator plots. The rationale and the mode of procurement were mainly traced with the help of the Checklist in Cultural Ecology. The analysis of the forest uses is presented in Section 6. "The forest uses".

Linking these two sources of information provides an encompassing picture of the recent history of social resource use and a general view of the resource use rationale of a rural community in Central Bhutan. Firstly, the two approaches allowed the cross-checking of the findings. For example, the stumps of felled trees were recorded during the forest inventory, giving indications what tree species of what size were used for a certain product and in what quantities. Secondly, the Forest Resource Use Survey gathered indications from the households of the quantities consumed and thus confirmed the intensity of the forest use. The Checklist in Cultural Ecology recorded the selection criteria—type of tree and dimension—of the villagers for a tree being felled for a certain purpose. The information were cross-checked with the findings of the forest inventory. The findings from the Checklist in Cultural Ecology are not presented in a distinct Table or Section, they are much more underlying in every chapter.

Furthermore, the two approaches were complementary. For example, the location of the different forest uses was possible through the forest inventory and could not have been assessed so precisely through interviews. On the other hand, the traditional entitlements could only be assessed through sociological methods only and not through the inventory.

4. The forest structure

4.1 Overview of the forest types

4.1.1 Description

The part of the forest inventoried ranges from 2'700 m.a.s.l. to 3'600 m.a.s.l. approximately, but the forest itself reaches up to 4'000 m.a.s.l. A map of the forest stands was generated with the data from transects made during the forest inventory (see Figure 4-1). The forest types were assessed in a grid of 50 m x 200 m. For the analysis, the forest types as defined during the inventory presenting similar characteristics were grouped together. The forest is composed of a multitude of stands, forming a kind of mosaic. Therefore the map of the forest types might appear a little confusing. However, some general rules can be defined. Roughly, one can divide the forest into three altitudinal zones. In the lowest part, along the river, at approximately 2'750 m.a.s.l. to 2'850 m.a.s.l. pure oak forests and blue pine forests with oak are found. A little further up, approximately between 2'800 m.a.s.l. to 3'000 m.a.s.l., are pure blue pine forests, blue pine forests with oak and blue pine with spruce and oak. Spruce forests — either pure or mixed with blue pine and/or hemlock — fir mixed with hemlock, and hemlock forests form the middle zone at approximately 3'000 m.a.s.l. to 3'400 m.a.s.l. The higher altitude forests, above 3'400 m.a.s.l., are composed of fir forest and patches of birch forests with maple. An estimation of the relative importance of the forest types, based on the inventory, is given in Table 4-1. Since for the oak forests only 4 inventory plots were recorded, these data were not considered for further analysis.

Table 4-1: Estimated distribution of the forest types (in ha and in percent), based on the number of plots recorded in the forest inventoried.
Source: forest inventory 1997-98.

Forest type	No. of plots	Area in ha	Area in %
Blue pine	27	108	14
Blue pine with oak	28	112	14
Oak	4	16	2
Mixed spruce	34	136	17
Hemlock	34	136	17
Hemlock/Fir	11	44	6
Fir	38	152	19
Birch	11	44	6
Former agricultural land	9	36	5
Total	**196**	**784**	**100**

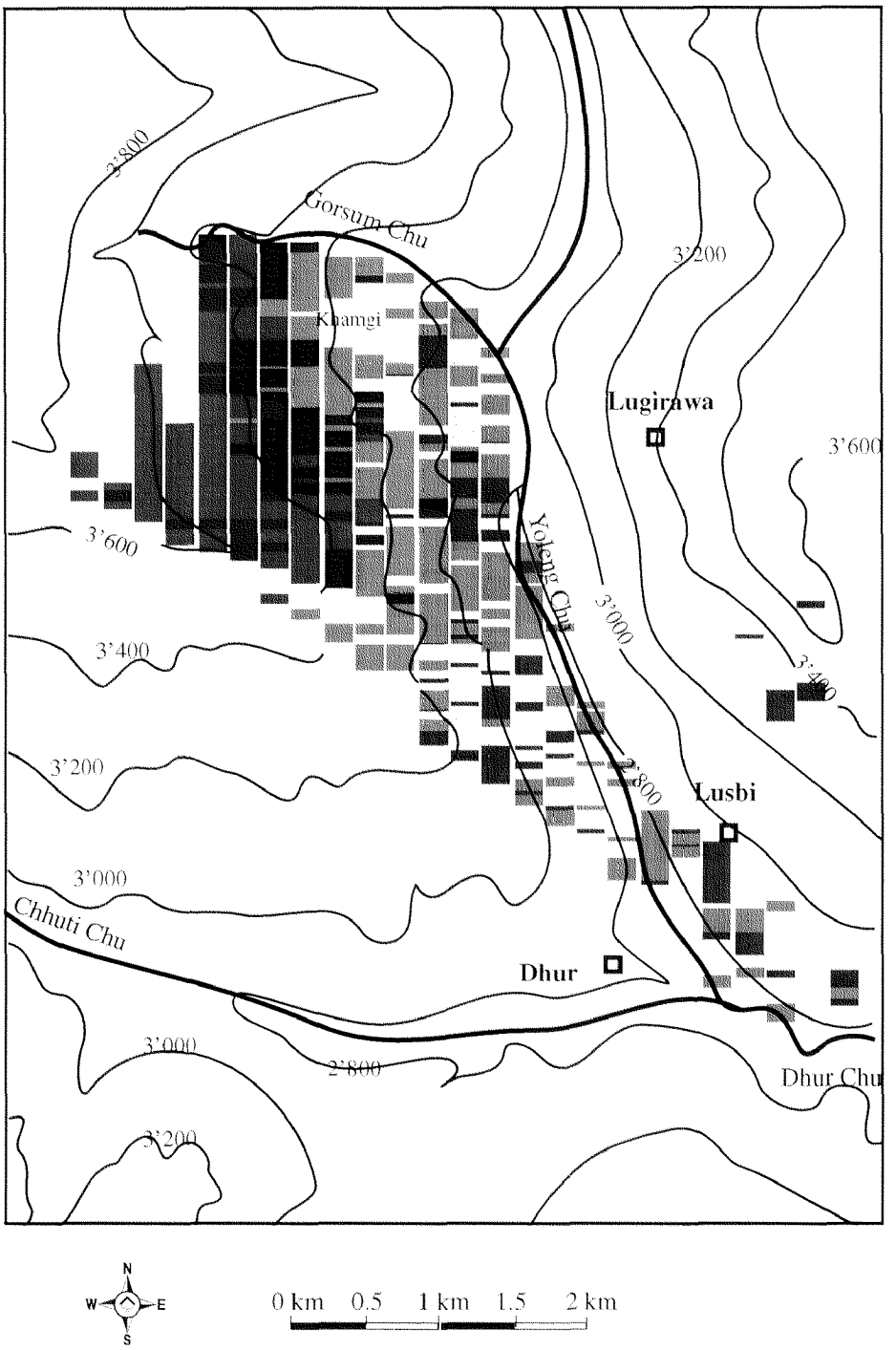


Figure 4-1: Map 1:50'000 of the forest inventoried with the distribution of the forest types. Source: forest inventory 1997-98. Topographical details from LUPP 1994.

4.1.2 Forest structure

Table 4-2 shows a summary of the main characteristics of the different forest types: the number of stems per ha, the basal area per ha and the volume per ha, with their 66% confidence interval. The figures consider all the tree species with a dbh equal to or greater than 8 cm.

The number of stems per ha ranges from 578 no./ha for the birch forests to 1'028 for the fir forests. The basal area was lowest in the forests on former agricultural land, with 25 m^2/ha, and highest in the fir forests with 108 m^2/ha and in the mixed hemlock and fir forests with 103 m^2/ha. The standing volume was relatively low, with 308 m^3/ha, for the forests on former agricultural land. The mixed hemlock and fir forests, with 1'580 m^3/ha, the fir forests, with 1'543 m^3/ha, and the hemlock forest, with 1'079 m^3/ha, reach considerable standing volumes per ha.

Table 4-2: Number of stems per ha, basal area per ha and volume per ha with their 66% confidence interval of the main forest types. Source: forest inventory 1997-98.

Forest type	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Blue pine	752	± 71	29	± 2.9	339	± 43
Blue pine with oak	937	± 71	39	± 3.8	471	± 66
Mixed spruce	699	± 58	39	± 6.1	548	± 113
Hemlock	716	± 68	73	± 7.3	1079	± 133
Hemlock/fir	865	± 117	103	± 15.7	1580	± 272
Fir	1028	± 64	108	± 7.4	1543	± 122
Birch	578	± 81	53	± 9.0	672	± 151
Former agr. land	729	± 153	25	± 4.9	308	± 69

An overview of the stem distributions for every forest type is presented in Figure 4-2. A semi-logarithmic scale was chosen in order to minimize the visual effect of the abundant broadleaf understorey and allow a better understanding of the distribution of the main stand-forming species.When considering these stem distributions, two groups with similar stem distributions can be formed. First, the blue pine forests, the blue pine forests with oak, the forests on former agricultural land, the mixed spruce forests, and the birch forests present similar stem distributions. The second group is composed by the hemlock forest, the mixed hemlock and fir forests, and the fir forests[22].

4.1.3 Stumps and logs

The forests are more or less intensely used.Table 4-3 gives a summary of the number of stumps and logs per ha in the different forest types. It is however difficult to compare the intensity of uses between the forest types, since nothing is known about the rapidity of the decomposition processes of the stumps of the different species.

Blue pine forests with oak are the most intensively used forests. Their relatively proximity to the village and the footpaths certainly contribute to this situation.

22. See also chapter 7.2. "Findings on the forest structure"

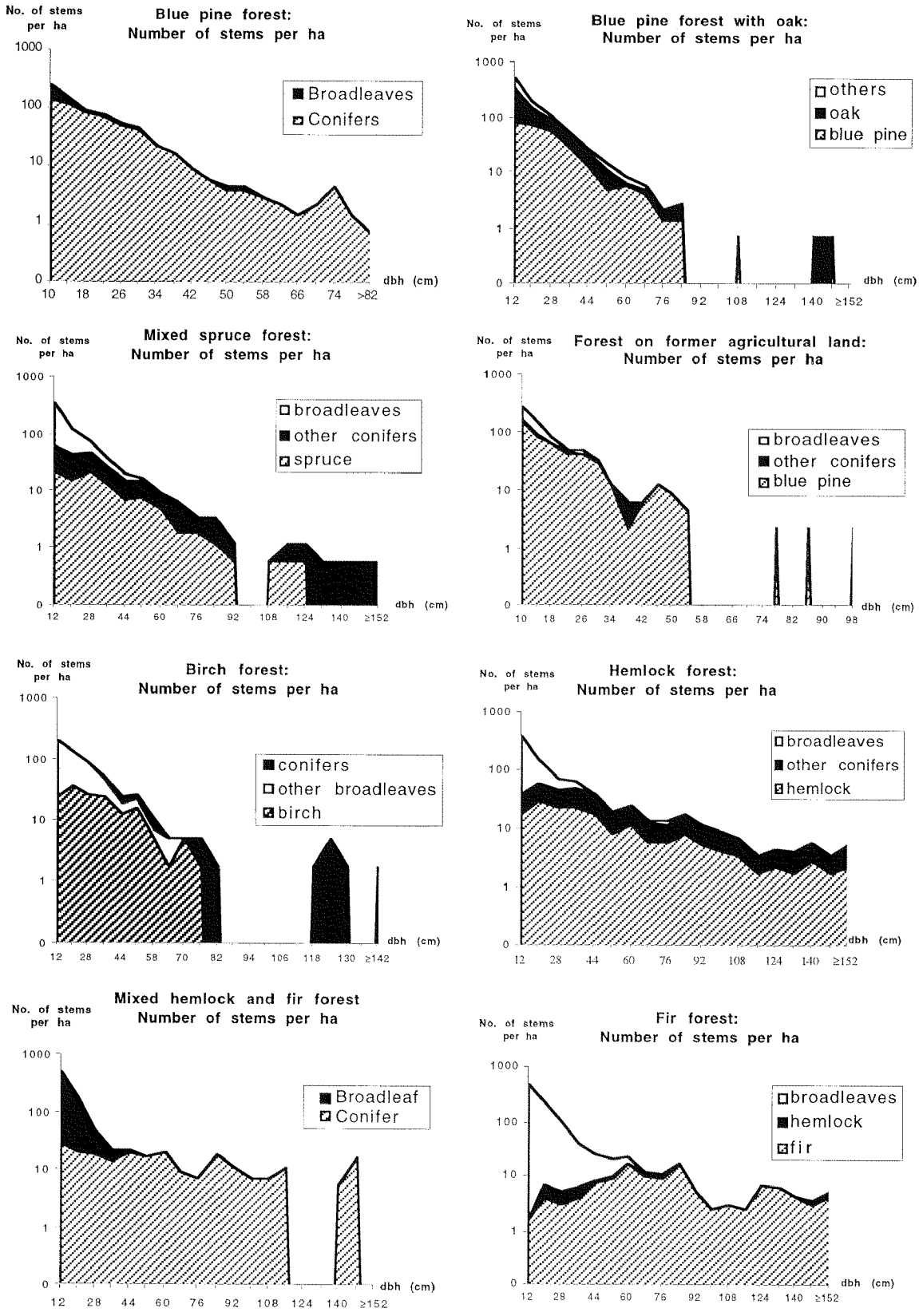


Figure 4-2: Overview of the stem distribution of the different forest types.

The forests on former agricultural land and hemlock forests are moderately to intensively used. Both are easily accessible by footpaths: the first due to the agricultural activities and the second due to bamboo extraction in these forests. The spruce forests and the blue pine forests are used moderately to extensively, due to their relative remoteness and difficult access. Fir and mixed fir and hemlock forests are used extensively. Most stumps indicated a natural death of the trees. Only a few products are taken from these forests, which are relatively far away from the village. On the other hand, those fir and hemlock forests close to the pastures are used moderately, mainly for fuel wood. Last, the birch forests are protected by their remoteness and no sign of wood extraction could be detected; all the stumps indicated a natural death of the trees.

Table 4-3: Number of stumps and logs per ha and 66% confidence interval. Source: forest inventory 1997-98.

Forest type	No. of stumps/ha	No. of logs/ha
Blue pine	79 ± 15	69 ± 16
Blue pine with oak	281 ± 52	120 ± 19
Mixed spruce	82 ± 14	77 ± 10
Hemlock	144 ± 42	124 ± 83
Hemlock/fir	84 ± 10	119 ± 14
Fir	107 ± 16	65 ± 10
Birch	38 ± 8	98 ± 28
Former agr. land	158 ± 52	38 ± 19

A tentative comparison of volume increment and timber extraction will be given here in order to provide the readers with an impression of the intensity of the timber extraction. It has to be emphasised here that this comparison was not part of this study and that it is based on a number of estimations.

In the past, some authors examined the annual increment of various forest types in Bumthang. Rohrbach stated that the average annual increment in middle-aged blue pine stands ranges between 12.6 and 13.5 m^3/ha/year [Rohrbach 1985]. Since, in the forests inventoried, blue pine stands are partly mixed with oak, the average of these two figures, reduced by 30%, was used for the estimate of the average annual increment. According to Bürgi, the average annual increment in the fir forest ranges between 3.23 m^3/ha/year on north-facing slopes and 2.24 m^3/ha/year on south-facing slopes [Bürgi 1992]. For the estimate here, the figures for the north-facing slopes were used, as the forests inventoried were mainly located on north and north-eastern slopes. Finally, as mixed spruce forest contains blue pine, which is relatively more productive than fir or hemlock, the annual increment was estimated to be 4m^3/ha/year. On the average for the whole forest, the annual increment was estimated to be around 5.4 m^3/ha/year. As a comparison, in the Gidakom FMU in Western Bhutan, the average annual increment for the whole forest was indicated to be only 3.93 m^3/ha/year [Dhital and Pushparajah 1992]. However, in the Gidakom case study, no information could be found about the composition and exposition of the forests to explain this difference.

The average timber extraction in the forests inventoried was estimated through the following procedure. For every stump the point of felling was estimated during the forest inventory. As no study has been conducted so far on the decomposition of stumps and logs in these forests, it was difficult to estimate the point of felling and tentative broad categories for the point of felling had to be made. The decomposition of stumps and logs depends on the species — blue pine is expected to decompose slower than hemlock or fir due to its higher resin content — on the diameter, on the presence of biological agents, and on the climate. Stumps from freshly felled trees could be easily identified, stumps from trees felled 2-3 years ago as well, but the older the stumps, the more difficult is was to estimate the date of felling. Therefore, to estimate the timber extraction only by the stumps, those trees felled up to 20 years ago were considered. The stumps had different heights. Whenever possible, the dbh was measured. When the stumps were less than 1.3m height, the dbh was estimated from the diameter measured at the highest point. On the basis of these measured and estimated dbh values, the volume was calculated in the same way as the volume of standing trees.

On the average for the forest inventoried, approximately 1.28 ± 1.24 m^3/ha/year were extracted — with a 66% confidence interval, if the estimate of the date of felling was accurate. With a 66% confidence interval, the annual amount of extracted timber would be lower than the average annual increment in these forests.

4.1.4 Regeneration

Table 4-4 gives an overview of the average regeneration per ha in the different forest types. Every young tree from 0.5 m height up to 7.9 cm dbh was recorded as regeneration. The birch forests and the mixed spruce forests had the least average regeneration. Regeneration was most abundant in the blue pine forests with oak.

Table 4-4: Regeneration per ha. Young trees of all species from 0.5 m height up to 7.9 cm dbh. Source: forest inventory 1997-98.

Forest type	Number per ha	66% c. interval
Blue pine	14'980	±3'913
Blue pine with oak	46'633	± 20'629
Mixed spruce	7'025	± 2'328
Hemlock	11'053	± 2'399
Hemlock/fir	21'287	± 4'279
Fir	16'503	± 5'132
Birch	2'895	± 2'124
Former agr. land	19'462	± 8'889

4.2 Blue pine forest

4.2.1 Description

The Himalayan Blue Pine—*Pinus wallichiana* A.B. Jackson (*P. excelsa* Wallich ex D.Don, *P. Griffithii* McClell)—is a pine with its needles in clusters of five. It is found from Afghanistan to South-East Tibet [Polunin and Stainton 1997]. In Bhutan, it is commonly found at altitudes ranging from 1'700 m.a.s.l. - 3'300 m.a.s.l. [Grierson and Long 1983]. Blue pine forests are found on dry sites or as secondary forests, since it is a strong pioneer species [Brandis 1906; Champion 1968; Grierson 1983; Troup 1986 (rep.)].

In the forest inventoried, pure blue pine forests represent 14% of the area or 108 ha (see Table 4-1). They are found in the lower part of the forest inventoried. Many blue pine forests were found along the fringes of pastures (in Figure 4-1.: the forests near the South-East ridge and the Khamgi pasture). The remaining blue pine forests were mainly on the southern slope of small ridges.

Two circular indicator plots were measured in the blue pine forests. Both plots were within 15 to 30 minutes walking distance of the settlements. The main characteristics of these two indicator plots are given in Table 4-5. Both indicator plots have a structure corresponding to the average blue pine forest.

Table 4-5: Main characteristics of the indicator plots in the blue pine forests. Source: indicator plot 1997.

Characteristics	Indicator plot 1	Indicator plot 2
altitude	2'875 m.a.s.l.	2'895 m.a.s.l.
exposition	250 g	255 g
slope	35 %	37 %
No. of stems/ha	844	637
Basal area m^2/ha	30	26
Volume m^3/ha	358	282

The two indicator plots show two "pictures" of a blue pine forest. The first picture is one of a single storied blue pine forest, similar to the one presented by the indicator plot 2 in Figure 4-3. These single-storied blue pine forest are mainly young stands which have colonized grass land, but older single storied forests were observed in remote areas or in areas difficult to access. It seems that the single storied blue pine forests are even-aged forests growing under relatively undisturbed conditions or the result of a major disturbance on a relatively large area. Small extractions of timber — similar to a thinning — do not affect the structure. With heavier extractions and increased disturbance, however, the cover of the upper storey is disrupted, creating gaps. Young conifer trees, broadleaved trees, and shrubs fill in the gaps.

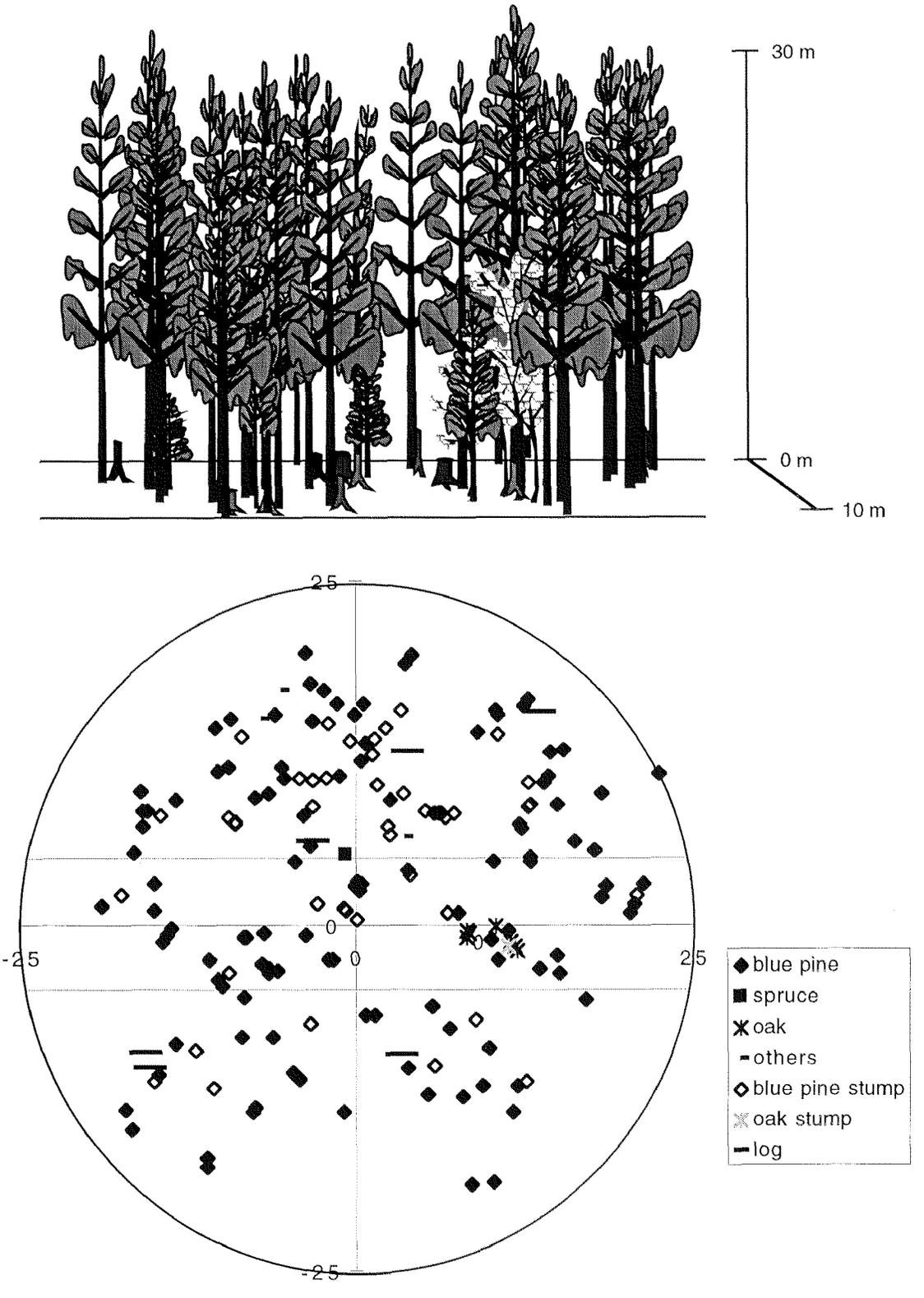


Figure 4-3: Blue pine forest: indicator plot no. 2.

The first indicator plot (see Appendix 2) gives a picture of a relatively more disturbed blue pine forest. Many trees have been removed, creating gaps in which young blue pines and oaks could grow.

4.2.2 Structure

The blue pine forests are almost pure stands of blue pine with few other species mixed in (see Table 4-6). On the average there were 752 stems per ha. The mean basal area was 28.64 m^2/ha and the mean volume 339 m^3/ha. These data are similar to those obtained by Ernst Rohrbach [Rohrbach 1989].

Table 4-6: Composition of the blue pine forest. Number of stems, basal area and volume per ha. The relative importance is given in brackets.
Source: forest inventory 1997-98.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Blue pine	517±68	(69%)	23.54±2.63	(82%)	294±40	(87%)
Hemlock	19±21	(2%)	1.64±3.31	(6%)	22±46	(7%)
Spruce	36±16	(5%)	0.91±0.43	(3%)	10 ± 5	(3%)
Willow/poplar	82±20	(11%)	0.68±0.17	(3%)	4±1	(1%)
Oak	41±35	(5%)	0.93±0.98	(3%)	8±9	(2%)
Other broadl.	21±15	(3%)	0.59±0.51	(2%)	2±4	(<1%)
Rhododendron	36±41	(5%)	0.34±0.36	(1%)	2±2	(<1%)
Total	**752±71**	(100%)	**28.64±2.9**	(100%)	**339±43**	(100%)

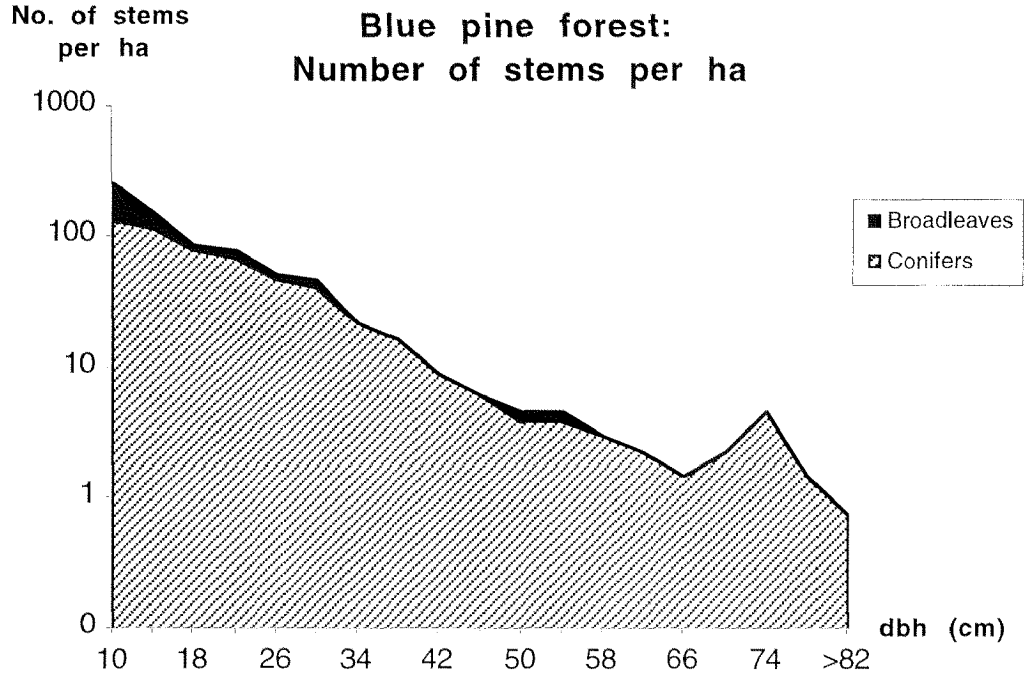


Figure 4-4: Number of stems per by diameter class in the blue pine forests. Source: forest inventory 1997-98.

The curve of the number of stems per diameter class has a hyperbolic shape. With a semi-logarithmic scale, the number of stems per ha decreases regularly with increasing diameter (see Figure 4-4). When compared to a straight descending line, there is a small surplus of conifers with diameters from 68 to 82 cm.

Blue pine is a strong pioneer species. It colonizes abandoned agricultural land within a few years. Such plots, which were located in forests clearly identified as forests on former agricultural land, are treated in a separate chapter (see 4.9 "Former agricultural land").

4.2.3 Stumps and logs

For every plot, details were recorded concerning the stumps and logs lying within the 5 ares of the plot. Table 4-7 shows the number of stumps and logs which were recorded in the blue pine forests. There was on average a total of 79 stumps and 69 logs per ha. There are many causes for the death of a tree: some were felled for various purposes and some died of natural causes. If we consider only the stumps of felled trees, 58 stumps/ha (41 to 75) were counted. This figure shows that the use in blue pine forests is moderate to extensive. They are less exploited than was expected. This fact can be explained by the situation that many parts of the inventoried blue pine forests are on steep slopes and therefore difficult of access. This result, however, is specific for the forest inventoried and cannot be generalised for all the blue pine forests of Bumthang. Indeed, in Bumthang the blue pine forests are mostly easy of access and are therefore intensively used. In total 37m^3/ha of wood in different stages of decay, mainly blue pine, were found lying unused in the forest. 18 m^3/ha of wood were left-overs after the felling of a tree and further 19 m^3/ha of wood were from trees which had died naturally.

In the field, it was determined for what reason a tree was felled or whether it had died naturally. Table 4-8 indicates the number of stumps per ha according to their category. Most of the stumps measured were those of trees which had died naturally. The two main reasons for felling a tree were to obtain firewood (20 stumps per ha), and to obtain poles (nearly 15 stumps per ha).

Table 4-7: Number of stumps and logs per ha by species in the blue pine forests. Source: forest inventory 1997-98.

Species	No. of stumps / ha	No. of logs per ha
Blue pine	64	60
Hemlock	1	1
Spruce	1	4
Oak	5	1
Willow	4	0
Other broadleaves	2	2
Rhododendron sp.	1	1
Total	**79 ± 15**	**69 ± 16**

Torch wood[23] collection caused the death of 8 pines per ha. Three types of death which might occur to a pine tree after torch wood collection were observed. Sometimes the villagers had cut once all around the tree while collecting torch wood. The tree thus is unable to transport water to its crown and dries off. In other cases, the villagers had already collected a large amount of torch wood on a tree. The stem became very slim and finally broke. In a few cases, the tree was relatively small and had proven to contain a large amount of torch wood. Then the tree was felled and transported away.

Table 4-8: Number of stumps per ha by category of elimination in the blue pine forests.
Source: forest inventory 1997-98.

Category of stumps	No. per ha
Natural death	21.5
Fuel wood	20.0
Pole	14.8
Torch wood	8.2
Beam	3.7
Flag pole	3.0
Plank	2.2
Broken accidentally	2.2
Cut for unknown reason	2.2
Fire	1.5
Total	**79.3 ± 15**

On average 2.2 trees per ha were broken accidentally while felling others. The villagers said that it happened frequently when they were given difficult trees to fell. Cutting only one fork of a forked tree was considered as most difficult. 2.2 trees per ha on average were cut for reasons which could not be identified. Both the stump and the tree lying next to it were found.

4.2.4 Regeneration

In the centre of every plot, a sub-plot of 1m radius was defined and the regeneration was counted. Regeneration was defined as any tree species from seedlings taller than 0.50 m height up to trees with a dbh of 7.9 cm. Shrubs were not counted as regeneration.

The regeneration is unequally distributed: 12 sub-plots out of 27 (or 44%) did not have any regeneration. Only when the conditions were favorable did regeneration occur. In the forests inventoried, a frequent limiting factor for the regeneration is the reduced amount of light on the ground, due mainly to the dense bamboo cover and sometimes to the trees as well. On average there were 14'980 ± 3'913[24] young trees of all size categories per ha (see Table 4-9). In the blue pine forests the regeneration was mainly composed of seedlings and

23. Torch wood is wood soaked with resin. It will be presented in detail in6.4.1 "Torch wood".
24. with the 66% confidence interval.

of young trees with a dbh between 1cm and 8cm; less regeneration was found in the category 0.5m to 1.3m height.

Most of the regeneration in the category of less than 0.5m height are blue pines. Fewer blue pines are found in the other two categories. It is, however, difficult to explain the differences between the categories.

The regeneration of the conifers species is shown in Table 4-10. Blue pine is by far the most strongly represented conifer species with 6'016 young trees per ha. Further some hemlock, and a little spruce and fir regeneration was found. In addition, among the broadleaved species, 1'062 ± 705 young oaks per ha were counted. The remaining regeneration is composed of diverse broadleaves species.

Table 4-9: Regeneration in the blue pine forests by size category.
Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	6'016	± 2'232
between 0.5-1.3 m height	2'005	± 964
1≤ dbh< 8 cm	6'959	± 2'757
Total	**14'980**	**± 3'913**

Table 4-10: Regeneration of conifers in the blue pine forests. All conifers from seedlings up to dbh = 7.9 cm were counted as regeneration.
Source: forest inventory 1997-98.

Species	Number per ha	66% c. interval
Blue pine	6'016	± 2'014
Hemlock	1'062	± 569
Spruce	708	± 339
Fir	354	± 190
Total conifer regeneration	**8'139**	**± 2'378**

4.3 Blue pine forest with oak

4.3.1 Description

Only a few pure oak stands were found, predominantly along the river. In contrast, oaks were very commonly mixed with blue pine and sometimes with blue pine and spruce. In this Section, the forests of blue pine with oak comprise both the forests of blue pine with oak and blue pine forests with spruce and oak.

The oak which is found in Bumthang is *Quercus semecarpifolia* Smith. It is an evergreen broadleaved tree up to 30 m height. The young leaves are spinous-dentate, similar to the leaves of *Ilex sp.*, and the older leaves are round and entire. *Q. semecarpifolia* is found

from Afghanistan to S.W. China [Polunin and Stainton 1997] and, in Bhutan, from Thimphu to Trashigang at altitudes ranging from 2'400 m.a.s.l. to 3'200 m.a.s.l. [Grierson and Long 1983]. However single trees (above Dhur) and even a stand (East of Lugirawa) were observed up to 3'400 m.a.s.l.

The blue pine forests with oak are found at a relatively low altitude. They represent around 14% of the forest inventoried (see Table 4-1). This forest type is common mostly on mesic sites, but sometimes also on dry ridges [Champion and Seth 1968]. When found on dry sites, the oaks remain stunted.

Two indicator plots were recorded. The indicator plot no. 3 (see Appendix 3) represents a blue pine forest with oak under disturbed conditions and indicator plot no. 4 (see Figure 4-5) represents a blue pine forest with oak under less disturbed conditions. Table 4-11 indicates the main characteristics of the indicator plots. The indicator plot no. 4 has values comparable to the average of the blue pine forests with oak, but a lower number of stems per ha (see also Table 4-12). The basal area and volume in the indicator plot no. 3 are higher than average, but the number of stems per ha is lower than the average.

Table 4-11: Main characteristics of the indicator plots in the blue pine forests with oak. Source: indicator plot 1997.

Characteristics	Indicator plot 3	Indicator plot 4
altitude	2'840 m.a.s.l.	2'830 m.a.s.l.
exposition	240 g	85 g
slope	30 %	45 %
No. of stems/ha	311	510
Basal area m^2/ha	45	38
Volume m^3/ha	562	461

4.3.2 Structure

The blue pine forests with oak are two-storeyed forests. The upper storey is composed of blue pines and oaks form the lower storey. Exceptionally, oaks can have up to 30 m height. Such heights were measured for some individuals or in a pure oak forest, but commonly the height of oaks was less than that of the blue pines in the blue pine forests with oak.

The ground of the blue pine forests and the blue pine forests with oak is mostly covered with bamboo (except for extremely dry sites, for example on the ridges). The main bamboo species is *Yushania microphylla* and the more rare one, *Arundinaria racemosa*. Both are spreading types of bamboo; *Yushania* has long rhizomes without roots and a hollow rhizome neck, whereas *Arundinaria* has rhizomes rooting at every node. Further *Arundinaria* prefers comparatively drier sites [Stapleton 1994]. Both bamboo types are mostly heavily browsed and hence less than a meter tall. If protected from grazing they can reach a height of 3-4 m, as for example, above the village of Lusbi.

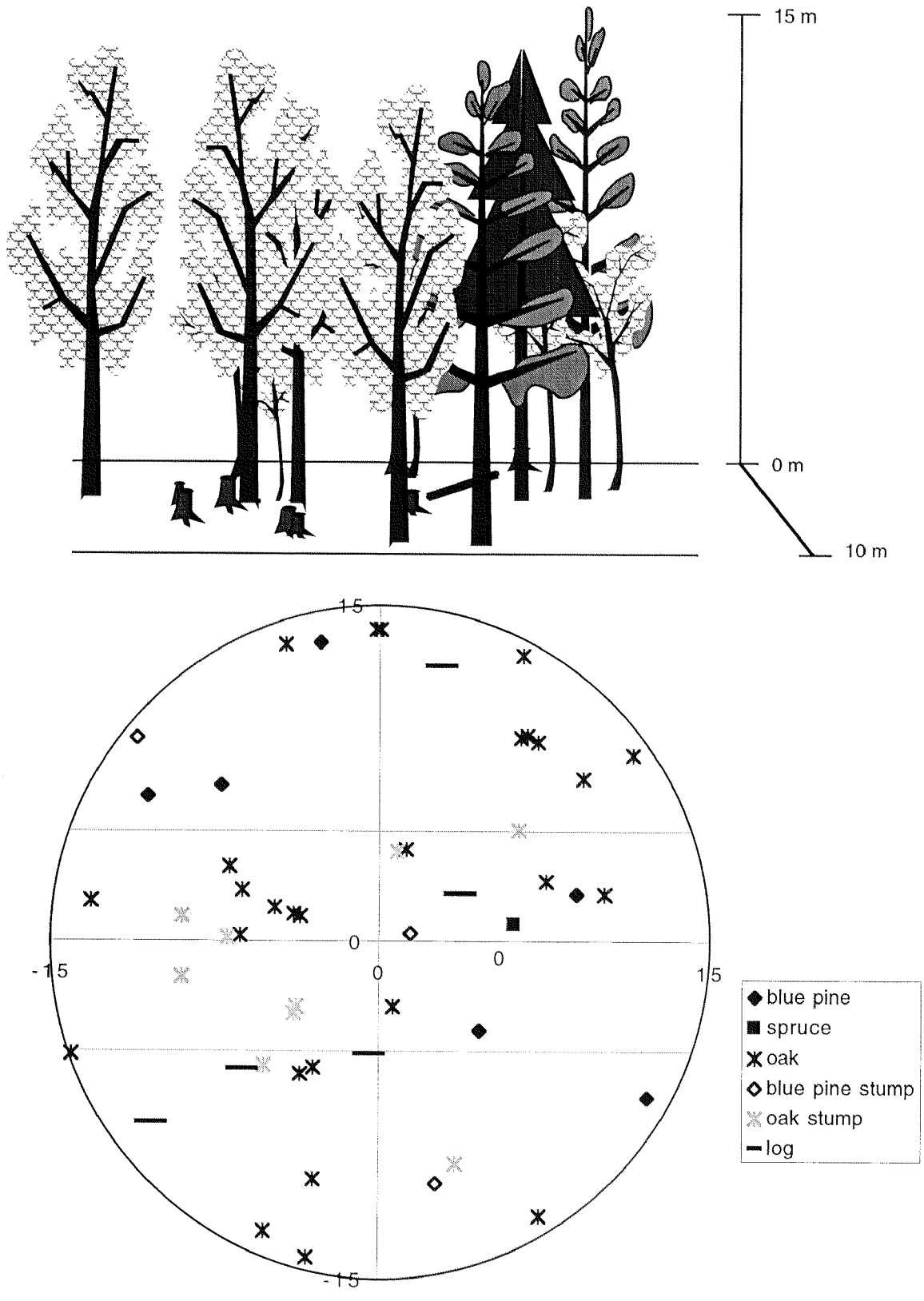


Figure 4-5: Blue pine forest with oak: indicator plot no. 4.

The composition of the blue pine forests with oak is given in Table 4-12. Oak constitutes the largest part of the forest in terms of number of stems per ha, but blue pines form most of the basal area and volume.

The oaks are lopped for fodder and firewood. Therefore many lopped trees can be observed in the forests near footpaths and settlements. Oaks respond very well to coppicing. Even older stumps have been seen to sprout again. Oaks have spreading canopies in the more disturbed stands, but in closed forests they develop longitudinal canopies.

Table 4-12: Composition of the blue pine forest with oak. Number of stems, basal area and volume per ha at the 66% confidence interval. The relative importance is given in brackets. Source: forest inventory 1997-98.
* Yew was found only in one plot, therefore no confidence interval is indicated.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Blue pine	274 ± 47	(29%)	18.7 ± 3	(48%)	274 ± 59	(58%)
Oak	423 ± 55	(45%)	14.0 ± 3.1	(36%)	134 ± 41	(28%)
Spruce	40 ± 15	(4%)	2.4 ± 1.2	(6%)	32 ± 17	(7%)
Other broadl.	59 ± 27	(6%)	1.7 ± 1.3	(4%)	17 ± 13	(4%)
Rhodo.	91 ± 52	(10%)	1.0 ± 0.6	(3%)	5 ± 3	(1%)
Maple	16 ± 9	(2%)	0.3 ± 0.3	(1%)	3 ± 3	(1%)
Willow	12 ± 7	(1%)	0.3 ± 0.3	(1%)	3 ± 4	(1%)
Hemlock	14 ± 11	(2%)	0.3 ± 0.2	(1%)	2 ± 2	(<1%)
Yew	2 *	(<1%)	0.05 *	(<1%)	<1 *	(<1%)
Birch	7 ± 21	(1%)	0.23 ± 0.8	(<1%)	2 ± 6	(<1%)
Total	**937 ± 71**	**(100%)**	**39.0 ± 3.8**	**(100%)**	**471 ± 66**	**(100%)**

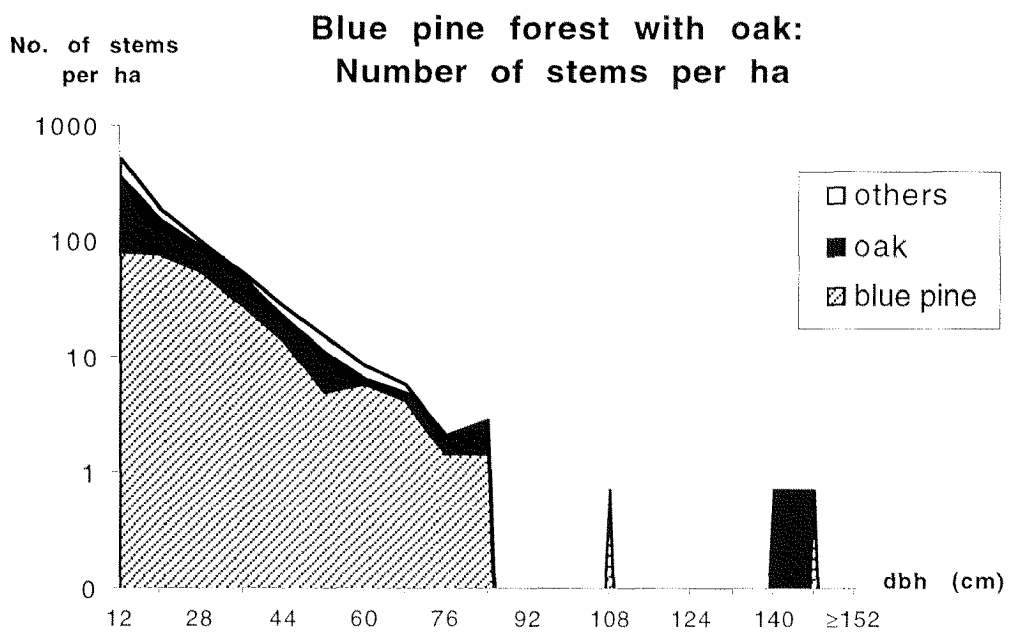


Figure 4-6: Number of stems per by diameter class in the blue pine forests with oak. Source: forest inventory 1997-98.

The distribution of the stems according to their diameter (see Figure 4-6) is similar to that of the blue pine forests. However, as expected, the blue pine forests with oak have a much higher proportion of broadleaves than the pure blue pine forests. Further, an initial deficit of young trees with a dbh<24 cm, compared to an exponentially decreasing distribution, was noticed.

4.3.3 Stumps and logs

281 stumps per ha were counted in the blue pine forests with oak (see Table 4-13). It is the forest type with by far the highest number of stumps per ha. Mainly oaks and blue pines were felled. However, the number of logs of blue pine is higher than that of oak. This can be explained by the fact that oaks are generally of smaller dimensions and felled for firewood. As all the parts of a tree can be used for firewood, the whole tree is removed, whereas blue pines are cut for several reasons and the unused part of the felled tree is left behind in the forest. In all 58m^3/ha of wood, mainly blue pine, were found lying unused in the forest. 10 m^3/ha of wood were left-overs after the felling of a tree and a further 48 m^3/ha of wood were from trees which had died naturally.

The trees were felled mainly for fuel wood (see Table 4-14); indeed about half of the stumps belong to this category. A few young oaks were felled for fodder. In this case, the young trees are left behind in the forest and their leafless branches are spread over the ground. It is, however, unusual that a whole oak tree is felled for fodder. Normally the oak is lopped at regular intervals to obtain the leaves for fodder and the branches for fuelwood.

Table 4-13: Number of stumps and logs per ha by species in the blue pine forests with oaks. Source: forest inventory 1997-98.

Species	No. of stumps / ha	No. of logs / ha
Oak	144	24
Blue pine	106	71
Hemlock	1	1
Spruce	4	7
Maple	1	0
Willow	1	1
Other broadleaves	8	6
Rhododendron sp.	16	10
Total	**281 ± 52**	**120 ± 19**

Sometimes, young blue pines are felled for their inner bark. The young shoot is peeled and the inner bark is eaten. These cases can be easily identified, since the outer peeled-off bark is found near the young felled tree. On average, 3.6 trees per ha were felled to maintain or repair a footpath or bridge. In all these cases a tree from the side of the footpath was chosen and felled. The wood was then cut to the right dimension and shape. The distance between the tree to be felled and the place at which it was needed was always very short. It was easy to recognise which plank or pole had been processed from the felled tree.

Table 4-14: Number of stumps per ha by category of elimination in the blue pine forests with oak.
Source: forest inventory 1997-98.

Category of stumps	No. per ha
Fuel wood	147.9
Pole	45.0
Natural death	38.6
Beam	19.3
Cut for unknown reason	9.3
Plank	5.0
Broken accidentally	4.3
Fodder	3.6
Bridge or footpath maintenance	3.6
Inner bark	2.1
Walking stick	1.4
Flag pole	0.7
Plough	0.7
Total	**281.4 ± 52**

4.3.4 Regeneration

Regeneration is very abundant in the blue pine forests with oak. Indeed there are 46'633 ± 20'629 young trees per hectare (see Table 4-15). The relatively high number of young trees is possibly a consequence of the higher intensity of logging in these forests. Through the selective felling of trees, the canopy is opened and more light reaches the ground, thus favoring the regeneration.

Table 4-15: Regeneration in the blue pine forests with oak by size category.
Source: forest inventory 1997-98.

Size	Number per ha	66% c.interval
Less than 0.5 m height	22'862	± 8'496
between 0.5-1.3 m height	15'355	± 11'553
dbh between 1 - 7.9 cm	8'417	± 2'880
Total	**46'633**	**± 20'629**

In Table 4-16 the conifer regeneration per ha is shown. Blue pine has the largest share with about 65% of the total regeneration and 85% of the conifer regeneration. Among the conifer regeneration, some young hemlocks, fir and spruces were measured. Spruce was found more sporadically, hence its high relative standard error. Furthermore 4'322 ± 2'687 oaks (at a 66% confidence interval) were counted per ha.

Table 4-16: Regeneration of conifers in the blue pine forests with oak.
source: forest inventory 1997-98.

Species	Number per ha	66% c. interval
Blue pine	30'596	± 16'717
Hemlock	7'279	± 2'474
Fir	910	± 683
Spruce	114	± 113
Total conifer regeneration	**35'942**	**± 19'922**

Blue pine is predominant in almost every size category, except in the dbh category between 1 cm and 7.9 cm, where a strong oak regeneration dominates. Both oak and blue pine are light-demanding species. Hence this figure confirms the impression that blue pine forests with oak are more disturbed. The changes in the oak regeneration might have different reasons: the occurrence of a seed year or the amount of light on the ground or the presence or absence of a larger opening. Little is known about *Quercus semecarpifolia*: its ecology, growth or, for instance, whether it is a more light-demanding species than blue pine. The ecology of oak requires further investigation.

4.4 Mixed spruce forest

4.4.1 Description

The East Himalayan spruce, *Picea spinulosa Griff.*, is the tallest conifer in Bumthang. It can reach up to 60 m in height. This tree is indigenous to Sikkim and Bhutan [Troup, 1986 (rep) #144]. It is abundant in Bhutan throughout the central part of the country between 2'400 m.a.s.l. and 3'600 m.a.s.l. [Grierson and Long 1983]. In the research area the spruce was found on mesic to moist sites. Indeed, Troup [1986 (rep.)] noticed that spruce is absent in the dry valleys of the inner Himalaya. Spruce was rarely found in pure stands, but usually mixed with blue pine or hemlock. Spruce might also be a pioneer species, especially at relatively higher altitudes, but is less extreme than blue pine [Rosset 1998].

Three different types of spruce forest were recorded: spruce forests[25] (13 plots), spruce mixed with blue pine (12 plots) and spruce mixed with blue pine and hemlock (9 plots). All of these types were found with or without an undergrowth of oak. Since these three types present strong similarities, they were grouped as "mixed spruce forests". These different types of spruce forest represent some 17% of the forest inventoried. They are mainly present around the Khamgi pasture, around the pasture behind the ridge, on the heavily grazed slope above Lusbi, and on North to North-East exposed slopes. Thus their presence around the pasture gives the impression that spruce forest appears at relatively higher

25. Spruces were rarely found in pure stands. "Spruce forest" is defined here as forest with an upper layer composed of 75% or more spruces.

altitudes — above the natural distribution zone of blue pine — under disturbed conditions, probably due to grazing. This question needs further investigation.

4.4.2 Structure

The mixed spruce forests tend to be single-storeyed forests. Mostly the spruce is mixed with other conifers (blue pine and/or hemlock). The upper storeys of these forests often reach 40 to 45 m, but single spruces were measured with a height of 50 m.

About one third of the spruce forests contained oak. In these cases the forest had two layers, the oak forming the middle storey.

On average, the mixed spruce forests had nearly 700 stems per ha, a basal area of 39 m^2/ha and a volume of 550 m^3/ha (see Table 4-17). The importance of the other conifer species can be seen in this table: there are nearly as many blue pines as spruces. However, spruces tend to be bigger than blue pines. The rhododendrons occur fairly often in these forests.

Table 4-17: Composition of the mixed spruce forest. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.
* Junipers and firs were found only in one plot, therefore no confidence interval is indicated.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Spruce	99 ± 10	(14%)	12.7 ± 2.2	(33%)	225 ±53	(41%)
Blue pine	90 ± 21	(13%)	8.1 ± 2.1	(21%)	134 ±45	(25%)
Hemlock	54 ± 19	(8%)	8.2 ± 6.3	(21%)	114 ±97	(21%)
Other broadl.	97 ± 31	(14%)	1.7 ± 0.5	(5%)	14 ±3	(3%)
Oak	42 ± 18	(6%)	1.9 ± 0.9	(5%)	17 ±8	(3%)
Rhodo.	149 ± 56	(21%)	2.1 ± 0.8	(5%)	10 ±4	(2%)
Maple	44 ± 23	(6%)	1.4 ± 0.8	(4%)	12 ±7	(2%)
Birch	23 ± 12	(3%)	1.2 ± 1.0	(3%)	10 ±10	(2%)
Willow/poplar	97 ± 45	(14%)	1.2 ± 0.5	(3%)	8 ±3	(1%)
Juniper	1 *	(<1%)	0.07 *	(<1%)	1 *	(<1%)
Fir	3 *	(<1%)	0.23 *	(<1%)	3 *	(<1%)
Total	**699 ± 58**	**(100%)**	**38.6 ± 6.1**	**(100%)**	**548 ±113**	**(100%)**

The graph of the number of stems according to the diameter class is shown in Figure 4-7. The trees are bigger than in the two first forest types, the curve therefore is flatter. Between 8 cm dbh and 30 cm dbh, the number of conifers per diameter class is more or less constant. Compared to a negative exponential distribution, there would be a deficit of young conifer trees in these size categories.

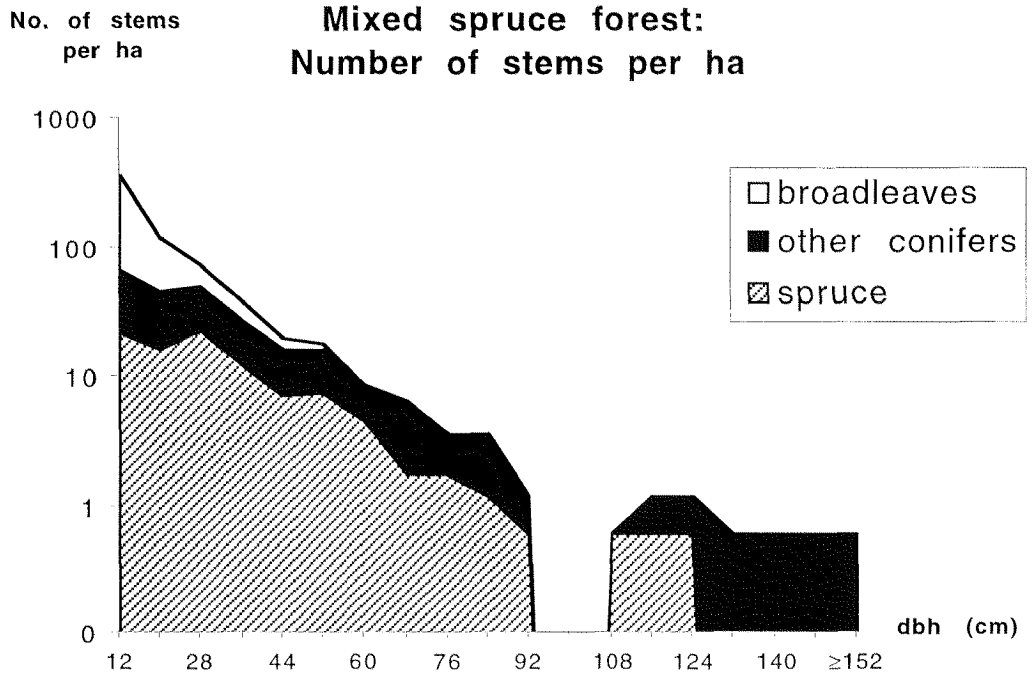


Figure 4-7: Number of stems per by diameter class in the mixed spruce forests. Source: forest inventory 1997-98.

4.4.3 Stumps and logs

On average 82 stumps and 77 logs per hectare of mixed spruce forest were found (see Table 4-18). The most intensively used species remains blue pine with approximately one third of the number of stumps. Spruce and hemlock are comparatively less used. Also most of the logs were from felled blue pine trees. This indicates that many parts of blue pine had been found not worth transporting away. When considering the volume of wood left in the forest, a total of 54 m^3/ha of wood was measured, mainly from spruce, hemlock and blue pine. 6 m^3/ha of wood, mainly from hemlock, were left in the forest after felling.

Table 4-18: Number of stumps and logs per ha by species in the mixed spruce forests. Source: forest inventory 1997-98.

Species	No. of stumps /ha	No. of logs /ha
Blue pine	28	31
Spruce	10	12
Hemlock	6	11
Oak	5	1
Maple/willow/birch	9	11
Other broadleaves	11	4
Rhododendron sp.	12	5
Total	**82 ± 14**	**77 ± 10**

These forests seem less intensively used. Indeed, more than half of the trees in the mixed spruce forest had died naturally (see Table 4-19). Only around 35 trees per ha were felled. The uses are diverse, fuelwood and poles being the main ones. Furthermore, some trees were cut to process planks for the maintenance of a bridge or to improve a footpath in marshy areas.

Table 4-19: Number of stumps per ha by category of elimination in the mixed spruce forests.
Source: forest inventory 1997-98.

Category of stumps	No. per ha
Natural death	47.1
Fuel wood	12.9
Pole	5.9
Cut for unknown reason	5.9
Bridge or footpath maintenance	3.5
Plank	1.8
Inner bark	1.8
Beam	1.2
Fire	0.6
Shingles	0.6
Walking stick	0.6
Total	**81.8 ± 14.3**

4.4.4 Regeneration

The regeneration is less abundant in this forest type compared to the first two (see Table 4-20). More than half of the regeneration comprises seedlings. Only a few young trees were found in the category 0.5 m to 1.3 m height.

Table 4-20: Regeneration in the mixed spruce forests by size category.
Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	4'496	± 1'834
between 0.5-1.3 m height	468	± 273
1≤ dbh< 8 cm	2'061	± 1'246
Total	**7'025**	**± 2'328**

The bulk of the regeneration is found with rhododendron species: in the category 0.5 m to 1.3 m height, they represent almost 90% of the regeneration! Rhododendron is also dominant in the category 1≤ dbh< 8 cm. Blue pines are present only in this class. The presence of blue pine regeneration could indicate that there had been a disturbance in one or several spruce forest patches in the recent past, resulting in enough light to favor the regeneration of blue pine.

Spruce is present in the first two categories and hemlock only as seedlings.
In all 3'372 young conifer trees per hectare were counted (see Table 4-21). Spruce represents nearly two thirds of the conifer regeneration and hemlock a little less than one third.

Table 4-21: Regeneration of conifers in the mixed spruce forests.
Source: forest inventory 1997-98.

Species	Number per ha	66% c. interval
Spruce	1'967	± 1'671
Hemlock	1'030	± 511
Blue pine	375	± 217
Total conifer regeneration	**3'372**	**± 1'671**

4.5 Hemlock forest

4.5.1 Description

The Himalayan hemlock, *Tsuga dumosa* (d. Don) Eichler, is a large evergreen conifer tree with pyramidal shape. Its branches are spreading horizontal to pendulous. This tree attains the largest diameters. In the present study and in long-term observation plots in Bumthang, hemlock with a dbh of 194 cm were measured [Giesch 1993; Rosset 1998].

The Himalayan hemlock is found in Uttar Pradesh, Bhutan and Myanmar [Polunin and Stainton 1997]. In Bhutan it is found commonly at altitudes from 2'400 m.a.s.l. up to 3'300 m.a.s.l. It mainly occurs on moist to humid sites and is completely absent on dry sites. Hemlock forms extensive pure stands or is mixed with fir [Grierson and Long 1983]. In the forests inventoried, pure hemlock forest was frequently encountered in wet and marshy areas.

In the areas examined, pure hemlock forests represented 17% of the forests. The forests of hemlock mixed with fir are presented in Section 4.7 "Mixed hemlock and fir forest". The pure hemlock forests were found on humid to wet soil, often along small streams. They were concentrated in the middle altitudinal zone of the forest inventoried.

Two indicator plots were measured (see Figure 4-8 and Appendix 4). Both indicator plots have a lower number of stems per ha than the average stem number per ha of the inventory (see Table 4-22). Indicator plot 5 also has a lower basal area and volume per ha. The figures for indicator plot 6 are slightly higher than the averages of the inventory. In these forests, where the trees reach large dimensions, it was difficult to measure an inventory plot with the same characteristics as the average forest. The presence or absence of a single big tree in the inventory plot changes the figures radically[26].

26. Indeed a hemlock of 100 cm dbh has a volume of 12.6 m^3 and one of 200 cm dbh, 65.5 m^3.

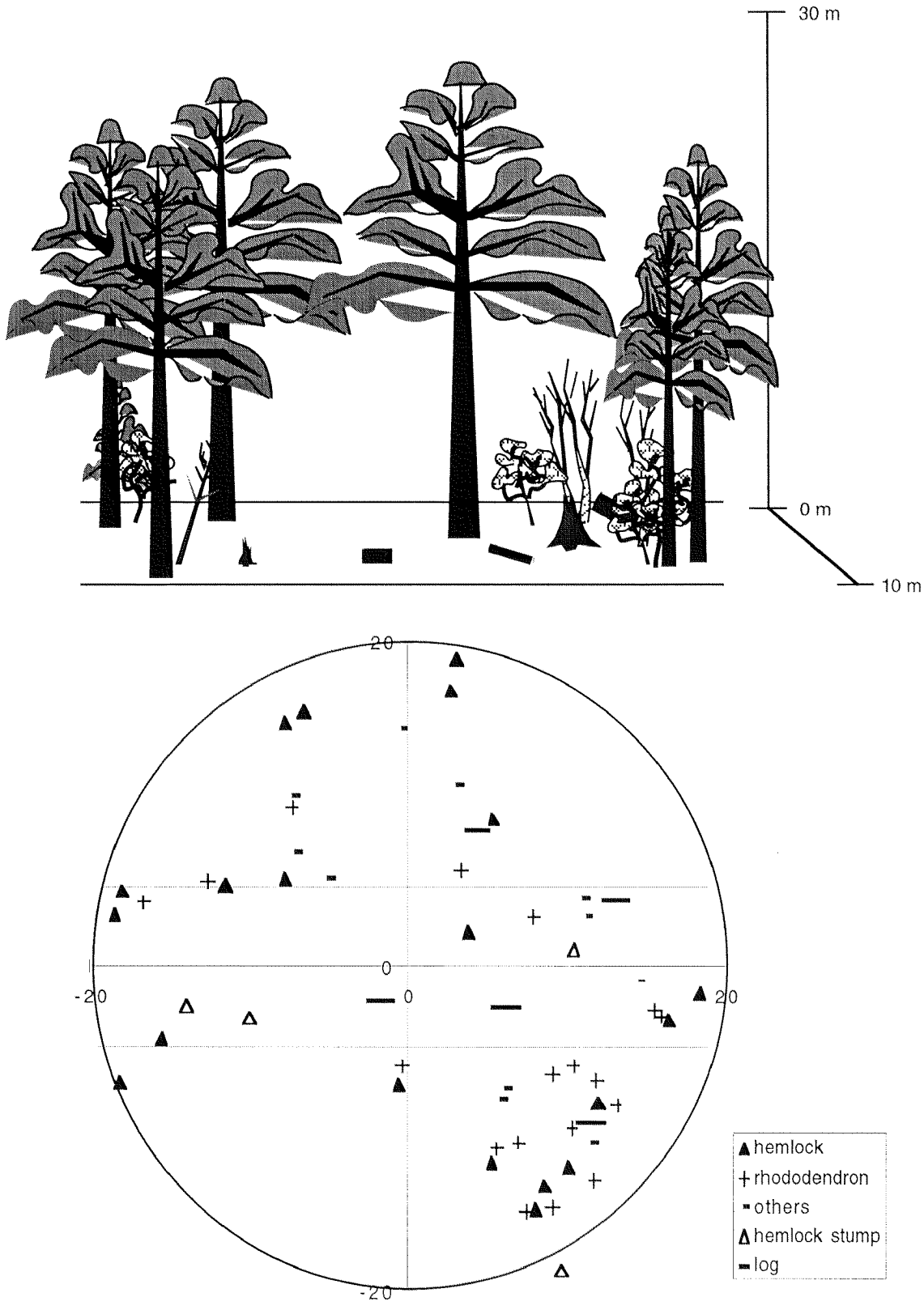


Figure 4-8: Hemlock forest: indicator plot no. 6.

Table 4-22: Main characteristics of the indicator plots in the hemlock forests. Source: indicator plot 1997.

Characteristics	Indicator plot 5	Indicator plot 6
altitude	3'210 m.a.s.l.	3'275 m.a.s.l.
exposition	100 g	30g
slope	40 %	60 %
No. of stems/ha	580	366
Basal area m^2/ha	57	78
Volume m^3/ha	817	1'211

4.5.2 Structure

The hemlock forests are multi-storeyed. On average, the hemlock forests had 716 trees per ha, a basal area of 73 m^2/ha and a volume of 1080 m^3/ha (see Table 4-23).

The upper layer formed by mature hemlocks is dominant. It is composed almost exclusively of hemlock; only few spruces, blue pines or firs were recorded. The middle layer contains medium-sized, future upper layer, hemlocks. The lower layer is formed mainly by rhododendron and maple, some other broadleaves (mostly *Enkianthus deflexus*), bamboo, and hemlock regeneration. Maple is usually a little taller than rhododendron and other broadleaves.

Table 4-23: Composition of the hemlock forest. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.
* Yew, willow and poplar were found only in one plot, therefore no confidence interval is indicated here.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Hemlock	180 ± 27	(25%)	52.1 ± 6.4	(71%)	814 ± 111	(76%)
Fir	10 ± 6	(2%)	4.2 ± 2.8	(6%)	70 ± 52	(7%)
Maple	127 ± 21	(18%)	4.7 ± 1.1	(6%)	42 ± 12	(4%)
Spruce	14 ± 5	(2%)	3.9 ± 2.5	(5%)	71 ± 51	(7%)
Rhododendron	282 ± 47	(39%)	3.5 ± 0.5	(5%)	16 ± 2	(2%)
Blue pine	10 ± 7	(2%)	2.1 ± 2.2	(3%)	40 ± 56	(4%)
Birch	22 ± 14	(3%)	1.1 ± 0.9	(2%)	10 ± 9	(<1%)
Oak	10 ± 9	(1%)	0.7 ± 1.2	(1%)	7 ± 15	(<1%)
Other broadl.	59 ± 16	(8%)	0.9 ± 0.3	(1%)	7 ± 2	(<1%)
Yew	1 *	(<1%)	0.01 *	(<1%)	<1 *	(<1%)
Willow/poplar	2 *	(<1%)	0.03 *	(<1%)	<1 *	(<1%)
Total	**716 ± 68**	**(100%)**	**73.3 ± 7.3**	**(100%)**	**1'079±133**	**(12%)**

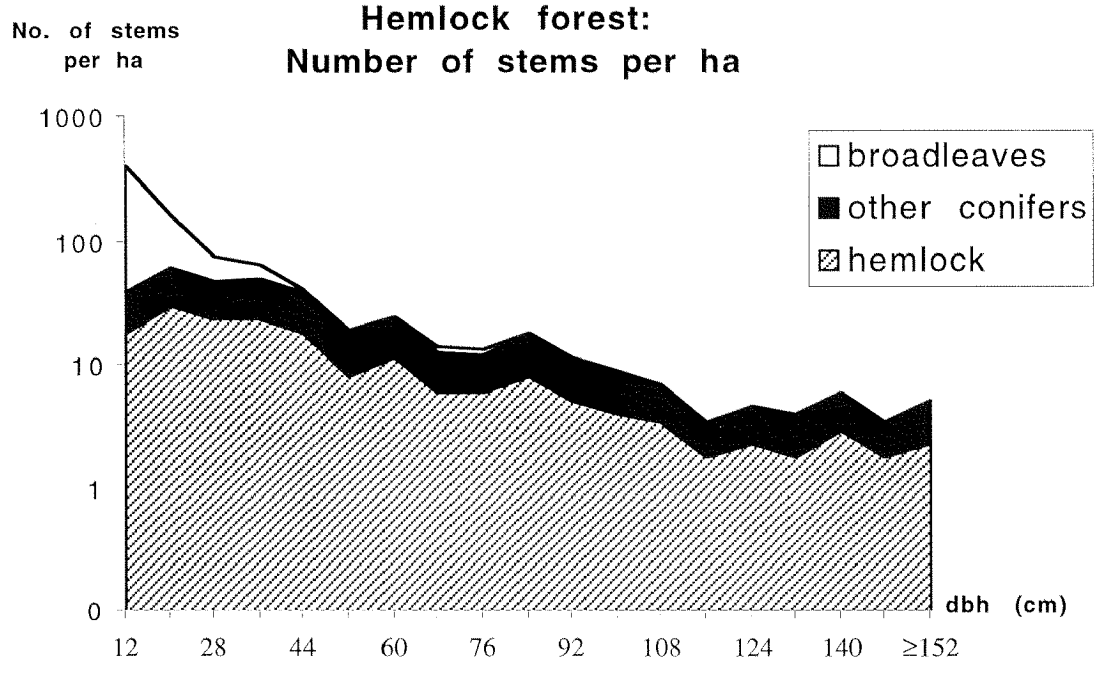


Figure 4-9: Number of stems per by diameter class in the hemlock forests. Source: forest inventory 1997-98.

A characteristic of the hemlock forest is the presence of a giant bamboo species, *Borinda grossa,* in the lower layer. This bamboo grows in clumps and can be up to 10 m tall and up to 4.5 cm in diameter [Stapleton 1994]. It is certainly the most important NWFP (Non Wood Forest Product) in the temperate zone of Bhutan.

The distribution of stems per diameter category is shown in Figure 4-9. The graph differs considerably from those of the previous presented forest types (blue pine, blue pine with oak, spruce). Two basic remarks can be made: the trees reach a bigger dbh, up to nearly 2 m in diameter, and the line is much "flatter". As Bürgi et al. described, this line is actually composed of two curves [Bürgi, Rinchen et al. 1992]. The first curve is that of the conifers. It is nearly horizontal: there are almost the same number of trees in all diameter categories. The second curve is the one of broadleaves. It is exponential or, as semi-logarithmic scale, a strait descending line.

4.5.3 Stumps and logs

In total 144 stumps and 124 logs per ha were counted in the hemlock forests (see Table 4-24). Rhododendron accounts for the highest number of stumps. A relatively high number of hemlock stumps and logs was recorded. However, only a small proportion of these hemlocks was felled and most of them died naturally.

Table 4-24: Number of stumps and logs per ha by species in the hemlock forests. Source: forest inventory 1997-98.

Species	No. of stumps/ha	No. of logs/ha
Hemlock	41	83
Blue pine	6	4
Fir, spruce	3	5
Rhododendron sp.	71	9
Maple/willow/birch	17	19
Other broadleaves	6	4
Total	**144 ± 42**	**124 ± 83**

Considering only the trees felled by the villagers, an average of 81 (± 40 at a 66% confidence interval) stumps per ha was measured. Thus the hemlock forests are used moderately to intensely. The high relative standard error indicates that the number of stumps per ha differ considerably from one plot to the other. Indeed the intensity of the use is very different between the plots: felled trees were recorded in only 9 of the 30 plots!

As seen above, hemlock forests are often located on very wet soil. Moreover cliffs, rocks and steep slopes were repeatedly found in these forests during the inventory. Consequently, access to most hemlock forests is not easy. On the other hand, the villagers frequently go to some hemlock forests to collect bamboo (*Borinda grossa*, Bumthangkha: rû). A few footpaths lead to the favorite bamboo collecting places, rendering these parts of the hemlock forests accessible. The forest around the bamboo collecting places is intensively used, whereas large tracts of hemlock forest remain unused due to difficult access.

Table 4-25: Number of stumps per ha by category of elimination in the hemlock forests. Source: forest inventory 1997-98.

Category of stumps	No. per ha
Fuel wood	65.9
Natural death	62.9
Pole	7.6
Fire	2.4
Shingles	1.8
Bridge or footpath maintenance	1.2
To carry bamboo	0.6
Plough	0.6
Beam	0.6
Total	**143.5 ± 41.9**

On average, 65.9 trees per ha were felled for fuel wood (see Table 4-25). This is by far the main use made of trees in the hemlock forest. The second most important category is that of trees which had died naturally, comprising 62.9 stumps per ha. The other uses together account for 14.8 stumps per ha. In these forests 0.6 trees per ha were cut to transport bamboo. Bamboo is tied in pairs to a slim pole. The slim pole is fastened with a rope, which usually is made out of young bamboo shoots, to the shoulders of a villager. The whole is then pulled to the village.

4.5.4 Regeneration

On average 11'053 young trees were recorded per ha (see Table 4-26). The seedlings were numerous and the small trees with a dbh between 1 and 7.9 cm were well represented. Yet trees are almost lacking in the category "0.5 m to 1.3 m height".

Table 4-26: Regeneration in the hemlock forests by size category.
Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	6'744	± 1'595
between 0.5-1.3 m height	94	± 94
1≤ dbh< 8 cm	4'215	± 1'531
Total	**11'053**	**± 2'399**

As in the mixed spruce forest, the bulk of the regeneration is formed by rhododendron species. Rhododendron regeneration represents 100% of the regeneration in the category 0.5 m to 1.3 m height, approximately 95% of the regeneration in the category dbh between 1 cm and 7,9 cm and nearly 50% of the seedlings (less than 0.5 m height). The greatest variety of species was found among the seedlings. In contrast, in the other categories, besides the massive presence of rhododendron, only a few hemlock and maple were recorded.

2'154 young conifer per has were measured on average (see Table 4-27). The regeneration of conifers in the hemlock forests is thus comparatively low. The regeneration of conifers is mainly composed of young hemlock. A few firs and spruces were also recorded.

Table 4-27: Regeneration of conifers in the hemlock forests.
Source: forest inventory 1197-98.

Species	Number per ha	66% c. interval
Hemlock	1'405	± 600
Fir	468	± 265
Spruce	281	± 203
Total conifer regeneration	**2'154**	**± 593**

4.6 *Fir forest*

4.6.1 Description

The East Himalayan fir, *Abies densa* Griff., is a large evergreen tree up to 40 m in height. It is found from east Nepal to south-east Tibet [Polunin and Stainton 1997]. In Bhutan, it forms extended forests between 3'000 m.a.s.l. and 4'000 m.a.s.l. It appears in pure stands or, at lower altitudes, mixed with hemlock and at higher altitudes it becomes stunted and mixed with juniper [Grierson and Long 1983]. In many regions of Bhutan fir is at the upper timber line.

In the inventoried area above 3'400 m.a.s.l. fir forest covers the whole slope, interrupted only by patches of birch forests. The fir forests themselves are constituted of a mosaic of stands in different development stages. 38 plots were recorded in this forest, representing 152 ha or 19% of the forest inventoried.

For the two indicator plots recorded in the fir forests (see Figure 4-10 and Appendix 5) the same problems were encountered as those in the hemlock forest. The figures for the number of stems, basal area, and volume are lower than the average for the whole forest (see Table 4-28 and Table 4-29). Indicator plot 7 is closest to the average, but it has a less developed layer of rhododendron.

Table 4-28: Main characteristics of the indicator plots in the fir forests.
Source: indicator plot 1997.

Characteristics	Indicator plot 7	Indicator plot 8
altitude	3'760 m.a.s.l.	3'600 m.a.s.l.
exposition	55 g	70g
slope	50 %	30 %
No. of stems/ha	709	438
Basal area m^2/ha	41	70
Volume m^3/ha	452	1'058

4.6.2 Structure

The structure of fir forests is similar to that of hemlock forests. A few big trees occupy the upper layer and the lower layer is characterised by rhododendron and maple, birch forming an intermediate layer.

On average 1'028 stems per ha were recorded (see Table 4-29), conifers constituting only around 14%. It is characteristic for these forests to have a dense undergrowth of rhododendron (39% of the stems) and maple (29%).The extremely high mean basal area and volume per ha is due to the firs. Indeed, they form 70% of the basal area and 80% of the volume. The fir forests in the neighboring valley were described by Bürgi et al. [Bürgi, Rinchen et al. 1992]. These show higher numbers of stems per ha and lower basal areas per ha. The results, however, are not statistically different from those of the fir forests presented here.

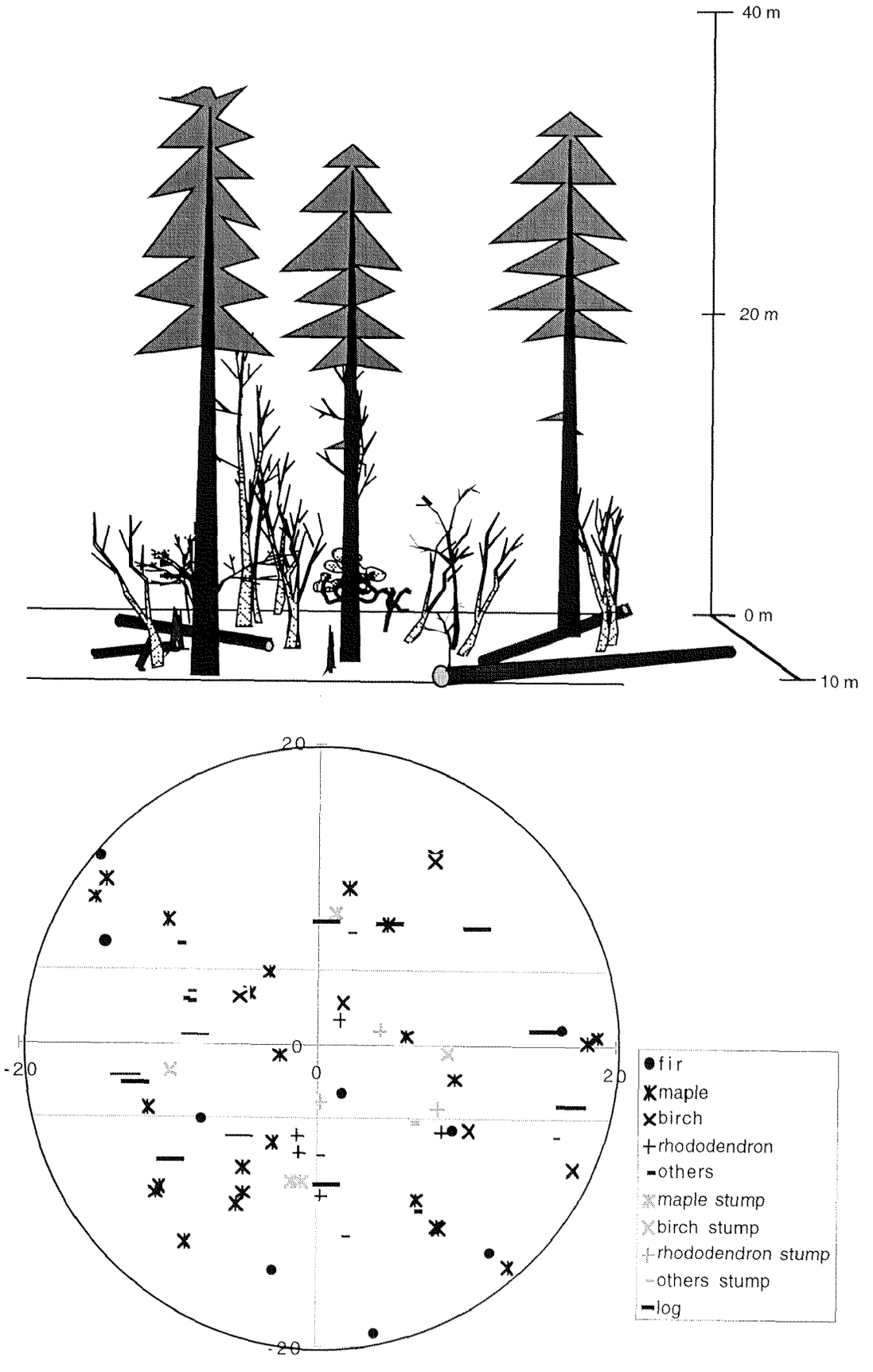


Figure 4-10: Fir forest: indicator plot no. 7.

Table 4-29: Composition of the fir forest. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.
* Blue pine, yew, willow and poplar were found only in one plot, therefore no confidence interval is indicated.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Fir	124 ± 9	(12%)	75.1 ± 6.6	(70%)	1'254 ± 116	(81%)
Birch	117 ± 18	(12%)	9.3 ± 1.3	(9%)	93 ± 13	(6%)
Maple	297 ± 33	(29%)	9.2 ± 1.1	(8%)	76 ± 10	(5%)
Rhododendron	398 ± 42	(39%)	8.3 ± 1.1	(8%)	42 ± 6	(3%)
Hemlock	13 ± 5	(1%)	4.0 ± 2.2	(4%)	65 ± 46	(4%)
Other broadl.	75 ± 24	(7%)	1.5 ± 0.4	(1%)	12 ± 3	(1%)
Willow/poplar	3 *	(<1%)	<1 *	(<1%)	<1 *	(<1%)
Blue pine	2 *	(<1%)	<1 *	(<1%)	<1 *	(<1%)
Yew	1 *	(<1%)	<1 *	(<1%)	<1 *	(<1%)
Total	**1'028 ± 64**	**(100%)**	**107.6 ± 7.4**	**(100%)**	**1'543 ± 122**	**(100%)**

The distribution of the number of stems by diameter class is similar to that of the hemlock forest (see Figure 4-11). It can be also understood as two superimposed lines: one straight downward line for the broadleaves and a horizontal one for the conifers. There are only a few young firs in this forest type. The majority of the firs are medium-sized: the mean diameter of the firs in the inventory plots was 90 cm dbh and the biggest fir had a dbh of 164 cm.

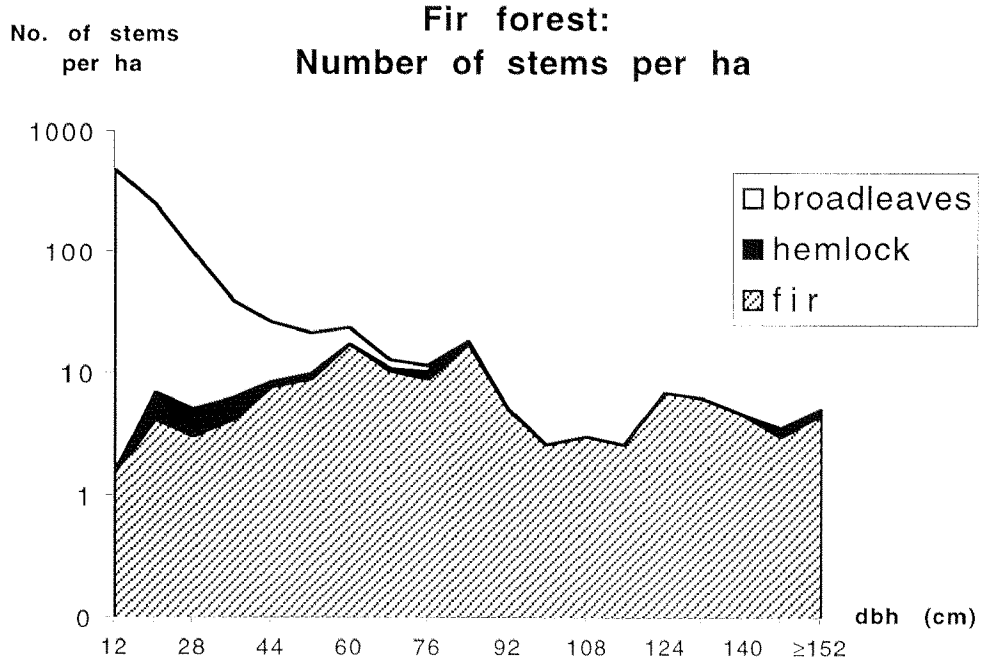


Figure 4-11: Number of stems per by diameter class in the fir forests. Source: forest inventory 1997-98.

4.6.3 Stumps and logs

On average 84 stumps and 199 logs were measured in the fir forests (see Table 4-30). The great majority of these trees had died naturally (see Table 4-31). In fact only 17 trees per ha were felled. A small number of trees were felled for fuel wood or for shingles. The use of fir forests is therefore very low compared to the forest types previously presented.

Table 4-30: Number of stumps and logs per ha by species in the fir forests. Source: forest inventory 1997-98.

Species	No. of stumps/ha	No. of logs/ha
Fir	37	57
Hemlock	1	6
Birch	7	17
Maple	15	18
Rhododendron sp.	20	17
Other broadleaves	4	3
Total	**84 ± 10**	**119 ± 14**

Table 4-31: Number of stumps per ha by category of elimination in the fir forests. Source: forest inventory 1997-98.

Category of stumps	No. per ha
Natural death	67.4
Fuel wood	5.8
Shingles	4.7
Pole	3.7
Fire	2.1
Plank	0.5
Total	**84.2 ± 10.4**

4.6.4 Regeneration

In total, regeneration is relatively abundant in the fir forests: 21'287 young trees were recorded per ha on the average. Regeneration was found in two thirds and fir regeneration in one third of the plots. Most of the regeneration were seedlings. The category of young trees between 0.5 and 1.3 m height is the least represented. 4'190 young trees with a diameter between 1 cm and 7.9 cm on average were measured.

Most young trees were rhododendrons. Further many maples were recorded, but only few birches and other broadleaves. The only conifer for which regeneration was found was fir: 6'286 (± 2'387 for a 66% confidence interval) young firs per ha were measured. Most of these young firs were seedlings.

Table 4-32: Regeneration in the fir forests by size category.
Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	16'007	± 3'917
between 0.5-1.3 m height	1'090	± 469
1≤ dbh< 8 cm	4'190	± 1'515
Total	**21'287**	**± 4'279**

4.7 Mixed hemlock and fir forest

4.7.1 Description

The mixed hemlock and fir forests are situated between the hemlock forests at medium altitudes (approx. 3'200-3'400 m.a.s.l.) and the fir forests at higher altitudes. It seems that the mixed hemlock and fir forests constitute a transition zone between the two forest types [Champion 1968; Grierson 1983; Troup 1986 (rep.)].

11 plots were recorded in the mixed hemlock and fir forests, which represent 44 ha or 6% of the forests inventoried.

The characteristics of the indicator plot (see Figure 4-12 and Table 4-33) conform with the average of the forest inventoried, except for the number of stems. The number of trees in the indicator plot was 484 trees per ha, the basal area to 90.3 m^2/ha and the volume to 1445 m^3/ha.

Table 4-33: Main characteristics of the indicator plots in the mixed hemlock and fir forests.
Source: indicator plot 1997.

Characteristics	Indicator plot 9
altitude	3'495 m.a.s.l.
exposition	95 g
slope	15 %
No. of stems/ha	484
Basal area m^2/ha	90
Volume m^3/ha	1'445

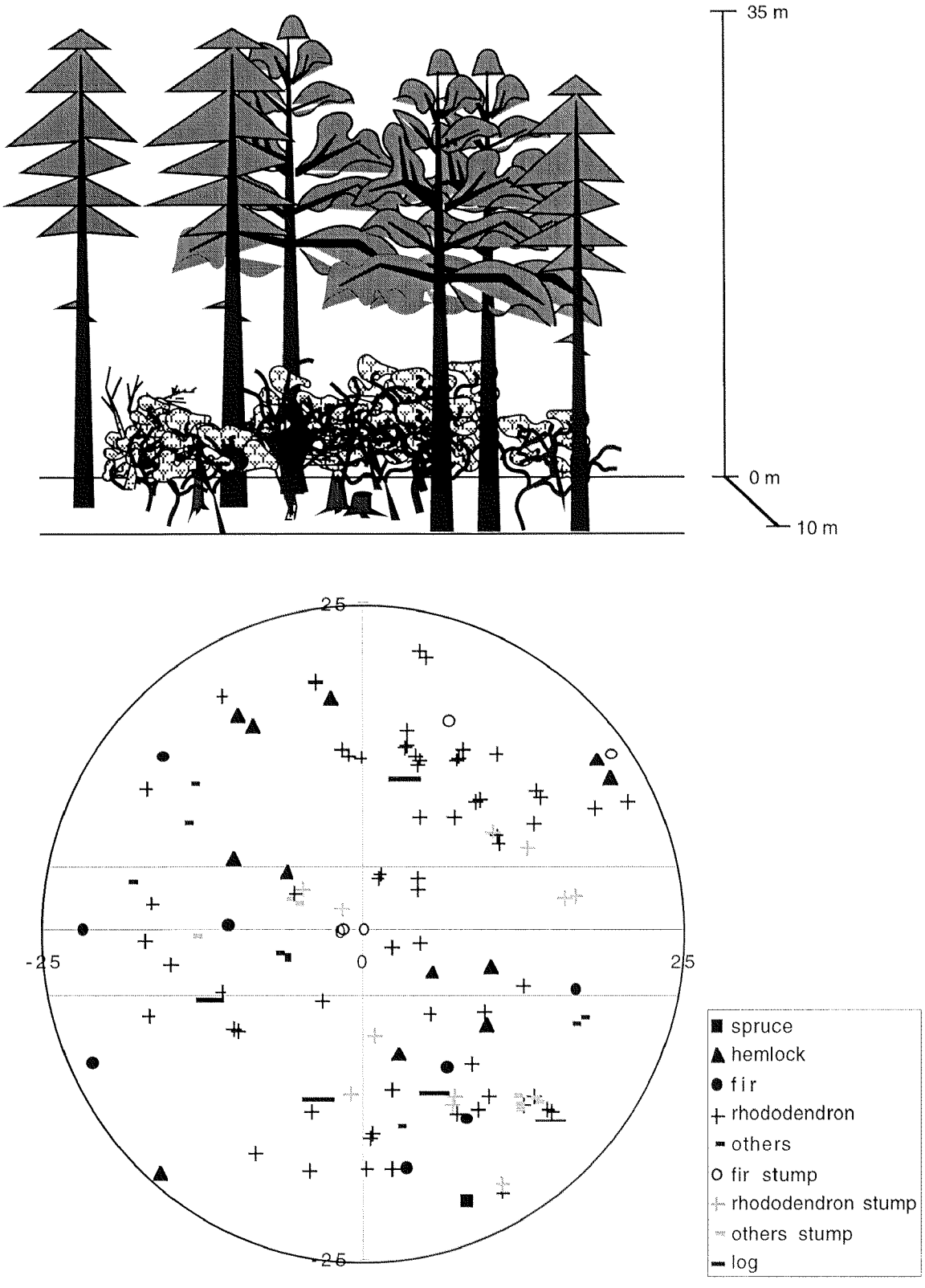


Figure 4-12: Mixed hemlock and fir forests: indicator plot no. 9.

4.7.2 Structure

The structure of the mixed hemlock and fir forests is similar to that of the fir forests. Indeed the mean number of stems per ha was 865, the mean basal area 102.8 m^2/ha, and the mean volume 1'580 m^3/ha (see Table 4-34). The presence of hemlock—equal in number to the firs—is the main difference between the two forest types. Among the other broadleaves mainly *Enkianthus deflexus* and *Symplocos paniculata* were found.

Table 4-34: Composition of the mixed hemlock and fir forests. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Fir	111 ± 17	(13%)	49.4 ± 10.75	(48%)	818 ± 187	(44%)
Hemlock	113 ± 22	(13%)	42.0 ± 8.07	(41%)	688 ± 143	(52%)
Rhododendron	320 ± 60	(37%)	5.1 ± 1.27	(5%)	24 ± 6	(2%)
Birch	73 ± 78	(8%)	2.4 ± 1.85	(2%)	19 ± 13	(1%)
Maple	67 ± 30	(8%)	1.7 ± 0.49	(2%)	14 ± 4	(<1%)
Other broadl.	182 ± 58	(21%)	2.2 ± 0.79	(2%)	17 ± 6	(1%)
Total	**865 ± 117**	**(100%)**	**102.8 ± 15.7**	**(100%)**	**1'580 ± 272**	**(100%)**

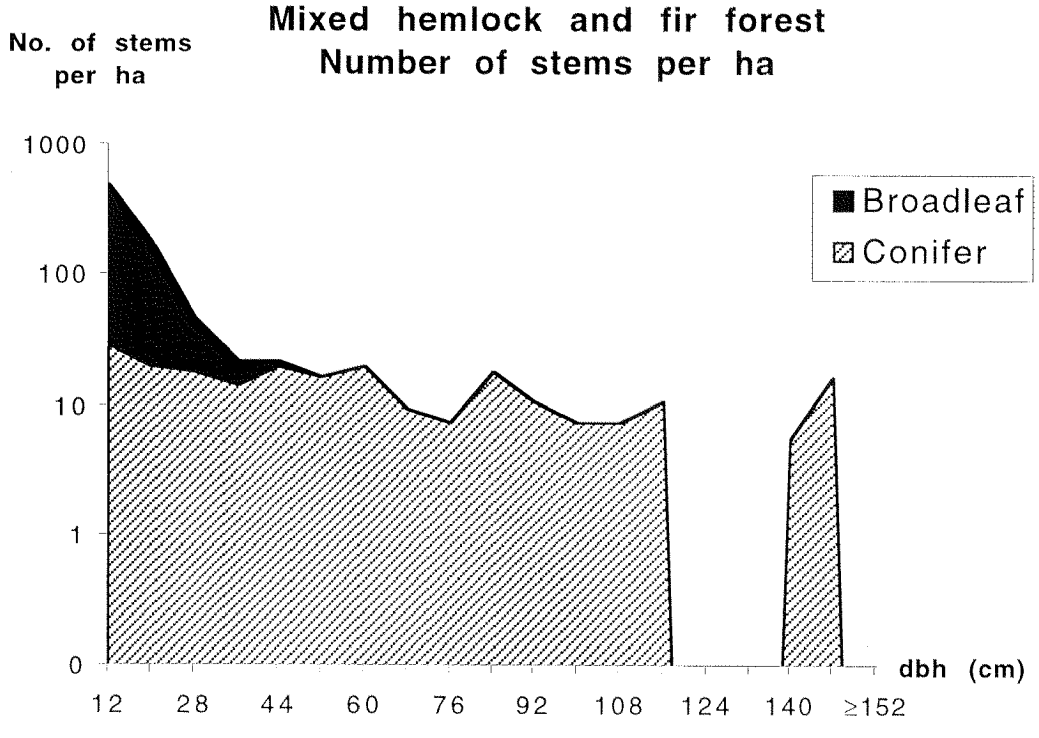


Figure 4-13: Number of stems by diameter class in the mixed hemlock and fir forests. Source: forest inventory 1997-98.

In Figure 4-13 the diameter distribution in the mixed hemlock and fir forests is shown. The stem distribution is similar to that of the hemlock forests and of the fir forests. The number of conifers is more or less constant in every diameter class, whereas the broadleaves have a negative exponential distribution.

4.7.3 Stumps and logs

On the average 107 stumps and 65 logs per ha were recorded in the mixed hemlock and fir forests (see Table 4-35). Almost all these trees had died naturally (see Table 4-36). On average only 15 firs per ha were felled and these were used for shingles. The mixed hemlock and fir forests are therefore extensively used for wooden products.

Table 4-35: Number of stumps and logs per ha by species in the mixed hemlock and fir forests. Source: forest inventory 1997-98.

Species	No. of stumps/ha	No. of logs/ha
Fir	45	29
Hemlock	15	24
Birch	22	0
Maple	7	0
Rhododendron	13	11
Other broadl.	5	2
Total	**107 ± 16**	**65 ± 10**

Table 4-36: Number of stumps per ha by category of elimination in the mixed hemlock and fir forests. Source: forest inventory 1997-98.

Category of stumps	No. per ha
Natural death	93
Shingles	15
Total	**107 ± 16**

4.7.4 Regeneration

On average 16'503 young trees per ha were recorded (see Table 4-37). The large majority were seedlings.The regeneration is composed of rhododendron, fir, maple, other broadleaves, and hemlock.

3'764 fir seedlings and 1'158 hemlock were recorded (see Table 4-38). All these young trees belonged to the category "less than 0.5 m height"; no conifers were found in the two other size categories.

Table 4-37: Regeneration in the mixed hemlock and fir forests by size category. Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	13'897	± 4'845
between 0.5-1.3 m height	1'158	± 647
1≤ dbh< 8 cm	1'448	± 788
Total	**16'503**	**± 5'132**

Table 4-38: Regeneration of conifers in the mixed hemlock and fir forests. Source: forest inventory 1997-98.

Species	Number per ha	66% c. interval
Fir	3'764	± 718
Hemlock	1'158	± 221
Total conifer regeneration	**4'922**	**± 938**

4.8 Birch forest

4.8.1 Description

The birch, *Betula utilis* D. Don., is a moderate sized deciduous broadleaved tree. It is found from Pakistan to south-west China [Polunin and Stainton 1997]. In Bhutan, it is found in the Thimphu, Trongsa, Bumthang and Trashigang districts at altitudes between 3'000 m.a.s.l. and 4'200 m.a.s.l. [Grierson and Long 1983]. It has a papery bark which peels off in strips. Birch is a strong light demander and often grows on open exposed slopes, where snow remains most of the winter [Troup 1986 (rep.)]. It can sometimes reach impressive dimensions: in Bumthang (Lame Gompa Research Forest) a birch was measured with 86 cm dbh [Giesch 1993] and in Gidakom one with 96 cm dbh [Rosset 1998].

11 plots were recorded in birch forests. The relative area of birch forests in the forest inventoried given in Table 4-1 is overestimated. Indeed, in this region, the birch forests formed small patches, of 1-2 tree heights in length, inside the fir forests and rarely larger stands.

The villagers of Dhur distinguish two types of birch at this altitude: one is a female birch (*mo shing*[27]), the other a male (*pho shing*). The wood of these two trees is used for different purposes. However, no evidence of two botanically distinct birch species was found at this altitude.

27. *Mo shing* means female tree and *pho shing* male tree. The villagers also make this distinction for another tree species, the juniper. The Weeping Blue Juniper, *Juniperus recurva* D. Don., is a "male" juniper (*pho shog*) and the Black Juniper, *Juniperus pseudosabina Fischer & Meyer*, is a "female" juniper (*mo shog*).

4.8.2 Structure

The characteristics of the birch forests are presented in Table 4-39. On average the birch forests had 578 stems per ha, 53.4 m^2/ha basal area and 672 m^3/ha standing volume.

Birch forms the upper layer, maple the intermediate, and rhododendron and other broadleaves the lower layer of the birch forests. Few firs and hemlocks were recorded. Their relatively big size (>70 cm dbh) indicates that they must be remainders of the climax forest (see Figure 4-14)

Table 4-39: Composition of the birch forest. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.
* Spruces were found only in one plot, therefore no confidence interval is given for this species.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Birch	156 ± 35	(27%)	15.6 ± 3.1	(29%)	165 ± 35	(25%)
Maple	169 ± 34	(29%)	7.9 ± 1.8	(15%)	69 ± 17	(10%)
Fir	31 ± 8	(5%)	12.6 ± 7.5	(24%)	208 ± 90	(31%)
Hemlock	16 ± 16	(3%)	10.7 ± 12.8	(20%)	185 ± 227	(28%)
Spruce	2 *	(<1%)	0.1 *	(<1%)	1 *	(<1%)
Rhododendron	149 ± 30	(26%)	4.2 ± 1.1	(8%)	22 ± 7	(3%)
Other broadl.	54 ± 7	(10%)	2.3 ± 1.2	(4%)	21 ± 14	(3%)
Total	**578 ± 81**	**(100%)**	**53.4 ± 9**	**(100%)**	**672 ± 151**	**(100%)**

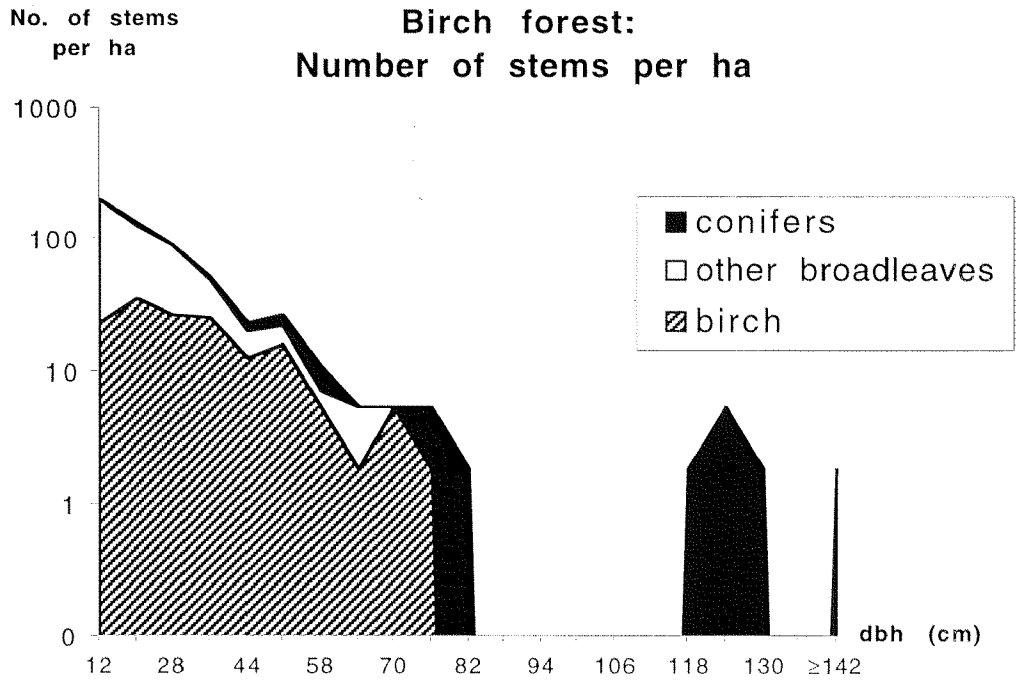


Figure 4-14: Number of stems per by diameter class in the birch forests. Source: forest inventory 1997-98.

As mentioned above, birch is a strong light demander. It therefore seems that birch is a pioneer species in the higher altitude forests. One or several big firs of the upper layer of the climax forest had broken and created a gap. These gaps were filled by surpressed firs or allowed the establishment of a pioneer forest, in this case with birch and maple. This type of long term succession in forests and the gap dynamics are already known and have been described, for example, by Watt and by Pickett [Pickett and White 1985; Watt 1947].

4.8.3 Stumps and logs

All the stumps and logs recorded in the birch forest were those of trees which had died naturally. Thus no use of trees was made in this forest type. All the birch forests were far away from the settlements, footpaths, and pastures. Probably it is their remoteness and the ban on birch wood which prevented the villagers to use these forests. Table 4-40 shows the number of stumps and logs per ha.

Table 4-40: Number of stumps and logs per ha by species in the birch forests. Source: forest inventory 1997-98.

Species	No. of stumps/ha	No. of logs/ha
Fir	11	13
Hemlock	5	7
Spruce, blue pine	0	11
Birch	4	25
Maple	9	25
Rhododendron sp.	9	13
Other broadleaves	0	4
Total	**38 ± 8**	**98 ± 28**

4.8.4 Regeneration

The regeneration in birch forest is shown in Table 4-41. On the average 2'895 young trees, mainly seedlings, were recorded. No tree between 0.5 m and 1.3 m in height could be traced. The regeneration is composed of rhododendron, maple, and fir. All trees with a dbh between 1 cm and 7.9 cm were maples. 290 fir seedlings per ha were recorded, with a 95% relative standard error.

Table 4-41: Regeneration in the birch forests by size category. Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	2'027	± 2'027
between 0.5-1.3 m height	0	-
1≤ dbh< 8 cm	869	± 869
Total	**2'895**	**± 2'124**

4.9 *Former agricultural land*

4.9.1 Description

Until recently, parts of the forests around Dhur were used for agriculture. A detailed description of the system as well as the social aspects of *pangzhing* are given in Section 6.6 "Pangzhing". Many of the abandoned pangzhings had been invaded by shrubs and trees. During the inventory, these forests were treated separately.

In Figure 4-15 indicator plot no. 10 in a young blue pine forest invading a pangzhing is represented. Many pastures have also reverted to forest. An early stage of reforestation is shown in Appendix 6. In Table 4-42 the characteristics of these two indicator plots are presented.

Table 4-42: Main characteristics of the indicator plots in the fir forests.
Source: indicator plot 1997.

Characteristics	Indicator plot 10	Indicator plot 11
altitude	3'085 m.a.s.l.	3'320 m.a.s.l.
exposition	120g	250g
slope	85 %	45 %
No. of stems/ha	14'933	2'629
Basal area m^2/ha	18	4
Volume m^3/ha	158	39

The former agricultural lands are not evenly reforested. In the early stage of reforestation, this rather comprises a mosaic of grassland and forest regeneration. For the indicator plots, the reforested parts were measured. Therefore, the number of stems per ha are higher in the indicator plot than for the average forests on former agricultural land.

4.9.2 Structure

The main species found on former agricultural land was blue pine, with 480 stems per ha, willow and poplar, with 116 stems per ha (see Table 4-43). Blue pine was found on every area of abandoned agricultural land; willow, poplar, spruce, and other broadleaves were found on the majority of the abandoned agricultural land; oak was sometimes found at lower altitudes (2'700-3'000m) and hemlock was found only sporadically.

For obvious reasons, the trees are comparatively young, therefore the figures for basal area and volume per ha are lower than in the adjacent forests. The distribution of the number of stems per diameter category is shown in Figure 4-16.

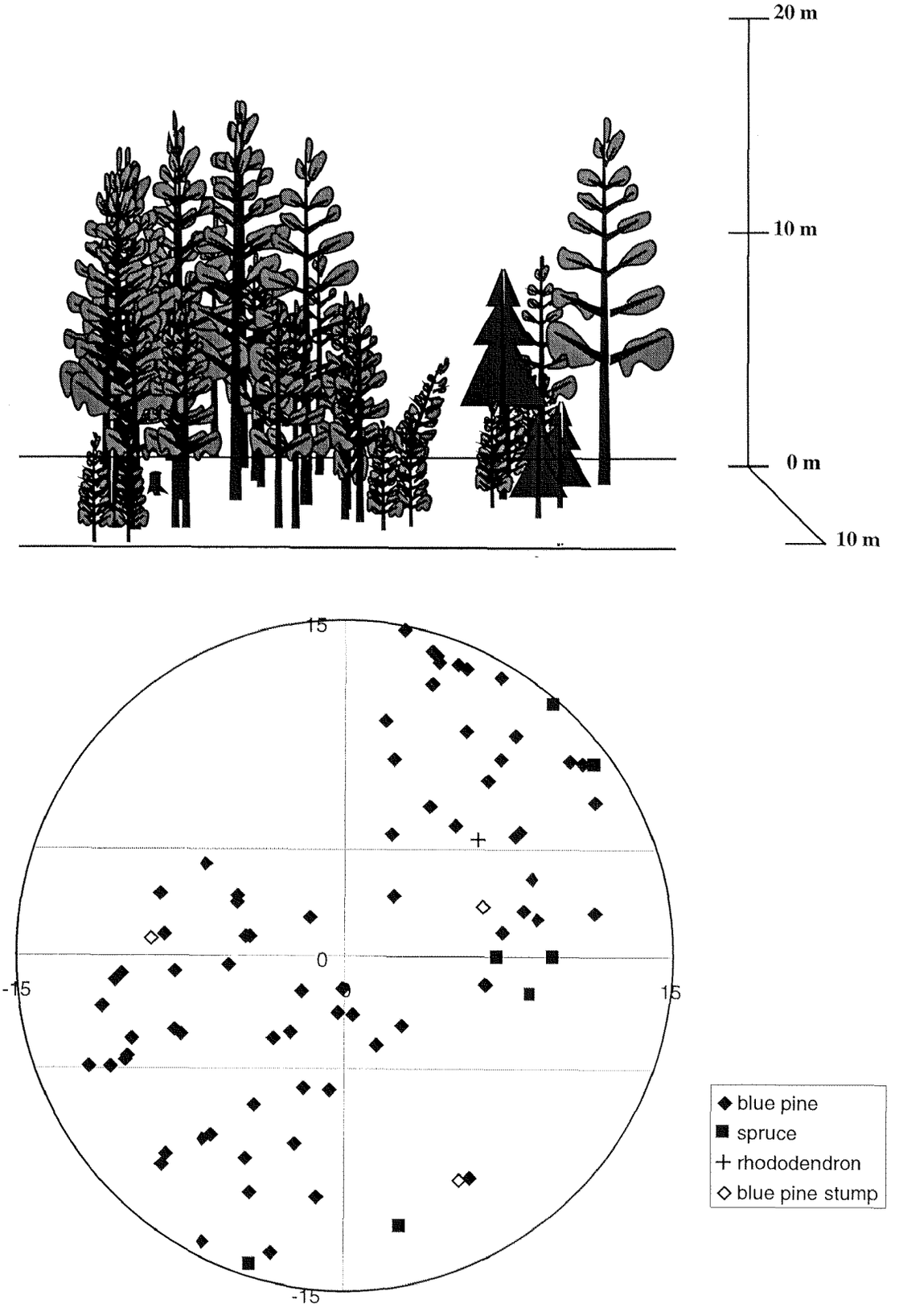


Figure 4-15: Forests on former agricultural land: indicator plot no. 10.

Table 4-43: Composition of the forest on former agricultural land. Number of stems, basal area and volume per ha with a 66% confidence interval. The relative importance of the species is given in brackets. Source: forest inventory 1997-98.
* Hemlock was found only in one plot, therefore no confidence interval is displayed in this table.

Species	No. of stems/ha		Basal area m2/ha		Volume m3/ha	
Blue pine	480 ± 140	(66%)	21.4 ± 4.5	(85%)	278 ± 67	(90%)
Spruce	27 ± 10	(4%)	1.0 ± 0.7	(4%)	12 ± 9	(4%)
Oak	44 ± 43	(6%)	1.1 ± 1.1	(4%)	8 ± 8	(3%)
Willow/poplar	116 ± 53	(16%)	1.0 ± 0.5	(4%)	6 ± 3	(2%)
Other broadl.	60 ± 24	(8%)	0.6 ± 0.3	(3%)	5 ±3	(1%)
Hemlock	2 *	(<1%)	0.02 *	(<1%)	<1 *	(<1%)
Total	**729 ± 153**	**(100%)**	**25.2 ± 4.8**	**(100%)**	**308 ± 69**	**(100%)**

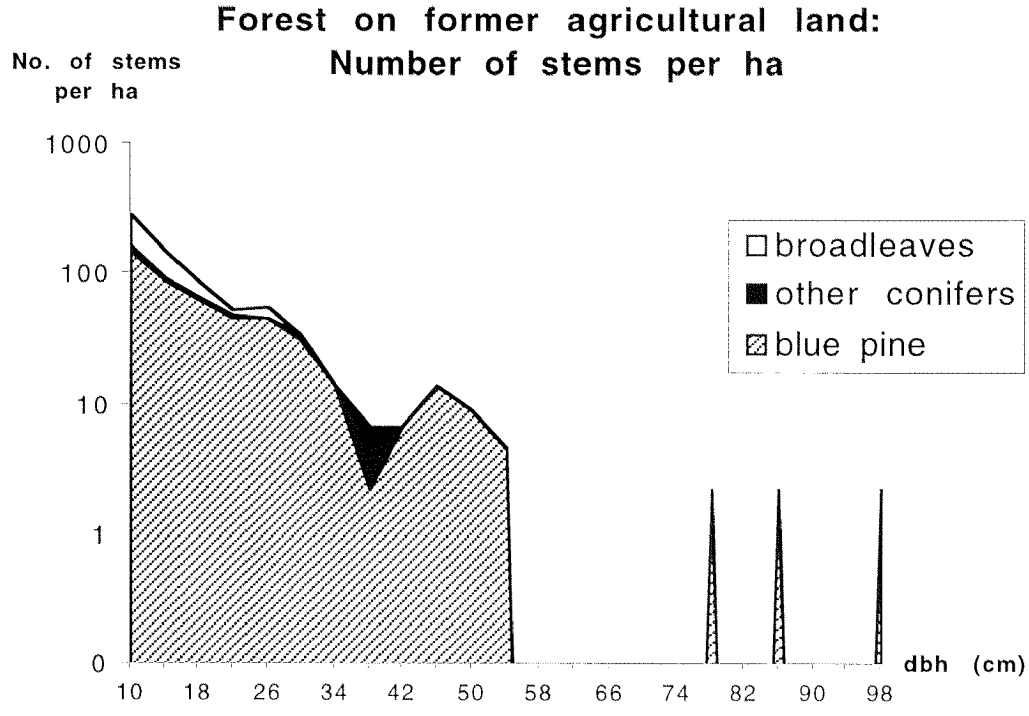


Figure 4-16: Number of stems per by diameter class in the forests on former agricultural land. Source: forest inventory 1997-98.

Above Lusbi, several pangzhings which had been invaded by broadleaves and shrubs were observed, mainly *Salix* sp., *Rosa macrophylla*, *Viburnum nervosum*, *Elsholtzia fructicosa*, *Jasminum humile*, and *Hippophae* sp.

4.9.3 Stumps and logs

The use of forests on former agricultural land is moderate to intense. Indeed, 158 stumps were recorded per ha (see Table 4-44 and Table 4-45), of which 104 had been felled. The most intensively used species was blue pine for firewood, poles and inner bark. Nearly all the willows had died naturally. The various broadleaves were used for fuel wood.

Table 4-44: Number of stumps and logs per ha by species in the forests on former agricultural land.
Source: forest inventory 1997-98.

Species	No. of stumps/ha	No. of logs/ha
Blue pine	80	29
Spruce	0	2
Oak	7	2
Willow/poplar	40	4
Other broadleaves	31	4
Total	**158 ± 52**	**38 ± 19**

Table 4-45: Number of stumps per ha by category of elimination in the forests on former agricultural land. Source: forest inventory 1997-98.

Category of stumps	No. per ha
Natural death	53
Fuel wood	49
Pole	31
Unknown reason	11
Inner bark	13
Total	**158 ± 52**

4.9.4 Regeneration

The regeneration on former agricultural land is relatively abundant: 19'462 young trees per ha were recorded (see Table 4-46). The regeneration is mainly composed of blue pine and also some spruce (see Table 4-47). Broadleaves are present only in the dbh category 1 - 7.9 cm.

Table 4-46: Regeneration in the forests on former agricultural land.
Source: forest inventory 1997-98.

Size	Number per ha	66% c. interval
Less than 0.5 m height	11'323	± 5'889
between 0.5-1.3 m height	4'600	± 2'606
1≤ dbh< 8 cm	3'539	± 2'458
Total	**19'462**	**± 8'889**

Table 4-47: Regeneration of conifers in the forests on former agricultural land. Source: forest inventory 1997-98.

Species	Number per ha	66% c. interval
Blue pine	17'339	± 8'096
Spruce	1'062	± 719
Total conifer regeneration	**18'401**	**± 8'045**

4.9.5 Average age of the trees

All the former pangzhing north of Dhur were inventoried. Their area was measured, the number and the size of all trees was recorded and the age of some of the trees was assessed. In all 17 areas which were used formerly as agricultural land and are now covered with forest were recorded. They represent in total 5.7 ha, the smallest area covering 350 m^2, the largest nearly 12'000 m^2.

The average age of the trees in forests on former agricultural land is shown in Figure 4-17; it ranges from 14 to 35 years.

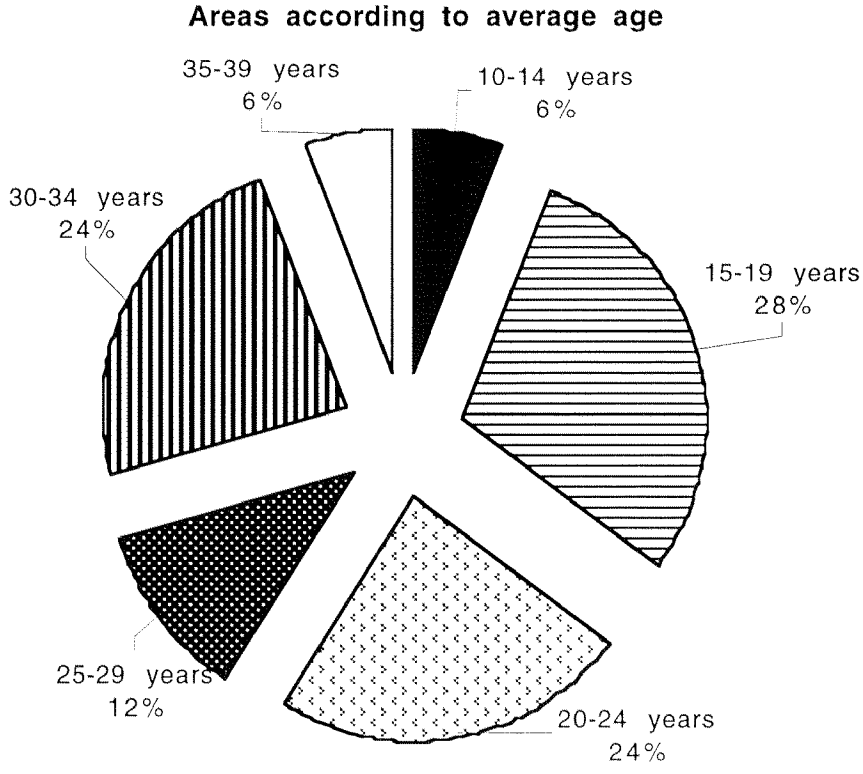


Figure 4-17: Distribution of areas according to the average age of the trees on former agricultural land. Source: assessment of the average age of trees on former agricultural land 1999.

4.10 Impact of the extraction of beams on the forest structure

A description of the surrounding forest was formulated for every inventory plot. This description recorded for what purposes and with what intensity a forest was used according to the information of the villagers. The forests were examined for evidences of the impact of forest uses on their structure. It however appears that large tracts of forests are not used at all and others are used very extensively by the villagers. In these forests no impact of the forest uses on the forest structure could be assessed. The forests in which beams are extracted constitute the only exception to this finding. The forests, in which trees are felled for beams, are described in the present Section and the product, beam, is defined in the Section 6.3.1 "Beams".

17 inventory plots were located in forests in which trees are felled for beams, mainly in blue pine forests with oak, but also in mixed spruce forests and forests on former agricultural land.

The structure of the forest can be characterised by the distribution of the number of stems per diameter class (see Figure 4-18). The diameter distribution in blue pine forests with oak is presented in Figure 4-6 and commented on in Section 4.3 "Blue pine forest with oak": the line descends straightly to diameters of 80 cm. Few individual trees with dbh above 80 cm were found.

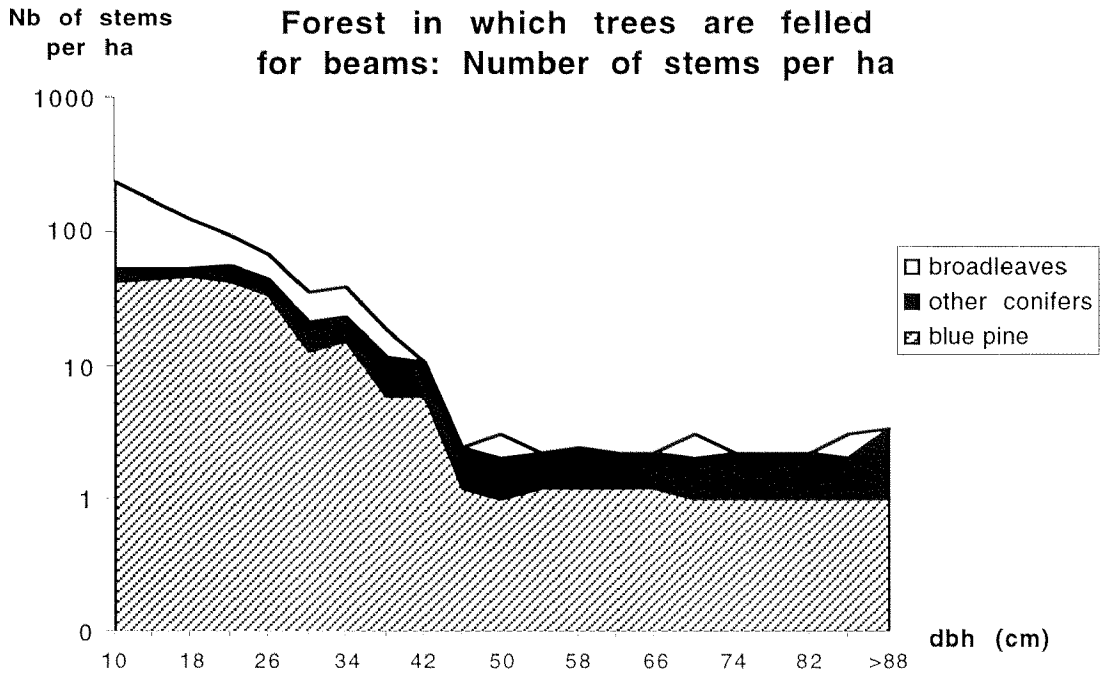


Figure 4-18: Number of stems per diameter class in the forests where trees are felled for beams. Source: forest inventory 1997-98.

When considering only those forests which are regularly used for extracting beams, the distribution of the diameter classes does not form a straight descending line. Indeed, there is a remarkable gap in the number of trees between the categories 42 cm dbh and 46 cm dbh

and a smaller gap between 26 cm and 30 cm. From 46 cm dbh onwards, only one blue pine per ha is to be found in each category.

The average size of the tree used for beams is discussed in Section 6.3.1 "Beams": it is around 30 cm dbh. The first irregularity in the diameter distribution is found in this diameter category. Blue pines over 44 cm dbh and still standing in these forests were not suitable for beams, i.e. either they were forked or damaged.

The extraction of trees for beams thus strongly affects the structure of the forest. However, this use is concentrated on few forest patches and does not affect large tracts of forest.

5. The social context of the forest uses

5.1 Population

5.1.1 Population groups

In the region of Dhur, two population groups have been settled for centuries: the *monpas* (also called *mon*) and the *brokpas* (see also Section 2.2.1 "Population" for the definition of these groups). Only a few people from other neighbouring regions have come to settle in Dhur. These people either came for a specific job (e.g. school teacher or forest contractor) or married a "*Dhurpa*" (inhabitant of Dhur). Every year, from June to September, a small number of cattle herders come from Kheng to graze their cattle.

The *monpas* consider themselves the original settlers of the region. No villager could explain their origin, but some supposed that they are related to the population further South or East (Kheng and Kurtoe), since their languages are similar. The *monpas* traditionally earn their livelihood through agriculture.

The *brokpas* are pastoralists. In the past, they were nomads living from trading and yak rearing. Nowadays most of them have bought a house in the village and converted to a semi-nomadic or even sedentary life-style. They themselves believe to originate from Tsampa, the border region between Bhutan and Tibet where they were unified (8th century) and led by the Lama Nyunchu Tshering Wangchuk, until the latter was defeated by Guru Rimpoche. They believe that during the reign of Shabdrung Nawang Namgyel in the 17th century, when many wars occurred between Bhutan and Tibet, the *brokpas* fled the agitated border region and settled in northern Bhutan. The *brokpas* of Chhoekhor Toe are proud to have retained their original language (*brokkat*) and culture (e.g. distinct religious ceremonies, often connected to the Tsampa region).

The villagers believe that the *brokpas* settled in the region after the *monpas*. The *monpas* already occupied the territory and therefore the newly arrived *brokpas* had to rent grazing land from the *monpas* against a tax in kind.

During the 18th or 19th century, the Bumthang aristocracy bought large tracts of grassland from the *monpas*. These employed some *brokpa* families to keep their yaks. The families keeping the male yaks were called *yaktse*, the families keeping the female yaks were called *naktse*. Further families herding the livestock of a *dratshang* (monastic community) are known as *zeeba*. The families were paid in-kind for their services. The situation of the *brokpas* thus improved.

In the past, the livelihood of the *brokpas* relied on the rearing of yaks and trading. Now that the border to Tibet is closed, most of the *brokpas* depend entirely on their yaks. The two population groups depend on each other: the *monpas* barter their buckwheat and wheat against yak butter and dried cheese (in *Bumthangkha*: *chugo*). Other products, such as yak wool blankets, ropes or bags, are exchanged. Through development and better access to the market, the *brokpas* have been able to increase the sale of their yak products

(butter, cheese, meat, handicrafts,...). The social position of the *brokpas* has thus improved.

5.1.2 Demographic data

82 households were recorded in the study area (see Table 5-1). The study area comprises three villages: Dhur, which is divided in four blocks and two "suburbs", Lusbi and Crongmanba[28]. Since these two do not have a temple, they join the important religious ceremonies in the village Dhur. In the present study, the term "Dhur" will always refer to the group of three villages.

In 1997, there were 622 inhabitants in Dhur (see Table 5-2). Almost exactly half of them were women; 54% were *monpas*, 41% were *brokpas* and 5% came from other regions of Bhutan. One family is still acting as *yaktse* and one family is known as *zeeba*. According to the information gathered during the Household Survey, no immigration or emigration took place during the last decades.

61% of the population lives permanently in Dhur (see Table 5-3). 11% are semi-permanent and 28% are absentees. A majority of *monpas* (73%) lives permanently in Dhur. The *monpa* absentees (24%) are mostly students, people who have obtained a job outside the village and a few people who have married outside Dhur, but still have land and even cattle in the village.

Table 5-1: Number of households according to the location. Source: Household Survey 1997.

Location	no. of households
Dhur: Gonpfey	24
Dhur: Khaisar	19
Dhur: Hjawang	14
Dhur: Shikshay	7
Dhur: Chutigang	1
Dhur: Menchigang	2
Lusbi	9
Crongmanba	5
Kheng	1
Total	**82**

Table 5-2: Population in the study area. Source: Household Survey 1997.

	Brokpa	Monpa	Others	**Total**
Male	134	161	18	**313**
Female	129	167	13	**309**
Total	**263**	**328**	**31**	**622**

28. One household comes from Kheng every summer to graze their cattle around Dhur. They are related to a family in Dhur and therefore considered as Dhurpa.

Table 5-3: Population of Dhur according to residential status and social group.
Source: Household Survey1997.

	brokpa	*monpa*	other	Total
permanent	138 (48%)	240 (73%)	4 (80%)	**382 (61%)**
semi-permanent	55 (19%)	9 (3%)	1 (20%)	**65 (11%)**
absentee	96 (33%)	79 (24%)	0 (0%)	**175 (28%)**
Total	**289 (100%)**	**328 (100%)**	**5 (100%)**	**622 (100%)**

Almost half (48%) of the *brokpas* live permanently in the village. Indeed often some of the *brokpa* households stays permanently in the village, while the others watch over the yaks. These household members stay permanently in the village, either because they take care of children attending school or because they feel to old to move with their yaks herds, or because they have started some other economic activity. Few families, for example, have obtained land and started to cultivate it. 19% of the *brokpas* live semi-permanently in the village: they watch over the yaks and come from time to time, especially in winter, to the village. 33% are absentees: either they stay permanently with the herd or they have left the village for studies.

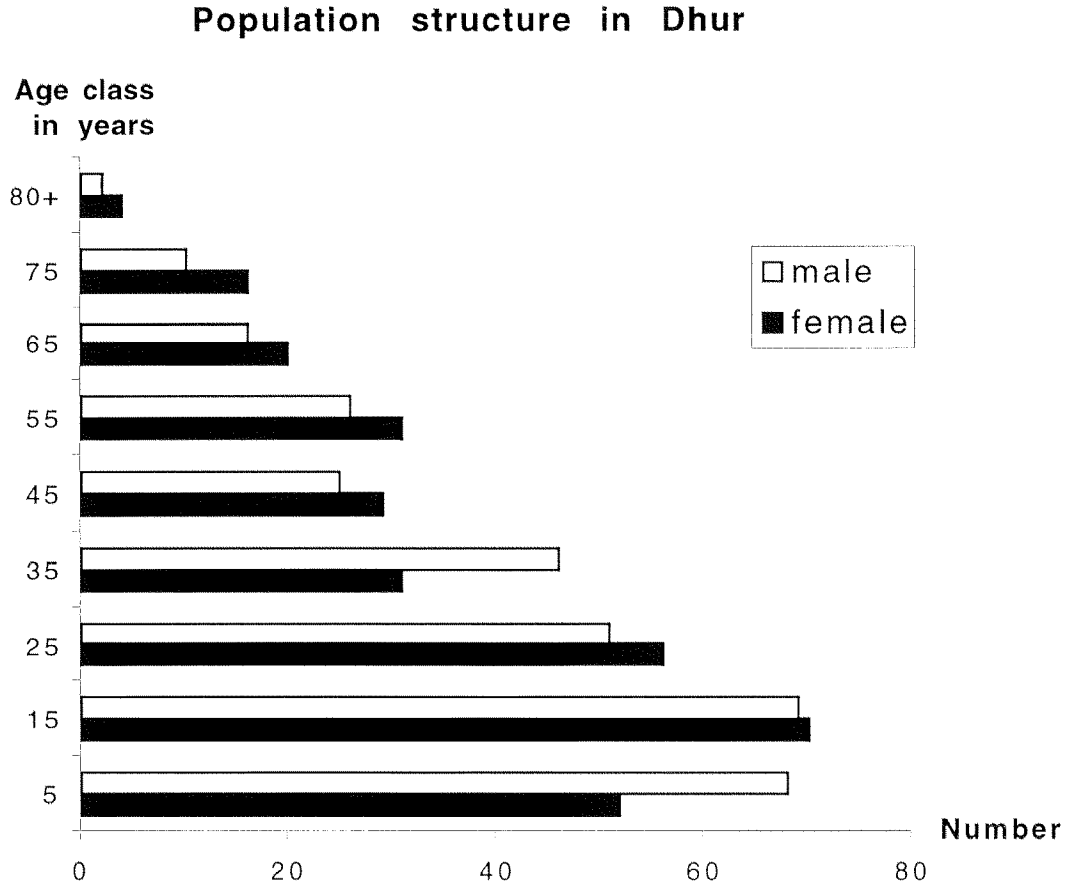


Figure 5-1: Population structure in Dhur: distribution of the population according to age class and sex.
Source: Household Survey 1997.

The age distribution is quite regular (see Figure 5-1). There are more men in the age group 0-9 years (group middle: 5 years) and 30-39 years and more women in all the other groups. This confirms the general tendency that women have a higher life expectancy, provided they survived the birth-giving age. The age class 0-9 years is slightly smaller than the 10-19 years group. It could correspond to the observation of some inhabitants that, after an initial boom due to a higher children's survival rate, the number of birth is now slowly reducing. The increase of number of children was unanimously explained by the improved medical facilities. Some villagers observed a slow down in the number of birth and explained it as a consequence of the family planning campaign and facilities.

This Section presents together with the results of the surveys in Dhur, the results of the additional interviews carried out in various villages in the two neighbouring valleys—20 households in the remaining part of Chhoekhor Toe and 20 households in Tang. The two neighbouring valleys display similar social and natural conditions to those in Dhur. These additional interviews allow differentiation between regional social features and local specificities.

No official statistics for the number of households and composition of the population in Bumthang were available. Nonetheless the additional surveys showed that the composition of the population in the two other valleys was different from that in Dhur. In the remaining part of Chhoekhor Toe, both *monpas* and *brokpas* households were encountered. The latter are found mostly in the northern part of this valley. In Tang, the households were all *monpas*. In both valleys, households which had been *doebas*[29] during the time of the feudal system were found. Out of the 40 households interviewed in these valleys, 26 were *monpas*, 10 *doebas,* 3 *brokpas* and one was Tibetan (see Appendix 20). Therefore the results of the interviews in these two valleys mainly reflect the situation of *monpas*.

5.1.3 Scholarity

The community primary school in Dhur was opened in 1990. There children can attend up to class 4. In future, villagers plan to have a school up to class 6. So far, children have to join the nearby primary school in Wangdicholing or the boarding school in the neighbouring valley, Chhumme, for classes 5 and 6. Classes 7 to 9 are generally attended in the nearby Jakar junior high school. For classes 10 to 12, the students have to join Sherubste College in Kanglung (Eastern Bhutan).

The literacy rate for the population between 6 and 50 years in Dhur is 34% for the female population and 46% for the male population. A higher proportion of literate males is found at all levels of eduction, except for the non-formal education (see Figure 5-2). The gender difference is even greater at the college level.

The difference in the education levels for the *monpas* and *brokpas* is not surprising: the *brokpas* are less represented in all categories of education (see Figure 5-3). The literacy rate for the population between 6 and 50 years in Dhur is 27% for the *brokpas* and 53% for the *monpas*. Due to their semi-nomadic lifestyle, it is more difficult for the *brokpas* to attend school. On the one hand, either the children attending school have to be entrusted to some relatives staying in the village or part of the family has to stay back in the village to look after the children. On the other hand, the families loose labour capacities when the

29. *Doeba*: landless farmers who had to rent or share-crop land. See also Section 2.2.1 "Population".

children attend school. Sedentary *monpas* loose labour capacities as well when their children join school, although their children might still help their family after school.

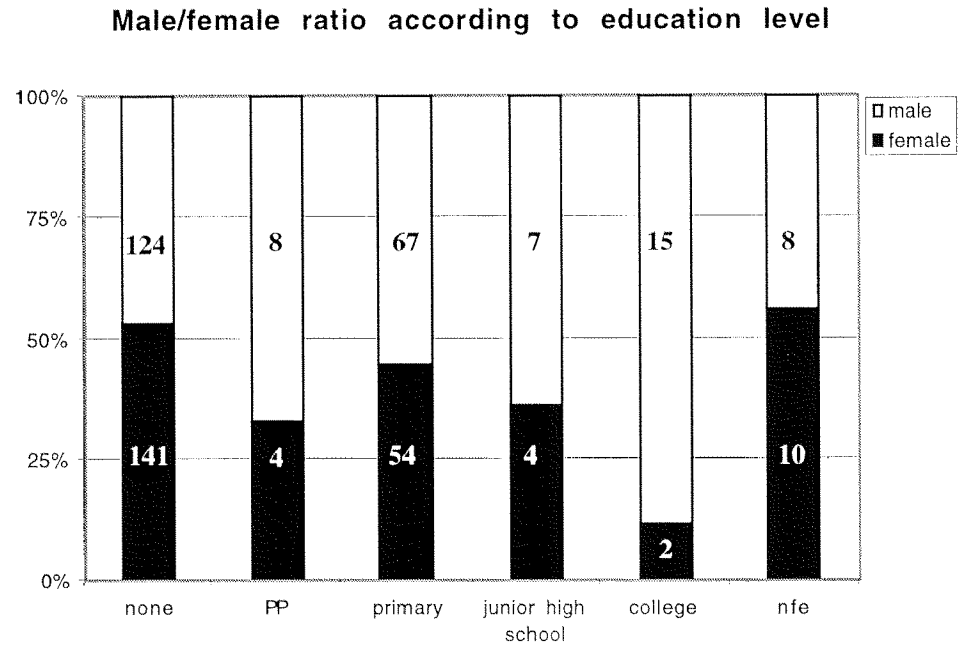


Figure 5-2: Proportion of male and female according to the level of education, based on the 6 to 50 years old population. PP: pre-primary, nfe: non-formal education. The numbers written in the columns represent the absolute numbers of students. Source: Household Survey 1997

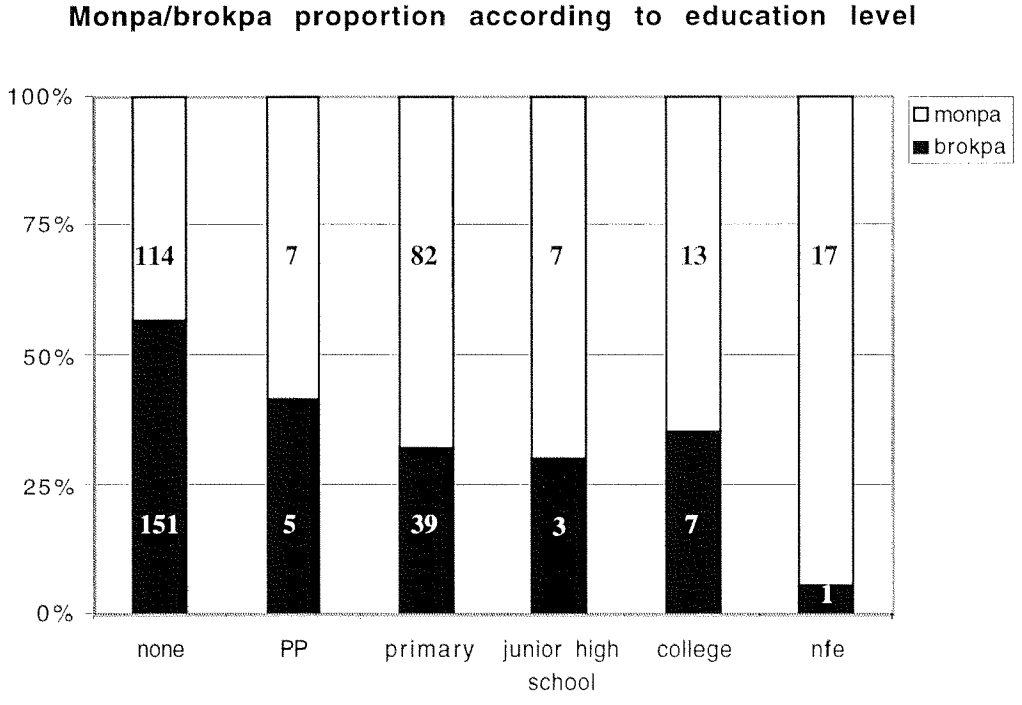


Figure 5-3: Proportion of *brokpa* and *monpa* according to the level of education, based on the 6 to 50 years old population (absolute numbers of brokpas and monpas in this age class were identical). PP: pre-primary, nfe: non formal education. The numbers written in the columns represent the absolute numbers of students. Source: Household Survey 1997.

5.1.4 Landholding

Landholdings were unequally distributed among the population. One third of the households each owned less than a acre of land, which corresponds to Brauen's findings for the same region, and 25% of the households each owned 25 acres or more [Brauen 1994]. Table 5-4 shows the proportions of households of the different population groups according to the size of their landholding. These figures are based on information from the households. Unfortunately, the *thrams* (land record registers) were not accessible to cross-check this information. Generally, *brokpas* owned less land than *monpas*. This difference is probably even greater than indicated in this table, since the *brokpas* often considered themselves owners of tsamdrogs, when legally they only had user rights. Globally, *khraebas* had more land than *szurbas*. This difference is inherent in the very definition of *szurbas* and *khraebas*[30]. *Szurbas* are households which have separated from the main household. In Dhur, when leaving the main household, the person looses his claim to a share of land from the main household. These landholdings include 15 households which owned land outside their village: 5 households had land in the region of Dhur (but outside their village), 6 households owned paddy fields in Tongsa or Paro, 3 households had land in the neighbouring valleys and 2 households kept land in their place of origin[31]. Except for the 4 households owning paddy fields in Tongsa and the 5 households having land in the region of Dhur, all this land had been acquired through marriage.

Table 5-4: Proportion of households of the different population groups according to the size of their landholding. Source: Household Survey 1997.

	Brokpa		*Monpa*		TOTAL	Other
	khraeba	*szurba*	*khraeba*	*szurba*		villages
Do not know	9%	0%	0%	0%	**2%**	0%
< 1 acre	32%	55%	0%	55%	**34%**	13%
1 - 4.9 acres	18%	36%	0%	15%	**14%**	15%
5 - 14.9 acres	18%	9%	14%	20%	**15%**	15%
15 - 24.9 acres	9%	0%	18%	10%	**10%**	22%
≥ 25 acres	14%	0%	68%	0%	**25%**	35%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The heritage system varied from one place to the other and sometimes from a family to the other. In Dhur, the children staying with the parents were entitled to inherit. In the remaining part of Chhoekhor Toe, a daughter—usually the eldest—inherited the land and house [Brauen 1994]. In Dhur, a few households gave a patch of land to the household members who separated from the main household (*szurba*), most however did not.

The landholding is subject to change. Figure 5-4 indicates what changes in landholding have occurred to the households in the last 50 years. 26% of the households in Dhur indicated that the size of their landholding had not change in the past 50 years. 12% of the households never owned any land and still did not. The landholding size had decreased for 23% of the households. The main reasons for the decrease were the introduction of a land

30. See also the definitions for *khraebas* and *szurbas* in Section 2.2.1 "Population".

31. One household owned paddy fields in Tongsa as well as land in a neighboring valley.

ownership ceiling of 25 acres and the partition of the land among family members. 39% of the households increased their landholding, due to *kidu* grants[32], purchase or inheritage.

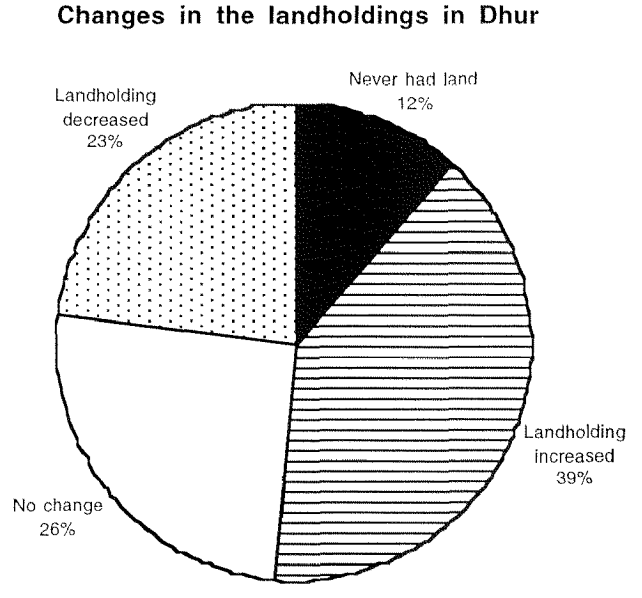


Figure 5-4: Changes during the last 50 years in the landholding size in percentage of the households. Source: Household Survey 1997.

In the two other valleys, where the additional interviews were carried out, a higher proportion of households, compared to the average in Dhur, had landholdings exceeding 25 acres (see Table 5-4). Fewer households in these two valleys had less than 1 acre of land. This difference might be due to the composition of the population: indeed in the other valleys, fewer *brokpa* households were interviewed. Concerning the changes in the landholding size, the situation in these two other valleys is similar to that in Dhur. There most people had lost land due to the landholding ceiling. The *doebas* did not own land in the past, but many of them have been able to buy land from their previous landlords.

5.1.5 Livestock

Table 5-5 shows the number of livestock and the average number of livestock per household in 1999. In addition to this livestock, 230 yaks and 60 sheep were kept by some households from Dhur for people and institutions outside of the village (Source: Household Survey 1997). It is not surprising to note that the *brokpas* own the largest part of the yak herds, since yak rearing is their main economic activity. On average, the *brokpas* own more horses than *monpas*. This is also due to the economic activities of the *brokpas*: indeed horses are necessary to transport loads between the pastures and the village, since yaks cannot be brought to lower altitudes during the summer. *Brokpas* keep also more sheep on average than *monpas*. On the other hand, *monpas* keep more cows and oxen. The yaks — sometimes also sheep — of the *monpas* are entrusted to the *brokpas* for herding.

32. The king might reward his subjects with a "*kidu* grant", which in this case consisted in a patch of land. The areas given as *kidu* grants in Dhur ranged from 0.1 to 5.3 acres:

The ratio between productive and unproductive animals is striking: there are 237 dry cows and oxen against 69 milch cows. For religious reasons, the culling of animals is forbidden and all animals, even unproductive, are kept.

Table 5-5: Number of livestock and average number of livestock per household, according to population group.
Source: Forest Resource Use Survey 1999.

	brokpa		*monpa*	
	number	**nb per HH**	**number**	**nb per HH**
milch cows	16	0.4	53	1.4
dry cow	23	0.6	94	2.5
ox	11	0.3	109	2.9
horse	262	6.9	93	2.6
sheep	82	2.1	29	0.8
milch *drey*[a]	263	6.7	21	0.6
yak, dry *drey*	639	16.4	37	1.0

a.*drey*: female yak.

5.1.6 Housing

The number of houses in Dhur has increased in the past decades. 45% of the houses were less than 9 years old and 65% of the houses were less than 20 years old (see Table 5-6). The increase of the number of houses however did not seem abnormal, but rather proportional to the increase of the population. Indeed 19 new houses were built during the last decade in Dhur and, during this period, around 125 people reached marriageable age.

Table 5-6: Number of houses in Dhur per age category.
Source: Household Survey 1997.

	number of houses	
Age of the houses	*Brokpa*	*Monpa*
< 5years	5 (14%)	9 (23%)
5- 9 years	1 (3%)	4 (10%)
10-19 years	7 (19%)	4 (11%)
20-49 years	6 (17%)	7 (18%)
50-99 years	9 (25%)	1 (26%)
100-200 years	4 (11%)	3 (8%)
>200 years	4 (11%)	2 (5%)

The *monpas* have built more houses than the *brokpas* during the past decade. The consumption of wood for construction increased not only due to the increase in construction, but also due to a different construction style [Norbu Tshering, Dodrong, pers. communica-

tion 2000]. Indeed, during the feudal system only higher ranking people were allowed to build houses with large carved windows. The remaining population had to construct its houses mainly with stones, or sometimes mud, and with less sophisticated windows.

Some houses reach considerable ages. The oldest house in Dhur is believed to have been built six centuries ago by a lama. Some of the oldest houses were constructed of rammed mud. The recent houses however were mainly constructed with stones and wood.

5.2 Activities

5.2.1 Residential status and employment

The vast majority of the population were active as subsistence farmers or herders. The livelihood of most *monpas* depended on subsistence agriculture and that of the *brokpas* on the rearing of yaks. Only 10% of the population in Dhur pursued other economic activities (see Table 5-7).

Table 5-7: Number of persons of the active population (6-60 years) per main occupation and residential status in Dhur.
Source: Household Survey 1997.

Occupation	Permanent	Semi-permanent	Absentee	Total
housewife	125	3	15	**143 (27%)**
student	66	3	44	**113 (22%)**
herder	10	53	37	**100 (19%)**
agriculture	71	1	1	**73 (14%)**
religion	21	1	16	**38 (8%)**
others	15	2	37	**54 (10%)**
Total	**308 (60%)**	**63 (12%)**	**150 (28%)**	

27% of the population considered themselves housewives. This activity is a full-time job in itself: it includes not only the domestic chores, but the actual management of the house and farm, including for example distribution of the work load or the allocation of the resources. 22% of the active population was enrolled in schools, a large part in or near the village. The students from class 5 upwards had to leave their village to join boarding schools. They constituted a large part of the absentees. 8% of the active population were engaged as monks in the monastic communities, mainly outside of the village, since the village does not have a monastic community. The yak and cattle herders formed the largest part of the semi-permanent population and over a fifth of the absentees. 10% pursued other economic activities, for example carpentry, but most were employed outside the village as employees.

5.2.2 Agricultural activities

The traditional staple food in Bumthang was buckwheat. 40% of the households in Dhur indicated that buckwheat is the main crop, in terms of quantity (see Table 5-8). Wheat was

the second most important crop. 24% of the households did not cultivate any crop. In Dhur, only 5% of the households indicated that potatoes formed the major part of their cultivations. In addition some households indicated that they cultivate potatoes in their kitchen gardens. Potato is a major cash crop in Bumthang. In Dhur, however potatoes were cultivated mainly for home consumption. The cultivation of potatoes for cash income was not very common: only 10% of the households in Dhur affirmed selling some of their potatoes.

On the other hand, the traditional barter of agricultural products was still very common: the *monpas* barter their buckwheat and wheat for yak products — butter and dry cheese — with the *brokpas*.

Table 5-8: Main crop cultivated by the household, in % of the households in Dhur and in the two neighbouring valleys.
Source: Household Survey 1997.

Crop	Dhur	Other villages
Buckwheat	41%	25%
Wheat	26%	48%
No crop cultivated	24%	5%
Potato	5%	20%
Vegetables, barley	4%	2%

In Tang and in the lower part of the remaining Chhoekhor Toe, 48% of the households indicated wheat as the major crop, 25% of the households buckwheat, and 20% of the households potato. Some households indicated cultivating potato as their second or third most important crop.

Potato was the major crop sold for cash income: in these two valleys, 62% of the households reported selling potatoes. However, potato cultivation was not uniformly distributed in these valleys. It was very intense in the lower part of the remaining Chhoekhor Toe and quite common in Tang. The upper part of the remaining Chhoekhor Toe was not yet cultivating large quantities of potatoes, due to its relative remoteness and lack of transportation facilities.

5.2.3 Brokpas' seasonal calendar

As described above, the *brokpas* of Dhur lead a semi-nomadic life. They spend a little more than half of the year in the vicinity of the villages and the remaining time in their summer pastures.

During the 9th month of the Bhutanese calendar (approx. October) the *brokpas* bring their yaks to the lower pastures near the villages. Before shifting to their winter pastures, they stay 2-3 weeks above the village of Dhur. During this time, the *brokpas* deliver a defined amount of yak products — dry cheese, butter and wool — to the owners of the yaks they were keeping for them. The *brokpas* have to repair their hut on the main winter pasture and collect firewood. Once this work is done, the men and the young women sell or barter

their yak products and refill their supplies. Men try to find some daily-wage work, while women weave blankets, raincoats or bags from yak wool. Usually, *brokpas* use 2-3 winter pastures. The yaks are kept 3-4 weeks on a pasture, then shifted to the next.

During the 4th month (approx. May), the *brokpas* move their yaks to the summer pastures. They usually have 3-4 summer pastures, sometimes up to 8 pastures. The men lead the male yaks, which carry the loads, to their main summer pasture. *Monpas* sometimes assist in this transfer against a payment in kind of butter and cheese. 2-3 days later, the women arrive leading the female yaks and the calves. Meanwhile, the men will have repaired the hut and collected fire wood. They will spend more or less two months in the main summer pasture. The chores are divided in the family: mostly women are milking and make butter and cheese, while men collect firewood, poles and shingles. They also have to round up the yaks. From time to time, the men leave to the village with some horses to sell yak products and buy some supplies.

During the 6th month of the Bhutanese calendar (approx. July), after two months have been spent on the main pasture, they shift their yaks to the next pasture. They take only a part of their belongings and supplies with them, the other part remaining in their hut on the main pasture. Depending on the size and quality of the pasture, they remain 2-4 weeks on a pasture before shifting to the next. From time to time they go back to the main pasture to collect some provisions.

5.2.4 Other economical activities

The main source of cash income for the households in Dhur is work on a daily wage basis. The road construction sites and forestry, for example, offer such opportunities for work. It is mainly men who pursue this kind of activity, since they have more opportunities and earn higher wages than women.

The sale of handicrafts — such as *yathras* (woven wool fabrics), yak hair blankets or cotton clothes — provides a small cash income to certain households.When performing rituals, the monks are paid for their services in kind or cash. However, most households indicated that this source of income is not very important. Most monks are children and do not receive very large sums. Only a few households with higher ranking monks can expect to get a more significant income from the rituals.

In the past, trade with Tibet was very common. Wool and woollen products, cotton clothes and paper, for example, were exchanged against salt and other products. As the border to Tibet is now closed, this trade has lost its importance.

5.3 Historical and cultural aspects

5.3.1 Aspects of rural life during the feudal system

The rural life during the first half of the 20th century, under the feudal system, is characterized by two elements: taxes and forced labour.

A large variety of in-kind taxes were levied according to a very complex system, which was described by Karma Ura in his historical novel [Ura 1995]. The taxes consisted, according to the availability of products in the region, of butter, buckwheat, wheat, meat,

textiles, hay and straw, shingles, charcoal, ash and soot, bark of *Daphne bholua* for paper, baskets and many more items. All these served as supplies for the government and army. Both *monpas* and *brokpas* as well as *khraebas* and *szurbas* were subject to taxation, but the taxation was heavier for the *khraebas.*

Every household had to do forced labour. The labour consisted for example of constructing official buildings or temples, carrying loads from one place to another[33] or work in the fields of the king. Several systems of forced labour succeeded on one another. For example, one of the systems was called *dugdom*: people had to do forced labour in groups of six people. It was replaced by the *phosit* (for men) and *mosit* (for women). The most recent system, based on "volunteers", is called *Shabtolami*[34]. It replaces the forced labour system, *Gundgang Ula.* Each system had its own rules concerning the number of labourers per household and the duration of the work. According to the villagers, the duration of the forced labour during the feudal system varied between three and six months per year[35]. Mostly the villagers were sent far away from their villages. The charge on the households was hence considerable, draining valuable labour capacities away from the village, even during cropping season. Thus the population suffered of acute labour shortage for their own work.

The system however also benefited the villagers. The *dzong* stored all the in-kind taxes they had levied. Huge amounts of food grains were available in the *dzong.* In return for their services, the villagers could get a "food loan" from the *dzong*, when their yield happened to be insufficient to last until the next harvest. The loan had to be paid back, but the farmers could avoid famine.

5.3.2 Changes in the population

Altogether, the population in Dhur was increasing over the past century. The increase is essentially due to birth. With the introduction of medical facilities, the infant and maternal mortality dropped and the population increase even intensified. It seems, however, that at present, in Dhur, the birth rate is decreasing due to the family planning campaign and the availability of contraceptive injections at village level.

No immigrants were encountered in Dhur. Only a few individuals from other villages have married inhabitants of Dhur and settled in the village. The villagers indicated that a larger number of Tibetan refugees once lived temporarily in Dhur, but have now settled in Jakar.

The elder villagers remember an epidemic — probably small-pox — which wiped out a high number of villagers in the 1950's. However, no household in Dhur died out completely. Other informants confirm that this epidemic had affected the whole region.

In the local history, new settlements have appeared while others have been abandoned. Around the monastery of Lugirawa, for example, ruins of houses and evidences of former agricultural activities can still be found. The ruins are those of the houses of *doebas* attached to the service of the previous Lama of Lugirawa. At the death of the latter, the

33. The so-called "porter tax". As porter tax, the *brokpas* had mainly to carry loads for trade to Tibet, whereas *monpas* had to carry loads within the country.

34. The main change introduced by the *shabtolami* is that the labour is remunerated (56 Nu/day in 1997).

35. Karma Ura indicates in his novel that the forced labour could account for up to half of the time of a household.

doebas abandoned the place — which was too high in altitude to allow a good harvest — and settled in different villages in the lower lying regions.

During the feudal system in the first half of the 20th century, there were important seasonal fluctuations in the population. Indeed the first two kings owned large areas of *pangzhing* in Bumthang. Labourers were brought from different regions to work on the *Pangzhing*. One year people from Kheng and Kurtoe had to come to cultivate the *pangzhing* of the king and the following year it was people from Mongar and Trashigang. Once their work was completed, the labourers returned to their village. These large areas of *pangzhings* were abandoned when the third king moved the capital to Paro and then to Thimphu in 1952. Most of these areas have now become naturally reforested. In the lower part of Tang, this is certainly the main reason for the increase in forest cover during the second half of the 20th century (see Figure 5-5).

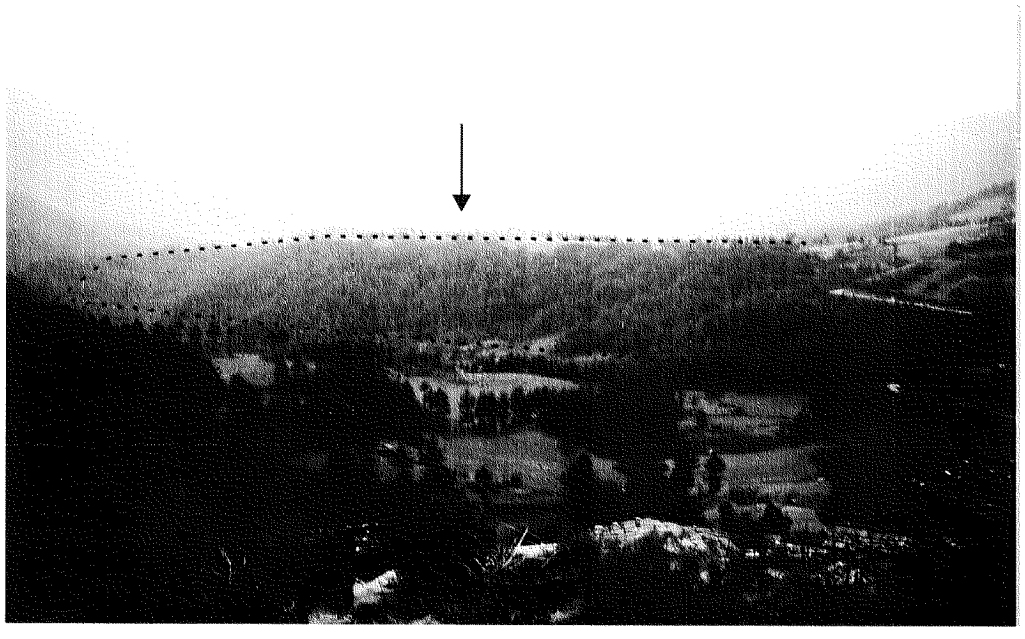


Figure 5-5: During the first half of the 20th century, this large tract of forest comprised *pangzhings*. Tang, 1999.

5.3.3 Traditional entitlement concerning forest uses

Before the promulgation of the Forest Act 1969, all the forests around the villages in Dhur belonged to *khraebas*, whereas the forest further away was common to all. The private forests, near the villages, were called *sogzhing*. Every *khraeba* household had its *sogzhing*. In contrast to the present definition of *sogzhing* — a right to collect litter from a particular patch of forest — Dhur's population still perceived the *sogzhing* as a patch of private forest. The importance of the extraction of wood products in these *sogzhings* was by far greater than the mere collection of litter.

In the past, the households, who did not own *sogzhing* — mainly *szurbas* and *brokpas* — but wanted to extract fire wood, beams or planks in the vicinity of the village, had to seek the permission of the *sogzhing* owner. A compensation for the extracted wood products had to be paid to the *sogzhing* owner either in kind or labour. The importance of the compensation varied with the size of the trees extracted. The alternative for the households

which did not own a *sogzhing*, was to obtain their wood from the forests further away. There they were able to extract wooden products free of cost, but needed more labour to bring them back to the village.

This rule applied for larger wood products entailing the felling of a tree — such as beams, planks or trees for fire wood — or larger quantities — such as small trees for fire wood. The collection of litter in a *sogzhing* was also reserved to its owners, at least in the part which was cleared of its undergrowth to facilitate the litter collection. Further occasional products were also reserved to the *sogzhing* owners. The manufacture of ploughs, a very important product in this context, requires hard wood: in Dhur, thick oak branches were used. Therefore large oak branches belonged to the *sogzhing* owner.

On the other hand, small wood products such as branches and NWFP — as mushrooms, edible and medicinal plants — could be collected freely, even in *sogzhings*.

Trees for shingles, branches for spoons and bamboo (*rû*) could be collected by everyone, since they could be found only in the forest further away.

In Dhur, these traditional entitlements are still widely applied.

5.3.4 Traditional entitlement concerning tsamdrogs and pangzhings

Similarly, during the feudal system, all the pastures near the village belonged to the *khraebas*. For the rent of a *tsamdrog* the herders had to pay 3 *marphog* [36] or 15 *sang* butter. In this case, the land was considered to belong to the *khraebas* and the grass to the cattle herders or *brokpas*. On the other hand, the summer pastures were considered to be fully owned — grass and land — by the *brokpas*.

Today there are still boundaries between the *tsamdrogs* of the *brokpas* and those of the *khraebas*. Usually the *tsamdrogs*, which the *brokpas* use in winter, are grazed by the cattle of the cattle herders in summer. There are also boundaries between the *tsamdrogs* of the cattle herders, who come from Kheng every summer, and the *tsamdrogs* of the villagers, but some *tsamdrogs* of the cattle herder are at the same time *pangzhing* of the villagers.

In Dhur, the *khraebas* have to seek permission of the cattle herder when they intend to cultivate their *pangzhing*, since then the area will not be available for grazing. Until the relatively recent past, as compensation, the *khraebas* had to construct a cow shed for the cattle herders and had to help them to move the cattle from one pasture to the other. This rule was modified approximately 35 years ago. Now the *khraebas* pay the cattle herders a compensation in kind in the form of buckwheat or wheat.

At present, the Forest Act 1969 prohibits the use of fire in the *tsamdrogs*, in order to prevent encroachments. During the feudal system however, the *tsamdrogs* were burned regularly. The villagers reported that it was even an obligation: they feared reprisals from the king, if they did not burn the pastures in time. The winter pastures were burnt during the 2nd month of the Bhutanese calendar (approx. March).

During the first month of the Bhutanese calendar, which is considered to be very auspicious, fires are prohibited for religious reasons. Indeed during the first month, every good deed equals a thousand good deeds realised in an ordinary month and every sin would

36. One *marphog* is equal to 5 *sang*. In Dhur, one *marphog* is approximately equal to 1kg.

weigh as much as 1'000 or more sins. A multitude of insects are killed when the *tsamdrog* are burnt, which constitutes a great sin in the Buddhist religion, so that burning the *tsamdrog* during the first month would multiply the sin.

The *tsamdrogs* were burnt mainly along the borders, in order to avoid the spread of bamboo or trees and favour the regrowth of grass. Every year 1/4 to 1/3 of the *tsamdrogs* were burnt. It therefore took 3-4 years to burn the whole area once. The use of fire was less important in the summer pastures. It was mainly used to obtain firewood and at the same time increase the grassland. During the 9th month (approx. October), before leaving for the winter pastures, a few fires were set to a group of shrubs. The shrubs died off and were used a year later as fire wood.

5.4 Cultural values of trees

5.4.1 Trees, religion and spirits

Trees play a major role for the rituals of purification through fumigation. Daily the villagers offer incense to the Gods[37]. In this relation, Tibetan buddhist texts describe nine purifying "trees"[38] (*bsang-shing*) [Karmay 1995]. Not all these species are as easily found, but juniper is relatively common. Juniper is called in Tibetan "the tree of Gods" (*lha-shing*), probably because it is the species most commonly used for incense. Further, because it is evergreen, juniper is also the symbol for eternity in the Bön religion.

In Vajrayana Buddhism "the term 'sentient beings' includes not just man but all six forms of existence of which man is only one" [Aris 1990]. Therefore villagers in Dhur used to believe that trees were sentient beings, to which one had to present their excuses, when they were going to fell them. Nowadays, however, this practice is fading and is followed only by a minority of people, mostly elderly.

Trees are frequently inhabited by spirits. In Dhur, two types of spirits were encountered: *lu* (*klu*) and *nepa* (see Figure 5-6 and Figure 5-7). Both types of spirits are of pre-Buddhist origin.

The *lu* is a snake-god akin to the Indian *naga*. The lu is the spiritual owner of the underground world [Schicklgruber 1997]. The villagers often build for the *lu*, a small *chörten*-like construction, the *lukhang* [Dujardin 1997].

Whereas the *lu* is a more benevolent spirit, the *nepa* might become dangerous if not respected. The *lus* and *nepas* can be either male or female. The *lu* will be always found in the vicinity of the village and the *nepa* near the village as well as further away in the forest. However, no tree inhabited by spirits was found deep inside the forest around Dhur. Both conifers and broadleaves, old trees as well as young trees, can be inhabited by spirits.

37. A description of the incense used in Dhur is given in section 6.5.3 "Incense".

38. The nine purifying "trees", according to Karmay, are: *a-krong* (designates several plants: *Arenaria, Tanacetum, Thamnolia....*), *Arenaria* sp., *Carex* sp., *Gerbera* sp., *spos-me* (unidentified), *Artemisia* sp., white rhododendron, juniper and sandal wood. Actually most "trees" are herbaceous plants.

In Appendix 7 a map of the village of Dhur is displayed and a list of the trees inhabited by spirits given.

The felling of a tree inhabited by a spirit is believed to cause the illness or even death of the culprit. Sometimes even cutting a single branch of these trees or using wood from a dead tree which had been inhabited by a spirit will incur injuries, illness or death. To sleep under a tree inhabited by a *nepa* is believed to shorten one's life.

Whether a tree is inhabited by a spirit or not is detected by the *tseepa* (astrologer). Usually villagers will consult the *tseepa* to be informed about the cause of an accident or illness. In some cases, the cause of this accident or illness has been related to a *lu* or *nepa*. The *tseepa* then identifies the location of the spirit and will recommend some rituals to appease the angry spirit.

On the other hand, junipers which have been planted are always inhabited by a *lu*.

A little below Saram, in the upper part of Chhoekhor Toe, a large solitary blue pine is known to be a *naamgo*, a "sky door". It is the only *naamgo* known in the region. The population respects this tree, as it is believed that anyone who cuts even a small branch will die on the spot.

5.4.2 Good trees

The population of Dhur distinguishes good trees and bad trees. Similarly to the nine purifying trees, most of the "good trees" are related in one way or the other to religion.

The following two trees are considered to be the best:

- Juniper sp., *Shogseng* (B):

  The juniper trees are good because the whole tree can be offered to the Gods: the needles as incense, the wood as book covers or as planks for the monastery.

  Further, a piece of juniper wood is put inside statues. A piece of juniper wood — as well as a piece of peach wood — is also needed for the cremation ritual.

- Betula utilis, *Takpa* (B):

  Birch wood is good because it is used for carvings to adorn the altar, and as printing blocks for printing books and prayer flags.

Further following trees and shrubs are considered to be good:

- Rhododendron arboreum, *Etho metho* (Dz):

  The rhododendron is considered to be good because its flowers can be offered on the altar.

Figure 5-6: This group of trees in a field nearby Dhur is inhabited by a *lu*. Dhur, 1996.

Figure 5-7: Often a small *lukhang* (*chörten* like structure) is build for the *lu*, more seldom also for a *nepa*, as is the case here. This particular *nepa* is benevolent and protects the village from sicknesses which could come up via the river. Dhur (Menchigang), 1997.

- *Gruman* (Dz)[39]:

  The gruman is an evergreen tree, which often decorates monastery courtyards.

- Acer sp., *Losumpa* (B):

  Maple is a good tree because it produces the best *zhas* (ball-shaped abnormal growths on some stems, see section "6.5.5 Zha and bau"). Cups are made from the *zha* and bring good luck to the house. There are three different maples: *Wombnak* (B), *Langman* (B) and *Wangmela* (B).

- Pinus wallichiana, *Dokseng* (B):

  Blue pine is good because it provides the best construction wood.

- Abies densa, *Wangseng* (B):

  Planks of fir wood provide the best material for religious paintings.

- Daphne bholua, *Shogshoseng* (B):

  The inner bark of this shrub is used to make paper for printing religious books.

- Peach, *Leaksing* (B):

  The fruit can be offered to the Gods. Further a piece of peach wood is needed in the ritual of cremation.

- Berberis sp., *Kipser* (B):

  Evil spirits are chased from one's person, when one passes the thorny branches over his body.

- Taxus baccata, *Kirang* (B):

  Yew is rather seldom. It is a good tree because it is needed to make buckets for carrying water and containers to churn milk.

5.4.3 Bad trees

Some trees are considered to be "bad trees", either because they cannot be used or for some cultural reasons. The following trees are considered to be bad, since they are of little or no use to the villagers:

- Picea spinulosa, *Nakseng* (B):

  If used as timber, spruce brings bad luck to the house. However, with some precautions, one can still use spruce as construction wood: to prevent losing one's good luck when using spruce in the house construction, one needs the religious books "bum" or "domang".

  On the other hand, spruce, poplar and fir planted near the house, will attract bad spirits which will come to inhabit the trees.

39. This tree could not be identified with certainty. Many different trees found during the field work were called "gruman". In this case "gruman" is a small-sized evergreen broadleaf tree.

- Tsuga dumosa, *Peyseng* (B):

  Hemlock should be used only for shingles. If someone makes planks from it, it is believed that the house-wife will get sick, since the hemlock planks render the rooms very cold.

- *Takrang* (B) and *Kiuser* (B)[40]:

  These two shrubs can't be used for anything. For this reason they are bad.

The following trees were classified as "bad" for cultural reasons:

- Populus sp., *Khashing* (B):

  If one plants a poplar near the house, spirits as for example *nepa*, *lu*, or *sabda* (goddess of the earth) will inhabit it. If the poplar dies it is a sign that the owner of the house is to die soon as well.

- *Shinzay* (B), *Shinjung metho* (Dz) (a rhododendron species with red flowers):

  The legend says that when Ashi Nasey went to see a lama, a drop of her menstruation blood fell on a *shinzay* flower. From this time on the flower has been red and the shrubs considered as impure.

- *Khema tajung* (B) (a rhododendron species with red flowers):

  The legend says that Ashi Yetsa was given as wife to the king of Tibet. On her way to Tibet, she used branches of *Khema* as a mattress for the night. Her menstruation blood dropped on the *khema* flower. From this time on, it has been considered as impure.

The importance of religion to the villagers can be seen from these descriptions. Indeed the reasons for considering a tree as "good" or "bad" often have a religious background. Further the practical use, or lack of it, was a criterion for classifying the tree as "good" or "bad".

40.These two shrubs could not be identified. *Kiuser* is a thorny shrub.

6. The forest uses

6.1 Importance of the forest products to the households

During the household survey, the villagers indicated the importance the different forest products have for them (see Table 6-1). Fuelwood was clearly identified by a majority of households of both groups as a very important forest product, whereas timber was perceived as very important product by only 15% and 11% of the households respectively, probably because only few households were concerned at this time with house construction or repair. In a RRA study on NTFP in Western Bhutan, Namgyel also found that the most important NTFP for the villagers was fuelwood [Namgyel 1996]. The collection of bamboo and litter was considered important by a majority of *monpas*, but only by few *brokpa* households. A large majority of the *brokpa* households did not own cattle and therefore did not use litter. *Brokpas* used bamboo for the construction of temporary huts, but mostly classified it as of medium importance.

In the two neighbouring valleys, the results were similar. However in these villages, a higher proportion of households ranked bamboo and construction wood as very important.

Table 6-1: Percentage of households having classified the product as very important (several mentions were possible).
Source: Household Survey 1997.

Product	*Brokpa*	*Monpa*
Fuelwood	89%	95%
Bamboo	26%	60%
Litter	11%	50%
Timber	11%	15%
Edible/medicinal plants	0%	3%

6.2 Fuelwood

6.2.1 Firewood[41]

According to the villagers, in the past, trees were cut for firewood once a year between April and May. The trees for firewood were preferably cut between the 19th and the end of each month, because it was believed that the wood would dry faster then. After the introduction of the Forest Act 1969, the forest service allocated trees for firewood to the villag-

41. Fuelwood is wood used as fuel in a broad sense. It includes firewood. The term firewood is used here as wood used for cooking and heating.

ers twice a year: *jarshing* (summer firewood) in April - May and *günshing* (winter firewood) in October - November. From 1990 onwards, the beat officer came only once per year, in spring, to mark the trees. According to Bumthang's forest ranger, from 1999 onwards, the villagers will be given trees for firewood again twice a year.

Firewood collection was and still is conducted collectively on a basis of mutual help. A group of men will go to the nearby forest and fell the trees. The ideal tree for firewood has to be large and straight with few branches. The villagers will choose the big trees here and there without consideration for the remaining forest stand. The trees are felled, chopped into pieces and the wood is left to dry in the forest, mostly spread out loosely and rarely piled. In autumn, groups of men and women come to carry the dry wood to the village.

In the past, all the forests near the village were designated as *sogzhing*[42] and belonged to the *monpa khraeba*. In Dhur, most of the forests near the village are still considered today to belong to the *khraebas*. The szurbas and the *brokpas* have to barter either butter, salt, or work for trees from the *khraeba's* sogzhing or use trees from the forests further away. Indeed, 29% of the households indicated that they have to pay the *sogzhing's* owner, either in kind (6%), in labour (9%) or in cash (14%), for the trees they fell in his *sogzhing*. This system however was not practised in the other two valleys.

At present, the rural population receives standing trees from the forest service for firewood free of cost. A household is entitled to the equivalent of one truck load or 12 m^3, visually estimated by the beat officer during the marking. The villagers, for their part, count the number of trees, they are allowed to fell. According to the survey, the *monpas* on the average cut yearly 4.6 trees per household and the *brokpas* 2.7 trees. 20% of the *brokpas* households affirmed not receiving any marked tree for firewood. The present system of tree allocation requires the presence of at least one member of the household during the distribution of permits in the village. The *brokpas* usually stay with their herds and rarely come to the village — though more and more *brokpa* families have started some different economical activities and at least some of their members stay permanently in the village. Therefore, they are often informed too late for the distribution of permits or marking.

60% of the households considered the number of marked trees as sufficient. The same figure was found for the other valleys. However, some villagers would prefer to receive more oak and spruce as firewood instead of blue pine.

In addition to the trees, dry wood is collected for firewood. On average, a *monpa* household collects 77 loads[43] and a *brokpa* household 168 loads of dry wood per year. *Monpas* collected the dry wood preferably in winter, because it is the dry season (see Table 6-2). Further, the households have a greater labour capacity in winter, since their children are on holiday. 44% of the *brokpa* households have to collect dry wood during the whole year, because of their semi-nomadic life-style.

42. The villagers are considering themselves as owner of these forests, but legally they have only a user right to collect litter in their *sogzhing*.

43. The weight of a load of wood depends on the strength of the person or child carrying it. The weight of a load varies between 10 kg and 30kg. For the estimate of the weight 20kg was used. The "dry" wood is usually composed of both dry wood and freshly cut shrubs or small trees. The weight therefore is rather the weight of fresh wood than of dry wood.77 loads would roughly correspond to 1'540 kg/year/household or 205 kg/year/person. 168 loads would correspond approximately to 448 kg/year/person. These figures however do not consider the trees felled for firewood. In comparison, Mahat estimated the consumption of fuelwood to be 400-500kg/year/person in the Sindhu Palchok and Kabhre district in Nepal [Mahat 1987].

In the other two valleys, the households collect an average of 184 loads of wood per year. 75% collect dry wood only in winter, 18% collect over the whole year (among them the three *brokpa* households) and 7% do not collect dry wood.

Table 6-2: Period during which dry wood is collected in Dhur (in % of monpa and *brokpa* households).
Source: Forest Resource Use Survey 1999.

Period	Monpa	*Brokpa*
Whole year	25%	44%
Only in winter	63%	44%
Only in summer	3%	3%
Never	10%	9%

82% of the households in Dhur believe that they use the same volume of firewood as 30 years ago, 9% believe that they use more mainly for heating, 5% believe they use less due to the improved stoves and 4% did not know. The proportions are similar in the other valleys.

From the data of the forest inventory, the type of trees used for the different products could be defined. For firewood a large variety of species was used. In terms of volume, blue pine was by far the most common tree species for firewood, followed by oak and rhododendron (see Table 6-3). In terms of number of stumps, however, oak was the most common (see Appendix 19).

Table 6-3: Tree species used for firewood in percentage of the total volume of firewood.
Source: forest inventory 1997-98.

species	In % of volume
blue pine	62%
oak	26%
rhododendron	9%
other broadleaf	2%
hemlock	1%
birch	<1%
spruce	<1%

Figure 6-3 shows the range of diameters of the stumps of trees felled for fuelwood. The extraction of firewood is by far the main reason for felling a tree. Most trees were of small size, with a few bigger individuals: the diameters range from 4 cm to 48 cm.

According to the qualitative data of the forest inventory, trees for fuelwood were extracted along the ridge, near the village and near the pastures (see Appendix 8).

6.2.2 Fuelwood for buckwheat cultivation

The wood which is burnt inside the mounds of earth to fertilize the buckwheat fields[44] is called *lon*. *Lon* is mostly composed of branches collected near the fields. The preferred tree species for *lon* is spruce.

6.2.3 Charcoal

In the past, the *khraebas* had to produce charcoal which was paid as a in-kind tax to the king. Yearly the *khraebas* had to provide one basket filled with charcoal. The baskets are loosely woven from bamboo, so that they are composed of solid woven parts of bamboo and empty spaces or "holes". The size of a basket was defined through its number of holes. A basket with 60 holes (see Figure 6-1) was required as charcoal-tax. When the basket was too small, the villagers were fined 1 *Nu*[45] or 1 *dré*[46] wheat per missing hole. The charcoal was used by the blacksmiths and goldsmiths working for the king.

To process charcoal, the villagers dug holes and set a fire in it. Branches of blue pine and spruce were added one by one to the fire. Once sufficiently burnt, the branches were taken out of the fire and dropped in water to stop the combustion. None of the households in the study area produces charcoal any more.

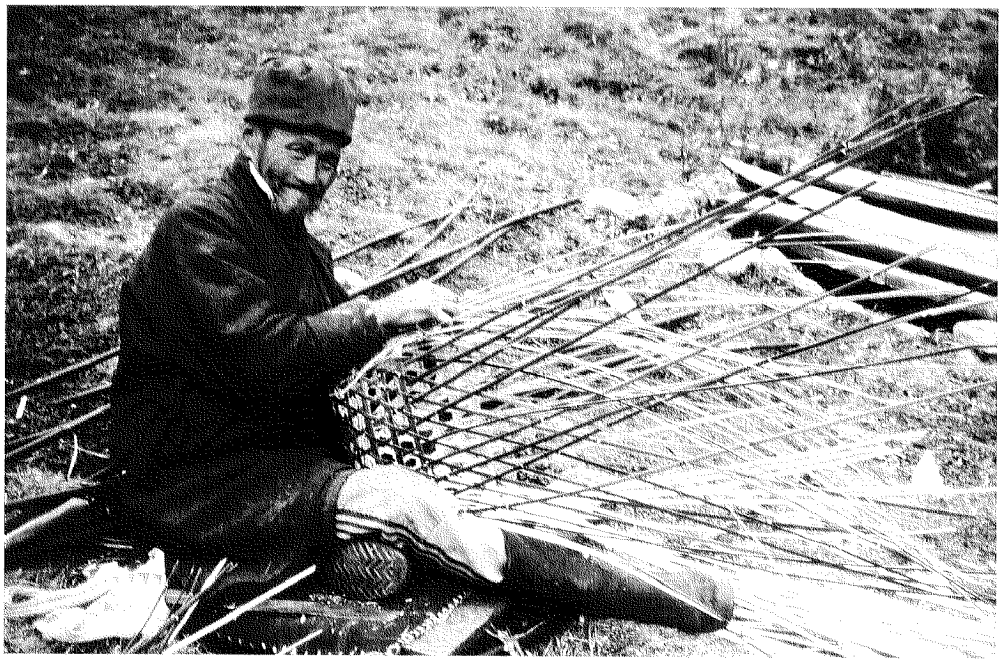


Figure 6-1: Weaving of a basket from bamboo. Tang (village of Tasur), 1996.

44. The cultivation of buckwheat fields is described in Section "6.6 Pangzhing".

45. *Nu* = *Ngultrum* (Bhutan's currency).

46. *Dré* = volume unit (in Bumthang approximately 2.1 liter or 1.7 kg wheat).

6.3 Construction wood

6.3.1 Beams

The villagers distinguish between two types of beams: *chams* and *khows*. *Chams* are beams of approximately between 20 x 20 cm and 30 x 30 cm with a length of approximately 3 to 4 m. *Khows* are beams of smaller dimensions — approximately 10 x 10 cm to 15 x 15 cm. The section of the beams can be rectangular or square. *Chams* are the main elements for house construction. Indeed, the foundation of the house is often constituted of stones, but the house itself is constructed of beams, which form the main structure. The walls are made out of woven bamboo covered with clay. *Khows* are used to supplement the frame of the walls, but do not have an important bearing function. The floors are of wooden planks.

Chams are commonly made from blue pine, because this wood does not warp while drying. When blue pine isn't available, fir might be used, because the inner part of the fir is dry. But the beams of fir contract when the temperature changes and fills the house with noises. Spruce is sometimes used for beams supporting the roof.

According to tradition, trees for *chams* can be cut during the whole year, but preferably between the 1st and 19th of every month[47], as the beams will last longer when the tree is felled within this period. However, the first and third month (approximately: February and April) are preferred. Men fell the trees. The work is done, as in the case of firewood, with the mutual help of other villagers.

The *cham* is processed with an axe by removing the excess wood from the round stem (see Figure 6-2). *Chams* are processed immediately after felling, because the fresh wood is easier to split. From an ideal tree — straight without branches and with cylindrical stem — up to three chams can be extracted, though most trees only yield one to two *chams* and one *khow*. *Khows* are by-products of the *chams*: a tree is never felled for *khows*, but only for *chams*. The *chams* are left in the forest to dry. Once dry, the men will carry them on their back to the village. Animal draft was never used for the transport of wooden products. The footpaths are too rough for a horse to pull a cham. Further, *chams* are too long to be placed on the horse's back. Therefore only the extracted products (*chams* and *khows*) will be carried to the village. The remaining splinters and logs are left in the forest.

To process *chams*, the villagers will go as far as needed in the forest to find a tree with the following characteristics: straight, with few branches and a cylindrical stem (more or less constant diameter with increasing height). In the forest inventoried, the trees for *chams* were felled mainly in the blue pine forests with oaks, in the proximity of the footpaths[48]. All but one of the stumps of trees felled for chams in the forest inventoried were blue pines. The diameters of the stumps ranged between 17 cm and 51 cm, with an average of 32 cm (see Figure 6-3). The tree is chosen with a slightly bigger diameter than the dimension of the beam required. In their *sogzhing*, the villagers will choose a tree here and there, in the government forest, however, they choose to fell the trees in groups. The location of the trees felled for *chams* in the forest inventoried is shown in the map in Appendix 9. As for firewood, some households in Dhur indicated that they have to pay for the trees to the *sogzhing* owner in addition to the royalty they pay to the forest service.

47. This period corresponds to the waxing moon, full moon and beginning of waning.

48. The areas where trees are felled for *chams* in the forest inventoried is shown in Appendix 9.

During the interviews, the households indicated the quantity of *chams* they have used during the past 12 years[49] (see Table 6-4). More than half of the households have not used any *chams* during the past 12 years. The *monpa* have used slightly more chams, but the difference is not very important. This slight difference is also confirmed by the age of the houses. More *monpas* (33%) than *brokpas* (17%) have a new house (see also Section 5.1.6 "Housing").

In the other two valleys, the results are similar to those for the *monpas* in Dhur, though a slightly higher percentage of households have used between 200 and 299 *chams* during the past 12 years (see Appendix 21).

Figure 6-2: Processing of a beam, below the village of Dhur, 1997.

49. The Bhutanese calender knows a cycle of 12 animals, one animal being attributed to every year. The question was: how many *chams* did you use between this and the previous "Tiger year"?

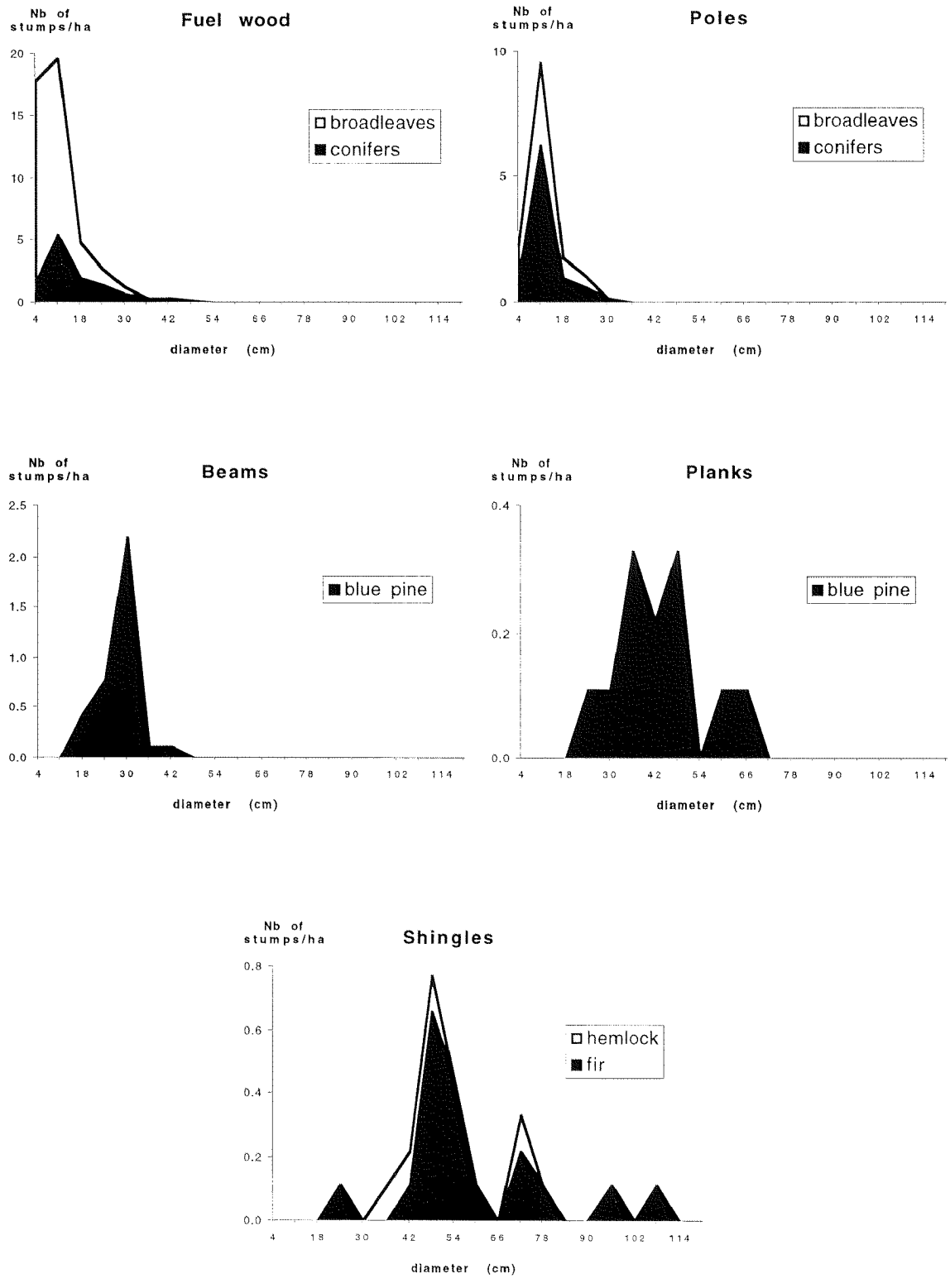


Figure 6-3: Overview of the diameter range of stumps according to the product. The number of stumps per ha was calculated over the entire forest, in order to indicated the relative importance of the products. Source: forest inventory 1997-98.

One third of the households estimated that they used the same number of *chams* before the introduction of the Forest Act (see Table 6-5). The *monpa* mostly considered to have used fewer *chams* before the Forest Act 1969 and have increased their consumption since. The villagers in remaining part of Chhoekhor Toe and Tang had a similar opinion to that of Dhur *monpas*.

All households in the three valleys use *chams*, which are chopped by axe, with the exception of three households who live in huts and do not use chams. 56% of the households declared themselves willing to use *chams* from a sawmill — provided they can afford it and that the sawmill is in the vicinity of the village — mainly because it would facilitate their work (see Table 6-6). 4% households believed that they would get more products (beams and planks) from a stem when sawn by a sawmill. 40% of the households would not consider using *chams* from a sawmill, mainly because they think they cannot afford it or because they do not plan to use any. The argument that the quality of sawn *chams* is inferior to the chopped ones was adopted by only 4%.

Table 6-4: Percentage of households in Dhur according to the number of *chams* used during the last 12 years. Source: Forest Resource Use Survey 1999.

No. of *chams*	***Brokpa***	***Monpa***
none	63%	51%
less than 10	3%	3%
10-49	13%	14%
51-99	8%	3%
100-199	13%	19%
200-299	3%	3%
>300	0%	5%
don't know	0%	3%

Table 6-5: How many *chams* did you use before the introduction of the Forest Act in 1969? In % of households. Source: Forest Resource Use Survey 1999.

	Dhur: *brokpa*	**Dhur: *monpa***	**Other villages**
more	20%	14%	10%
same	35%	35%	35%
less	28%	43%	53%
don't know	18%	8%	3%

Table 6-6: Would you use chams from a sawmill? In % of households.[a]
Source: Forest Resource Use Survey 1999.

Justification	yes	no
Less work	52%	-
More products	4%	-
Cost	-	21%
Do Not need *chams*	-	14%
Quality	-	4%
Transport	-	1%
Total	**56%**	**40%**

a. 4% did not know.

6.3.2 Planks

Planks are called *pang* in *Bumthangkha*. They are used mainly for the floors and carpentry work (for example: wooden boxes, shelves, *chodom* and *choezom*[50]). In some houses, the ceiling of the upper floor is made with planks. These planks are called *naampang*.

The villagers indicated that they go to the forest to process planks in small groups of 2-3 men, depending on the amount of work to be done. They choose trees of bigger dimensions than for chams, but with the same characteristics (straight, few branches, cylindrical bole)[51]. The planks are processed traditionally by axe, though nowadays a few carpenters have a saw to process planks. With an axe, the villagers might extract 12 to 17 planks from a good tree, 1 to 10 planks from a tree of lower quality. Planks are processed from freshly cut wood, since it is easier to split. Only blue pine might be used, because the wood of other species warps while drying.

Table 6-7: Percentage of households in Dhur according to the number of planks used during the last 12 years. Source: Forest Resource Use Survey 1999.

No. of planks	*Brokpa*	*Monpa*
none	63%	54%
less than 10	5%	3%
10-20	8%	0%
20-50	5%	19%
50-100	15%	19%
100-200	0%	3%
more than 200	3%	0%
don't know	3%	3%

50. *Chodom*: small table; *choezom*: altar.

51. The areas where trees are felled for planks is shown in Appendix 10.

Most households (in Dhur: 63% and 54% respectively) indicated that they have not used any planks during the past 12 years (see Table 6-7 and Appendix 22). These results do not differ considerably from those for the *chams*. Planks are mainly needed when a new house is constructed at the same time as a household also needs *chams*. The villagers indicated that planks last several decades or even centuries, since they do not get in contact with water and therefore planks only seldom need to be replaced.

Only a minority of households (20% and 14% respectively in Dhur), as it was the case for the *chams*, considered they needed more planks before the introduction of the Forest Act 1969 (see Table 6-8).

The acceptance of sawn planks is even higher than for the sawn *chams* (see Table 6-9 and Appendix 24). 71% of the households in Dhur and 78% of the households in the other villages declared themselves willing to use sawn planks, provided they could afford it and that the sawmill was in vicinity of the village. The main arguments were that using sawn planks would necessitate less labour and that a higher number of planks could be extracted from a log with a saw.

Table 6-8: How many planks did you use before the introduction of the Forest Act in 1969? In % of households. Source: Forest Resource Use Survey 1999.

	Dhur: *brokpa*	Dhur: *monpa*	Other villages
more	20%	14%	10%
same	38%	35%	35%
less	25%	43%	53%
don't know	18%	8%	3%

Table 6-9: Would you use planks from a sawmill? Source: Forest Resource Use Survey 1999[a].

Justification	yes	no
Less work	36%	-
More planks	19%	-
Quality	7%	-
Lack of labour	5%	-
Time	3%	-
It will be compulsory	1%	-
Cost	-	13%
Do Not need planks	-	12%
Total	**71%**	**25%**

a. 4% did not know.

6.3.3 Shingles

Shingles are called *mong* in *Bumthangkha*. Shingles were and still are largely used to cover the roofs of the houses. Only few families who can afford it cover their roofs with corrugated tin sheets.

According to the villagers of Dhur, the intention of processing shingles has to be kept secret, otherwise evil spirits will affect their work and prevent them finding a good tree. A group of men will gather secretly and leave early in the morning for the forest. There they will choose a tree of big dimensions. Indeed, during the inventory, the measured stumps of trees felled for shingles had an average diameter of 72 cm, with diameters ranging from 26 cm to 140 cm (see Figure 6-3 and Appendix 19). Juniper is the preferred species, but it is very rare in the forests around Dhur. Consequently the villagers use fir for their own needs and sometimes spruce or hemlock for other people. Once they have found a tree which seems to be suitable, they hit the stem to hear whether the tree is sound or rotten. If the tree seems sound, they cut a piece out of the tree and test the piece extracted trying to split it. If the fibres are straight and the test piece easy to split, they proceed with felling the tree. Otherwise, the tree is left with its "window" (see Figure 6-4).

Figure 6-4: Fir with a "window". Lame Gompa, 1992.

The tree is felled with an axe and the lower part of the stem is cut into sections. The shingles are processed by splitting the wood with a knife and hammer (see Figure 6-5). The upper part of the tree remains untouched. The shingles are left to dry for one year in the forest. Both men and women will then carry them to the village. Nowadays the villagers need a permit and have to wait for the marking. However, the villagers choose the tree, they would like to have marked. This choice is crucial: if the tree turns out to be unsuitable for shingles, the villager has to start the procedures for a new permit again. In the forests of this study, the trees felled for shingles were located in fir forests and mixed fir and hemlock forests, near the ridge and the footpaths. The locations are shown in Appendix 11.

Figure 6-5: Processing of shingles, Dhur, 1997.

In the study area, the villagers count the shingles in pairs. The number of pairs of shingles needed to cover the roof depends on the size of the house. On average in Dhur, the *brokpas* needed less shingles than the *monpas* to cover the roof of their house, since their houses are often smaller (see Table 6-10). In the other two valleys, the consumption of shingles is notably higher, with 76% of the households using over 500 pairs of shingles.

Table 6-10: Number of pairs of shingles needed to fully cover a roof in percent of the households. Source: Forest Resource Use Survey 1999.

No. of pairs	Dhur: *brokpa*	Dhur: *monpa*	Other villages
no shingles	5%	8%	3%
1-250	38%	26%	5%
250-500	23%	21%	18%
500-1000	23%	18%	48%
>1000	0%	21%	28%
don't know	13%	5%	0%

A roof covered with shingles needs maintenance. Every second year, the shingles have to be turned. Every three to six years they have to be replaced (see Table 6-11). The old shingles are used as firewood. In Dhur, most households replace the shingles every three years. The *monpas* tend to replace the shingles more frequently than the *brokpas*. In the other two valleys, the majority of households replace the shingles every four to six years.

Most households in Dhur replace 25% to 50% of their shingles at a time (40% of the households) or 50% to 75% of their shingles (40% of the households). 16% of the households even replace more than 75% (see Table 6-12). In the other two valleys, fewer households replace more than 75% of the shingles and 92% replace 25% to 75% of the shingles.

Table 6-11: Frequency of the replacement of shingles in percent of households. Source: Forest Resource Use Survey 1999.

Frequency	Dhur: *brokpa*	Dhur: *monpa*	Other villages
every 1-2 years	3%	3%	3%
every 3 years	45%	54%	25%
every 4 - 6 years	37%	34%	53%
every 7- 12 years	11%	6%	20%
don't know	5%	3%	0%

Table 6-12: Percentage of shingles which get replaced every time. Source: Forest Resource Use Survey 1999.

% shingles replaced	Dhur	Other villages
<25%	5%	5%
25-50%	40%	38%
50-75%	40%	54%
>75%	16%	3%

On the average a household in Dhur needed 23 pairs of shingles per year. From the indications of the villagers in Dhur, one can extract an average of 110 pairs of shingles from a tree. This figure was confirmed by the indications in the other two valleys, where the villagers said they extracted 120 pairs of shingles on the average from a tree. The consumption of shingles was much higher in the other two valleys however: on the average a household needed 78 pairs of shingles per year. This fact is related to the larger average size of the houses in these villages and therefore to the higher number of shingles needed to cover the roofs.

6.3.4 Poles

Poles are used for various purposes:

- For fences in the garden: often willows are planted to serve as living poles;
- For fences around the fields: to protect the fields against cattle and game;
- For small fences to keep the young yaks together in the night;
- For huts: small huts are constructed in the fields. People stay in these huts to watch their fields at night to protect their crops from wild boars;
- For cow sheds: since 1992, by a decree of the *Dzongda*, the villagers in Bumthang have been forbidden to keep their cattle inside their houses any more. Cow sheds are constructed outside the village;
- For prayer flags: long, straight and slender stems are needed, therefore only conifers can be used. For recurring festivities, as for example *Losar*[52], the same pole is used for several years. New prayer flag poles are needed on special occasions, for example the death of a family member. The use of trees for prayer flag poles is therefore sporadic.
- Short poles are needed to tether animals.

In Dhur 64% of the households had cut trees for poles during the previous year in order to make fences (see Table 6-13). The proportion is even higher in the other two valleys: indeed 95% of the households had used poles for fences in the previous year. The difference can be explained by the composition of the population: in Dhur, most *brokpas* do not own fields or garden and therefore do not need to fence them. 23% of the households in Dhur used poles for other purposes, mainly to tie animals, whereas in the other two valleys only 5% of the households did so. Further 22% (35% in the other villages) of the households in Dhur needed poles to construct or repair huts and 5% (10% in the other villages) used poles to construct or repair sheds.

38% of the *brokpa* households and 22% of the monpa households claimed not having cut any tree for poles during the previous year (see Table 6-14). The monpas of Dhur used slightly more poles than the *brokpas*. 60% of the households in the two neighbouring valleys indicated using more than 30 trees for poles in the previous year.

52. New year. The date of the new year varies, but it is generally in February.

Table 6-13: For what did you use poles last year? Answers in percent of households. Source: Forest Resource Use Survey 1999.

Purpose	Dhur	Other villages
fence	64%	95%
hut	22%	35%
cow shed	5%	10%
other	23%	5%

Table 6-14: How many trees did you fell for poles last year? Answers in percentage of households. Source: Forest Resource Use Survey 1999.

No. of poles	Dhur: *Brokpa*	Dhur: *Monpa*	Other villages
none	38%	22%	5%
1-10	15%	35%	8%
10-20	25%	14%	18%
20-30	5%	14%	8%
30-50	5%	5%	25%
>50	10%	8%	35%
don't know	3%	3%	3%

Trees for poles can be felled at any time, by both men and women, except for the prayer flag poles. Only men can fell a tree for a prayer flag pole. The most often mentioned species used for poles was blue pine: 41% of the households in Dhur and 68% of the households in the other villages stated that they used blue pine for poles (see Table 6-15). In Dhur 31% of the households (23% in the other villages) have planted willow trees for fencing. In the two neighbouring valleys, 40% of the households have used several species of broadleaves and shrubs (e.g.: poplar, buckthorn, oak, shrubs). During the inventory a wide variety of tree species used for poles were recorded. Most stumps found in this category were of blue pine or oak, followed by maple, spruce, hemlock, fir and others (see Appendix 19). Their diameters ranged from 3 cm to 28cm, with an average of 12 cm (see Figure 6-3). The smaller poles were probably used to tether animals and the larger ones for the construction of huts or sheds.

Table 6-15: What species do you use for poles? (Several answers were possible). Source: Forest Resource Use Survey 1999.

Species	Dhur	Other villages
blue pine	41%	68%
willow (alive)	31%	23%
rhododendron	21%	13%
other conifer	23%	10%
other broadleaves	21%	40%

6.4 Small wood products

6.4.1 Torch wood

Kuan is the local name for torch wood. Torch wood, also sometimes called candle wood, is wood soaked with resin. The shedding of resin is a natural reaction of some trees in response to a wound. The freshly uncovered wood "bleeds" and the resin protects it from rotting or insects. Torch wood is used for lighting fires (it is then called *metikuan*), to produce light in the house or as torch. 63% of households in Dhur still use *metikuan* regularly to start fire. *Kuan* as source of light and torch has now been fully replaced by kerosene lamps and electric torch lights by 70% and 72% of the households respectively (see Table 6-16 and Appendix 25). However, when kerosene is not available, some households have recourse to *kuan*.The results of the survey did not show significant differences in the use of *kuan* between *monpas* and *brokpas*.

Table 6-16: For what do you use kuan? In % of Dhur's households. Source: Forest Resource Use Survey 1999.

	start fire	light	torch
regularly	63%	4%	9%
sometimes	9%	26%	19%
only in the past	28%	70%	72%

Kuan is produced exclusively by blue pines. Some blue pines exude *kuan* without having been hurt by a villager. Other trees are wounded purposely to induce the shedding of resin and to initiate the production of kuan. When seeking a *kuan seng* (tree containing torch wood), the villagers look out for big pine trees with an elliptical stem or leaning trees. Drops of resin on the bark are believed to be an indicator of the presence of kuan inside the tree. When such a tree is found, a part of the tree will be cut at men's height. Periodically *kuan* will be extracted from the tree until the tree breaks or dies. The villagers reported that they usually extract *kuan* every year for about 20 years until the tree dies. About 6-7 baskets of *kuan* can be extracted from a tree. *Kuan* is usually extracted at man height. In a few cases however, a simple ladder, made of an assemblage of 1-3 poles, is used to extract *kuan* higher up on the tree (see Figure 6-6).

Candle trees can be used by anyone. There isn't any ownership claim, even if the tree is located on a sogzhing.

Around the village, few trees qualify for *kuan* production, since they are mainly of small dimensions, so the villagers go further away to collect *kuan*. The location of some *kuan* trees in the forest inventoried is shown in Appendix 13. Usually men collect *kuan*. They mostly go to the forest only to collect *kuan* or sometimes collect it while herding the cows. Since *kuan* trees are generally deep in the forest, the men will go in small groups for safety reasons. *Kuan* might be collected at any time of the year. In the past, *monpas* used to collect *kuan* monthly.

On the average, the *monpa* households in Dhur said they had collected 19 baskets per year in the past; those from the other two valleys 23 baskets per year (see Table 6-17). *Brokpas* collected *kuan* several times during the winter for their consumption in the winter pasture and once in spring (one to three yak loads) to carry it to their summer pasture. On the average a *brokpa* household collected 11 baskets per year. In the past the consumption of *kuan*

of the *khraebas* did not show significant differences from the one of the *szurbas*, though it had been expected that the *khraebas* used more kuan, since they previously had to pay taxes in form of *kuan* and soot.

Figure 6-6: A candle tree (*kuan seng*, B.) below Lusbi. The two poles allow the villagers to climb and extract the kuan a little further up on the tree.

The consumption of *kuan* has dropped drastically nowadays, due to the ban on *kuan* extraction: on average the *monpa* households said that they now collect 2 baskets yearly and the *brokpas* 0.7 baskets yearly. The consumption of *kuan* is probably slightly higher, since some households were reluctant to answer the questions related to the extraction of *kuan*. The *kuan* is mostly extracted from living trees, but is also found, in smaller quantities, together with firewood. To make some interviewees feel more comfortable, it was agreed that "the *kuan* was found together with the firewood".

The *brokpas* mentioned several times that they preferred to use kerosene, because 5 litres of kerosene produce as much light as 40 kg of *kuan*, but is much easier to carry. Further, the use of kerosene is preferred because kuan produces a lot of soot while burning. On the other hand, *kuan* gives a brighter light than kerosene and is not easily extinguished by the wind.

During the feudal system, the *khraebas* used to have to pay three baskets of *kuan* every year as tax: one basket during the 6th month of the Bhutanese calendar for the Kurjey *lhakhang* (monastery), one basket on 7th month for the Jambay *lhakhang* and one basket on 9th month for the *dzong*[53]. In addition to this every *khraeba* household had to give 9 *dré* soot (*jout phi*) as tax. The soot was collected from the *kuan* which was used as light in the houses. Two stones were embedded in the wall: on the lower one the burning chips of *kuan* were laid and the soot was collected on the upper one (see Figure 6-7). The soot was sent to Punakha and used as ink, for writing the holy books and printing the prayer flags.

Table 6-17: Average number of baskets of kuan extracted yearly by the households. Source: Forest Resource Use Survey 1999.

	Dhur: monpa	Dhur: *brokpa*	Other villages
nowadays	2.0	0.7	2.3
50 years ago	19.3	11.0	22.8

Figure 6-7: A "*kuan* holder" in a old house in Dhur. The *kuan* is laid on the lower stone. The soot is collected on the upper stone. Dhur, 1996.

53. Approximately July, August and October respectively.

6.4.2 Oak branches

The oaks in the surroundings of the village are regularly lopped. The branches are cut mainly for two purposes: for fodder and for firewood. When the ground is covered with snow and the cattle cannot find grass, the villagers cut oak branches and leave them on the ground, so that the cattle can feed on oak leaves. However, according to W. Roder (pers. com.), the nutritive value of these leaves is very low. After some weeks, the branches are collected and used as firewood. Every year during the second month (approximately March), the oaks are lopped and their branches used as firewood. The same trees are lopped again on the average 6-7 years after the first cut.

53% of the households in Dhur said that they lopped oaks, in equal proportions in the government forest and in their *sogzhing*. On the average, these households lop 5 trees per year. The oak trees standing in a sogzhing are considered by a large majority of households to belong to the *sogzhing's* owner. The oaks standing in the government forest however are believed to be free for anyone to use.

Oak wood is further used for following purposes:

- ploughs
- sharp points of ploughs
- axe handles
- spade handles
- racks

6.4.3 Other small wood products

Wood is also used for the processing of a multitude of small objects needed in rural life. For each utensil, the wood of a certain tree species is preferred. For example, birch is preferably used for spoons, whereas a knife handle is made from maple or willow (see Table 6-18).

Table 6-18: Preferred species according to the utensils.
Source: Checklist in Cultural Ecology.

Utensil	Preferred species
spoon	birch
bath tub	birch
guitar	birch
bowls	maple (*zha* or *bau*)
knife handle	maple or willow
spindle	willow
knife cover	fir

6.5 Non-Wood Forest Products

6.5.1 Bamboo

The most important non-wood forest product in the study area is a tall variety of bamboo: *rû* in the local language (*Borinda grossa*). Young shoots of bamboo are called *shi*. *Rû* is used for many purposes:

- baskets for carrying (see Figure 6-1);
- containers or baskets;
- mats;
- fences (see Figure 6-8);
- inner walls of houses;
- ceilings;
- walls and roof for huts and sheds;
- flat plates;
- supports for round-bottomed pots;
- filters (for *bangchang*[54]);
- ropes (from *shi*, see Figure 6-8);
- containers for churning milk[55].

Rû is found in hemlock forests, in wet areas and along streams. The areas in the forest inventoried where *rû* is collected are shown in Appendix 12. *Rû* is further collected along four streams south of the forest road, and mostly by men. When large quantities of *rû* are needed, as for a house construction, women will participate in the extraction of *rû*. The bamboo stems are cut. The *rû* are hung in pairs over an horizontal stick — therefore *rû* is always counted in pairs. This stick is tied on the shoulders of a person, who will pull the assemblage. A person can pull 15 to 40 pairs of *rû* depending on his or her strength.

The yearly consumption of *rû*, according to the villagers, is shown in Table 6-19. It seems to be lower in Dhur than in the other villages. In the two neighbouring valleys, 35% of the households indicated that they used more than 500 *rû* per year, whereas in Dhur only 22% of the monpas' and 3% of the brokpas' households used this quantity. In Dhur, the brokpas use less *rû* than the monpas. The monpas use great quantities of *rû* to make fences for their fields, whereas brokpas need mats to construct small huts. Two mats produce a waterproof roof for their shelters.

In Dhur, most households estimated that they still use the same quantity of *rû* as they did 50 years ago, whereas in the other villages the households believed they had increased their consumption (see Table 6-20). These perceptions, however, were closely linked to the situation of the individual households: households with only elderly people generally consumed less in the way of products. A household which has grown numerous over the last decades needs more products.

---

54. *Bangchang* is a variety of home made beer. Boiling water is added to fermented wheat in a pot. The filter is placed inside the pot. The *bangchang* is extracted by pressing the wheat and filtering the beverage through the bamboo filter.

55. To make containers to churn the milk, the *rû* has to be placed in the fire, so that it is bursting. The flat burst pieces of *rû* can then be processed to a container.

Table 6-19: Yearly consumption of *rû* in percent of the households.
Source: Forest Resource Use Survey 1999.

Numbers:	Dhur: *brokpa*	Dhur: *monpa*	Other villages
none	5%	16%	15%
1-100	50%	24%	13%
100-200	33%	22%	18%
200-500	10%	19%	20%
>500	3%	22%	35%

Figure 6-8: This villager is making a rope of bamboo. In the background a fence made from bamboo can be seen. Dhur (Menchigan), 1996.

Table 6-20: Evolution of the consumption of *rû* in the last 50 years, in percent of the households. Source: Forest Resource Use Survey 1999.

	Dhur	Other villages
decreased	28%	25%
remained same	40%	33%
increased	24%	43%
don't know	8%	0%

Some households plant *rû* in their garden. This practice was found to be rather common in Dhur, where 29% of the households had *rû* in their garden (see Table 6-21). It was less common in Chhoekhor Toe, with 15% of the households having *rû* in their garden, and not planted at all in the gardens of Tang. In Dhur, 48% of the gardens were planted with *rû* many generations ago.

Rû was planted in the gardens for several reasons. Until the middle of the 20th century, each *khraeba* household had to give one bamboo basket per year as tax. Only a little is needed to make a basket. To avoid long walks in the forest, some households planted *rû* in their garden. However, 44% of the gardens in Dhur have been planted with *rû* during the past 15 years and all the *rû* gardens in the other villages of Chhoekhor Toe were planted recently. The villagers indicated that one reason for now planting *rû* in their garden was that in future they might have to pay a royalty on it. They planted *rû* in their garden to make sure that they will continue to have access to this product.

Rû planted in a garden is unanimously considered to belong to the owner of the garden. For the ownership of the *rû* in the government forest the answers diverged: 78% believed that it belongs to everybody, 21% that it belongs to the government and 1% that it belongs to the village.

Table 6-21: When was planted the *rû* in your garden? Answers from Dhur in percent. Source: Forest Resource Use Survey 1999.

Time	% of *rû* gardens
1-5 years ago	22%
6-15 years	22%
16-50 years	13%
>50 years	48%

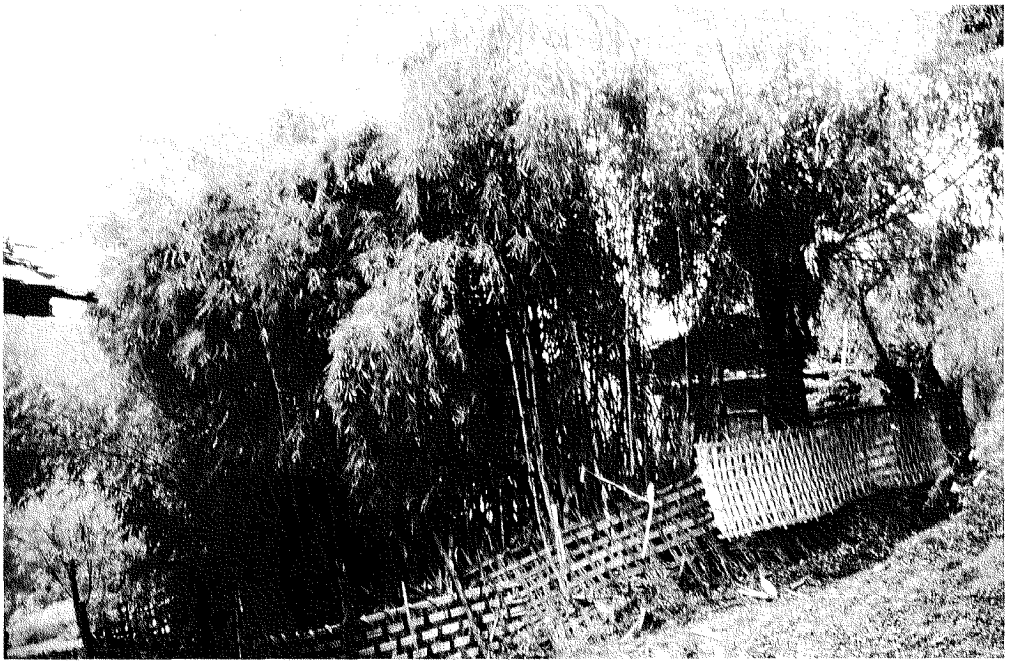


Figure 6-9: *Rû* in a garden in Dhur (Hjawang), 1996.

The other bamboo species which can be found in the study area are far less important. They are used for:

- *Mek* (*Yushania microphylla*) is used for brooms.
- *Mek shi* (young shoots of mek) is used for ropes to assemble the fences.
- *Migma* (*Temnocalamus*?) is used for brooms.
- *Rû jong mi* ("small rû") is used for arrows.

6.5.2 Litter

Dry pine needles and, to a lesser extent, fern are collected and used as litter in the cow sheds. This litter is called *sho* in *Bumthangkha* and *sog* in *Dzongkha*. The used litter, composed of pine needles mixed with dung, is spread in the fields as fertilizer. *Sho* is mainly composed of dry pine needles and therefore collected exclusively in blue pine forests. The areas where *sho* is collected in the forest inventoried are shown in Appendix 14. Some families own *sogzhing*: a patch of forest, where they have the usufruct right to collect litter. To make the collection of *sho* easier, the *sogzhing* is cleared of shrubs and undergrowth. The collection of *sho* is done mostly by women. They collect the pine needles with racks and carry the *sho* in specially big baskets (*sho tsang*).

Since *sho* is used as litter for cattle, it is collected mainly by *monpas*. Indeed 68% of the *brokpa* households said that they did not collect *sho* (see Table 6-22). Most households collected 10 to 25 loads of *sho* per year. 55% of the *sho* was collected in *sogzhings*, 43% in the government forest and 2% in the *pangzhings*. The proportions were similar in the other two valleys, with a slightly higher proportion (6%) collected in *pangzhings*.

In the past, *sho* was collected once a year during the 10th month of the Bhutanese calendar (approx. November). The *sho* was then piled up near the house (see Figure 6-10). Now most families collect the *sho* little by little throughout the whole winter (dry season) or, in rare cases, throughout the whole year (see Table 6-23).

77% of the households of Dhur said that the *sho* in a *sogzhing* belongs to the *sogzhing* owner (see Table 6-24). In the past, all the forest around the village was considered to be the *khraebas*' sogzhing. The *szurbas* had to go a long way to collect their *sho*.

Table 6-22: Number of loads of litter collected yearly, in percent of the households. Source: Forest Resource Use Survey 1999.

	Dhur: *brokpa*	Dhur: *monpa*	Other villages
0 loads	68%	18%	27%
<10 loads	10%	10%	13%
10-25 loads	15%	50%	35%
25-50 loads	5%	10%	15%
>50 loads	2%	12%	10%

Table 6-23: Frequency of *sho* collection, in % of the households. Source: Forest Resource Use Survey 1999.

	Dhur	Other villages
Several times per year	40%	48%
Once per year	15%	28%
Never	44%	25%
Don't know	1%	0%

Table 6-24: Ownership of the *sho* in the *sogzhing* and in the government forest according to Dhur's population, answers in percent of the households. Source: Forest Resource Use Survey 1999.

	in the *sogzhing*	in the forest
sogzhing owner	77%	0%
common good	17%	91%
government	0%	4%
don't know	6%	6%

Nowadays some *sogzhing* owners tolerate the *szurbas* collecting sho from their *sogzhing* in those areas which have not been cleaned of shrubs and undergrowth vegetation. Probably for this reason, 17% of the households in Dhur and 29% of the households in the other villages indicated that the *sho* in the *sogzhing* is a common good. 91% of the households in Dhur and 98% of the households in the two neighbouring valleys considered that the *sho* in the government forest is a common good. A majority of the households in Dhur and in the other villages considered that their consumption of *sho* has not changed during the past 50 years (see Table 6-25).

Traditionally, the cattle were kept overnight in the ground floor of the houses. A decree of the *Dzongda* in 1992 imposed the villagers to build separate cattle sheds. As the population of wild dogs seems to have decreased, the cattle is now left more often outside. Therefore the villagers need less *sho*. On the other hand, some *brokpa* households, or part of these households, have settled permanently in the village and started rearing cattle and therefore have begun to collect litter.

Table 6-25: Evolution of the consumption of litter in the past 50 years, in percent of the households.
Source: Forest Resource Use Survey 1999.

	Dhur	Other villages
decreased	23%	13%
remained same	61%	70%
increased	10%	17%
don't know	6%	0%

Figure 6-10: Litter consisting in dry pine needles.
Chhumme, 1996.

6.5.3 Incense

Incense is part of everyday life in a Bhutanese village. It is burnt every day in small ovens in front of the houses, needed in the religious ceremonies and offered in temples. Three main types of incense have to be distinguished:

- *sang* (from blue pine): fresh blue pine needles and branches (sometimes also fir and rhododendron);
- *sang* (*balu-solu*): loose and dry incense, collected locally from various plants;
- *peu*: commercially prepared incense sticks.

The blue pine needles are generally offered daily in small ovens outside of the house. The other two incenses, "*balu-solu*" and *peu*, are offered on the altar in the house or in the temples.

Fresh branches of blue pine are collected the whole year round in the vicinity of the villages. The households collect small quantities at a time: ranging from one bundle daily to one basket monthly. The *brokpas* do not always find blue pine on their winter pasture; they then use fir and Rhododendron species instead.

The "*balu-solu*" incense is a mixture composed of several of the following plants:

- *Balu: Rhododendron anthopogon*
- *Solu: Rhododendron nivale*
- *Shog seng: Juniper sp.*
- *Pampoe: Nardostachys jatamansi*
- *Khema (Rhododendron sp.?)* and *khamgar.*

"*Balu-solu*" is collected mainly by the *brokpas* from their summer pastures. Some households collect the incense once and dry it, others collect small quantities daily or weekly. The average yearly consumption is one to two rice bags of *balu-solu* per household. In Dhur, some *monpa* households collect "*balu-solu*" on the mountain above their village (Rala Phola). Other *monpa* households in Dhur and in the neighbouring valleys buy their "*balu-solu*" incense from the *brokpas*. Table 6-26 shows what incense the different groups use. In Dhur, 53% of the *monpas* said that they use blue pine branches exclusively. In the other villages, the proportion of households using only blue pine branches even reaches 85%. 45% of the *brokpas* in Dhur use only "*balu-solu*", 29% use both "*balu-solu*" and blue pine and 26% use only blue pine.

Table 6-26: What plants do you use for incense? Answers in percent of households. Source: Forest Resource Use Survey 1999.

	Dhur: *brokpa*	Dhur: *monpa*	other villages
blue pine	26%	53%	85%
balu-solu	45%	19%	10%
both	29%	28%	5%

91% of the households in Dhur and 97% in the other villages believe that everyone is allowed to cut blue pine branches for incense in anyone's sogzhing. 94% of the households in Dhur and 100% in the other villages believed that anyone can collect blue pine branches and other plants in the government forest to be used as incense.

6.5.4 Inner bark of blue pine

Whad (local name in Chhoekhor Toe) or *jaanker* (in the other valleys) are the local names of the inner bark of blue pine trees. People used to eat the inner bark of young trees or of the present year's shoots on older trees (see Figure 6-11). Before the introduction of the Forest Act of 1969, the villagers used to collect *whad* during the fourth and fifth month (approx. May-June). It is believed that a regular consumption of *whad* prevents tuberculosis[56]. Children appreciate whad for its sweetness. In the past, it was the only kind of sweet children could get [K. Roder, pers. com. 1998].

Nowadays, the peeling of trees for *whad* is prohibited. Therefore, during the interview, the villagers denied consuming *whad*. Only a few confessed to eating *whad* from trees they were felling for firewood. Others admitted that children peel young shoots and eat the inner bark while herding the cattle. In the neighbouring valleys, 50% of the households conceded eating small quantities of *whad* regularly.

Table 6-27: Ownership of *whad* in the *sogzhing* and in the government forest according to Dhur's population, answers in percent of households.
Source: Forest Resource Use Survey 1999.

	in the *sogzhing*	in the forest
government	12%	69%
sogzhing owner	83%	-
common good	3%	27%
doesn't know	2%	4%

83% of the households in Dhur believed that *whad* in a *sogzhing* belongs to the *sogzhing* owner and 69% that the *whad* in the government forest belongs to the government (see Table 6-27). In the other two valleys 83% of the households considered that *whad* in the forest is a common good.

56. According to D. Vilinac (National institute of traditional medicine, pers. com. 1998), it is possible that the terpentine contained in the inner bark might help to prevent infection with tuberculosis.

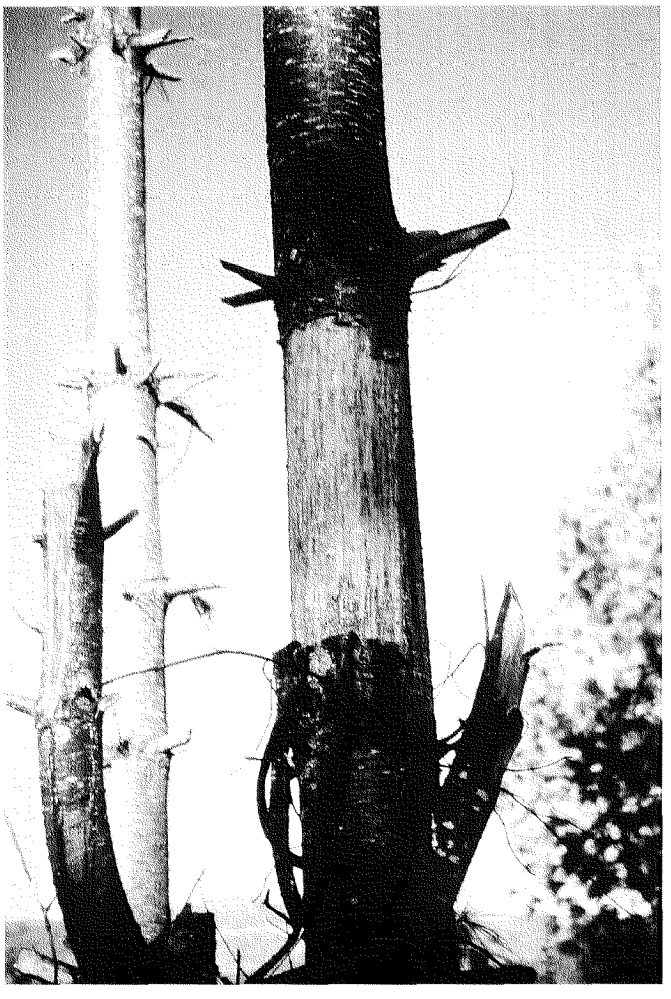


Figure 6-11: Blue pine peeled for its inner bark. Tang, 1996.

6.5.5 *Zha* and *bau*

Zha is a ball-shaped abnormal growth on the stem of some trees. It is very rare and therefore very precious. *Zha* are used to make bowls and cups (*phub*). The most precious *zhas* are found on the root of *yongsengma* (*Elsholtzia fructicosa*), on *khenpa* (?) and on *losumpa* (Acer sp.). *Baus* are similar to *zhas*, but of lower quality.

Cups are usually plated inside with silver, because silver is believed to neutralize poison. However, cups made from precious *zha* are not plated with silver. A red point (*gyamtsochola*) will be drawn on the bottom of the cup and is believed to be able to neutralize poison. A cup made of a precious *zha* is a status symbol, as an old saying states: "Unlucky people finds *zhas*, but lucky people will use *zhas*".

73% of the households in Dhur believed that a *zha* belongs to the one who finds it, 8% that it belongs to the government and 19% did not know. No household ever found a *zha*, though one household in Dhur stated having found several *baus*.

6.5.6 Edible plants

A list of edible plants used by the villagers is provided in Appendix 18.

Most berries and edible plants are consumed directly on the spot. In Dhur, one third to one half of the *Eleagnus* berries (*dambri marip*), however, are collected and brought home. The berries are mashed and used to sweeten buckwheat porridge. Several key informants mentioned that, in the past, the villagers collected these berries to make an alcoholic drink.

The quantities of edible plants which are collected are, however, negligible. The quantities of the most collected plant, *Eleagnus*, ranged from 1 *bangchung* (small container: approx. 1 litre) to one basket (approx. 10 litres) yearly.

Table 6-28: Percentage of households collecting berries and other "sweet" plants. Source: Forest Resource Use Survey 1999.

	Dhur: *brokpa*	Dhur: *monpa*	Other villages
Eleagnus sp.	56%	82%	90%
strawberry	12%	24%	68%
cherry	10%	5%	8%
remnija	12%	0%	5%
tanglipa	7%	8%	25%

Mushrooms are collected during the 6th-7th month of the Bhutanese calendar (approx. July-August). The majority of the villagers considers it as a sin to collect and eat mushrooms, because it causes the death of worms which live inside the mushrooms. Due to this religious taboo, it can be expected that the real proportion of households collecting mushrooms is higher than indicated here. Indeed during the Household Survey in 1997, only 11% of the households in Dhur admitted collecting mushrooms. After three years of field work, a certain trust had been built up. During the Forest Resource Use Survey 1999, 60% of the *brokpa* households and 68% of the *monpa* households in Dhur conceded that they did collect mushrooms. In the other two valleys, 43% of the households also admitted that they did. The contacts with these villagers was by far less intensive, therefore the results are less reliable.

The locations where mushrooms are collected in the forest inventoried are shown in Appendix 15.

Only 9% of the households in Dhur and 18% of the households in the other villages believed that they used more edible plants 50 years ago. The villagers affirmed that they never collected many edible plants, because in the past, when the harvest was bad, they could go to the dzong to get a "loan" of grain. Further, the forests are temperate and offer only a limited quantity of edible plants, and this only for a limited period. Sangay Wangchuk mentioned that the rural population in Radhi (Eastern part of the country) consider people collecting edible plants from the forest as of lower social status [Wangchuk, 1997]. This perception was not verified in the study area.

96% of the households in Dhur believed that edible plants, whether in a sogzhing or in the government forest, are a common good. The same opinion was current in the other vil-

lages. 91% of the households in Dhur and 100% of the households in the other villages believed that mushrooms found in the government forest are a common good.

6.5.7 Medicinal plants

The number of medicinal plants available in Bhutan is impressive [FAO 1996]. The average villager in the study area is familiar with, however, only a few medicinal plants and their uses. The indigenous doctor (*dungtso*) possesses knowledge on the medicinal plants. A few villagers who help the *dungtso* in collecting plants seem to have a better knowledge of medicinal plants, but do not know how to prepare or use them. A few plants nevertheless are commonly known and used by the villagers (Source: Checklist in Cultural Ecology):

- *putishing* (*Picorrhiza kurroa*) for coughs and colds;
- *bongmar* (*Aconitum sp.*?) for coughs and colds;
- *jamey kundey* as antidote for poisons;
- resin for cracks in the hands and feet;
- a mixture of *tanglipa*, *gipser* and *juguli* for skin diseases;
- *tsando* and *bongdo* as poison for arrows.

Putishing (*Picorrhiza kurroa*) was by far the most frequently mentioned medicinal plant during the interviews. 10% of the *brokpas*' households in Dhur, 0% of the *monpas*' households in Dhur and 8% of the households in the other villages stated that they sometimes collect medicinal plants. One *brokpa* household in Dhur mentioned that they regularly collect medicinal plants for the *dungtso*. Whether these figures are true is debatable. The collection of many medicinal plants is prohibited by law. Some medicinal plants, for example *Cordiceps sinensis*[57], sell for a high price in the black market. Some households might be tempted to collect it illegally.

15% of the households in Dhur estimated that they collected more medicinal plants 50 years ago. In the neighbouring valleys, all the households considered that this had not changed. 41% of the households believed that the medicinal plants are a common good, 17% thought they belong to the government and 42% did not know.

6.5.8 Fodder plants and other plants

Some villagers collect fodder plants to supplement the fodder of the livestock. Oaks are lopped, as described in 6.4.2 "Oak branches", when the ground is covered by snow, to allow the cattle to feed on the oak leaves. Further *mek* (*Yushania microphylla*) is collected, especially to feed the young yaks when they are rounded up during the night. A few other plants were mentioned by individual households. In Tang, some households mentioned lopping willows for fodder.

57. Local name: *yertse gömpo* meaning "summer plant, winter worm". It is in fact a mushroom parasiting a worm. It is a tonic. The population in the study area believes that this plant might cure a large variety of diseases.

10% of the households in Dhur and 18% of the households in the other villages confirmed collecting fodder. 27% of the households in Dhur and 16% of the households in the other villages believed that they use less fodder than 50 years ago.

Besides the edible, medicinal and fodder plants, some others plants are collected for various purposes:

- Flowers, especially *Rhododendron arboreum*, are collected to adorn altars;
- *yongsengma* (*Elsholtzia fructicosa*) is used to polish wooden floors;
- the roots of *changang* and *babloo* were used in the past as soap.

6.6 Pangzhing

Pangzhing is a grass land shifting cultivation system commonly used in Bumthang [Norbu 1996; Roder 1992, 1993]. It is different from *tseri*, the bush fallow shifting cultivation system prevalent in the south and east of the country [Upadhyay 1995].

Pangzhing is widely practised in Central Bhutan, at elevations ranging from 2'500m up to 3'800m. *Pangzhings* represent 61.5% of the total agricultural land of the district, whereas the permanent fields represent only 29%[58]. This system is used specially for fields located far away from the settlements, as the fields in vicinity of the village are used for permanent cultivations, mainly of wheat. The main crop cultivated in the *pangzhings* is buckwheat. Buckwheat was until recently the staple food in Bumthang. Nowadays, those who can afford it replace buckwheat with rice. In Bumthang, the *pangzhings* are cultivated for 1-2 years with bitter buckwheat (*Fagopyrum tataricum*) often followed by one year with sweet buckwheat (*Fagopyrum esculentum*), then left fallow for 6-20 years. When left fallow, the *pangzhings* become grown in by grasses, then by blue pines (see also Section 4.9 "Former agricultural land"). During the fallow period, the area is used as pasture.

The villagers of Dhur report that the buckwheat cultivation starts directly after the ploughing of the wheat fields during the 6th month (approx. July). Temporary huts are built and *lon* (fuelwood for fertilizing the fields, see 6.2.2 "Fuelwood for buckwheat cultivation") is collected. This work is mainly done by the young boys, while herding the cows. During the 7th month (approx. August), the family consults the *tseepa* (the village astrologer). The *tseepa* determines the exact time when the digging should start and in what direction. At the given time, a young boy of the family will start digging a few centimetres in the given direction. The boys gather after this work and celebrate. On the next day, the men join the boys and the work might be pursued in the most convenient direction. Often a household will ask the help of their neighbours. The top soil layer is cut with a hoe up to a depth of five to six centimetres. The soil is then allowed to dry completely. When this work is completed, in Dhur, tradition demands that the boys of the lower part of the village to fight with those of the upper village. It is believed that if the lower village wins the fight, the rain will be abundant, but if the upper village wins, the sun will shine and the yield will be good. The dry soil is then heaped in mounds by both men and women. Some fuel (*lon*), consisting of branches, blue pine needles or leaves, is added inside the mounds. The

58. See also Section 2.3.3 "Land use".

mounds are then lighted. They smoulder for several days. After a few days, the burnt soil is spread. During the 3rd month (approx. April), the fields for the lower cultivation (*korba*) are sown, when a certain shrub (*kawser*) blossoms. During the 4th month (approx. May), when the new spruce shoots appear, the higher fields (*gonthog*) are sown.

This system was most probably developed locally in response to the texture of the soil and the climate. It was self-sustaining for generations and well adapted to the local conditions: the soils are very poor in available phosphate, but through the burning the available phosphate increases [Roder 1993]. The cultivation on *pangzhing* is very labour intensive: 150 to 400 labour days per ha. The cutting of the soil is by far the most labour intensive (around 150 labour days per ha) [Norbu 1996]. At the same time, the return per labour day is three times lower than for the permanently cultivated fields.

6.7 Grazing

The importance and composition of livestock in the study area is presented in Section 5.1.5 "Livestock". The grazing in the study area is on pastures and on the *pangzhings*, but also in the forest. The forest grazing was characterized through the Forest Resource Use Survey. The households were asked when and where their livestock grazed. The average numbers of months the different livestock types spend either in the pasture or in the forest are presented in Table 6-29. Basically, the villagers prefer to graze their livestock on pastures, but the availability of pastures is limited. Further, some households do not own pasture — or *pangzhing* — and do not have any alternative than to graze their cattle in the forests.

Table 6-29: Average number of months the livestock spends on the pasture and in the forest, in Dhur. Source: Forest Resource Use Survey 1999.

	Months in pasture	Months in forest
Milch cow	8.2	3.8
Dry cow	6.7	5.3
Ox	4.7	7.3
Sheep	11.4	0.6
Horse	11.0	1.0
Milch *drey*[a]	9.6	2.4
Yak and dry *drey*	8.8	3.2

a. *Drey* is a female yak in the language spoken in Bumthang.

Clearly, the horses and the sheep are mostly kept on pastures. Oxen and dry cows spend half of the year in the forest. Milch cows spend more time on the pastures than in the forests. The yaks are usually kept half of the year in the summer pastures, above the timberline. In winter they spend around 3 months in the pastures until the fodder is exhausted and the remaining three months in the forest. In this case also, the productive animals are kept on the pastures, whenever possible. The situation in the other two valleys is different. Many of these villages own community pastures, where the livestock is kept. However, the

pastures are often in a bad condition and to a large extent covered with forest. Therefore comparison with data from Dhur seems inappropriate.

The areas where grazing take place in the forest inventoried are shown in Appendix 16. The livestock grazes nearly everywhere. The notable exception is the central part of the forest. The terrain in this area is very steep and marshy. Furthermore, due to the thick humus layer, almost no ground vegetation is to be found.

Whereas mostly cattle graze in the southern part of the forest, yaks mainly graze around Khamgi, the winter pasture of some brokpas. Along the river Yoleng chu is a footpath leading to several summer pastures. Near this footpath are several small pastures and former pangzhings. These are used both by cattle and yaks. It is clearly defined who is entitled to graze their cattle in what location inside the forests. For example, the lower village of Dhur grazes its cattle south of the forest road and beneath the village of Lusbi. The upper village of Dhur, Gonpfey, grazes its cattle in the forest above the village and the middle village above the mill, west of the forest road.

Some livestock is watched and some roams freely. Often the livestock is kept in a combined regime: it is watched during the cropping season and left free in winter. The percentage of livestock according to the type and regime is shown in Table 6-30.

Yaks and sheep are watched in 92-95% of the cases. Only a few animals are left to roam free the whole year round. Horses and oxen are often kept in a combined regime. In the two neighbouring valleys, the combined regime is not applied. There, the majority of the livestock is watched the whole year round.

Table 6-30: Percentage of livestock that is watched, roams freely or kept in a combined regime. Source: Forest Resource Use Survey 1999

	watched	free	combined
Milch cows	70%	18%	12%
Dry cows	62%	8%	30%
Ox	35%	8%	57%
Sheep	95%	5%	0%
Horse	51%	6%	43%
Milch *drey*	92%	4%	4%
Yak and dry *drey*	92%	4%	4%

7. Discussion

7.1. Methodological reflections and general remarks on the findings

7.1.1. Reflections and general remarks on the forest survey

One of the main objectives of the present study was to analyse the structure of forests used traditionally by the rural population and a further objective was to assess the impact of the forest uses on the forest structure. The structure of a forest is very complex. In this study, the forest structure was characterised with the help of several indicators, such as the number of stems, the stem distribution, basal area and volume, which were recorded during an inventory. Through the choice of selected indicators a simplification of the complex of forest structure was made. The forest inventory appeared to be a well adapted method for obtaining information on the species composition and distribution, as well as the dimensions of the trees. It allowed the verification of whether the stem distribution was disturbed, thought small disturbances could not be assessed. The main disadvantage of this method was that the quality of the single trees within the forests was not assessed.

The results of the forest inventory more or less correspond to the findings of other studies in the country. A direct comparison of the results of the present inventory with those of previous studies was, however, difficult. Indeed, on the one hand, only a few such studies have been conducted, though studies on the ecology and silviculture of Bhutanese conifer forests are more abundant than studies on Bhutanese broadleaved forests or on other forestry subjects in this country. On the other hand, the forest type definition varied from one author to another, so that it was not always clear what forest types were to be compared. Further, the present study assessed only forests on north- to north-east-exposed slopes. From findings of other studies, it appeared that these forests — at least the fir and hemlock forests — have a higher productivity on north-exposed slopes than on the drier south-exposed sites [Bürgi et al. 1992].

In the forests inventoried, the standing volume of the blue pine forests was 339 ± 43 m^3/ha (with a 66% confidence interval). Sargent indicated a lower value (approximately 200 m^3/ha) for these forests [Sargent 1985], but the standing volume of the present study corresponds fairly well to the indications of Rohrbach for middle-aged blue pine forests (153-337 m^3/ha) [Rohrbach 1989]. Rohrbach actually indicated a very large range of standing volumes for blue pine forests: indeed, it ranged from 272 m^3/ha to 705 m^3/ha [Rohrbach 1985]. For the blue pine forests with oak, Sargent estimated a similar — slightly higher — figure for the standing volume: 570 m^3/ha [Sargent 1985]. In the present study the standing volume for blue pine forest with oak was 471 ± 66 m^3/ha. The figures of the present study for the mixed spruce forests are lower than those found by Sargent or Rohrbach for the mixed spruce and hemlock forest and for the mixed conifer forests [Rohrbach 1985; Sargent et al. 1985]. Probably, both authors considered forests with a higher proportion of hemlocks. The figures of the present study for the standing volume in fir and mixed fir and hemlock forests are higher than

those of other authors, though Rohrbach had a very close figure with 1'323 m^3/ha standing volume [Bürgi et al. 1992; Rohrbach 1989; Sargent et al. 1985].

The main difficulty in the forest inventory and in the measurement of the indicator plots was the dense bamboo undergrowth. It limited visibility strongly and therefore had to be cut down. It cannot be excluded that the dense bamboo undergrowth somehow affected the quality of the measurements. Further, due to the dense bamboo undergrowth, the way from one forest inventory plot to another had to be cut, thus slowing down the progress of the field work.

7.1.2. Reflections and general remarks on the survey of the sociological context

To answer the questions of the assessment of the social context of the forest uses, the traditional forest management system and rationale of the rural population, and in order to estimate the quantities of forest products extracted, an array of sociological methods was used. It has to be emphasised that the sociological methods are concerned with perceptions. The findings of this study therefore represent the villagers' perception of the forest uses and forest products.

Bhutan's population is composed of a multitude of ethnical groups [Pommaret 1997]. Therefore there are limitations in comparing this study with studies carried out in other regions, as the population differs in its composition and the context varies significantly. Changes in tradition, culture, and languages occur even from one valley to the next. To the author's knowledge, only one single ethnological study has been carried out in Chhoekhor [Brauen 1994]. The findings of the present study do not contradict this ethnological study. However, one has to consider that the village presented in Brauen's study differs both in terms of composition of the population — Brauen's village was composed of *monpas* and one Tibetan household — and of its context — the economy of Brauen's village is market oriented whereas Dhur relies significantly on a subsistence economy. However, only minor differences in the findings of these two studies were noticed.

Karma Ura described the allotment and management of communal pastures in Ura — one of Bumthang's four valleys [Ura 1993]. This system could not be verified for Dhur, as there is no communal pasture. Indeed, in Dhur, the forested area is divided among the families for grazing. Also the migration of cattle in Dhur is far less intense than that described by Karma Ura for the valley of Ura.

During the sociological surveys of this study, some contradictory statements were expressed by villagers. For example, the indications concerning the price of a tree differed from one household to the other: e.g. for firewood, some households indicated that they received their trees free of cost, others indicated that they paid 10-20 *Nu.* per tree (approx. 0.25-0.5 US$). When such statements were made, the key informants were asked about these discrepancies. In this particular case it was found, with the help of key informants, that one group obtained trees from a *sogzhing* and had to pay compensation to the *sogzhing* owner, although trees for firewood are provided free of cost by the forest service.

Answers to several questions related to the forest uses differed from one interviewee to the other, for example, the indications about the extraction of torch wood or about medicinal plants. To clarify these subjects, four collective meetings were held with key informants in the village and these particular subjects were debated. It became obvious that the knowledge of every villager seemed to be mainly based on his own experiences, which might

differ from the experiences of other villagers. This underlines the very important fact that knowledge is not uniformly distributed among the population. For instance, knowledge of medicinal plants could only be traced from those villagers who collect medicinal plants for the *dungtso* (traditional doctor). Furthermore the uses of medicinal plants was only known by *dungtsos*. In the village of Dhur, only two men were skilled in carving wooden spoons and able to answer questions related to woodwork. Knowledge about timber was among the men, as it is mostly they who carry out this type of work. The type of survey carried out in the present study kept a provision for the unequally distributed knowledge. Indeed, during the surveys, the household could designate the person who was most competent to answer the questions and it was not uncommon that the interviewee changed during the interview, when a different household member felt more competent to answer the questions on a certain subject.

During field work it appeared that the quality of the results of the surveys depended on a good relationship based on mutual trust with the villagers. The most striking example were the different findings of the Household Survey in 1997 and the Forest Resource Use Survey in 1999 concerning the collection of mushrooms, as already mentioned in passing in Section 6.5.6 "Edible plants". The majority of the villagers considers it a sin to collect and eat mushrooms, because it causes the death of worms which live inside the mushrooms. Due to this religious taboo, during the Household Survey 1997, only 11% of the households in Dhur said that they collect mushrooms. After I had worked for three years in the village, the population had become aware of the aims of my study and had gained confidence. During the Forest Resource Use Survey in 1999, 60% of the *brokpa* households and 68% of the *monpa* households in Dhur admitted collecting mushrooms.

The interviews in the two neighbouring valleys were very helpful in establishing whether some of the findings were local specificities of Dhur or whether they were valid for a larger area. For example, one of the main findings — that the traditional system exists parallel to the modern forestry system in Dhur — could not be verified in the two other valleys. The comparative interviews showed that the findings of this research are valid for Dhur, but generalizations could not be made.

7.1.3. Reflections and general remarks on linking forestry and sociological methods

The combination of forestry and sociological methods provided satisfactory results. Indeed, forestry inventory and indicator plots alone would not have been adequate to fulfil the objectives of the present study, neither would it have been possible solely with sociological surveys. Both methods were necessary to give an encompassing view of the traditional forest uses and their evolution and impact on the forest structure. The forestry methods allowed fulfilment of the objective of analysing the structure of forests used traditionally by the rural population, whereas the sociological surveys revealed the social context of the forest uses. The objectives of analysing the characteristics of the forest products used traditionally by the rural population, the traditional forest management system and rationale of the rural population, estimating the quantities of forest products extracted, and assessing the impact of the traditional forest uses on the forest structure could only be satisfactorily met through the combination of both approaches. These two approaches allowed cross-checkings and pinpointed confirmations or contradictions. For example, the forest inventory gave indications of the type and dimension of trees felled for a specific purpose. The Forest Resource Use Survey, as well as the Checklist in Cultural Ecology,

confirmed the use of a certain type of tree for a certain purpose. The indications of the key informants and direct observations allowed the description of the processing of different forest products. During the forest inventory and in the indicator plots evidence for the methods of the processing of timber was verified.

Due to time restrictions of the study only some of the forests used by the villagers were surveyed. If the whole forest used by the villagers had been surveyed, it would have been possible to cross-check the indications of the villagers given during the interviews concerning their consumption of forest products with the number of stumps in every category. An extrapolation of the consumption of the forest products in the forests inventoried would be difficult, since the extraction of forest products is selective. It would be an interesting question for further studies to assess the extent of forests used traditionally by a village, in order to define how many forests would be required by a village community to fulfil its needs for forest products.

7.2. Findings on the forest structure

7.2.1. Stem distribution

One objective of the present study was to analyse the forest structure of the forest used traditionally by the local population. From all the features which were measured, the stem distribution proved to be the most appropriate for characterising the forest structure. The indicator plots are well-suited to give a picture of the forests, but show subjectively chosen sections of the forest.

Figure 4-2 shows the stem distributions in the various forest types found in the forests inventoried. Two groups with similar stem distributions can be observed. Table 7-1 shows the forests types according to these two groups.

Table 7-1:Forest types according to structure type.

Structure "type 1"	Structure "type 2"
Blue pine forest	Hemlock forest
Blue pine forest with oak	Hemlock/Fir forest
Forest on former agricultural land	Fir forest
Mixed spruce forest	
Birch forest	

The stem distributions of the forest types in the first group are characterised by an exponential decrease of stems with increasing diameter category (see Figure 7-1). This type of stem distribution was found in blue pine forests, blue pine forests with oak, forests on former agricultural land, mixed spruce forests, and birch forests. It is the pattern of stem distribution expected for larger areas of forests with a sustainable structure or for forests under uneven-aged management. However, to date no study has been conducted in

Bumthang which certifies that this stem distribution actually indicates a sustainable forest structure. Nevertheless, considering all the results of the forest inventory, indicator plots and direct observations, it can be assumed that the structure of the forests is sustainable.

The second group of stem distributions — hemlock forests, hemlock forests mixed with fir and fir forests — is characterised by two superposed lines: one for broadleaves and one for conifers. The number of conifers is almost constant in every diameter category, with a little increase for the medium-sized diameter, whereas the diameter distribution of the broadleaves is exponential (see Figure 7-2). This feature has already been described by A. Bürgi [Bürgi et al. 1992].

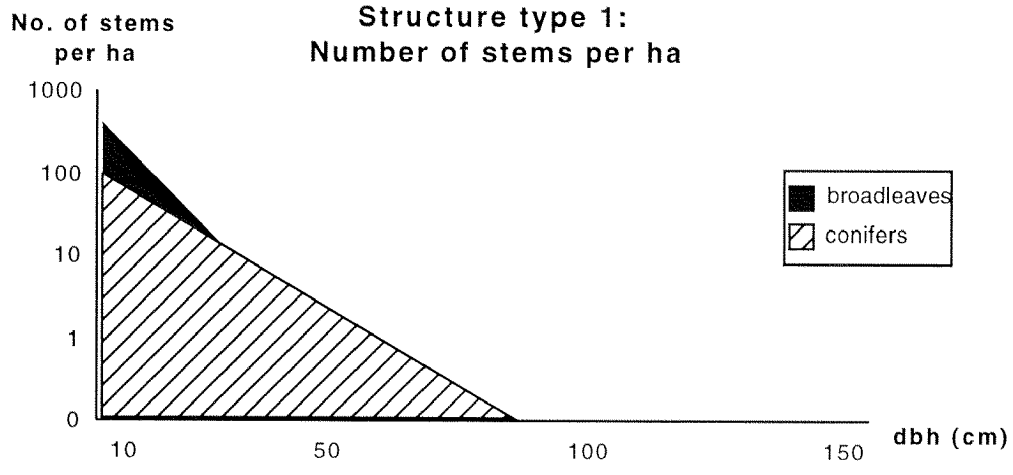


Figure 7-1: Model for the diameter distribution in the forests of structure "type 1".

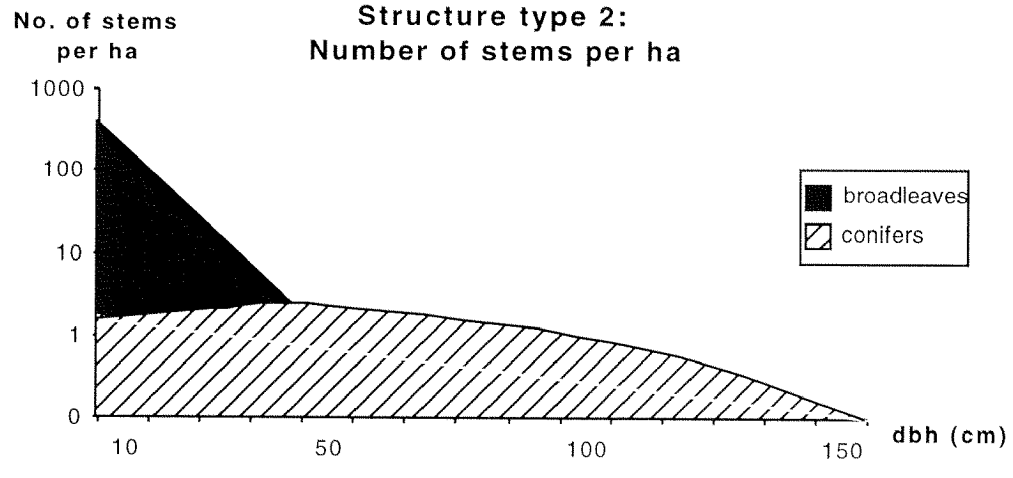


Figure 7-2: Model for the diameter distribution in the forests of structure "type 2".

The stem distribution for the broadleaves in the second type is similar to that of the first type. It shows an exponential decrease of stems with increasing diameter category up to a dbh around 40-45 cm, but the number of broadleaf trees is by far higher in the second type. The stem distribution of the conifers in the second group differs notably from that of the first group. Indeed, in the second group the conifers reach much greater dimensions — up to 150 cm dbh, with a few individuals up to 200 cm dbh — whereas in the first group the conifers reach diameters only up to 80-90 cm. Further, the stem distribution for the conifers in the second group follows a more or less horizontal line. That means that there are almost the same number of trees in every diameter category. This stem distribution is comparable to that of European virgin forests in the late optimal stage and on average over all the stages [Korpel 1995; Leibundgut 1993]. The forest texture is a further similarity between the forests of the second group and the European virgin forests. Both are characterised by an irregular assemblage of small patches of forest stands.

Bürgi indicated that due to the longevity of firs, only little regeneration is needed to ensure the sustainability of the fir forests [Bürgi et al. 1992]. He further suggests that this stem distribution does not indicate a lack of young growth. It is therefore possible that a small number of young trees is sufficient to replace the older ones, and that this stem distribution is the one of a sustainable forest for these forest types.

7.2.2. Forest types and anthropogenic pressures

As can been seen in Figure 4-1, the inventoried forest is composed of various types of forest. These naturally vary with changes in the topography. They change with increasing altitude from blue pine and oak forests to fir forests. However, several forest types are to be found at the same altitude, depending on the site conditions. On drier southern slopes blue pine forests and blue pine forests with oak occur. Mixed spruce forests grow on the northern side of the slope and hemlock forests proliferate in the more humid moulds and along streams.

Some forest types reveal the anthropogenic pressure on the natural environment. The large tracts of blue pine forests which characterise Bumthang's landscape are the most striking example. The larger part of them comprises pioneer forests, often on former agricultural land. These pioneer forests are characterised by an almost even-aged forest structure. Another type of blue pine forest was encountered. These blue pine forests have a very inhomogenous structure with multiple layers. They do not have an even-aged structure as expected for the former agricultural land, nor did they appear on dry sites. These forests were most probably the result of massive anthropogenic interference: the gaps caused by the villagers through the selective use of large parts of the main forest layer favoured regeneration of blue pine. The trees which were of no use to the villagers were spared. The forest therefore is a mixture of older trees of lower quality with blue pines. The repeated extraction of trees favoured the vertical structure with multiple storeys. Not all the blue pine forests are the result of anthropogenic pressure; indeed, blue pines can also form climax forests on dry sites — e.g. on ridges and on south-exposed slopes.

Along the river, the forest on former agricultural land is composed of both blue pine and oak. It was not possible to trace which of these two species started growing first, since the age of the oaks could not be assessed precisely. Indeed, the autumn wood of these oaks is very difficult to distinguish, as it is mostly composed by only one row of cells. It can, however, be stated that the oaks had a good annual increment at this early stage and that the

age of the oaks on former agricultural land differed only slightly from the age of blue pines in the same area. In lower lying areas and with the presence of mother trees, oaks are regenerating well in these larger openings on former agricultural land. According to the villagers, the oaks are growing relatively fast: a 66-year-old man reported having cultivated wheat amidst young oak trees in his youth. These oaks have currently a height of 30 m and a dbh of 40cm to 60 cm. Whether this proves correct or not, several reasons would suggest further research on this species. The demand for oak wood is increasing, especially for logs for mushroom cultivation and firewood.

The spruce forests mostly occur around pastures, near Khamgi and along the ridge south of the forests inventoried. On the fringe of the pasture the forest was obviously younger than the average. This seems to confirm Rosset's observation that spruce is a pioneer species at higher altitudes [Rosset 1998].

7.2.3. Impact on the forest structure

One of the main questions of the present study was to assess the impact of traditional forest uses on the forest structure. The forest structure and the extraction of trees in the various forest types are described in Section 4. "The forest structure". Blue pine forests with oak seem to be the most intensively used forests, probably due to their proximity to the village and the trails. The forests on former agricultural land and the hemlock forests are moderately to intensively used, as both are relatively easily accessible. Spruce and blue pine forests are used moderately to extensively, due to their relative remoteness and difficult accessibility. Fir and mixed fir and hemlock forests are used extensively. Birch forests are protected by their remoteness and no traces of wood extraction were visible.

The locations of the forest uses are shown in a series of maps (see Appendices 8 to 16). From these maps, it can be seen that the location of a forest use is determined by the following three factors: the availability of the forest product, its distance from the village or place of work and its accessibility. Indeed, a longer walk along a trail is preferred to cutting a short distance through the thick bamboo undergrowth.

The impact of the forest uses on the forest structure therefore varies with the forest type and the products extracted. In most forest types, the forest uses are so extensive that the forest uses do not affect the forest structure significantly. In the case of cutting shingles, for example, very few large trees were cut. The extraction of shingles thus slightly reduces the number of trees in the larger dbh categories (see 6.3.3 "Shingles" and Figure 6-3). The extraction thus "simulates" the natural death of a tree.

The most important extraction of wood, in terms of number of felled trees per ha, is fuelwood collection. The major part of the felled trees, however, are broadleaves and of relatively small dbh. The effect of the extraction of trees for fuelwood is almost the same as that of a thinning, with the difference that during a silvicultural thinning operation the best trees are favoured and not felled.

The only use which has a noticeable impact on the forest structure is the extraction of blue pines for beams (see Section 4.10 "Impact of the extraction of beams on the forest structure"). Blue pines with a dbh around 30 cm are extracted. The only blue pines with a dbh over 44 cm were those which do not have the characteristics needed for processing: they are either forked, branchy or damaged. Instead of sparing the best trees, these are felled, and the trees of lesser quality are left. The structure of the forests in which the extraction

of trees for beams takes place is thus strongly affected. However, this has to be taken cautiously. In Dhur, the extraction of trees for beams was very punctual: it concentrated on few forest patches. On average the forest structure was not affected, since large tracts of forests remained untouched.

7.3. Findings on the forest uses

7.3.1. Some trends concerning the consumption of forest products

It was part of the objectives not only to estimate the quantities of forest products extracted by the villagers, but also to detect any trends. The quantities of forest products consumed by the villagers, as well as some indications about the consumption of these products in the past, are presented in Section 6. In the present Section some indications of the possible trends in the consumption of certain forest products are given.

From the number of stumps it was possible to estimate that the overall consumption of forest products has been slightly increasing over the last decades. The number of stumps, however, did not explain the reasons for the increase. It could only be assumed that the increase in the consumption of the forest products was related to the population growth.

From the Forest Resource Use Survey, from direct observations and through interviews with key informants, further information was gathered about the trends in the consumption of forest products. The consumption of *whad* (inner bark of blue pines) was drastically reduced with the introduction of the Forest Act 1969. The villagers used to consume *whad* regularly, as they believe that it reduces the risk of tuberculosis. Only a few young blue pines were found damaged for *whad* during the survey.

The extraction of *kuan* (candle wood) was also reduced by the Forest Act 1969. *Kuan* has since then been replaced by kerosene in a majority of households. The households even preferred the use of kerosene, as it is easier to transport and produces less soot. The villagers still extract *kuan* for the following two reasons. Some households do not earn cash and cannot afford to buy kerosene, even if it is subsidised. These households are not "poor", but self-sufficient with little or no cash income. It mainly applies to households composed exclusively of elderly people or women. Another bottle-neck is the erratic supply of kerosene at the petrol station. To bridge the periods when kerosene is not available, the households revert to *kuan*. It can be expected that the extraction of *kuan* will fade away with the improvement of the kerosene supply and increased cash income of the households.

Many households would prefer to cover their roofs with corrugated tin sheets, as these requires less maintenance than roofs with shingles. So far, the high price of corrugated tin sheets and the high cost of transportation prevent them from replacing the shingles with corrugated tin sheets. Only a few wealthy households in Dhur can afford to buy them. With increasing cash income, it is likely that the shingles will slowly be replaced by corrugated tin sheets.

7.3.2. The pangzhings

The findings concerning the *pangzhings* appear in several Sections and are amalgamated here in order to answer the question of the origin of the large tracts of young blue pine forests, which was one of the underlying questions of this study (see 1.1 "Background").

These young blue pine forests are all located on former agricultural land, mainly *pangzhings*. Therefore the system of *pangzhing* is described in Section 6.6 "Pangzhing" and the traditional entitlements in Section 5.3.4 "Traditional entitlement concerning tsamdrogs and pangzhings". The structure of forests on former *pangzhings* is described in Section 4.9 "Former agricultural land". The average age of the trees on these former *pangzhing* was measured and the results are displayed in Section 4.9.5 "Average age of the trees".

The average age of the trees of a *pangzhing* ranes between 14 and 35 years. As the reforestation did not start in the year when the cultivation stopped, but a few years later, the cultivation of theses *pangzhing* must have stopped 20 to 40 years ago, depending on the area. The size of the *pangzhing* may also influence the speed of the reforestation, but the correlation between age and size was not significant. Therefore it can be assumed that the cultivation of these 17 *pangzhings* did not stop in the same year, but gradually 20 to 40 years ago. Since there is a time span of about 20 years between the earliest and the latest reforested area, several events or factors must have led to the reforestation.

Through the Household Survey and information from key informants, several explanations can be given why the *pangzhings* were abandoned. The explanations confirm that the cultivation of *pangzhings* did not stop at a certain time on all of them, but piecemeal over a long period of time.

- During the 1950's an epidemic (smallpox?) reduced the population drastically. In Dhur, however, no household was completely exterminated by the epidemic (see Section 5.3.2 "Changes in the population"). Therefore the landholding was not reduced, but the labour capacities necessary for the cultivation of the *pangzhings* were.
- During the first half of the 20th century, large areas belonging to the king were cultivated by forced labour (see Section 5.3.2 "Changes in the population"). In Dhur the following places were cultivated by the villagers for the king: Gorsum, Oromit, Kirgigang, Tabula, and Krangma. These areas were abandoned when the third king moved to Paro in 1952 and then to Thimphu. In the lower part of Tang, it is certainly a main factor for the abandonment large areas of *pangzhing* (see also Figure 5-5).
- In 1959, after a Land Survey, a ceiling of 25 acres for the amount of land per household was decreed. The excess land had to be returned to the government. In Dhur, 12 households — all *khraebas* — said they had lost some land due to this ceiling. Along the river, Yoleng Chu, the mounds of earth to fertilise the land were already formed in the *pangzhing* and were ready to be lighted, when the cultivation was abruptly stopped. The mounds can today be seen still amid a young blue pine and oak forest.
- Due to the Forest Act of 1969, fire was banned on the pastures. During their fallow period, *pangzhing* are used as pastures and in the past they were regularly. Previously, the fire prevented the growth of trees and bamboos in these areas. Fire as management tool was banned and was not replaced by other measures. Therefore, trees and bamboos were able to invade pastures and *pangzhings*.

- Some households indicated having stopped the cultivation of *pangzhing* due to lack of labour. Indeed, some households did not have any male members or only elderly people, and were thus strongly limited in their labour capacities.
- Some households indicated that *pangzhing* cultivation became more labour-intensive, due to an increase in the wild boar population. A higher labour input is now needed to guard the fields against the wild boars. Since the labour is limited, the cultivation is decreasing.
- Some *pangzhing* areas were abandoned because the surrounding *pangzhing* areas were abandoned. Indeed, several households used to cultivate their *pangzhings* together, so that they could help each other and further share the work of guarding the fields against game. When neighbours abandoned an area, a household would have had to work alone in a certain place. The work load would therefore be too much for a single household and the cultivation was consequently abandoned.
- In the remaining part of Chhoekhor Toe, numerous households declared that they abandoned *pangzhing* cultivation because it is too labour-intensive and the returns are poor. In the lower part of Chhoekhor Toe (Tangbi), most households invest their labour in potato cultivation, which promises higher return and cash income.

As can be seen above, labour is a chief reason for abandoning *pangzhing* cultivation. The highest impact on the landscape is natural reforestation of the former *pangzhings* of the king. On a smaller scale, the pangzhing of individual households have grown over due to a lack of labour or the land ceiling. On the one hand, the villagers have gained labour capacities for their own cultivation, since they do not have to perform intensive forced labour any more. On the other hand, they have lost labour capacity, since children are now sent to school. *Pangzhing* cultivation is very labour-intensive and its return low [Norbu, Wangdi et al. 1996]. The transition from a subsitence to a market oriented economy will cause the loss of significance in cultivating *pangzhings*.

7.3.3. The consequences of the introduction of forest regulations

Before the promulgation of the Forest Act of 1969, the forests near the village of Dhur belonged to different *khraeba* families. South of Dhur village, the forests belonged to another village or to the aristocracy. Further north, since there were no more villages, the forests were common to all.

The fundamental change induced by the Forest Act of 1969 was the transfer of ownership of the forests and forest produce — whether in reserved forests or on private land — to the government.

> "His Majesty's Government reserves the right to the absolute ownership of trees, timber and other forest produce on private land" [RGOB 1969].

The Forest and Nature Conservation Act of 1995 confirmed this ownership, but kept a provision for social and community forestry [RGOB 1995]. However, both Acts permit the collection of firewood for bonafide domestic use from dead trees and the collection of leaf-litter, both free of royalties. Other forest uses require a permit and the payment of a royalty or fee.

The use of forests registered as *sogzhings* were defined in the Land Act 1978:

> A "person, in possession of forest land maintained for manure and registered in *Thram*, has the right to make use of only the dead leaves for manure. He/she can not do any cultivation in such land. For the proper growth of manure trees, the owner can cut the branches of the trees from time to time and utilise other trees grown in the forest after acquiring permission from the Forest Department." [RGOB 1978]

A characteristic of Dhur is that both systems — the traditional and the modern one — co-exist. That means the villagers act according to both modern law and traditional entitlements at the same time (the traditional entitlements are described in Section 5.3.3 "Traditional entitlement concerning forest uses"). The villagers who do not own *sogzhing*, therefore have to pay a royalty to the government and a compensation to the *sogzhing* owner for a tree. This superposing of regulations was not confirmed in the two other valleys, it is a peculiarity of Dhur.

The *sogzhings* in Dhur are unequally distributed among the population. Therefore the villagers of Dhur expressed their fear that, since the boundaries of the *sogzhings* are not marked in the field, the powerful *sogzhing* owners will expand the size of their *sogzhing* in order to get a higher income by selling trees.

The Forest Act 1969 prohibited fires in a reserved forest and fires which could endanger such forests. The Forest and Nature Conservation Act 1995 confirms this, but allows controlled camp fires. Fires on *tsamdrogs* were banned. In the past the villagers used to burn 1/4 to 1/3 every year of the pasture to favour the growth of grass and to avoid the spreading of bamboo and trees (see Section 5.3.4 "Traditional entitlement concerning tsamdrogs and pangzhings"). The pastures have slowly begun growing in with bamboo (*Yushania microphylla*) and trees. On the one hand, the size of the pastures is reduced and on the other hand their quality decreases. Indeed, according to the *brokpas*, grass grows continuously even when grazed, whereas bamboo regenerates from grazing only one year later. This reduces the quantity of fodder on the pasture. When the fodder on the pasture becomes scarce, the yaks become restless and browse further away, mostly in the forests.

The reduction of the quality of pastures was unanimously recognised by the villagers in Dhur, as their most crucial problem as well as by the villagers in the adjacent valleys.

7.3.4. The rationale of the villagers concerning forest uses

The use and management of different forest products is described in Section 6. "The forest uses". During the forest inventory, the stumps were recorded and helped to define what trees were used by the villagers for what purpose. Figure 6-3 shows the diameter and the tree species used for their main wooden products.The mean diameters of the trees cut for poles, beams, and planks are increasing respectively. There is a strong relationship between the dimension of the felled tree and the product the villager wants to use it for. For every product a tree is chosen with adequate characteristics (for example: straight, cylindrical stem with few branches) and a size close to the product to be processed. The product is used and the remainder is left behind in the forest.

Ideally the trees are felled once they have reached their maximum yearly volume increment. From such a tree a maximum of wood products — beams and planks — can be obtained; the remaining wood is then used for minor wood products such as firewood, pulp, or wood chips. The situation in Bumthang is different. In the perception of the vil-

lagers, the forest resources are plenty and thus there seems to be no need to manage them economically.

For the villagers, the limiting factor has always been the labour capacities. In the past, the households had to render compulsory labour services (see Section 5.3.1 "Aspects of rural life during the feudal system"). The elderly villagers still remember having to spend several months per year for the various labour services. The time remaining for working on their own fields was thus scarce. Nowadays, the labour services are reduced to a great extent. The villagers have to do some work for their community — cleaning the village, maintenance of the infrastructure and so on — and the newly introduced labour service, *Shabtolami*, still requires labour, but is remunerated. With the reduction of forced labour the villagers have gained labour capacities, but lost the labour input of their children, who now attend school.

Traditionally, the forest products are used in a way to optimise the labour input: one goes as far as needed to obtain a tree fitting one's purpose, extracts the product needed, but leaves the remaining parts of the felled tree. The tree chosen is slightly bigger than the beam or plank to be used, since the traditional processing is done by chopping off the excess wood from the stem. With this technique, no planks can be extracted in addition to beams, so that the remaining wood can only be used as fuelwood. However, as trees for fuelwood are available close to the village, the villagers need not invest so much labour to use the left-overs as fuelwood.

This traditional management system was the adequate response of the villagers to their situation: resources were plenty, but labour scarce, so they minimised the labour input needed to fulfil their needs. It should, however, be considered whether this system can be maintained or should in the long run be replaced by a more economical management of natural resources.

8. Forest management in a transitional context

Bhutan's situation with regard to its forest resources is unique. The neighboring countries have experienced severe deforestation during the past centuries and their forest resources have become insufficient to cover the needs of a steadily increasing population. Therefore, the prices for wood and wooden products in these countries have and still are strongly increasing up to the point that wooden products, for example furniture, are now considered as luxury commodity. India's scarcity of forests products puts heavy pressures on the Bhutanese forests. Other countries as well, as for example Japan and Taiwan, show interest for concessions to extract timber or at least to buy Bhutanese timber. On the other hand, a tempting wealth is hidden in the Bhutanese forests, both in the form of timber and in the form of NWFP. The priorities of the RGOB were always to satisfy the domestic demand of forest products before exporting the surplus. The forest resources and extraction exceed the domestic demand and in consequence, a considerable amount of round timber was auctioned to India over the years. In 1998, a ban was decreed on the export of round timber in order to generate the added value domestically. Moreover, as the present policy encourages the development of the private sector, it can be expected that the wood-based industries will increase. The experience in Gedu with a plywood factory has shown that the supply of timber for the industry might be problematic, as the amount of wood needed for such plants exceeds the amount of timber available in the forests already opened up by forest roads. To solve the problem, either the size of the wood-based industry will have to be adapted or the availability of timber increased through further opening up of forests. In any case, with the creation of private wood-based industries, new regulations will be needed.

The Forest Act 1969 was mainly concerned with the nationalisation of the forests. The character of this law is derived from existing laws from the region. It was mainly inspired by India, as can be seen for example by the designation of the forest categories — e.g. Government Reserved Forests. It contains mainly restrictive prescriptions in order to use and manage the forests in the interest of national development. The introduction of the Forest Act of 1969 has substantially affected the traditional management of the forests resources by the rural population. The main change, in the perception of the rural population, has been that they have lost their independence regarding the use of forest products. From time of the Act onwards, forms have to be filled in and permits are required to extract timber and some NWFP. Further, some forest uses were forbidden, for example the extraction of *whad* and *kuan* and the collection of medicinal plants. The authority of the State, strongly felt by the rural population through the forestry institution and system, has replaced the existing local management systems.

The Forest and Nature Conservation Act of 1995 basically kept the same line, but reveals the influence of international interests in biodiversity, nature conservation and protection of endangered species, as can be seen for example through the production of a list of protected plant and game species and the introduction of a social and community forests concept. It keeps a provision for a social forestry scheme for forests grown on registered private land and a community forestry scheme for the establishment and management of community forests in government reserved forests. Respective rules have been outlined in

the meantime according to the provision in the law. The fact that the Social Forestry Rules, drafted in 1993, were not officially approved until very recently denotes the reluctance of the RGOB to implement this scheme. Several community forests however have been provisionally established in the frame of development projects, notably in the eastern part of the country and in the Wangdi-Phodrang district.

A change in the legislation, such as the implementation of the social and community forestry rules, would substantially affect the forests in general and forest management in particular, as can be seen from the example of Nepal. On the one hand, social and community forestry would possibly enhance the development and the generation of added value on local scale. On the other hand, it would require clear regulations on the management of these forests in order to secure their sustainability, on the distribution of the products and benefits within the community and on the marketing — or even export — of wood, wood products, or NWFP.

Nepal has a comparatively long experience with community forestry, dating back to the 1970's. The situation of Nepal differs remarkably from that of Bhutan: the forest cover is significantly lower in Nepal and the forests handed over to the user groups are, in most cases, degraded. Further, Nepal's population density is much higher and characterised by its heterogeneity in terms of ethnic groups and castes. An on-going discussion in Nepal is whether the user groups should be allowed to market the extracted forest products freely — selling forest products on urban markets for example — or whether its distribution should be done within the community and regulated externally. Freedom to convert the forest products into cash might enhance the empowerment of the community, but hides the danger of an unequal distribution of the benefits as well.

In the case of Bumthang, forests are plentiful and would certainly furnish a considerable income for the rural population, if they were allowed to manage the forests and market the forest products themselves. The returns which could be expected from a tree plantation eclipses those of a buckwheat field and would require a much lower labour input. Further, studies of the RNR-RC Jakar have established that benefits can be expected as early as the second thinning of blue pine stands with an average age of 15 years is done [RNR-RC Jakar, Blue pine field day, Chhumme, 10.10.1997]. In this sense, blue pines are probably the better "cash crop". As the trends in Bumthang are to abandon the cultivation of *pangzhings* due to labour shortage and as the labour capacities will probably not increase, since the children sent away to study are not likely to return to their villages to carry on the farming, social forestry on registered private land could constitute a response to the changing social context. Bumthang's population is maybe not as heterogeneous as the Nepalese, but, given the previous traditional entitlements which are locally still in use, it should be deliberately checked whether the existing social groups would interfere with a fair distribution of the forest products or benefits. Further, it was demonstrated through this study that the traditional forest management did not affect the forest structure, because it was extensive. In certain cases, for example the extraction of beams, the traditional management affected the forest structure. An intensification of the traditional management, as could be imagined in the frame of social or community forestry, would put the present notion of sustainability of the forests in question. To meet this problem, the regulations for forest management will have to be adapted, and new regulations concerning the distribution and marketing of the forest products have then to be promulgated.

To date, the marketing of timber has followed a triple-pricing policy. Timber is sold at three different prices depending on the buyer: the lowest price is paid by the rural population, a slightly higher price is paid by the urban population, whereas the highest price is paid by the export market. This latter price is a market price determined by auctions. The aim of this triple-pricing policy is to allow a fair access to forest products considering the disparate availability of cash within the population. As was already noticed by Wangchuk, a negative side-effect of the triple-pricing policy is that timber designated to be used in rural areas finally ends up in the urban areas [Wangchuk 1997]. Further the present pricing policy does not take into consideration the quality of the tree or timber, with the exception of the firewood prices prevalent in the capital, which depend on the tree species.

A change in the pricing policy, for example the introduction of market prices for timber, would not only correct the negative side-effect, but also considerably improve the present forest management. Indeed, in consequence, the timber and therefore the tree would gain in value. Trees of higher value will lead to a better utilisation of the logs; valuable trees would not end up as firewood and fewer logs would be left behind to rot in the forests. A maximum of products will be extracted out of a tree in order to maximise the returns. The remainders of the timber extraction will then be used as firewood. Timber extraction according to assortment will therefore probably fade away and lead to a conventional forest management system based on an optimised yield and sustainability.

Further, a pricing system according to the quality of the timber — species, size, branchiness, straightness and so on — will influence the forest management. As long as the timber price does not consider the quality, the buyer will try to get the qualitatively best log or tree, as it costs no more than a tree of lower quality. A price depending on the quality will affect the choice of the buyer, as he will have to optimise his investment. In some cases, the buyer will prefer lower quality timber to a lower price. The demand for lower quality timber can therefore be expected to rise.

A market price is not in contradiction with the concept of a fair access to the resources, since tools, for example subsidies, can be used. However, the present forest infrastructure is insufficient to fulfil the needs in timber of the whole population, especially when considering the remoteness of many rural areas. To ensure access to forest products for the entire population, it can be suggested that either the State forest service has to be expanded or the management of the forests delegated to local institutions.

REFERENCES

Aris, M. (1980): Bhutan. The early history of a Himalayan kingdom. Vikas Publishing House, Sahibabad.

Aris, M. (1982): Views of medieval Bhutan: the diary and drawings of Samuel Davis 1783. Serindia/Smithsonian, London/Washington D.C.

Aris, M. (1990): Man and Nature in the Buddhist Himalayas. In: Rustomji, N. K. and Ramble, C. (eds.): Himalayan environment and culture. Indian Institute of Advanced Study, New Delhi, pp. 85-101.

Aris, M. (1994): The raven crown: the origins of Buddhist monarchy in Bhutan. Serindia, London.

Atkinson, E. T. (1882): Geology of the Himalayas. Reprint by Cosmo Publications, New Delhi, 1980.

Bachmann, P. (1993a): Forsteinrichtung im Rahmen einer integralen forstlichen Planung. *Schweiz. Z. Forstwes.* **144**(12): 919-926.

Bachmann, P. (1993b): Von der Holznutzung zur integralen Waldplanung. *Raumplanung* **21**(1): 10-12.

Bachmann, P. (1995). Information needs for management planning in modern forestry. Proceedings of the Monte Verità conference on forest survey designs, May 2-7, 1994, pp. 125-134.

Bailey, F. M. (1924): Through Bhutan and Southern Tibet. *Geographical Journal* **64** (4): 291-297 + map.

Bargatzky, T. (1986): Einführung in die Kulturökologie. Umwelt, Kultur und Gesellschaft. Dietrich Reimer Verlag, Berlin.

Bhargava, O. N. (ed.) (1995): Bhutan: a geological account. Special publications n° 39. Geological Survey of India, Calcutta.

Brauen, M. (1994): Irgendwo in Bhutan. Wo die Frauen (fast immer) das Sagen haben. Waldgut, Zürich.

Brokensha, D. (eds.) (1980): Indigenous knowledge systems and development. University Press of America, Lanham MD.

Bürgi, A. (1992): Case study n°3: Lame Gompa research forest. In: RGOB et al. (eds.): Forest inventory and management. Forest management and conservation project FAO BHU 85/016, Thimphu, pp.31-36.

Bürgi, A., Rinchen et Dorji, T. (1992): Structure, productivity, regeneration and possible utilization of the fir (Abies densa Griff.) forests in Chumi valley, Central Bhutan. IFDP, Lame Gömpa.

Bürki, A. (1981): Bestandesstrukturen Gebirgsfichtenwald. Charakterisierung von Strukturtypen durch Inventurdaten aus Kontrollstichproben. Zürich, Diss. ETH n°6864.

Chambers, R., Pacey A. et Thrupp, L. A. (1994): Les paysans d'abord: les innovations des agriculteurs et la recherche agronomique. Karthala, Paris.

Champion, H. G. and Seth, S. K. (1968): A revised survey of the forest types of India. Manager Publications, New Delhi.

Clemens, J. and Nüsser, M. (1997): Resource management in Rupal valley, Northern Pakistan: the utilization of forests and pastures in the Nanga Parbat area. In: Stellrecht, I. and Winiger, M. (eds.): Perspectives on history and change in the Karakorum, Hindukush, and Himalaya. Rüdiger Köppe Verlag, Köln, pp. 235-263.

Croll, E. and Parkin, D. (eds.) (1992): Bush base: forest farm. Routledge, London/New York.

Descola, P. (1994): In the society of nature. Cambridge University Press, Cambridge.

Dhital, D. B. and Pushparajah, M. (1992): Case study n°2: Gidakom forest management unit. In: RGOB, ADC, Helvetas, FAO et UNDP (eds.): Forest inventory and management. Forest management and conservation project FAO BHU 85/016, Thimphu, pp. 24-30.

Dorji, T. (1995): Assessment of non timber forest resource utilization in Eastern Bhutan. RGOB, Forestry Services Division, Khangma.

Dove, M. R. (1994): Transition from native forest rubbers to Hevea brasiliensis (Euphorbiaceae) among tribal smallholders in Borneo. *Economic Botany* **48** (4): 382-396.

Driem, G. v. (1993): Language policy in Bhutan. In: Aris, M. and Hutt, M. (eds): A traditional order and the forces of change. London, Strachan-Kiscadale, pp. 87-105.

Duffield, C., Gardner, J. S., Berkes, F. et Singh, R. B. (1998): Local knowledge in the assessement of resource sustainability: case study in Himachal Pradesh, India, and British Columbia, Canada. *Mountain Research and Development* **18** (1): 35-49.

Dujardin, M. (1993): Bhutan's human settlements sector: dynamics of tradition and modernity. In: Aris, M. and Hutt, M. (eds.): A traditional order and the forces of change. London, Strachan-Kiscadale, pp. 137-159.

Dujardin, M. (1997): Von der Festung zum Bauernhof: eine lebendige Architektur. In: Schicklgruber, C. and Pommaret, F. (eds.): Bhutan: Festung der Götter. Serindia, London, pp. 61-83.

Ebner, R. (1996): Local knowledge of trees among the Bhil in Southern Rajasthan. With special reference to its value and implications for rural development. Arbeitsberichte Internationale Reihe Nr. 96/4 der Professur Forstpolitik und Forstökonomie, ETHZ, Zürich.

FAO (1996): Non-Wood Forest Products of Bhutan. RAP publication 1996/6, Bangkok.

Gadgil, M. and Vartak, V. D. (1976): The sacred groves of Western Ghats in India. *Economic Botany* **30** (2): 152-160.

Gansser, A. (1983): Geology of the Bhutan Himalaya. Birkhäuser Verlag, Basel.

Giesch, C. (1993): Les forêts de conifères du Bhoutan central: description des types de forêts et de leur structure à partir d'une première série de relevés de surfaces d'observation à long terme et propositions pour la mise en valeur de ces forêts. EPFZ, Chaire de sylviculture, Zurich.

Gilmour, D. A. and Fischer, R. J. (eds.) (1992): Villagers, forests and foresters: the philosophy, process and practice of community forestry in Nepal. Sahayogi Press, Kathmandu.

Grierson, A. J. C. and Long, D. G. (1983): Flora of Bhutan. Vol. 1, part 1. Royal Botanic Garden, Edinburgh.

Grujic, D. (1999): Aufstieg und Niedergang des Himalaya am Beispiel Bhutans. *Die Alpen* **75** (8): 32-45.

Guenat, D. (1991): Study of the transformation of traditional farming in selected areas of central Bhutan: the transition from subsistence to semi-subsistence, market oriented farming. Swiss federal institute of technology (ETH), Department of Agriculture. Zürich.

Gupta, A. K. and Ura, K. (1992): Indigenous farming technologies and environment: experiences in Bhutan. In: Jodha, N. S., Banskota, M. et Partap, T. (eds.): Sustainable mountain agriculture: farmers' strategies and innovative approaches. Oxford & IBH Publishing Co., New Delhi, pp. 539-568.

Helvetas and SDC (1989): Country Programme. Swiss cooperation with Bhutan. Helvetas, Thimphu and Zürich.

Helvetas and SDC (1993): Landesprogramm 1993-1997: Zusammenarbeit der Schweiz mit Bhutan. Helvetas, Thimphu, Zürich und Bern.

Herbst, P. (1993): Report on forest management planning (management plan Shingkhar East). Vol. 1: Current situation, future management, implementation and control. IFMP WangtangLa-ThrumsingLa, ADC and RGOB, Thimphu.

Hess, C., Schönhut, M., Sodeik, E. et Vries, S. (1998): Partizipation unter der Lupe: ethnologische Begenungen mit partizipativen Methoden im Forschungs- und Aktionszusammenhang. *Entwicklungsethnologie* **7** (2): 11-48.

Irvine, D. (1989): Succession management and resource distribution in an Amazonian rain forest. In: D. A. Posey and W. Balée, Resource management in Amazonia. Advance in economic botany. New York, 223-237.

Ives, J. D. and Messerli, B. (1989): The Himalayan dilemma. Reconciling development and conservation. Routledge, London and New York.

Kapos, V., Rhind, J., Edwards, M. et Price, M. (forthcoming): Developing a map of the world's mountain forests.

Karmay, S. G. (1995): Les Dieux des terroirs et les genévriers: un rituel tibétain de purification. *Journal asiatique* **283** (1): 161-207.

Kievelitz, U. (1995): Analysis of the environmental and social situation in Nahi Gewog, Wangdi-Phodrang district. Results of a Rapid Rural Appraisal June 21 to June 24, 1995. RGOB, FSD/GTZ, Thimphu.

Knuchel, H. (1923): Über die Anpassung der Betriebseinrichtung an die heutigen waldbaulichen Verhältnisse. *Schweiz. Z. Forstwes.* **74** (7,8): 195-204.

Knuchel, H. (1944): Über Bestandeskarten und Bestandesprofile. *Schweiz. Z. Forstwes.* **95** (1): 373-383.

Korpel, S. (1995): Die Urwälder der Westkarpaten. Gustav Fischer, Stuttgart.

Köstler, J. N. (1953): Bildliche Darstellung des Bestandesgefüges. *Allg. Forst- und Jagdzeitung* 125 (2): 69-76.

Kovda, V. A. and Lobova, E. V. (1971): Soil map of Asia, n°4. 1:6'000'000. Moskov.

Kuensel (1997) (Dzongkha development commission): Notification: names of dzong, dzongkhag, drungkhag and geog in Dzongkha and roman Dzongkha. 18. Oct., pp. 12-13.

Lamprecht, H. (1954): Über Strukturuntersuchungen im Tropenwald. *Z. für Weltforstwirtschaft* **17** (5): 161-168.

Laumans, P. (1994): Height-diameter functions from PIS for country-level site classification and local volume table selection. UNDP/FAO, Thimphu.

Leibundgut, H. (1959): Über Zweck und Methodik der Struktur- und Zuwachsanalyse von Urwäldern. *Schweiz. Z. Forstwes.* **110** (3): 111-124.

Leibundgut, H. (1993): Europäische Urwälder. Paul Haupt Verlag, Bern & Stuttgart.

Leurs, R. (1996): Current challenges facing participatory rural appraisal. *Public administration and development* **16**: 57-72.

Linkenbach, A. (1997): Social struggle and conflict of interests in the Garhwal forest. In: Stellrecht, I. and Winiger, M. (eds.), Perspectives on history and change in the Karakorum, Hindukush, and Himalaya. Rüdiger Köppe Verlag, Köln, pp. 325-344.

LUPP (1994): Bumthang Dzongkhag. 1: 100'000. RGOB, Ministry of Agriculture, Thimphu.

LUPP (1994): Land use working map, Bhutan 78l10, 1:50'000. RGOB, Ministry of Agriculture, Thimphu.

LUPP (1995): Data sheet for all gewogs in Bumthang dzongkhag. RGOB, Ministry of Agriculture, Thimphu.

LUPP (1997): Atlas of Bhutan. Land cover & area statistics of 20 Dzongkhags. RGOB, Ministry of Agriculture, Thimphu.

Maag, B. (1994): Wald und Bäume in der Welt zweier Tamang-Dörfer in Zentral-Nepal. Beobachtungen unter besonderer Berücksichtigung der Rolle der Tamang-Frau bei der Walderhaltung. Arbeitsberichte Internationale Reihe Nr. 94/6 der Professur Forstpolitik und Forstökonomie, ETHZ, Zürich.

Mahat, T. B. S., Griffin, D. M. et Shepherd, K. R. (1986): Human impacts on some forests of the middle hills of Nepal. Part 2. Some major human impacts before 1950 on the forests of Sindhu Palchok and Kabhre Palanchok. *Mountain Research and Development* **6** (4): 325-334.

Maier, E. (1996): Situation analysis of the social-/community forestry sector in the Dzongkhags of Punakha and Wangdue-Phodrang. RGOB, FSD/GTZ, Lobesa.

Messerschmidt, D. A. (1991): The uses of anthropology in agro/social forestry R and D: approaches to anthropological forestry. In: W. R. J. Burch and Parker, J. K. (eds.): Social Science Applications in Asian Agroforestry. Oxford, pp. 145-179.

Moench, M. and Bandyopadhyay, J. (1986): People-forest interaction: a neglected parameter in Himalayan forest management. *Mountain Research and Development* **6** (1): 3-16.

Namgyel, P. (1996): Beyond timber - what value of the forest? FRC/BG-IFMP occasional paper n°1, Forest research centre/GTZ, Taba.

Namgyel, P. (1997): History and development of forestry research in Bhutan. RNR-RC Yusipang. Thimphu.

Negi, S. S. (1989): Forest types of India, Nepal and Bhutan. Periodical Expert Book Agency, Delhi.

Norbu, L. (1997): Forestry research in Bhutan. RNR-RC Yusipang. Thimphu.

Norbu, S., Wangdi, D., Roder, W. et Wangdi, K. (1996): Traditional practices of Bhutanese mountain farmers to maintain soil fertility in buckwheat systems. International Crop Science Congress, Delhi. (unpublished).

Norbu, U. P. (1993): Indigenous forest management systems in Bhutan. Fourth Annual Common Property Conference,16-19 June, Manila. (unpublished).

Pickett, S. T. A. and White, P. S. (eds.) (1985): The ecology of natural disturbance and patch dynamics. Academic Press, Orlando.

Polunin, O. and Stainton, A. (1997): Flowers of the Himalaya. Oxford University Press, Delhi.

Pommaret, F. (1995): "Maîtres des trésors" (gter bdag): divinités locales et médiums au Bhoutan. In: Blondeau, A.-M. (ed.): 7th Seminar of the International Association for Tibetan Studies. Verlag der Österreichischen Akademie der Wissenschaften. Vienna, pp. 79-97.

Pommaret, F. (1996): On local mountain deities in Bhutan. In: Blondeau, A.-M. and Steinkellner, E. (eds.): Reflections of the mountain. Essays on the history and social meaning of the mountain cult in Tibet and the Himalaya. Verlag der Österreichischen Akademie der Wissenschaften, Vienna.

Pommaret, F. (1997): Ethnisches Mosaik - Die Völkergruppen Bhutans. In: Schicklgruber, C. and Pommaret, F. (eds.): Bhutan: Festung der Götter. Serindia, London, pp. 43-60.

Pommaret, F. and Imaeda, Y. (1991): Bhutan. Passport books, Illinois.

Posey, D. A. (1992): Interpreting and applying the "reality" of indigenous concepts: What is necessary to learn from natives? In: Redford, K. H. and Padoch, C. (eds.): Conservation of neotropical forests. Columbia University Press, New York, pp. 21-34.

RGOB (1969): The Bhutan Forest Act. Ministry of Trade, Commerce, Industries, Forest and Mines. Thimphu.

RGOB (1978): Land Act. Law committee, Thimphu.

RGOB (1985): National forest policy of Bhutan. Thimphu.

RGOB (1993): Social forestry rules 1993: private forest rules, community forest rules. Ministry of Agriculture, Forestry Services Division. Thimphu.

RGOB (1994): Statistical Yearbook of Bhutan 1993. Ministry of Planning, Central Statistical Organization, Thimphu.

RGOB (1992): Druk Gyalpo Jigme Singye Wangchuk and twenty years of development. Ministry of Social Services, Department of Education, Thimphu.

RGOB (1995): Forest and Nature Conservation Act of Bhutan, 1995, Thimphu.

Roder, W. (1990): Traditional use of nutrient inputs. *ILEIA Newsletter* **6** (3): 3-4.

Roder, W., Calvert, O. et Dorji, V. (1992): Shifting cultivation systems practised in Bhutan. *Agroforestry systems* **19**: 149-158.

Roder, W., Calvert, O. et Dorji, V. (1993): Effect of burning on selected soil parameters in a grass fallow shifting cultivation system in Bhutan. *Plant and Soil* **149**: 51-58.

Rohrbach, E. (1985): Observations and investigations on silviculture and yield. Coniferous forests: mesic montane forests. Vol. 1. Helvetas, Thimphu.

Rohrbach, E. (1989): Silvicultural research in the forestry units Dhur, Domkhar, Hurchi and in the Lame Gompa research forest (1986-1988). Coniferous forests: mesic montane forests. Vol. 2. Helvetas, Zürich.

Rosset, J. (1998): Temperate conifer forests of Bhutan. A review of forestry research activities until June, 1998. RNR-Research Centre, Jakar.

Rosset, J. and Rinchen (1997): Local volume tables for main conifer species in the Bumthang region. RNR-Research Centre, Jakar.

Sansonnens, B. (1996): Agroforesterie indigène en Asie tropicale humide: structure et dynamique. Analyse comparée de deux études de cas. *Mitteilungen der Eidgenössischen Forschungsanstalt für Wald, Schnee und Landschaft* **71** (1): 1- 207.

Sargent, C. (1985): The forests of Bhutan. *Ambio* **14** (2): 75-80.

Sargent, C., Sargent, O. et Parsell, R. (1985): The forests of Bhutan: a vital resource for the Himalayas? *Journal of Tropical Ecology* **1** (3): 265-286.

Schickhoff, U. (1997): Ecological change as a consequence of recent road building: The case of the high altitude forests of the Karakorum. In: Stellrecht, I. and Winiger, M. (eds.): Perspectives on history and change in the Karakorum, Hindukush, and Himalaya. Rüdiger Köppe Verlag, Köln, pp. 277-286.

Schicklgruber, C. (1997): Götter und heilige Berge. In: Schicklgruber C. and Pommaret, F. (eds.): Bhutan: Festung der Götter. Serindia, London, pp. 159-174.

Schmidt-Vogt, D. (1989): Die Höhenwälder im Jugal-Himal (Nepal): Waldtypen und Waldentwicklung unter dem Einfluss menschlicher Nutzung. Deutscher Geographentag, Franz Steiner Verlag, Wiesbaden.

Schmidt-Vogt, D. (1990): High altitude forests in the Jugal Himal (Eastern central Nepal): forest types and human impact. Geoecological Research n°6, Franz Steiner Verlag, Stuttgart.

Schmidt-Vogt, D. (1993): Traditional use of high altitude forests in the Nepal Himalaya. South Asia Institute, University of Heidelberg.

Schmidt-Vogt, D. (1997): Stand structure as an indicator of forest change due to human impact: a methodological contribution with examples from Nepal and Northern Thailand. In: Stellrecht, I. and Winiger, M. (eds.): Perspectives on history and change in the Karakorum, Hindukush, and Himalaya. Rüdiger Köppe Verlag, Köln, pp. 287- 302.

Schönhuth, M. (1996): 'PRA' (Participatory Rural Appraisal) im Diskurs. *Entwicklungsethnologie* **5** (2): 11-33.

Schönhuth, M. (1998): Machen wir uns ein Bild davon - PRA: Ansatz-Instrumente-Herausforderungen. Zürich (unpublished).

Schütz, J.-P. (1990): Sylviculture 1. Principes d'éducation des forêts. Presses Polytechniques et Universitaires Romandes, Lausanne.

Schweinfurth, U. (1983): Man's impact on vegetation and landscape in the Himalayas. In: Holzner, W., Werger, M. J. A. et Ikusima, I. (eds.): Man's impact on vegetation. Dr. W. Junk Publishers, The Hague/Boston/London, pp. 297-309.

Seeland, K. (1989): Entwurf einer Kulturökologischen Checkliste. Zürich, NADEL. (unpubl. manuscript)

Seeland, K. (1997): What is indigenous knowledge and why does it matter today? In: Seeland, K. and Schmithüsen, F. (eds.): Indigenous Knowledge of Forests and For-

est Uses among Tribal Communities in India. Forstwissenschaftliche Beiträge der Professur Forstpolitik und Forstökonomie, Bd. 19, ETHZ, Zürich, pp. 12-21.

Seeland, K. and Schmithüsen, F. (eds.) (2000): Man in the Forest. Local knowledge of forests and forest uses among tribal communities in India. D.K. Publ., New Delhi.

Stapleton, C. (1994): Bamboos of Bhutan. Whitestable Litho Ltd., Kew.

Troup, R.S. (reprint 1986): The silviculture of Indian trees. International Book Distributors, Dehra Dun.

United Nations (1991): Bhutan: explanatory brochure. Economic and social commission for Asia and the Pacific, New York.

UNDP (1996): Bhutan: Development co-operation report 1994. UNDP, Thimphu.

UNDP (1998): Statistics from the 1998 Human Development Report. http:// www.undp.org/hdro/ectrends.htm

UNDP and FAO (1984): Forestry development in Bhutan. Report on remote sensing land use and vegetation mapping. BHU/75/007/1983, FAO.

UNESCO (1997): Statistical yearbook 1997. UNESCO & Bernan Press, Paris & Lanham.

Upadhyay, K. P. (1995): Shifting cultivation in Bhutan: a gradual approach to modifying land use pattern. Community forestry case study series, FAO, Rome.

Ura, K. (1993): Development and decentralization in medieval and modern Bhutan. In: Aris, M. and Hutt, M. (eds): A traditional order and the forces of change. London, Strachan-Kiscadale, pp. 25-49.

Ura, K. (1993): The nomads' gamble. National environment commission, Thimphu.

Ura, K. (1995): The hero with a thousand eyes. A historical novel. Allied Printers, Bangkok.

Wagner, J. (1994): The ethno-botany of four villages in Zhemgang dzongkhag: a RRA. Save the children USA, Zhemgang.

Wangchuk, S. (1991): The natural resources of the Himalayan Kingdom. In: Sherubtse college (ed.): Bhutan and its natural resources. Vikas Publishing House, Kanglung/New Delhi, pp. 44-52.

Wangchuk, S. (1997): Local perceptions and indigenous institutions as forms of social performance for sustainable forest management in Bhutan. Forstwissenschaftliche Beiträge der Professur Forstpolitik und Forstökonomie, Bd. 20, ETHZ, Zürich.

Wangmo, T. (1982): Thimphu tshechu festival. Dept. of Tourism, Thimphu.

Wangmo, T. (1983): Paro tshechu festival. Dept. of Tourism, Thimphu.

Wangmo, T. (1986): Wangdiphodrang festival. Dept. of Tourism, Thimphu.

Warren, D. M., Slikkerveer, L. J. et Brokensha, D. (1995): The cultural dimension of development: indigenous knowledge systems. Intermediate technology publications, London.

Watt, A. S. (1947): Pattern and process in the plant community. *Journal of Ecology* **35** (1,2): 1-22.

White, J. C. (1910): Journeys in Bhutan. *Geographical journal* **35** (1): 18-42 + 104 (map).

White, J. C. (1909): Sikkim and Bhutan: twenty-one years on the North-East frontier, 1887-1908. London, (rep. New Delhi, 1972).

Whyte, A. V. T. (1977): Guidelines for field studies in environmental perception. United Nations Educational, Scientific and Cultural Organisation, Paris.

Whyte, W. F. (1984): Learning from the field. A guide from experience. SAGE, Newbury.

Whyte, W. F. (1994): Participant observer: an autobiography. ILR Press, Ithaca/New York.

Wiart, J. (1983): Ecosystème villageois traditionnel en Himalaya népalais: La production forestière suffit-elle aux besoins de la population? Ecologie appliquée. Université scientifique et médicale de Grenoble, Grenoble.

World Bank (1994): Bhutan. Country economic memorandum. South Asia Region, World Bank, South Asia Country Department I, Washington D.C.

GLOSSARY

LANGUAGES:

B: Bumthangkha (language spoken in Bumthang)
Dz: Dzongkha (national language)

N.B.: The spelling in the Roman alphabet might differ from one author to the other. As far as possible, a spelling already existing was used. The names in Bumthangkha were spelled phonetically with the help of key informants. For the names of locations, the official spelling in Roman dzongkha was used [RGOB, 1997].

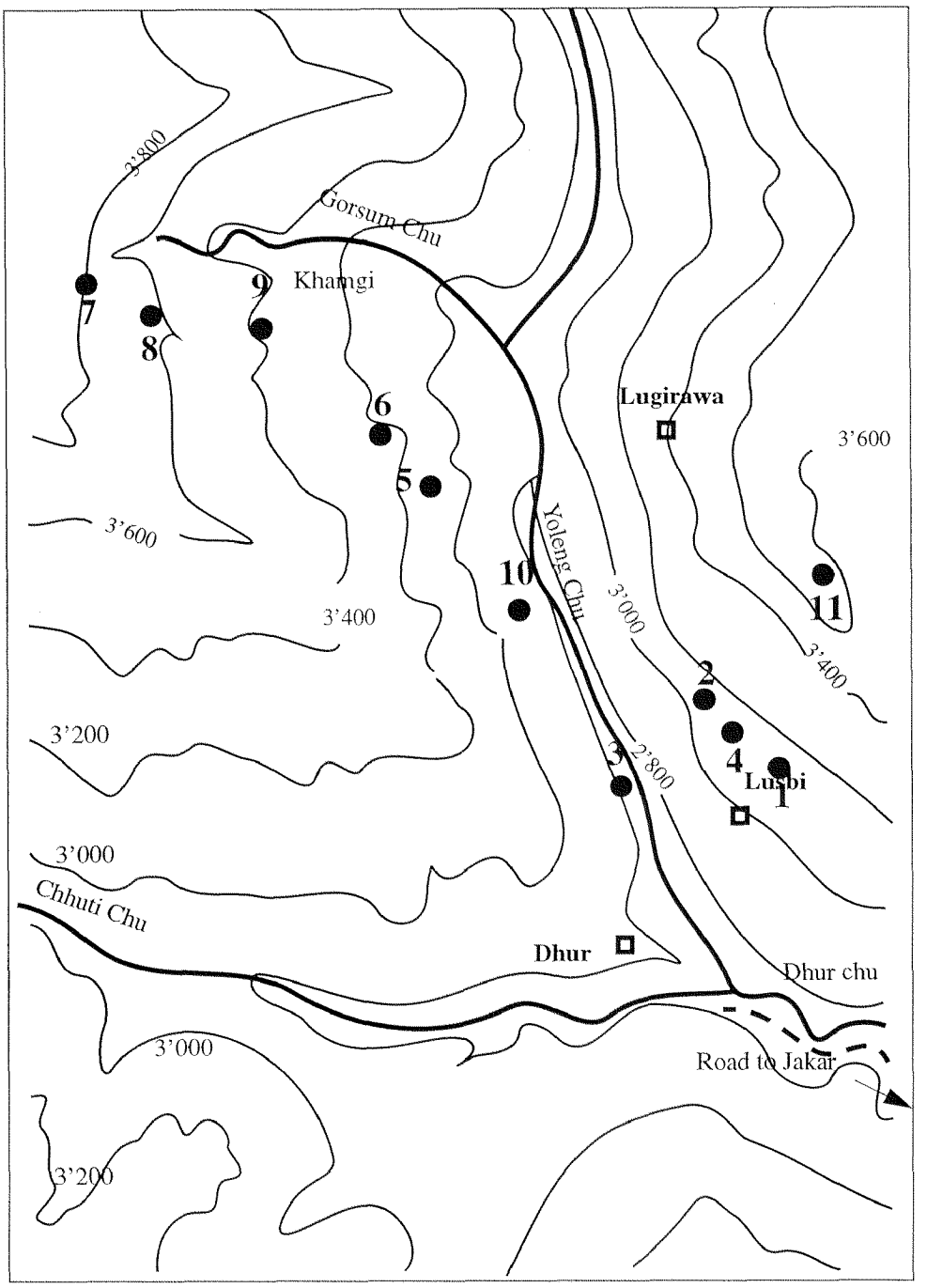
Local name	English
balu (B)	*Rhododendron anthopogon*, used as incense
bangchang (B)	home-made beer prepared with hot water. It is often drunk warm
bangchung (B)	small container (usually round) made of bamboo
bau (Dz)	abnormal growth on the tree stem used for making bowls, similar to *zha*, but less precious
brokkat (B)	language of the brokpas of Bumthang
brokpa (B) or bhzop (Dz)	yak herder
bumthangkha (Dz/B)	language spoken in Bumthang
cham (Dz, B)	beam
chhimi (Dz)	member of the National Assembly representing a geog
chipon or liaison (Dz)	messengers between villages and dzong
chodom (B)	small table
choezom (Dz/B)	altar
chöje (Dz)	heads of families descended from famous religious teachers
chörten (Dz)	buddhist reliquary
chu (Dz)	river
chugo (B)	dried yak cheese
dangchung	slim poles on the roof to hold the shingles Dangchungs are laid from top to bottom on the roof
doeba (B)	landless farmers who share-croped land during the feudal system
dratshang (B/Dz)	monastic community
dré (B)	volume unit (in Bumthang approximately 2.1 litre or 1.7 kg wheat)
drey (B)	female yak
dugdom (Dz)	forced labour system, carried out in groups of six people

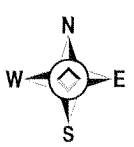
Local name	English
dung (B)	noble family in Bumthang during the feudal system
dungsto (Dz)	traditional doctor
dzong (B/Dz)	fortress and building of the district's administration
dzongda (Dz)	district governor
dzongkha (Dz)	national language of Bhutan
dzongrab (Dz)	assistant of the district administrator
dzonkhag (Dz)	district
geog (Dz)	sub-district
gompa (Dz)	temple
Gungdang Ula (Dz)	forced labour system (ceased in 1995)
günshing (B)	winter firewood
gup (Dz)	head of a sub-district (geog)
gyamtsochola (B)	red point drawn on the bottom of a cup believed to neutralize poison
jaanker (B)	edible inner bark of the blue pine; this name is used in the lower part of Chhoekhor
jarshing (B)	summer firewood
jout phi (B)	soot
kamzhing (Dz)	permanently cultivated land, mainly with wheat, barley and potatoes
Khema (B)	Rhododendron sp. (?), used as incense
khow (B)	small beam
khraeba (B)	tax-paying household in the feudal system
kuan (B)	torch wood
kuan seng (B)	candle tree
langdo (B/Dz)	unit of area: the area a pair of oxen can plough in one morning. On dry land, it corresponds to approximately 1/3 acre (1'350 m^2)
Lhotsampas (Dz)	population group, literally: inhabitant of the South
liaison or chipon (B)	messengers between villages and dzong
lon (B)	fuelwood to fertilize the fields
Losar (B/Dz)	New Year according to the Bhutanese (Tibetan) calendar. The date for Losar varies from year to year, but it is usually in February
lu (Dz)	serpent deity akin to the Indian naga
lungsey (B)	beam or pole to hold the roof (lower side)
marphog (B)	A marphog is equal to 5 sang. In Dhur one marphog is approximately equal to 1 kg
mek (B)	a small variety of bamboo: *Yushania microphylla*

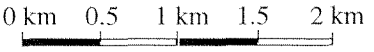
Local name	English
mesungpa (Dz)	fire-watcher
metikuan (B)	torch wood to light fires
mitup (B)	unit of time, corresponding approximately to 80 years
mong (B)	shingle
mosit (Dz)	forced labour system for women
naampang (B)	planks between the ceiling in the upper part of the house, under the roof
naktse (B)	brokpa household keeping female yaks for a landlord during the feudal system
nepa (B)	spirit of pre-buddhist origin
Ngalong (Dz)	population group of western Bhutan
Ngultrum or Nu. (Dz)	Bhutanese currency. In 1998, 1 US$ was approximately equal to 37 Nu.; 1 Swiss Franc to 26 Nu.
nuenath (B)	important religious festival in Dhur
pampoe (B)	*Nardostachys jatamansi*, used as incense
pang (B)	plank
panglin (B)	unit of area for the pangzhings. It is the area a man can dig in 3 days (approx. 1/9 acre). In the past (15-20 years ago), it corresponded in Dhur to the area a man could dig in 6 days
pangrin (B)	the rent for a panglin
pangula (B/Dz)	person who had to dig the pangzhings for the king during the feudal system
pangzhing (B)	grass land shifting cultivation area or system
peu (B)	commercially prepared incense sticks
phita (B/Dz)	unit of volume. In Dhur a phita is 1/3 of a dré, that means approx. 0.7 litres
phob (Dz)	bowl
phosit (Dz)	forced labour system for men
putishing (B)	*Picorrhiza kurroa*, used as medicine for cough and cold
rû (B)	a tall variety of bamboo: *Borinda grossa*
sang (B/Dz)	unit of weight, corresponding to approximately 330g
sang (Dz/B)	locally collected incense
shabtolami (Dz)	system of remunerated voluntary work

Local name	English
Sharshop (Dz)	population group of eastern Bhutan
shi (B)	young bamboo shoot
sho (B)	litter (pine needles, spruce needles, oak leaves, fern,...)
sho tsang (B)	basket to carry *sho* (litter)
shog seng (B)	juniper
singchang (B)	home-made beer which is prepared with cold water. In Dhur, it is mostly prepared from wheat
sog (Dz)	litter (pine needles, spruce needles, oak leaves, fern,...)
sogzhing (Dz)	patch of forest where one has a usufruct right to collect litter (sog)
solu (B)	*Rhododendron nivale*, used as incense
szurba (B)or zurpa	households which have separated from the main household
tapshing (B)	firewood
tekpa (Dz)	dried yak cheese
thram (Dz)	land record register
tsamdrog (Dz)	natural pasture in which people have an user right to graze
tschesa (Dz)	kitchen garden
tsechu (Dz)	temple festival
tseepa (Dz/B)	village astrologer
tseri (Dz)	bush fallow shifting cultivation system prevalent in the south and east of the country
tshogpa (Dz)	village representative
whad (B)	edible inner bark of the blue pine. This name is used in the upper part of Chhoekor
yaktse (B)	brokpa household keeping male yaks for a landlord during the feudal system
yathra (Dz/B)	woollen cloth traditionally woven in Bumthang
yertse gömpo (B)	*Cordiceps sinensis*, used as a medicine
yongsengma (B)	*Elsholtzia fructicosa*
zeeba (B)	brokpa household keeping livestock (yaks and sheep) for a monastic community
zha (Dz)	abnormal growth on the tree stem, used for making bowls
zim (Dz)	slim poles on the roof to hold the shingles. Zims are laid accross the roof

Appendix 1: Approximate location of the indicator plots



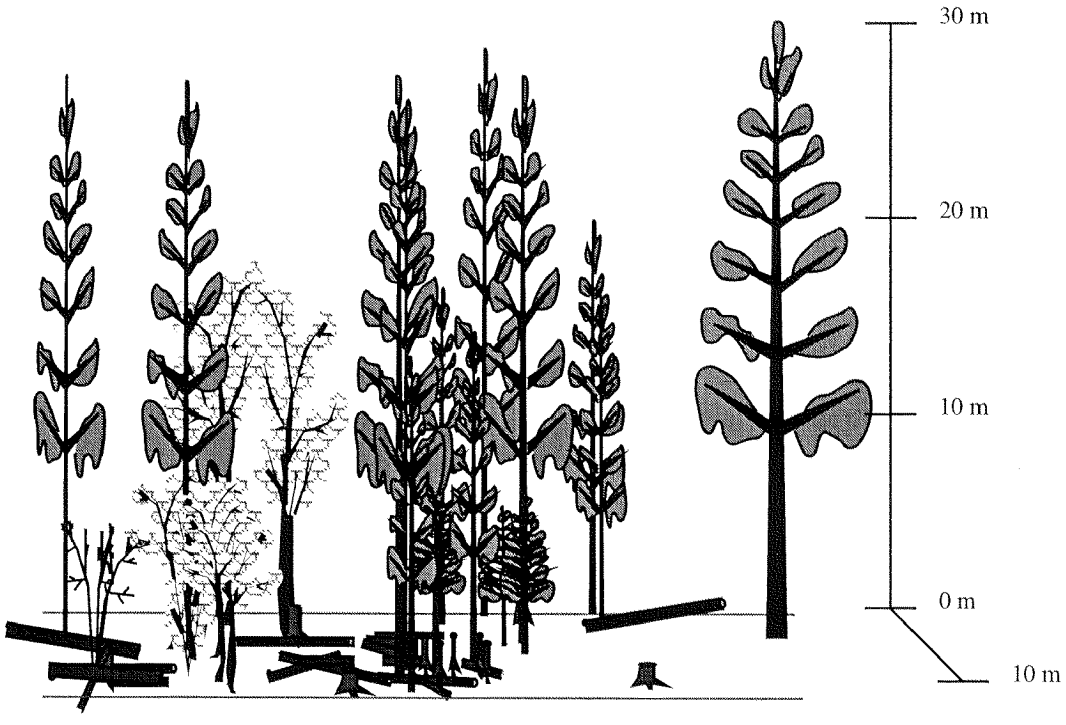


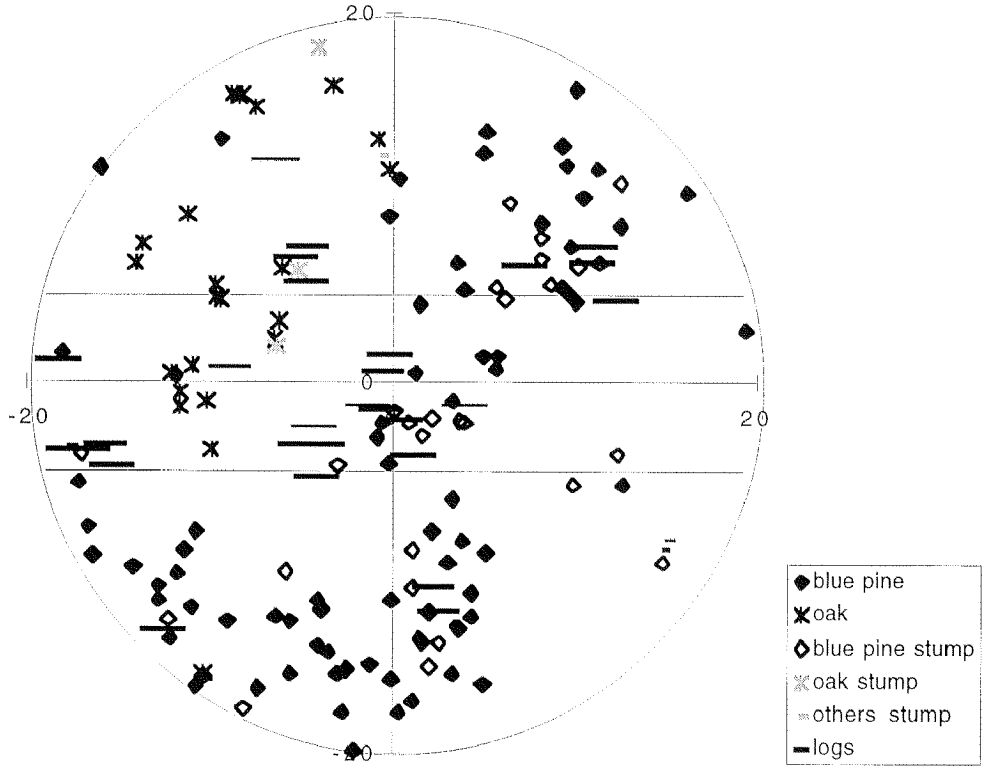


Indicator plots:

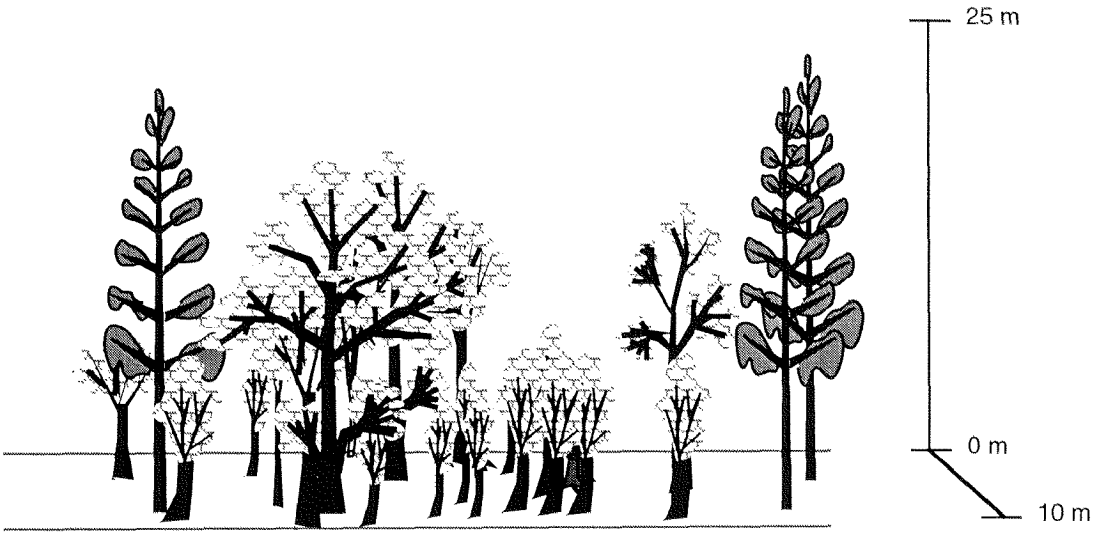
1, 2: Blue pine forest
3, 4: Blue pine forest with oak
5, 6: Hemlock forest
7,8: Fir forest
9: Mixed fir forest with hemlock
10, 11: former agicultural land

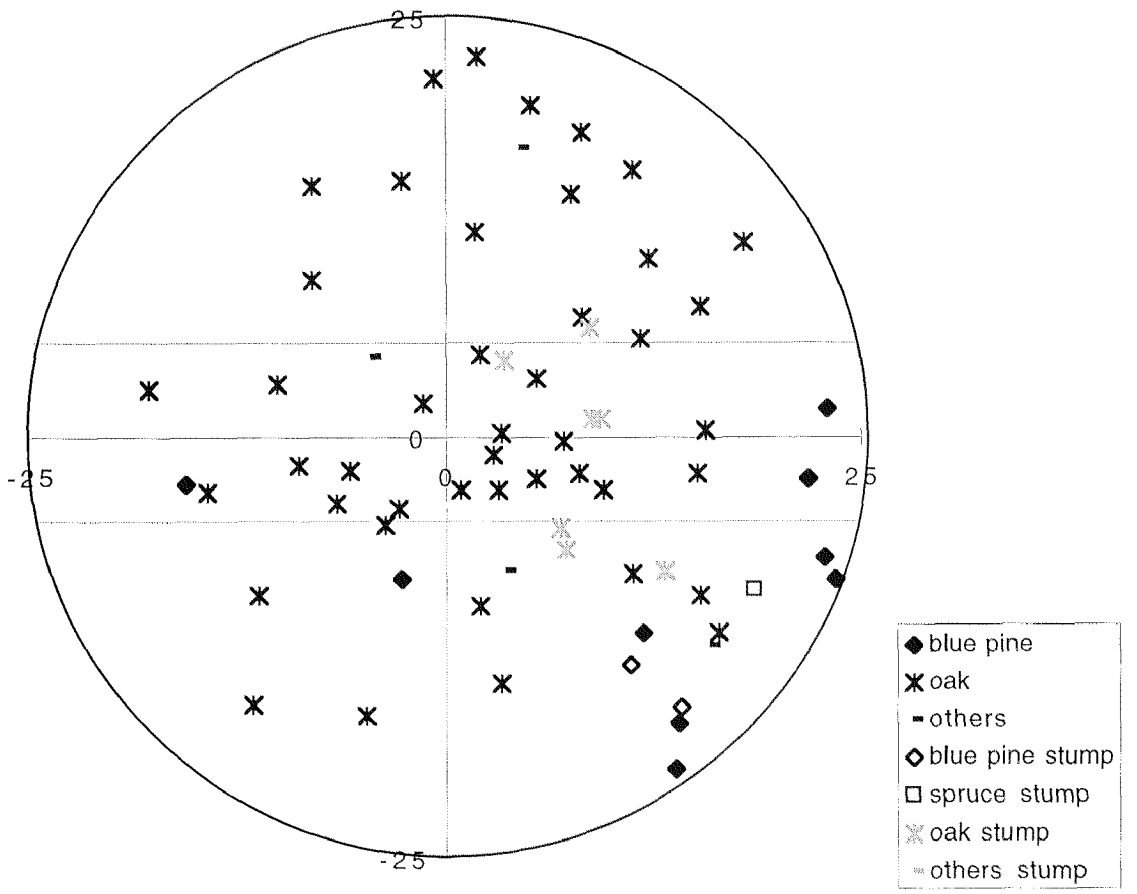
Appendix 2: Blue pine forest, indicator plot 1



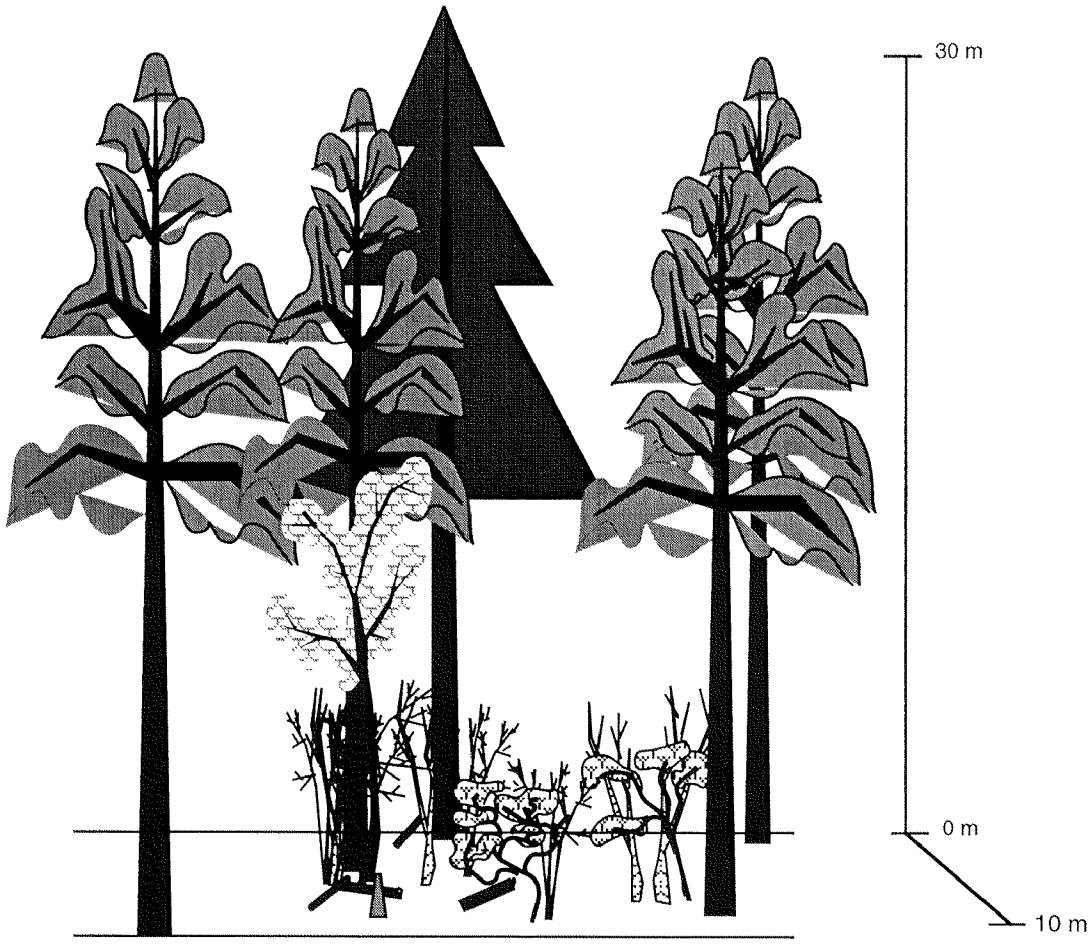


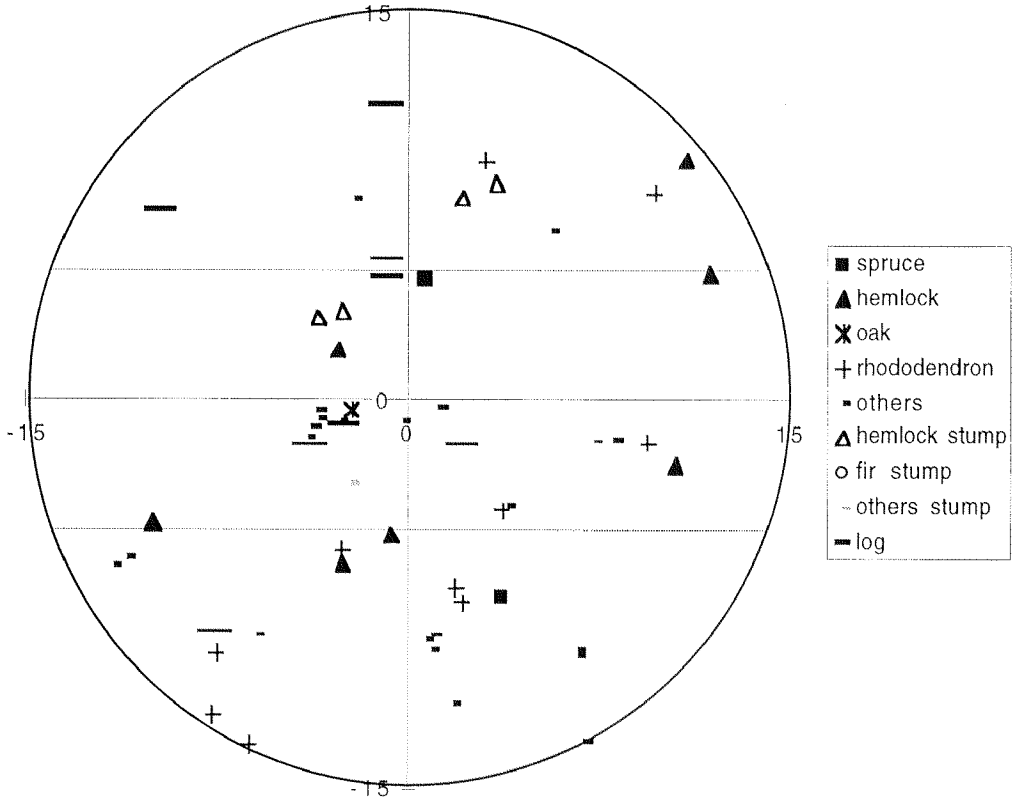
Appendix 3: Blue pine forest with oak, indicator plot 3



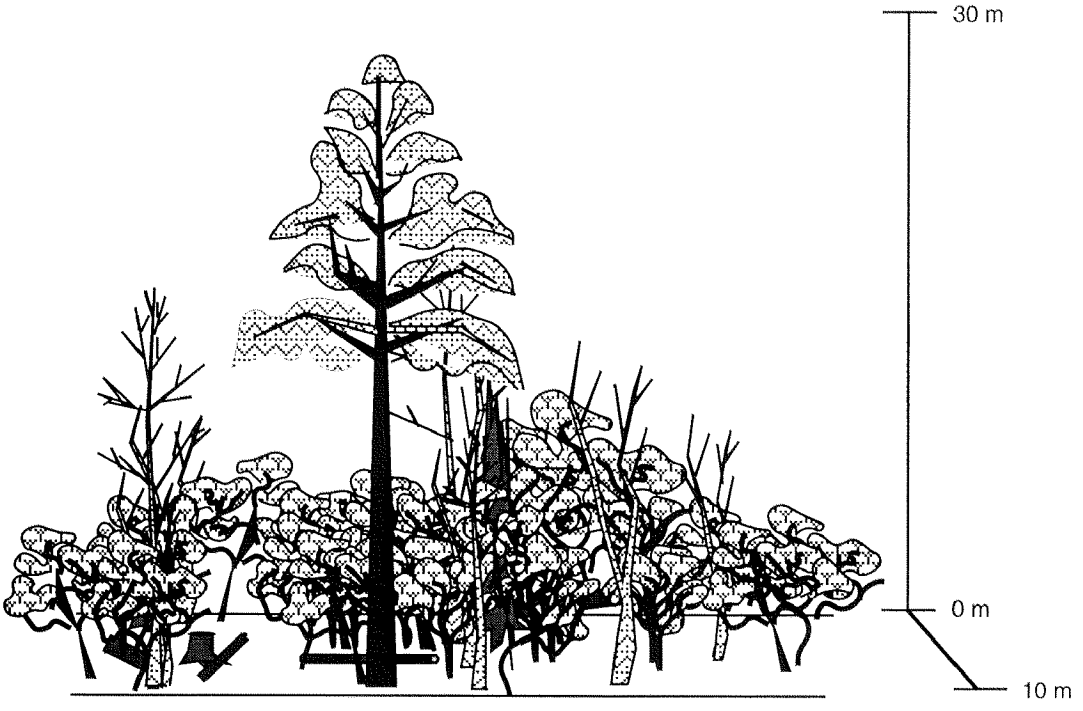


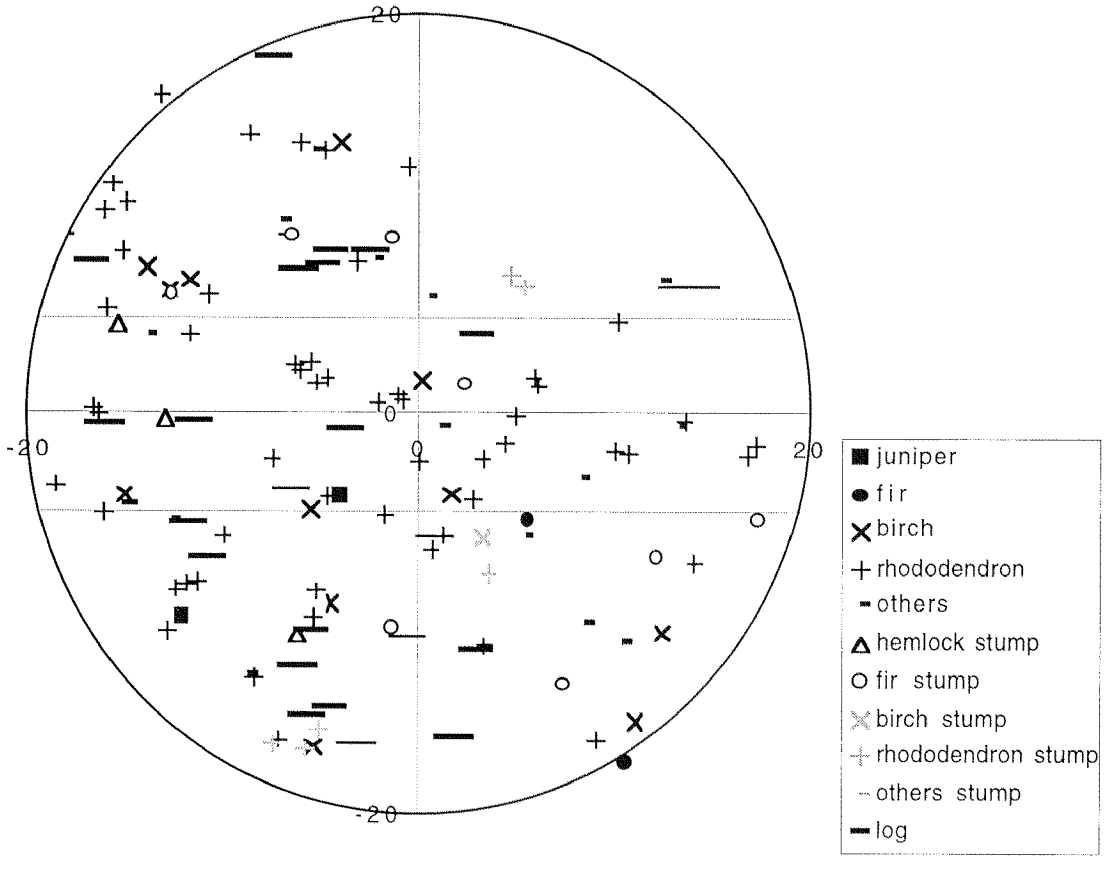
Appendix 4: Hemlock forest, indicator plot 5



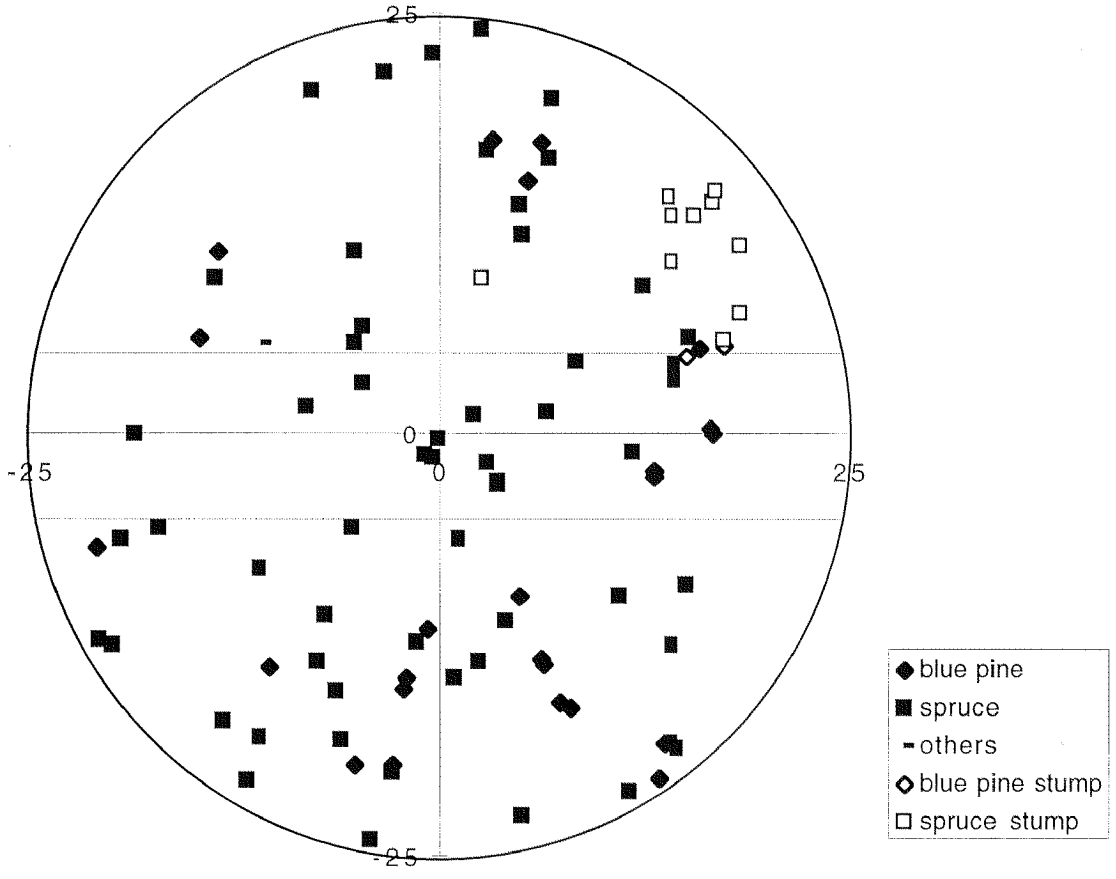


Appendix 5: Fir forest, indicator plot 8

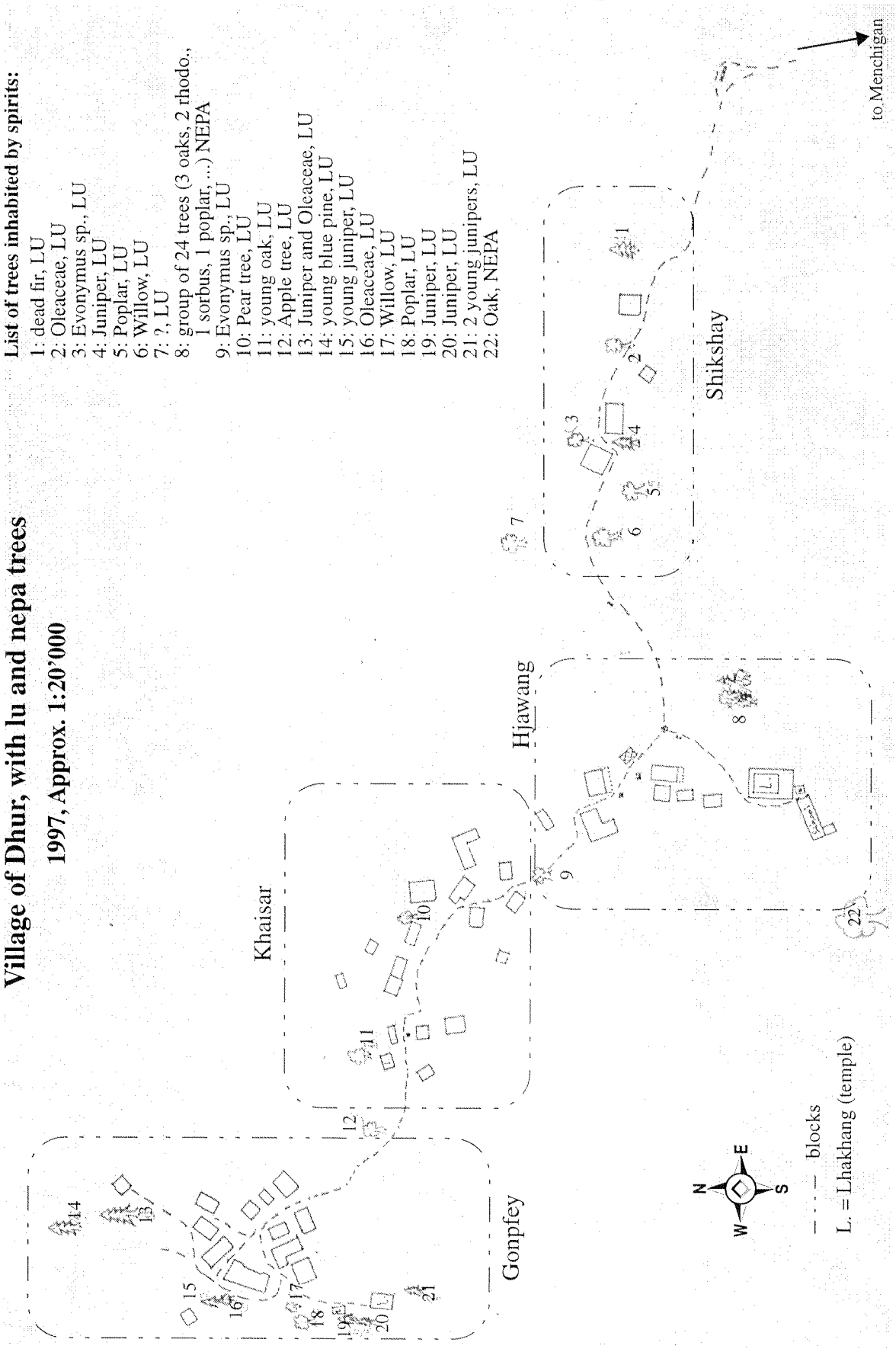




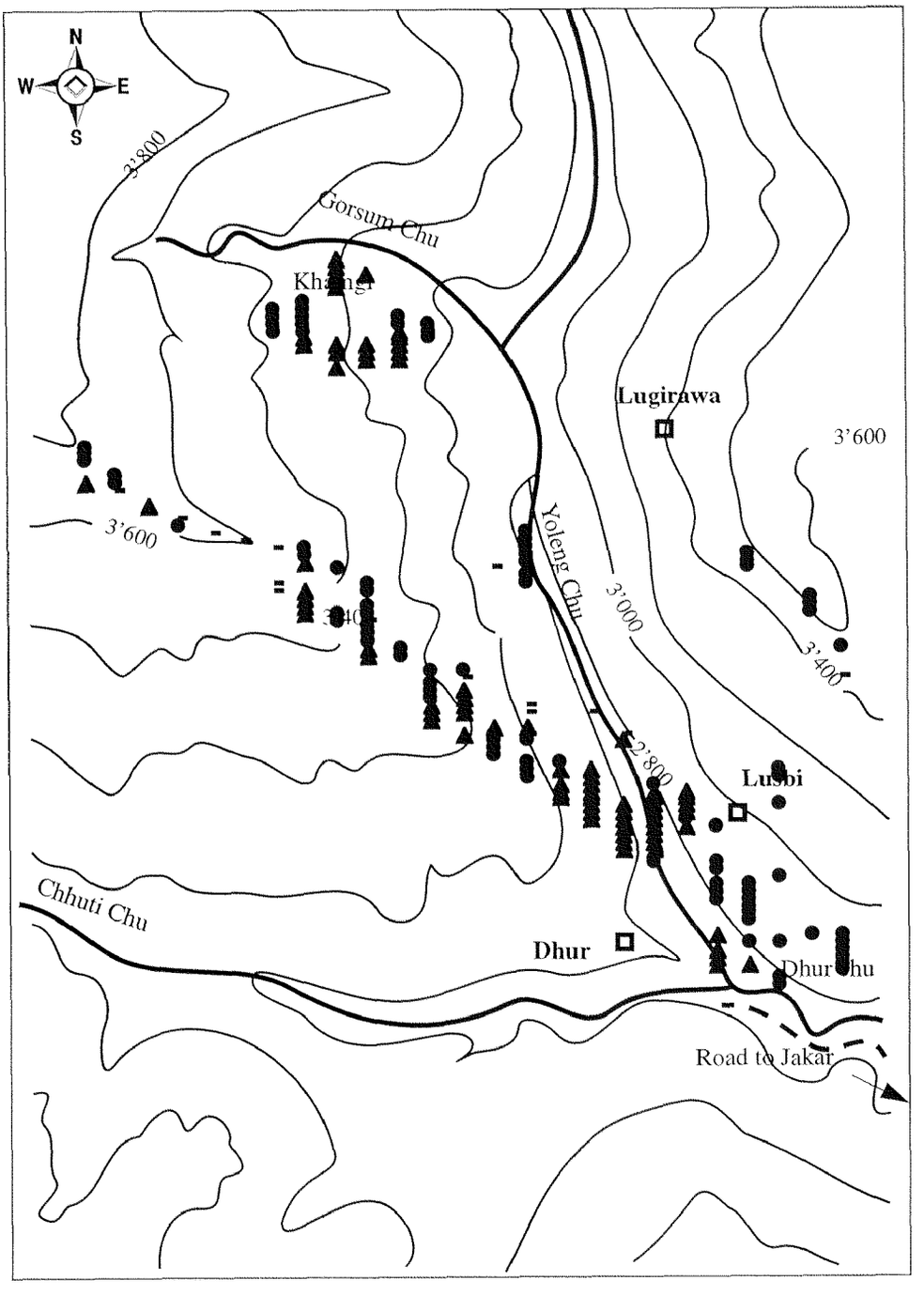
Appendix 6: Former pasture, indicator plot 11



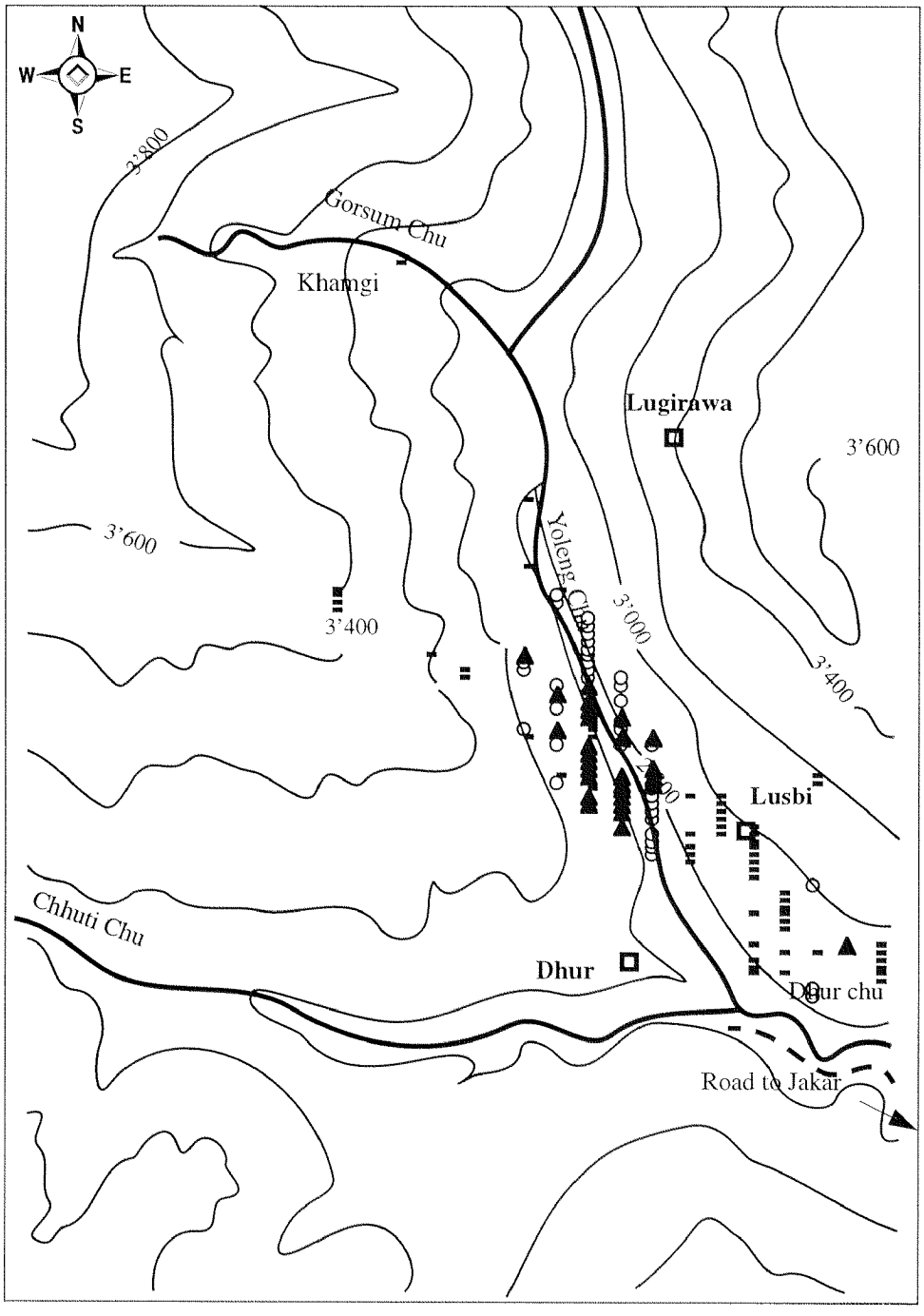
Appendix 7: Sketch map of Dhur with lu and nepas trees, 1997



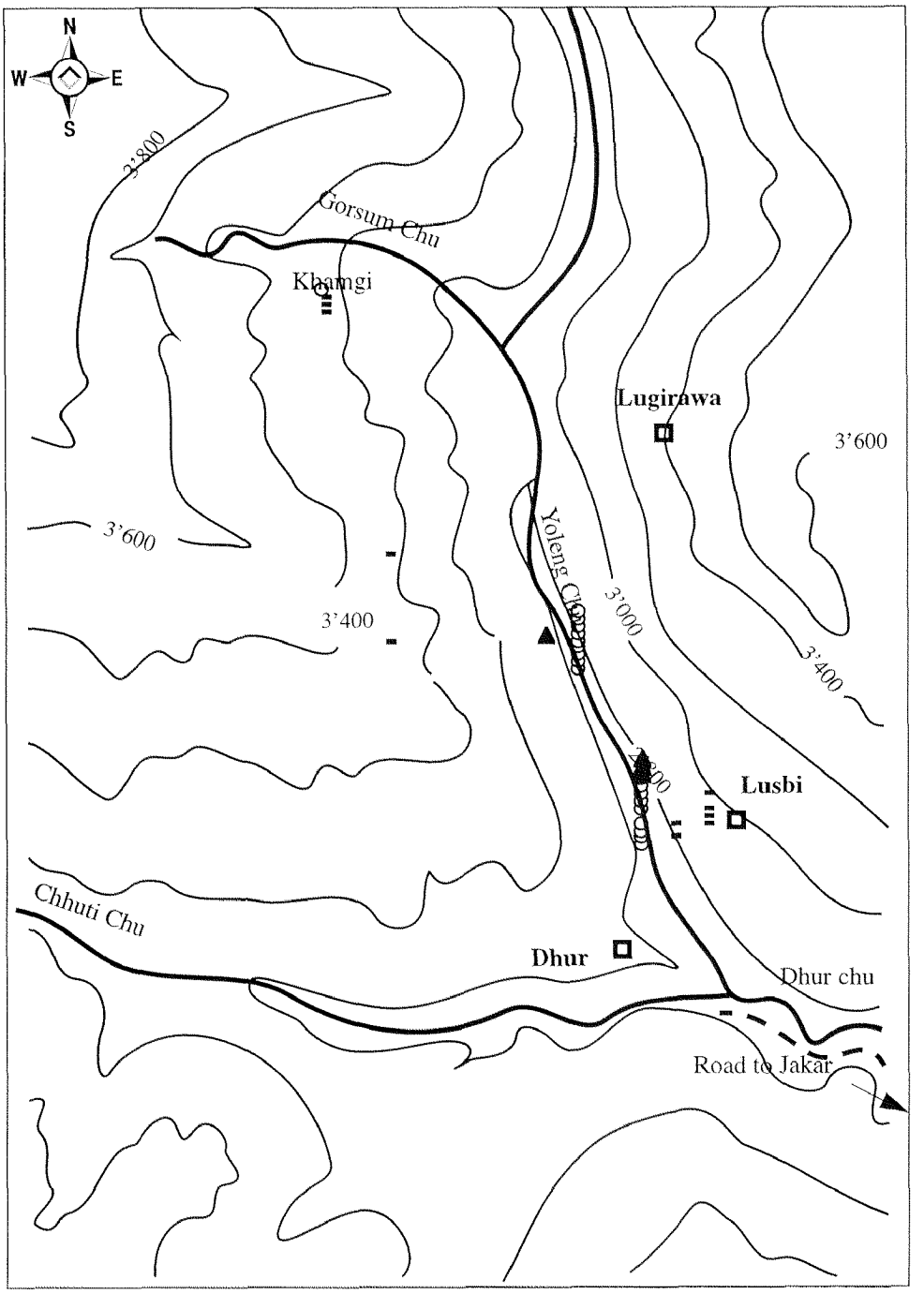
Appendix 8: Location of the fuel wood collection. 1:50'000.



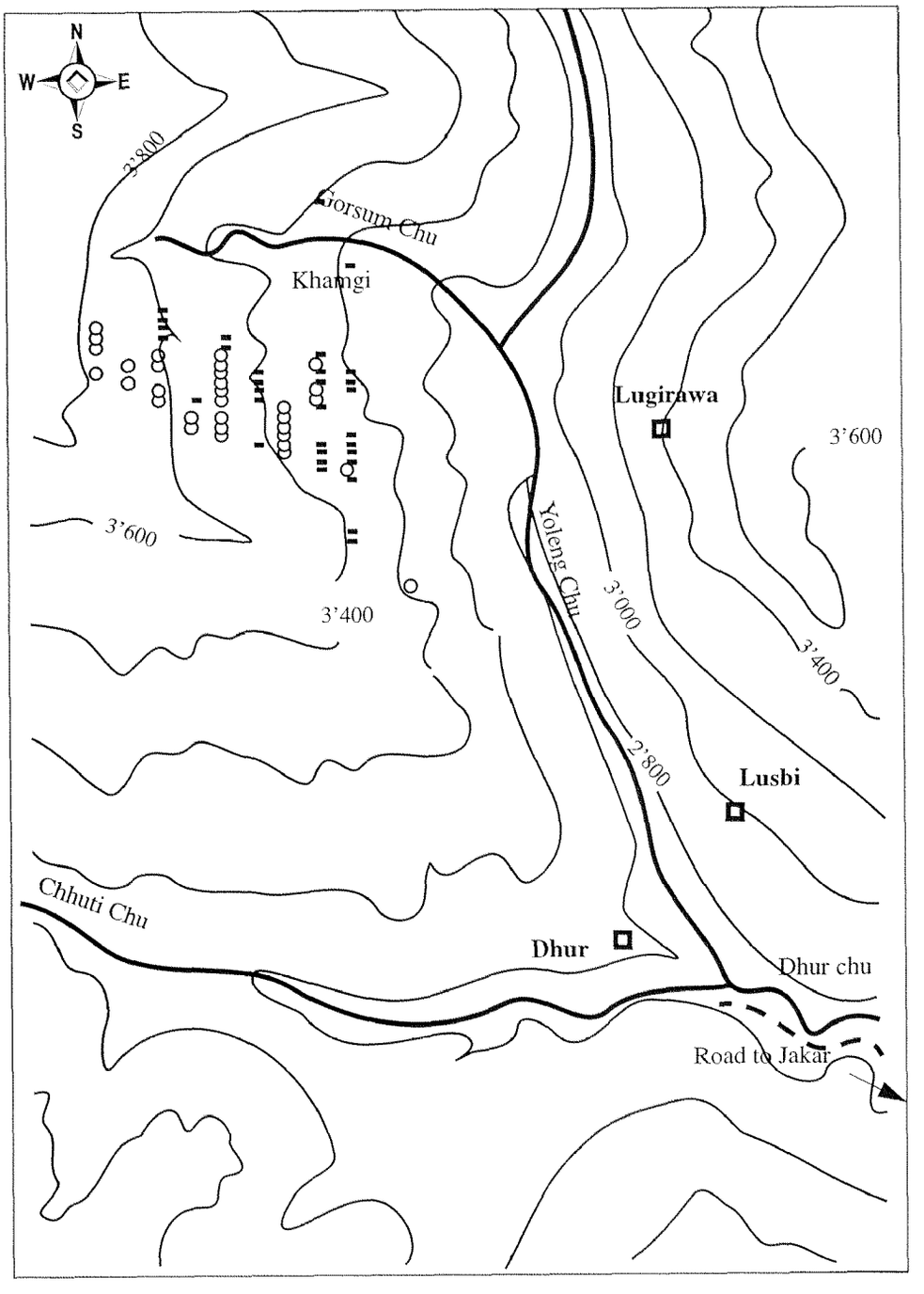
Appendix 9: Location of the trees felled for beams. 1:50'000



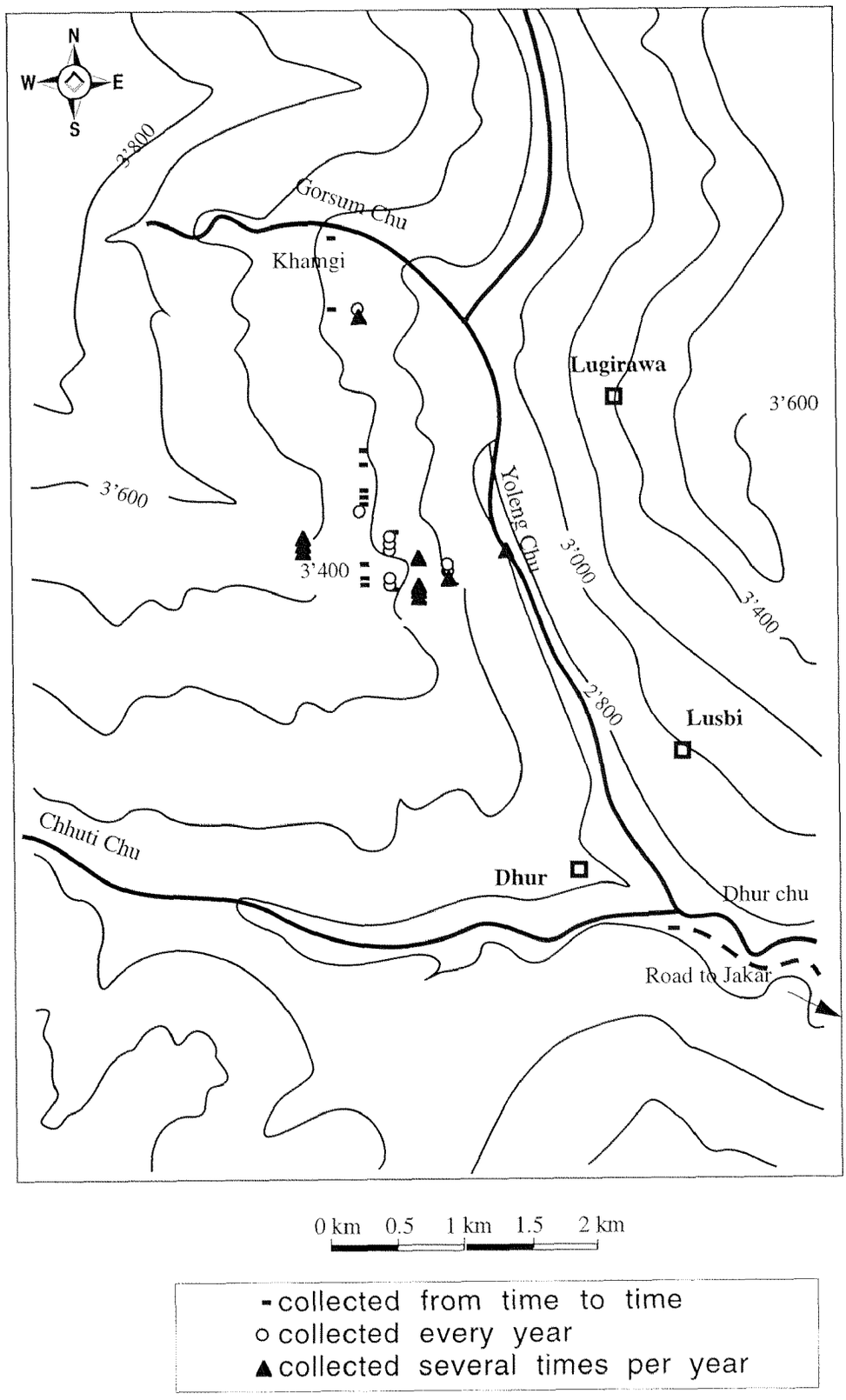
Appendix 10: Location of the trees felled for planks. 1:50'000.



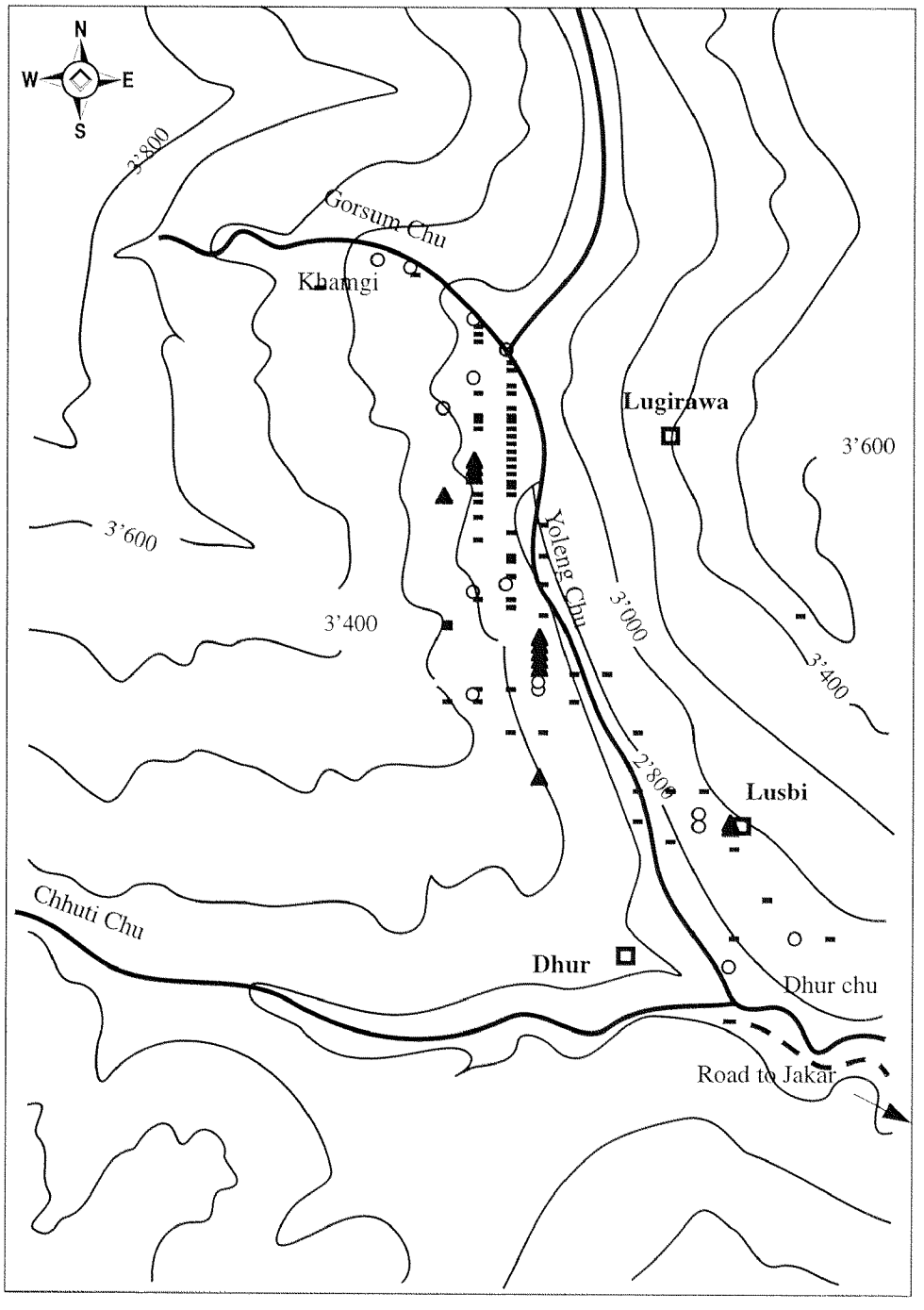
Appendix 11: Location of trees felled for shingles. 1:50'000.



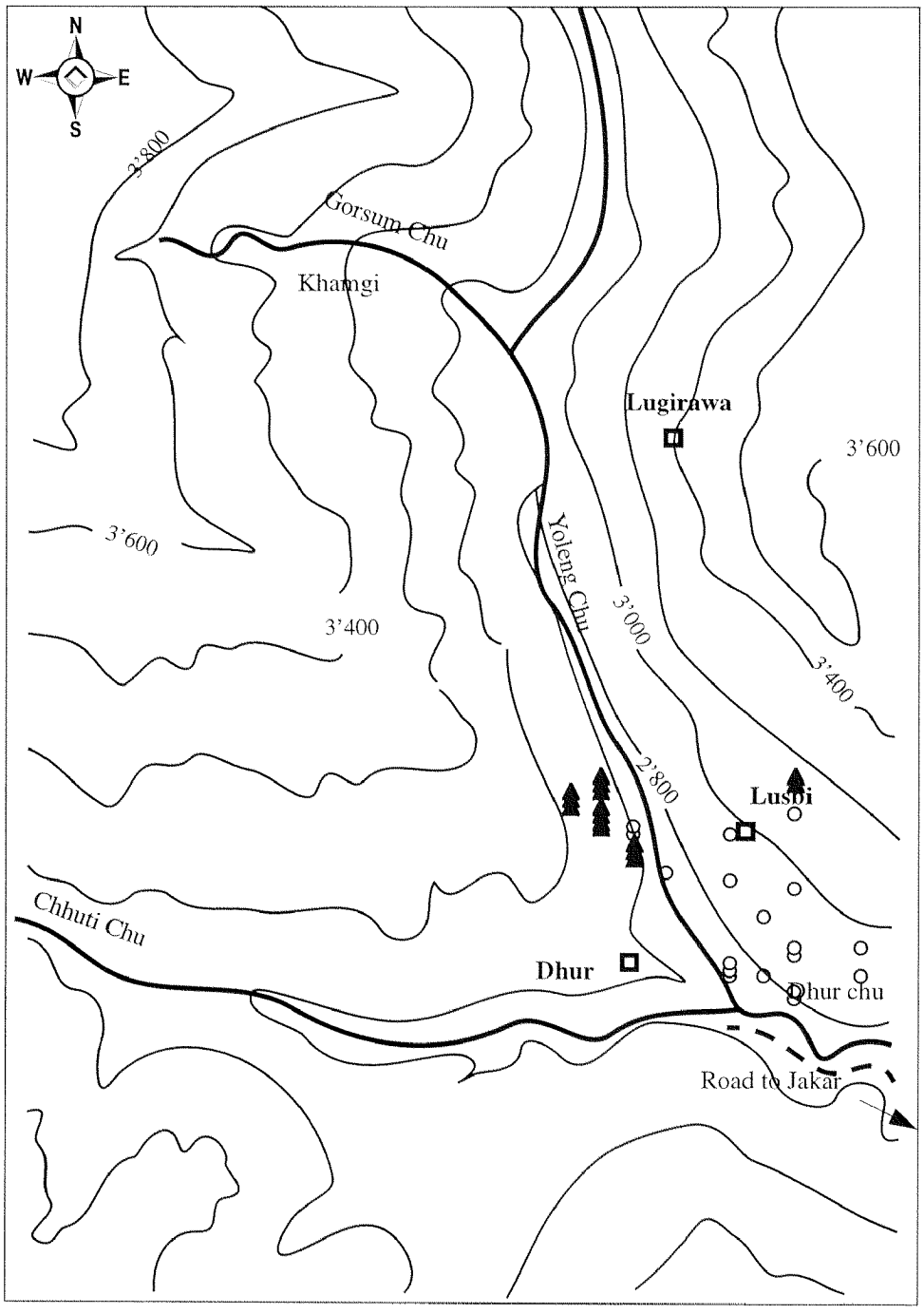
Appendix 12: Location of bamboo (*Borinda grossa*) collection. 1:50'000.



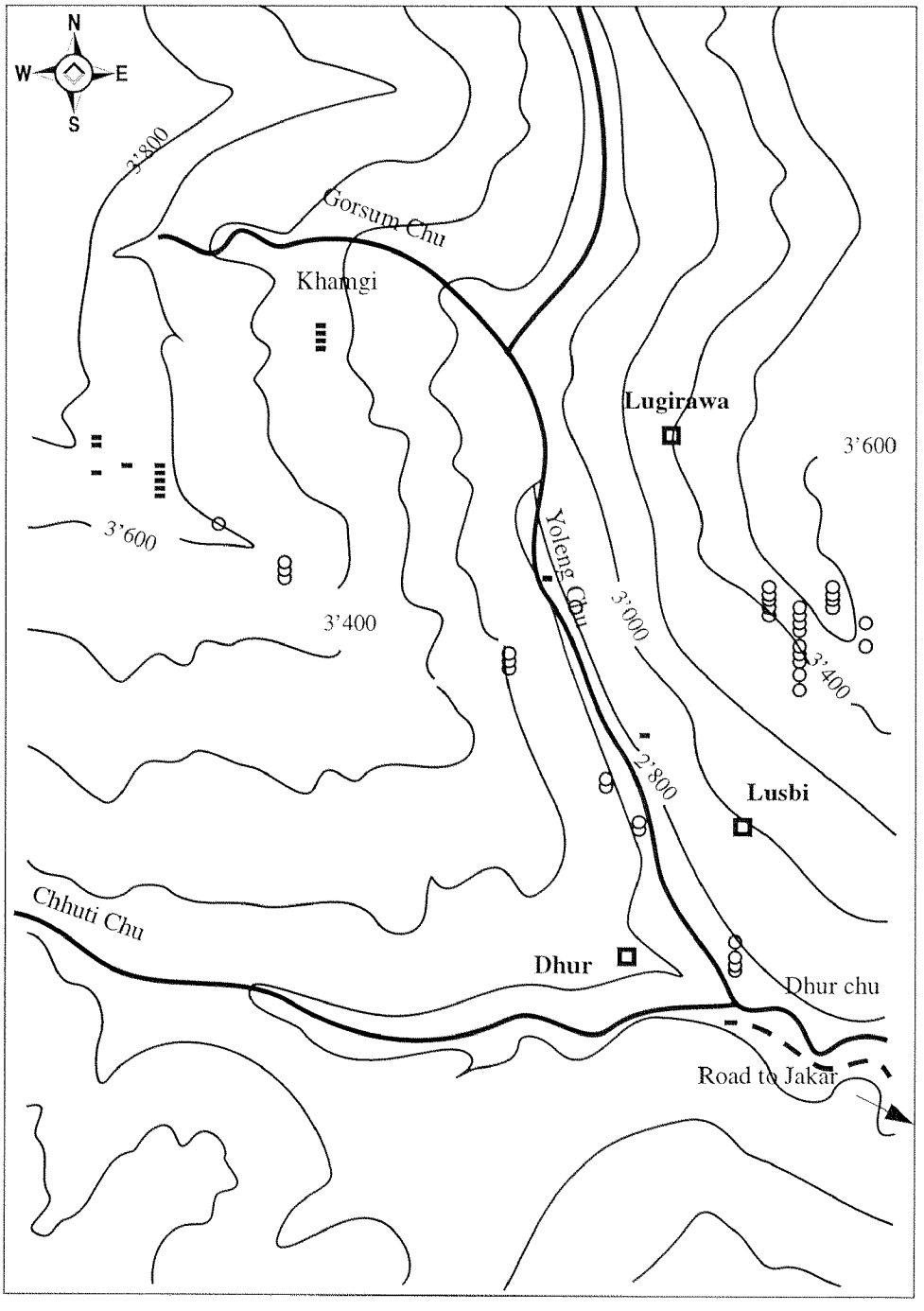
Appendix 13: Location of torch wood collection. 1:50'000.



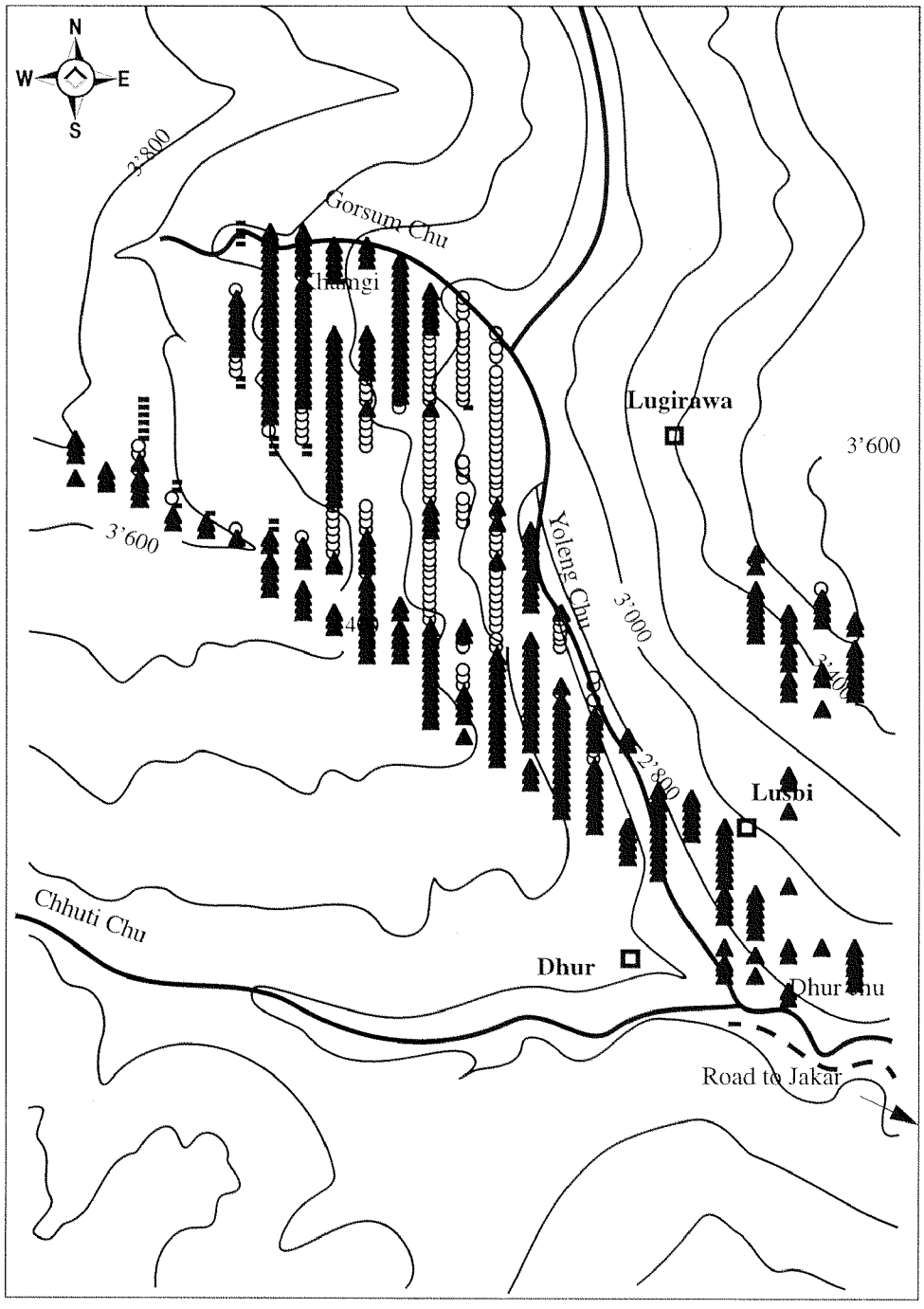
Appendix 14: Location of litter collection. 1:50'000.



Appendix 15: Location of the mushroom collection. 1:50'000.



Appendix 16: Location of forest grazing. 1:50'000.



Appendix 17: Scientific and local plant names.

Table A-9: Scientific and local names of tree and shrub species. Source: Survey with the Checklist in Cultural Ecology and forest inventory 1997-98.

Scientific name	Bumthangkha	English
Abies densa	Wangseng	East Himalayan fir
Acer campbellii	Losumpa	Maple
Acorus calamus	Shuda	-
Berberis sp.	Kipser	-
Betula utilis	Takpa	Birch
Cordiceps sinensis	Yertsa gyonbob	-
Corylus ferox	Saskay	-
Cotoneaster frigidus	Grunang sang	-
Daphne bholua	Shogsho seng	-
Eleagnus parvifolia	Dambri marip	-
Elsholtzia fructicosa	Yong sengma	-
Enkianthus deflexus	Jigwa kambur	-
Evonymus tingens	Jarjala	-
Hippophae sp.	Tey seng	Buckthorn
Hypericum choisianum	Sonashushey	-
Inula royleana	Las kay metho	-
Juniperus pseudo-sabina	Mo shog	Black juniper
Juniperus recurva	Pho shog	Weeping blue juniper
Juniperus sp.	Shog seng	-
Juniperus squamata	Pamaa	-
Lindera heterophylla	Whom thow seng	-
Lyonia ovalifolia	Bum shing	-
Nardostachys jatamansi	Pampoe	-
Picea spinulosa	Nakseng	East Himalayan spruce
Picrorhiza kurrooa	Putishing	-
Pinus wallichiana	Dokseng	Blue pine
Populus rotundifolia	Kha shing	Poplar
Prunus sp.	Membri	Cherry
Prunus sp.	Leaksing	Peach
Quercus semecarpifolia	Kharseng	Oak
Rhodo sp.	Rakpa	-
Rhodo sp.	Tshersang	-
Rhododendron anthopogon	Balu	Rhododendron
Rhododendron nivale	Solu	Rhododendron
Rosa macrophylla	Badzima	-
Rubia cordifolia	Tsut	-
Salix wallichiana	Shang may	Willow
Sorbus thibetica	Karshingmo	-

Table A-9: Scientific and local names of tree and shrub species. Source: Survey with the Checklist in Cultural Ecology and forest inventory 1997-98.

Scientific name	Bumthangkha	English
Symplocos paniculata	Shago seng	-
Taxus baccata	Kirang	Yew
Tsuga dumosa	Pey seng	Himalayan Hemlock
Viburnum nervosum	When zengma	-
?	Aram	?
?	Bumsangma	?
?	Bungkharshing	?
?	Dop seng	?
?	Jama	?
?	Klathpa	?
?	Ligsirma	?
?	Sa marip	Strawberry ?
?	Sirpula	?
?	Zimseng	?

Appendix 18: Edible plants

Table A-10:List of edible plants available in the region of Dhur. Source: Survey with the Checklist in Cultural Ecology.

Type	Local name
berries:	dambri marip (*Eleagnus parvifola*);
	samarip(strawberry)
	kali sirdi (cherry)-
	tanglipa (*Rosa sp.*)
other "sweets":	padzima (*Rosa sp.*: young shoot)
	whad (*Pinus wallichiana*: inner bark)
	takpa (*Betula utilis*: phloem)
vegetables:	enderlonglong
	dema
	nyajung
	tama
	gunzula
	khondo
	dhomlakpa
	safula
	tabri (fern shoot)

Table A-10: List of edible plants available in the region of Dhur. Source: Survey with the Checklist in Cultural Ecology.

Type	Local name
tea:	buyenba (mistletoe on blue pine and hemlock)
	sonachuchey (Hypericum choisianum)
	pangja
	changmey (Salix sp)
	kharseng (young oak leaves)
	naktja (dried conifer resin)
	khali (cherry)
	tolo latja
mushrooms:	silli shamu
	dungshi shamu
	shingtse shamu (common in spruce/rhodo. forest)
	chinmo shamo
	taksher shamu (on dead hemlocks)
	lamo shamu

Note: the field work was done in winter and thus many plants couldn't be identified.

Appendix 19: Felled tree species according to the product.

Table A-11: Stumps and their average diameter according to products. The species are mentioned in order of importance according to the number of stumps. The species which were used far less are printed in smaller letters. Source: forest inventory 1997-98.
* the number of records was too low to allow a statement.

Product	Species	Average diameter
Fire wood	Oak, rhododendron, blue pine, *Eleagnus,* hemlock, birch, maple, spruce, willow, poplar, *Symplocos, bumsengma(local name)*	12 cm
Beam	Blue pine, fir, spruce	32 cm
Pole	Blue pine, oak, maple, spruce, hemlock, fir, birch, *Evonymus,* poplar, willow, rhododendron	12 cm
Plank	Blue pine	51 cm
Shingle	Fir, hemlock	72 cm
Plough	Oak, Rhododendron	*
Fodder	Oak	*
Inner bark	Blue pine	10 cm
Torch wood	Blue pine	28 cm

Appendix 20: Households interviewed in Chhoekhor Toe and Tang

Table A-12: Number of households interviewed in Chhoekhor Toe and Tang according to the population groups. Source: Additional Household Survey 2000.

	Chhoekhor Toe	Tang
Monpa	12	14
Brokpa	3	0
Doeba	4	6
Other	1	0

Appendix 21: Quantity of chams: answers in Chhoekor Toe and Tang.

Table A-13: How many chams did you use during the last 12 years? Answers of 40 households in Chhoekor Toe and Tang. Source: FRUS 1999.

Quantity of chams	Households %
none	49%
10-50	10%
50-100	3%
100-200	18%
200-300	18%
>300	3%

Appendix 22: Quantity of planks: answers in Chhoekhor Toe and Tang.

Table A-14: How many planks did you use during the last 12 years? Answers of 40 households in Chhoekhor Toe and Tang. Source: FRUS 1999.

Quantity of planks	Households %
none	55%
less than 10	5%
10-20	0%
20-50	8%
50-100	13%
100-200	8%
> 200	13%

Appendix 23: Acceptance of chams from a sawmill in Chhoekhor Toe and Tang.

Table A-15: Would you use chams from a sawmill? Answers of 40 households in Chhoekhor Toe and Tang.[a]
Source: FRUS 1999.

Justification	yes	no
Less work	43%	-
More products	15%	-
Time	5%	-
It will be compulsory	3%	-
Lack of manpower	3%	-
Cost	-	25%
Don't need chams	-	3%
Total	**68%**	**28%**

a. 5% didn't know.

Appendix 24: Acceptance of planks from a sawmill in Chhoekhor Toe and Tang.

Table A-16: Would you use planks from a sawmill? Answers of 40 households in Chhoekhor Toe and Tang.[a]
Source: FRUS 1999.

Justification	yes	no
Less work	38%	-
More products	28%	-
Time	5%	-
It will be compulsory	5%	-
Lack of manpower	3%	-
Cost	-	15%
no need	-	3%
Total	78%	18%

a. 5% didn't know.

Appendix 25: Past and present use of kuan in Chhoekhor Toe and Tang.

Table 16-1: For what do you use kuan? Answers of 40 households of Chhoekhor Toe and Tang. Source: FRUS 1999.

	light fire	light	torch
regularly	92%	12%	12%
sometimes	8%	5%	5%
only in the past	0%	83%	83%

Appendix 26: Questions of the Household Survey 1997.

(Note: Only the questions were reproduced here. The orginal questionnaire kept provision for additional space and multiple choice answers).

1. Household description
   - 1.1 Location of the household (village, Household number)
   - 1.2 Head of household (name, sex)
   - 1.3 To which groups do you belong? (brokpa/monpa/other, khraeba/szurba/other)
   - 1.4 Composition of household (relationship with the head of the household, sex, age, class, occupation, residential status).
2. Landholding
   - 2.1 How much agricultural land do you own? (Kamzhing, Pangzhing, Tseri, Tsamdrog, Sogzhing, Forest, Improved pastures, Natural pastures, other).
   - 2.2 Do you own pangzhing areas on which now big trees are growing? (size)
     If no: Are you using pangshing areas you don't own?
     If yes: How do you use this area?
   - 2.3 On what land do you have user rights, but don't own the land? (Kamzhing, Pangzhing, Tseri, Tsamdrog, Sogzhing, Forest, Improved pastures, Natural pastures, other).
   - 2.4 Do you own land outside of Dhur? (location, type, size)
   - 2.5 Did you have more/same/less land at the time HM was living in Bumthang? Why did you loose land? **or** When and how did you get more land?
3. Possessions
   - 3.1 Animals (number of yaks, cattle, horses, mule/donkey, sheep, poultry, others)
   - 3.2 Houses
     - 3.21 Do you own the house you live in?
     - 3.22 What do you have in your house? (running water, cups and plates, smokeless stove, radio/tape recorder, gas stove, other)
     - 3.23 How old is your house?
     - 3.24 How many houses do you own?

3.4 Donation

3.41 Do you make donations to the lakhang or gompa? (regurlarly, more or less regularly, from time to time, on special occasions only, never, don't know)
What do you donate? (money, dalda, incense, scarf, other)
How much do you donate in total per year?

3.42 Did you go for naigkhor (pilgrimmage)?

3.43 On what occasions do you make donations?

4. Social relations

4.1 What work your household has to perform together with other households for the village community?

4.2 Does your household perform some special services which only your household is offering for the village community?

4.3 Flow shart:

5. Activities

5.1 What crop or vegetable do you cultivate in the largest quantity on your own field/ garden? -do- the second largest quantity? -do- the third largest quantity?

5.2 From what crop or vegetable you cultivate on your own land do you get the biggest income? -do- the second biggest income? -do- the third biggest income?

5.3 How important are these activities in your household? (Yak herding, pangzhing, tsamdrog, sogzhing, collecting NTFP in the forest, collecting rû, cutting trees for fuelwood, cutting trees for construction wood, weaving, cultivating one's own field/garden, cultivating the fields of other people, contract work, trading, maan-grangnyo)

5.4 How important are the following income generating activities in your household? (Selling yathra, selling handicrafts, selling cow products, selling yak products, selling potatoes, shop keeper, salary, contractor, performing rituals)

5.5 What products do you sell/barter?

5.6 What three products do you buy/barter most?

6. History

6.1 What changes in the population of your village did you see during the last decade? Was it remaining same /did it increase/did it discrease? Why? Did some people go away? Where? Did people come from other regions? What region?

6.2 a) What are the most important economic changes for your household in the last 10 years?
b) What are the most important economic changes for your household after the introduction of the Forest Act (1969)?
c) How was the economic situation in the village in 1950s?
d) How was the economic development after the capital shifted to Thimphu (1952)?

Appendix 27: Questions of the Forest Resource Use Survey 1999.

(Note: Only the questions were reproduced here. The orginal questionnaire kept provision for additional space and multiple choice answers).

1. Identification:
   - 1.1. Location:
   - 1.2. Household number
   - 1.3. Name of the head of the household.
2. fuel-wood
   - 2.1. Summer fire-wood (jarshing)
     - 2.1.1 How many trees are you allowed to cut for fire-wood per year? (species, quantity)
     - 2.1.2 What species and how many trees would you cut every year, if you were allowed to cut them?
     - 2.1.3 Where do you get your trees for summer fire-wood? (in my sogshing, in the government forest, in my relative's sogshing, don't know, others)
     - 2.1.4. How much do you pay per tree for fire-wood?
   - 2.2 Winter fire-wood (günshing)
     - 2.2.1. How often do you collect günshing?
     - 2.2.2. How much winter fire-wood do you collect per time? (species, quantity, location)
   - 2.3. Additional fire-wood
     - 2.3.1. Do you collect additional fire-wood? How often? How many headloads per time?
     - 2.3.2 For how many months do you have fire-wood at home? (dry wood, fresh wood)
   - 2.4 History concerning fire wood
     - 2.4.1 What was different in the way you collected firewood before the introduction of the Forest Act 1969?
     - 2.4.2 What system was better? For what reason?
     - 2.4.3 Did you use more/same/less fire-wood before the introduction of the Forest Act?
3. Construction wood
   - 3.1 Cham and planks
     - 3.1.1 How many chams and planks did your household need in the last 12 years? (categories)
     - 3.1.2 How many chams and planks did you use (within 12 years) before the introduction of the Forest Act? (more/same/less)
     - 3.1.3 Where do you take your chams and planks? (in my sogshing, in the government forest, in my relative's sogshing, don't know, others)
     - 3.1.4 How much do you pay per tree for chams or planks?

3.1.5 Do you use chopped or sawn chams and planks?

3.1.6 Would you use sawn chams, if they would be available near the village?

3.1.7 Would you use sawn planks, if they would be available near the village?

3.2 Shingles

3.2.1 How often do you replace shingles?

3.2.2 How many shingleps do you replace every time?

3.2.3 How many trees do you use each time you are replacing shingleps?

3.2.4 Did the Forest Act affect the way you were replacing the shingleps (frequency , number (more/same/less), organization)?

3.3 Poles

3.3.1 How many trees did your household cut for poles last year? (categories)

3.3.2 What are the three most important uses for poles? And what species do you mostly use for it?

4. Grazing

4.1 Where do you graze what livestock how many months and how? (table)

4.2 Where do you graze your animals in the forest? (sketch map)

5. NTFP

5.1 What NTFP does your household collect? (rû, kuan, sog, oak branches, tool handles, plough, wood for spoons, spindle, zha, whad, sang, mushrooms, medicinal plants, edible plants, fodder plants, others)

5.2 How did your consumption of the different products evolve in the last 36 years? (more/same/less)

5.3 Rû

5.3.1 Do you have rû in your garden? (yes/no/don't know) When did you plant the rû? Why did you plant rû?

5.3.2 How much rû does your household collect per year? (From your garden? From the forest? Others)

5.4 Kuan (candle/torch wood)

5.4.1 For what do you use kuan? (for starting the fire, for light in the house, as torch outside, others)

5.4.2 How much kuan do you collect per month? (From your sogshing? From the forest? Others)

5.4.3 How much kuan did you collect per month 36 years ago?

5.5 Sog (litter)

5.5.1 What economic importance has the sog for your household?

5.5.2 How much sog do you collect per year? (From your sogshing? From the gvt forest? Others)

5.6 Oak branches

5.6.1 For what purpose do you cut oak branches? (for fodder, for fire wood, for both reasons, don't know, others)

5.6.2 How many oak trees do you lopp per year? (From your sogshing? From the gvt forest? Others)

5.6.3 How often do you lopp the same tree? (Every XX years)

5.7 Sang (incense)

5.7.1 How often do you collect sang?

5.7.2 How much sang do you collect every time? (species, quantity, location)

5.8 Other plants (medicinal, edible, fodder...)

5.8.1 What plants and for what purpose does your household collect? (Species, purpose, quantity)

5.8.2 Are there plants you would like to collect, but aren't allowed to? (Species, purpose)

5.9 To whom belong the different NTFP? When they are in the garden, sogzhing or government forest? (rû, kuan, sog, oak branches, tool handles, plough, wood for spoons, zha, whad, sang, mushrooms, medicinal plants, edible plants, other plants)

6 The forest legislation

6.1 What are the main advantages of the forest legislation for your household?

6.2 What are the main disadvantages of the forest legislation for your household?

6.3 What would you change in the forest legislation, if you could do so?

Christina GIESCH

Personal data

Date of birth:	08.12.1968
Place of birth:	Geneva
Nationality:	Swiss
Family status:	unmarried

Education

1974 - 1982	Primary and secundary school. International school "La grande Boisière", Geneva.
1982 - 1983	Secundary school. Cycle d'orientation, Bernex/Geneva.
1983 - 1987	Grammar school. Collège de Saussure, Geneva. Certificat: Federal maturity certificat, type C (sciences).
1988 - 1994	ETHZ, faculty of forestry, Zurich. Diploma: Forest engineer ETH.

Work experience

1991 - 1992	Practical work as part of forestry studies: • Arrondissement forestier 8, Tavannes (Canton Berne), G. Montandon. • Integrated Forestry Development Project (Helvetas), Bhutan/Asia, Dr. A. Bürgi. • Arrondissement forestier 8, Martigny (Canton Wallis), R. Métral.
1994 - 1996	ETHZ Faculty of forestry, chair of forest inventory and planning, Zurich. Assistant: participation and preparation of the courses and exercises of the 5th and 6th semester; diverse works at the chair (webmaster, translations).
1996 - 2000	PhD thesis: "The evolution of the traditional forests uses and their impact on the forest structure, with regard to sustainability." 3 times 7-8 months field work in Bhutan.