San Thwin

Deforestation Analysis in Eastern and Western Myanmar

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Dissertation to obtain Ph.D. degree from

Faculty of Forestry Science and Forest Ecology,

Georg-August University of Göttingen

Submitted by:

SAN THWIN

born in Mawlamyine, Myanmar

INSTITUTE OF FOREST POLICY AND NATURE CONSERVATION

FACULTY OF FORESTRY SCIENCE AND FOREST ECOLOGY

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Supervisor I : Prof. Dr. Maximilian KROTT
Supervisor II : Prof. Dr Gode GRAVENHORST

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Deforestation Analysis in Eastern and Western Myanmar

1. Introduction

FAO (1996) suggests that 60% to 70% of tropical forest conversion is to permanent or short-fallow agriculture, rather than to land covers suggestive of long-fallow, slash-and-burn agriculture. Moreover, some slash-and-burn agriculture is oriented to export rather than subsistence crops. Many uses of the terms deforestation exist in the literature and it is sometimes defined as a radical removal of vegetation, to less than 10 % tree cover. This definition meaning is a very narrow one, focusing on land cover conversion to other land use (Wunder 2001).[1] Due to the expansion of agricultural cash crop, forests are converted to other land use. The importance of the export of crops as a driving force behind deforestation is difficult to generalize. Large landowners have traditionally controlled most of the farming land and in a manner which is more economically feasible. The small landowners often enter the forest frontier to cultivate again (Roper, 1999).[2] It is estimated that small farming accounts for nearly 2/3 of all deforestation (Rowetal, 1992). Expansion of the agricultural frontier has lead to deforestation and increased social tension (Wood, 1992, Becker, 1997 and D Alves, 2001).[3] A Mexico-wide study using municipal-level data (Deininger and Minten 1996) provides evidence that poverty is more closely associated with forest cover than with deforestation – that is, the poorest live in areas too remote to suffer from much deforestation.[4]Myanmar is one of the Asian countries endowed with rich natural resources. It is especially famous for its teak production. Its economic growth was stable before 1962. The government applied a centralized economic policy from 1962 to 1988. Myanmar faced policy failures that were related to its socialist economic policy. Then it changed its economic policy from a socialist to a market economy system. This study advances beyond previous empirical analyses by instigating empirical work which encompasses the investigation of satellite data on vegetation changes.

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[1] Wunder, S., 2001, Deforestation and economics in Ecuador: A Synthesis p2
[2] Roper, J., 1999, Deforestation: Tropical forest in decline CIDA forestry advisers Network
[3] Alves, 2001, Deforestation and frontier expansion in the Brazilian Amazon
[4] Chomitz, K .M., 2001, Environment-poverty connections in tropical deforestation WDR on poverty and development 2000/01 Stiglitz Summer Research Workshop on Poverty, Washington D.C

1.1 Statement of the Forest Decline Problem

From 1975 to 1989, the forest resources depletion rate in Myanmar was 0.64 percent, according to the assessment of the Forest Department (Myanmar Forestry Journal, 1999). During that period, only government-owned timber corporations harvested and processed timber and other hard wood species and exported them to other countries. The deforestation rate was comparatively low in that period. After the change in economic policy, the rate of forest degradation increased. Forest cover declines annually by 390,000 ha and the annual rate of loss is 1.6 % (FAO, 1997).

The Forest Department is handicapped by poor pay, inadequate staffing and a lack of staff. The departments have been ineffective in adequately putting forward the pro-forestry argument to political decision-makers and to the public at large (Roper, 1999). Lack of proper management can be attributed to the absence of effective control, biases in forest policy, or the lack of confidence in the legal system (Andaluzetal, 1996, Sloze and Quevedo, 1992, Szwagrzak, 1994 Pacheco, 2001).[5] Common resources like state-owned forests are not viewed as opportunities for collective management of valuable resources. Due to the weak common pool resource arrangement, forests become 'open-access resources' and tend to be exploited and degraded. This is classical 'common-property dilemma', which contributes substantially to the depletion of the tropical forests. When the land is legally allocated to the communities, the situation would be preserved. If community forestry initiative is expedient, forest denudation could be thwarted and the typical case of 'tragedy of the common' could be avoided (Tint, 1996).[6] Often, developing countries also face serious problems of environmental degradation (Strong, 1991).

Poverty is one of the greatest threats to the environment. In poor countries, poverty causes deforestation and this environmental damage reinforces poverty. Many choices that degrade the environment are made in developing countries because of the imperative of the immediate survival, not because of a lack of concern for the future. Any plan of action for environmental improvement must therefore include programs to reduce poverty in the developing world (Jepma, 1995).[7]

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[5] Pacheco, P., 2001, Deforestation and forest degradation in low land Boliva. C Wood and R. Porro eds Land use and deforestation

[6] Tint, K., 1996, National progress report – Myanmar Asia-Pacific Forestry commission 6th session, p 5

[7] Jepma, C.J., 1995, Tropical Deforestation: A Socio-Economic Approach

Land use changes associated with deforestation are often more comprehensively explained in terms of economic and institutional variables (Olive, 1998).[8] As deforestation proceeds, the remaining forests are increasingly being transformed into clear slopes, where permanent and seasonal flooding occur, which makes it unsuitable for agriculture and other land uses.

There are many reasons for deforestation in Myanmar. One main cause of the deforestation is shifting cultivation. Most of the farmers did not receive economic gains from the centralized government policy (ADB, 1996). Those who are poor often destroy natural resources in order to survive: they cut down forests, overgraze lands or overuse marginal lands (Myrdal, 1957, Brundtland 1998: 28 Wunder, 2001). The poor are not ignorant of the process of deforestation or blind to its effects (Eckholm *et.al*, 1984).

Although Myanmar is an agriculturally based country, agricultural production and exports have not progressed in the past due to a lack of technology and the problems of the farmers in producing export-oriented agricultural products. Some of the farmers did not own enough land to grow rice. Farmers could not use fertilizer and modern agricultural technology to improve their crop production. The use of fertilizers has declined, due to the fact that the subsidy element has been reduced. Since paddy production is more profitable than before, richer farmers were able to use more fertilizers. Productivity has also been adversely affected by a decreased supply in pesticides, farm machinery, implements and fuel. However, the small size of the holdings and the swamp conditions of paddy lands had largely frustrated earlier efforts to increase productivity by means of mechanised farming. Tractors tended to be used for non-agricultural purposes, such as pumping water and transporting passengers (ADB, 1996). Shifting cultivators have no cash to purchase basic food sold in villages, even at subsidized rate Some did not have adequate land to cultivate their crops. Therefore, they cut trees, burn, encroach and grow crops in forested areas (S.M Wint, 1997). Indigenous people have the rights to utilize forest for cultivation. Due to population expansion, the natural resources- - especially forests - have been depleted. Shifting cultivators, poor people who reside near natural forests, have damaged the natural resource to grow their crops.

Shifting cultivators not only use and depend on the forest for the success of their agricultural methods but also for a wide rage of technological materials, a large proportion of their food and products that have cash value. With an increasing population and a relative

[8] Olive, C.A., 1998, Land use change and sustainability, Department of Geography publication series No. 51 p 25

decrease in the total amount of land available, fallow periods have become shorter. The fallow forest becomes a bush, or a very short fallow period results in a decline in yield, erosion and soil degradation. This situation is associated with a decrease in the quality of life and poverty (Chin, 1987).

The shifting cultivators have not been able to participate in development. Approximately ten million shifting cultivators are landless and live in absolute poverty in Myanmar (Tint, 1999). The survival of the forests depends on the type of policy interventions implemented to meet the basic needs of local people. The taungya system, a reforestation technique which originated in Myanmar (Burma), is a suitable method with which the living standards of the people in the forested regions can be improved. It is a Burmese term for temporally cultivation on hill land. Shifting cultivators were allowed to grow crops and also plant other variable species in taungya (Takeda, 1992). This system creates activities to enhance efficient agricultural and agrarian reform, and a variety of rural infrastructure measures, such as extension services, networks and credit facilities. Tropical forests contribute to several key sectors of development. This insight should engender a basic change in our perception of the forests and their contribution to human welfare. One of the policy reappraisals is to promote an focused view of what is influencing the degradation of forests, and what possible solutions provide for their survival of the most appropriate means (Kingsbury, 1992).[9]

This can be achieved by laying down a sound foundation of collective resource management that is based on the collective sharing of both rights and responsibilities. While people have to manage resources as a common property, they will also need to share a common responsibility in order to derive these common benefits. Collective forest management is thus a process that ensures continuity in resource generation, stability in physical and social environments, and sustainability in the production of goods and services. Deforestation is related to political, economic and socio-economic circumstances at the international, national and local levels. Policy-making bodies at the local, national and international levels re-examine the role and response in determining the future welfare of forest resources and the people who depend on them. Domestic price intervention, especially with reference to the price for support for products grown on converted land have contributed to the loss of primary forest (National Resource Council).[10]

[9] Hurrell, A., and Kingsbury, 1992, The international politics of the environment, pp 430-440
[10] National Resource Council, 1993, Sustainable agricultural and the environment in the humid tropic

Deforestation contributes to other forms of environmental degradation, such as climate change, soil erosion and biodiversity loss. Poverty contributes to deforestation due to the fuel wood crisis and for agricultural expansion in Myanmar (Humphrey, 1996).[11] Wilsson (1988) states that tropical forests which are destroyed or seriously depleted, due to population expansion, increase already extensive poverty. Millions of people in developing countries have also contributed to the depletion of resources and environmental stress. The poor and the hungry are always constrained to destroying their environment by cutting dawn forests and depleting soil, in order to survive (Silven, 1992).[12] Population growth in the 20th century results in the depletion of natural resources (Chinese Academy of Sciences, 2001).[13]

Technical factors are dealt with in many income-generating measures to be developed and promoted in the interest of shifting cultivators. In order to reduce deforestation and to alleviate poverty, especially with regard to the grass root level subsistence farmers, the technical progress of the income-generating program has played a vital role in achieving its success (FREDA, 1997)[14] Perennial crop technology could theoretically recline deforestation; however, in practice, it is not possible. Large farmers are unwilling to accept the new technology, as due productivity would be low.[15]Annual crop technology appears to have little potential (Cattaneo, 2002).[16]Technological changes that can produce a high yield are likely to increase deforestation.

Deforestation is likely to be greater if technological changes are labour- or capital-saving, or both, since this will release resources for the expansion of additional cultivation, (Southgate, 1980). Because the new technology is expansive, farmers can allocate more labor and capital to their existing farms, leaving them with fewer resources for expansion. Technology that makes a more intensive production system more profitable reduces agricultural expansion into forests (Nghiep, 1986 and Holden, 1999).

Deforestation has been largely attributed to the expansion of cropland and permanent pasture (Joramillo and Kelly, 1997). When destruction of the tropical forests occurs, it usually is pioneer shifting cultivation, not the integral swidden that is practiced by people who have the

[11]Humphreys, D., 1996, Forest politics: The evolution of international cooperation
[12] Silven, C., 1992, One earth, one future: our changing global Environment, National Academic Science p 1-12
[13] India National Science Academy and Chinese Academy of Sciences, 2001, Growing population, changing landscape: Studies from India, China- and the US p 9-10
[14] Wint, S.M., 1997, Review of shifting cultivation in Myanmar
[15]http:// www.ifpri.org/pubs/abstract/1297ab129.pdf

knowledge to manage the forest ecosystem, farming and can prevent the degradation of the forest areas (Moran, 1993). Shifting cultivation appears to be the most effective method for dealing with the ecological realities of the tropical forests (Aitkin, 1992). It is an active manipulation of a patch of the forests and conversion to a more open and useful succession for the cultivators (FAO, 1991).[17] The growing demand of an increasing population for agricultural land and encroaching on the forests are widely recognized as important causes of deforestation.

Angelesen (1999) states that although higher agricultural prices may not increase deforestation for subsistence farming, because farmers are able to meet basic consumption without cutting more land, deforestation decreases when agricultural prices are higher (Hengdijk, 1994 angelesen, 1999), while models that assume farmers maximize profit show the opposite (Monela, 1995).[18]

With a well-functioning market, as land resources become scarce, incentives will increase for people to development technology to farm previously unused land (expansion) and production per existing unit of land (intensification), people will substitute more abundant resources such as fertilizer and labor for land (National Resource Council, 1993).[19] Higher prices for agricultural products encourage forest clearing and also make available capital to put additional land into agricultural production. Land use changes in response to a change in population, agricultural prices and income. Analytical models have been very useful in highlighting a vital role of the underlying market and behavioral assumptions (Angelesen, 1999). The constructions of roads has increasingly opened up forests, due to the loggers, shifting cultivators, and mining companies, result in greater deforestation (World Guide, 2000). Policies regarding land tenure rights have resulted in agricultural land and the consequent migration of poor peasants into the forest, producing, in turn, increased deforestation.[20]

The production of cash-crop products means, in many cases, a large amount is produced for exports markets . In the Amazon, agricultural production depends on the higher level of land use intensification with the decreasing rate of deforestation. Decreasing deforestation is brought

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[16] Cattaneo, A., 2002, Balanced agricultural development and deforestation in the Brazilian Amazon, research report 129

[17] FAO, 1991, shifting cultivators, local technological knowledge and natural resources management in the humid tropic, Community forestry note 8

[18] Agelesen, A., 1999, Rethinking the cause of deforestation: Lessons from economic models p 81

[19] National Resource Council, 1993, Population and land use in developing countries p 3

[20] www.asb.cgiar.org/poverty_innov.shtm

about as a result of increase pressure for environmental conservation (National Resource Council, 1993).

Agricultural growth contributes to a rise in deforestation in Ivoire cote. The government's policy for large-scale agricultural development results in deforestation due to the large-scale use of tractors in cultivation.

This study focuses on deforestation and addresses several related questions, such as: Why do people who are dependent on the forest expand forest resources? Which socio-economic variables are more likely to increase or decrease deforestation? How do shifting cultivators have an impact on resource endowment (poverty) agricultural expansion, aid organizations, and the level of wealth ? To what extent did poverty and land use change in the study areas? To what extent were the rural poor pushed towards the frontier forest?

Shifting cultivation by poor agriculturists is considered to be quantitatively the most serious threat to the remaining forests. "Shifting cultivators" appear to be responsible for the major part of deforestation and this fact has been used to argue that broader socio-economic problems, often outside the forest areas themselves, need to be addressed, if a sustainable solution for deforestation is to be found.[21]

This study investigates land use and its changes and the contribution of different socio-economic factors in relation to deforestation in Myanmar. Statistical techniques are used to identify correlations between important socio-economic variables and deforestation. Deforestation models have provided insights that can improve the formulation of policy . This study focuses mainly on a model that describes links between forest cover loss and technological progresses, crop prices, infrastructure development and crop yield changes in the villages.

Shifting cultivators partly belong to a subsistence system or are integrated into local and regional markets. The expansion of the agricultural sector into the tropical forest area is mainly for export crops (Tostern, 1992). Subsistence-oriented, slash-and-burn farming may be less widespread than formerly thought. Recent research confirms that road construction induces

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[21]Deininger, K.W. and Minten, B., 1996, Poverty policies, and deforestation: The case of Mexico, The World Bank, International Food Policy Research Institute, Working Paper No. 5, Policy Research Department, World Bank, July

deforestation. This is a causal relationship related to the increased attractiveness of agricultural conversion and is modulated in predictable ways by market access (Chomitz and Gray, 1996).

There may be an important role for the introduction of improved agricultural technologies as a poverty alleviation device in many marginal hill slope areas (Scherr, 1999). A higher density of government maize-purchase depots, indicating higher maize prices, is associated with a significant increase in deforestation in Mexico. Increasing agricultural prices actually encourages deforestation. Higher levels of poverty have significantly contributed to increased deforestation and are of direct relevance to policy (Deininger and Minten, 1996).

In this study, an attempt is made to address the impact of important factors such as population, crop prices, distance to the road and technological progress on the levels of deforestation. Observations have also been made concerning factors leading to an increase in shifting cultivation at the local level; such as landholders' behavior, upland, cropland, agricultural expansion and poverty conditions.

Encroachment on the forest does not have a disastrous effect, as long as the soil cover is not irreparably damaged. There are about 2 million families practicing shifting cultivation in Myanmar (Tint, 1999). There has been a decrease in the fallow period to three or four years, which does not allow the soil to recover its fertility. This leads to a change in the vegetative structure of the forest to degraded secondary shrub; without any production potential. agricultural yields fall and the farmers become poor.

It is now being recognized that any further expansion of shifting cultivation on forestland would be at the expense of environmental and ecological stability. In the absence of a concerted effort to rehabilitate the shifting cultivators and the shifting cultivation areas, these areas would be rendered unproductive and lost forever. It may also result in the loss of forest cover in perpetuity, which the country can ill afford; particularly in view of the very important role of forests in the national economy (Khaing, 1994).[22] The action of the local agents is sensitive to national and international factors influencing deforestation. The choice of effective policy instruments has to be based on the causes of deforestation (Palo, 2000).

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[22] Khaing, K.S., 1994, Community development and Conservation of Forest Biodiversity Through Community Forestry, RECOFTC Report 12, p 320.

[23] Grainger, A., 1993, Controlling tropical deforestation

The changes in land use take place in response to various underlying factors , including population growth, economic development, poverty and government policies. The deforestation problem arises from the expansion of human activities in forested areas, and partly from the poor way in which lands and forests are managed (Grainger, 1993) If land use is not improved, forest resource depletion will continue to increase (Reppetto and Gillis, 1988).[23]

1.2 Objective of the study

This study has the following objectives:

1) To investigate land use change and its effect on the natural resources in three upland regions in the eastern, middle, and western parts of Myanmar;
2) To analyze the factors influencing land cover vegetation conditions; especially focusing on the role of the shifting cultivation on common land;
3) To obtain recommendations for a better understanding of the complex interaction of these changes over time, which should further improve decision-making at the regional and national level;
4) To formulate regionally adaptable and sound policy interventions, which stimulate benefits in view of the trade-offs among economic, environmental and social objectives in the process of sustainable rural development. Pursuing these objectives, the study aims to contribute to improve forest management.

Over the past decade, environmental and development concerns converged with increasing interest in both the tropical forests, as an important ecosystem, and the well being of the people who live near them. The importance of the forests and the non-industrial forest products to the quality of life and even survival of a very large number of poor rural people in tropical developing countries seems indisputable (Pirez and Arnold, 1996).

1.3 Outline of the study

This chapter gives an introduction of the country's situation, problems of forest management in Myanmar and the factors affecting shifting cultivation. Chapter 2 develops a theoretical framework of land use change, based on the economic theory of deforestation. Chapter 3 deals with the forest policy in Myanmar and with the impact of forest depletion on

climate change. Chapter 4 outlines the material and methodology of the study, including the selection of the survey areas, satellite images, and methods of analysis. Chapter 5 describes land use changes on the three study areas; namely, the Nyaung Shwe township (eastern part of the country), Paukkaung township (middle part) and South Mindon (western part). Normalized Difference Vegetation Index maps are analyzed by using satellite images. Land use maps of the three areas are shown in this chapter. Chapter 6 analyzes the socio-economic conditions of the study areas. Economic models are outlined in this section. Chapter 7 discusses the determinants of deforestation and shifting cultivation. Chapter 8 concludes with policy recommendations.

Chapter 2 Theoretical Framework

2.1 Definitions

Deforestation is defined, in the strict sense, as being the complete clearing of tree formations (closed or open) and their replacement by non-forest land uses (alienation). Deforestation refers to a "change of land use from forest to other land use or the depletion of forest crown cover to less than 10 percent (FA0, 1995).[24] Myers, (1991) refers to deforestation as the " complete destruction of forest cover... so that not a tree remains and the land is given over to non-forest purposes." Biologists, ecologists and conservation agencies tend to consider deforestation as the degradation of "entire forest ecosystems" involving wildlife species, gene-pools, climate and biomass stocks (Myers, 1989).[25]

There are a number of approaches to definitions of afforestation, reforestation and deforestation. One approach involves the concept of land-use change. Deforestation can be defined as the conversion of forest to non-forest land. Reforestation and afforestation can be defined as the conversion of non-forested lands to forests, with the only difference being the length of time during which the land was without forest. An alternative definition of deforestation might be based on a decrease in the canopy cover or carbon density by a given amount or crossing one of a sequence of thresholds. Similarly, afforestation and reforestation could be defined in terms of an increase in canopy cover or carbon density. None of these definitions involves the concept of a land-use change (Watson, 1998). [26]

There are various definitions of shifting cultivation. The most commonly used defines shifting cultivation as any agricultural system in which the fields are cleared (usually by fire) and cultivated for shorter periods than when they are fallow (Conklin, 1957). With the development of the agro-ecosystem approach and its holistic view of agricultural systems as part of the greater "natural ecosystem," there has been a redefinition of shifting cultivation. The agro-ecosystem approach attempts to integrate "the multiplicity of factors affecting cropping systems" (Gliessman, 1985:18).[27]

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[24] FAO, 1995, Forest resource assessment 1990, Forestry paper 124

[25] Barraclough, S., and Ghimire, K., 1990, The social dynamics of deforestation in developing countries: Principla issues and research priorities UNRISD, Discussion paper 16 p 7

[26] Watson, R.T., 1998, IPCC Special Report on Land Use, Land-Use Change And Forestry (http://www.grida.no/climate/ipcc/land_use/)

[27] FAO, 1991, shifting cultivators, local technical knowledge and natural resources management in the humid tropic, Community forestry note 8

2.2 Economic Theory of Deforestation

According to economic theory, the following two factors can be identified as influencing deforestation:

1. *Competition of the human population for the remaining ecological niches on land.* This competition reflects the rapidly expanded population growth of developing countries;
2. *Failure in the national economic systems.* "Failure" in this sense means the low progress of the economic system to reflect the true value of the environmental systems in the working of the economy.[28]

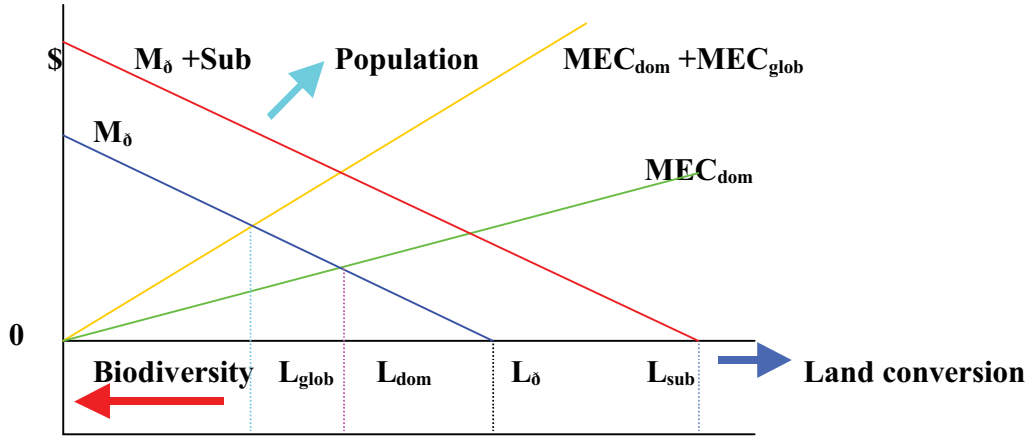


Figure 1.1 Economic failure, land conversion and biodiversity loss.
Source: W.L. Adamowics *et al.,* 1996

Figure 1.1 summarizes the essence of a theory of deforestation in term of the "orthodox" theory of externalities. It can be stated as a simple exposition of the general theory expounded by Sandler (1993). The horizontal axis indicates the rate deforestation (left to the right) and, on the other side, the situation of biodiversity (increasing from right to the left), $M_ð$ indicates the marginal private benefit (marginal profit) function and shows that marginal profits decline as more land is converted. Infrastructure developments- especially roads- will lower conversion costs and raise profit margins, so that $M_ð$ shifts outward (Schneider, 1992, Cervigni, 1993). Land conversion imposes "local" externalities, especially where the conversion is from tropical

[28] Adamowics, W.L., Boxall, P.C., Luckert, M.K., Phillips, W.E., and White, W.A., 1996, Forest economic and environment, CAB International, Pub: Wallingford p 3-29

forest to agricultural expansion, especially shifting cultivation. In figure 1.1, these externalities are shown as MEC_{dom}. There are different kinds of "failure" which can be present at one and at the same time.

$L_ð - L_{sub}$ = intervention government failure

$L_{dom} - L_ð$ = local market failure

$L_{glob} - L_{dom}$ = global market failure

In practice, there are mechanisms for dealing with these failures (Pearce, 1995). Efforts to deal with local market failure may take into account land-tenure policies, land-use zoning, ethnic rights and taxation. Recognizing policy intervention failures is essential for reform and for considering environmental conditions in development programs. Global failure is more complicated, because of the need to create a worldwide market situation. The local social optimum L_{dom} is compared with the private local optimum of $L_ð$. To the local externalities, one must be add the global externalities, indicated by MEC_{glob}. The total externality is therefore $MEC_{dom} + MEC_{glob}$ and the "global optimum" is L_{glob}. If it is possible to "capture" the global externality, then less land conversion takes place and more biodiversity is "saved". Finally, the forest sector is rarely left to market forces: government intervention is the rule, not the exception. A second type of economic failure leading to deforestation is "intervention" or "government failure" – the deliberate intervention by governments in the operation of market forces. Subsidies will tend to encourage agricultural expansions and induce land conversion to capture a larger market. However, the demands of a rich overseas market could also result in agricultural intensification and hence reduced pressure on forested lands.

An important example of the global external effects is the release of CO_2, which will contribute to the accelerated greenhouse effect. In order to derive a value for the "carbon credit" that should be assigned to a tropical forest, the following parameters can be used:(i) the net carbon released when forests are converted to other uses, and (ii) the economic value of one ton of carbon released to the atmosphere. The carbon released from the burning tropical forests contributes to global warming (Adamowics, 1996).

Under-investment is typically the consequence of market failures. The interplay of market forces will not secure an economically efficient rate of land conversion. This is because those who convert the land do not have to compensate those who suffer the local consequences of that conversion–extra pollution and sedimentation of water from deforestation.

The institutional settings, especially property rights, have important implications for deforestation. Orthodox discussions of property rights (Heilbroner, 1993) focus on a private-versus-public dichotomy. Panayotou (1993) shows that reasons for local market failure are ill-defined or non-existent property rights, missing markets, high transaction costs inhibiting trade in conversion benefits, public state of conversion benefits, market imperfection, such as a monopoly, a high discount rate, uncertainty and risk aversion, and irreversibility. Other studies (World Bank, 1986) have linked the cause of poverty and hunger to production failure, due to a suppression of markets, while others have identified it with distribution of failure (UNDP, 1994).

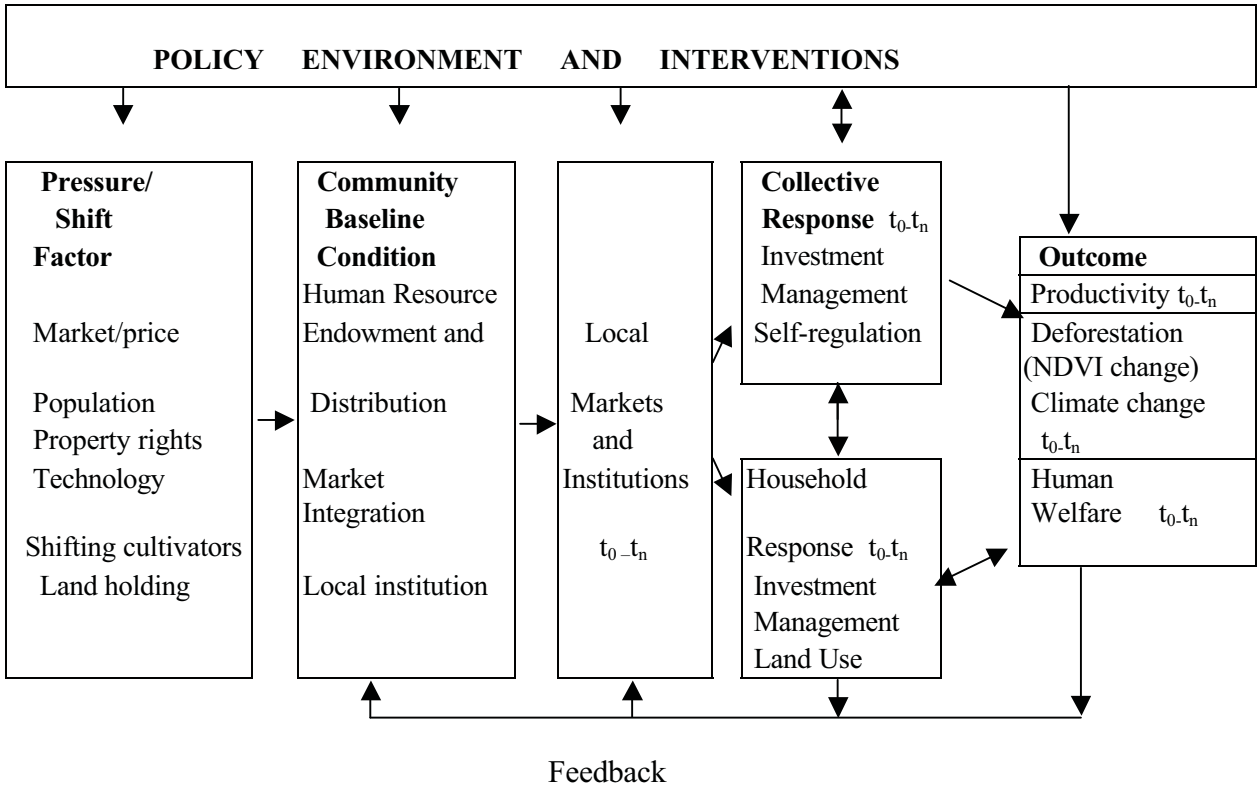
More generally, economic factors, as well as demographic factors, ecological factors and political and social factors, are underlying causes of tropical deforestation (Palo, 1987; 1990). Economic factors include, for example, economic activity levels, income, market failure, as indicated above, demand for and prices of wood, agricultural products, and infrastructure, exchange rates, external debt, and public incentives. Political and social factors comprise such issues as foreign policies, political stability, corruption, speculation, war, international and national asymmetry aspects, tenure and property rights, government failures, and securing the basic needs for the population.

Polo (1994) states that the forest transition, which implies an increased public emphasis on forest conservation, is often not realized, because of the failure of the market and inappropriate property rights, political unrest and missing information in developing counties. This argument explains that scarcity is not a sufficient reason, but does not deny it as necessary reason for the forest transition. It must be realized that scarcity is the motivation for ownership and market exchange. When most tropical forests are publicly owned and open–access, the prevailing tendency has been to apply comparatively low administrative pricing, with the consequence that the profitability of the management of the forests has been undermined. Therefore, the remaining standing forest is undervalued, which advances deforestation. Such a situation increases deforestation when there is no "invisible hand"(e.g., efficient markets) to raise the stumpage prices and the value of the remaining forests. An optimum mix of markets and policies is needed to challenge deforestation (Palo, 2000).

The theory of development is still very much in the early stages of development. Two of these are of classic importance. Malthus and Ricar draw a gloomy picture of increasing population pressing ever harder on a limited natural resource base, with stagnation and poverty

the inevitable outcome; a theory sometime used to explain why poor nations are poor, and often referred to by those who regard population control as the one and only necessity to assure development (Gregory, 1972).[29]

2.3 Pathways of Land Use Change



Source: Scheer, 1996
Figure 1.2 Theoretical framework for the pathway of land use change

Figure 1.2 shows the theoretical framework for the pathway of land use change relating to population pressure, natural resources endowment, local market productivity and the human welfare condition. As indicated in the frame, property rights that determine the land holding by the local people are important, because they influence the distribution of natural resources. When crop prices are high in the local market, local farmers are likely to expand their cultivated land to increase income for daily life. Agricultural land expansion leads to land use change and to damage to the natural resources. If the local population can obtain development assistance, such as credit, welfare programs and infrastructure, local people can manage and invest on a small scale to generate income for their livelihoods. The more poor local people there are who

[29] Gregory, G.R., 1987, Resource economics for foresters, New York u.a.: Wiley,

reside near the natural habitats, the greater the threat of forest cover loss. Excessive removal of forest cover is likely when local agricultural crop prices and paddy field prices increase at the village level. Landlessness in the rural areas may also cause accelerated removal of vegetation, especially if landless farmers who live in forested areas are facing an unemployment. Therefore, a possible way to support their livelihood is to expand the natural forest to cultivation.

As indicated in figure 1.2, deforestation is also influenced by policies; such as agricultural development policies, fiscal incentives and investment regulations. National development policies may increase population pressure. Other policy influences related to deforestation are dam construction, large-scale industrial agriculture and transmigration programs. Policies that promote the export of agricultural crops are another example of policies that have an impact on the forests.

Figure 1.2 also shows some outcome indicators. Natural resources depletion can be expressed by the deforestation level, which can be derived from satellite information, using the Normalized Different Vegetation Index (NDVI).

2.4 Factors Influencing Deforestation and Shifting Cultivation: Insights from the Literature

Poverty is a primary cause of forest degradation. According to the Forest Consultancy Groups study in 1991, permanent low land agriculturists earned two times the income of the shifting cultivators who live in upland areas (FAO, 1996). Due to the expansion of cultivation in up land areas, rural poverty in the uplands encourages damage to the natural resources. Improper land use, such as steep-slope cultivation, shifting cultivation without proper fallow periods and overgrazing, has an impact on the degradation of forests (Thet and Winn, 1995).[30] In situations in which population pressure leads to reduce fallow period cycles, shifting cultivation can become a major cause of forest depletion and degradation, severely threatening the sustainability of the forest estate and the forest resources. However, it is not merely an economic practice of the landless poor living in and around the forests. It is both a cultural practice and a way of evolving in consonance with the physiographic set-up that has thrived for thousands of years; in particular, for the ethnic minorities residing in the hilly and frontier regions.

[30] Thet, S.,Winn, O., 1995, Watershed management in Myanmar issues and opportunities

The agricultural frontier is rapidly expanding into forested areas, which accelerates deforestation and land-use/land-cover changes (Wagner 1962, Parra Va´zquez and Mera Ovando 1989, De Jong and others 1999, Ochoa-Gaona and Gonza´lez-Espinosa 2000). Technologies such as irrigation that require substantial infrastructure and that benefit farmers with access to markets are particularly likely to reduce pressure on forests: they may tend to push down agricultural prices and push up wages, without increasing the profitability of frontier farming.

The effect of input price increases on forest clearing also depends on the assumptions underlying economic models of farm-household decision-making. Fertilizer price increases had practically no short-term effect on land use, in the studies by Ruben *et al.* (1994). However, Monela suggests that they increase deforestation in the long run. Higher fertilizer prices may induce farmers to change from sedentary farming to shifting cultivation and to clear more forest (Holden Nghiep (1986) and (1993b, 1996). Price increases in other inputs, such as pesticides, seeds and hand tools, and higher interest rate reduce forest clearing (Ruben *et al.* 1994). Higher village level population density and average household size correlate with more deforestation in India, but deforestation cannot be fully be explained by the effect of demographic variables on wage, land prices, incomes or consumption expenditures (Foster, 1997). Greater credit availability in Brazil and Tanzania allowed farmers to expand their crops area and pasture (Monela, 1995; Ozorio de Almeida and Campari 1995). Indigenous households in Bolivia and Honduras were found to clear less forest when they received more credit (Godoy *et al*. 1996, 1997). No link was found between credit use and deforestation in Ecuadador (Pichon, 1997). Higher incomes among small farmers correlated with more forest clearing, in the long-term, in the Brazillian Amazon (Ozorio de Almeida and Campari, 1995). High discount rates among indigenous farmers in Bolovia lead them to clear less forest, since impatient farmers prefer to engage more off-farm wage labour that provides them with immediate cash incomes (Godoy, 1997). Farm size did not affect annual clearing rates by colonists in Brazil (Jones *et al*. 1995), but larger farms of colonists tended to have a higher percentage of their total land in forests in Ecuador (Pichon, 1997).[31]

Low input price and labor ratios and technology improvement in alley cropping and sedentary cultivation were found to reduce deforestation. As long as land–labour ratios are high,

[31] Kaimowitz D., and Angelsen, A., 1998, Economic model of tropical deforestation a review p 31- 98

farmers will continue to engage in shifting cultivation under a wide variety of conditions (Nghiep, 1986 and Holden, 1993b).

Farmers with a subsistence model-type of behaviour tend to prefer shifting cultivation, and clear less forest when they obtain access to labour-saving technology changes. Increasing farm productivity in Brazil and the Amazon led to less total forest clearing, because farmers who have successfully avoided soil degradation have more productive land and thus have no need to compensate for lost productivity on degraded lands by clearing forest (Jones *et al*., 1995). In India, agricultural productivity growth at the village level had a high positive correlation with deforestation. (Foster *et al*., 1997). Farmers who have been on their farms longer tended to have less forest (Pichon, 1997). Less deforestation occurs when households have more secure tenure and when there is less threat of encroachment on their lands by outsiders (Godoy, 1996 and Pichon, 1997). A price increase in the agricultural input fertilizer may provoke greater deforestation in some countries of southern Africa (Angelsen and Kaimowitz, 1999). Angelsen (1998) pointed out that increasing pesticide and farm implement prices may lower deforestation. He found that agricultural credit was positively correlated with greater deforestation in tropical Latin America. When introducing new crops which increase yields and are able to be exported, an increase in the area of forest cleared by the farmers could be observed. If the new technology can be used intensively, land expansion may enhance the profitability of agriculture, especially if there are economies of scale.

If land clearing improves land tenure security, farmers are likely to clear more forest in order to secure property rights. Deforestation in Latin America is lower where land tenure security is high. High land costs lead to deforestation, because landless people cannot buy land to cultivate. Constantly, rising land price encourage deforestation for speculative purposes in contexts where farmers obtain (more-secure) property rights by clearing lands (Angelsen, 1998).

Population expansion at the local and national level has an important impact on deforestation. When the number of family members within household increases, there is a need to search for more land to grow crops; especially when other possibilities of increasing the farm household income are not available. Population also has indirect effects on agricultural and forests products. Due to the expansion of the population, local people need to cut timber for building material and daily needs, and for the energy needed for cooking. When the population increase tends to lower wages, forest clearing for cultivation may be a consequence. As population pressure increases, the intensity of multiple cropping of food crops and trees first

increases, but then decreases again, in favour of staple, after a certain threshold value has been reached (Java: Berenschot et al., 1988).

The main actors having a role in deforestation include a network of entrepreneurs, companies and small farmers (Rudel and Roper, 1997). Investment of capital in agricultural development enhances the opening up of forest areas, if it does not focus on intensification. Producer prices are strong incentives for farmers to extend their cultivated area. Changes in these prices have often been one of the important structural adjustment recommendations to foster institutional reform in the agricultural sector (FAO, 1990). Increased producer prices have been used as a way to stimulate crop production and resource allocation, as higher producer price gives farmers improved ability to purchase inputs and improve agriculture (Palo and Vanhanen, 2000).[32] Due to work locations being far away from the city, it is not easy to get better job opportunities for the forest dwellers. Although Liu, Iverson, and Brown (1993) reported significant forest clearing up to around 15 kilometres from the nearest road, forest clearing declines rapidly beyond distances of 2 or 3 kilometres from a road. Some empirical evidence suggests that where farmers can obtain property rights by clearing forests, land-titling projects can encourage them to clear larger areas (Kaimowitz, 1996). Few models focus specifically on the relation between population and the demand for agricultural and forest products.

Economic liberalisation and globalisation are likely to make this aspect less important at the national and regional levels, because global demand is increasingly likely to determine prices and demand. New prospects for agricultural and forestry exports may lead to rapid deforestation in countries where small domestic markets previously limited deforestation. Several studies have shown that population growth in previously forested, low-population areas occurs in response to road construction, available high-quality soils, and growing demand for agricultural products (Harrison 1991; Southgate, Sierra, and Brown 1991; van Soest 1995; Andersen 1997).[33] According to analytical models, policies to improve the terms of trade for agriculture tend to raise the prices received by farmers and hence increase deforestation (Jones and O'Neill 1994, 1995). Land tenure plays a vital role in the dynamics of forest degradation (Rudel and Roper 1997). The agricultural expansion rapidly depletes forested areas, which accelerates degradation

[32]Palo, M., and Vanhanen, H., 2000, World forests from deforestation to transition?

[33] Angelsen, A., and Kaimowitz, D., 1999, Rethinking the Causes of Deforestation: Lessons from Economic Models, The World Bank Research Observer, vol. 14, no. 1, The International Bank for Reconstruction and Development / World Bank pp 73-98

and land-use/land-cover changes (Gaona and Espinosa, 2000). It is noted that the lower the aid obtained from the donor organisations, the greater is the shifting cultivation at the local level of the study areas. In Myanmar, 22 % of the rural population was functionally without land in 1988 (Jazairy et al., 1992). Poorer families are more likely to clear the forest, either to grow crops or to cut wood, because they have shorter time horizons (higher discount rates). The counter argument says that such families are less likely to do so, because they lack the necessary capital to put additional land into production (Rudel, 1993). Some policies designed to attenuate deforestation, such as the promotion of agro-forestry systems, may be applicable to most agricultural settings, but other proposals should be adjusted to reflect different causes of deforestation and fragmentation (Houghton 1994, Rudel and Roper 1997). Some rural communities are utilising carbon sequestration incentives to change their productive systems (De Jong and others 1997, 1999).

2.5 Rational Choice Theory of Collective Action

Since forest management at the local level often involves the co-operation of resource users, the theory or collective action provides important analytical tools for studying problems of forest management. A dominant approach to analyse collective action is the rational choice theory. This theory explains human behaviour as goal oriented. It assumes that the decision-makers make a rational decision: they can make the necessary comparisons between the alternatives they face and can choose the best available alternative, which allows them to use their scare resources in order to get an optimal result. This theory is based on two substantial assumptions, which permit the theorist to assume that the individual's choices are consistent with his or her preferences. The theory is equally known for its method as it is for its substantive conclusions. The bold step is to see that a political phenomenon, such as a legislative struggle, can be covered by, or understood as, a 'rational choice system'.[34] Miller and Falaschetti (2001) pointed out that the first powerful generation of the rational choice models addressed interest groups, co-operations, the state, and other non-market organisations by assuming that 'people respond to incentives' (Miller and Falaschetti, 2001).[35] Lalman and Oppenheimer assumed that an individual is able to rank alternatives from best to worst. Such a ranking will have the property of transitivity. Transitivity is the condition that if alternative *a* is better than *b* and *b* is

[34] http://www.bsos.umd.edu/umccc/intro.pdf
[35] Miller, G, and Falaschetti, D., 2001, Constraining rational choice: allocation vs. efficiency and the origin of the commitment problem

better than *c*, then it is certain that *a* is better than *c.* Actors (individuals, states and organisations) are thought to choose according to what is the best for them, given own preference or taste. An actor's preferences are represented in the theory as a utility function, which registers not only the order of an individual's preference, but its intensity as well.[36]

People might desire collective action to control negative externalities or to encourage the production of the positive externalities and the provision of public goods.[37] People co-operate to form collective organisations, because they trust that more benefits can be obtained from collective action than if they carry out the respective activities alone. In contract-theories of the state, collective action is the core of the justification of the state. The theory of collective action is based on a model of the individual that is consistent with empirical evidence about how individuals make decisions in social dilemma situations (Ostrom 1998).[38]

The following reasons promote using the rational choice behavioural model:

1) It identifies relations among structural variables and the livelihood of individuals solving the social dilemma;
2) A model of human behaviour based on theory consistent with evolutionary and adaptive heritage needs to join the rank of the theoretical tools used in the social and biological sciences;
3) Public policy regarding "The Tragedy of the Common" can be analysed based on an assumption that rational individuals are trapped in a social dilemma (see in detail Ostrom, 1998).

Increases in the profitability of agricultural products, whether these result from infrastructure investment, market development, changes in market prices, technological innovation, or government policies affecting these factors, will promote expansion of agriculture into marginal areas, if the costs of productive factors are unaffected by the change (Angelsen, 1996).[39]

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[36] see illustration of political instability classical example of the voter paradox concerning best to the worst http:// www. bsos.umd.edu/govpt/oppenheimer/831/finitervol.pdf, Dvid Lalman, Joe Oppenheimer, Formal rational choice theory: A cumulative science of politic

[37] http: // garnetacns.fsu.edu/-holcombe/chp7.pdf

[38] Ostrom, E., 1998, A behavioral approach to the rational choice theory of collective action, American political science review vol.92, No. 1P 1

[39] Pender, J., Scherr, S., and Durón, G., 1999, Pathway development in the hill slide of Honduras: Causes and implication for agricultural production , poverty, and sustainable resources use, Environment and Production Technology Division International Food Policy Research Institute, 2033 K Street, N.W.Washington, D.C. 20006 U.S.A.

The development of new policies, or new political processes and structures need to be considered in relation to the causes of deforestation and for promoting the knowledge of local and indigenous peoples whose participation plays a vital role in forest restoration measures (Humphrey, 1996).[40]

Palo (1999) pointed out that the political will of the national governments plays a key role, as indicated by the political instability in a system. Also, political will may as such induce and support forest degradation (Kasa, 1999).[41] In order to arrive at more concrete policy recommendations, however, there is a need to examine more the variations in poverty reduction, government performance, ethnic conflicts and economic growth within a country and between countries (Woolcock and Narayan, 1999).[42] Social capital theory suggests that economic performance is also dependent on social and cultural factors at both micro- and macro-levels (Collier, 1998).

Deforestation is linked to issues of collective choice at local, regional, national and international levels (Ostrom, 1999). Ecological economics is described as being concerned with issues of environmental sustainability. Various authors found that the realm of classic collective choice theories is modified by insights from political science and economics (Commons, 1950; Olson, 1965; Noeth 1990; Ostrom, 1990; Miller 1992). Social capital is a vital input factor to solve problems related to the management of common property resources. Social capital refers to the networks, rules, norms and trust that constitute a society's capability to deal with economic, social and environmental problems (Hediger, 1999).[43] Social capital can be linked to the behavioural theory of rational choice (Satz and Ferejohn, 1994; Ostrom 1998). Shared social visions are important for collective action and thus have policy implications for future perspectives. Satz and Ferejohn, (1994) and Ostrom (1998) state that a behavioural approach to a 'softer' rational choice theory is useful and related to evolutionary development psychology. It has been especially useful in developing the concept of social capital (Anderson, 2000).[44]

NGOs with a conservation agenda also play an important role in the policy process. An interesting example is the provision of micro-credit by NGOs. In order to reduce the

[40] Humphreys, D., 1996, Forest politic: The evolution of international cooperation pp 22

[41] Palo, M., and Vanhanen, H., 2000, World forests from deforestation to transition? p 13

[42] Woolcock, M., and Naryan, D., 1999, Social capital application for development theory, p 15

[43] Hediger, W., 1999, Sustainable development social welfare: ecological Economics 32 (2000) 481–492

[44] Anderson, C. L., Locker, L., Nugent, R., 2000, Microcredit, social capital and common pool resources,

deforestation in Thailand and in the western part of the Myanmar border, a micro-credit development program was implemented to promote resource sustainability and livelihoods. Thus, poverty reduction and natural resource management are linked.

Kingl states that political change affects the power relationship among different kinds of social groups and institutions in society. The main social actors consist of the state, central and local government, local communities (farmers, ethnic minorities, logging industry employees), domestic and international business non- government organisations, and the military.[45]

The problem of self-interested behaviour can result in a long-term tragedy of outcomes, as the classic prisoner's dilemma suggests. Individuals acquire what they need, if they have open access without consideration of future aspects (Bromley, 1999).[46] This problem is also referred to as "free riding". Armin Falk's model accounts for the fact that there are selfish subjects who behave in the way predicted by the standard Rational Choice Theory. In the absence of institutions that externally enforce efficient appropriation levels, the selfish players are pivotal for the aggregate outcome (Ostrome and Falk, 2002). Political stability influences economic performances and is essentially linked to the social structure (Nee and Ingram1998; Ostrom, 1999). Social capital can contribute to a better life-style, by allowing individuals to meet their aspirations by improving their socio-economic conditions through collective action (Castle, 1998). Social capital theory shows how norms and rules are linked to the resources that individuals are able to apply to decrease risk, have access to services, acquire information, and co-ordinate collective action (Grootaert, 1998). The theory of the rational choice is consistent with the view that there is a relation between trust, reputation and the norms of reciprocity. They reinforce each other and make it possible to promote participation in collective-action situations (Ostrom, 1998). Forest resources become open access due to a lack of assignments of property rights to the forests. This has led to deforestation, because free riders are not willing to participate in forest conservation measures (Lise, 2000). Game theory models have also been developed to explain the observed frequency of collective action in natural resource management (Ostrom 1994). State-owned forests have become open-access regimes, and this is one of the reasons of deforestation and forest degradation (Kant, 2000).[47]

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[45] http:// dlc.dlib.indiana.edu/documents/dir0/00/00/02/39/dlc.00000239-00/kingl/04/300.pdf, kingl, Political economy of tropical and boreal forest

[46] Bromley, D.W., 1999, Sustainable development p 20

[47] Kant, S., (2000), A dynamics approach to forest regimes in developing countries, Ecological economics 32 (2000) 287-300

2.6 Policy cycle

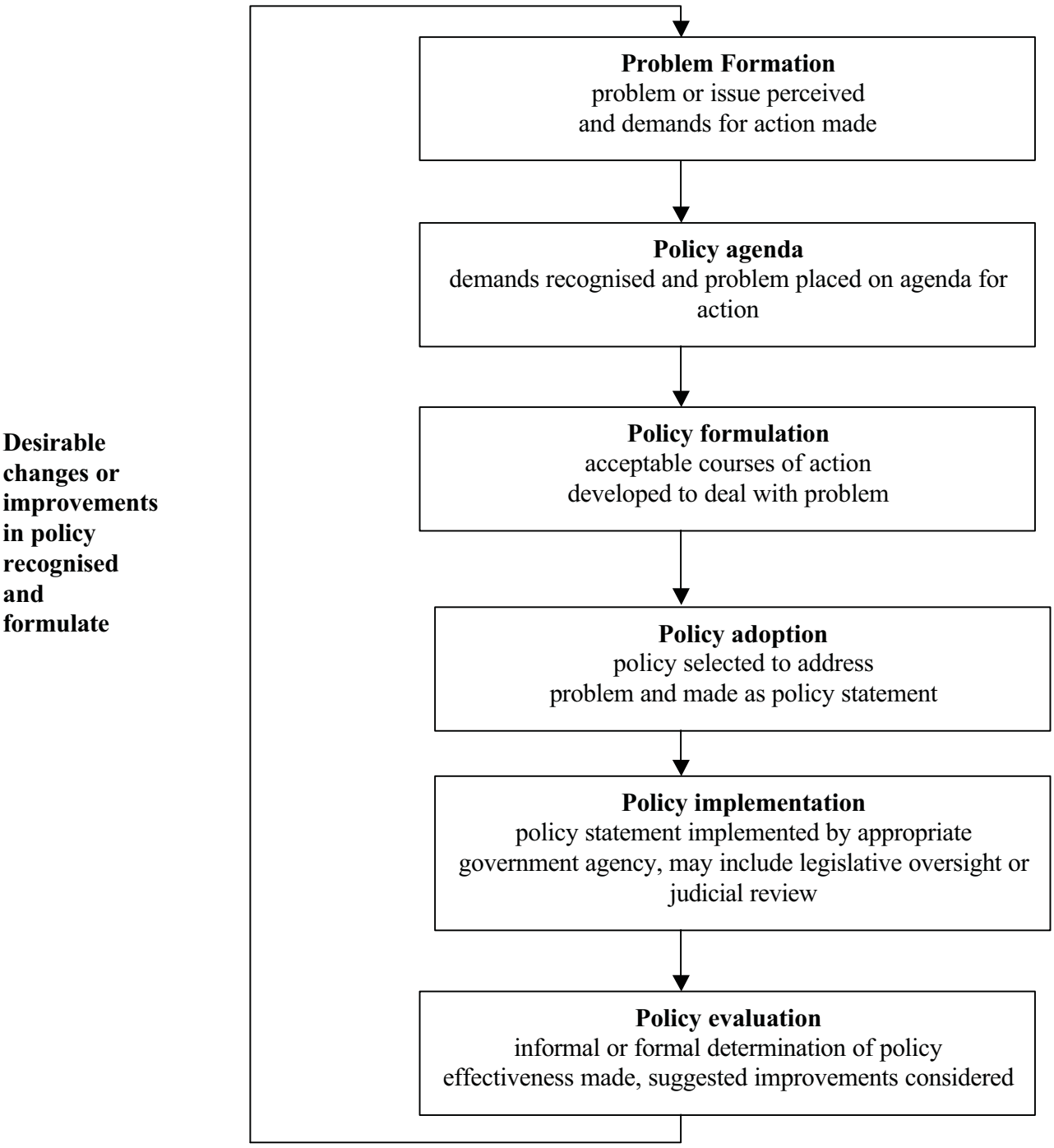

Figure 1.3 Policy cycle
Source: adapted from Anderson et al (1984)

One of the important institutional prerequisites for sustainable forest management is a legislation that establishes appropriate and reliable forms of forest tenure, including various forms of forest ownership and usage rights. Forest laws and regulations must include provisions that determine: 1) the categories and nature of forest ownership; 2) the rights and obligations of different categories of forest owners; 3) the categories and nature of usage rights. The organisation of policy implementation is usually divided into an administrative element for the forest sector and a privatised one for timber processing (Krott, 1998).[48]

Figure (1.3) shows the ideal policy cycle. In this cycle, in order to acquire policy termination, there are three steps which must be followed. These include policy formulation, policy implementation and policy evaluation. Policy development is followed by legally binding norms. Laws and regulations are thus the result of policy formulation processes, as well being the basis for policy implementation. Incentive measures can promote sustainable forest uses and, in particular, those practices and benefits that are of concern to the community as a whole.

Inter-organisational analysis is important, since it views power residing in organisations rather than individual actors and concentrates its analysis on the organisations involved in the decision-making process. Thus, the composition of the organisation, how it participates in the policy process, and the outcome of that process become the critical variables. The emphasis is on associating organisational participation with specific policy outcomes. Desired policy outcomes are examined and resulting policy decisions are analysed to see how close they come to the desired outcomes (Caputo, 1993).[49]

The process of formulation and implementation of policies and laws should be considered as a single continuum rather than as two isolated stages. When forest policy is to be formulated, legislation should consider the following facts. First, a policy must not conflict with the constitution or other fundamental laws of a country. Secondly, consideration if and how forestry legislation could help to implement the desired policy can be important in formulating the policy in a pragmatic way. The third point relates to the relevant institutions. It is necessary to consider their effectiveness, weakness and failure in the past, because this can contribute to a formulation of new policies and laws. Finally, it is essential to devise legislation that facilitates

[48]Kissling-Naf, I., and Bisang, K., 2001, Rethinking recent changes of forest regimes in Europe through property-right theory policy analysis, Forest policy and Economic Journal 3 (2001) 99-111

[49] Caputo, D.A., 1989, "Network Perspectives and Policy Analysis: A Skeptical View" in "Networks of Power" p112

future policy formulation or revision; for example, by creating policy advisory bodies that will also eventually propose revisions to the legislation. The process of policy formulation and the contents of forestry laws are being profoundly affected by the concerns for broad participation and the recognition of all interests. The details vary enormously as might be expected at an experimental stage (Cirelli, 1993).[50] The reconciliation of conflicting interests, which has been posited as a basic challenge for forestry legislation, must be faced throughout policy formulation, legal drafting and implementation. Forestry law should set out fundamental needs that implement the established policy. Rules should specify issues, such as the boundary demarcation of forest areas, activities prohibited in these areas or detailed management practices. Policy makers need scientifically reliable information to decide how to manage land use towards sustainable development. Therefore, data is necessary to formulate sound forest policy and integrated land use change (Briassoulis, 2001).[51]

Low productivity, floods and climate change constrain the capacity of the institutions to achieve sustainable forest management.[52] Tropical deforestation is often depicted as a major environmental issue for different reasons including potential impacts on the climate, loss of plant and animal species, and the impact of an ecosystem loss (Brown and Pearce, 1994). Natural resource management should make it possible for individuals and local communities to maintain their own flexibility, or the ability to respond effectively to an uncertain and changing environment. This is a challenge, because of their increased dependency on political developments (McCay, 1998).[53]

To make good decisions, people need skills and an understanding of the decision-making process. This information is difficult to acquire in authoritarian systems. People in organisations have been conditioned to expect rights and responsibilities to be out of balance. Participation is about balancing rights and responsibilities , not about taking rights away from one group (for example, management) so they can be given to another group (for example, workers, Mclagan Nel, 1995).[54]

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[50] Cirelli, MT., 1993, Forestry legislation revision and the role of international assistance, Unasylva, 44 (1993) 3: 10-15

[51] Briassoulis, H., 2001, Policy-oriented integrated analysis of land use change: An analysis of Data needs, Environment management Vol.27, No 1, pp 1- 11)

[52] http://dlc.dlib.indinana.edu/document/ir0/00/00/02/39/dlc.00000/kingl/041300.pdf, Kigl, Political economy of tropical and boreal forests

[53] Davidson-Hunt, I.J., and Berkes, F., 2000, Environment and society through the lens of resilience: Toward a human-in-ecosystem perspective p 18

[54] McLagan, P., & Nel, C., 1995, The Age of Participation: New Governance for the Workplace and the World. (P 232 & 236)

Ellefson (1992) mentions that the decisions reached by courts can have an impact that reaches far beyond the litigants directly involved in a dispute. Although the courts' approach to policy-making may be different from the approaches of legislatures and executive agencies, courts must nonetheless be recognised as important participants in the policy process. Judicial policy-making has a number of characteristics which make it different from the policy-making of legislatures and executive agencies. A forest resource dispute must be presented to the courts before the machinery of judicial policy-making can be set in motion; parties such as private citizens, interest groups, and government agencies must initiate the process. Because the judicial agenda setting is passive, the forest resources policy emanated from the courtroom may be neither comprehensive nor programmatic. The policy-making of courts also differs between the executive and legislative branches of government with regard to communication of agreed-to policy. Forest resource policies may also be legitimised by the action of judicial systems; notably local, state and federal courts. Because of increased litigation involving social and natural resource issues, courts have set forth an ever-increasing number of decrees that legitimise forest policies. One valid objection to it is that policy makers simply lack the intellect and the resources (time and finances) needed to achieve complete rationality. They are seldom, if ever, in a position to comprehensively evaluate or intellectually understand the range of policy options that could be used to address a forest resource issue policy (Ellefson, 1992).

Jone states that policy decisions arrived at by rational incrementalism, are the product of advocacy and bargaining. They result from mutually agreeable adjustments in the values, objectives and policies that are advocated by the various parties who are interested in a forest resource issue. Progress toward a policy decision involves trial and error, successive approximations and continuous incremental modification of objectives and policy options. A good policy is one that gains consensus, rather than one that meets criteria of economic efficiency or effectiveness.

Some important generalisations about formulation are (Jone, 1984):

- More than one set of agency actors may be involved in policy formulation, frequently producing competing proposals.
- Insufficiently defined issues may be the focal point for policy formulation, frequently producing policy options that lack effectiveness and defy evaluation. For example, tax policies, cost-sharing subsidies and technical assistance programs may be focused on often ill-defined forestry problems of non-industrial private owners of forests.

- Executive agencies of government may be involved in the policy formulation process; they cannot, however, claim sole jurisdiction over formulation activities.
- Formulation and reformulation of policy options may occur over an extended period of time without conclusion, frequently being fraught by an inability to secure political support for a set of policy options that can be offered to policy-makers for a decision.
- Formulation of policy and program options for addressing forest resource issues occurs on a continuing basis throughout the forestry community. Such activities may involve a one-time effort of limited duration or may be institutionalised for continuing attention.

Formulation is linked to and has an impact on nearly all stages of the policy process. Formulation sharpens the options available for selection and enables policy-makers to direct attention to a more realistic range of policy solutions. However, formulation that is incomplete because more studies may be needed can provoke policy-makers to postpone selection, with the result that they may appear indecisive or hesitant to take action. In the worst circumstances, analysts may be inclined to follow their own judgement and policy preferences, rather than wait for the decisions of those in authority. Formulation then becomes selection. Termination is an important but much-neglected part of the policy process, a part that signals the beginning of the process as much as it does the end. The task of dismantling a forest resource program may be so distasteful that administrators will prefer to ignore or shun the necessary activities. The reality, however, is that most policies, programs and agencies will eventually have to be adjusted, curtailed, replaced or even eliminated. Termination activities are linked to many other segments of the policy process (Ellefson, 1992).[55]

2.7 Functional Forestry Law

If forestry law is geared exclusively to public ownership, it may present considerable obstacles to private initiatives in tree planting. The policy cycle is closed when the authorities select one option to deal with the precipitating policy problem. If implementation of the policy option fails to alleviate the original conditions or triggers additional problems, the cycle may start again, perhaps activating other domain actors' participation (Kingdon, 1984). This

[55] Ellefson, P.V., 1992, Forest Resources Policy: Process, Participants and Programs, New York: McGraw-Hill, series

multiplicity of competing activities places significant constraints on any given policy cycle and must somehow be taken into account in the empirical analysis (Laumann and Knoke, 1989).[56]

The term "functional forestry law" refers to a wide range of laws and regulations that have an indirect impact on forest conservation and development (Montalembert and Schmithüsen, 1993).[57] The legislation referring to the general and specific aspects of environmental protection and the legislation that is principally concerned with renewable natural resources, including sector-specific legislation related to agriculture, animal husbandry and fisheries; the legislation dealing with social and economic measures for the development of rural areas, including land tenure legislation, land-use planning legislation, regional and national development and investment laws as well as tax legislation; and the legislation on nature protection, including laws protecting flora and fauna.

It is necessary to formulate the policy, plans and programs to meet the challenge of forest resources degradation with the sustainable utilisation and production of forest goods and services. Concerning uncontrolled conversion to other types of land uses, policies are needed to effectively formulate national to regional and sub-regional goals, programs and criteria for their implementation and subsequent improvement. It is also essential for formulating, establishing, developing and sustaining an effective system of forest extension and public education, to ensure better awareness, appreciation and management of forests with regard to the multiple roles and values of trees, forests and forest lands.

The Agenda 21 describes - with regard the forest policies - the methods and mechanisms adopted to support and develop the multiple ecological, economic, social and cultural roles of trees, forests and forestland. More effective measures and approaches are often required at the national level to improve and harmonise policy formulation, planning and programming. In order to ensure a rational and holistic approach to the sustainable development of forests, participation of the general public especially women and indigenous people, local organisations, non-governmental organisations and co-operatives, development of technical and multidisciplinary skills, quality of human resources, forestry extension, decentralization, responsibility and incentive systems are important.

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[56] Laumann, E.O., & Knoke, D., 1989, "Policy Networks of the Organizational State: Collective Action in the National Energy and Health Domains" in "Networks of Power" edited by Robert Perrucci and Harry R. Potter p 27

[57] Montalembert, M.-R. and Schmithüsen, F., 1993, Policy and legal aspects of sustainable forest management (An analysis of the role of policy and legislation in promoting the sustainable conservation and use of forest resources for multiple benefits)

Establishing links with other data systems and sources relevant to supporting forest management, conservation and development, while further developing or reinforcing existing systems, such as geographical information systems, is appropriate. By using scientific technical applications, output could be received for supporting program formulation and implementation. These measures are conducive to meeting the policy challenges outlined above. Forests have been and are being threatened by uncontrolled degradation and conversion to other types of land uses, which are influenced by increasing human needs and agricultural expansion. The impacts of loss and degradation of forests are manifest in the form of soil erosion, loss of biological diversity, damage to wildlife habitats, degradation of watershed areas, deterioration in the quality of life, and reduction of the options for development.

The theory of evolution has elements which are relevant to common pool resource dilemmas and the problem of co-operation. Darwin (1874: 178-179) stated that: "It must not be forgotten that, although a high standard of morality gives but slight or no advantage to each individual man and his children over other man of the tribe, yet that an increase in the number of well-endowed men and advancement in the standard of morality will certainly give an immense advantage to one tribe over another. A tribe including many members who, from possessing in a high degree the spirit of patriotism, fidelity, obedience, courage, and sympathy, were always ready to aid one another, and to sacrifice themselves for the common good, would be victorious over other tribes; and this would be natural selection."[58]

As the theory of collective action outlined above shows, co-operation is necessary to avoid the abuse of natural resources. As a result, benefits can be obtained even for future generations. If all participants choose to be free riders, the collective benefit will not be produced. The theory of collective action provides guidance for an effective form of government management that plays a vital role in the policy analysis of common-pool resource management (Ostrom, 1990).[59]To meet the problem of forest degradation, it is essential to assist tribal people; for example, by promoting their participation in afforestation programs in remote areas.

[58] Ostrom, E., and Richerson, P.J., 2002, The drama of the common p 403
[59] Ostrom, E., 1990, Governing the Commons: The evolution of institutions for collective action Cambridge Univ. press, XVIII (The political economy of institution and decision)

Chapter 3 Forestry Policy in Myanmar

3.1. An Overview of the Situation in Myanmar

3.1.1. Background Information

The current economic situation of Myanmar in Southeast Asia is mostly influenced by the development that took place after the country gained independence from Britain in 1948. It was a noted rice-producing country in Asia and was the world's second largest rice producer. The growth in gross domestic product (GDP) averaged more than 6 percent between 1950 and 1960. Myanmar possesses a rich basis of natural resources, especially an extensive forest cover. Before 1962, there were forest guards to patrol the natural forest. After 1988, forest protection in the different regions of the forest administration became a very difficult task, due to lack of the guards needed in order to patrol the forestlands effectively. Thus, the systematic organization of forestry, which was implemented from 1856 to 1942, was not able to deal with the new challenges. Low agricultural productivity and poverty have resulted in a change in land cover, as the population grows in Myanmar (Forestry journal, 1995).[60]Most of the common property land was transformed to become private property. Privatisation is especially problematic in Myanmar, because teak (Teacktona grandis) is owned by the state, wherever it is situated, under the forest law (1992).

An inventory has been carried out in the natural forests of Myanmar in recent years. The future yield was estimated by calculation of the stock of teak (*Tectona grandis*) according to certain girth classes. These results were taken as the basis for making estimates of the rate of growth. The annual yield of the forest, in terms of trees of exploitable girth class, was prescribed in the first Forest Working Plan for Burma. Due to the importance of forest management based on the principle of sustained yields, a trained forest service of the highest quality was formed.

The country's human development index after independence was higher than compared to 1980 to 2000 in terms of literacy rate, a free press and an elected parliament. There are 153 ethnic groups in the country. After independence, the government was faced with an ethnic problems; especially with the Karen ethnic group and the communist party. The economic system was transformed from a market economy to a centrally planned economy in the period from 1962 to 1988. The government monopolized production and trade, and all of the farmers' agricultural products could only be sold to government officials. The government redistributed basic goods,

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[60] Myanmar Forestry Journal, 1995, Minister of Forestry vol 3, No 2 p 8-13

such as rice, cooking oil and other household needs to the people at a low price. A co-operative system was applied at the local levels throughout the country. This system benefited managers at each level of the whole system, from the local level to the state level. National income was not increased adequately and, in the mid-1980s, it started to decline. In 1987, Myanmar was officially decleared a "less-developed nation" by the United Nations.

Approvals for direct foreign investment fell by 96 percent in 1999. The government focused instead on improving agricultural output, largely by bringing more land under agricultural production. However, agricultural production has barely kept pace with population growth. Inflation has averaged slightly less than 30 percent for the past decade. In terms of key economic indicators, Myanmar had, in 1999, a gross domestic product (GDP) of $US 55.9 billion (in 1995 $US), a population of 41.46 million and a GDP per capita of $US 1,348. In terms of global rankings, this placed Myanmar on rank 56 out of 191 countries in terms of GDP, 27 out of 191 countries in terms of population and 151 out of 191 countries in terms of GDP per capita. In the context of regional economic developments, Myanmar is faltering, as is indicated by falling stock markets and a significant devaluation in a number of countries including Indonesia, Malaysia, South Korea and Thailand, as well as the slow economic growth and economic problems in Japan.[61]

3.1.2 Natural Resources of Myanmar

Table 3.1 shows the status of land utilisation in Myanmar in 1996.

Table (3.1) Status of land utilization in 1996

	Area Km^2	Percent
Net Area agriculture	87,663	(12.96)
Fallow Land	13,747	(2.03)
Cultivable Wasteland	81,290	(12.01)
Reserved Forest	103,090	(15.24)
Other Forest	240,677	(35.57)
Other land	150,110	(22.19)
Total land area	676, 577	(100)

Source: Forestry Fact Sheets, 1996.

[61] http://database.townhall.com/heritage/index/country.cfm?ID=102

According to the satellite images produced in 1989, the whole country's forest cover was 43.3 percent and the forest affected by shifting cultivation was 22.8 percent of the total area of the country. According to the forestry fact sheet, published the Forest Department Myanmar, reserved forest and other forest areas together total 343,767 Km^2 or approximately 51 percent of the total area of the country. According to the above table, the extension of reserved forests, other forests and unclassified land suitable for crops, leaves the total sum of the net sown and fallow areas as the current areas available for cultivation. Fallow areas fluctuate, as some are left uncultivated for certain periods, as part of a well-defined rotation system, practiced for soil conservation purposes. They normally come under crop production again following the dormant period (MoF, 1996).[62] Myanmar, one of the agro-based countries in the Southeast Asia, is characterized by agricultural production. It was a rice exporter in the past. It is well endowed with adequate land resources for agricultural development. Competition for land use necessitates an integrated approach to the planning and management of land resources.

Table (3.2) Forest cover status in 1996

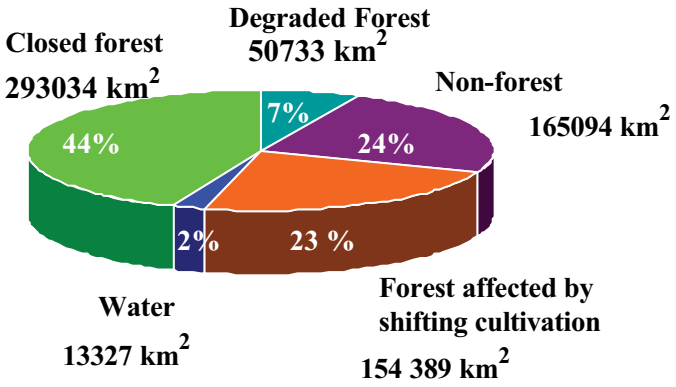
Sr No.	Forest cover	Area km^2	Total land area%
1	Closed forest	293,269	43.3
2	Degraded forest	50,963	7.5
3	Forest affected by shifting cultivation	154,389	22.8
	Total	498,621	73.6

Source: Forestry in Myanmar, 2000

In Myanmar, about 9 million hectares or 13 per cent of the total land area is under cultivation. Since a total of about 18 million hectares is estimated to be suitable for agricultural purposes, some 10 million hectares more new land can be brought under crop cultivation and livestock farming. Myanmar is still endowed with extensive natural forest. 43.3 percent of its area is under closed forests and another under woodland.[63] Table (3.2) shows the forest cover status of Myanmar in 1996.

[62] Golden Myanmar journal, 1999, Ministry of Agricultue, vol 6, No. 1 p 1
Land utilisation areas of state and divisions are addressed in this paper

[63] Ohn U, 1999, The promotion of private initiative for forest sector development, FREDA, Technical paper No. 15



Total 676577 km^2

Source: Forestry Fact sheet, 1998
Figure 3.1 Land use of Myanmar 1989

Figure 3.1 illustrates land use of the entire area of the country. Myanmar is rich in forest resources. Teak is the most valuable tree in Myanmar. The analysis of the 1989 Landsat TM imagies has indicated that Myanmar is still endowed with one of the most extensive natural forests in the World. An assessment of the change in forest cover conducted in 1990 revealed the actual forest cover rate as being 220,000 ha or 0.64 percent of the actual forested area during a period of 1 year from 1975 to 1989. These changes were shifting cultivation, illegal cutting and encroachment for agricultural purposes (FAO, 1997).[64]

Table (3.3) Permanent forest status in Myanmar

Sr No.	Legal classification	Area (ha)	Total land area%
1	Reserved forest	11,112,000	16.4
2	Protected public forest	1,479,000	2.19
3	Protected area system	1,527,000	2.26
	Total	14,527,000	20.85

Source: Facts about Ministry of Forestry, 1999

Table 3.3 shows the status of the permanent forest estate at the end of 1998. The share of the reserved forest is 15 percent. In order to allow for the extraction of timber by government officials and private timber traders, these forests are safeguarded as production forests. There were five national parks[65] and 28 sanctuaries in the whole country in 2001.[66] The natural forests

[64] FAO, 1997, Asia-Pacific forestry sector outlook study, country report of Myanmar, working paper No. 8, p 10
[65] see detail described the location of that parks, Myanmar Forestry Journal, 1994 Vol 2 No.3, p 30- 34
[66] see Report, 2001Natue and wildlife Conservation Division Forest Department, myanmar. Detail sancturies of the whole contry have been described in that report.

of Myanmar provide substantial opportunities. The coverage of the protective area system will be increased up to 5 percent in the short-term and up to 10 percent in the long-term.

Table (3.4) Composition of major types

Types of Forests	Area (ha.)	%
Tidal, beach and dune, and swamp forests	1,376,900	4
Tropical evergreen forests	5,507,800	16
Mixed deciduous forests	13,425,300	39
Dry forests	3,442,400	10
Deciduous dipterocarp forest	1,721,200	5
Hill and temperate evergreen forest	8,950,100	26
Total	34,423,700	100

Source: Forestry in Myanmar, 2000

Practically all the forests in Myanmar (over 34 millions ha) are natural forests. In order to encompass all the diverse ecosystems, they are classified into eight major forest types as shown in the table (3.4). Due to variations in the climate, topographical conditions and a wide range of latitudes, the forest flora varies from sub-alpine species to the typical rain forest species. The Forest flora is, in turn, classified on an ecological basis into the climatic and edaphic climaxes and several additional types. There are altogether 48 sub-divisions under the ecological classification, the predominant type depending upon the regions and the mix of deciduous teak and hardwood-bearing forest, the most important of all the types.

Table (3.5) Extent of closed and degraded forests affected by varying degrees of shifting cultivation (SC)

Type of forest	Area (km^2) with			Total (km^2)
	<25% SC	25-50% SC	50-75% SC	
1. Closed forest	55,507	35,567	17,934	109,008
2. Degraded forest	13,371	37,700	45,967	97,038
Total	68,878	73,267	63,901	206,046

Source: Planning and Statistics Division, Forestry Department

Table (3.5) indicates, according to the 1989 appraisal carried out by Forest Department, closed and degraded forests which have been affected by shifting cultivation.

Table (3.6) Growth of shifting cultivation from 1975 to 1989

Sr. No.	Particulars	1975	1980	1989
1.	Area of closed and degraded forests affected by SC, km^2	177,520	189,815	206,046
2.	Percent of total land area	26.2	28.1	30.5
3.	Annual growth, km^2		2,049	1,623
	Annual growth, ha		204,920	162,310

Source: Forest Department

The area of closed and degraded forests affected by shifting cultivation (SC) has grown over the years as shown in table (3.6).

3.1.3 Socio-economic and Cultural Setting (Ethnic Groups)

Until recently, there has been a fairly strong correlation between ethnic and biological diversity. Where many distinct ethnic groups live, there is also likely to be considerable habitat diversity with corresponding conservation of fauna and flora. As distinct cultures evolve, ethnicity develops as the signature. This is reflected as much in dress as in natural resources management or social structure. Poverty and social fragmentation are particularly pronounced in areas with high ethnic diversity. There are altogether 135 ethnic groups known as nationalities. Shifting cultivation is a main land use agent of forest loss in Myanmar, as is shown in the table (3.9). According to the 1983 census, ethnic Barmar accounted for 69 percent of the total population.

Table (3.7) Shifting cultivation and ethnic groups share

	Kachin	Kayah	Kayin	Chin	Rakhine	Shan	Mon
Ethnic groups	12	9	12	51	7	34	1
Shifting cultivation area %	9.1	35.5	36.5	47.4	9.5	42.9	22.8

Source: Landsat TM 1989, Forest Department Myanmar

According to the analysis of the Land Sat TM 1989 carried out by the Forest Department, there is also a relation between ethnic diversity and natural resource problems. The

highest rate of deforestation was observed in Chin State, which is home to 51 ethnic groups. Shan State has 34 groups. The deforestation rate of that state is the second largest.

3.2. Problems of Forest Management

Teak (*Tectona grandis)* has a natural distribution in countries neighbouring Myanmar. Compared with other countries, Myanmar's teak is the best. As a type of wood known throughout the world, Teak been exported to other countries. Under the changing principles for forest development to be in harmony with economic, social and environmental considerations, it is essential find a balance between conservation and exploitation. Illegal timber production is one of the main reasons for forest loss. Forests are being depleted, due to excessive cutting for agriculture, usually for shifting cultivation and increased demand for fuelwood, timber and non-wood forest products by the increasing population. In Myanmar, fuel wood and charcoal are still being utilized, both in rural as well as in urban areas. Fuelwood accounts for 78.3 percent and charcoal for 5.8 percent of the household energy consumption. The fuel crisis is considered to be one of the factors causing deforestation in the whole country [67](See below).

Development efforts are considerably challenged by misuse, mismanagement and destructive use of the soil and natural resources abundant on it. Due to the various constraints which are beyond the control of the forestry organisations, the future yield of teak in Myanmar from natural forests is expected to decline, and their extent will be reduced as a result of extensive cutting and conversion to other land uses. Illicit felling and marketing, conversion of natural forests to extensive plantations of teak monocultures adversely affect the fauna and flora (Keh, 1997).[68] Of a number of causal factors resulting in forest degradation and depletion, agricultural expansion has always been the main cause of deforestation.

Dr. Brandis, a German scientist, introduced a working plan for the natural teak forest of Bago Yoma in 1856. This very old, systematic management of forest is still used in Myanmar. The system of management is a one with a felling cycle of 30 years. Depending on the forests in which teak occurs, the cutting girth limit varies with the condition of the forest. Exploitable sizes are decided at a breast height of 4' 6", according to the criterion of good forest and poor forest, 7' 6", and 6', respectively. The fixed diameter limit for other hardwood varies with the species.

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[67] Minister of Forestry, 1995, Myanmar Forestry Journalvol 3, No 2 p 8-13

[68] Saw Kelvinh Keh, 1997, Wither goest teak plantation establishment Proceedings World Forestry congress XI Past and present teak plantation situation, illicit logging and marketing are mentioned in that paper.

There are, however, many problems in girdling operations: the felling cycle is less than 30 in some regions, and there is a weakness in recording future yields. Due to the low government payment, most of the Forest Department staff are not particularly motivated to give correct data. It is very difficult to control forestry operations in remote areas. It is clear that illegal logging occurs in forests situated in good areas.

Intensively managed plantations can provide employment and income to rural communities; especially when local people are able to obtain a fair share of the benefits from the teak plantations. Teak plantations play an important role in carbon sequestration in Myanmar. However, there has been no systematic assessment of the potential role of the plantation in CO_2 fixation (FAO, 1999).[69]

There were 36 territorial forest divisions in the country in 1983. Each plan covers a ten-year period and, when that period expires, the plan is revised in conformity with the requirement of that particular forest division. There are three working circles common to the working plans; namely,

1. Teak-selection working circle
2. Hardwood-selection working circle
3. Local-supply working circle

The method of treatment adopted in this working circle is the "Burma Selection System", in which trees having a fixed girth are harvested in the thirty years felling cycle (Forestry note, 1985).[70] Burmese involvement in the teak trade predated that of the Europeans (see below).[71] At present, for forest management purposes, the country is divided into nine territorial forests state and eight territorial forest divisions. Each forest state or division is divided into forest districts, in turn overlapping with the political districts. A total of 63 forest districts have been organised. Each forest district is a forest management unit (FMU), for which a separate management plan is formulated and implemented. The management plans divide forest districts into Working Circles (WC), on the basic of forest type, accessibility, management objectives, and nature and form forest produce available. The Myanmar Selection System (MSS) is applied in all the WCs, which are again divided into a number of felling series (FS). Annual yields are fixed by felling series.

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[69] FAO, 1999, Site, Technology and productivity of teak plantation, FORSPA publication No. 23, Teaknet Publication No. 2 p 6

[70] Ministry of Agriculture and Forest, 1985, Note on forestry in Burma

[71] Bryant, R.L., 1993, Contesting the resource: The politics of forest management in colonial Burma, p 77-106

As the Forest Department asserted control over the teak forest, it also came into conflict with shifting cultivators. To understand why shifting cultivators were opposed to the Forest Department requires an appreciation of the social and ecological conditions of *taungya* cultivation. With an extensive network of hills, Myanmar has been home to an array of groups practicing diverse forms of shifting cultivation. But, in the formulation of colonial forest policy, there was the tendency to simplify this complexity by lumping together disparate practices under the all-embracing term 'taungya'.

Actual felling against Annual Allowable cutting (AAC)

Prescribed teak AACs can be summarised as follows:

From 1946 to 1970 873,500 m^3

From 1971 to 1995 610,000 m^3

From 1996 to 1999 378, 000 m^3

From 2000 to date 342,000 m^3

The Myanmar Timber Enterprise (MTE) extracted, during the last 20 years from 1980-81 to 1999-2000, a total of 11.75 million m^3 of teak and 20.1 million $m^3$of other hardwoods. Over 20 years, actual felling had exceeded AACs in 12 years. The actual felling of other hardwood has been very much lower than the prescribed amount. At present, AAC is lower compared to the previous period's AACs. This means that forest resources are following a trend of degradation, because AAC is continually declining. Commercial logging exceeding the AAC limit deviates as an unsustainable trend and will jeopardize natural resources management.

Table (3.8) Annual Allowable Cuts for Teak and other Hardwoods

	No. of trees	Cu. ton	Cu. Meter
Teak	124,213	226,924	409,062
Other Hardwood	1,795,424	2,879,560	3,236,071

Source: Planning & Statistics Division, FD, 1998

AAC share of the hard wood is higher than teak, as is shown in table (3.8). It is necessary to promote wood processing to manufacture value-added timber products due to the export of lesser-known hard wood species. Forest management in Myanmar is focused on the sustainable management of natural teak-bearing forest. Trees of exploitable size are selectively

marked within the bounds of the annual allowable cuts (AAC) carefully calculated for each felling series, based on the principles of sustain yield management (FAO, 1997).[72]

Government polices, such as agricultural programs and the privatisation policy, represent a threat to natural resources. Policies which may result in deforestation by the local people, who migrate to increase their cultivation or who are encouraged to shift indiscriminately to other crops as a result of price policy or market developments, act against sustainable forest management. Policies that modify forest tenure and rights of use may have inequitable impacts on traditional forest dwelling communities.

The problem of forest depletion has even been greater in the case of the mangroves in the Ayeyawady delta; they were depleted at a rate of twice the national average. A recent move to boost agricultural production has focused on clearing for new land instead of intensifying the existing ones. This has encouraged increasing encroachment into the forest. For Myanmar, there still remains, however, room for improved technologies to increase crop yields. The following comparison substantiates this point.

3.2.1 Paddy Field Yields and Forest Resource Degradation

The paddy yields of Myanmar are lower compared with other countries, as shown in table (3.9). The land cultivated per capita is higher than in other Asian countries. Extremely low farm productivity, thus, is a matter of serious concern.

Table (3.9) Paddy field production, 1998

Country	Japan	China	Indonesia	Vietnam	Myanmar
Yield, kg/ha	6416	6248	4133	4005	2880

Source: K Tint, 2002 FAO paper draft

The agricultural land-holding situation also has a considerable impact on forest cover loss. If agricultural technology is promoted, paddy yields will increase. This may reduce the need to place land under cultivation, thus reducing forest resource degradation. Rainfed paddy is now being planted on 12 million acres (4.86 mil. ha). If the current per ha yield can be doubled (reaching 92% of China's yield), it would be equivalent to acquiring another 4.86 million ha.

[72]FAO, 1997, Asia-Pacific forestry sector outlook study, country report of Myanmar, working paper No. 8, p6

This would be beneficial in terms of all of the three objectives of sustainable development: social, economic and environmental objectives.

3.2.2 Problems of Watershed Managment

The terrain of Myanmar ranges from the river flood plains of the south to the mountainous watershed in the north and west and the extensive plateau area of Shan state, in the east. Therefore, the mountainous watershed of the country is quite widespread and provides rich renewable and non-renewable resources that are threatened by watershed degradation. The main problems for watershed management in Myanmar are:

- Socio-economic problems,
- Technical /institutional problmens and
- Natural disasters.

Socio-economic Problems

Poverty resulting from complex natural and man-made phenomena can be considered as the prime cause of watershed degradation. Poverty appears to be more acute in upland areas than elsewhere in the country. A socio-economic study in 1991 of the Inlay lake Watershed conducted by a forest consultant group showed that shifting agriculturists living in upland areas have the lowest income (about Ks 7,700 per household per year) compared to the permanent agriculturists in lowland areas (max. of about Ks 14,000). There is no reliable data available on migration from the upland to the lowlands. Subsistence agricultural expansion to the upland is the major cause of destruction of watershed resources. Migration to the lowland, as a result of the better wages offered, results in labour shortages in the upland watershed areas (Sharema).[73]

Improper land use, such as slope cultivation without soil conservation measures, inappropriate cultivation in lowlands, shifting cultivation without a sufficient fallow period, overgrazing or uncontrolled grazing, etc., has resulted in the degradation of land and other watershed resources. This problem is very serious in Chin State, Shan State, Kayah State and Kachin State, where steep lands are common. Land tenure or ownership of land resources is an important socio-economic factor which greatly affect the farmers' decisions regarding land use,

[73] Sharma, N., 1999, Asia PWMTA-farm field document No. 6, Recent development status and gaps in participatory watershed management education and training in Prem, Asia PWMTA-farm field document No. 6,

land conservation and development on the farms. Most of the upland land areas are classified either as reserved forests or protected forests, in Myanmar. Most of the upland cultivators are traditional landowners, who have cultivated the land for decades. But now their ownership has become illegal, since the forest cover areas are now state land. However, two types of land ownership are still found:

- land owned by the village, community or monks, and
- individually owned land.

Most upland farmers who do not own the land legally are not willing to adopt any soil conservation or resource-protection practices. However, as the government is becoming aware of the need to preserve natural resources, there is now a controversy over whether to expel illegal settlers or to legitimise their right. Thus, the existing lands tenure system is causing complex problems.

Technical / Institutional Problems

Poorly planned and executed infrastructure development activities, such as road construction and mining in fragile watershed areas and timber extraction, impair streams and pollute the natural environment. Inadequate institutions and organisational arrangements have contributed to watershed resource degradation over the years. Since watershed management is multi-disciplinary, various branches of government institutions need to cooperate to survey, design and implement watershed-management programs. Central institutional and inter-departmental coordination at all levels are therefore required to minimise the duplication of efforts and to promote effective implementation. In the absence of cooperative work with other departments, unplanned and uncontrolled upland rural developments are likely to accelerate further environmental degradation.

3.2.3 Problems of Managing Forest Plantations

The establishment of forest plantations started as early as the late 1850s, as gap or compensatory plantations, but the annual target never exceeded 700 ha until 1960. The FD and Dry Zone Greening Department have planted around 45,000 ha per year. In addition, special teak plantation projects were started in 1989, with the main objective of increasing yield. Planting 20,000 acres each year, a 40-years rotation has been envisaged, in order to be able to harvest a final yield of about 1.8 million cubic metres every year.

Total plantation areas of 704,720 acres were established from 1988 to 1998 by the Forest Department. There are four kinds of plantation: commercial plantation, village- supplied plantation, industrial and catchment-protection plantations (Myanmar Forestry, 1999).[74] 57 percent of the teak plantations were established in the whole country as commercial plantations. Industrial plantations which represent 7 percent of the total, consititute a small amount. The Asian Development Bank and the World Bank also established large-scale teak plantations through project aid. Failure began to set in due to inadequate staffing and labour shortages, the selection of vast areas of unsuitable sites, resulting in untimely cultural operation, accelerated erosion and site degradation, thereby affecting the proper growth of the trees.

Industrial plantation might be established to increase more timber export, in order to obtain foreign exchange, instead of producing timber from natural forests. Forests are being managed with weak management plans. In order to obtain the required target for the wood demand for commercial purposes, there is a need to invest in industrial plantations, so that a larger amount of timber can be exported. However, large-scale establishment of teak plantations can cause serious soil erosion.

The tenure situation for teak is as follows: On annexation, the teak forest was declared by proclamation to be the property of the state. This was in accordance with established custom under the king of Burma. Teak had been the property of royalty; all teak trees were the property of the king and teak timber was a monopoly (Burma teak 1896).[75]

The International Tropical Timber Organization (ITTO) defines sustainable forest management (SFM) as the process of managing permanent forest land to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services, without undue reduction in its inherent value and future productivity and without undue undesired effects on the physical and social environment."

The taungya system is one of the joint forest management operations in remote regions of Myanmar. This system can be found only under Forest Department afforestation in very limited areas. Those who are practising shifting cultivation under that system are called taungya cutters. Others who do not co-operate with the Forestry Department's conservation measures are considered as shifting cultivators. Due to the limited manpower of the local forest administration and a lack of finance, it is very problematic to organize all of the shifting

[74] See Forestry situation in Myanmar, Forest Department, 1999, p 6
[75] Forest Department, 1896, Garden and forest, the Burmas teak Forest, Vol 9, p 4

cultivators in the plantation establishment programs. However, with community forestry, it is possible to create a better life for them. In order to get benefits from long-term forest plantation, they have to wait at least 10 years to get timber from the forests. Howver, they are not willing to participate in community forestry, because the political situation is not stable in Myanmar. They do not have trust in or believe in the current and future condition of the forest operations. It was the interlaced nature of these problems that made co-operation as essential as it was problematic.

An estimated two million families, or 10 million people, are involved in shifting cultivation. A policy goal is to increase the participation of these families by providing better incentives to them in cooperate afforestation programs in spite of the problems identified above.

The government is also conducting reforestation programs involving the local communities to counterbalance deforestation problems. The deforestation rate of Myanmar for a 14-year period (1975-1989) was 218,800 hectares per annum (FD, 1999). The forestry department is promoting forestry plantation to enrich and reforest these denuded areas. At present, the Myanmar Government is implementing a program of vegetating the arid zones in the 13 districts in the central part of Myanmar. Since 1977/78, a nationwide tree-planting program has been conducted, with the participation of local communities and non-governmental and governmental organisations. Total 494,200 (ha) were planted from 1963 to1995, and the current annual planting target is approximately 33,000 ha. Under the ALGAS Project, Myanmar conducted its first inventory of greenhouse gas emissions.

In 1937-38, the government again revised the policy to increase the plantation establishment to 600 ha per annum. Up until that time, only a few plantations were established each year. These plantations were formed more in a compensatory nature in scattered small plots of approximately 20 ha. Extensive forest plantations in large blocks were formed from 1972, and a large-scale plantation program was started in 1980. There were obstacles facing the establishment of large-scale plantations. It is important to maintain those plantations for the long-term. However, the manpower and funds needed to conserve those plantations are very limited. On the other hand, there were corruption problems at the level of some of the local plantations' administrators; a factor that hampered sustainable development. Currently, it is very difficult to establish a plantation with the small amount or resources provided according to official government plantation norms, due to the fact that inflation is very high in Myanmar. This means that the funds paid by the government for plantation establishment are much lower than

the actual cost. Thus, local plantation administrators face the problem of acquiring labour for the plantation operations.

3.2.4 Fuelwood Situation

Myanmar is utlising its forest on a very conservative scale. However, Myanmar is facing serious problems regarding shifting cultivation, excessive harvesting of fuelwood and charcoal for local needs, agricultural encroachment of various forms and illegal extraction to a certain extent. Fuel wood and charcoal are still being used in the rural as well as in the urban areas. The main areas of usage are brick-making, pottery work, tobacco curing, and household cooking. Consumption of fuelwood is higher in the rural compared to the urban area. The rural population was 44 million (76 percent) in 1995, some people live in the rural areas and the rest in the urban areas (Nyunt, 1995).

In Myanmar, statistics show that an urban household consumes 1.4 cubic tons of wood or charcoal a year, while a rural household utilises 2.5 cubic tons of wood or charcoal a year. At the national level, demand for fuelwood is estimated to be 30 million tons per annum, while the recorded fuelwood production is about 20 million cubic tons. Actual consumption of fuelwood could be higher than the recorded data, due to the unrecorded felling of fuelwood and illegal extraction of charcoal (MoF, 1995).

In Yangon, more than 50 percent of the residents used charcoal that comes from delta mangrove forests whose ecology is seriously threatened, due to over exploitation. In the year 1994, the whole country consumed 18.7 million cubic tons and, with a growth rate of 1.1 percent, the consumption was about 20 million cubic tons by the year 2000 (Nyunt, 1996).

3.2.5 Problem of Climate Change

Climate issues have become increasingly recognized and linked to natural resources policy. Climatic patterns have been historically ascribed to technical domains, with politicians and administrators left to initiate policy responses (Blench, 1998). Understanding climate is central to building policy in the area of natural resources, both in annual weather forecasting and forecasting over a longer time-scale, in which conceptual models of climate are constructed on the assumption of some consistency in weather patterns. Such models should form the basis for long-range planning, especially in relation to agriculture and water supply. World weather systems are a unity, but climatic patterns and events are categorized according to social

constructions. Thus 'drought' and 'floods' exist in relation to what is considered to be normal rainfall, rather than being entities that can be defined independently. Weather can be thought of as shock events overlaying a background of acceptable variation. Shocks, such as floods, high winds and drought are sufficiently anomalous within the lifetime of observers as to be classified as unpredictable and life-threatening (Blench and Marriage, 1998).[75]

Biodiversity and related carbon stocks will continue to decline while they remain undervalued. Although habitat loss, as a consequence of land clearing, is currently more serious in terms of its impact than foreseeable climate change, the combination of the two will continue to have an impact on the way in which natural resources are managed. There is a need to provide land managers and policy makers with the incentive and the capacity to make decisions for adaptive and sustainable management of natural resources. Sala *et al.,* (2000) also identified uncertainties in policy development as a key unknown and emphasised that, for this reason, they have presented scenarios rather than predictions of changes in biodiversity. Consequences for global warming are such that the Inter-governmental Panel on Climate Change (IPCC-WGII-TAR) forecasts an increase in global atmospheric temperature of 1.5 to 5.8°C by 2100, accompanied by a rise in sea level from 15cm to 95cm.[76]

In the 19th century, deforestation and hence CO_2 emissions resulting from land use change was nearly twice as high in the temperate countries of the developed world than in the rest of the world. Tropical countries are responsible for almost all emissions caused by a change in land use and deforestation concentrated in a few major countries. The burning of fossil fuels for energy is the main, but not the only source of CO_2 emissions. Land-use changes, mainly in the form of deforestation and forestland conversion to other uses, currently contribute about 20 percent of the global CO_2 emissions from anthropogenic sources. In order to forecast CO_2 emissions in the future, there is need to consider the factors underlying the dramatic shift in rates of deforestation and hence forest cover between regions and over time. Unfortunately, reliable time series on deforestation and forest areas are not available.[77]

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[75] Blench, R., and Marriage, Z., 1998, Climate uncertainty and natural resouce policy: What should the role of government be? Nature resource perspective No. 31

[76] http://www.biodiv.org/doc/meetings/tegcc/tegcc-01/official/tegcc-01-02-en.pdf

[77] http://www.cid.harvard.edu.edu/caer2/htm/content/papers/confpubs/paper45/paper45, Panayotou, T., Sachs, J., and Peterson, A., Consulting Assistance on Economic Reform II Developing Countries and the Control of Climate Change: Empirical Evidence, Discussion Paper No. 45

Grubb (2002) represented the international slipover in terms of its impact on the relative emission intensity, defined as the ratio of CO_2 emission to GDP, in different parts of the world. The spill over is represented as follows:

$$e_2(t) = (1 - \sigma t/\mathrm{T})\ e_2^*(t) + \sigma t/\mathrm{T}\ e_1(t)$$

$e_2(t)$ = the ratio of emission to GDP for developing countries at time t

$e_1(t)$ = the ratio of emission to GDP for developed countries

T= 110 years

$$\sigma = \sigma_s + \sigma_t + \sigma_p$$

Where σ_s is the spillover due to economic substitution effects, σ_t is the spillover due to the diffusion of technology improvement, and σ_p is the spillover due to policy and the political influence of industrialised country actions on developing country actions. It is considered to be a more likely range for the parameter and the climatic implications. Emission intensity in the developing countries would grow to five times that of the industrialised countries, according to the emission traectories for different spillover assumptions (Grubbet et.al 2002).[78]

Future changes in climate and atmospheric carbon dioxide are likely to affect the productivity of forests (Joyce et al., 2001) and the forest sector (Brown and Solomon et al., 1996). Trading patterns of a region play an important role in whether the region achieves any economic gains associated with the climate change (Perez, 2002).[79]

Many climatologists believe that the "enhanced greenhouse effect", caused by the observed accumulation of the carbon dioxide, methane, nitrous oxide, and chlorofluoro carbons in the atmosphere, is likely to raise mean world temperature by about 2 degrees C by the year 2030 and mean sea level by around 30-50 cm on a comparable time scale (Warrick et al., 1988). A growing body of research has also examined the possible effects of climate change on individual species and biotic communities. Small changes in temperature alone may differentially alter the spatial distribution of predator and prey species in marine ecosystems (Murawski, 1993). Small changes in temperature and rainfall particularly can cause major changes in fruit or seed

[78] Grubb, M.J., Hope, C., 2002, Climate implications of the Tokyyo protocol: The contribution of international spillover, Climate change journal, 54: 11-28

[79] Perez-Garcia, J., and Joyce, L.A., 2002, Impacts of the climate change on the global forest sector, Climate change journal 54: 439-461

production in forest ecosystems. The response of a forest to climate change may depend as much on the direct effects of climate and vegetation on soil properties (Pastor and Post, 1988).

Cumulative impact studies are typically implemented to help analysts and decision-makers understand the long-term negative impacts of a particular action. This analytical paradigm, however, can also be used to evaluate the potential environmental benefits associated with policies and regulatory programs that affect land use management decisions (Bennett, 2001).[80]

The ability of animal and plant species to shift their ranges in response to climate change also depends on dispersal mechanisms. Global warming could lead to the spread of infectious diseases, such as cholera, malaria and yellow fever. Anopheles mosquitoes, which carry malaria, are limited to areas with average temperature of 16 degree C, but, with global warming, the range of these mosquitoes could be dramatically extended northward (Martin and Lefebvre, 1995). One study in Rwanda found that a 1 degree C temperature rise caused malaria infections to increase by 337 percent. Myanmar has established the following regulations and programs to support the national climate change objectives.

A greenhouse gas inventory, one of the subjects of national communication, has been compiled by the Department of Meteorology and Hydrology for change in land use and the forestry sector, the agricultural sector, the energy sector and the industrial processes sector. It is based on the IPCC Guidelines for National Greenhouse Gas Inventories to estimate the emission of CO_2, CH_4, N_2O, NO_x, CO and gas for the period from 1990-91 to 1997-98. Also, the Union of Myanmar has actively participated in the ALGAS project (Asia least-cost Greenhouse gas Abatement Strategy), which was a study by 12 Asian countries of national emissions of greenhouse gases in 1990, the projections of GHGs emission to 2020 and an analysis of GHGs abatement options in different economic sectors.

3.3 Development of Forest Policy in Myanmar

Burma first experienced imperialism during engagement with Great Britain. A border conflict in 1824 between the British colonial powers in India and the ruling Konbaung dynasty of

[80] Bennett, D.A., 2001, Evaluating Nonpoint Pollution Policy Using a Tightly Coupled Spatial Decision Support System, http://link.springer-ny.com/link/service/journal/00267/bibs/0027006/10270825

Burma eventually lead to British colonisation in 1826. The Burmese Monarchy was eventually abolished and the country annexed into the British Empire of India, allowing for the exploitation of Burma's rich natural resource base (Cribb, 2001).

Myanmar kings formulated a complex system designed to maximize revenue and maintain control. As indicated above, the teak trade controlled by regulating extraction from the forest under a system of girdling and Myanmar's involvement in the teak trade predated that of the Europeans. From at the least the 17th century, southern Myanmar exported locally built teak ships (Bryant, 1993).

The guiding principles had been derived from a policy document prepared in 1894. Now, they are enshrined in the Myanmar Forest policy of 1995. The Ministry of Forestry approved a national forest policy in 1995. It was formulated by adapting the concepts of the Earth Summit's Agenda 21 and the forestry principles on sustainable management to domestic political, socio-economic and environmental conditions. Without having a proper policy of its own, the Forest Department had carried out its duties for a great period of time by following either ad hoc policy guidelines or the Indian Forest policy of 1894 formulated during British colonial days. However, that policy statement was no longer adequate, in the light of the Forestry Department's expanded mandate under the Forestry Law. Thus, the National Forestry Policy, as that law, emphasises the need to integrate the goals of timber production, wildlife and environmental conservation, the role of the private sector in the timber industry, and the maintenance of biological diversity and social forestry (FAO, 1995).[81]

3.3.1 Past forestry Policy, Law and Administration

The statement of forest policy for both Burma and India was affirmed in 1894. It recognised four main classes of forests viz: (1) Protected forests, which are essential on climatic or physical grounds; (2) Commercial forests, which afford a supply of valuable timber for commercial purposes; (3) Local supply forests – the use of which is to provide the local people with essential needs in respect of timber, firewood etc., and (4) Nature reserves, sanctuaries and national parks. The Forestry Department has operated in an entirely modified political and economic context after independence.

[81] FAO, 1998," Teak for the future " Proceeding of the second seminar on teak Forest policy Forest Law, RAF publication 98/5 Teak publication No. 1

Civil war broke out during most of the postcolonial era, because diverse political and ethnic groups were in dispute with the Rangoon-based government. These political economic conditions have ultimately influenced the policy and practices of the Forest Department in the postcolonial era.

Thus, civil trouble has meant that the rectification of order in the forests has been a continual concern of that department, while the quest for socialism prompted the creation of a State Timber Board. It has proven to be a powerful rival in forest management. The forestry technique and land management practices regulate commercial timber harvesting.

The department also transformed essential implications to a style of socialist forestry. Most of the timbers were exported to other countries as raw timber materials. There was no advance technological development of wood processing to exports to make valued-added products which could get much more foreign exchange on being sold. However, the level of deforestation of the country during that time was lower compared to the market economic system period from the 1990s until 2000. In 1988, the State Law and Order Restoration Council (SLORC) came to power, forest management underwent various changes which, in aggregate, may signal a new direction for Burmese forestry in the 1990s.

During the 1950s, forest officials tried similar activities to end forest degradation in the Dry Zone. The push to thwart shifting cultivation combined with the plantation program especially restored the Mount Popu. Forest officials also carried out afforestation programs in the regions of the ethnic minorities of the country. Since practicing shifting cultivation was widespread in the Chin, Kachin and Shan hills, policy action was implemented in these areas.

The National Commission for Environmental Affairs (NCEA) was founded in 1990s with the aim of preserving natural resources. The NCEA is chaired by the Minister of Foreign Affair and comprises cabinet ministers and senior government officials. It is primarily concerned with the development and coordination of national environmental policy, but also is the agency in charge of relations with other countries and international organisations on environmental matters (NCEA, 1993).[82]

The Forest Department has various pressures to neglect sustainable forest management and to permit the exploitation of forest resources. This is because the timber corporation cannot

[82] NCEA, 1993, National Commission for Environmental Affairs, Environmental Policy and Legislation, Myanmar, Ministry of Foreign Affair Yangon,

meet set timber quotas, due to difficult access insecurity in the remote areas, shortages of extraction power, high extraction losses and other problems.[83]

Laissez-faire was applied in the early nineteenth century to justify clear teak extraction by private enterprise in colonial Tenasserim, but the growing influence of sustainability set the direction toward 'rational' forest use. However, that system was challenged in the late colonial era as nationalistic ideas appeared to overlook forest politics. With independence, nationalism remained a powerful force in the country's politics, yet it was directed to a program of economic development assumed under socialism. However, the relative weakness of the postcolonial Burmese state- only partly remedied by the military after 1962 - imposed a practical limit to the implementation of the new socialist policies. A common theme of governance throughout the period 1948-88 was therefore the existence of a discrepancy between the rhetoric of ambitious development plans and the reality of an economic policy failure that ultimately led to the country acquiring the status of a a 'least-developed country' in 1987, as mentioned in the introduction (Far East, 1987).[84]

There was disagreement between the State Timber Board and the endeavours of the Forest Department to reform a system of rationalised forest use based on sustainable development in the post colonial era.

The state has largely abandoned socialism in favor of a gradual opening up to the global capitalist economy, while the armed forces have apparently prevailed over the country's insurgent forces. The forest sector has undergone dramatic change since 1988. The Thailand-Myanmar border was insurged, so that illegal logging exploitation by loggers of that region and forest cover depletion in that region would cease. Therefore, SLORC allowed border timber trade along the Thai-Myanmar border to the timber companies. If timber trade was not permitted in that region, forest resources would be degraded, becauses of illegal loggers from the other side. Thus, changing the policy of the government affected the natural resources endowment of the country.

In the past period, Thailand was one of the timber producing countries. Due to a timber shortage, Thailand meanwhile became an importer of timber. Thailand's timber companies intend to benefit from border area forest exploitation. The forest cover in the 1980s was down to about 15 percent of Thailand's total land area, residual forests were the subject of increasingly

[83] Forestal International, Forest Feasibility, p. 20
[84] Far East Economic Review, 22 October 1987.

bitter conflicts between villagers, environmental groups, business and the state. The Thai government decided to ban all further logging in the country in 1988. Clearly, if the country's timber industry was to survive, a new source of supply needed to be found urgently.

The state probably obtained a greater control over non-timber forest trade in secure areas. Yet, these measures nonetheless failed to halt the depletion of accessible forests by the peasantry. The Forest Department could not protect the forest from depletion, due to a lack of staff and resources. This loss of control inevitably resulted in 'severe degradation in value, quality and quantity of the forest'. The manpower of the Forest Department has increased since the late 1980s, so too has the range of duties assigned to the Forest Department afforrestation program.

The State Peace and Development Council (SPDC) has sought to prevent illegal logging trade from getting out of control through well-publicized prosecution; in early 1994, for example, 127 officers were jailed for up to seven years for illegal logging in the upper Sagaing Division and in the Kachin State. Just as revenue earned from timber contributed to the survival of the regime in the late 1980s and early 1990s, so too timber revenues are being used increasingly for personal wealth and by the economic elite.[85]

Forest management in the 1990s was implemented in a distinctive political and economic context which set it apart from both the colonial and the socialist eras. In this regard, the growing international concern about environmental degradation and the associated worldwide interest of the 1992 Earth Summit in the promotion of sustainable development policies has had a noticeable impact on the way in which the state approaches environmental questions. On the one hand, the West's concern about tropical deforestation has prompted unparalleled international scrutiny-and criticism–of forest management. On the other hand, the SPDC has sought to turn such concern to its advantage, as it has extolled the virtues of long-standing trading of 'sustainable' forestry to which it professes unswerving allegiance (FD, 1989).[86] The SPDC has also implemented other policies, committees and projects, created for the good of 'green Myanmar'. The Forest Department was assigned a mandate to conserve the forests in the forest law in 1992.

In practice, the NCEC delegates its work to four specialized sub-committees which meet three or four times a year to discuss problems and proposed solutions relating to the

[85] Hurst, 1990, Rain Forest Politic: Ecological Destruction in Southeast Asia, London,
[86] Forest Department, 1989, Forestry Situation in Myanmar, Yangon, p.15

conservation of the natural resources, the control of pollution, research, information and education matters, and international cooperation. Since the 1990s, the main task of the NCEA and its sub-commitees has been to formulate a national environmental policy. Although still in the planning stage in 1994, the general aim of the policy is to promote an integrated approach to environmental management, in keeping with the national goal of sustainable development and the country's international treaty commitment, based on state-of-the-art environment knowledge, as well as the support of an informed public (NCEA, 1993).[87] The national environmental policy will provide a framework for the mandate arrangement of environmental laws and regulations. SPDC's environmental agenda has also revolved around the country's active participation in international agreements and organisations concerned with environmental matters.[88] The government participated in both the Framework Convention on Climate Change, the Convention on Biodiversity and the Global Environmental Facility, as well. The country decided to join the International Tropical Timber Organisation (ITTO) in 1993, and drew up a national Tropical Forestry Action Plan. It is also active in the effects of regional flora on wildlife conservation, as part of its formal commitment to protect endangered wildlife.[89] These various initiatives highlight the SPDC's intent to participate actively in international fora on environmental issues and thereby tap funds that might be available for environmental conservation.[90] These initiatives reflect the prominence of green issues in SLORC's thinking in the 1990s (NCEA, 1997).[91]

The country's economic development had a direct impact on sustainable development of the natural resources enrichment. For example, natural gas purchasing from Thailand depleted forest cover, because forest covers were cut for linking the gas pieline to reach the border area with Thailand. The country's economic development also depends on political stability. Now, it is a very complicated matter to solve the deforestation problem and reach the goals of sustainable forest management. That quest is more often than not associated with unsustainable use of the country's forests (FD Myanmar, 2001).[92] Both directly and indirectly, logging has

[87] ibid; National Commission for Environmental Affair, The need for a National Environmental Policy in Myanmar, Yangon in 1993
[88] Coltman, C.L., 1954, 'Burma and the FAO', Burma 4 (January 1954),
[89] Ministry of Forestry, 1994, The wildlife, Natural Forests and Nature Preservation Law
[90] Forest Department, 1990, Greening Project Report, Myanmar
[91] Ministry of Foreign affair, 1993, National Commission for Environmental Affair, (NCEA) Environmental Policy and Legislation, p.2
[92] Forest Department, 1993, Report, National commission for Environmental Affairs, Need for the Environmental Policy, p 1-7

been responsible for much deforestation in the country, but as it is integrated into the international economy, new development projects are placing an added strain on the country's forests (Tint, 1991).[93]

The current policy recognises the following six imperatives (MOF, 1995).[94]

1. Protection of the soil, water, wildlife, biodiversity and the environment;
2. Sustainability of forest resources, to ensure perpetual supply of both tangible and intangible benefits accrued from the forests, for the present and future generation;
3. Basic needs of the people for fuel, shelter, food and recreation;
4. Efficiency to harness, in a socio-environmentally friendly manner, the full economic potential of forest resources;
5. Participation of the people in the utilisation of the forest in a manner promoting conservation; and
6. Public awareness concerning the vital role of the forest for the well-being and socio-economic development of the nation.

The government preserves 30% of the total land area as reserved forest and 5% as protected area systems. It encourages participatory forestry and makes Environment Impact Assessment (EIA) of development projects obligatory and the intensification of silviculture and management. It promotes non-timber forest products and private investment in the wood-based industry, encourages down-stream wood processing and use of under-utilised species, gradually phasing out round log export, and strengthens forestry research, training and institutions, in both quantitative and qualitative terms.

Reserved forest areas in Myanmar constitute 16.4%, and the areas of protected forests represented 2.19% in 1999. As indicated above, the target of the current forest policy is to expand the areas of the reserved forest to 30 % and the areas of protected forest to 5 % of the total land area. The need to restore the country's seriously degraded forests, as a result of decades of warfare, logging and shifting cultivation, would appear to place a premium on the Forest Department's conservationist mandate. It supports measures in accordance with forest principles adopted at the United Nations Conference on Environmental Development (UNCED) in 1992 (FAO, 1998).

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[93] Tint, K and Hla, H., 1991, Forest Cover of Myanmar: The 1989 Appraisal, Yangon, 1991, p. 14; Blower et al., 'Burma (Myanmar)'p. 107.

[94] Ministry of Forestry, 1995, Myanmar Forest Policy

Thus, forestry policy highlights environmental and biodiversity conservation, and the extended setting-up of the permanent forest estate and protected area system. The Forest Law provided opportunities for the promotion of private sector involvement in timber trade and it decentralises management responsibilities.

The Ministry of Forestry in Myanmar comprises the Forest Department and the Myanmar Timber Enterprise (MTE). The Forest Department is responsible for forest policy and program implementation, and it controls MTE and the survey department. MTE, the only government-owned logging agency is responsible for the extraction, procession and marketing of timber.

The Dry Zone Greening Department (DZGD) is responsible for reforestation of degraded forests and reforestation of the environment in the dry zone of central Myanmar. The Planning and Statistics Department (PSD) is responsible for coordinating and facilitating the tasks of FD, MTE and DZGD following the directives of the Ministry of Forestry, and acts as a forum on policy issues in forestry (MoF, 1999). [95]

Existing legislation relevant to watershed management include the Forest Law, 1992, and the Shan State Soil Conservation Act, 1951. The Forestry Policy states that shifting cultivation is discouraged through adoption of improved practices for better food production and a better quality of life for shifting cultivators. The forest policy has identified six imperatives which include the protection of soil, water, wildlife, biodiversity and environment, and the basic needs of the people for timber fuel, shelter, food and recreation. The policy stipulates that sustainable forest management maximises social and environmental benefits for the country and its population and restores ecological balance and biodiversity. When deciding on policies and changes to enhance the awareness of forest dwellers, it is most relevant to consider who has rights to access and use the forests, who actually utilises or maintains forests and who controls the resources.

3.3.2 Myanmar Forest Law (1992)

The new forestry law was promulgated in 1992. The former law had been enacted in 1902. The new law marked a shift from treating Myanmar forests as purely commercial resources to a wider range of objectives. It emphasises the importance of forests' contribution to the food, clothing and shelter needs of the public and for perpetual enjoyment of benefits by

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[95] Ministry of Forestry, 1999, Forest Department, Forestry in Myanmar

conservation and protection of forest. A special legislation is necessary to make forestry policy effective. The Burma Forestry Act became law in 1881. Thereafter, amendments have been made from time to time to suit changing conditions. They included provision for the constitution of reserved forests and powers, rights and duties therein, the general protection of forests, forest products, the control of forest products, in transit, penalties and procedures, and attributing special powers to forestry officials (Win, 1999).[96]

Rule 28 states that the Forest Department shall publish a notification prohibiting the practice of the shifting cultivation in a defined tract of forest cover land at the disposal of the Government. It is not allowed to extend into the land notified under regulation 28 without the permission in granted under regulation 29. Whoever violates that rule for the purpose of shifting cultivation is punishable with imprisonment for the term of six months, or a fine of five thousand kyats.

However, there is no plan on how many plantations might be compensated for due to the elimination of shifting cultivators. According to the compensation right, local communities are responsible for participating in the conservation of natural resources with joint or collective management. Although the Forest Department has been enforcing measures regarding the encroachment of the shifting cultivation into the forested areas, shifting cultivators pay some amount of cash as a fine to the local level forest staff members for farming in the forested areas. It is clear that appropriate law enforcement needs to be strengthened to achieve sustainable forest management. At the same time, poverty-reducing strategies must be laid down for the development of the upland forest dwellers. It is essential to implement such a fight against rural poverty with a participatory approach. Forest policy has become one of the most controversial and heated issues in development.

A special legislation is necessary to ensure the effect of the forest policy. The new forest law, in line with the Myanmar Forest Policy, focuses on a balanced approach towards conservation and development issues implicit in the concept of sustainable forestry. It decentralises management and opens up opportunities for increased private sector involvement in the timber trade.

As clarified by the major activities mentioned, forest resources of Myanmar are being managed towards sustainable development within the context of securing the resource base,

[96]Win, T., 1999, "Natural resource management of myanmar" 8th Regional seminar on earth observation for tropical eco-system management

production, conservation of biodiversity, replenishment of renewable resources, and acknowledging the social and cultural dimension. Under-utilised or less-used timber species are to be evaluated and introduced to both domestic and world markets. With regard to the promotion of lesser-used species, utilisation and markets, efforts are being undertaken in many ways; i.e. through research and development, an activity programme and internationally funded projects.

So far, only teak and a few hardwood species are harvested at the commercial level and many of the non-teak hardwoods are substantially not utilised from the point of commercialisation. Even large tracts of bamboo resources are still poorly utilised for commercialisation. The forestry sector is now providing enough room for the expansion of the private sector and international entrepreneurship to fully utilise these under-utilized forest resources.

A significant attainment of Myanmar towards sustainable development is that Myanmar has completed a report on the estimates of resources needed and costs involved for the implementation of International Tropical Timber Organisation Criteria and Indicators. In order to achieve sustainable development, Myanmar has initially identified 5 criteria, 27 indicators and 100 activities at the national level, and 6 criteria, 23 indicators and 66 activities at the district (Forest Management Unit) level.

The Forest administration has encouraged community participation in managing forest resources, particularly to satisfy the basic needs of the rural people. Basic principles for implementing the forest policy were prescribed in section 2 of the law. The constitution of the permanent forest estates, such as reserved forests and public forests, were prescribed in section 3. Sections 4 and 5 cover management of forests and plantations. Forest utilisation, logging operations and wood transport were covered in sections 6 and 7. Section 9 specified the right to establish a wood-based industry. Punishment, appellate matters, penalties and miscellaneous points were prescribed in sections 10 to 13.

Regarding fines and punishments of those committing offences, as regulated in the law, it should be mentioned that they are not appropriate for the current situation, because the inflation rate is not accounted for. For example, for those persons who carry out shifting cultivation in reserved forests, it is easy to pay as a fine a comparatively small amount of money. In view of such a rule, offenders think that the offence is not serious and that paying the fine is cheap. They

continue to commit forest offences. Similarly, in the case of the illegal hardwood timber extraction, those offending the regulations can pay the fine for the punishment without any problems.

The polluter pays principle is described in the forest law to safe-guard the trend of sustainable forestry. Commercial timber logging companies have been given the right to exploit timber from the natural forest and have obtained a profit from the forestry service. It is necessary to compensate for establishing plantations for the damage caused by a loss of biodiversity.

Forests are regarded as state property and there are no privately owned forests. The forests were traditionally classified into two categories of forests: reserved forest and unclassified forests. The reserved forest have legally enforced restrictions on their use, but rural communities are allowed to utilise the products of the unclassed forests, except for protected plants and wildlife species.

An administrative machinery is necessary to give effect to the Burma Forest Act and the Forest Department is the appropriate body to carry out the provisions contained therein. To provide a legal status to make the protection of wildlife effective, the Myanmar Wildlife Protection Act of 1936 was also proclaimed, and has played a key role in the conservation of wildlife in Myanmar. It provides inter alia for:

(a) the establishment of wildlife sanctuaries;

(b) the definition of three categories of protected wild animals;

(c) the prohibition of unlawful hunting;

(d) the control of wildlife trade (Myanmar Forestry, 1994).[97]

Wildlife protection has been mandated by legislation since 1936, which was replaced in 1994 by a new, updated legislation referred to as the Protection of Wildlife and Protected Areas Law. In 1980, the government of Myanmar accepted the assistance of UNDP and FAO for developing a nature conservation program. As a result, a project was prepared with development objectives for the conservation of natural ecosystems, protection of endangered species of animals and plants, and the development of a system of a national parks and nature reserves (Lwin and Uga, 1990).[98] Being aware of the importance of environmental protection and biodiversity conservation, Myanmar aims to increase the area of national parks and

[97] Ministry of Forestry, 1994, Myanmar Forestry journal vol.2,
[98] Lwin, T., Uga., & Khaing, S.T., 1990, Wildlife conservation in Myanmar

sanctuaries, as indicated above, up to 5 per cent of the total land area for effective protection under various categories (Myanmar Foresty, 1994).[99]

3.3.3 Program Planning and National Forest Program

In the late 1970s, the government of Myanmar requested technical assistance from FAO and UNDP to introduce the concept of watershed management, though the training of staff and the development of technologies are on a pilot scale. Project formulation began in 1981, and in 1987, the UNDP/ FAO/GOM project "Pilot Watershed management for Kinda Dam", MYA/81 /003, was defined. In the 1990s, the scope of the project was expanded to include interventions in Inle Lake and Phugyi watersheds. Through the MYA/81/003 project, basic principles of watershed management, including planning, have been introduced with training by the Forestry Department in 1992. Continued UNDP /FAO development assistance is envisaged as the future WM program is planned to expand from a pilot level to a national scale. Watershed management for three critical areas, MYA/93/005, is one of the leading projects of a comprehensive Human Development Initiative (HDI) program, undertaken by the UNDP and GoM, in conformity with the UN Governing Council's Decision 93/21. The project is designed to improve the overall quality of life of an estimated 120,000 inhabitants, comprising an ethnic minority population of 90,000. Further, to reserve the environmental degradation trend in the critical areas (Inle, Phugyi and Kinda Watersheds), establishment of improved land-use practices on government-owned, community and the private lands is planned from 1994-1995. Although the exact extent of degraded lands in watershed is yet to be defined, it is believed that they are at different states of degradation. Such degradation is evidenced by widespread soil erosion, formation of gullies and landslides, increased sediment deposit in the dams and reservoirs, irregular stream flow and decreasing crop yields.

The extent of the watershed degradation problems in Myanmar needs to be recognised urgently to preserve the reservoirs of multi-purpose dams. The contemporary policies, legislation and controlling effective protection and management of watershed resources are insufficient to arrange and implement extensive resource management. The lack of a broad policy, particularly on upland tenure, also delays the improvement of people's participation in watershed management. Land tenure in watershed areas is a primary issue. Land tenure contains

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[99] Ministry of Forestry1994,Myanmar Forestry Journal,Vol 2 No. 3,

the formal (state recognized) and informal (customary) rights of access to different kinds of land, the right of transfer, and right to determine changes in the use of that land. Formally and informally held land rights may be in harmony or in conflict with rules within the watershed areas. A Work Committee for the Development of Border Areas and National Races, within the Ministry of Progress in Border Areas and National Race and Development Affairs, as well as the Forestry Department and the Myanmar Agriculture Services have been implementing soil and water conservation activities in upland areas independently. Thus, a specialised organisation and effective institutional arrangement is required to coordinate watershed management activities. As watershed management is a multi-sectoral, inter-disciplinary subject involving many technical disciplines, informed policy-makers, capable planners, skilled managers and motivated field workers are essential for implementation efficient watershed management. Substantial amounts of capital are required to extend the accomplished potential of the environment to support people in the upland of Myanmar. The current level of people's awareness is not sufficient. Technical and administrative capabilities to run public awareness campaigns need improvements. Mass media, local educational networks and NGO need to be fully utilised. Appropriate incentives for self-help provide a vital role to pursuade local people to participate in watershed management programs. Subsidies might be required to bridge the gap between the adoption of a protection measures and the achievement of sustainable development.

As indicated above, the rural population is heavily dependent on forest resources for fuel, food and timber. Degraded forest account for 7.5% of the total forest area. The underlying cause of forest degradation can be summarized as follows: socio-economic problems, scarcity of land in densely populated areas, illegal agricultural expansion, shifting cultivation, low agricultural output, improper land use and illegal fuelwood extraction.

According to the official statistics, Total of 408,409 ha were planted from 1963 to 1992, of which 67 % are commercial and industrial woods species, 25 % local species, while the rest are protected species in watersheds. The annual planting program is now fixed at around 32,400 ha per year. Special emphasis is being given to the greening program in the dry zone. The objectives are to reforest and prevent desertification and to meet the critical fuelwood needs of the rural people. The planting area had been around 6,900 ha per a year. According to the Japan-FAO Association report concerning STRAP Project, March 1998, the annual plantation area was increased from an average of 29,400 ha in 1990-94 to 37,200 ha in 1997.

The initial adoption of a market economy was announced in 1988. As a result, many private timber companies became involved in timber industries to promote the market economy, the Government formed the Privatization Commission on the 9th of January 1995, to oversee and ensure the successful implementation of the privatisation process. In line with reorienting the policy toward an appropriate market-oriented economic system, the government adopted the following four objects:

- Development of agriculture as the base for the development of other sectors of the economy;
- Proper evolution of the market-oriented economic system;
- Development of the economy inviting participation in terms of technical know-how and investment from sources inside the economy and abroad; and
- The initiative to shape the national economy must be kept in the hand of the state and the people of the nation.

3.3.4 Forest Action Program

Although the forest cover is high, the distribution pattern is uneven, with the central dry zone almost bare of forests, while the northern regions are closed, biodiversity-rich forests. Causes forest degradation include land conversion and fuelwood collection, as discussed above. Again there is a need to meet timber requirements for development works that have been going on with increasing pace. Shifting cultivation is yet another accumulative factor in forest cover loss.

In view of the necessity to conserve the forest resources in order to achieve the national goal of sustainable forest management and development, and for optimisation of socioeconomic benefits and environmental stability, a new forest policy has been adopted. The new policy is historically structured according to a need-driven basis, to address sustainable forest management without impairing the production capacity, while at the same time meeting social and community needs, and conserving biological diversity and environmental stability (Myanmar Forest Action Plan, 1995).[100]

The preliminary work of launching the National Forestry Action Program (NFAP) started in 1995, to formulate an issues paper as a basis for the NFAP exercise, to be entirely carried out by nationals. The main aim was to explore possible funding support for the remaining

[100] Forest Department, 1995, National Forest Action Plan, Myanmar,

NFAP process, to include in-depth studies of the forestry sector, and formulation of strategies, programs projects and activities, including the strengthening of the institutions. The operation recognises that the contemporary use of a forest resource base is not sustainable. The problems have been presented in a matrix form, as a logical framework, to permit a preferred scope of the linkages between issues and national goals.

The regime also promised development assistance and initiated a Border Areas Development scheme under the Ministry of Border Areas and National Races in 1993.

The government is participating in the following on-going regional programs/ projects:

- Special teak plantation program
- Nation-wide tree planting and greening program
- Dry Zone Greening Project
- National code of forest harvesting practices
- Model forest project
- GCP/RAS/154/NET: Regional Wood Energy Development Program for Asia;
- GCP/RAS/158/NE: Support to the Reorientation Forestry Policies and Institutions of countries of Asia in Reform to a Market Economy;
- GCP/RAS/161/NET: Participatory Watershed Management Training in Asia; and
- GCP/RAS/163/NET: Forestry Research Support Program for Asia and Pacific (FORSPA)

Moreover, the Myanmar Government was a member of two recently completed regional projects. The important salient results of support from these two projects on forestry development in Myanmar are as follows:

- GCP/RAS/142/JPN: Strengthening Re-afforestation Program in Asia (STRAP). Four zonal working groups on mangrove, teak, hilly and dry zones were formed to deliberate and make recommendations on policy, problems and constraints, people's participation, technical matters, and suggest problem resolution on re-afforestation programs.
- GCP/RAS/137/JPN: Forestry Planning and Policy Assistance in Asia and the Pacific Region. This project assisted the Government in the formulation of a National Forest Policy, 1995.
- In addition to the above, as a follow up to the recommendations made at the 17th APFC meeting held in Yogyakarta, Indonesia, February 1998, particularly on the formulation of a National Forest Harvesting Code of practice, the government is in the process of preparing a draft of the code.

Myanmar has been the headquarters of TEAKNET. The STRAP project was instrumental in the formation of TEAKNET. The objective of the TEAKNET is to strengthen interaction among all those concerned with the conservation and sustainable management of teak-bearing forests and plantations through sharing of information and promoting collaborative efforts to deal with common problems.

International organisations, mainly FAO /UNDP, have supported the capacity building of the remote sensing and GIS infrastructure of the Forest Department by providing technical assistance, as well as logistics. A three-year Information System Development Project (ISDP) was implemented in 1995-96 for the management of tropical forests in Myanmar.

3.4 Current Policy Issues

3.4.1 Strategies to Deal with Deforestation and the Fuelwood Problem

Being aware of the current trend in fuelwood consumption, the Forest Department has to increase capacity in planting more trees for fuelwood. With the presently available resources, either in the form of manpower or funds, the Forest Department will not be able to satisfy the fuelwood requirements of the country entirely through establishing fuelwood plantations.

In order to solve the fuelwood shortage problem, the Forest Department has been progressively establishing fuelwood plantations: Currently over 30,000 acres (12,141 ha) are being planted for fuelwood annually, compared to 2,000 acres (810 ha) per year during the last 25 years.

It is calculated that such fuelwood plantations could produce 8-13 cubic tons per acre per year during the 12 year-rotation periods. In addition, starting in 1977-78, seedlings were distributed and efforts were made to establish fuelwood wood lots, to reduce the gap in fuelwood demand, starting with 4.5 million seedlings a year to over 11.0 millions since 1992-93.

Village-owned plantation establishments were also attempted in the 1980s, but the plantation programme has not been fully established by the local people, due to the scarcity of an extension organisation at that time. In the 1990s, the Forest Department introduced a program in which local people joined together with the staff of the Forest Department in planning and implementing fuelwood plantations. The purpose of these plantations is to supply fuelwood to the local people and to encourage more conservation measures for the sustained supply of fuelwood from such areas. The new forestry law also authorises private entrepreneurs to acquire land and establish fuelwood plantations close to urban areas, for trade purposes.

The most serious environmental degradation to be addressed by such programs is in the central dry zone, which is barren and has no forest cover. Although heavily forested in the past, heavy exploitation due to population expansion has devastated the forests. The Ministry of Forestry has, through peoples' participation, been taking the lead role lately in the reforestation program, by planting some 12 million trees annually. In addition, the Forest Department established 1.26 million acres from 1895 to 1994 (Myanmar Forestry, 1999). In view of the necessity for countrywide re-afforestation programs, the 9 districts of the Dry Zone were given a priority status. A multi-purpose, fuelwood project was implemented under UNDP in Dry Zone division. The Dry Zone is a notably difficult area for tree planting, because of the harsh conditions for tree growth. Evapo-transpiration in the dry season is higher than the total rainfall. There are two rain periods per year and the average annual temperature is around 64 °F (FAO, 1995).

The population of the Dry Zone area is about 11 million, close to one-third of the country's population, with 80 % in rural areas. Agricultural and farming are the two main occupations. The region is climatically and edaphically best suited for peas, beans and oil crops (FAO, 1995).[101]

Myanmar has several variant climate zones, ranging from the temperate region of the north to the dry zone in central Myanmar and the monsoonal belts in the northwest, west and south. Except for the dry zone area, there is sufficient rainfall in Myanmar during the rainy season, which extends from May to late October. The weather is generally dry the rest of the year. The coastal regions, the delta region and the northern part of the country have an annual rainfall of about 5000 mm. However, the annual rainfall in the central part of Myanmar is less than 600 mm. The dry zone area is especially different from the other regions in the country in terms of dryness and hot weather conditions. Although the average mean temperature is about 27° C, the temperature often rises to above 40° C, in the hot season. According to the rainfall pattern, the dry zone has an area of about 21,000 squared miles (54,390 km^2), or about 10 % of country's total area. It comprises Lower Sagaing, Mandalay and Magway Divisions. There are altogether 13 districts and 57 townships in the dry zone. In line with its policy of sustainable forest management, care has been taken not to over-exploit forest resources commercially.

[101] FAO, 1995, Strengthening Re-afforestation Program in Myanmar, Japan International Co-operation Agency, Forest Department Myanmar field document No 5

3.4.2 Strategies to Deal with Climate Change

In the framework of forest policy, strategies to deal with climate change play an important role. In Myanmar, they are closely related to the tasks of the Dry Zone Greening Department, which was entrusted with the following objectives:

1. To create green cover in the Central Dry Zone of Myanmar
2. To protect and conserve the environment as a whole, and land and water resources in particular
3. To provide the basic needs for forest products the rural people.
4. To enhance the socio-economic development of rural people on a sustainable basis
5. To raise local people's awareness of the value and beneficial effects of forest and trees
6. To enhance knowledge and promote participation of the public on environmental conservation and sustainable development
7. To improve micro-climate conditions of the environment so as to support sustainable productivity of agriculture
8. To prevent desertification

The major tasks to be implemented by the Dry Zone Greening Department have been set as follows:

- Establishment of forest plantations;
- Protection and rehabilitation of remaining natural forests;
- Initiating development and utilisation of wood fuel substitutes; and
- Water resources development

The dry zone of central Myanmar is a barren environmental area covering an area of about 8.72 million ha in 57 townships. Forest Department has been undertaking a range of measures to prevent and check the environmental degradation of the area since 1960s, but with limited success, due to an unfavourable climate and population pressure. In 1997, the government instituted a new department entitled “Dry Zone Greening Department”, in order to step up greening and rehabilitation activities, with energetic efforts for improved social and environmental stability in the entire Central Dry Zone. Myanmar acceded to the UN Convention to Combat Desertification in those countries experiencing serious drought or dersertification in

1994 and ratified the framework of Convention on Climate Change in November 1994 (Myanmar forestry, 1999).[102]

Deforestation is generally regarded as the first step along the road to desertification. Deforestation degrades the vegetation cover and makes the soil more vulnerable to erosion by subsequent over-cultivation and/or over-grazing. The productivity of agricultural land is likely to decline as a result of soil degradation. The exercise of National Forestry Master Plan (NFP) for Myanmar reflects the cultural, social, economic, ecological, and political conditions of the country. Myanmar is still in the process of developing specific mechanisms to ensure financing for combating desertification. Apart from the annual budget of NCEA, there are the annual budget allocations for various line ministries concerned with varying aspects of natural resource management and desertfication control (UNCCD report, 1999).[103]

Myanmar is now a party to several international and regional conventions and agreements relating to environment; namely,

1. Vienna Convention for the Protection of the Ozone Layer, 1985;
2. Montreal Protocol on Substances that Deplete the Ozone Layer, 1987;
3. London Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer, 1990;
4. United Nations Framework Convention on Climate Change, 1992; and
5. United Nations Convention to Combat Desertification in those Countries Experiencing serious Drought and/or Desertification, Particularly in Africa, Paris, 1994.

The Government of Myanmar signed the United Nations Framework Convention on Climate Change (UNFCCC) on the 11thJune 1992 and ratified the convention on the 25th November 1994.

Myanmar' s commitments to the UNFCCC include the following tasks.

1. Developing national inventories on sources and sinks of all greenhouse gases (GHGs);
2. Formulating implementing, and publishing national and regional programs to mitigate climate change;

[102] Ministry of Forestry, 1999, Forestry in Myanmar,

[103] UNCCD, 2000, United Nations Convention to Combat Desertification, National Report on the UNCCD implementation Union of Myanmar

3. Promoting and cooperating in the development, application, and transfer of technologies, practices, and processes that control, reduce, or prevent GHGs emissions;
4. Promoting sustainable forest management practices by conserving and enhancing sinks and reservoirs of GHGs;
5. Cooperating in the development of adaptation programs for potential impacts of climate change;
6. Taking climate change considerations into account in relevant social, economic, and environmental policies;
7. Promoting and cooperating in research and data development to help understand and reduce the potential impacts of climate change;
8. Promoting and cooperating in the exchange of technical, scientific, socioeconomic, and legal information related to the climate system and climate change;
9. Promoting and cooperating in education, training and public awareness campaigns related to climate change, and
10. Communicating information to the Conference of the Parties related to implementation of the convention' s commitments.

As mentioned above, under the ALGAS Project, Myanmar conducted its first inventory of greenhouse gases emissions.[104] Regional and local responses to land use and land cover changes vary widely, depending on available resources and on local political, social and economic conditions. Adjustment of short-term, specialised human behaviours to account for their broader long-term, ecological consequences depends, in part, on improved understanding of those consequences, but ultimately depends on politics (Holdgate, 1991) developing the institutions, management styles and policies that link individuals with their impacts on the environment (McNeely, 1997).[105]

The World Bank relates poverty to forest strategies (World Bank, 2001) and recommends the following measures in theis context:[106]

[104] http://www.ap-net.org/fccc_my/conven/index.htm
[105] McNeely, J.A., 1997, Conservation and future: trend and options toward the year 2025 IUCN biodiversity
[106] World Bank, 2001, Forest Policy Implementation Review & Strategy 2nd Technical Advisory Group Meeting report

- Promoting policy, institutional and legal frameworks to ensure rights of forest-dependent people;
- Empowering women, poor and marginalized groups to take a more active role in formulating and implementing forest policies and programs;
- Supporting the scaling up of collaborative forest management;
- Integrating forest, agro-forestry and small enterprises into rural development strategies

The World Bank report paper formulates the argument that 'market failures' are one of the main underlying causes of forest loss in developing countries. The main solution proposed by the draft strategy to these failures is the 'creation' of markets for these undervalued environmental services, such as the sequestration of 'greenhouse gases', stabilisation of microclimates, flood prevention, erosion control and biodiversity conservation (World Bank 2000).[107]

The World Bank suggests that the new forestry policy's main objective is poverty alleviation. For this to be effective, it is crucial that the new policy should include specific safeguards to secure the interests of the poor and vulnerable social sectors. The World Bank emphasizes the link between environmental capital and other types of capital. Environmental capital refers to the natural resource base, including Common Property Resources (CPRs) and its management. Coping and enabling strategies of rural households to deal with crisis situations, which draw, however, on environmental capital may include: adoption of unsustainable agricultural practices; overuse of CPRs, changes in natural resource management strategies, etc., in response to downward and upward pressures, respectively. Social and political capital refers to those social organisations, relationships and networks (family, self-help groups, charity, international organisation, government, etc.) which provide critical support in times of crisis. Coping strategies which draw on social/political capital include: making claims on relatives, neighbours, patrons, etc.; acquiring access to resources and services (public works projects, emergency aid, health, education, water,), migration in search of public relief, etc. There are both hypothetical and empirical links between deforestation, soil erosion, the flood/drought cycle and reduced soil fertility (ESCAP, 1994). There is controversy about the links between

[107] World Bank, 2000, Forest Policy Implementation Review & Strategy 2nd Technical Advisory Group Meeting report

poverty/social deprivation and processes of environmental decay; specifically, whether or not the poor actively degrade their environment in order to maintain their livelihoods (World Bank 2000).[108]

3.4.3 Public Awareness and People Participation

Forest degradation and deforestation in Myanmar reflect an interaction between forest management and the overall development of the society. As can be derived from official statements, the government is fully conscious of the importance of the people's awareness and participation in the forestry development activities, to ensure sustainable relationship between people and the forest resource base. Rural community's active participation is an essential component in the forestry development programs. Human development initiatives have, through various projects within the forestry sector, sought to uplift the rural areas and sustain the economy. Initiatives such as village resources conservation/management plans have proved to be important for preservation or containing forest degradation and deforestation. Initiatives have also been undertaken to grant forestry credits for the establishment of plantations under the community forestry rule. Under section 14 and 15 of the forest law, anybody, including villagers, can establish plantations.

3.4.4 Collective Resources Management and Co-management

Involvement of people's participation is a vital role in policy formulation and implementation with the help of NGOs for the development of stakeholders. This can ensure a rational balance between its ecological and economic roles. Forests are occupied by forest-dwelling communities, as well as by recent forest-dependent encroachers from around the forests. The vital role of forests in maintaining biodiversity values and in acting as a global carbon storage area and reforested area as a carbon sink, reducing air pollution and mitigating global warming, must be recognised (ADB, 1995).[109]

Against this background the World Bank made a commitment to encourage and assist to establish proper land use policies and rationalise user rights to publicly owned forest areas. The Bank will, prior to financing any forestry project, carry out social assessments. To promote collective resource management, analytical data on forest management are also important. The

[108] World Bank report, 2000, Some Thougt about the World Bank's new forest policy, Forest peoples programme
[109] ADB, 1995,The Bank's policy on Forestry p 5-11,

ultimate users of such analytical results should be policy- and decision-makers who (may) need scientifically rigorous and reliable information to decide how to direct land use and its change towards sustainable paths (Briassoulis, 1997).[110]

There are real limits on inference that cannot overcome without better understanding of the economic social, and political difference among groups and household and how these differences might vary in space and time. For a few of these conditions, the Famine Early Warning System (FEWS) added some caveats to the interpretation (FEWS, 1997:12):

'The ability of a household to withstand emergencies is conditioned by

(a) The depth, diversity and quality of their resource base

(b) The breath of their income portfolio

(c) Their relationship to economic social and political hierarchies (Liverman, 1998).[111]

People's participation in the protection and development of forests and the forest communities should be motivated to identify themselves with the development and protection of forests from which they derive benefits. Broadly, concepts that involve both state agencies and local communities in forestry are referred to as Joint Forest Management. Although the primary objective of JFM is to give users a stake in forest benefits and a role in planning and management for the improvement of forest conditions and productivity of forests, other objectives include supporting sustainable forest management and equitable distribution of forest products. It encourages communities to take a decisive role in forest management, based not only on the concern for the environment, but also for food security and employment. JFM, in return for the villagers' efforts to prevent forest encroachments, illicit felling, unregulated grazing, and timber extraction and poaching, provides them with several benefits. The most important aspect of these benefits-sharing arrangements is a share in the final harvest. In this respect, JFM is quite unique and has provided people with an economic incentive for conservation, in addition to giving them a stake in the success of the programme.[112]

Participation is also an aspect of human development. According to the human development report (1995), the rank of the human development of Myanmar index was 132. This report indicates that participation is taking into account three classes of variables; namely,

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[110] Briassoulis, H., 1997, Policy-Oriented Integrated Analysis of Land-Use Change: An Analysis of Data Needs

[111] Liverman, D., 1998, People and pixel: Linking RS and Social Science Commitee on the Human Dimension of global change national research council

[112] World Bank, 2000, Some Thoughts about the World Bank's new forest policy, Forest people programme report

(1) For power over economic resources based on earned income, the variable is per capita income.
(2) For access to professional opportunities and participation in economic decision-making, the variable is the share of jobs classified as professional, technical administerial, and managerial.
(3) For access to political opportunities and participation in political decision-making (UNDP, 1995).[113]

Aung Kyin (1996) points out that, in Myanmar, the management of the remaining forests and trees becomes increasingly important in the rehabilitation of degraded lands, supporting agriculture, enhancing food security, protecting water and increasing the well-being of the population. It is necessary to solve the domestic energy problem: it is one of the urgent prerequisites for the planning of the sustainable forest management. It is evident that rural poverty and ecological degradation are closely linked (Kyin, 1996).[114]

Gilmore explained that co-management is one of the operations with the local community and the government official. Illegal logging and environmental degradation have often been associated with these programs. Hence, attention has turned to developing forest co-management systems which are acceptable to local communities, sometimes drawing on systems of property rights regimes which prevailed in earlier centuries. Alienation of common property forest resources and large-scale deforestation appear to have often been associated with colonisation.

To establish successful co-management systems, local people have to trust the local administer. If they do not believe the local or regional administers, they will not be willing to participate in any natural resource conservation activities. There may be significant indirect benefits which occasionally stimulate reforestation in the public interest, such as for watershed benefits and wildlife retention. Participation in reforestation, whether privately or as part of a community collective action, can bring benefits such as increased social acceptance, respect and status. These become increasingly more difficult to quantify, and perhaps increasingly doubtful in terms of their significance to most farmers' decision-making. But they do need to be include may be decisive in specific instances (Harrison and Herbohn, 2001).[115]

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[113] UNDP, 1995, Human resource development report 1995, OXFORD p 78
[114] Kyin, A., 1996, Approach for the sustainable management of nature tropical forest in Union of Myanmar
[115] Harrison, S.R., Herbohn, J.L., 2001, Sustainable farm forestry in the tropics: social and economic analysis and policy pp 217-282

Both FD and the people have to share responsibility for the protection of remaining forest. It is up to the administrator and decision makers to decide whether they want to continue the conflictual situation between the forest department and local communities or involve the people in the task of preserving forests. The law has to be given a new orientation that will live up to the double objectives of forests being biodiversity and people's livelihood (Fernandes, 1996).[116]

3.4.5 International Co-operation

Various projects with bilateral and multilateral donors support Myanmar's forest policy. A small-scale example is a joint effort between Forest Department (FD) and the Japanese Youth NGO, called Yomiuri Shimbun. It has been implemented since 1995-96 for a four year period, during which about 450 ha of agroforestry plantations were established in the Nyaung-Oo township of the Central Dry Zone. Three projects of environmentally sustainable food security and micro-income opportunities in the critical watershed of Shan State of eastern Myanmar, the delta area of lower Myanmar, and in the dry zone of the central Myanmar are being implemented jointly by FD and UNDP/FAO. These projects as components of UNDP's Human Development Initiative Program and are designed for increased food production and income generation for the rural poor, through environmental conservation and management. The Ayeyawady delta, the central dry zone and KARAMOSIA international in the Inle region are also working with the FD in the field of community development, through environmental conservation and rehabilitation. As has been indicated above, FD has been actively participating in international conventions relevant to the biodiversity, combating desertification and trade in endanger species, and also in the forest-related events organised by UN bodies, FAO, ITTO, ASEAN and the Bangladesh-India-Myanmar-Sri Lanka-Thailand-Economic cooperation (BIMST-EC). Myanmar has been a member country of the International Centre for Integrated Mountain Development (ICIMDO) since 1992. Information exchange and dissemination, and the demonstration of conservation technologies are the major areas of cooperation between FD and ICIMOD (N. Sint, 2000).

[116] Fernandes, W., 1996, Drafting people forest bill: The forest dewller-social activist alternative, India social Institute Newdelhi, p 23-32

Chapter 4 Material and Methodology

4.1 Selection of Study Areas

Three study areas were selected to obtain deforestation pattern of three regions and these regions locate three different forest ranges. Nyaung Shwe, situated in eastern part of the Shan Division is one of the study areas. There is a famous lake located in the area, known as Inn Lay Lake, a wetland conservation region where migratory birds can be found. Most of the shifting cultivators reside in the upland region of that lake. Paukkaung is located in the middle part of the country. Teak-bearing forest types can be found in that township. South Mindon is situated on the western part of the region. Dry upper mixed deciduous forest is located in that township. There is considerable area of public forests cover in that region.

Nyaung Shew, Paukkaung and South Mindon are townships in the eastern, central and western part of Myanmar, respectively. Nyaung Shew township is situated in the eastern part of the country between East 97° 02′and North 20° 10′. Paukkaung township is located between East 95° 5′ and North 18° 40′. South Mindon township is situated on the western part of Myanmar between East 91° 3′ and North 19° 38′. Figure 4.1 provides a land use map of Myanmar in 1989 and shows the location of study areas.

4.2 Data collection

4.2.1 Satellite images

In order to get information about the land-use change in the study sites, natural resources information from satellite images was acquired from Michigan University's (USA) Tropical Rain Forest Information Center (TRFIC) and the Forestry Department of Myanmar. Land Sat TM satellite images (Path 134 Row 47, Path 132 Row 46 and Path 133 Row 47) of two different years (1989 and 2000) were investigated for the study sites. This study uses Remote Sensing (RS) to acquire vegetation index maps.

Some of the satellite images are provided by Forestry Department of Myanmar. Landsat TM and ETM CD were analysed with Environmental Visualized Interpretation software from the computer section of the Forestry Department. The satellite image data resolution is 30 m x 30 m. Satellite images archive information was obtained from the internet web site at www. bsrsi.msu.edu.

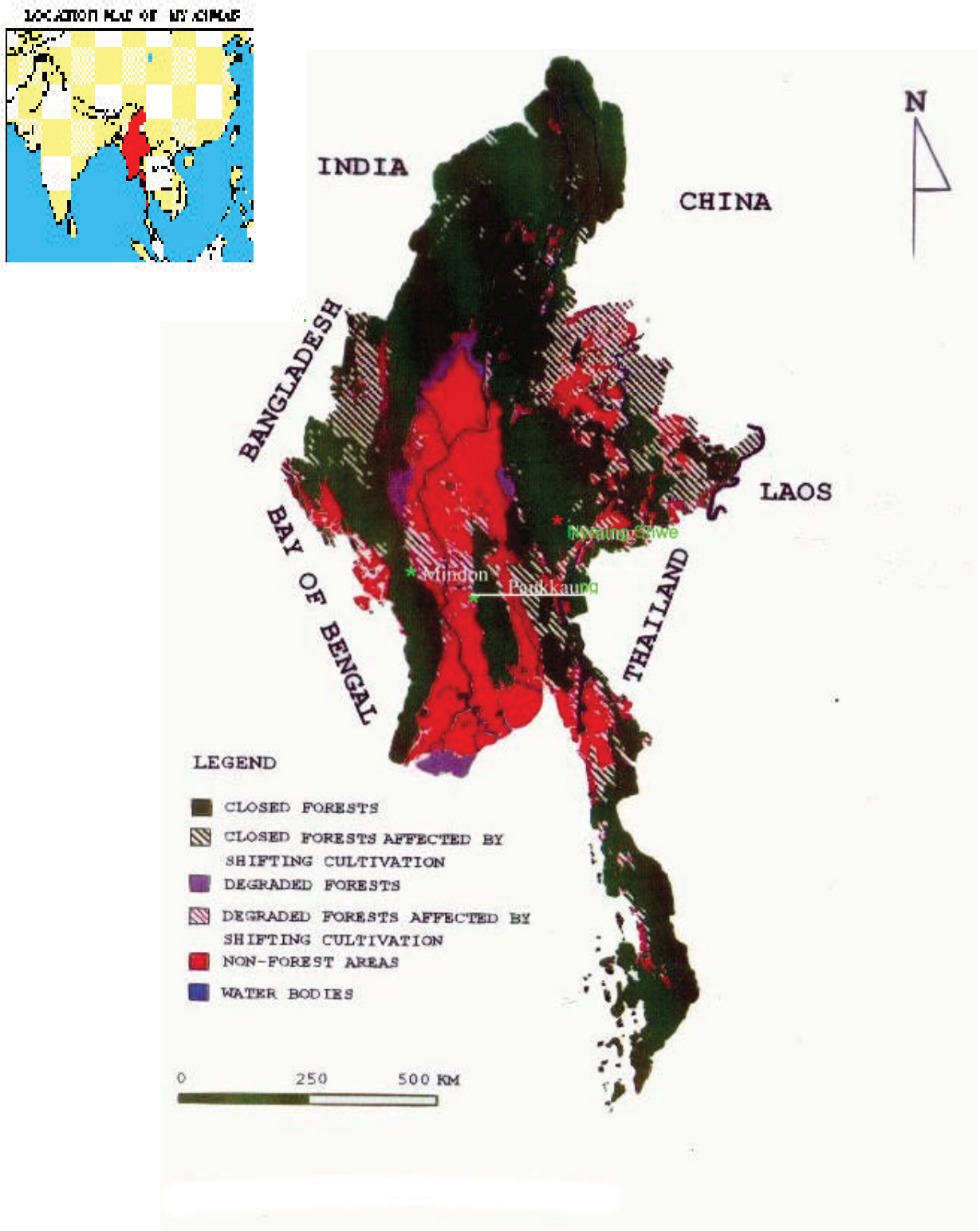

Figure (4.1) Land use map 1989 and the location of study areas

Source: Forest Department Myanmar, 1999

4.2.2 Village survey

To get further information on land use change in the three locations in Myanmar under consideration, the eastern, western and middle upland regions of the country, a survey focussing on socio-economic data was conducted in a random sample of 86 villages. Group discussion and communal level interviews with the village leaders and elder village people were conducted to obtain recall data. Questionnaires were compiled for the village level interviews. Village survey questions related to the following: population, migration, land use, small tractor and pumps used in the villages, crop yields, lowland cultivation, paddy cultivation, upland cultivation especially shifting cultivation, productivity of the cultivated crops, home gardening, land expansion, land holding areas, forest rules, forest rule offenders, fertiliser usage, cultivation methods, agricultural input, soil erosion condition, participation measure in soil improvement, crop market price, land holding by the local people, land records, land fencing, land law, land price, crop prices, accessibility of roads, welfare situation and infrastructure development of the villages.

4.3 Data analysis

4.3.1 Analysis of land cover change by using the Normalized Difference Vegetation Index (NDVI)

The net photosynthesis is directly related to the amount of photosynthetically active radiation that plants absorb. The more visible sunlight (during the growing season) a plant is absorbing, the more it is photosynthesizing and the more productive it is. Conversely, the less sunlight the plant absorbs, the less it is photosynthesizing, and the less productive it is. Either scenario results in NDVI value that, over time, can be averaged to establish the "normal" growing conditions for the vegetation in a given region for a given time of the year. In short, a region's absorption and reflection of photosynthetically active radiation over a given period of time can be used to characterize the health of the vegetation there, relative to the norm. In most climates, vegetation growth is limited by water, so the relative density of vegetation is a good indicator of agricultural drought. Comparing this month's or this year's NDVI data with the 20-year average reveals whether the productivity in a given region is typical, or whether the plant growth is significantly more or less productive.[117]

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[117]http://earthobservatory.nasa.gov:81/Library/MeasuringVegetation/measuring_vegetation_2.html

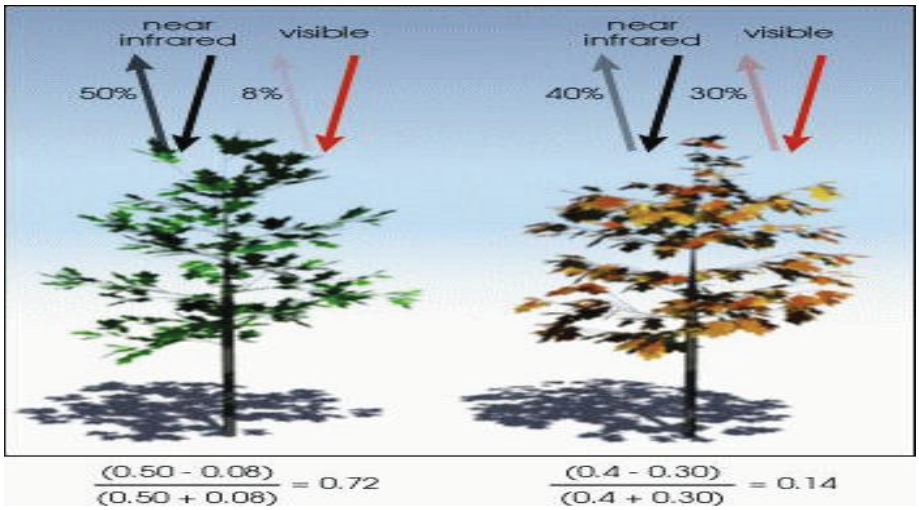

Figure (4.2) Normalized Different Vegetation Index (NDVI) value situation of two stages
Source:http://earthobservatory.nasa.gov/Library/MeasuringVegetation/measuring_vegetation_2.htm

The following equation is the approximate net photosynthetic production (PN) of the whole forest canopy per m^2 ground area over a day:

$$PN = A \times d \times LAI$$

Where A = average rate of photosynthesis (gC m^{-2} leaf area hr^{-1}) for all leaves in the canopy, d = day length (hr), and LAI is the leaf area index estimated for each pixel (English et al., 1994). Net photosynthetic production can be estimated each LAI classes by using this relationship. LAI is roughly ten times NDVI.

NDVI is calculated from the visible red and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared radiation. Damaging or sparse vegetation (right) reflects more visible radiation and less near-infrared radiation as shown figure (4.2). The numbers on the figure above are representative of actual values, but real vegetation is much more varied (Illustration by Robert Simmon).

Nearly all satellite vegetation indices employ this difference formula to quantify the density of plant growth on the earth near-infrared radiation minus visible red divided by near-infrared radiation plus visible red radiation. The result of this formula is called the Normalized Difference Vegetation Index (NDVI).

NDVI = (near-infrared - visible red)/(near-infrared + visible red)

Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves give a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green

leaves. The signal formed as the combination of two channels (visible red and near IR) can work serve particularly effectively for the description of land vegetation (Kogan, 1995 and Dason and Plummer, 1995).[118]

NDVI-related vegetation index were applied extensively to compute vegetation amount on a world basis. Foreign countries routinely use average NDVI information to assess crop over vast region. Maximum 10 days NDVI images are corrected for cloud cover and used to provide crop forecasts. Multi-year NDVI images are used to monitor vegetation (Jensen, 1996)

The NDVI and other vegetation indexes have been used extensively to monitor natural vegetation and crop conditions, identify deforestation in the tropic, and monitoring areas undergoing desertification and draught. Vegetation absorbs much of the incident blue, green and red radiant flux for photosynthetic functions; therefore, vegetated areas appear dark in TM band 1 (blue), 2(green), and 3 (red) images. Vegetation reflects approximately half of the incident near-infrared radiant flux, causing it to appear bright in the band 4 (near-infrared). Band 3 is the red chlorophyll absorption band of healthy green vegetation discrimination. Band 4 is especially responsive to the amount of vegetation biomass present in a scene. It is useful for crop identification and emphasises soil-crop and land-water contrasts (Jensen, 1996).

Afforestation programs need to be planed where NDVI has a low level regions by using normalised different vegetation index NDVI map. Changes in forest cover could be investigated at two different times creating those maps. Those maps indicated changes in NDVI values, green cover level.

4.3.2 Satellite Data Analysis

There are 7 bands in the satellite images namely: band 1 to band 7. The important bands are band 3 and 4, in order to obtain the Normalized Different Vegetation Index (NDVI) maps, which indicate the spectral vegetation reflectance. Analyses of the remote sensing data were conducted using Remote Sensing RS and Geographic Information System (GIS) earth view 3.1 software. The NDVI was employed to investigate the density level of the study areas for the vegetation cover. Geometric rectification, image to map was carried out GCP (Ground Control Points) before processing images in Forest Department in Myanmar. First level geometric correction was done using standard parameters from data producer at Forest Department RS

[118] Sharkov, E.A., 1998, Remote sensing of tropical region, Chichester [u.a.]: Wiley, Wiley-Praxis series p 178

and GIS sections. Images were roughly corrected into Latitude and Longitude (Lat/Long). Second level geometric correction was done using 1:50,000 topographic maps.

Ground control points were located on the reference maps (topographic maps), which must match up with the points on image data, perform the process of rectified image to maps. The selection of GCPs requires permanent attributes, such as rivers or road intersections. Map projecting was done with Lambert Conformal Conic, India Grid System Zone III B and unit in yard to match the topographic maps of Myanmar. Using control points served to rectify the images. 15 GCP points were located in geometric correction. Using control points rectifies the images.

Procedures of registration image to a map are as follow:

1. Perform a theoretical analysis of possible error, in order to get appropriate form of transformation.
2. Locate corresponding GCP points in the reference map and image (pixel/line) coordinate systems.
3. Formulate a mathematical transformation for the image based on the georeferencing information.
4. Implement the transformation and subsequently resample the image data to match the new projection/georeferencing (Franklin, 2001).

South Mindon' images were carried out with image to image retification. After getting the rectified images, NDVI maps were created.

There are three operations in mapping: (1) The definition of hierarchical set of classes, (2) Assignment of each individual to a class, (3) Placement of the classified individual in its correct geographic position (Franklin, 2001). Image classification was carried out by separating data into groups with clustering, classify data into group, and use cluster to define signature or use cluster as classes. Classes were searched natural grouping of the properties of pixels, as examined in multispectral for similar pixels. An unsupervised ISODATA clustering and Principle Component Analysis (PCA) techniques were also employed to classify the image assigning 5 classes for South Mindon so that possible land use types were obtained. The color image products were used as an ancillary tool for visual interpretation. The classes were demarcated on transparency overlays and a class code was added. These interpretation products have been used as an input for digitizing and final map production (T.Haeusler, 1991). Hard copies of the study area image maps were printed out. Then, the training stage was used to identify representative attributes of each type of land cover. Nyaung Shwe and Paukkaung land

use maps and land use data were acquired from UNDP watershed project and model forest project RS and GIS section Forest Department in Myanmar.

First-produced false color composite RGB, 4,5,3 study area images and then visual interpretation of the single image were applied to acquire land cover maps. Theoretically, the vegetation index can vary from -1 to + 1, but the actual rate from –0.1 to 0.6 is closely related to vegetation. A higher vegetation index represents denser vegetation. The value range of NDVI absolute is (-1 to +1) and the value range of NDVI relative is between 1 and 255.

As indicated above, healthy absorbs visible light, especially red light, and reflects near infrared light. Health green vegetation reflects 40 to 50 percent of the incident NIR energy (0.7 to 1.1 ìm), with the chlorophyll in the plant absorbing approximately 80 to 90 percent of the incident energy in the visible (Jensen, 1996).[119]

Table (4.1) Normalized Difference Vegetation Index (NDVI) classes

No	NDVI absolute	Classes name
1	< 0.05	Non vegetated area
2	0.05-0.10	Very spare vegetation
3	0.01-0.15	Spare vegetation
4	0.15-0.20	Low density
5	0.20-0.25	Low to middle density
6	0.25-0.30	Middle density
7	0.30-0.35	Middle to high density
8	0.35-0.40	High density
9	0.40-0.50	Very high density
10	0.50-0.55	Very high density low chlorophyll activities
11	0.55-0.6	Very high density low to middle chlorophyll activities
12	0.6>	Very high density high chlorophyll activities

Source: Yana Juhana (2001)

Table (4.1) shows Normalized Difference Vegetation Index (NDVI) classes of Indonesia. Normalized Difference Vegetation Index of Myanmar may be changed list in that

[119] Juhana, Y., 2001, A comparison study of forest degradation, fragmentation and deforestation, and estimated by using satellite image data through visual interpretation and digital image classification, 25 p

table. On the basis of the satellite interpretation, the deforestation situation of the three areas was investigated; To identify the villages, where forests were seriously degraded, the Normalized Difference Vegetation Index (NDVI) was analyzed. It can be considered to be a useful tool for implementing land use planning.

4.3.3 Socio-economic Data Analysis

Social economic data were analysed by using SPSS, in order to obtain results linked to the social and deforestation situations of the study areas. After getting socio-economic data of 86 villages, regression results relating to deforestation and shifting cultivators were calculated by using the SPSS statistical social software package.

Technological change, crop prices, local market access population, rice yield change and time to the nearest road have effects on deforestation. Deforestation percentage was used as the dependent variable. It was calculated from the NDVI results index. Based on the theoretical considerations in Chapter 2, the following independent variables were chosen for the deforestation model to indicate the driving forces such as technology and market access and the conditions upon which they act: population density, small tractors, pumps used in the villages, pigeon pea price changes, time to road, shifting cultivation area changes, pea edible oil price and rice yield change. In a second equation, shifting cultivators were considered as the dependent variable, and acreage per landholder, change in the fertilizer price, aid organizations, wealth levels, low land and upland cultivation were hypothesized to have an effect on the increase in shifting cultivators, and subsequently on deforestation. Land distribution, paddy field expansion, paddy field acreage, crop land expansion (upland and lowland) and television ownership (as an indicator of wealth level) were also considered as influencing factors.

4.4 Profile of the study areas

4.4.1 Nyaung Shwe

Inlay was chosen not only because of its serious watershed degradation problem, but also because of its importance in the national interest as a well-known tourist attraction in the country. The problem of sedimentation of the lake due to the erosion of the watersheds has reached an unmanageable in scale, which would eventually affect Lawpita hydro-electricity generation, if timely actions are not effectively taken to address the problems. Inlay lake is situated in the Nyaung Shew township, which was formerly in the Southern Shan Forest Division. Transport to and from Nyaung Shwe poses no problems, as it is reachable by road

and air and there is a good communication and road network as well as water transport. It also has a tremendous importance as one of the largest wetlands and for its cultural importance, with a unique way of life of the people living in the Inn (lake) and because of its historical backdrop.

The lake and the region around it is plagued with acute problems of erosion and sedimentation, resulting from the absence of tree cover due to shifting cultivation. Many water-catchment areas have become practically entirely denuded (MYA/81/003).[120] Out of the total area, 16.55 % is under reserved forest cover, but this status is doubtful due to the large degree of denudation. A total area of 23 % is under the public forests with no stringent legal control. Cultivated lands nearby including shifting and permanent taungyas account for 28 % and a combination of the public forests and cultivated areas amount to 33 %. All of these have compounded the erosion problems (FAO, 1993).

They have little alternatives to this practice. There is one essential difference between the shifting cultivation they practice and the ones practiced elsewhere: They are not practicing the nomadic type moving around every year so as to cut the forest anew (FAO, 1993). A good network of roads to serve the villages in the West is still lacking. In addition to the permanent roads, fair-weather roads and cart-tracks, there are many foot-paths. Though lacking in permanent roads, one can say that they have a fair network of semi-permanent transport systems. It is envisaged that a good networking system would be highly beneficial to the local economy and markets, and therefore would greatly contribute to regional development (UNDP/FAO, 1993).

4.4.2 Floating islands, shifting cultivation and nature conservation in Nyaung Shwe

Nyaung Shwe is a tourist attraction, and migratory birds can be found in big lake called Inlay. The extent of Inlay Lake is 9.5 miles from north to south and 3.5 miles from east to west, and its open area of water is about 23.42 sq. miles, the lateral zone about 28.12 sq. miles and the floating islands were about 27.96 sq miles in 1996. The Lake is very shallow and the deepest point at present does not exceed 18 feet. It is clear that the area of the lakeside is particularly dependent on the shifting cultivators of the upland region of that remote area. Due to the sedimentation rate being very high, the lake's area has become narrower than before (Myint, 1996).

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[120] FAO, 1993, Socioeconomic study of Inlay lake watershed project report

The floating islands are linked to shifting cultivation in that region. Soil erosion affects that lake, because local landless poor are practising shifting cultivation, especially in the northern part of that area. Sedimented soil particles composed of Graminae and Cperaceae, *Phragmites karka* (kyu-phyu) and *Phragmites communies* (kyu-ni), three Cyperaceae, *Cyperus digitatus* can be found and become floating lands, where migratory birds can be found. Now, the floating islands occupy 27.96 sq miles of the lake where there is no soil on the islands. To meet the nature conservation objectives, it is essential to maintain the natural floating islands for supporting the habitats of the bird species. Most of the local people used to apply floating land for cultivation (water garden). The thickness of the submerged portion is about 4-5 feet in depth and is composed of running stems, roots, rhizomes and numerous, hair-like adventitious roots tightly interwoven as a thick compact mass, which serves as a mattress for the water garden. When *Colocacia antiquorum* (Pein Yar) emerges, this indicates that the floating island is no longer in use, because the roots and rhizomes of *Colocacia* destroy the compact mass of the mattress, which leads to the destruction of buoyancy and consequently no more cultivation can be implemented on it (Myint, 1996).[121]

In recognition of the importance of conserving wetlands for humans and nature, many countries are working towards the sensible use of wetlands and increasing numbers are joining the Convention on Wetlands (Ramsar, Iran, 1971). Within Asia, two major flyways are recognised for Anatidae. They are the Central – South Asian Flyway and the East Asian Flyway. In dealing with migratory species such as most Anatidae, effective conservation programs can greatly benefit from internationally co-ordinated initiatives (Miyabayashi and Mundkur, 1999).[122]

Table 4.2 List of the migratory species in East Asian Flyway

Species and sub species	Regions	Population estimate trend
Anser indicus	S Asia-Myanmar	16,800-18,900
Cairina scutulata	India-Myanmar	170

Source: Yoshihiko Miyabayashi and Taej Mundkur, 1999

[121]Myint, K.W., 1996, 'Study on the Formation of the floating Island of the Inlay Lake from the Botanical point of View' Forestry Science Research papers, 9/ 95-96 p2

[122] Miyabayashi, Y and Mundkur, T., 1999, Atlas of Key Sites for Anatidae in the East Asian Flyway Wet land international

Table 4.2 lists the names of migratory bird populations estimated in the East Asian flyway, and Table 4.2 shows the endangered migratory birds in the East Asian Flyway.[123] In particular, water birds' habitats are located on natural floating islands in Inlay Lake. As a result of the establishment of the floating cultivation lands by the local people, migratory birds are likely to disappear.

Table 4.3 Endangered species in East Asian Flyway

English Name	Species name	IUCN 1996	Green 1996
Indonesian white –winged duck	*cairina scutulata scutulata*	Endangered	Endangered
Indo-Malaysian white-winged duck	*cairina scutulata leucopterus*	Endangered	Endangered

Source: Yoshihiko Miyabayashi and Taej Mundkur, 1999

4.4.3 Mindon

Mindon township is located in the western part of the Myanmar. There is a lack of transportation infrastructure, due to the lack of a highway road since 1988. This may have contributed to resource conservation, because natural resources are often seriously threatened by the illegal loggers and shifting cultivators. In general, people who are residing in the northern part of that town are poorer than those in southern part of that township.

The natural forest area is 40 percent in that township. Common forestland (unclassified forests) cover is 49 percent. In public forestland, teak trees can be found in good condition. There are nine reserved forests (196535 acres) and two protective public forests (56550 acres). Commercial plantations were established over 15,966 acres from 1967 to 2000.[124] The Forest Resource Environment Development and Conservation Association (FREDA) has been engaged in a wide range of activities, like a socio-economic survey for rural community development, planning and demonstrations for community participation in reforestation and forest conservation. FREDA is a non-political, non- profit and non-governmental organisation in the forestry sector of Myanmar. Its primary objective is to promote and participate in all forms of activities related to sustainable forest management, natural environment conservation,

[123] Miyabayashi, Y., and Mundkur, T., 1999, Atlas of Key Sites for Anatidae in the East Asian Flyway Wet land international

[124] see in detail report, 2001, Forest Department of Mindon township p 1-5, Although plantations data are list in the report, some of the them were destroyed by the local people due to the encroachment of the shifting cultivators.

wildlife protection, reforestation and community development at the grass roots level. It is recognised both nationally and internationally.

The objectives include reforestation of barren slopes and the introduction of appropriate agro-forestry technology, including growing leguminous trees and fruits trees, together with the provision of short-term cash, on gentle slopes. A series of formal and informal meetings with the farmers and leaders of the target villages were sponsored by FREDA and JOFCA, at the initial stage, as well as in the process of implementation. Awareness was increased and farmers were stimulated to participate in the project. Many expressed aspirations for improving their land-use activities, the formation of community forests and the improvement of infrastructure, like up-grading their village roads and water supply system under the project.

A participatory approach was therefore achieved and a three years project was operated from 1999 to 2001 in Mindon. It is expected that increased productivity would lead to the sustainable development of the rural communities and the practice of shifting cultivation would be reduced in the target areas of the regions. A similar program was also implemented in the Kalaw township by FREDA, to promote the establishment of orange orchards and to supply clean water for income generation and the alleviation of poverty. The program was supported by German funding.

4.4.4 Paukkaung

According to the land use categories of the Paukkaung township, 38 percent is covered by reserved forests. The percentage of public forest areas is 9 percent (FD report, 2001). There are two dams known as North and South Nawin. Hence, this township has a very vital role in maintaining forests in the catchment area. These two dams supply water for the agricultural development of the low-land areas. The whole township, with more than 80 percent of its population being rural, has traditionally been dependent on forest resources for daily needs and for the business as well. Teak trees have become very rare when compared with the past girdling of teak (marking for extraction teak) record. Girdled trees have declined over time. According to the logging record, over-logging exceeded the actual sustainable yield.[125] The North Nawin Dam was constructed in the 1970s and South Nawin dam was constructed in the late 1980s. Villages, located at those constructed dam sites, have been moved to other sites and have lost their cultivation lands where these were occupied by the dam water. They resettled in

[125] Forest Department, 2002, Paukkaung model forest, Forest Department's reports p 3

nearby upland catchment areas and practiced shifting cultivation, due to landlessness. Due to the government agricultural development policy, shifting cultivators have been increased and have resided even in the reserved forest. That is why forest resources are being depleted, and soil and water erosion has occurred. On the other hand, over-exploitation of logs has an impact on sedimentation increase in the reservoir.

In 1997, the Forestry Department took actions against forest offenders. There were 197 cases, of which the majority were related to encroachment of shifting cultivation. Among these offences, 15 offences were connected with the illegal logging of teak. It is difficult to control and check the trafficking of illegal timber, because of corruption problems and inadequate facilities.

One post-UNCED initiative was the Canadian–sponsored International Model Forest Network (IMFN), established in 1994 to foster cooperation and collaboration in the advance of Sustainable Forest Management, through a world-wide network of landscape-level working model forests (Johnson). In the Paukkaung model forest, the main problem is encroachment into the forest and landlessness, due to dam construction, as indicated above. The model forest management system is based on a community participatory approach. A strong and functional partnership among government agencies, local communities and local administrative bodies should be established. Mechanisms for the development of forestland allocation, ownership of forest products, incentive provision, in-kind and technology support, extensive services, empowerment and equitable sharing of benefits are envisaged to promote an effective participation.

Chapter 5 Land use change

5.1 Land use change in study areas

As indicated in Chapter 4, satellite images were analysed using the Normalised Difference Vegetation Index (NDVI). The Nyaung Shwe satellite image was from the 18th of January 1995; the path and row are 132 /46. The second images were acquired on the 12th of April 2000. The Paukkaung township satellite images were acquired on the 30th of March 1996; path and row are 133/47. A further image was acquired, dated 6th of March 2001. The South Mindon township satellite image was acquired on the 2nd of August 1989; path and row are 134/47. The second image was from the 2nd of July in 2000.

Investigations were made in three forest ranges; namely, Shan range (Nyaung Shwe township), Pago range (Paukkaung township) and western range (South Mindon township). Normalised Different Vegetation Index maps were obtained by using empirical satellite images of those townships, as outlined in Chapter 4.

From the analysis of forest cover change, the forest area declined from 3.7 % to 2.8 % during the period from 1995 to 2000 in Nyaung Shwe. The degraded forest area has increased from 18 % to 22% during that period. Agricultural land area occupied 29 % in 1995. That area increased to 41 % in 2000.

In Paukkaung, forest cover declined from 44% to 31% in the period from 1996 to 2001. The degraded forest area of that township decreased from 4.5 % to 1.2 % during that period. The agricultural area has undergone a change from15 % to 30 % in the period from 1996 to 2001.

In South Mindon, the forest area decreased from 35% to 30% in the years between 1989 and 2000. The degraded forest area increased from 15% to 22% during that period. The agricultural area has changed from 44.5 % to 45 % from 1989 to 2000.

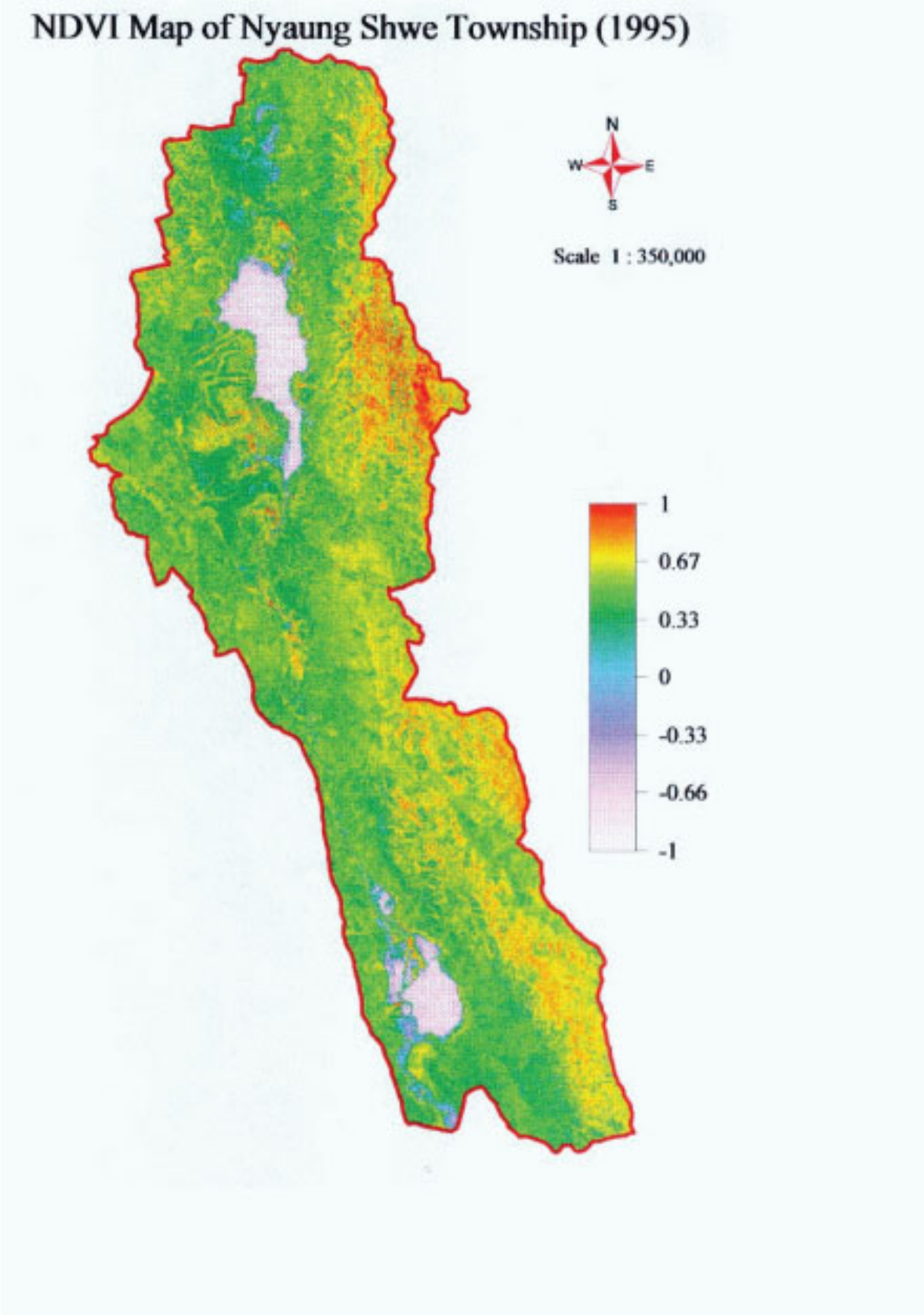

Figure (5.1) Nyaung Shwe NDVI result map (1995) acquired date 18-1-1995, Path/Row: 132/46

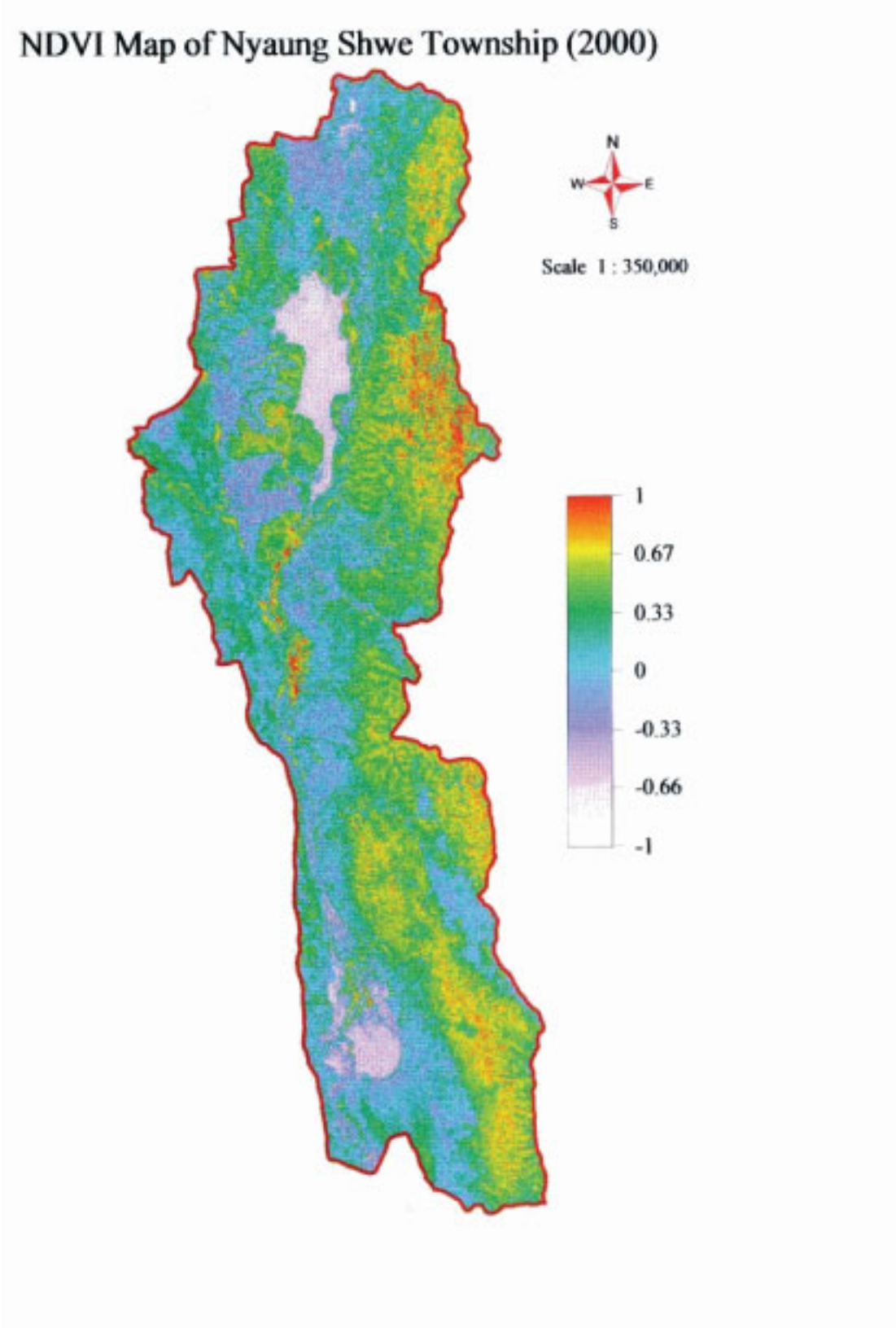

Figure (5.2) NDVI map of Nyaung Shew (2000) date acquired 12-4-2000, Path/Row: 132/46

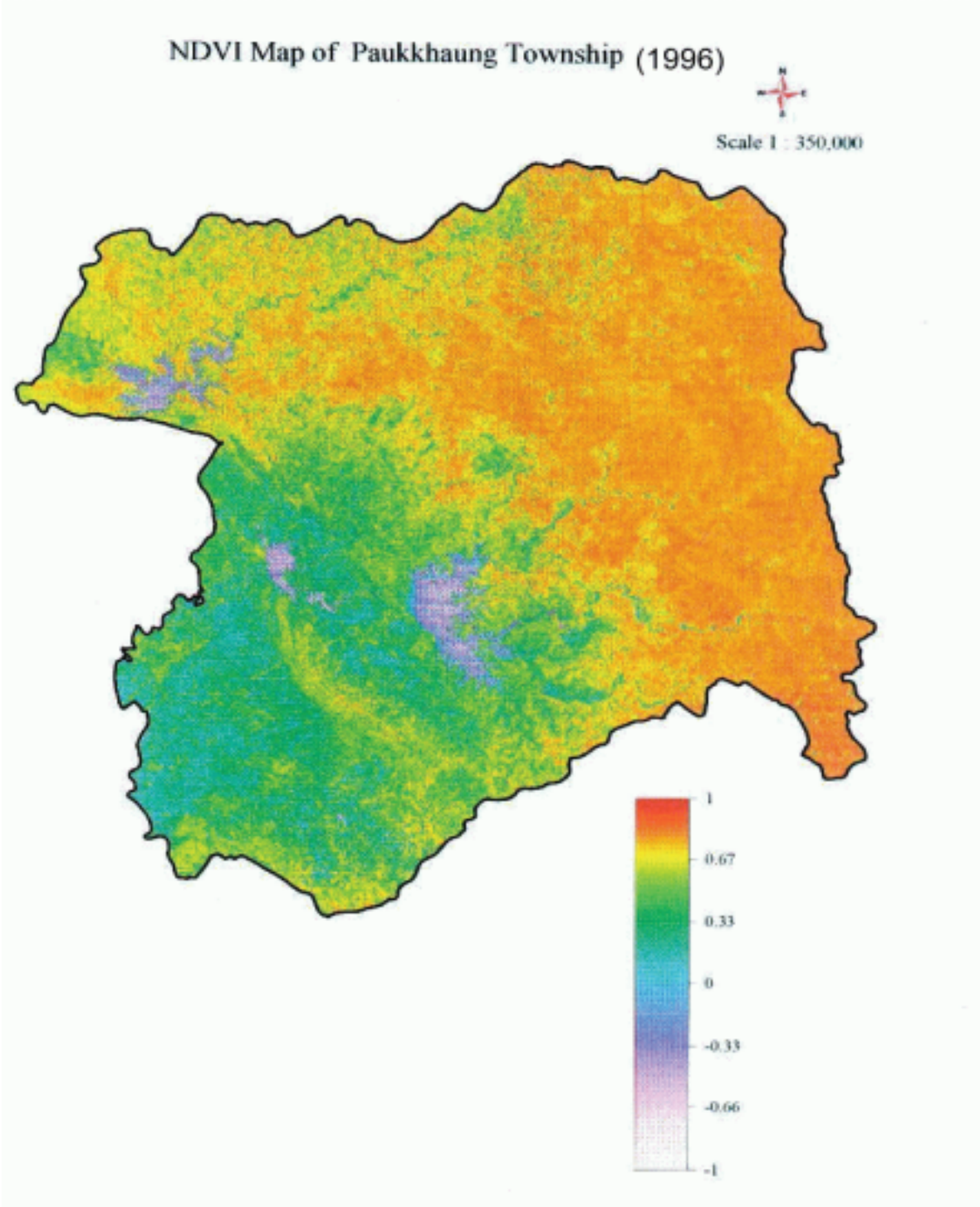

Figure (5.3) Paukkaung NDVI result map (1996) acquired date 30.3. 1996, Path/ Row: 133/_47

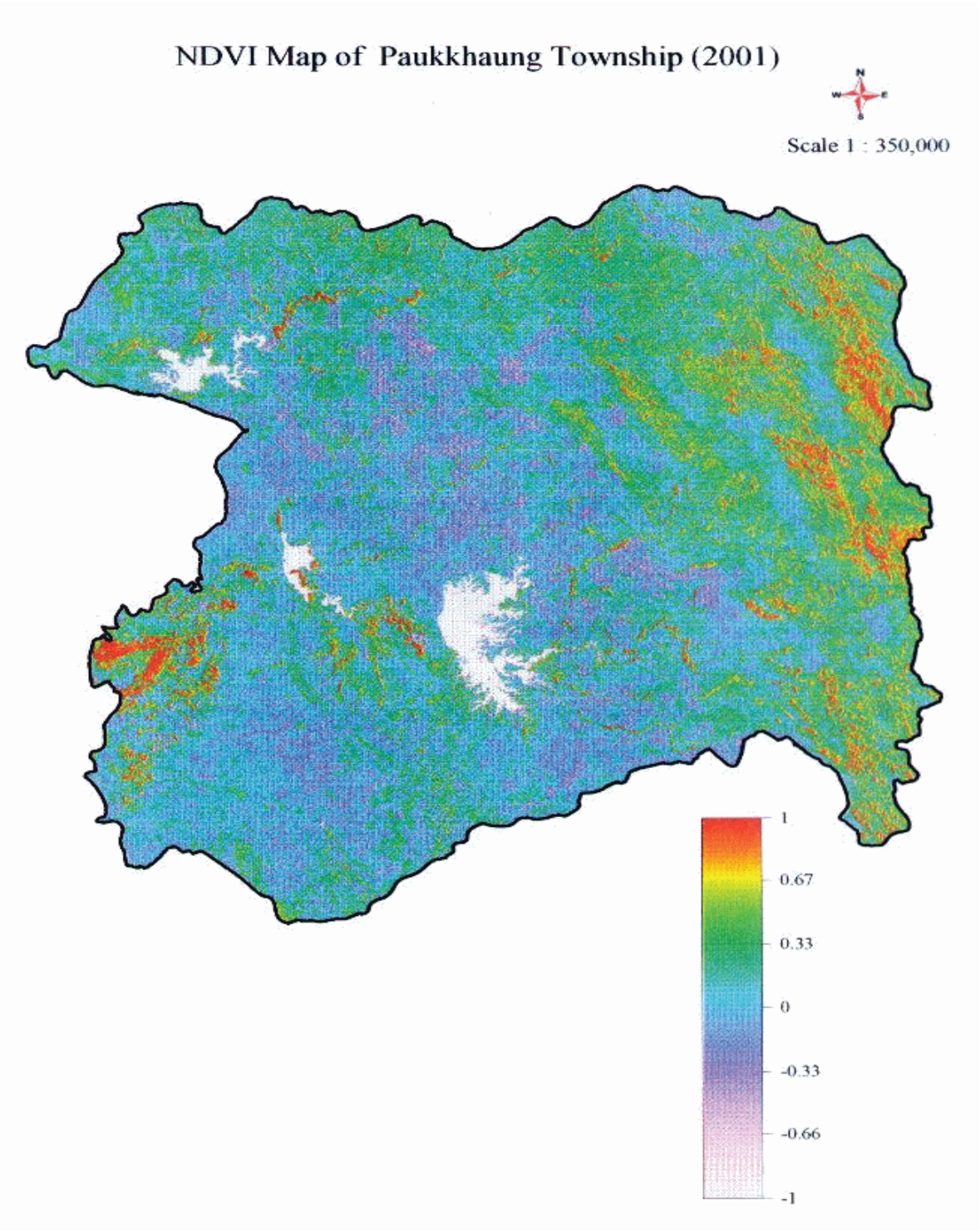

Figure (5.4) Paukkaung NDVI result map (2001) acquired date 6.3. 2001, Path/Row: 133/_47

5.2 Vegetation changes in the study areas

Figures (5.1) and (5.2) show the NDVI results of the Nyaung Shwe township. The northern part of that township is seriously degraded as indicated by an index level - 0.33 in the 2000 NDVI map. In 1995, the NDVI value was approximately 0.33 to 0.67. Green cover can be found in northern parts of the region. This shows that the forest cover was in a good condition. Index level changes depend on the shifting cultivators who reside near forested lands. Normally, those who live in northern parts of region are poor and practise shifting cultivation. In the 2000 NDVI map, the green cover index level indicates zero in the northern parts of region. This means that green cover decreased in that region. The NDVI index showed minus values in some regions, indicating that there was no green cover vegetation in those regions. Northern part of the Lake indicates below zero and Eastern region shows plus value. Yellow to red colours indicate good conditions of vegetation at two time periods.

Figure (5.3) shows the NDVI change of the Paukkaung Township based on 1996. Figure 5.4 displays the results of the NDVI index for Paukkaung 2001. The result of the 1996 NDVI value for the eastern part of that township shows an index of more than 0.67. The index level changed significantly compared to that of the 1996 map. Thus, the forest cover situation was good at that time. In contrast to the value of the 2001 result, it indicates a level of 0.33. Forest degradation occurred in the middle and especially in the eastern part of that township, having an index value of less than zero in 2001. There was a high density index level for the eastern part of that township in 1996.

Reserved forest cover is 38.6 % and public forest cover 9.5 % in the Paukkaung township. There are 52 village tracts composed of 207 villages in Paukkaunk. The total population was 108,732 in 1998. There are 14 villages where minority ethnic Karen nationalities practise their traditional land use system. Due to their long-term residence and traditional knowledge, their land use system is considered to be in harmony with the environment. The rural population of that township is mainly based on the agriculture. Paddy cultivation in the rainy season and cultivation of beans and pulses in winter months are common there. Sugarcane and rubber trees used to be planted on public forestland.

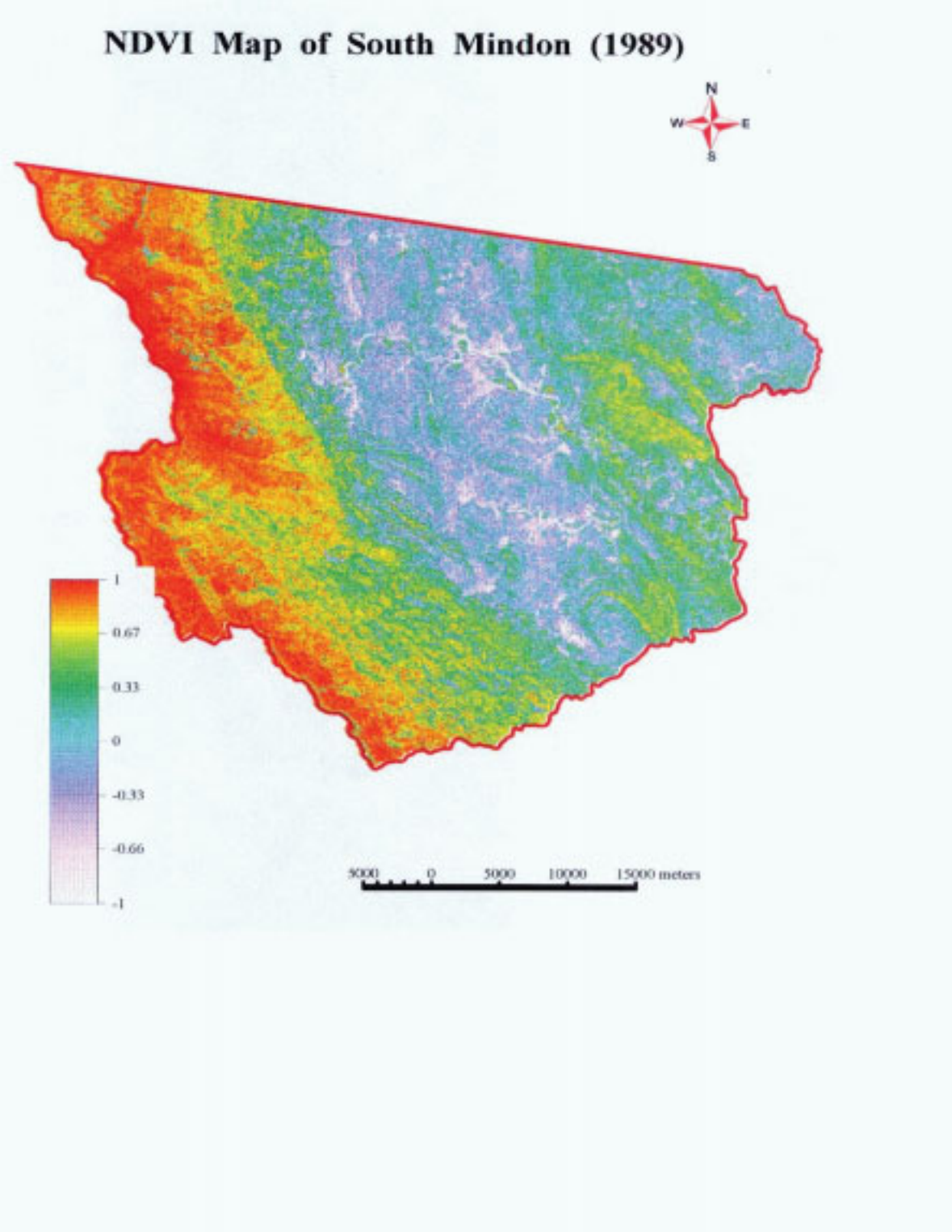

Figure (5.5) South Mindon NDVI result map (1989) date acquired 2-8-1989Path/Row: 134/_47

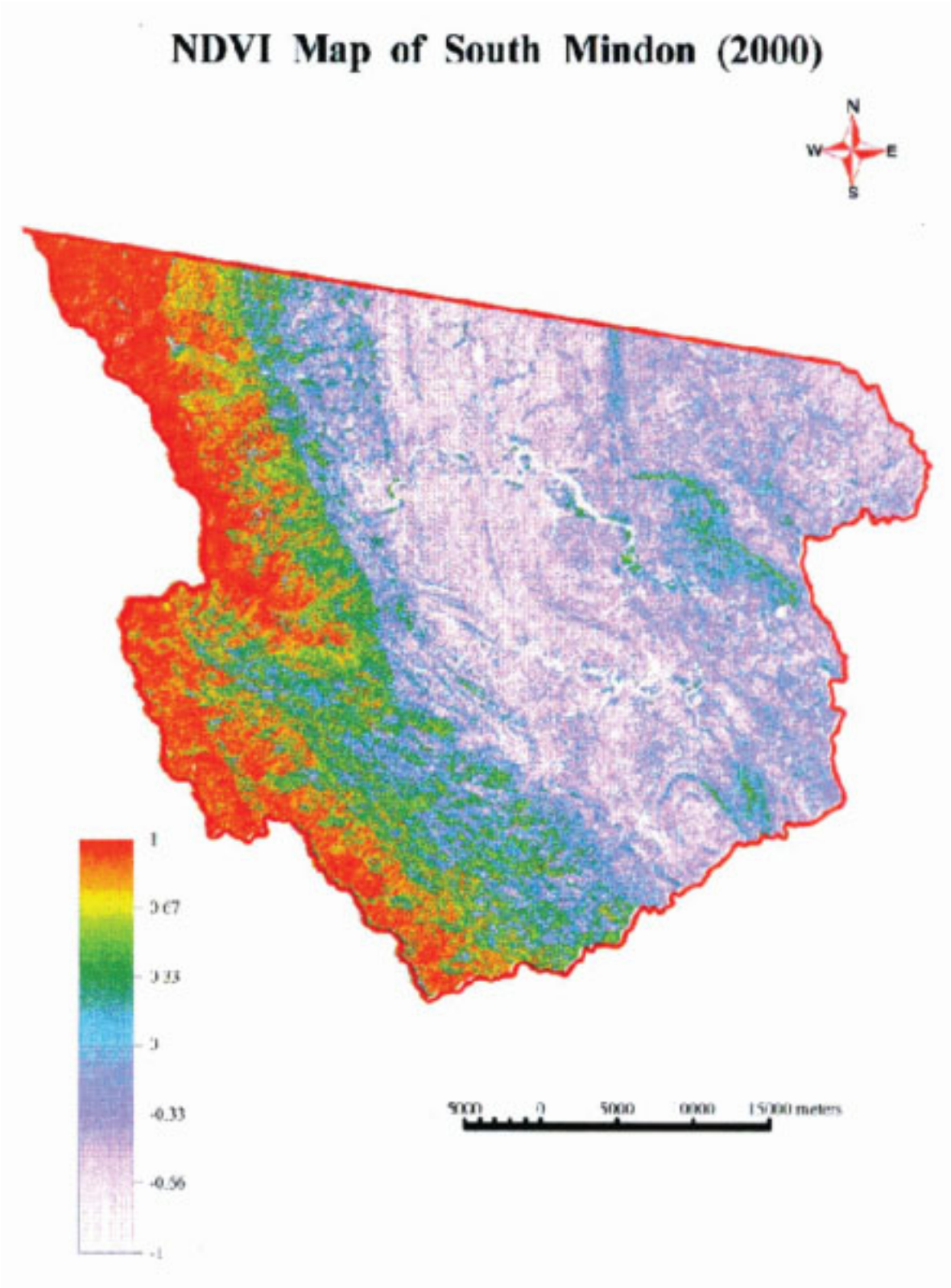

Figure 5.6 South Mindon NDVI result map (2000) date acquired 2-7-2000 Path/Row: 134/_47

Figures (5.5) and (5.6) indicate that the vegetation cover changed in South Mindon between 1989 and 2000. The NDVI index result did not significantly change in the western part of the region in both 1989 and 2000. However, the result of the eastern part of township shows an index of – 0.33 in 2000. The NDVI 2000 in the South Mindon map indicates that the eastern part of the region produced a value close to zero compared to the map of 1989, as shown in Figure 5.6.There was no vegetation in the eastern part in 2000. In that region, common forestlands show rising depletion, due to the local people practising shifting cultivation. Deforestation has progressed at a high rate. The process of the agricultural conversion inevitably engendered deforestation. Fundamental causes of forest resource degradation are specific shifting cultivation and indiscriminate trees-cutting firewood and timber harvesting. Deforestation and non-sustainable extraction can occur when the rate of wood products harvest exceeds forest growth (Postel and Ryan, 1991).

Table (5.1) Forest cover loss in three regions

Region	Period	Loss of forest area (ha)	Deforestation rate
Nyaung Shwe	1995 to 2000	1263	0.746
Paunkaung	1996 to 2001	23808	0.683
South Mindon	1989 to 2000	8521	0.872
		Average	0.767

Source: calculation of three study areas' land use maps

The rate of deforestation was calculated with the formula proposed by Dirzo and Garci´a (1992): $r = 1 - [1 - (TA_b - TA_e / TA_b)]^{1/t}$, where TA_b and TA_e are total forested area at the beginning and end of the period being evaluated, and t is the number of years within the period. Deforestation rates for the three regions are given in the table (5.1). The rate of deforestation in South Mindon is higher than that in others regions. In absolute terms, the forest cover loss is highest in Paukkaung .

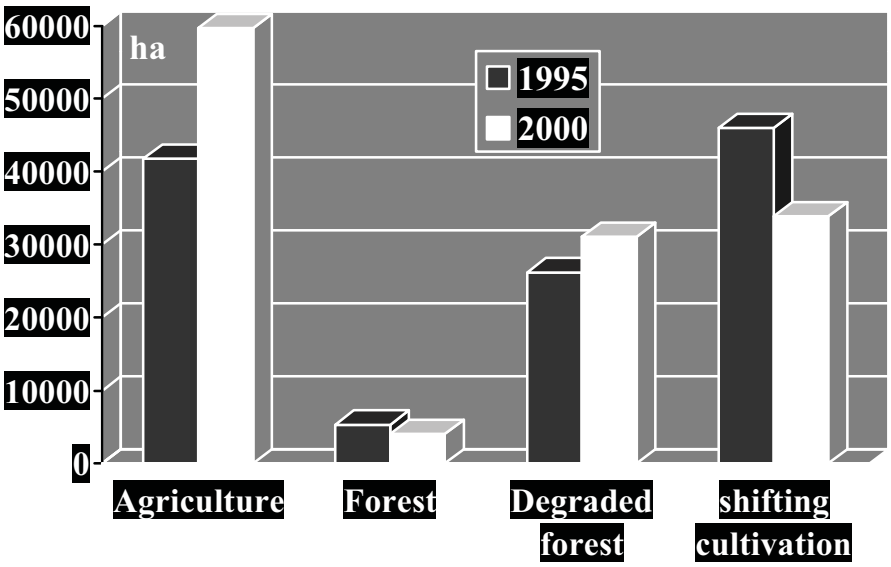

Figure (5.7) Nyaung Shwe land use (1995-2000)

Figure (5.7) shows a land use classification comparison of the two periods 1995 and 2000 in Nyaung Shwe. The forest cover of that township decreased between 1995 and 2000. Accordingly, the area of agricultural cultivation in the year 2000 was higher than that of the area in 1995. In the year 2000, the area of shifting cultivation was lower than that of the area in 1995. Due to the population expansion of that town, the number of shifting cultivators used to increase. Figure (5.8) and (5.9) indicate land use maps for the Nyaung Shwe township in 1995 and 2000.

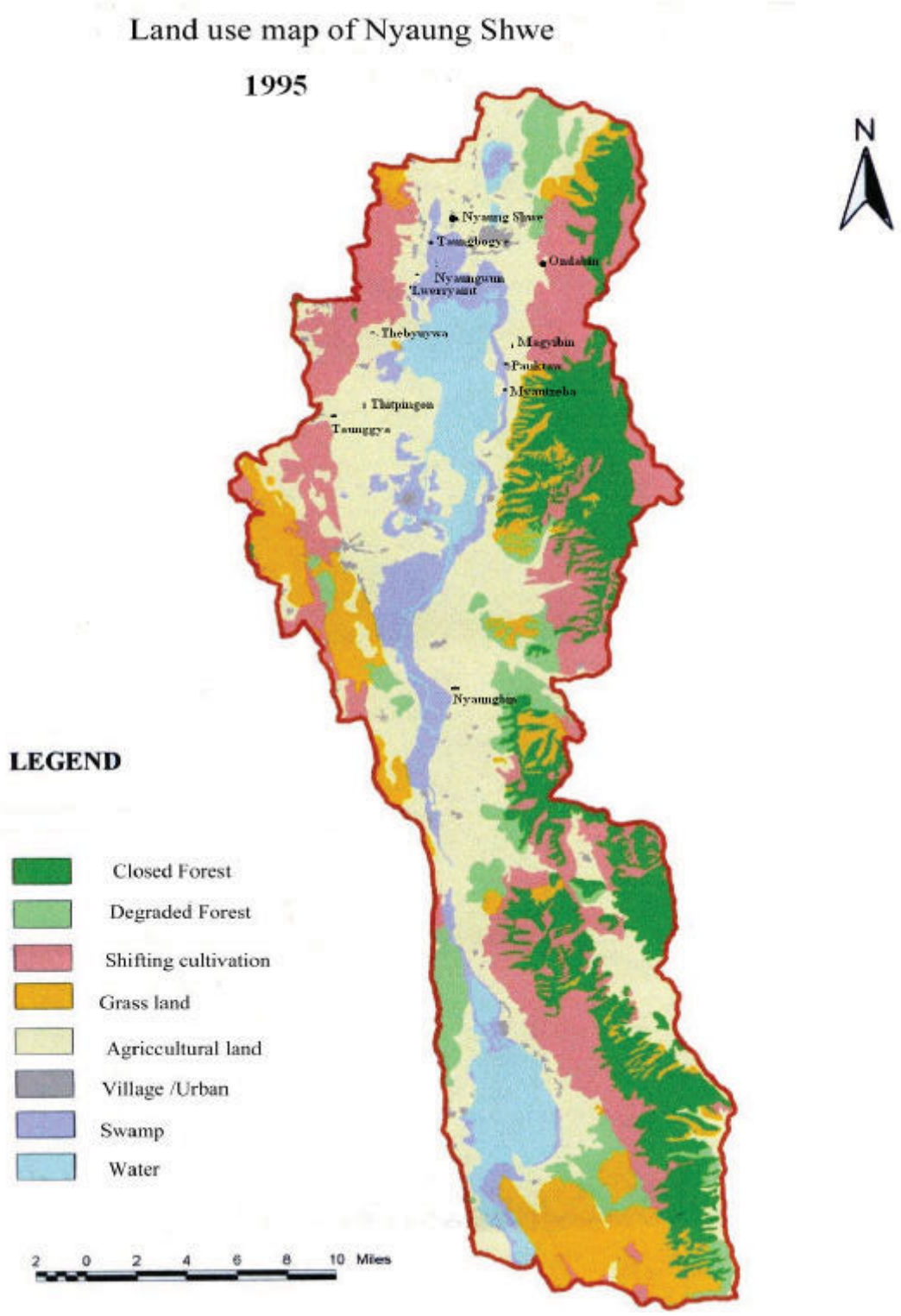

Figure (5.8) Nyaung Shwe land use map 1995

Source Forest Department, Myanmar, 2001

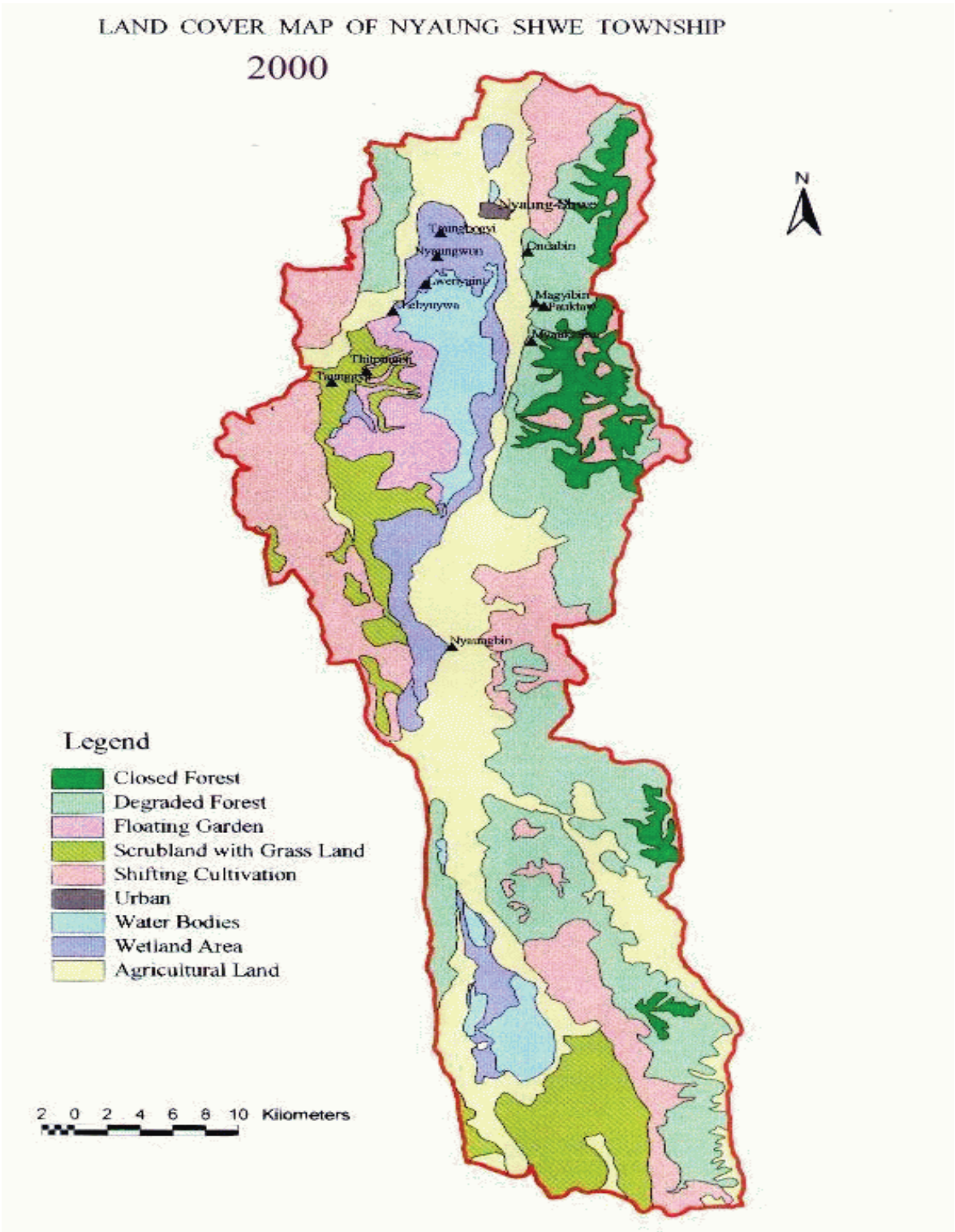

Figure (5.9) Nyaung Shwe land use map 2000
Source: Forest Department Myanmar, 2001

Figure (5.10) Paunkkaung land use 1996
Source: Forest Department Myanmar, 2001

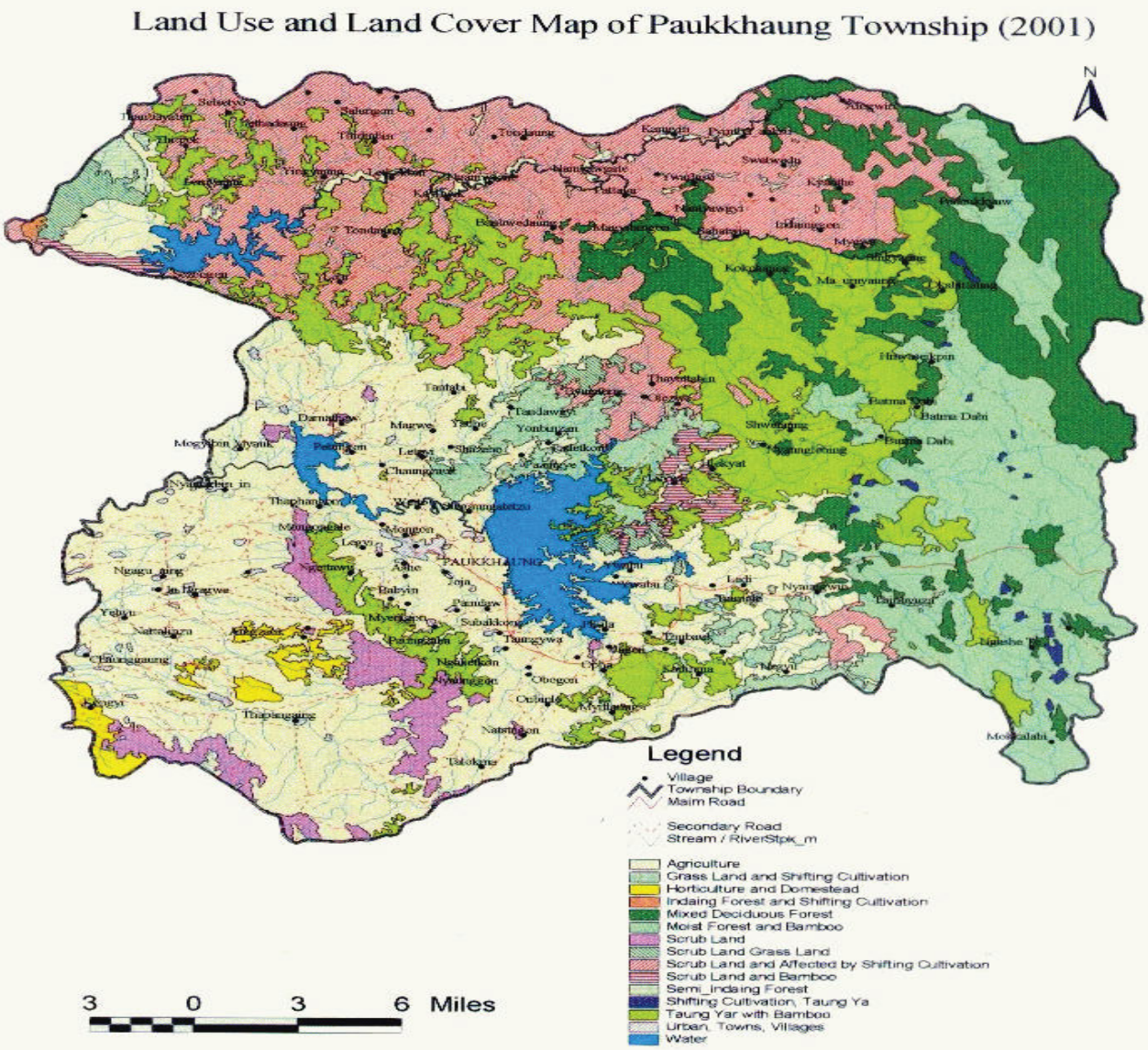

Figure (5.11) Paunkkaung land use map 2001

Source: Forest Department Myanmar, 2001

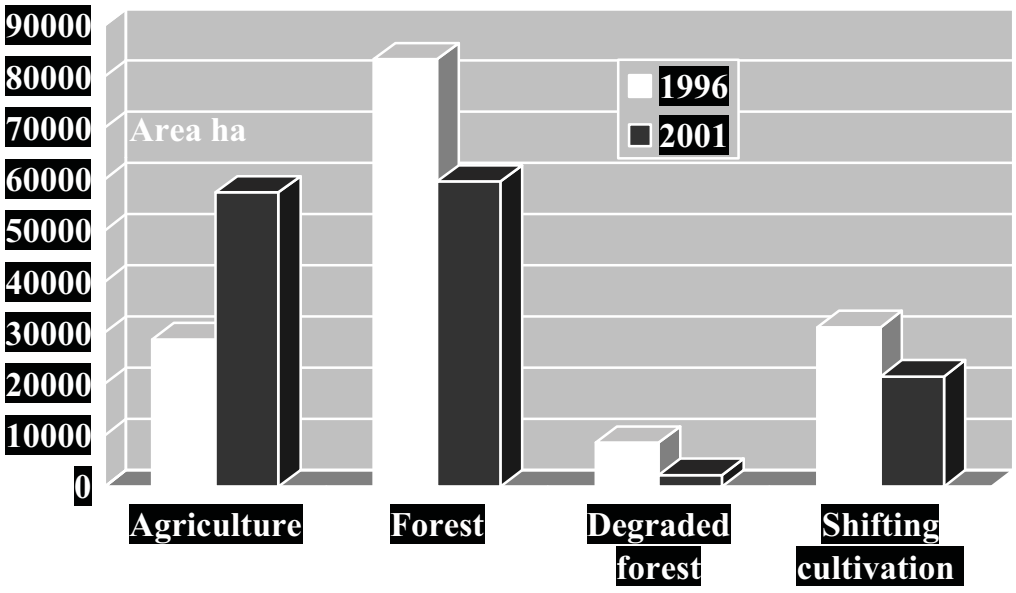

Figure (5.12) Paukkaung land use (1996-2001)

Figures (5.10) and (5.11) show the land use maps for the Paukkaunk township in 1996 and 2001. Figure (5.12) indicates the change in land cover of the Paukkaung township between 1996 and 2001. The area of agricultural cultivation increased in that period. Forest cover declined, which can be attributed to commercial logging associated with illegal loggers and forest encroachment by landless people, due to the construction of the two dams in that town for agricultural development. The area of shifting cultivation in 2001 is lower than that of in 1996.

Land use change comparisons of the three regions are influenced by commercial logging. Due to the few forest areas located in Nyaung Shwe township, there were no commercial logging operations in that region. Local people illegally cut fuel wood and expanded the agricultural land into the upland region. Commercial logging, but also practising of shifting cultivation, could be found in both Paukaung and Mindon townships. There is evidence that illegal logging occurred both in Paukaung and Mindon townships. Therefore, land cover changes in Paukkaung and south Mindon townships are significantly higher than in the Nyaung Shwe township.

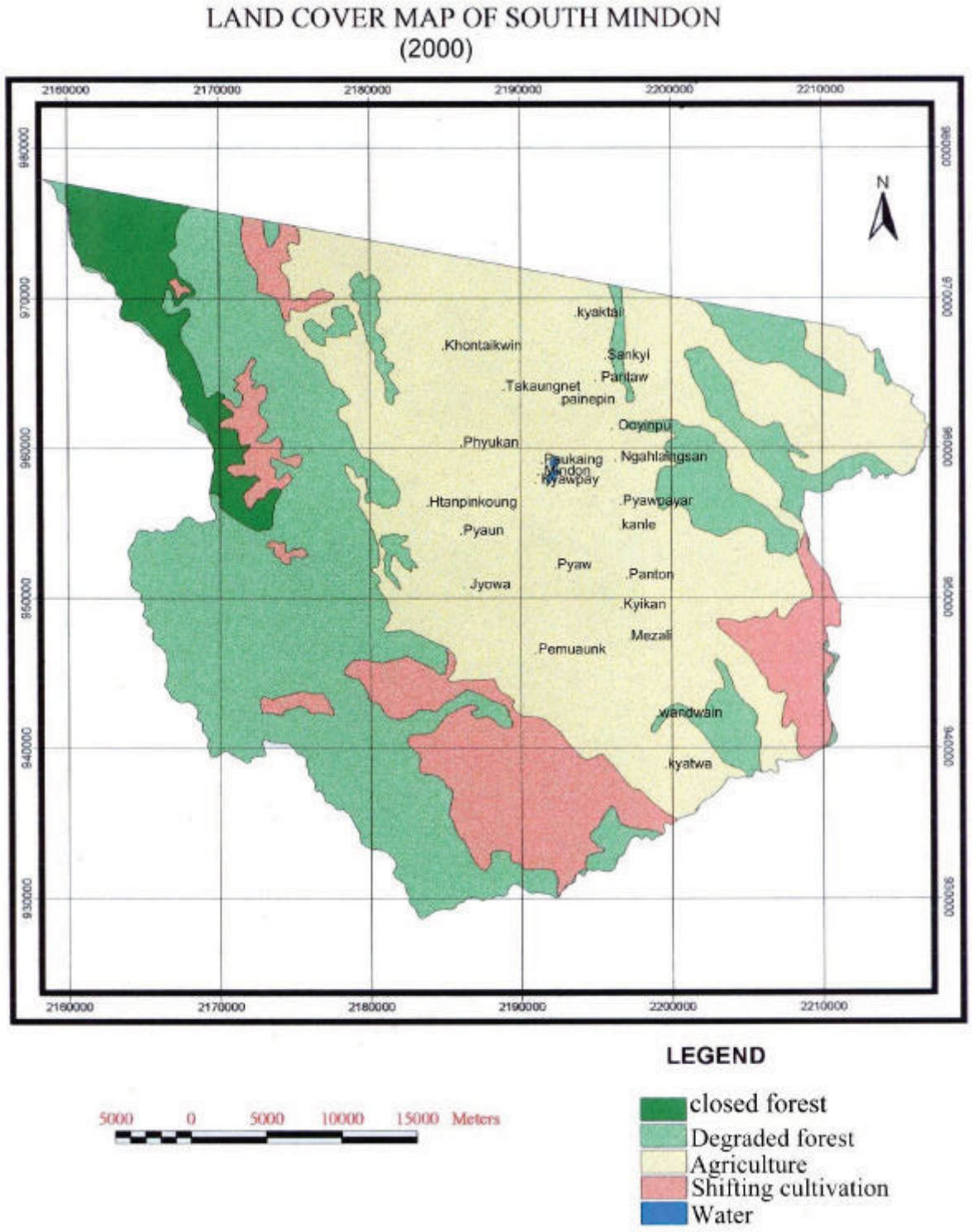

Figure (5.13) South Mindon land use map 2000

Source: Landsat TM 2000

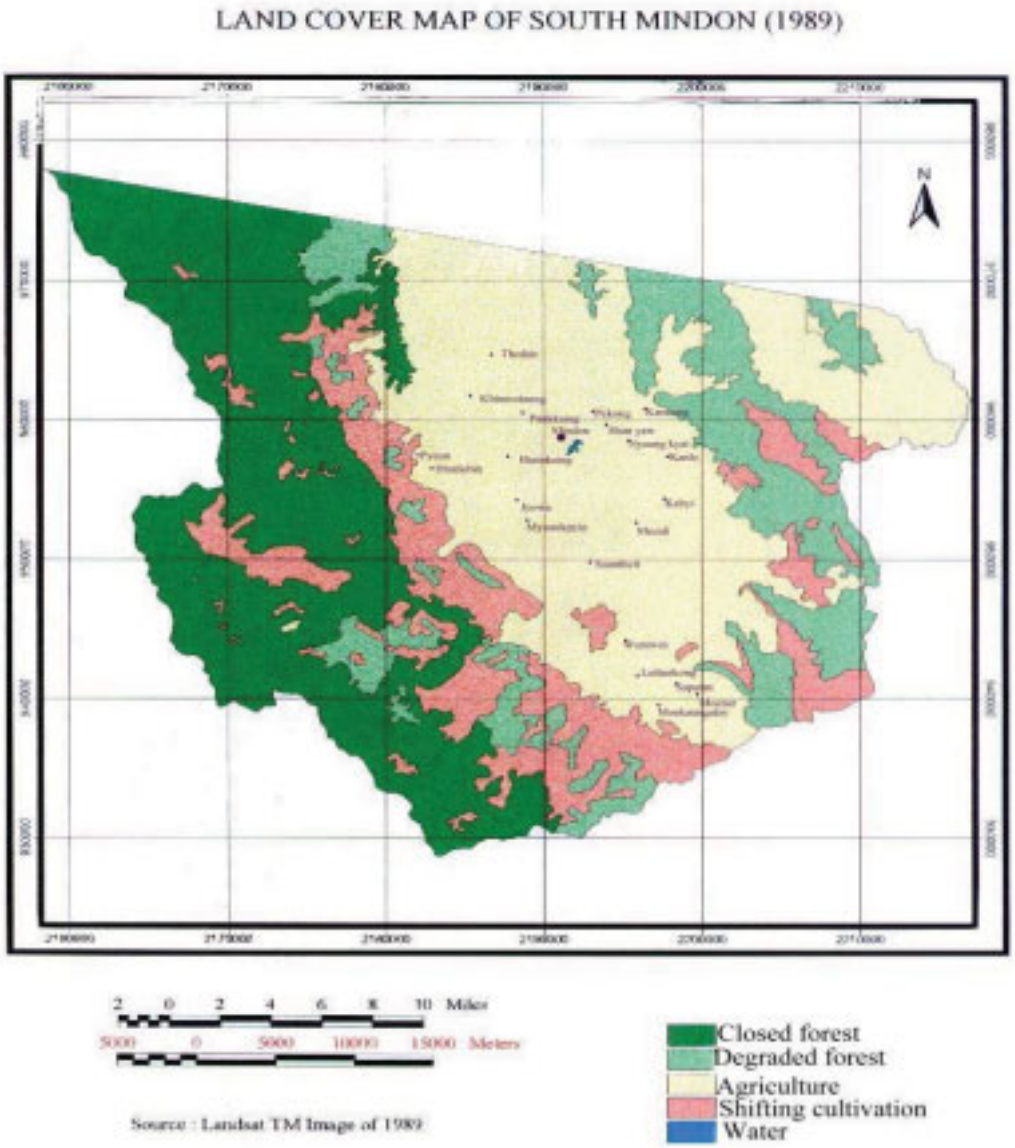

Figure (5.14) South Mindon land use map 1989

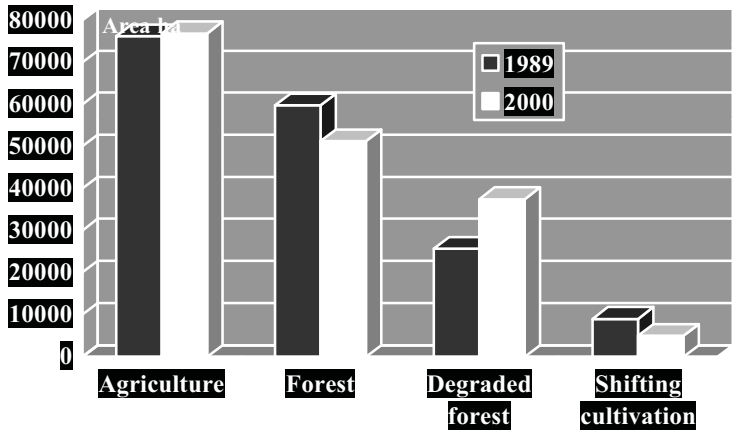

Figure (5.15) South Mindon land use (1989- 2000)

Figures (5.13) and (5.14) show the land use maps for south Mindon township in 1989 and 2000. Figure (5.15) displays changes in land cover of the south Mindon township in 1989 and 2000. The area of agricultural land in 2000 has not significantly decreased, compared to the area in 1989. Forest cover in the year 2000 decreased compared to the cover in 1989. The area of degraded forest increased more in 2000.

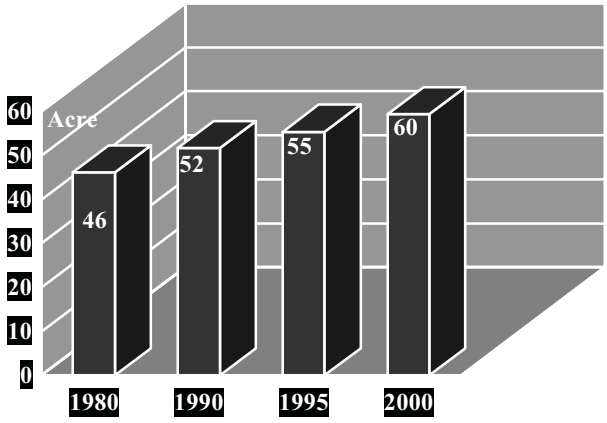

Figure (5.16) Average Shifting cultivation area (acres) per village change in three regions

Figure (5.16) shows the average change in area per village for the three regions. During the 20-year period, the average shifting cultivation area per village increased to 60 acres in 2000 compared to the 1980s. Local people increased cultivation to acquire more income. Therefore, the average area of cutting increased to 52 acres in the 1990s. The average cutting

area increased to 55 acres in 1995. The government allowed agricultural extension by the private companies in Nyaung Shwe and Mindon. Thus, some of the landless faced the difficulty of acquiring land for cultivation, due to occupation by these companies. The productivity of their crops was likely to decrease.

5.3 Climate Parameter Changes in the Three Regions

Table (5.2) shows mean changes in annual rainfall for the three regions in 2000, compared to the period between 1985 and 1994. The mean annual rainfall of Naung Shwe and Mindon is about 1500 mm higher than the mean for 1984-94. The mean annual rainfall dropped to more than 1300 mm in both regions in 2000. Even though longer date series are required to establish causal relationships, this can be seen as evidence that the forest cover loss of that region had an impact on the rainfall. Similarly, the mean annual rainfall of the Paukkung township also declined from 1129 mm to 1037mm in the period from 1985-95 to 2000.

Table (5. 2) Annual rainfall mean change by regions

Regions	Annual rainfall mean mm	
	1985-94	2000
Paukaung	1129	1037
Naung shwe	1563	1332
South mindon	1596	1323

Source: Meteorology Department Myanmar, 2000

Table (5.3) Annual mean temperature changes in three regions

Regions	Annual mean maximum temperature °C		Annual mean minimum temperature °C	
	1985-94	2000	1985-94	2000
Paukkaung	33.20	33.33	22.40	22.78
Nyaung Shwe	24.70	24.93	13.90	14.44
South Mindon	38.67	40.00	20.67	23.00

Source: Meteorology Department Myanmar, 2000

The annual mean maximum and minimum temperature (°C) change in the three regions is shown in table (5.3). The annual mean maximum temperature was 33.2 °C in 1958/94 and

33.33 °C in 2000 in the Paukkaung township. The annual mean minimum temperature difference was 0.4 °C during that period. The annual mean maximum temperature of Nyaung Shwe township was 24.9 in 2000. The annual mean maximum temperature difference of Nyaung Shwe township was 0.23 °C compared to 1985-94. The annual mean minimum temperature difference was 0.5 °C there. The annual mean maximum temperature of Mindon township was 40 °C in 2000. The annual mean maximum temperature difference was 1.3 °C compared to1985-94. The annual mean minimum temperature difference of that town was 2.3 °C. The temperature difference for the Mindon township was higher than that of the other townships.

5.2 Socio-economic village data

Table (5.4) Descriptive statistics of yield, prices and participation in plantation

	N	Minimum	Maximum	Mean	Std. Deviation
Paddy price kyat/basket (1995)	86	0	1500	715.71	288.24
Paddy price kyat /basket (2000)	86	3500	6000	4739.53	601.82
Fertilizer price kyat/ 50 kg (2000)	86	2000	7000	5013.95	1238.90
Fertilizer price kyat /50 kg (1995)	86	750	4000	1819.19	896.17
Home garden acre	85	0	40	4.61	8.11
Irrigated rice field acre	86	0	380	8.12	44.25
Household in community forest	78	0	33	1.18	5.02
Household watershed plantation	82	0	8550	153.56	960.54
Household in forest plantation	79	0	1000	48.59	147.70
Rice yield kg per acre (1990)	21	312.90	1355.90	876.12	328.83
Rice yield kg per acre (2000)	21	208.60	2086.00	933.73	597.77
Pigeon pea yield kg per acre (2000)	17	48.98	489.78	228.08	201.74
Pea nut yield kg per acre (2000)	17	45.36	396.90	162.09	115.62
Edible oil yield kg per acre (1990)	40	0	220.50	96.16	71.56

Source: Village survey

Table (5.4) shows the descriptive statistics of yields, prices and participation in plantations. Due to the high rate of inflation, paddy and fertiliser prices were different during a five-year period. Rice yields were high in the year 2000, because local people used fertilisers to increase productivity in low land regions. Household numbers of people participating in community activities was very low in the three regions. By contrast, household numbers of people participating in watershed plantation was high in the three regions.

Table 5.5 shows the descriptive statistics of rule enforcement. The number of shifting cultivators violating official rules is low in the three study areas. In some regions, it is difficult to enforce the rule on encroachment, in relation to those who illegally clear forest for cultivation, due to the poor situation regarding the rural livelihoods. Although the cultivators know that forests are protected by the rules of the forestry law, they do not have alternative income sources.

Table (5.5) Descriptive statistics on Shifting Cultivation and Rule enforcement (per village)

	N	Minimum	Maximum	Mean	Std. Deviation
(2000) Rule offenders	69	0	20	.52	2.69
No. of shifting cultivators (1995)	85	0	186	28.16	33.94
Fallow land area in acres	18	0	200	57.61	66.87
Fallow period	84	0	5	2.46	1.48
Fallow land area in acres	18	0	200	57.61	66.87
Cultivation time in the same area	83	0	4	.92	.81
No. of guilty for illegal shifting cultivators	85	0	1	3.53E-02	.19
Rule offenders of shifting cultivation	86	0	1	.34	.48
No. of rule offenders	69	0	20	1.03	3.29
No. guilty	83	0	14	.46	1.95

Source: Village survey

Chapter 6 Analysis

6.1 Regression results for the study areas

6.1.1 Determinant of deforestation in the study areas

According to the theoretical model used in this study, as outlined in Chapter 3, the independent variables of deforestation take into account the population expansion of the villages, small tractors used in the villages and the number of pumps used in the villages as indicators of technology, crop market prices, change in shifting cultivation areas, rice yield and changes in rice yield.

According to the theoretical framework, population density is expected to have a positive effect on deforestation pressure. The number of small tractors and pumps used in the villages is related to technological and agricultural development. Agricultural development is essential to increase the rural peoples' productivity. The use of small tractors and pumps is influenced by the socio-economic status of the households. As small tractors are a labour-saving technology, their effect on deforestation is not clear. They may increase deforestation, especially since they are also used for transport. Pumps allow farmers to use agricultural land more intensively (land-saving technology) and are, therefore, expected to decrease deforestation. Pumps allow farmers to grow crops two or three times each season, which underlines their land-saving effect. For the upland cultivators, it is, however, difficult to use pumps for cultivation. In general, increasing the number of pumps is likely to reduce deforestation.

According to the theoretical model, market accessibility influences the degree of deforestation. Deforestation can be expected to decrease with increasing distance to the road. Theoretically, crop market prices also have an impact on deforestation. It is hypothesized that peanut and edible oil crop price increases lead to greater deforestation. The prevalence of shifting cultivation is also hypothesized to increase deforestation because, taking the fallow area into account, the land requirements for agricultural production are higher under shifting cultivation than under permanent cultivation systems. The switch from shifting cultivation to permanent cultivation is, however, difficult due to problems to control weeds and maintain soil fertility without external inputs. As an indicator of agricultural productivity, changes in rice yield increases are also expected to influence deforestation. The effect is, however ambiguous. Increasing rice yields could decrease deforestation due a land saving effect, or increase deforestation by making agricultural production economically more attractive. Table 6.1 indicates descriptive statistic influences on independent variables of deforestation.

Table (6.1) Descriptive statistics of dependent and independent variables of deforestation

	Minimum	Maximum	Mean	Std. Deviation
Deforestation (NDVI) change %	.10	.35	.2255	9.834E-02
Population density per ha	.33	1289.34	21.6015	144.5993
Small tractors used in village	0	40	.79	4.40
Pumps used in village	0	4	.18	.66
Pigeon pea price change (kyat)	.93	3.71	1.6648	.4098
Time to a road in hours	0	4	.48	.90
Shifting cultivation change (acre)	.00	15.00	1.6959	2.1043
Peanut price (1995) Kyat/basket	800	1200	991.76	171.97
Crop (edible oil) price (1995) Kyat / basket	5000	6500	5638.26	512.37
Rice yield change in kg	.63	1.67	1.1351	.2731

Table (6.2) Regression analysis results of the deforestation in the study areas

	Coefficients	Std. Error	t
(Constant)	-9.884E-02	.155	-.639
Population density per ha	4.693E-03	.002	2.208
Small tractors used in the village	1.293E-02	.082	.158*
Pumps used in the village	-1.665E-02	.026	-.630
Pigeon pea price change	-3.354E-02	.032	-1.046
Time to road in hours	-4.091E-02	.011	-3.612*
Shifting cultivation area change	6.143E-04	.005	.130
Peanut price (1995)	3.949E-04	.000	4.016**
Crop (edible oil) price (1995)	8.753E-07	.000	.028*
Rice yield change	-1.502E-02	.054	-.279

Note: Dependent variable: deforestation percent with a mean of 0.213 Std deviation 0.1004 No. of observation 86 DF= 49, R= 0.739, R squared = 0.546, adjusted R squared = 0.444, Std err = 7.357E-02, *= significance level 0.05, **= significant level 0.01,

Table (6.2) shows results of regression analysis for deforestation in the study areas. The model has an adjusted R squared of 0.444, indicating a reasonable fit of the estimated model, taking into account that cross-sectional data are used. The dependent variable is deforestation percentage in the study villages. As explained above, independent variables are population density per km^2, pump usage to get water for cultivation, small tractors usage for the agricultural cultivation, rice and pigeon pea price change in the market, and transport from the local village to the market. The regression results show that population density is positively associated with deforestation percentage, but it is not significant. In addition, as the coefficient indicates, the effect is relatively small. The use of small tractors does increase deforestation, as

hypothesized, and is statistically significant at the 0.05 level. The use of pumps had the effect to decrease deforestation, but the effect of this variable was not significant. Nevertheless, the results indicate that labour-saving agricultural development policies, such as tractors, may increase deforestation, while land-saving technologies, such as pumps, may reduce deforestation. The peanut price also had a significant positive impact deforestation, whereas the pigeon pea price had a decreasing impact, which was, however, not significant. To explain the differential impact of these two crops, one would have to consider their relation in more detail. The price of edible oil also had increased deforestation, an effect which was significant. Rice yield increases decreased deforestation, indicating that the land-saving effect was relevant, but the result was not statistically significant.

The time needed to get to the nearest road had a significant negative impact on deforestation, as hypothesized. This indicates a classical dilemma. While roads increase market access and development options, they have a negative impact with regard to the deforestation problem. The change in the area under shifting cultivation, expectedly, tends to increase deforestation. This influence was, however, not statistically significant.

6.1.2 Determinant of shifting cultivators

For reasons of scope, shifting cultivation is analyzed here in a separate model, even though using the predicted shifting cultivation area in a two-stage model of deforestation would be possible to avoid endogeneity problems. According to the theoretical considerations of Chapter 3, shifting cultivation is expected to have a direct effect on deforestation. The dependent variable is household number of shifting cultivators in the villages. The independent variables include land distribution (land size classes), paddy field size and expansion, low-land cultivation acreage and land expansion, fertilizer price change, aid organizations and TV ownership, as an indicator of the wealth level. Table 6.3 shows the descriptive statistics of the dependent variable and the independent variables that are expected to have an influence on the prevalence of number of shifting cultivators.

Table (6.3) Descriptive Statistics of dependent and independent variables having an influence on shifting cultivators

	Minimum	Maximum	Mean	Std. Deviation
Shifting cultivators	0	186	28.16	33.94
10 acres landholders	0	20	1.19	3.80
1 acre landholders	0	100	15.01	25.02
Landless	0	150	24.92	31.26
Low land cultivation	0	1300	58.88	160.91
Paddy field expansion	0	1	.12	.32
Paddy field acreage	0	540	98.58	123.87
Fertilizer price change (kyat)	.83	5.00	3.3244	1.4042
Low land cultivation acreage	0	500	25.36	84.93
Crop land expansion	0	1	.79	.41
Other land expansion (upland)	0	1	.81	.39
Aid organisations	0	1	.48	.50
Television ownership (level of wealth)	0	200	10.02	23.88

Table (6.4) Results of regression analysis for shifting cultivators

	Coefficients	Std. Error	t
(Constant)	21.350	13.329	1.602
10 acres land holders	-6.056	1.751	-3.459*
1 acre land holders	.741	.207	3.579*
Landless household No.	-.331	.191	-1.738
Paddy field acreage	7.986E-02	.052	1.534
Fertiliser price change	.490	3.041	.161
Crop land expansion	-.229	11.317	-.020**
Paddy field extension	43.689	17.343	2.519
Other land expansion (upland)	10.029	11.437	.877**
Low land cultivation acre	-1.347E-02	.051	-.265
Aid organisations	-12.269	7.733	-1.587
Television ownership (level of wealth)	-.119	.146	-.812

Note: Dependent Variable: household No. of shifting cultivators (1995) with a mean of 30.47 Std deviation = 36.36 No of observation 86 DF= 59, R= 0.699, R squared = 0.488, adjusted R squared = 0.371, Std err = 27.14, *= significant level 0.05, **= significant level 0.01,

Table (6.4) shows the results of the regression analysis concerning the number of shifting cultivators in the three study areas. The fit of the model, indicated by R squared of 0.488 is acceptable for cross-sectional data. Expectedly, the size of the land holdings has an impact on the shifting cultivation. Shifting cultivation is more likely to occur if land holdings are in the range of 1 ha, but less likely, if the more households are either landless or have

holdings in the land size class of 10 ha. Except for the landless households, the results were significant.

Unexpectedly, the number of shifting cultivating households increases with the extension of paddy cultivation, but the results were not significant. Higher fertilizer prices also tend to increase shifting cultivation, but the result was not significant.

Expectedly, the number of shifting cultivating households is higher in villages, where upland cultivation is more prevalent, which was also statistically significant. Some of the farmers grow second season crops in cropland areas. Cropland cultivation includes agricultural crops, except paddy. This type of cultivation reduced shifting cultivating significantly. The coefficient of the cropland expansion is 0.229 and is statistically significant at the 1 percent level. This result suggests that the more second season crops cultivation takes place, the less the number of shifting cultivators at the village level.

The presence of aid organizations is negatively associated with the number of shifting cultivators in the villages, which indicates that these organizations chose to work in villages with lower incidence of shifting cultivation or have managed to reduce shifting cultivation. The coefficient was not significant, however. Expectedly, television ownership, as an indicator of wealth was negatively associated with shifting cultivators in the villages, but this coefficient was not significant either.

Chapter 7 Discussion

This chapter discusses the empirical findings concerning deforestation and the statistical models and places them in a wider policy context. According to the model, land holdings, technological change, crop prices and local market access influence deforestation. For agricultural development, agricultural inputs, such as fertiliser and small tractors, are necessary. However, as our results show, labour-saving technologies such as tractors may increase deforestation, while land-saving technologies such as pumps may reduce deforestation. Agricultural product price changes experienced by the producers also have an effect on deforestation. Technological progress will increase the relative profitability of agriculture and may therefore increase the extent of agricultural land (Angelsen, 1999). The findings in the literature, with which the results obtained here can be compared, are ambiguous. Kita (1995) concluded that technological progress also leads to more deforestation, while Panayotou and Sungsuwan, 1994;Southgate, Deininger and Minten forthcoming) found the opposite effect. There is agreement that it is important to promote agricultural development to obtain foreign exchange for exported agricultural products, because the country's economy is agro-based. Considering the ambiguous impact of agricultural technology on deforestation, is essential to reach a balance between economic, ecological and social aspects of sustainability in safeguarding natural resources. Due to constraints in terms of finance and access, most of the shifting cultivators could not use chemicals and fertilisers to increase yields, in order to raise their income. Some of the villages in Nyaung Shwe region have received fertiliser through aid from development projects at low prices. Other studies have shown that higher fertiliser prices may cause farmers to change from sedentary farming to shifting cultivation and to clear more forests (Holden Nghiep, 1996 and 1993b, 1996). Angelsen (1999) found that an increase in fertiliser prices results in a decrease in the area under cultivation. However, that result was not significant. In this study, a change in the fertilizer price was found to be positively associated with the extent of shifting cultivators. This result was, however, not statistically significant either.

The use of pumps was an example of technology that had a positive impact with regard to the deforestation problem. If more pumps can be used at the local level, it will be possible to have a growing season 2 or 3 times in a year in the subsistence case. Getting water for second season crop cultivation depends on pump availability. Lowland cultivators who own small amounts of land are likely to expand cultivation on to the forested areas, due to low

productivity. If the second crops can be grown in the second growing season, land productivity will be increased and people will be able to increase income generation within a year.

Regarding agricultural productivity and deforestation, one also has to consider long-term effects. In India, productivity growth had a high positive correlation with deforestation at the local level (Foster, et al., 1997). Due to growing crops repeatedly in the same area, soil fertility rates declined. Therefore, increases in rice yields may due to this effect ultimately result in greater deforestation. In the model estimated in this study, the impact of rice yields on deforestation was, however, not significant. Most of the low land paddy field owners in our study areas produce enough rice for their subsistence. Under the socialist system, farmers were also obliged to sell rice to the local government at fixed prices. After the political change, the country's economic policy shifted to the market economy system. It is now not necessary for the upland cultivators to sell their crops to the local government, as was the case in the past period.

The government has allowed private companies to cultivate crops, especially in South Mindon and Nyaung Shwe. Private companies have increased productivity by using advanced agricultural inputs. Most of the local communities have faced difficulties due to the occupation of the extensive land by private companies. One can assume that, therefore, local communities may be more likely to increase their cultivation land on to forested areas. However, the role of commercial companies and their incentives to engage in deforestation was not analysed in this study.

The findings on deforestation suggest that forestlands are severely threatened, due to increased use by the local people. An unexpected finding is that population density was not statistically significant as a factor influencing deforestation. This may be due to the fact that population density is endogenous, which was, for reasons of scope, not considered in the model specification. Other studies have established a clear link between population and deforestation. In India, a higher village level population density average household size leads to more deforestation (Foster, 1997). Within three study areas, the eastern parts of the region (Nyaung Shwe) have the lowest population density. Paukkung township has the highest population density. The implementation of family a planning programs in the rural areas would help to reduce poverty and the pressure on natural resources.

The solution to the problem of resource degradation in Myanmar, as well as in developing countries depends not only on appropriate technologies and efficient market prices, but also on local level institutions of resource management and the organisations to enforce

them (Baland and Platteau, 1996; Rasmussen and Meinzen-Dick, 1995).[126] Land degradation and decreased fallow periods are not necessarily linked to community management and these processes can depend also on the demand for land products and the bequest a value of the forest for future generations within the communities (Larson and Bromley, 1990). Agricultural technology progress may be critical in achieving the goals of economic growth and reduced poverty, but it cannot do so by itself (Pinstrup-Andersen and Hazell 1985; Freebairn 1995). [127] Agricultural technology can contribute to increased food production, economic growth and poverty alleviation.

Deforestation also depends on infrastructure development of the rural areas, such as the construction of roads and dams. In order to transport local farmers' products to the market, the time to get to the nearest road is a vital factor for the local people who wish to access the market. Time to the road was negatively associated with the level of deforestation and the result was statistical significant. This points to another conflict in achieving sustainable development. While roads are essential to provide market access, thus providing income sources, they tend to have a negative impact with regard to deforestation. The findings are in line with other results obtained in the literature. Pender and Scherr (1999) found that the effect of poor market access is associated positively with the preservation of forest on steep slopes in Honduras. Other studies also show that forest clearing decreases rapidly beyond a distance of two or three kilometres from a road, although Liu et al. (1993) and Mamingi et al. (1996) reported significant forest clearing associated with much greater distance to roads in Cameroon, the Philippines and Zaire. Nelson and Hellerstein (1997) found that the distance to villages had a much more significant effect on land use than distance to urban areas.[128]

Angelsen (1996) pointed out that, in situations in which land rights are obtained by forest clearing, the effect will be to encourage deforestation. Expectedly, shifting cultivation was positively associated with deforestation, but the influence was not significant. This

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[126] Gebremedhin, B., Pender, J and Tesfaye, G., 1999, Community natural resources management: The case of woodlots in northern Ethiopia, Discussion paper No. 60 Environment and Production Technology Division,International food policy research institute, Washington, D.C

[127] Kerr, J. and Kolavalli, S., 1999, Impact of agricultural research on poverty alleviation: Conceptual framework with illustrations from the literature, Discussion paper No. 56, Environment and Production Technology Division,International food policy research institute, Washington, D.C

[128] Kaimowitz, D., and Angelsen, A., 1998, Economic model of tropical deforestation: a review/ Bogor, Indonesia: CIFOR, Centre for International Forestry Research p 41

cultivation type is linked to the property rights regime. Many poor local people are unable to buy low land or paddy fields, because of high land prices, which increases the incentive to convert forest in order to establish, at least informally, rights to land resources.

Agricultural output prices are also important factors influencing deforestation. The results show that this influence depends on the type of crops, and possibly, their interaction. In the model estimated here, the price of peanuts had a significant influence on deforestation, while the price of cowpeas had not. Crop (edible oil) price positively impacts on deforestation percentage. These findings with regard to peanuts are in line with the results by Angelsen and Shitindi (1999), who found that increasing the producer price for food crops has been responsible for the conversion of more forestland into cropland.[129]

The results of the regression analysis presented in the previous section also indicate that the size of land holdings is related to the number of shifting cultivators. If large land holdings (size class of 10 acres) prevail, shifting cultivation is less likely to occur. However, there are not many of such large landholdings. The number of shifting cultivators is higher, if landholdings of one acre prevail. These two results support the hypothesis that smaller landholding leads to an increase in shifting cultivators and leads to more pressure on deforestation.

An important question is the relation between poverty and deforestation. In this study, low numbers of ownership of TVs in the village were considered as an indicator of poverty. The results concerning this variable suggest that poor people are more likely to engage in shifting cultivation at the local level. However, the variable was not statistically significant. Evidence from the literature shows a link between poverty and deforestation. A subsistence-oriented, slash-and-burn cultivation in agriculturally marginal areas at the forest fringe may increase deforestation (Chomitz, 1999).[130] The role of shifting cultivation for deforestation and its link to poverty is debated in the literature. FAO (1996) suggests that 60% to 70% of tropical forest conversion is to permanent or short-fallow agriculture, rather than to long-fallow slash-and-burn agriculture; moreover, some slash-and-burn agriculture is oriented to export rather than subsistence crops. It has also been argued that poverty is more closely associated with forest cover than with deforestation – that is, the poorest people live in areas too remote to suffer from much deforestation (Deininger and Minten 1996). Small-holder cultivation of

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[129] Angelsen, A., 1999, On the economic of the deforestation with regional panel data evidence from Tanzania, Working paper in Economics, No. 0498

[130] Chomitz, K.M., 1999, Environment–poverty connection in tropical deforestation discussion notes prepared for Summer Workshop, World Bank, Development Research Group, July 7

export-oriented tree crops was found to be closely associated with deforestation, in an Indonesia-wide study using village-level census data (Chomitz and Griffiths 1996).

Non-Governmental Organisations (NGO) and forest plantations by the Forestry Department, UNDP, FAO as well as other projects could play an important role in assisting local people to improve agricultural productivity and reduce shifting cultivation. In the model estimated in this study, aid organizations were associated with less shifting cultivation, but it is difficult to draw conclusions on causal effects with regard to this variable. As indicated in the previous chapter, such organizations could also work in areas where there is less shifting cultivation. Nevertheless, the role of such organizations and programs is certainly important in reducing deforestation. To counter deforestation and to reduce shifting cultivators in the long run, it is necessary to provide incentives to the local people to co-operate in the restoration of the degraded forests.

However, Myanmar has few international relations and, therefore, there is little international assistance to promote economic development compared to the other Asian countries. Nevertheless, community-based management should continue to be encouraged, including strengthening community participation in project preparation, implementation and monitoring. The issuing of Community Forestry Instructions (CFI) in 1995 was a major breakthrough in the history of Myanmar Forestry. It aims at decentralisation in forest management and addresses the basic needs of the local people through a participatory approach and environmental restoration.

The international community could also use the convention on biological diversity, the International Tropical Timber Agreement, and other intergovernmental processes to provide both information to and request information from the government about forest management and timber production. It would be beneficial, if international donor agencies are more positive in assisting the government of Myanmar to undertake essential environmental programs, rather than refrain from it because of political reasons.

Deforestation can have substantial off-site hydrological impacts, including local flooding, gullies erosion, and sedimentation of streams, reservoirs and coastal waters. These impacts can adversely affect the poor (e.g. cultivation of down slope areas, destruction of local fisheries) as well as the better off (sedimentation of hydropower and irrigation infrastructure). The severity and incidence of these effects depends on local bio-geophysical conditions, settlement patterns and water use patterns (Chomitz and Kumari 1998). Tropical deforestation also contributes about 20% to the increase in greenhouse gases believed to cause climate

change. While the economic impacts of climate change are uncertain and difficult to quantify, they are believed to be felt primarily on the poorest countries and poorest people (Chomitz, 1999).

In general, the country's development patterns have to be considered in order to better understand deforestation: Problems arise from an increasing population, leading to an increase in the number of people in need of land for cultivation and a slow growth in non-agricultural income sources in both the cities and countryside.[131] The reasons why the rapid deforestation takes place in all of the study areas are complicated. Some of the variables considered, such as the prevalence of small tractors, pumps used in villages, crop prices, landholders, crop land expansion, upland expansion and time to the nearest road are also relevant in other parts of the country. Other variables, including changes in rice yield, landless people and paddy field acreage are different in other parts of the country, which has to be considered when deriving conclusions for the country.

Forestry policy and other policies affecting forestry need information about the real potential of forests, social and developmental aspects, and the principle of good forest management. Remote sensing techniques can be used to provide policy-relevant information on deforestation. Ultimately, the science being conducted should provide a strong underpinning for management decisions and policy. This does not happen automatically, and special efforts are required to sensitise policy analysts and managers to the state-of-knowledge and to help define mechanisms by which significant scientific results can be used for better decision-making. Visualisation, e.g., using maps showing deforestation rates, can be an important tool for policy makers and stakeholders.

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[131] Repetto R. C., and Gillis, M., 1988, Public policies and the misuse of forest resources, Cambridge u.a.: Cambridge Univ. World Resource Institute, p 15

Chapter 8 Conclusions and Policy Recommendations

8.1 Conclusions

After the change in economic policy from a socialist to a market-oriented system, the scope for policy failure decreased. However, one could observe increasing forest degradation. In this study, deforestation levels were analyzed using the Normalised Different Vegetation Index (NDVI) on data obtained from satellite images. The results of regression analysis were determined by analyzing socio-economic data from 86 villages. As the analysis has shown, there is a complex set of factors that explains tropical deforestation in Myanmar. Population increase, poverty, type of technology, market access and producer prices have to be considered as important determinants of deforestation.

Myanmar's forestry policy stipulates that sustainable forest management maximizes social and environmental benefits for the country and its population, restores ecological balance and bio-diversity. It includes a provision for the constitution of reserved forests and powers, rights and duties therein, the general protection of forests, forest products, the control of forest products, penalties and procedures.

In view of the necessity to conserve the forest resources to achieve the national goal of sustainable forest management and development, and for optimization of socio-economic benefits and environmental stability, a forest policy has been adopted. However, implementing this policy still remains a challenge. Forests are occupied by traditional forest-dwelling communities, as well as by recent forest-dependent encroachers from other areas. People's participation in the protection and development of forests and forest communities should be motivated to identify themselves with the development and protection of forests from which they derive benefits. The primary objective of joint forest management, as practiced in India, is to give users a stake in forest benefits and a role in planning and management, to achieve improvement in forest conditions and the productivity of forests.

Although new agricultural technology is essential for increasing production and alleviation of poverty, a trade-off has to be made between economic, ecological and social goals for future generation. Land tenure plays a key role in the dynamics of deforestation. The lack of alternative economic opportunities and an increase in the number of households encourages local people to cut marginal forestlands for cultivation. Development policies should respond to the needs of the farmers, taking into consideration the specific socio-economic and environmental characteristics of a region. Development policies can contribute to forest protection, if they are able to reduce rural poverty and, at the same time, decrease encroachment on forestlands. Export

policies, especially those relating to agricultural and forest products, have an impact on deforestation, which may exceed the influence of policies that improve production for the domestic market. This question requires particular attention in the context of globalised agricultural markets and trade liberalization.

The policies in question include not only those formulated by government agencies nominally responsible for overseeing forest utilization ('forestry policies'), but also a wide range of other policies designed to serve broader governmental goals ('non-forestry policies'), but which nevertheless have undermined the value of natural forest assets. Land tenure policies may encourage deforestation. The most direct influence comes from tenure rules that assign property rights over public forests to private parties, on condition that such land is developed or improved. Such rules have facilitated small holder expansion into forested regions. Any regulatory policies sufficiently restricting a change in the remaining forest as compared to other land use could reduce deforestation. Even though the government it is willing to protect the remaining forest resources, a low local administrative capacity and lacking incentives for forest conservation activities constitute major challenges.

An important policy to reduce deforestation is the creation of suitable employment opportunities which are to be expected from a sustainable forest utilization. Migration to the forested region because of overcrowding and landlessness in settled agricultural regions often result due to the slow growth of non-agricultural employment opportunities. Allocating the resources that are necessary to protect the forest resources, while at the same time promoting co-management or joint-forest management is an important task. So far, development assistance involved in the forest sector has not paid enough attention to agriculture, which is a main driving force behind deforestation.

When the national government enforces rules that contradict traditional use rights to the forests, local communities and individual households have been unable and less willing to safeguard the forests against destructive encroachment or over-exploitation. It has also proven difficult to persuade people to participate in collective actions for the establishment of degraded forests, due to a tendency to believe that sufficient forest regeneration will occur naturally.

Policy failure also occurs because the net profits from forest exploitation and restoration of forest resources have been overvalued, as a consequence of overestimating both the direct and indirect economic benefits of forest use versus conservation. Against the premise that the forest conversion has already exceeded the social optimum, regulatory policies should efficiently prohibit the further conversion of the land cover. Such policies might consist of extending

protected areas, forest concession agreements and regulations requiring permits to change forests to other land uses.

At the local level, fostering collective action for community forestry is an important step to integrate local people. The question of landlessness has to be addressed in this context, e.g., by providing opportunities for leasing land for participating in community forestry. Due to a lack of experience with such systems, a promising option is to entrust local people with land allocation for a defined period, which is, however, long enough to create incentives for sustainable use. A period of 30 years appears to fulfill this goal. Community forestry certificates should be issued to the local community in the whole country. To achieve more trust and more interest on the part of villagers, the general political frame conditions are important. Trust essentially depends on the stability of the political system. Moreover, land allocation to local villagers should be sufficiently large for each member of the user groups, taking into consideration that forest plantation is usually a long-term project.

The international community can play an important role in supporting projects and programs that make a difference on the ground. Community-based programs should be accompanied by a systematic monitoring of the forests in Myanmar, which is urgently required to conserve natural resources. Satellite-based, forest monitoring systems should be established, to provide regular surveillance of the forest.

An important aspect to make community-based systems work is a fair benefit-sharing of the final harvest. In this respect, Joint Forest Management (JFM) is quite unique and has provided people with an economic incentive for conservation, in addition to giving them a stake in the success of the program. This can be achieved by laying down a sound foundation for collective resource management that is based on the collective sharing of both rights and responsibilities**.** Thus, while people will have to manage resources as a common property, they will also need to share a common responsibility, in order to share in these common benefits. Collective forest management is thus a process to ensure continuity in resource generation, stability in physical and social environments, and sustainability in the production of goods and services. There is a need to extend the participation by indigenous people and local communities, forest dwellers, and other communities which are dependent on the forest in forest-based, economic activities. To promote involvement of the local community, it is necessary to gain the trust of the local communities in the local administer for them to participate in the conservation and management of natural resources. Without trust, farmers hesitate to co-operate in collective action, which

results in low productivity and forces the farmers towards unsustainable activities and further endangering of the environment.

The results of this study also show that policies to promote agricultural production should be assessed with regard to their impact on forests. The provision of small tractors, which was promoted by government policies, can result in more deforestation, as the results of our model indicate. Tractors are a labor-saving technology, which may well increase the area under cultivation, including the area for commercial cultivation for markets. By contrast, land-saving techniques such as pumps, which allow for the intensification of agricultural production, can be beneficial both for poor farmers and for the environment. Government policies should concentrate on such "win-win" solutions.

The study also allows us to draw policy conclusions concerning infra-structure development. As in other studies, the variable "time to reach the nearest road" had a significance impact on deforestation, thus supporting the hypothesis that improved access to the market results in more forest degradation. However, infrastructure development is at the same time an important measure to provide income opportunities and alleviate poverty. Therefore, policy makers have to consider this important trade-off. The results from the second model concerning land holding affirms the hypothesis that poverty is associated with a higher incidence of shifting cultivation, which is problematic with regard to deforestation due to the comparatively high land demand of this cultivation system. The promotion of permanent cultivation systems, including systems that allow for two or three harvests per year, is an important policy measure to reduce shifting cultivation and deforestation.

8.2 Policy recommendations

Based on the considerations presented in the last section, the policy recommendations derived from this study can be summarized as follows:

Technological progress: Policies that promote technological progress are important to increase agricultural productivity, reduce poverty and, hence, reduce the pressure on the forests. However, it is important to take the type of technology and its possible direct and indirect impact on deforestation into account. Technologies such as pumps, which have a land-saving effect, are more likely to improve rural livelihoods and reduce pressure on forests than saving-saving techniques such as hand tractors. In view of limited non-agricultural employment opportunities, saving-saving agricultural technologies have a strong tendency to increase the area under agricultural production at the expense of forest cover.

Infrastructure development: There is an important policy trade-off involved in infrastructure development. While road construction is important for poverty alleviation, it can also lead to increased deforestation. Infrastructure development may also attract migrants, such increasing the pressure on forest resources. Therefore, infrastructure development should be accompanied by policies that safeguard forest resources.

Market prices: Policies that increase market prices have an ambiguous effect on deforestation. On the one hand, they may reduce the pressure on forest resources by allowing households to reach a certain income level with a lower amount of land. On the other hand, they may increase deforestation by making crop production economically more attractive. Therefore, as in the case of infrastructure development, policies that increase producer prices should be accompanied by policy measures that safeguard forest resources.

Shifting cultivators: The switch from shifting cultivation to permanent farming systems can be supported by a range of policy measures, including secure land tenure (property rights) for the rural households, credit programs for agricultural inputs, agricultural extension, food safety and other poverty alleviation measures and the promotion of resource conservation measures.

8.3 Recommendations for Further Studies

This study has concentrated on deforestation, and the factors influencing this process. There is a range of related policy issues that require further research. As the experience of other countries has shown, community forestry can be important to achieve sustainability in the long-term. However, more research on community forestry in Myanmar is required in order to find out which policies are essential to promote this system. It is also necessary to further study the question of how forest depletion at the local level is related to fuel wood scarcity and how this affects the possibilities of poor households to get the energy for their daily needs, especially for cooking. Fuel wood plantations that are established with the participation of the local people have good prospects to overcome this problem. Participatory forest management and human resources development policies are the key to restoring natural resources, as well. Participatory afforestation programs should, therefore, be a concern both for future studies and policy measures. Another area for further research relates to the financing of sustainable forestry. Both foreign donor organization and domestic resources are essential in this context. Finally, future research should concentrate on the identification of “win-win” solutions that help to overcome trade-offs between economic, ecological and social objectives of development.

Summary

The present study deals with deforestation problems in Myanmar. The deforestation rate in this country is comparatively high. Illegal logging and shifting cultivation are considered as the main causes of deforestation. This study investigates deforestation in three regions of the eastern, central and western parts of Myanmar. To this end, satellite image analysis of the three study areas was carried out in order to obtain green-cover vegetation patterns using the Normalised Difference Vegetation Index (NDVI). The rate of deforestation in the three areas under investigation was then calculated from the land-use data.

To obtain further information on the change in land use at the three locations in Myanmar under consideration, a survey focussing on socio-economic data was conducted in a random sample of 86 villages in the three study areas. Group discussions and interviews at the communal level with village leaders and elder village inhabitants were conducted in order to collect data on the villagers' recollections of land use change and socio-economic changes. The interviews at the village level were based on a questionnaire. For the village survey, questions related to the following areas were asked: population, technology (small tractors and pumps) used in the villages, crop yields, paddy cultivation, other lowland cultivation, upland cultivation - especially shifting cultivation - productivity of the cultivated crops, land expansion, land holding areas, fertiliser usage, agricultural input, crop prices, time taken to reach roads (in hours), the welfare situation and infrastructure development in the villages. Two regression models for deforestation and for the prevalence of shifting cultivators were analysed using the SPSS program. The deforestation rate and the number of shifting cultivator were analysed as the dependent variables. The explanatory variables regarding deforestation took into account the expansion of the population in the villages, small tractors and the number of pumps used in the villages, as indicators of technology, crop market prices, change in shifting cultivation areas, rice yields and changes in rice yield.

It was hypothesized that small tractors, which represent a labour-saving technology, may increase deforestation, while pumps, which allow farmers to use agricultural land more intensively (land-saving technology), can be expected to decrease deforestation. Pumps allow farmers to grow crops two or three times each season, which underlines their land-saving effect. It was also hypothesized that increases in peanut and edible oil crop prices result in greater deforestation. Changes in rice yield were also expected to influence deforestation. In general, producer price increases were expected to expand the cultivated area. Therefore, the local market price has an impact on natural resources. The time needed to get to the nearest

road was expected to have a negative impact on deforestation. The empirical results confirmed the hypotheses, even though not all factors had a significant influence. A statistically significant influence was found for the utilization of small tractors, the distance to the road, and for peanut and other edible oil prices.

To increase the productivity of the local people, it is essential to utilise modern agricultural implements. If the transport situation is such that there is easy access to the local market, local people are more likely to expand cultivation, to obtain a higher income from their agricultural products. The extent of shifting cultivation is positively associated with the rate of deforestation, even though this variable was not statistically significant in the estimated regression model.

Land distribution (land-size classes) is an important parameter which can be associated with the incidence of shifting cultivation. The 10 acre class was found to be negatively associated with the number of shifting cultivators. A lower land size was associated with a higher incidence of shifting cultivation. This implies that smaller land holdings put pressure on the forests. Expectedly, the expansion of upland cultivation is associated with increasing shifting cultivation, while the expansion of other crop land has the opposite effect. Other variables, such as the presence of development programs, did not show a statistically significant influence.

A policy change is expected to be able to bring about a substantial decline in the destruction of forest resources. An effective development policy will be able to produce a decline in rural poverty and result in less rapid encroachment on forestlands. The lack of alternative economic opportunities and an increase in the number of households encourages local people to convert marginal forestland for cultivation. Farmers with small land holdings have begun to clear steep hillsides in mountainous areas that were formerly forested. Aid organisations can reduce the pressure on deforestation. It is important to encourage upland farmers by providing incentives and establishing plantations on public forest land. Poverty-reduction programmes are urgently needed to safe-guard the remaining forest. Development policies can contribute to forest protection, if they can reduce rural poverty and, at the same time, decrease encroachment on forestlands. Effective regulatory policies placing restrictions on changing the remaining forest into areas for other land use, in combination with development programs, could reduce deforestation.

A specific policy recommendation derived from the regression model of deforestation is that the provision of small tractors, which was a policy promoted by the government, can result in more deforestation. Tractors are a labour-saving technology; which may well increase the area under cultivation, including the area for commercial cultivation for the market. Pumps,

which facilitate the intensification of agricultural production, can be beneficial to both poor farmers and the environment. Government policies should therefore concentrate on such “win-win” solutions.

Zusammenfassung

Myanmar weist verglichen mit anderen Ländern eine hohe Entwaldungsrate auf. Die Hauptursachen für Waldvernichtung ist Wanderfeldbau. Diese Studie untersucht die Zerstörung des Waldes dreier Regionen im östlichen, zentralen und westlichen Myanmar. Zu diesem Zweck wurde zuerst eine Satellitenbildanalyse der drei Studiengebiete durchgeführt, um das vorhandene Vegetationsmuster mittels Vegetationsindex NDVI (Normalized Difference Vegetation Index) zu ermitteln. Anhand der Landnutzungsdaten wurde anschließend die Rate der Abholzung errechnet. Um weitere Informationen über die Änderung der Flächennutzung in den drei Untersuchungsgebieten zu erhalten, wurden sozioökonomische Daten über Zufallsstichproben in 86 Dörfern aufgenommen. Dazu wurden Gruppendiskussionen und Interviews auf Kommunalnebene mit Dorfvorstand und Dorfältesten durchgeführt. Die Dorfbewohner wurden mittels Fragebögen interviewt. Dabei wurde Auskunft zu folgenden Themen erbeten: Bevölkerung, Nutzung von kleinen Traktoren und Pumpen, landwirtschaftliche Erträge, Anbau im Tiefland, Reisanbau, Anbau im Hochland - insbesondere Wanderfeldbau, Produktivität der Anbaukulturen, Ausdehnung der landwirtschaftlichen Nutzfläche, Größe des landwirtschaftlichen Besitzes, Düngemittelverbrauch, landwirtschaftlicher Aufwand (Input), Preise für landwirtschaftliche Erzeugnisse, Entfernung zu Straßen in Stunden, Vermögensverhältnisse und die Entwicklung der Infrastruktur in den Dörfern.

Die Abnahme der Waldfläche und die Anzahl der Wanderfeldbauern wurden mit SPSS anhand von zwei Regressionsmodellen analysiert. Dabei wurden die Abnahme der Waldfläche und die Anzahl der Wanderfeldbauern als abhängige Variablen betrachtet. Die unabhängigen Variablen bezogen auf die Verringerung der Waldfläche beinhalten die Nutzung kleiner Traktoren und die Zahl an Pumpen als technologische Indikatoren, Marktpreise für landwirdtstchaftliche Produkte, die Änderung der Fläche in Wanderfeldbau, Reiserträge und die Änderung der Reiserträge. Kleine Traktoren, die eine arbeitssparende Technologie darstellen, können die Abholzung erhöhen. Pumpen erlauben den Landwirten ihr Ackerland intensiver zu nutzen (landsparende Technologie) und lassen folglich eine Verringerung der Abholzungsrate vermuten. Sie ermöglichen den Landwirten zwei oder drei Ernten pro Anbauperiode, was deren landsparende Wirkung unterstreicht. Um die landwirtschaftliche Produktivität der lokalen Bevölkerung zu erhöhen, ist eine Verwendung moderner landwirtschaftlicher Produktionsmittel ein wesentlicher Faktor.

Es wird die Hypothese aufgestellt, daß eine Steigerung der Preise für Erdnüsse und Speiseöl zur Zunahme von Waldrodungen führt. Ebenfalls wird erwartet, daß sich Änderungen im Reisertrag auf die Verringerung der Waldfläche auswirken. Wenn sich der Preis für landwirtschaftliche Produkte erhöht, neigen lokalen Bauern dazu, ihre Anbaufläche zu vergrößern. Folglich hat der lokale Markpreis eine Auswirkung auf die Naturressourcen. Der erforderliche Zeitaufwand bis zum Erreichen der nächsten Straße hat ebenfalls eine signifikant negative Wirkung auf die Abholzung. Je näher das jeweilige Dorf zur Straße liegt, desto höher ist der Druck auf den Wald. Eine Verbesserung der Transportsituation ist daher vermutlich mit einer Verminderung der Waldfläche verbunden. Wenn die Transportsituation einen einfachen Zugang zum lokalen Markt ermöglicht, ist davon auszugehen, daß die lokale Bevölkerung ihre Anbaufläche ausdehnen wird, um ihr Einkommen aus Agrarerzeugnissen zu erhöhen. Eine Zunahme der Fläche unter Wanderfeldbau steht allgemein in positivem Zusammenhang zum Prozentsatz an Abholzung.

Die Landverteilung (Landbesitzklassen) ist ein wichtiger Parameter, der mit dem Faktor der Wanderfeldbauern in Beziehung gebracht werden kann. Die Klasse von 10 Morgen Landeigentum wurde gefunden, um eine negative Beziehung zur Anzahl der Wanderfeldbauern herzustellen. Eine Abnahme der Größe des landwirtschaftlichen Besitzes war mit einer Zunahme des Wanderfeldbaus verbunden. Landeigentum von weniger als Ackerbau im allgemeinen mit Ausnahme von Tieflandreis korreliert mit der Anzahl an Bauern, die Wanderfeldwirtschaft betreiben. Unterstützung der Bauern durch Hilfsorganisationen führt zu einer negativen Beziehung und hilft die Wanderwirtschaft einzuschränken.

Wesentliche Ursachen für die Zerstörung der Wälder liegen zudem in schlechtem Waldmanagment. Die politisch Verantwortlichen sollten versuchen, die Bedeutung der natürlichen Wälder sowie deren schnelles Schrumpfen als auch die Verschlechterung des Waldzustandes im Allgemeinen zu verstehen. Änderungen in der Politik würden einen Verlust der natürlichen Ressource Wald verringern helfen.

Entwicklungsstrategien zur Verringerung der Armut der ländlichen Bevölkerung könnten ihr Vordringen in den Wald verlangsamen. Das Fehlen alternativer Einkommensquellen und die Zunahme der Anzahl der Haushalte zwingt die Bevölkerung dazu, marginale Waldflächen für den Anbau zu roden. Kleinbauern mit nur geringer Anbaufläche beginnen mit der Nutzung von steilen Hängen ehemals bewaldeter Gebiete des Berglandes.

Über Hilfestellungen für die Bauern des Berglandes läßt sich der Druck auf den Wald verringern. Es ist wichtig, sie durch verschiedene Anreize zum Schutz der Wälder zu ermutigen und gemeinschaftlich genutzte Waldflächen wieder aufzuforsten.

Programme zur Verringerung der Armut sind dringend notwendig, um die verbliebenen Wälder zu erhalten. Die Politik zur Entwicklung des ländlichen Raumes kann einen Beitrag zum Schutz der Wälder leisten, wenn sie in der Lage ist, die ländliche Armut zu vermindern und gleichzeitig das Vordringen der Bevölkerung in den Wald eindämmt. Politische Strategien jeglicher Art, die wirksam eine anderweitige Nutzung der noch existierenden Waldflächen einschränken, könnten einer weiteren Entwaldung entgegenwirken.

Aus dem Regressionsmodell kann die Hauptempfehlung für die Politik abgeleitet werden , daß der Einsatz von kleinen Traktoren, der durch staatliche Maßnahmen gefördert wurde, in einer verstärkten Waldrodung resultieren kann. Traktoren sind eine arbeitssparende Maßnahme, mit denen es den Bauern ermöglicht wird, ihre Anbaufläche einschließlich der Fläche für kommerzielle Kulturen auszuweiten. Pumpen, die eine Intensivierung des Anbaus erlauben, können sowohl förderlich für die Bauern als auch für die Umwelt sein. Maßnahmen seitens der Regierung sollten sich auf solche ‘‘win-win‘‘ Ansätze konzentrieren.

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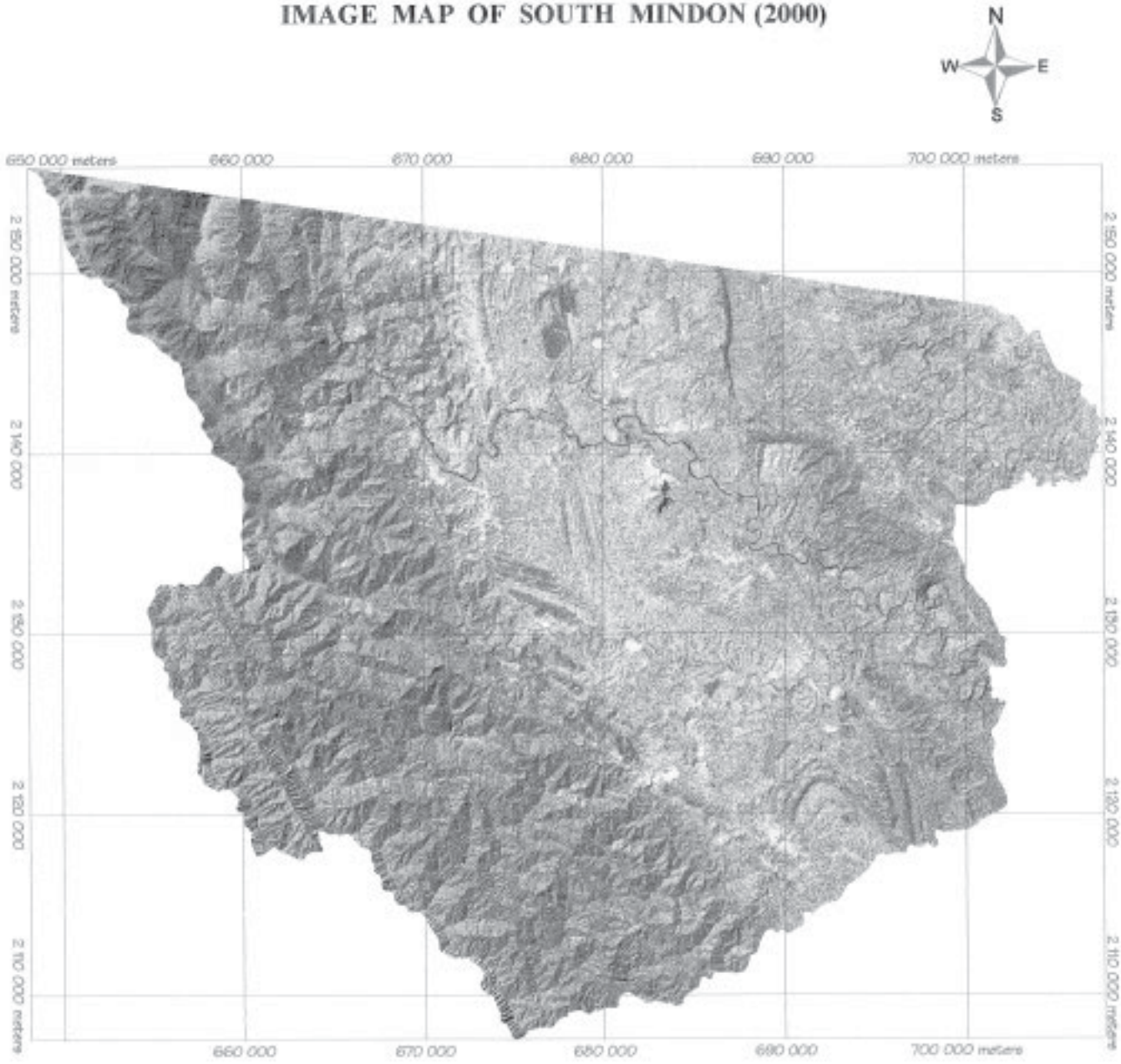
IMAGE MAP OF SOUTH MINDON (2000)

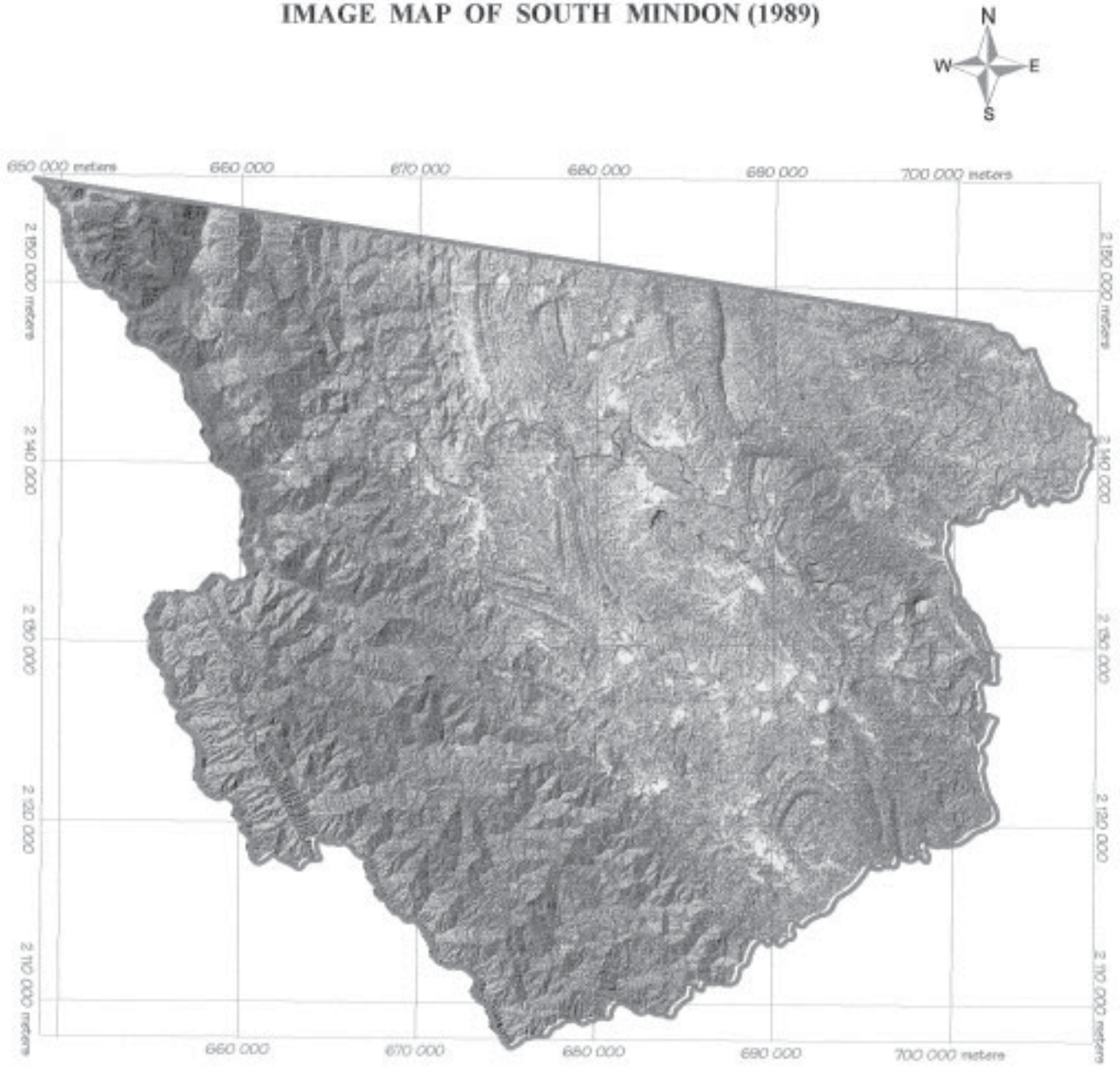


Acquired Date	**: 2_7_2000**
Satellite Sensor	**: Landsat 7**
Path / Row	**: 134_047**
Band	**: 4,5,3**
Projection	**: UTM**
Units	**: Metre**

5000 0 5000 10000 15000 meters

Appendex 1.Satellite image of South Mindon (2000)

IMAGE MAP OF SOUTH MINDON (1989)



Acquired Date	: 8_2_1989
Satellite Sensor	: Landsat 4
Path / Row	: 134_047
Band	: 4,5,3
Projection	: UTM
Units	: Metre

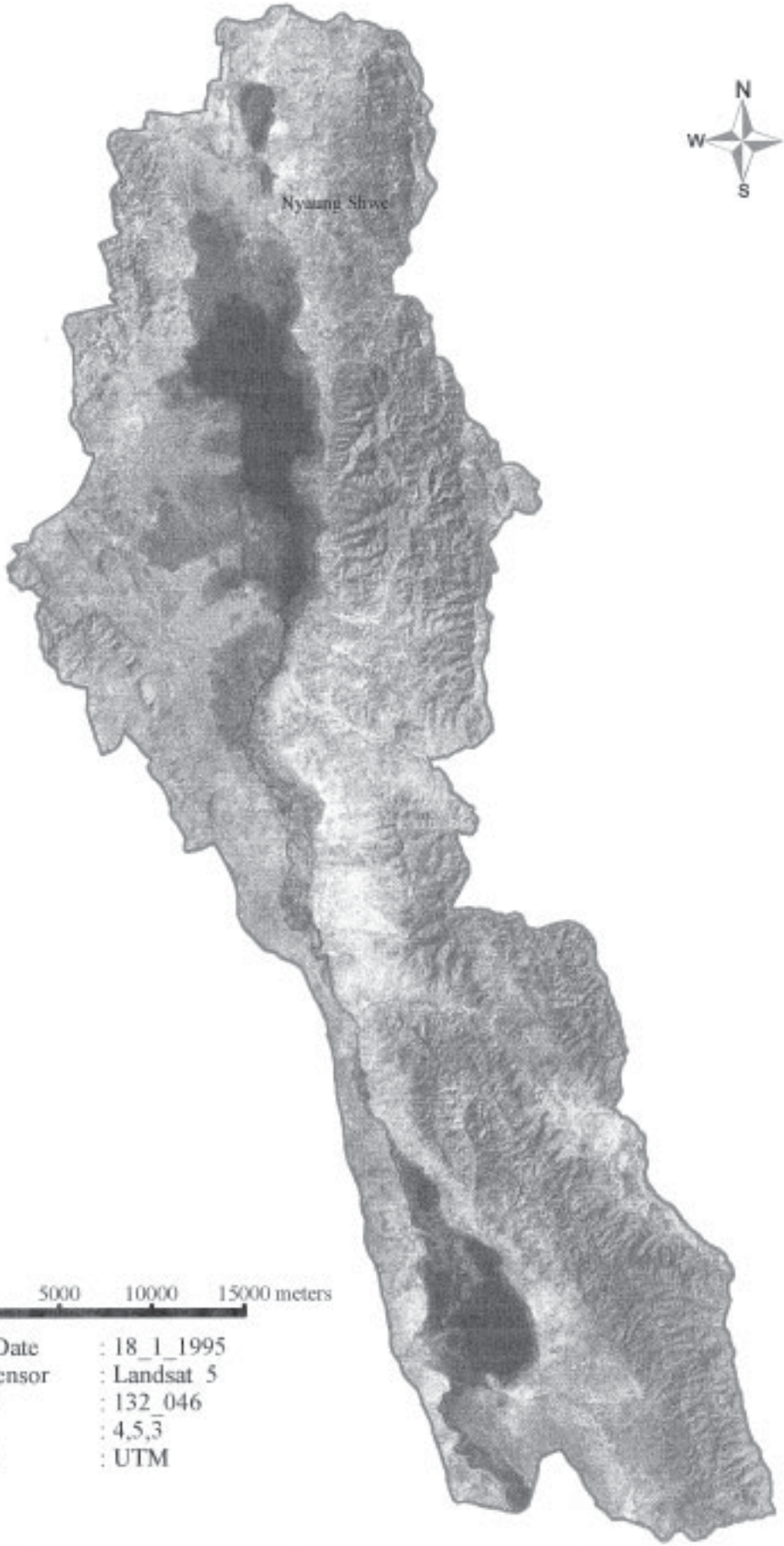
5000 0 5000 10000 15000 meters

Appendix 2. Satellite image of south Mindon (1989)

IMAGE MAP OF NYAUNG SHWE TOWNSHIP (2000)

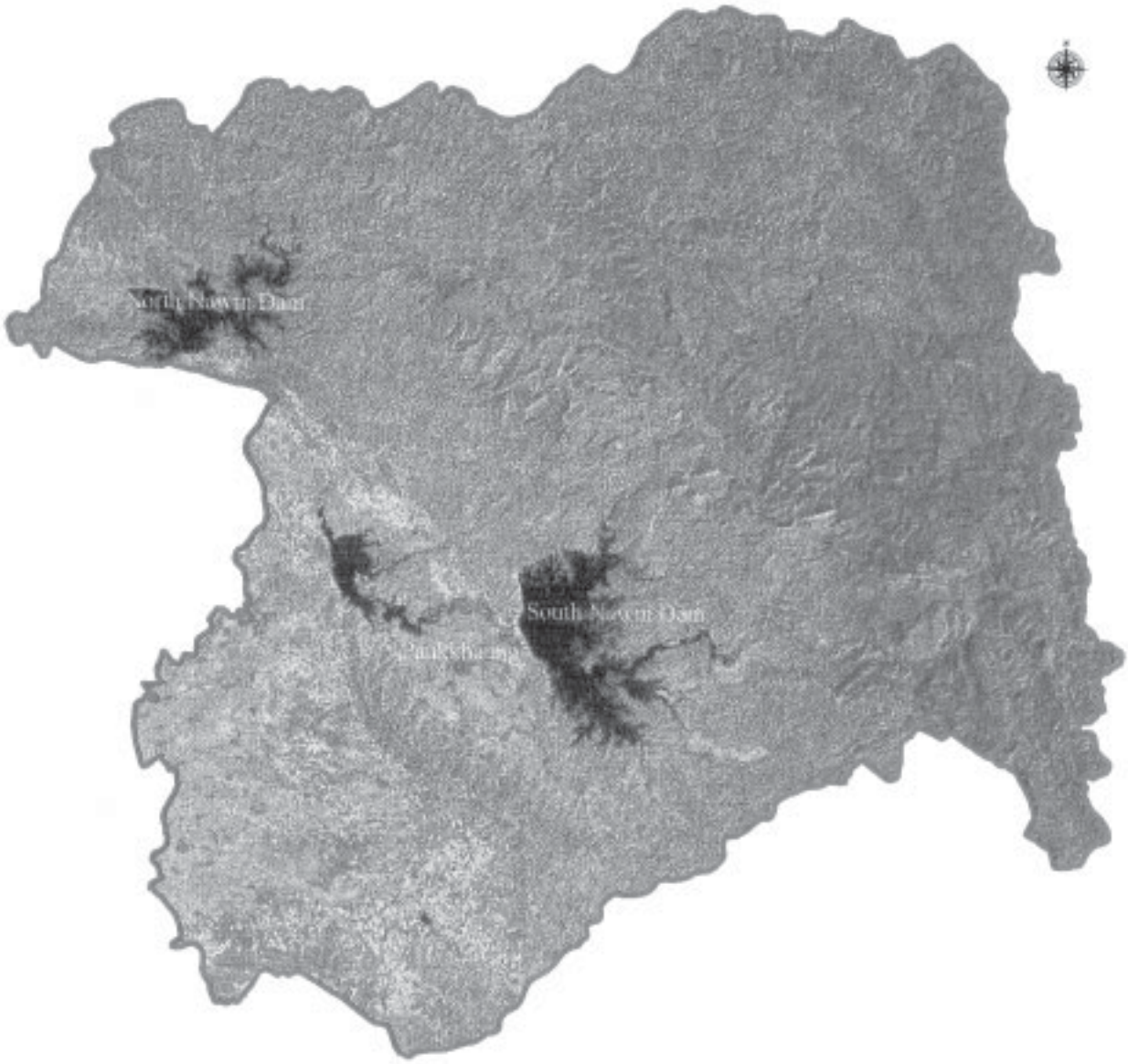
Appendix 3. Satellite image of Nyaung Shwe 2000

IMAGE MAP OF NYAUNG SHWE TOWNSHIP (1995)



Appendix 4. Satellite image of Nyaung Shwe (1995)

Landsat TM Imagery of Paukkhaung Township (1996)



Scale 1 : 350,000

2 0 2 4 6 8 10 kilometers

2 0 2 4 6 8 10 miles

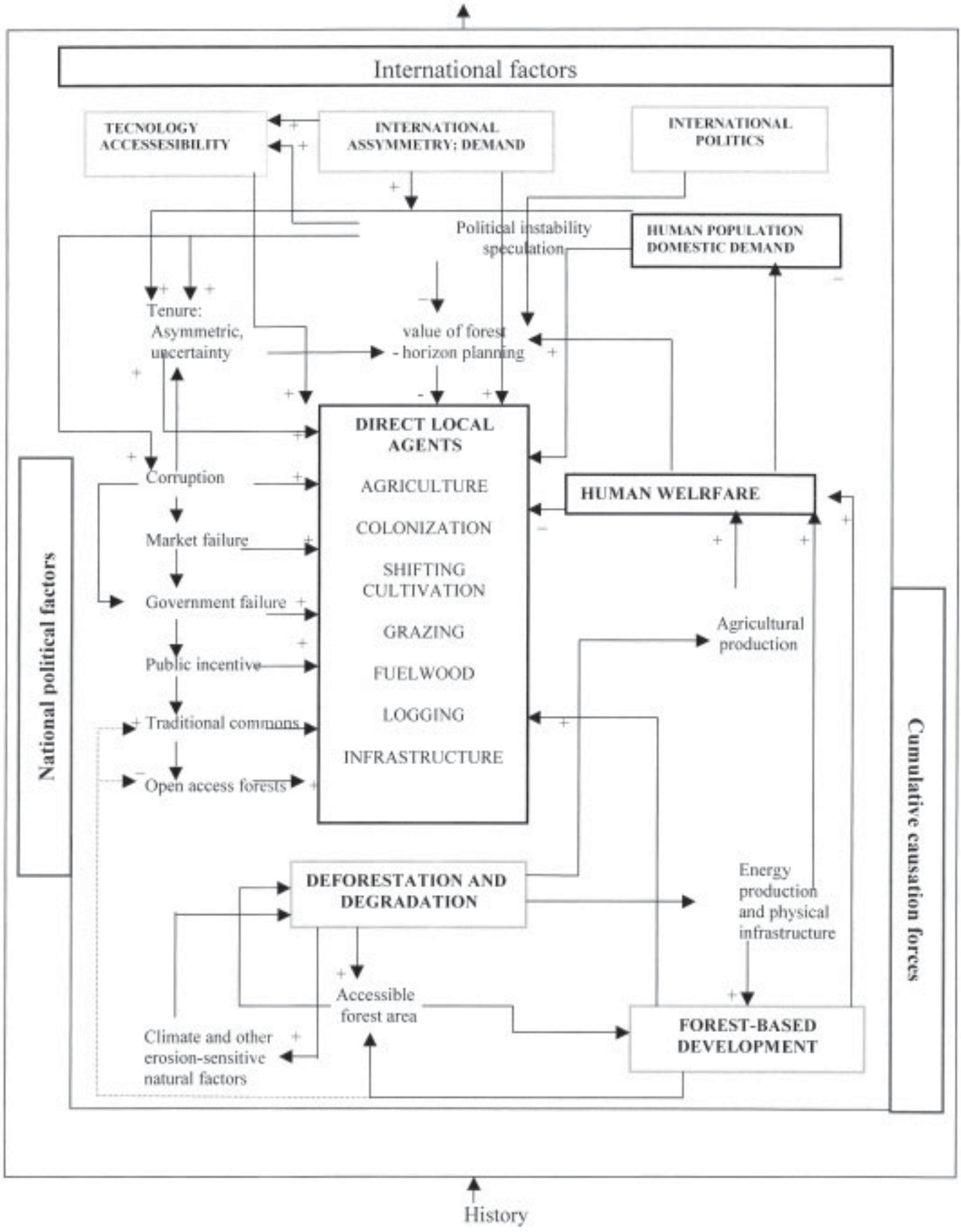
Appendix 5. Satellite image of Paukkaung (1996)

Appendix 6 Shifting cultivation and deforestation rate by state and division (1989)

	State and Division	Shifting cultivation area Sq Km	Shifting cultivation percent	Depletion rate per year
1	Kachin	8.119	9.1	0.68
2	Kayah	4.165	35.5	1.65
3	Kayin	11.080	36.5	1.45
4	Chin	17062	47.4	2.15
5	Mon	2804	22.8	3.01
6	Rakhine	3482	9.5	0.78
7	Shan	66896	42.9	0.40
8	Sagaing	5163	5.5	0.68
9	Bago	5594	14.2	2.21
10	Mandalay	6611	17.9	1.48
11	Ayeyarwady	2928	5.3	2.37
12	Yangon	478	4.7	1.30
13	Magway	15433	34.4	4,07
14	Tanintharyi	5637	13	0.68

Source: Forest Department Myanmar 1996

Appendix 7 Causality of deforestation (Polo, 2000)



Appendix 8 (a) Extraction of teak and other hardwoods from 1980-81 to 1999-2000

Year	Actual felling, m^3		Year	Actual felling, m^3	
	Teak	Hardwoods		Teak	Hardwoods
1980-81	957,280	1,166,170	1990-91	559,780	611,440
1981-82	862,930	875,930	1991-92	507,720	758,160
1982-83	798,130	1,153,550	1992-93	540,590	797,240
1983-84	508,050	899,360	1993-94	398,240	806,970
1984-85	641,990	884,250	1994-95	431,980	1,105,050
1985-86	779,130	1,027,080	1995-96	386,550	1,156,950
1986-87	706,540	896,930	1996-97	406,050	1,382,100
1987-88	654,230	603,690	1997-98	370,710	1,614,280
1988-89	633,630	641,500	1998-99	453,950	1,358,010
1989-90	632,750	643,750	1999-2000	520,400	1,722,510
Total				**11,750,630**	**20,104,920**

Source: Ministry of forestry, 2001

Appendix 8 (b) Local distribution and export of teak and other hardwoods (1992-93 to 2000-2001)

Year	Local distribution (m^3)				Export (m^3)			
	Teak		Hardwoods		Teak		Hardwoods	
	Log	Sawn	Log	Sawn	Log	Sawn	Log	Sawn
1992-93	1,890	44,270	19,070	178,530	187,830	58,290	53,340	423
1993-94	2,340	56,690	17,720	219,770	209,700	46,020	111,820	1,870
1994-95	1,650	24,560	19,720	259,500	187,740	40,590	99,360	1,310
1995-96	5,510	22,050	102,720	311,250	175,160	36,010	136,570	980
1996-97	6,010	18,590	43,480	345,300	213,390	36,230	195,440	1,260
1997-98	4,300	15,440	47,260	355,180	219,510	28,900	263,470	3,030
1998-99	14,310	13,210	122,280	322,790	272,380	37,570	404,350	660
1999-00	3,680	12,930	150,340	298,950	378,510	20,210	600,390	880
2000-01	-	25,790	-	403,200	270,000	43,340	180,000	1,800

Source: Ministry of forestry, 2001