

Expansion of Tree Plantation in Northeast Thailand: An Application of the Northeast Thailand Village Information System (NETVIS)

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Abstract

In Northeast Thailand, tree plantation in both public and private lands has progressed significantly in the last decade. Eucalyptus is the most popular species and its plantation is expected to replace commercial cultivation of upland crops. Eucalyptus plantation may become the dominant form of landuse of uplands in the Northeast in the near future, as kenaf was in the 1960s and cassava has been since the 1970s. Remote sensing technology for monitoring landuse has rapidly been developed and applied to data collection of national statistics. However, forest areas estimated from satellite images continue to decline and do not reflect recent expansion of tree plantations, partly due to the difficulty of distinguishing newly planted forest land from idle land and upland fields by remote sensing. The present study, therefore, aims at monitoring and mapping recent reforestation in Northeast Thailand based on the results of a questionnaire survey, available databases and national statistics, as a preparatory step to combining remote sensing technology with various types of field survey. NETVIS, an integrated GIS developed by the authors, which incorporates the Village Data Base (*KCC2K*) and agricultural statistics as its primary data, is applied to this study. The major

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products include maps of tree plantation distribution by kinds of tree, types of land and ages of plantation, maps of community land available for tree plantation and community forest plantation, and maps of upland field distribution by kinds of crop. These maps and an analysis of landuse changes indicate that in Northeast Thailand around 2 % of agricultural land, mostly cassava field, has been replaced by tree plantation, mostly eucalyptus, in the last decade. On the other hand, community lands recently planted and available for future tree plantation are scattered all over the Northeast.

I INTRODUCTION

In Northeast Thailand, tree plantation in both public and private lands has progressed significantly in the last decade. Eucalyptus is the most popular species and its plantation is expected to replace commercial cultivation of upland crops. It is harvested five to seven years after planting and every two to five years thereafter, and used for paper production, furniture making and construction scaffolding. Eucalyptus plantation may become the dominant form of landuse of uplands in the Northeast in the near future, as kenaf was in the 1960s and cassava has been since the 1970s (Kono *et al.*, 1994).

Remote sensing technology for monitoring landuse has rapidly been developed and applied to data collection of national statistics. However, forest areas estimated from satellite images continue to decline and do not reflect recent expansion of tree plantations, partly due to the difficulty of distinguishing newly planted forest land from idle land and upland fields by remote sensing. The present study, therefore, aims at monitoring and mapping recent tree plantation in Northeast Thailand based on non-remote-sensing data, including the results of a questionnaire survey, available databases and national statistics, as a preparatory step to combining remote sensing technology with various types of field survey. Its major focuses are 1) what area is presently occupied by tree plantations, 2) where

tree plantations are distributed, and 3) how much land is available for expansion of tree plantations in the near future. Both private and public lands are covered by the study.

The Northeast Thailand Village Information System (NETVIS), an integrated GIS developed by the authors, which incorporates the Village Database (*KCC2K*) and agricultural statistics as its primary data. Furthermore, NETVIS has a database of longitude and latitude of about 26,000 villages (*mu ban*), which is equal to 91% of the total villages, in the northeastern part of Thailand. This database enables various kinds of maps to be produced based on the village-level information.

II DATA USED

Data used in the present study are as follows.

1. Questionnaire survey

To collect information on the present status of tree plantation on private and public lands, a questionnaire survey was carried out in four provinces, Yasothon, Buriram, Maha Sarakham and Nong Bua Lamphu, in cooperation with the Royal Forest Department (RFD) and the Reforestation and Extension Project in the Northeast of Thailand (REX). Questionnaires were distributed to all village headmen (*phu yai ban*) in the four provinces through four nursery centers of RFD in the Northeast and provincial offices of RFD or district offices at the beginning of June, 1996 (Table 1). After filling out the questionnaire, village headmen sent it to Maha Sarakham Nursery Center by mail or brought it to a district office. Response rates are summarized in Table 2.

2. Village level socio-economic conditions

Village Databases (*KCC2K*) for 1986, 1988, 1990 and 1992 were already

incorporated in NETVIS and are referred to in the present study. These databases cover a wide range of information, including basic information on population and households, infrastructure, production environment, education, and hygiene (Nagata, 1996a; 1996b). Some studies done using NETVIS were reported in earlier papers (Nagata, 1996b; 1996c; Nagata *et al.*, 1996).

3. Landuse and areas planted with major crops

Data available in *Agricultural Statistics of Thailand* (Office of Agricultural Economics; hereafter cited as *Agricultural Statistics*) were referred to in the present study. Landuse data are available by province for the period from 1975 to 1992, except 1987, 1989 and 1990. Landuse of the total farm holdings is classified into eight categories: "housing area," "paddy land," "field crops," "fruit trees and tree crops," "vegetables and flowers," "grassland," "idle land," and "others". A note defines "idle land" as an area which overgrown with grasses, and which has not been planted with crops in the recent past; while "other" land includes roads, sidewalks, ditches, wells, and fish ponds. Data on areas planted with rice, maize, cassava, sugarcane, mungbean, sorghum, soybeans, groundnuts, cotton, and kenaf are available by province for the period from 1980 to 1994. Data on areas planted with various fruit trees and tree crops are available by province for 1992 (Department of Agricultural Extension, 1993).

4. Database developed by the Community Forestry Division, RFD

The Community Forest Department is collecting information on community forests in the whole country and developing a database. Items included in the database are location (village name), forest type, year established, area, land status and remarks. The present study referred to the database compiled before 1992, which includes 10,293 cases of community forest in the Northeast. These community forests are distributed in 6,300 villages, in 1,425 sub-districts (*tambon*), 215 districts and 19 provinces in the Northeast.

III PRESENT TREE PLANTATION AREA

1. Validation of data

Table 3 summarizes the results of the survey. The average non-eucalyptus private tree plantation areas in the three provinces other than Nong Bua Lamphu coincide with the areas of "fruit trees and tree crops" in *Agricultural Statistics*. Moreover, the results of the questionnaire survey and a database developed by the Community Forest Department of RFD, mentioned below, show similar frequency distributions in the size of public tree plantations. Therefore, it is judged that the results of the questionnaire survey reflect the present situation of tree plantations in the four provinces and are valid in the following analysis.

2. Results and Discussions

2.1 Eucalyptus plantations on private lands

The average area of eucalyptus plantations on private lands does not significantly differ between provinces and is presently 40 to 50 *rai* (1 *rai* = 0.16 ha) per village, of which 50% was planted during the last five years (1991 - 1995) (Table 3). Assuming that the average area of eucalyptus plantations per village is 40 *rai*, the total areas of eucalyptus plantations on private lands in the Northeast is estimated to be 1.1 million *rai*, which is equal to 2% of the total agricultural land. Eucalyptus plantations in the Northeast were mainly established from the mid-1980s, and thus their area increased by 0.2% of the total agricultural land per year during the last decade.

2.2 Non-eucalyptus tree stands on private lands

Areas of tree stands other than eucalyptus per village are 40 to 50 *rai* in Buriram and Maha Sarakham provinces and more than 100 *rai* in Yasothon and Nong Bua Lamphu provinces. The area newly planted during the last five years does not differ significantly between provinces and is about 20 *rai* per village. Estimated areas of tree stands other than eucalyptus in the three provinces other than Nong Bua Lamphu in 1991, as mentioned above, coincide closely with the

areas of "fruit trees and tree crops" in *Agricultural Statistics*. This indicates that both eucalyptus and non-eucalyptus plantations have expanded at the same rate during the last five years in Yasothon, Buriram and Maha Sarakham. The major non-eucalyptus trees in these provinces are mango, cashew, para rubber, and sweet bamboo (Department of Agricultural Extension, 1993). In Nong Bua Lamphu, the estimated area of tree stands other than eucalyptus in 1991 is two times larger than the area of "fruit trees and tree crops" in *Agricultural Statistics*. The difference is thought to be accounted for by natural forests and plantations of non-eucalyptus trees such as teak and *pradu* (*Pterocarpus macrocarpus Kurz*).

2.3 Tree stands on public lands

The average area of community forests in the four provinces is 150 *rai*, of which 25 *rai* was newly planted during the last five years, with half of newly planted trees being eucalyptus. It is remarkable that the average area of community forest in Yasothon is as large as 250 *rai*, of which 30% is recently planted eucalyptus.

IV DISTRIBUTION OF EUCALYPTUS PLANTATIONS

1. Method of analysis

Two factors are hypothetically assumed to determine the distribution of eucalyptus plantations. These are land availability and labor availability. Land availability is assumed to be quantified in terms of the scale of cassava farm holding, because cassava is the dominant field crop in the Northeast and in the process of being replaced by eucalyptus plantations (Figure 1). The questionnaire-surveyed districts are classified into three types based on the average scale of cassava farm holding: large (10 *rai* or over), medium (5 to 10 *rai*) and small (less than 5 *rai*). Labor availability is assumed to be quantified in terms of the proportion of the total labor population that is working away from the village (Figure 2). The districts are also classified into three types from this viewpoint: high (one-third or more),

medium (one-fifth to one-third) and low (less than one-fifth). With these criteria, all the surveyed districts in the Northeast were classified into nine types, and the average area of eucalyptus plantations in each type was calculated.

2. Results and discussions

The results show a clear correlation between the area of eucalyptus plantations and the scale of cassava farm holding (Table 4). Expansion of eucalyptus plantations is concentrated in areas with large cassava farm holdings. This indicates that many of the lands planted with eucalyptus were formerly cassava fields, and this trend is expected to continue in the future. On the other hand, no correlation can be found between eucalyptus plantation and labor availability. This indicates that there are various reasons why villagers work away from their home villages. Replacement of cassava by eucalyptus is both a cause and a result of working away. A lack of diversity in local working opportunities is another reason for a high proportion of working away, because the proportion is comparatively high in areas of monoculture of rice (Figure 2).

V LAND AVAILABILITY FOR TREE PLANTATION IN THE YEAR 2000: PRIVATE LAND

1. Method of estimation

The area of potential tree plantation (PTP) on private lands of the Northeast in the year 2000 was estimated based on landuse data in *Agricultural Statistics*. Two types of land were considered: recently abandoned agricultural land, and rarely cultivated agricultural land. The former is assumed to be included in "field crops" in the landuse data in *Agricultural Statistics*, because the area of "field crops" and the sum of areas planted with the major field crops were almost the same until the mid-1980s, since when the area of "field crops" has tended to be larger than the sum of areas planted with the major field crops. The latter is assumed to be part of the "idle land," which consists of rarely cultivated arable land and non-arable land.

Therefore, PTP is calculated by the following equation.

$$A_{ptp} = A_t - A_h - A_p - A_u - A_f - A_v - A_g - A_w - A_{na}$$

where A_{ptp} is the potential tree plantation area, A_t is the area of farm holdings, A_h is housing area, A_p is the area of paddy land, A_u is the area under field crops, A_f is the area under fruit trees and tree crops, A_v is the area under vegetables and flowers, A_g is the area of grass land, A_w is the area of water bodies, farm roads, ditches and dikes and A_{na} is the area of non-arable land.

The area under field crops is calculated by the following equation.

$$A_u = \sum (C_i * A_{pli})$$

where C_i is assumed to be 1 for maize, cassava, sugarcane, sorghum, cotton and kenaf, 0.5 for groundnut and 0 for mungbean and soybeans, and A_{pli} is the area planted with the i th crop.

The changes in each type of landuse and the area planted with each crop were extracted from the yearly fluctuating raw data of the past 20 years, extrapolated to the year 2000 and input into the above equations. The area of non-arable land was assumed to be constant and equal to the minimum area of "idle land" during the last 20 years.

2. Results and discussions

Land availability in 2000 was estimated for two cases. Case 1 assumes that the present trend of abandoning agricultural land will continue, and Case 2 assumes that the trend will accelerate.

The results are summarized in Figures 3 and 4. PTP is 3.8 million *rai* at present, of which 1.1 million *rai* has already been planted, mostly by eucalyptus. This will increase to 4.3 to 6.5 million *rai* in the year 2000. These lands are mostly abandoned cassava fields, so that their distribution should be similar to present cassava field distribution (Figure 1). This suggests that, in the near future, land

availability will not limit the expansion of tree plantations, even though the rate of expansion is two or three times faster than that of the last decade.

VI LAND AVAILABILITY FOR FUTURE TREE PLANTATION: PUBLIC LAND

There are two questions in the Village Database related with community forest, as follows.

Q1 How much land is available for planting community forest?

Q2 Of this, how much land has already been planted?

The results are summarized in Table 5 and mapped in Figure 5 and 6. They show that 31% of the villages in the Northeast have community land for tree plantation, of which 62% of the villages had already planted their land. The average area of available land for all villages is 75 *rai*, of which 13 *rai* has already been planted. These lands are scattered all over the Northeast.

VII CONCLUDING REMARKS

The major conclusions of the present study are summarized below.

- 1) It is estimated that, at present, 2% of agricultural land in Northeast Thailand is occupied by eucalyptus plantations.
- 2) Many of the present eucalyptus plantation occupy former cassava fields, and this trend is expected to continue in the future.
- 3) Private land availability will not limit the expansion of tree plantations in the near future, even though the rate of expansion is two or three times faster than that of the last decade.
- 4) Lands available for community forest plantation are scattered all over the

Northeast and average 75 *rai* per village.

The monitoring and mapping of tree plantation in the present study is still unsatisfactory, mainly due to lack of data on the present tree plantation situation. In order to establish suitable policy for forest resources conservation and reforestation, it is particularly recommended that monitoring of eucalyptus plantations should be included in *KCC2K*, in the same way as field crops, that tree plantation surveys should be carried out by RFD at the district level, and that this information should be combined with monitoring and mapping based on remote sensing data.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to Mr. Kengo Yoshida, JICA expert, Dr. Shinya Takeda, Kyoto University, Dr. Monton Jamroenprucksa, Kasetsart University, Mr. Somchai Manopiroonporn, Royal Forestry Department, Mr. Anan Son-ngai, field manager, Mr. Suthep Pawaretwitthayalan, Mr. Bandit Kopmu, Mr. Wanlop Waeowichit, Mr. Somphon Chaicharat, chiefs of the nursery centers of REX, and the staff of the JICA-REX Project for their suggestions and support in data collection.

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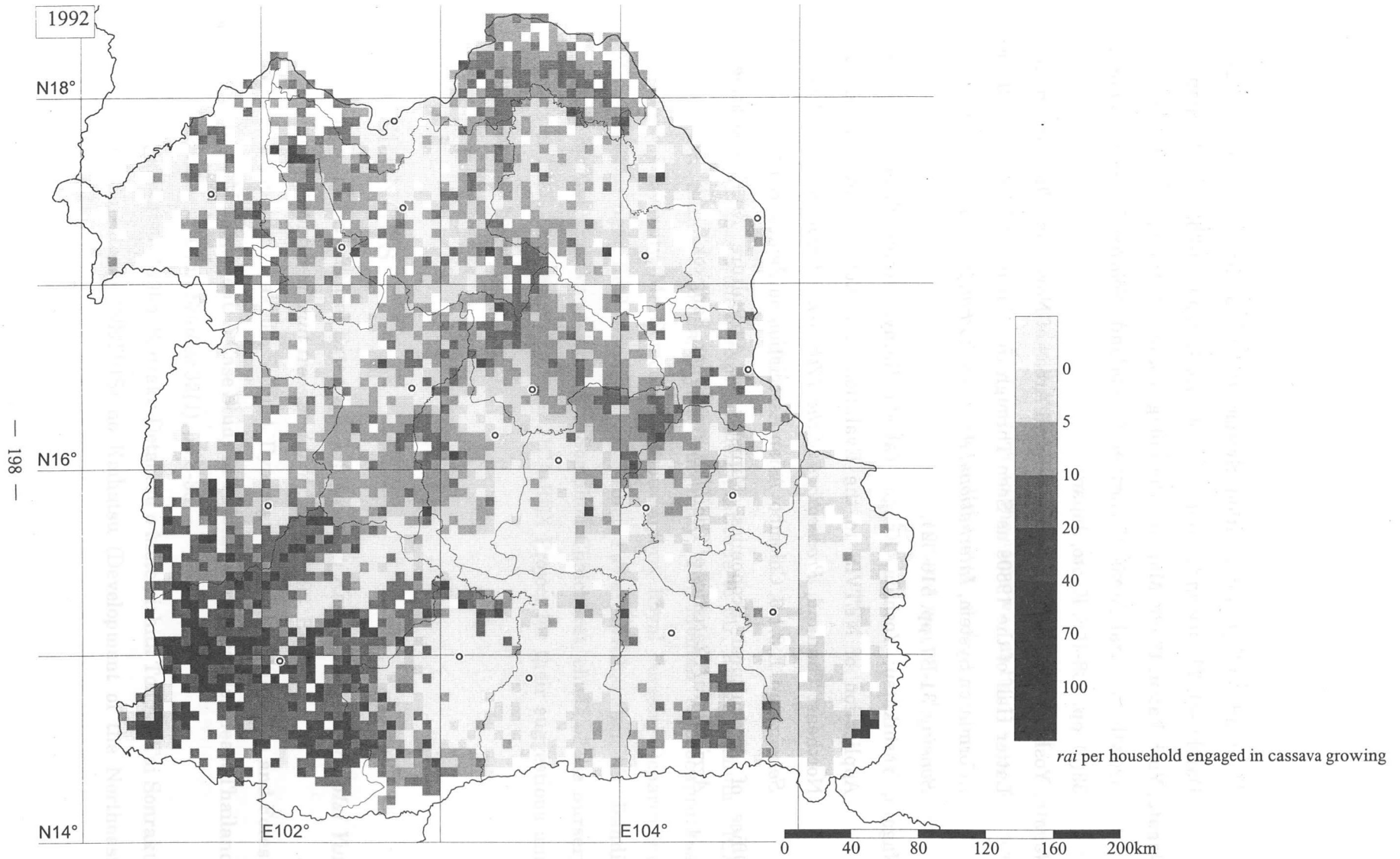


Figure 1 Cassava Farm Holdings

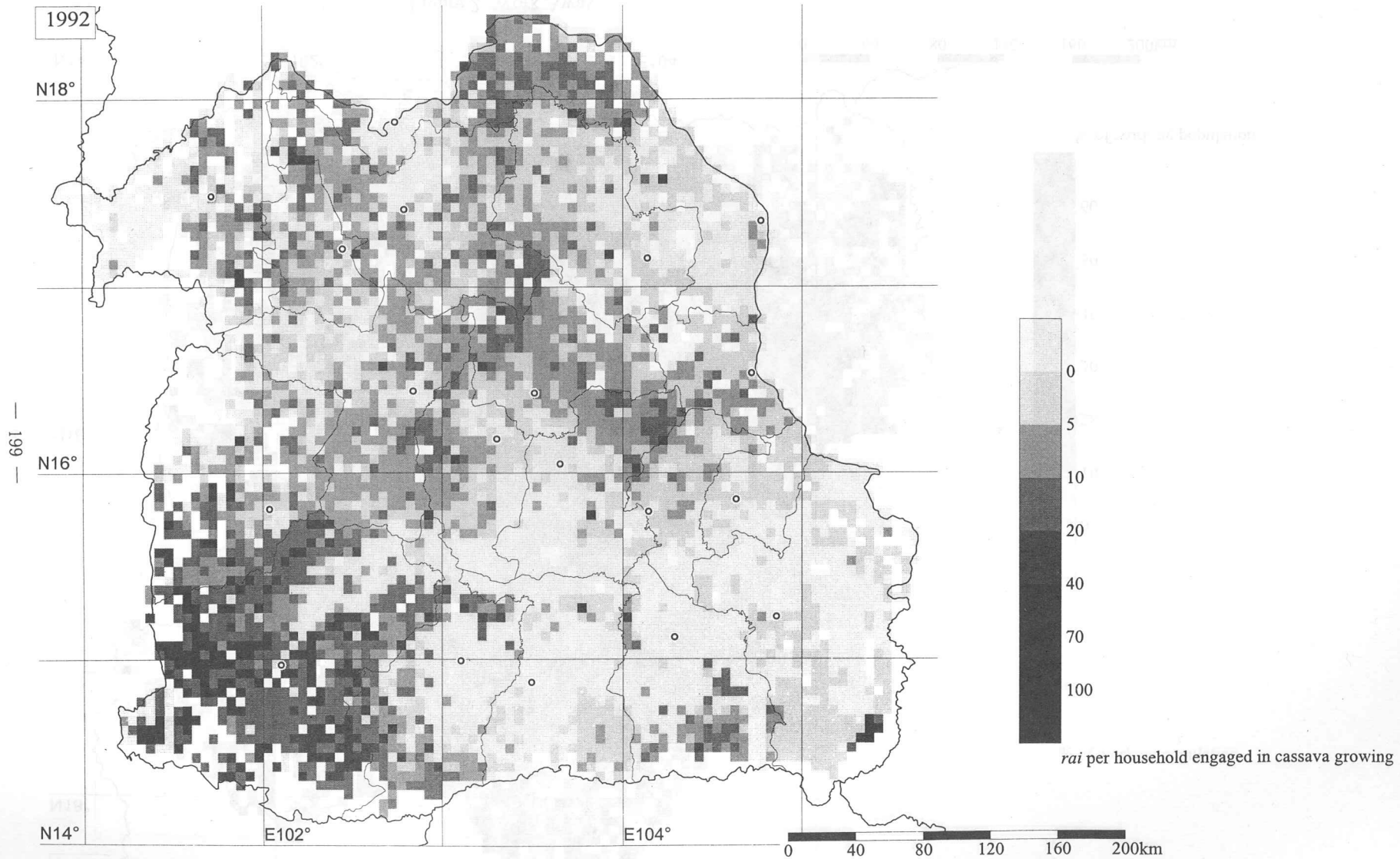


Figure 1 Cassava Farm Holdings

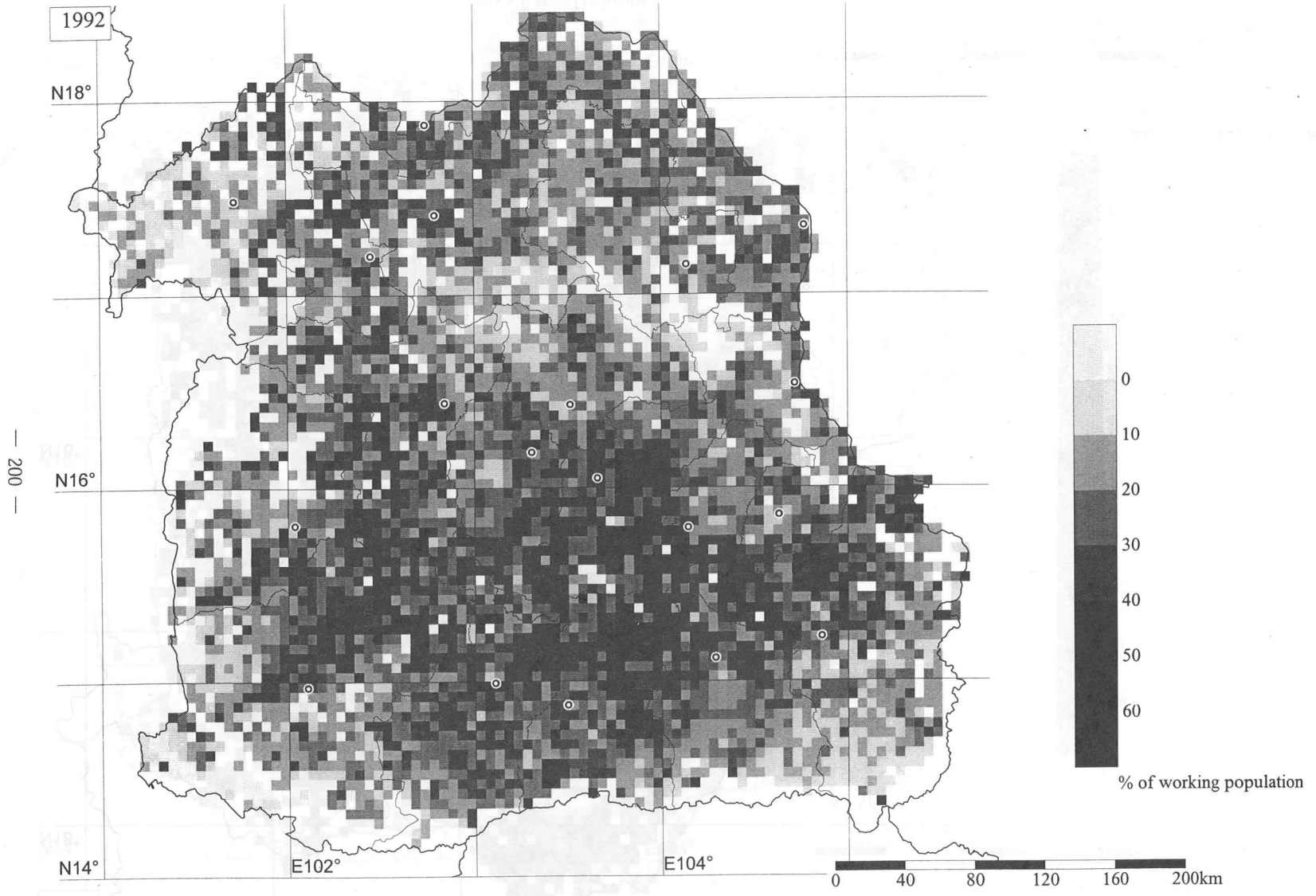


Figure 2 Work Away

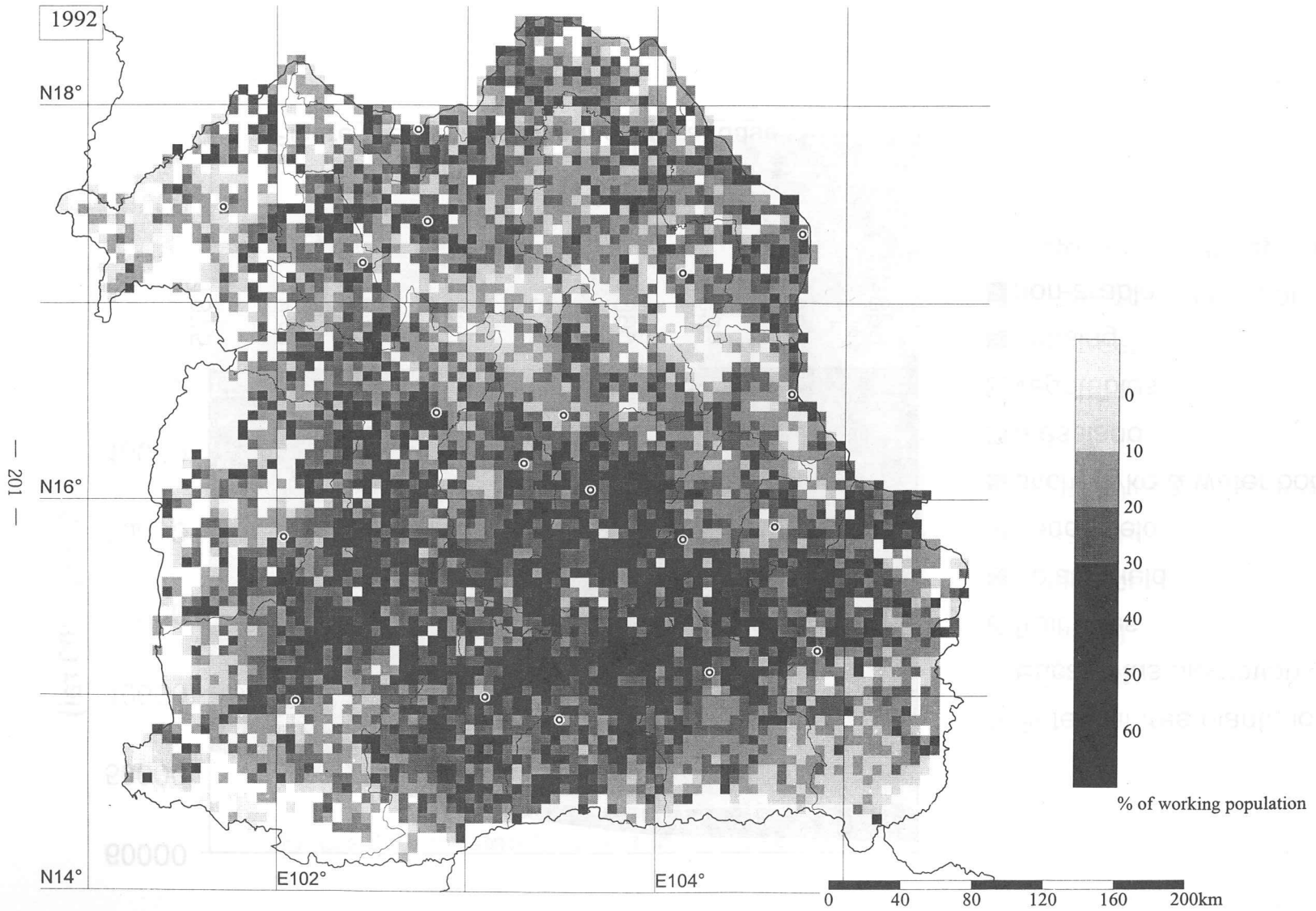


Figure 2 Work Away

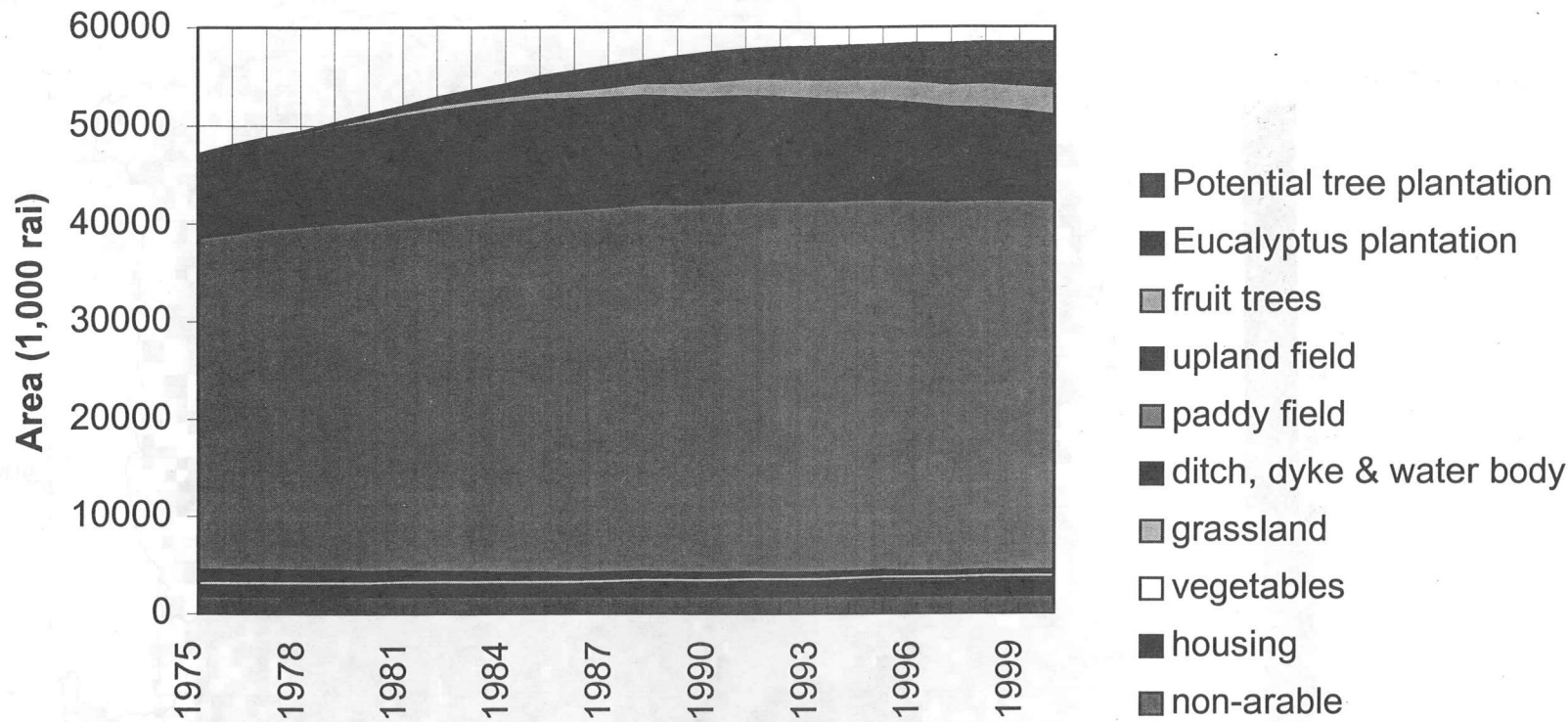


Figure 3 Estimated Changes in Landuse

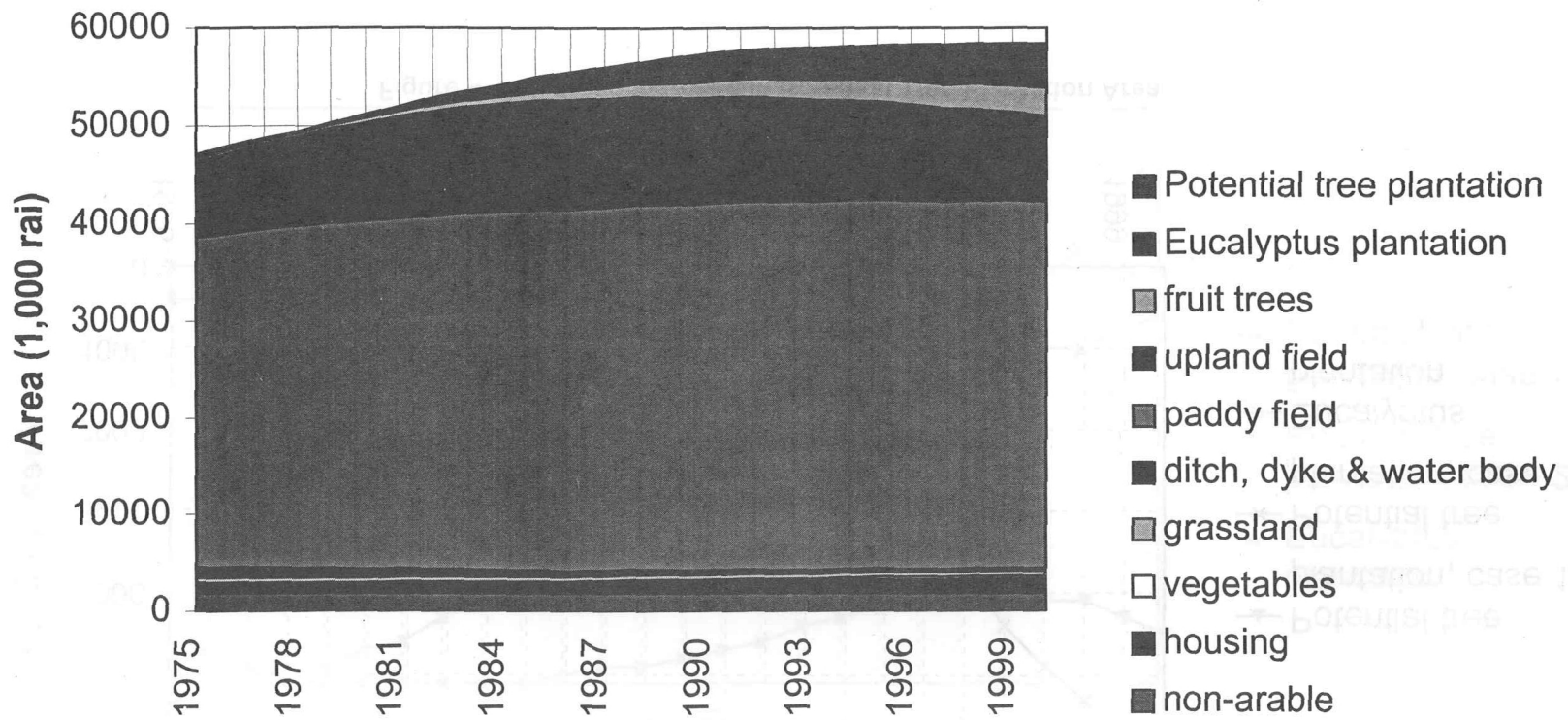


Figure 3 Estimated Changes in Landuse

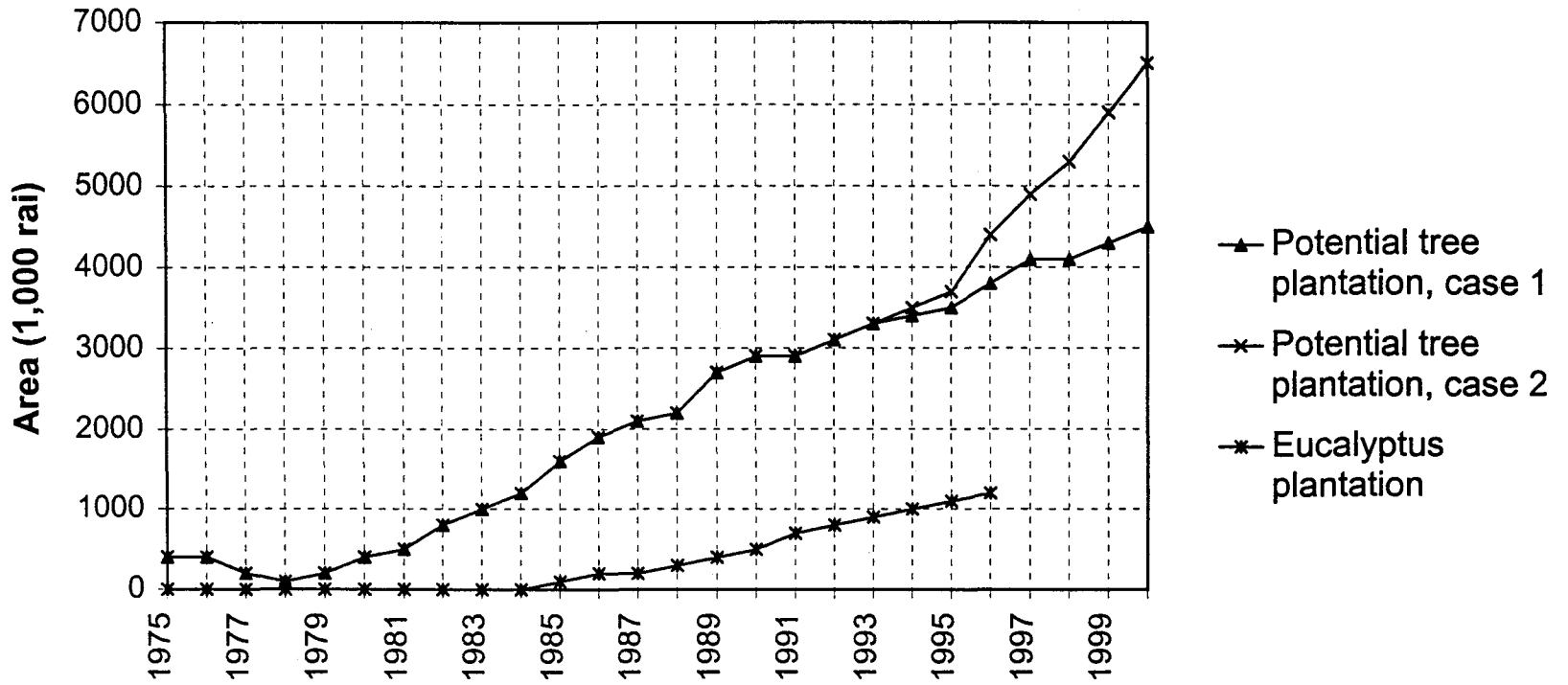


Figure 4 Estimated Increase in Potential Tree Plantation Area

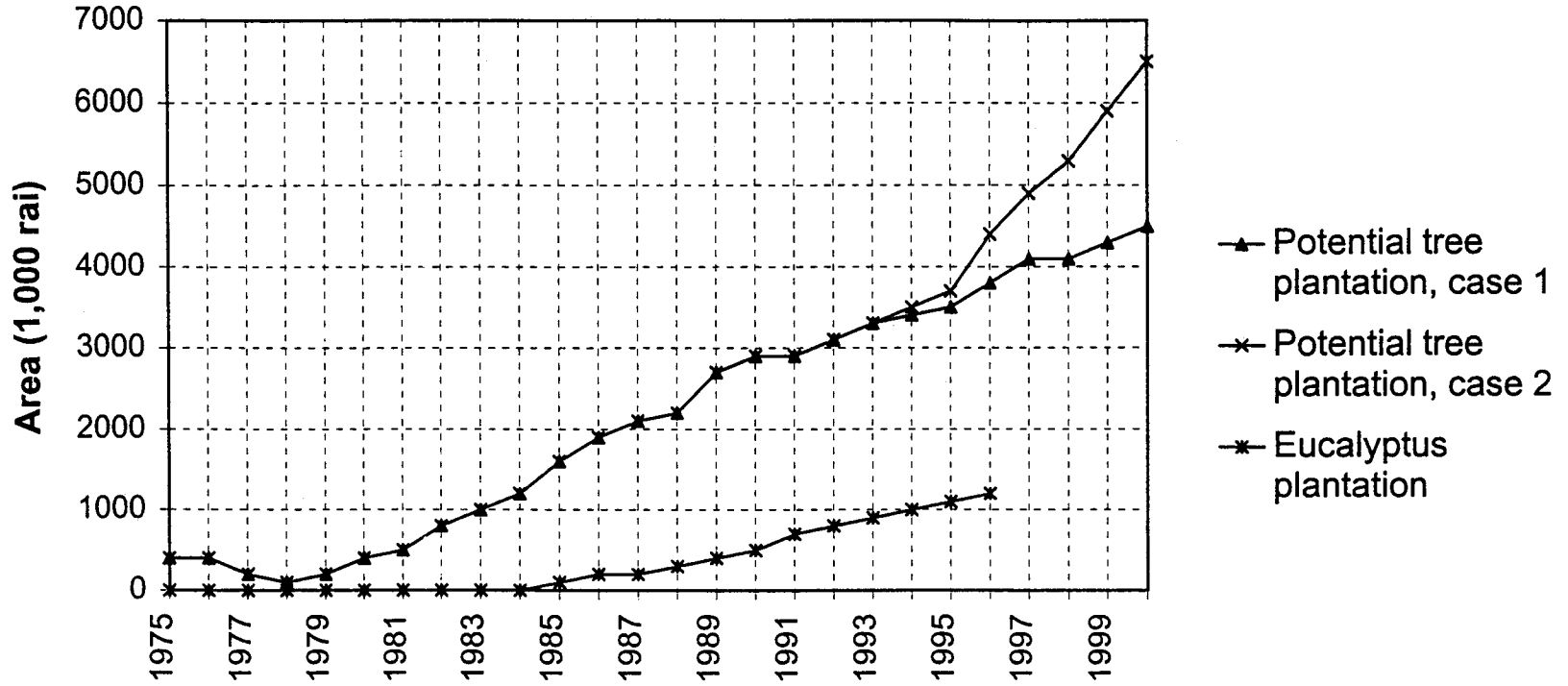


Figure 4 Estimated Increase in Potential Tree Plantation Area

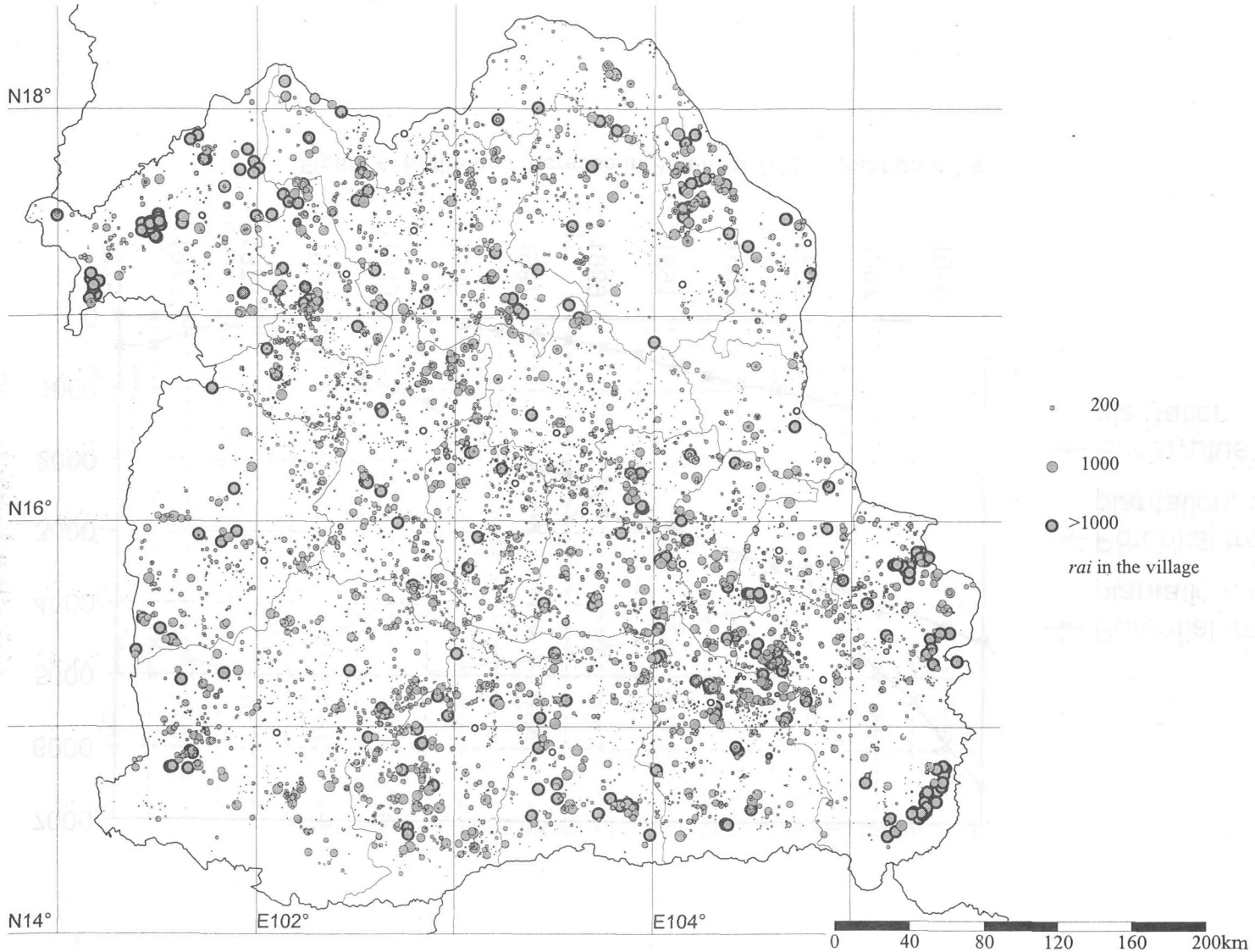


Figure 5 Available Area for Community Forest

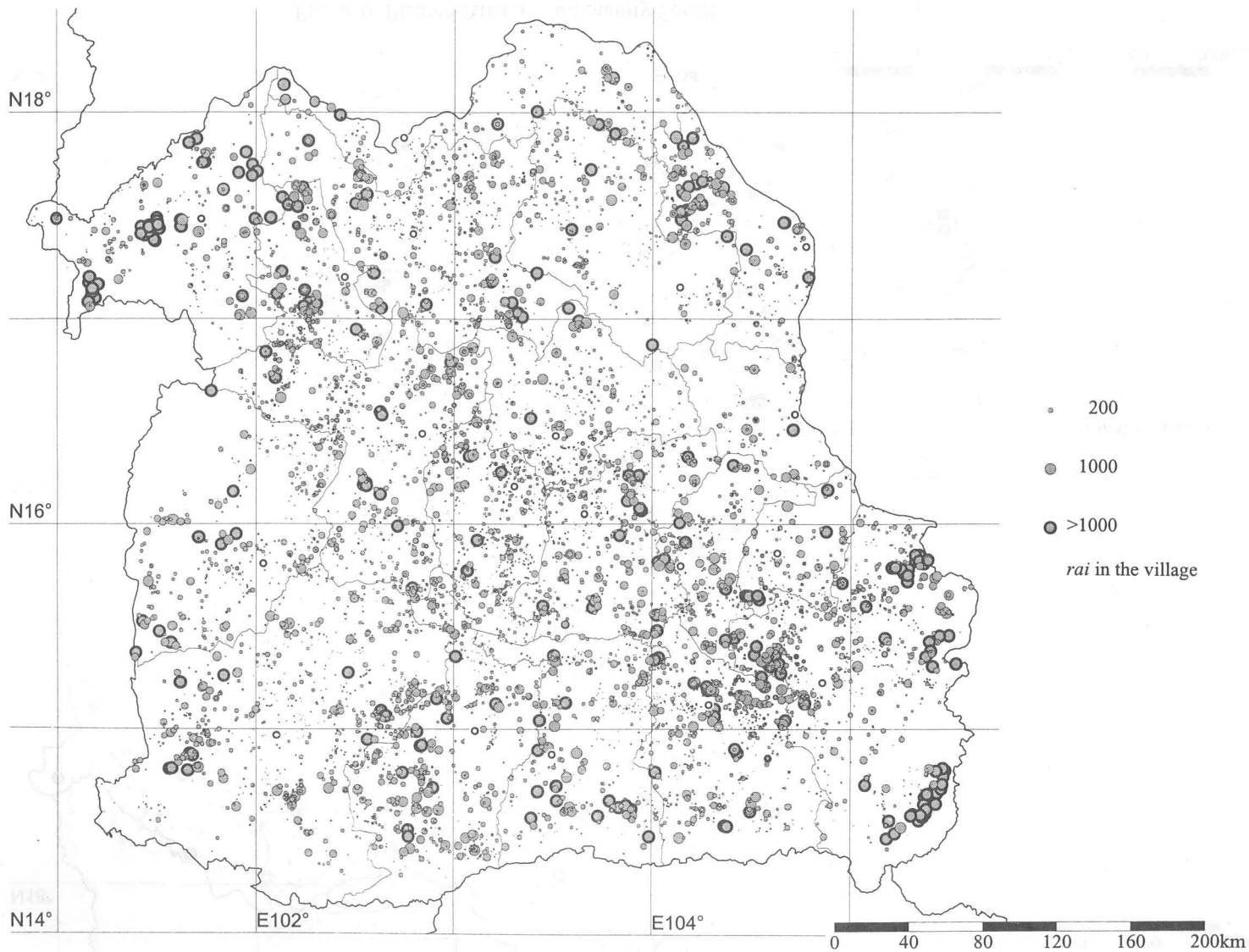


Figure 5 Available Area for Community Forest

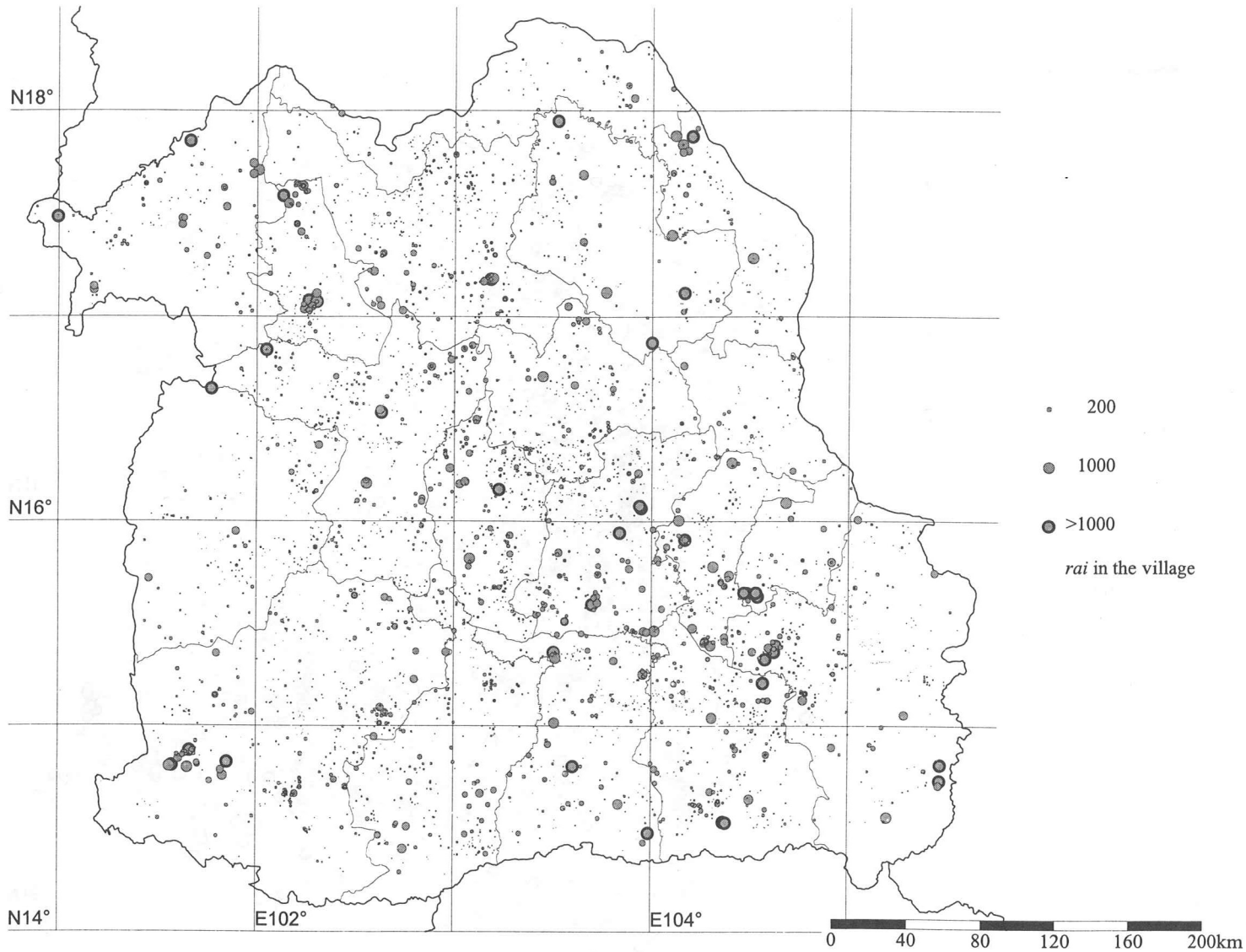


Figure 6 Planted Area of Community Forest

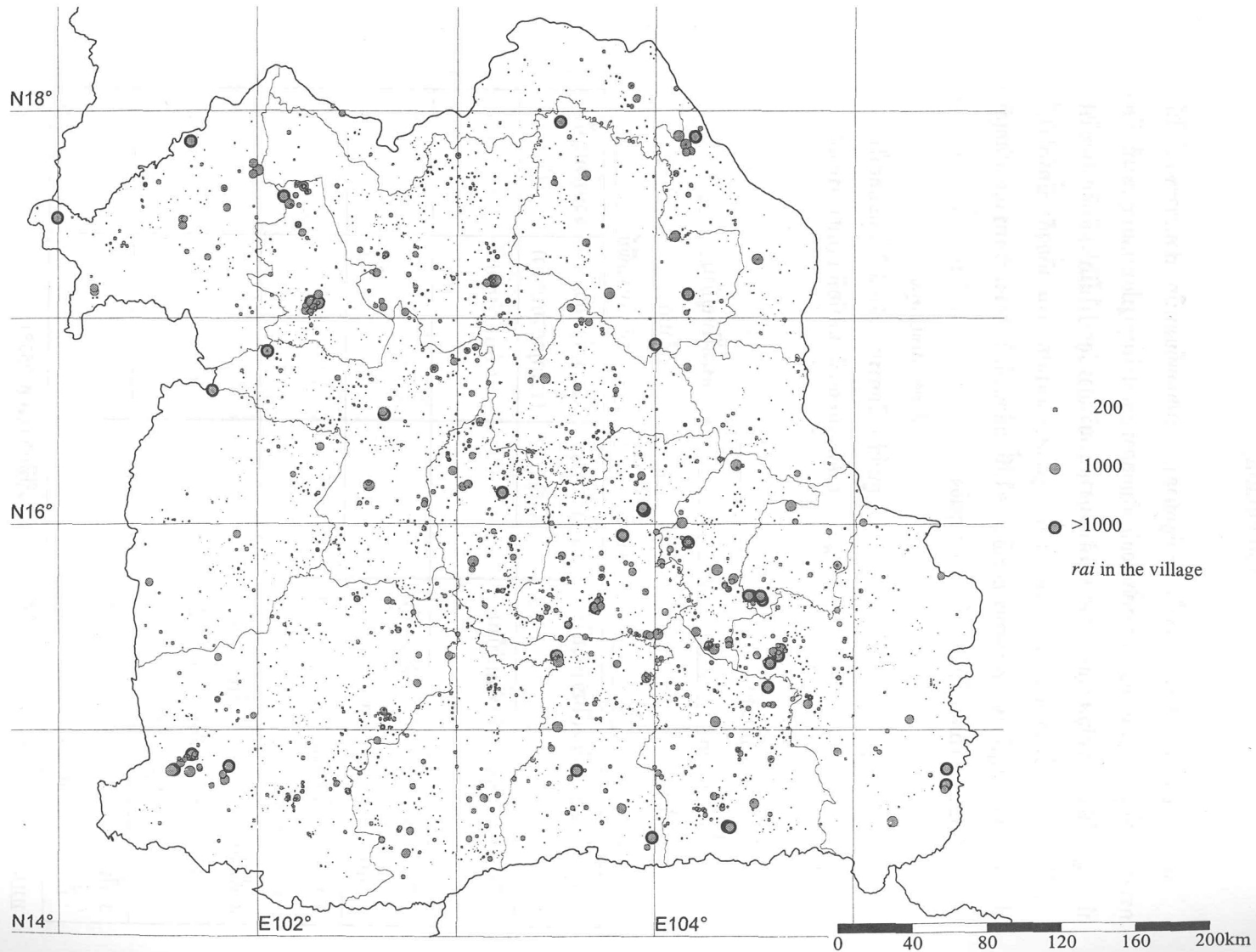


Figure 6 Planted Area of Community Forest

Table 1 Questionnaire Sheet

แบบสอบถาม

โครงการส่งเสริมการเพาะชำกล้าไม้และปลูกป่าภาคตะวันออกเฉียงเหนือ ส่วนเพาะชำกล้าไม้ กรมป่าไม้ ต้องการสำรวจและรวบรวมข้อมูลเกี่ยวกับผลการปลูกป่าในทุกรูปแบบและทุกพื้นที่ เพื่อนำข้อมูลที่ได้ไปประเมินผลและวางแผนการดำเนินงานส่งเสริมการปลูกป่าให้มีประสิทธิภาพต่อไป

โครงการฯจึงใคร่ขอความร่วมมือจากท่าน กรุณาตอบแบบสอบถาม เกี่ยวกับเนื้อที่ป่าไม้ ประเภทต่างๆในหมู่บ้านของท่านตามรายละเอียดต่อไปนี้ แล้วส่งคืนให้โครงการฯทราบตามที่อยู่ที่แนบมาพร้อมนี้(โดยไม่ต้องติดแสตมป์) จักขอบพระคุณยิ่ง

ด้วยความขอบคุณ

ศูนย์ส่งเสริมการเพาะชำกล้าไม้และปลูกป่า
ภาคตะวันออกเฉียงเหนือที่ 1 (มหาสารคาม)

วันที่กรอกแบบสอบถาม _____

ชื่อ-นามสกุล _____ ตำแหน่งผู้ใหญ่บ้าน _____

ชื่อบ้าน _____ หมู่ที่ _____ ตำบล _____

อำเภอ _____ จังหวัด _____ รหัสไปรษณีย์ _____

กรุณาให้รายละเอียดเป็นจำนวนไร่	ในที่สาธารณะ (ไร่)	ที่ส่วนตัว (รวมทุกครอบครัว)	รวมทั้งหมู่บ้าน (ไร่)
1. พื้นที่สวนป่ายูคาลิปตัสทั้งหมู่บ้าน			
2. พื้นที่ปลูกไม้ยูคาลิปตัสในช่วง 5 ปีที่ผ่านมา (พ.ศ. 2534-2538)			
3. พื้นที่สวนป่ายูคาลิปตัสที่ตัดฟันในปีที่แล้ว (พ.ศ. 2538)			
4. พื้นที่ป่าทั้งหมดในหมู่บ้าน รวมถึงป่าธรรมชาติ สวนพืชป่า สวนผลไม้ (ยกเว้นสวนป่ายูคาลิปตัส)			
5. พื้นที่ปลูกไม้ยืนต้นอื่นๆ ในช่วง 5 ปีที่ผ่านมา (พ.ศ. 2534-2538)			

หมายเหตุ กรุณาให้ราคาขายเฉลี่ยไม้ยูคาลิปตัสในปีที่แล้ว (พ.ศ. 2538)

ราคาตันละ _____ บาท และ/หรือ ไร่ละ _____ บาท

Table 1 Questionnaire Sheet

แบบสอบถาม

โครงการส่งเสริมการเพาะชำกล้าไม้และปลูกป่าภาคตะวันออกเฉียงเหนือ ส่วนเพาะชำกล้าไม้ กรมป่าไม้ ต้องการสำรวจและรวบรวมข้อมูลเกี่ยวกับผลการปลูกป่าในทุกรูปแบบและทุกพื้นที่ เพื่อนำข้อมูลที่ได้ไปประเมินผลและวางแผนการดำเนินงานส่งเสริมการปลูกป่าให้มีประสิทธิภาพต่อไป

โครงการฯ จึงใคร่ขอความร่วมมือจากท่าน กรุณาตอบแบบสอบถาม เกี่ยวกับเนื้อที่ป่าไม้ ประเภทต่างๆ ในหมู่บ้านของท่านตามรายละเอียดต่อไปนี้ แล้วส่งคืนให้โครงการฯ ตามที่อยู่ที่แนบมาพร้อมนี้ (โดยไม่ต้องคิดแถมปี) จักขอบคุณยิ่ง

ด้วยความขอบคุณ

ศูนย์ส่งเสริมการเพาะชำกล้าไม้และปลูกป่า
ภาคตะวันออกเฉียงเหนือที่ 1 (มหาสารคาม)

วันที่กรอกแบบสอบถาม _____

ชื่อ-นามสกุล _____ ตำแหน่งผู้ใหญ่บ้าน _____

ชื่อบ้าน _____ หมู่ที่ _____ ตำบล _____

อำเภอ _____ จังหวัด _____ รหัสไปรษณีย์ _____

กรุณาให้รายละเอียดเป็นจำนวนไร่	ในที่สาธารณะ (ไร่)	ที่ส่วนตัว (รวมทุกครอบครัว)	รวมทั้งหมู่บ้าน (ไร่)
1. พื้นที่สวนป่ายูคาลิปตัสทั้งหมู่บ้าน			
2. พื้นที่ปลูกไม้ยูคาลิปตัสในช่วง 5 ปีที่ผ่านมา (พ.ศ. 2534-2538)			
3. พื้นที่สวนป่ายูคาลิปตัสที่ตัดฟันในปีที่แล้ว (พ.ศ. 2538)			
4. พื้นที่ป่าทั้งหมดในหมู่บ้าน รวมถึงป่าธรรมชาติ สวนพืชป่า สวนผลไม้ (ยกเว้นสวนป่ายูคาลิปตัส)			
5. พื้นที่ปลูกไม้ยืนต้นอื่นๆ ในช่วง 5 ปีที่ผ่านมา (พ.ศ. 2534-2538)			

หมายเหตุ กรุณาให้ราคาขายเฉลี่ยไม้ยูคาลิปตัสในปีที่แล้ว (พ.ศ. 2538)

ราคาต้นละ _____ บาท และ/หรือ ไร่ละ _____ บาท

Table 2 Percentage of Completed Questionnaires Returned

Province	Distributed	Returned	Percentage
Yasothon	779	123	16
Buriram	2,317	443	19
Maha Sarakham	1,603	518	32
Nong Bua Lamphu	623	166	27
Total	5,322	1,250	23

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Table 3 Average Tee Plantation Areas by Province

Province	Present Tree Plantation			Area Planted in the Past Five Years		
	Eucalyptus	Other	Total	Eucalyptus	Other	Total
Yasothon	58	128	186	24	29	53
Buriram	45	43	88	19	15	34
Maha Sarakham	38	46	84	17	23	40
Nong Bua Lamphu	43	185	228	21	29	50
Average	43	71	114	19	21	40

(rai / village)

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(rai / village)

Table 4 Eucalyptus Plantation by Land and Labor Availability

Cassava Farm Holding	Work Away			Average
	High	Medium	Low	
Large	(42)	76	(59)	73
Medium	(10)	49	42	44
Small	32	29	(48)	32
Average	29	52	43	45

(Values are in *rai* per village)

Note: Classification of a village (*muban*) follows to that of the district (*amphoe*) in which the village is located.

Note: Numbers in parentheses are average of two or one district.

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Table 5 Available and Planted Areas of Community Forest

Available Area for Community Forest (<i>rai</i>)	Planted Area of Community Forest (<i>rai</i>)					total
	0	0 to 50	50 to 100	100 to 200	over 200	
0	68.42	0.20	0.02	0.02	0.06	68.71
0 to 50	6.01	10.72	0.00	0.01	0.02	16.76
50 to 100	1.75	1.96	0.75	0.01	0.02	4.49
100 to 200	1.55	1.19	0.62	0.54	0.01	3.91
over 200	2.63	1.20	0.50	0.55	1.25	6.13
total	80.36	15.27	1.89	1.13	1.35	100.00

(Values are percentage of 25,906 villages in the KCC2K 1992)

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0 to 50	6.01	10.72	0.00	0.01	0.02	16.76
50 to 100	1.75	1.96	0.75	0.01	0.02	4.49
100 to 200	1.55	1.19	0.62	0.54	0.01	3.91
over 200	2.63	1.20	0.50	0.55	1.25	6.13
total	80.36	15.27	1.89	1.13	1.35	100.00

(Values are percentage of 25,906 villages in the *KCC2K* 1992)