The Underlying Causes and Impacts of Fires in South-east Asia

Site 3. Tanah Tumbuh, Jambi Province, Indonesia

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Site Report

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The underlying causes and impacts of fires in South-east Asia. Site 3. Tanah Tumbuh, Jambi Province, Indonesia

by

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Cover photo: The PT Tebora oil palm plantation camp burned down by protesters
Photo by: Jasnari

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ABBREVIATIONS AND TERMS

Adat rights	**Customary ownership or use rights recognized by local customary law**
AVHRR	Advanced Very High Resolution Radiometer
EU	European Union
EU-JRC	the Joint Research Centre of the European Union
ha	Hectare
km	Kilometer
m	Meters
MDF	Medium Density Fibreboard
NES	Nucleus Estate Smallholder project, a government-sponsored plantation development program in which transmigrants receive title to a portion of the developed plantation project
NOAA	National Oceanic and Atmospheric Administration, USA
RTRWP	Provincial land use planning
Stakeholders	People or groups of people interested or responsible for forest management, including landowners, local communities, industry and government organizations.

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SUMMARY

This report describes the underlying causes of fires in a site in Jambi Province, Sumatra, Indonesia. The site is located in an expired logging concession, and consists mostly of rubber plantations, which are run by the original inhabitants of the area, agricultural land, and large-scale oil palm plantations. Socio-economic research and hot-spot analysis suggest that fires used in land clearing for oil palm plantations were the most common cause of vegetation fires in the site. The clearing of land for smallholder rubber establishment also contributed to forest land fires. A third cause of fire that was found were its use in land tenure conflicts between smallholders and plantations. There appeared to have been burning by either group to claim the other group's land. There were cases when trees and buildings were burned down as part of conflicts. Few quantitative data are available on land use practices and changes in the site. Consequently, it is not possible to assess how much each of the underlying causes have contributed to the total fire and smoke problem in the site. To supplement existing information, more detailed land cover change analysis, related to socio-economic findings will be undertaken in 2001.

1. INTRODUCTION

The focus of this report is the study site of Tanah Tumbuh in Jambi Province, Sumatra (see Figure 2-1). The site represents a case study of the relationship between oil palm plantation development and fires, including the role of communities surrounding plantations. The rapid development of oil palm in Indonesia (e.g. see Casson, 2000) is shown by an increase in oil palm plantation area from 120,000 ha in 1969 to almost 3,000,000 ha in 1999 (Appendix I shows an overview of the oil palm plantation development in Indonesia). Fire is commonly used in land clearing for oil palm, because it is cheap and effective (Tomich *et al.*, 1998b). It is therefore suspected that the development of oil palm plantations contributed to the fire and smoke problem in Indonesia, as also reported by Barber and Schweithelm (2000).

Another reason why it is expected that the presence of large oil palm companies increases the risk of fires is the policy of land allocation for large companies, including oil palm plantations. The allocation is often determined without recognizing the rights of local people who already occupy and cultivate that land. Fires are often used to drive off local communities from their land (Tomich *et al.*, 1998a). The feeling of perceived injustice by smallholders, decreases their incentive to control the spread of fire to large-scale tree plantations (Suyanto *et al.*, 2000). As a consequence of land tenure conflicts, local communities frequently burn plantation grown trees that were established by large companies (Suyanto, *et al.*, 2000). Since the start of the political reformation period in Indonesia in mid-1998, the manifestation of land tenure conflicts between local communities and large companies has increased (Suyanto, *et al.*, 2000), leading to ever more visual signs of violence and burning of property as companies can no longer rely on the armed forces to quell the unrest.

The objective of the research in this site is to study the relationship between oil palm development and fire and the role of land tenure conflicts with the communities that live around the oil palm plantation areas.

2. SITE DESCRIPTION

For this research, the Tanah Tumbuh located in the Muara Bungo District, Jambi Province, Sumatra was selected (see Figure 2-1). The Tanah Tumbuh study site (129,200 ha) is located on the boundary between the Jambi and West Sumatra Provinces. It consists partly of low-lying plains and partly of the foothills and lower slopes of a mountainous area. Elevation of this site ranges from 100 to 500 m above sea level. Soil types include latosols and red-yellow podsols (Bureau Central Statistics-Tanah Tumbuh Sub-district, 1996). The study area contains transmigration sites, timber plantations, oil palm plantations, and tree-crop plantations, and virtually no natural forest. The PT Mugi Triman logging concession that was granted in 1975 occupies 67 % of the study area. In 1989, a large tree-crop plantation was established together with a transmigration area (total 120 km^2).

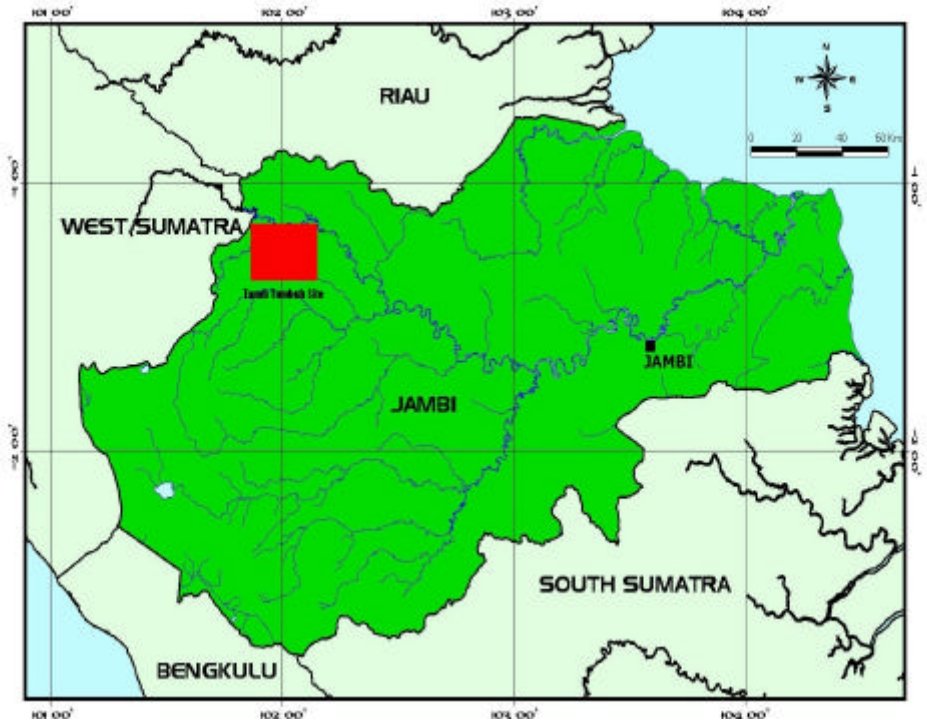

Figure 2-1 Location map of the study site

Four communities, or villages were selected for this research; all of them located on the border of the oil palm plantations. These are called Rambah, Tebing Tinggi, Bukit Kemang and Sungai Sarap (see Figure 2-2). These four villages were established about one hundred years ago form a unit under the customary law (*adat*) called *Batin Dua Batang Ule*. The village settlements are located along the Batang Ule River, while their wet rice fields are located in the valleys and flat areas.

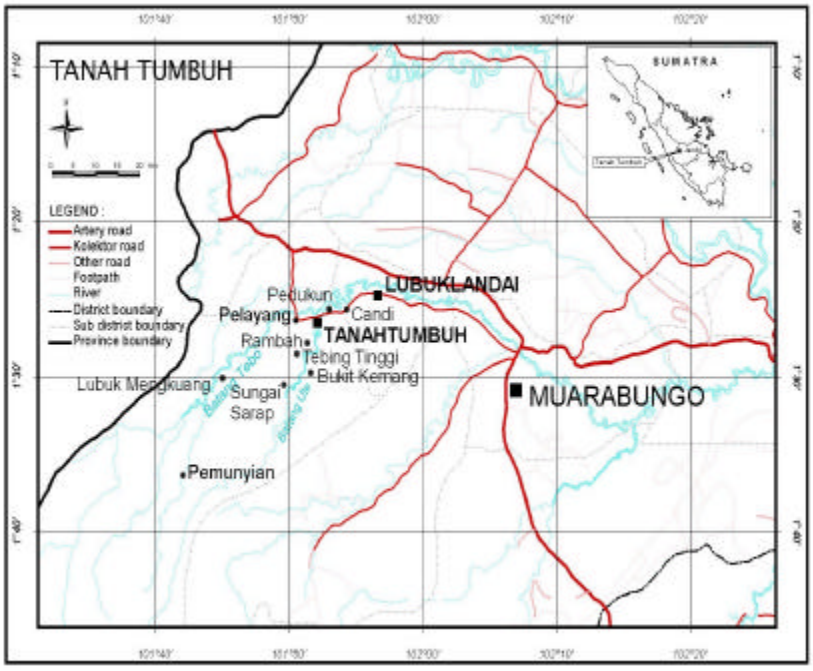

Figure 2-2 Detailed map of the study site showing village locations and other land marks

Perennial crop systems dominated by rubber are located on the surrounding hills. The Dutch colonial Government introduced rubber trees in 1910, and encouraged farmers in these areas to plant rubber by providing free seedlings. The rate of rubber garden establishment has increased rapidly since then. In 1955, the area of rubber in this site was estimated to be 3,500 ha. Between 1960 and 1970, the production of rubber on this site was very high. At that time each household owned, on average, 10 ha of rubber gardens. The rubber production attracted migrants from Java who came to this site to work as rubber tappers. In the 1970s, the production of rubber declined, because the rubber trees were generally too old (> 40 years) and rubber yield and number of trees per hectare decreased. As a result, laborers from Java left the site. Replanting of old rubber gardens rarely occurs, and the old rubber gardens that had been established since 1910 still exist.

These gardens are called “jungle rubber” or “rubber agroforest”, because wild woody species are also allowed to grow among the rubber trees, which may help protect the rubber from grassy weeds (Gouyon *et al*., 1993).

The use of secondary forest is under the control of the customary law (*adat*) leader. Every member of the community has equal access to forest. Forest has been used for shifting cultivation for a long time in a system that gives farmers use rights but not land ownership. However, rubber farming has replaced shifting cultivation. According to customary law, farmers who open up forest and plant trees obtain more secure land rights (individual rights). Suyanto and Otsuka (In press) found that, with increasing population and profitability of tree crops, the communal land rights in Sumatra have evolved to a more individualized land tenure system. The *adat* leader in this study site, however, reserves some area to be maintained under the communal land tenure to achieve equity among the members of the community and also to ensure food security. There are two types of communal land use. Firstly, there is *tanah batin*, in which members of community are only allowed to plant food crops and are prohibited to plant trees in order to avoid an individual land claim. Secondly, there is *rimbo bulian*. *Rimbo bulian* consist of communal forest land covered mainly by *bulian* trees (*Eusideroxylon zwagerii*). The area of *rimbo bulian* is around 150 ha and is located in the western part of the site. According to *adat* law, each member of the community has the right to use *bulian* timber only for internal utilization (house construction) within a village, and they are prohibited from selling it.

Two privately owned oil palm plantations occupy almost 22,000 ha of the study site. One oil palm plantation is PT Tebora, a member of the Sinar Mas group, which is one of the biggest oil palm cartels in Indonesia. PT Tebora has been operational in the study site since 1994, and owns almost 11,900 ha of land. A second oil palm plantation is PT Sukses Maju Abadi (PT SMA), a joint venture with a Malaysia investor. PT SMA has been operational since 1996 and owns 9,500 ha of land. Between 1995 and 1998, thousands of hectares of land in those two plantations have been burned as part of the land preparation process for oil palm, which was one of the reasons that this site was chosen for more detailed investigations.

3. METHODOLOGY

4.1 Socio-Economic Study Methods

Sketch mapping at landscape level and rapid rural appraisals were conducted between March and May 2000. The sketch map was developed based on an administrative map with a scale of 1:200,000, and a land use map with a scale of 1:100,000. The Land Title Office of the Bungo Tebo District (*Badan Pertanahan Nasional*) issued both maps. Data collected during interviews with oil palm plantation managers, community leaders, and local Government officers, and additional field observations, were overlaid onto the base map. This information included the history of the plantations and villages, the history of land clearing and planting, details on land clearing techniques, fire history, demography, land use, agricultural activities, and land tenure conflicts.

4.1.1 Remote Sensing and GIS

To date, the Project has been unable to obtain any recent cloud-free satellite images of the study site, and only one older 1991 image was available. As most changes in the area and fire events were expected to have occurred after 1991, this image wasn't used for land use classification purposes or the identification of burn scars. The only remotely sensed data that were used in this study were NOAA-AVHRR hot-spots.

4.1.2 Derivation of fire hot spots

Hot-spots data from NOAA-AVHRR imagery were obtained from various sources and covered 13 periods between 1992 to 1999 (for more detail refer to Appendix II). These hot-spot data were overlaid onto a basic land-use map, to identify which areas within the study were most affected by fires. For this purpose, the approximate outline of the PT Tebora and PT SMA oil palm plantations were hand drawn onto the land-use map. Although, this methodology could lead to some inaccuracies, it is considered adequate at this preliminary stage of the research. For details on the methodology used in hot-spot analysis refer to Stolle (2000).

4.2 Integration of Social Science and Remote Sensing

As the availability of remote sensed data was limited, the integration of social science and remote sensing consisted only of overlaying the hot-spots onto a land-use map, to see whether the hot-spot findings supported the results from the socio-economic research.

4. RESULTS

4.1 Fires

4.1.1 Fires as a tool in land clearing by large scale companies

Figure 4-1 shows a sketch map of the present land use in the Tanah Tumbuh site. A big fire in late 1997 in this area resulted from land clearing activities for the establishment of oil palm plantations (see Figure 4-2). Table 4-1 shows the area of land clearing in the PT Tebora plantation. In 1994, PT Tebora started to open up the land in their concession. The same land was, however, also claimed by local communities with traditional land rights. They had used this land for planting rice under a shifting cultivation system. PT Tebora offered the farmers compensation for this land by allowing them to join as a partner under the Nucleus Estate Smallholder (NES) system or alternatively to sell their land to the company. The response of farmers to the firm's offers was, however, very negative. Thus, in 1994/1995, PT Tebora could only clear 707 ha, of the total 4,207 ha allocated to them.

Table 4-1 Land clearing areas for oil palm development in PT Tebora and PT SMA by year

Company	**1994-1996**	**1997-1998**	**1999**	**Total**
PT Tebora	707	3,500	0	**4,207**
PT SMA	1,500	3,440	300	**5,240**
Total	**2,207**	**6,940**	**300**	**9,447**

Sources: Interview with the staff of PT Tebora and PT SMA

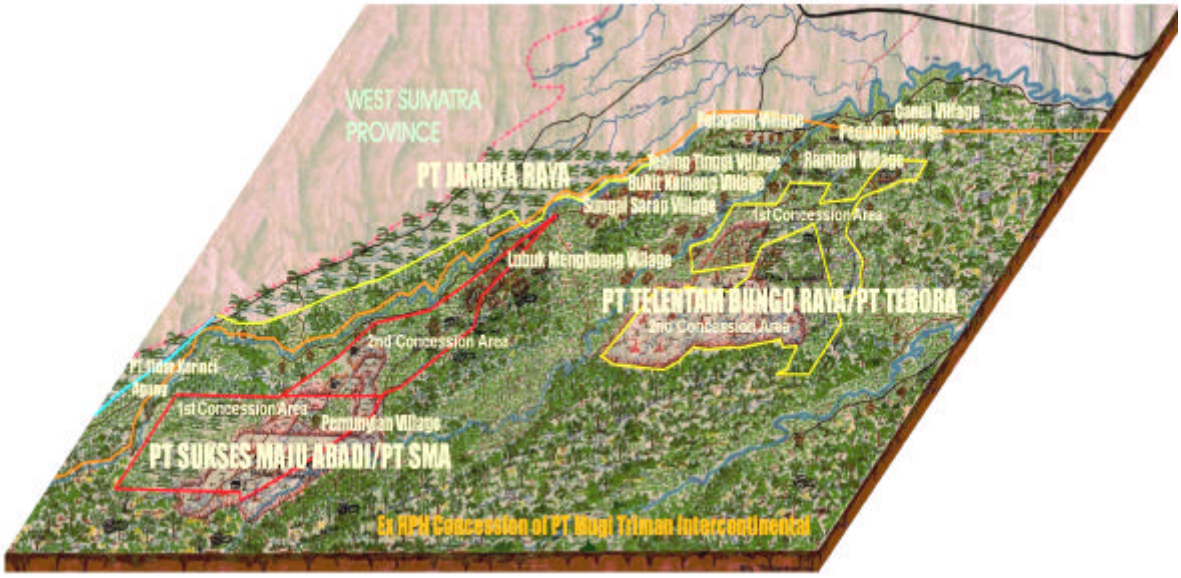

Figure 4-1 Sketch map of the Tanah Tumbuh site

In 1997, PT Tebora shifted their activities to a different part of their concession area. Unlike the first area, there had not been any farmer's activities, and it was therefore easier for the firm to operate there. The firm cleared 3,500 ha in 1997 and 1998. Thus, from 1994 to 1999, PT Tebora had already opened up 4,207 ha of land. According to PT Tebora staff, the firm had used mechanical (non-burning) land clearing techniques since 1998. The claim is still being investigated.

Figure 4-2 Young oil palm plantation in PT Tebora

PT SMA had started to clear the land in 1996. From 1996 to 1999, 5,240 ha of land were cleared for oil palm plantation development. Until 1997, PT SMA had used fire for land clearing, and, in 1996 and 1997, PT SMA burned 4,765 ha of land, or about 90 % of the total area cleared between 1996 and 1999. Since 1998, PT SMA reportedly stopped using fire for land clearing and replaced this by mechanical techniques. Although Government regulations were issued in 1995 prohibiting the use of fire in land clearing, large companies continued to use fire in preparing land for oil palm plantation development. The use of fire in land clearing indicates that burning is still thought by many to be the cheapest and most effective way to ensure crop nutrition. The zero burning method, despite having positive agronomic and environmental effects, is also accompanied by several crucial technical constraints (see Suyanto *et al*., 1996). The technical constraints on slash-and-mulch (zero-burning) are the slow release of nitrogen from decaying mulch, or even its complete immobilization, difficulties in establishing a crop in a thick mulch layer, problems with diseases (fungi), pests (snakes), difficulties to walk into fields for crop management, and the fact that a dried mulch layers remains a fire hazard (Suyanto *et al.*, 1996).

4.1.2 Fire as a tool in smallholder land clearing

For a long time, farmers in Indonesia have used fire for land clearing for the traditional shifting cultivation of food crops. Although, the farming system in Sumatra has change from shifting cultivation to more intensive, tree-based farming systems, fire is still used in land clearing (Tomich, *et al.*, 1998b). Rubber (*Hevea brasiliensis*) is the main tree-based farming system in our site. Rubber agroforest is more sustainable than shifting cultivation, because of a long life production cycle (more than 30 years) and the associated relatively high biodiversity. According to Michon and Foresta (1995), the plant biodiversity of the jungle rubber is one third to one half that of natural forest. Figure 4-3 shows the process of jungle rubber establishment. Usually in Sumatra, farmers open forest by using slash-and-burn techniques. Then, they plant upland rice in the first to third year, followed by rubber trees. Rubber trees need little care, and after around 10 years, rubber tapping can be started and can be continued for up to 30 years.

Figure 4-3 Process of jungle rubber establishment

Table 4-2 shows the distribution of smallholder rubber plantations by tree age and area of wet rice fields in four villages in the study site. In the Bukit Kemang and Sungai Sarap villages, rubber production is more important than rice cultivation. The area of young rubber below 5 years old accounts for 51 % of the total rubber area in the Sungai Sarap village. This indicates that farmers in Sungai Sarap are more active in clearing forests for the establishment of rubber. Beside the distance to forest being the closest compared to the other villages, there may be another major reason for the high forest clearance activity

in this village. Planting trees such as rubber in the communal forest land gives “private” land rights. According to customary law, people who clear communal forest land and plant commercial trees get relatively strong individual ownership rights. These rights, however, may be taken back by customary law, if land remains uncultivated for an extended period.

Table 4-2 Area of rubber by tree age, and area of wet rice field (in ha)

Age of rubber tree (year)	Rambah and Tebing Tinggi	Bukit Kemang	Sungai Sarap
1	0	31	168
2	0	15	236
3	0	12	160
4	0	7	245
5	0	55	227
6-9	144	160	124
10-20	0	145	244
21-30	0	22	317
>30	1,500	800	300
Total rubber areas	**1,644**	**1,246**	**2,021**
Wet rice field areas	**600**	**80**	**15**

In contrast to the situation in Sungai Sarap and Bukit Kemang, there are no young rubber tree areas in Rambah and Tebing Tinggi, and more than 90 % of the rubber gardens in these two villages are more than 30 years old. Farmers do not use fire when replanting old rubber, but apply a technique locally called *sisipan*. According to Joshi *et al.* (In press), large number of farmers in the Jambi area practice this *sisipan* technique, which involves farmers planting new rubber seedlings in the existing rubber garden to replace the dead, dying, unproductive and unwanted trees. In relation to the fire problem, the *sisipan* method can help reduce fire and smoke that is normally associated with tree crop development.

4.1.3 Fire as a weapon in land tenure conflicts between local communities and oil palm plantations

The Government's inequitable land allocation policy for smallholders and large-scale plantation or logging operations often creates tenure conflicts (e.g. Suyanto *et al.*, 2000). This study site provides an example of such tenure conflicts between oil palm plantations and smallholders, and how this can lead to increased vegetation burning.

PT Tebora obtained 5,000 ha for a first concession in 1994. Since farmers already cultivated the land, PT Tebora was required to pay compensation to these farmers. First, the company offered farmers to be a partner under the Nucleus Estate Smallholder (NES) system. The NES System, however, was canceled and replaced by the Prime Cooperative Credit for Members (*Koperasi Kredit Primer Anggota* = KKPA). Farmers felt that the KKPA system was unfair because under that system farmers had to release 5.6 ha of their land to the company. For this, they would only receive 2 ha of oil palm plantation with a credit of around 14 million Rupiah (US$ 6,478). Farmers also had to sell their palm oil to the company, which would then deduct 30 % of the sale for the repayment of the farmer's debt. Therefore, very few farmers were interested in the KKPA.

PT Tebora then offered to buy farm land for a price of between 150,000 and 200,000 Rupiah (US$ 69–92) per ha. Through the village leader, farmers received information that PT Tebora planned to take the land in the concession area without any compensation if farmers were unwilling to sell their land. Hearing that news, some farmers decided to sell, but still, by early 1995, only around 700 ha of the total 5,000 ha had been released. PT Tebora started to clear the 700 ha of land using slash-and-burn techniques. Farmers suggested that PT Tebora did not properly manage the fire, as it escaped and destroyed 100 ha of rubber garden belonging to farmers. In 1997, along with the land clearing activities in the second forest land concession, fires also spread out to the farmer's gardens, and around 500 ha of rubber garden were destroyed. Farmers suspected that PT Tebora deliberately let fires escape into their rubber gardens. On the other hand, PT Tebora stated that the fires that caused the damage did not originate in their plantation, and they blamed the farmers' own land clearing activities.

In early 1998, along with the political reformation spirit in Indonesia, farmers in the four villages demanded compensation for the damage to and loss of rubber trees. Moreover, they also claimed back the land from the concession areas, and demonstrated against the oil palm plantation. Following this, PT Tebora promised to give one ha of oil palm plantation to each farmer in these four villages. Since PT Tebora did not fulfill this promise, several demonstrations were held in October 1998 and May 1999. According to our key informants (both from the company and the communities), some farmers tried to burn oil palm trees in May 1999, but the fire did not spread widely and did not kill any oil palm trees.

On May 29, 1999, the villagers in these four villages demonstrated again in the base camp of PT Tebora. PT Tebora already knew of this plan and anticipated the demonstration by asking the police to handle the situation. The involvement of the police and the use of firearms during the demonstration caused a general uproar leading to a serious clash between the police and farmers. Among others, farmers burned down the PT Tebora base camp and oil palm tree nursery. After this, PT Tebora stopped their activities in the area.

4.1.4 Fire information from hot-spots

Of the 283 hot-spots that were detected in the study area between 1992 and 1999, 41 % were detected in 1997. Table 4-3 shows the hot-spot densities in various parts of the study site in the 1992–1999 period. In 1992 and 1993, there were few fires. The increase in fires started in 1996, had its peak in 1997, and dropped first in 1998 and then further in 1999. 1997 was therefore an exceptional fire year, although the increase in fires started already in 1996. Since the drought in 1997 started around July (Global Precipitation Climatology Center, 2000) it seems that fires in this area were not triggered by drought, although the drought may have increased the fires. The study area seems to have a slightly higher fire density than the average in Jambi Province (see Table III-1, in Appendix III), but it follows the same trend as described above, with the possible exception of 1998. While, in 1998, fire densities in Jambi had decreased, those in the study area were still high.

Table 4-3 Fire hot-spot densities in different parts of the Tanah Tumbuh study area

Year	1992	1993	1996	1997	1998	1999	Average
Total Tanah Tumbuh Study site	0.2	0	6.3	9.5	4.2	1.7	**3.7**
Ex-logging zone in study site	0.1	0	7.5	11.0	5.2	2.2	**4.4**
Non-forest zone	0.5	0	3.7	6.5	2.1	0.7	**2.2**
Logging areas in Jambi	0.2	0.1	4.5	6.0	1.2	2.1	**2.4**
Sumatra	0.3	0.2	2.2	3.7	2.0	2.0	**1.7**

A large part of the study area is located in an ex-logging concession area. This area (named 'ex-logging zone in study site' in Table 4-3) has higher fire densities than both the non-forest, and the overall study area, indicating that the ex-logging concession is particularly vulnerable to fire. It also has a higher occurrence of fire compared to other logging areas in Jambi.

Figure 4-4 shows the location in the study site the fires occurred in 1997. Two hot-spot concentrations are clearly shown within the boundaries of the PT SMA and PT Tebora oil palm plantations (delineated by the blue and green lines in Figure 4-4). Several other hot-spot concentrations can be seen, one of which can at least be retraced to new rubber establishment. Unfortunately, detailed land cover and land use classifications are not available, and the hot-spot occurrence can therefore not be explained in detail.

Finally, the study area had more than twice the average Sumatran fire density in 1996, 1997 and 1998 (see Table 4-3), and can therefore be categorized as a fire-prone area. The study area shows an increase in fire occurrence since 1996, although the 1997 fire densities are much higher than in any other year. The fires therefore do not seem to be triggered by the 1997 drought, but appear to be a continuation of the 1996 fire events.

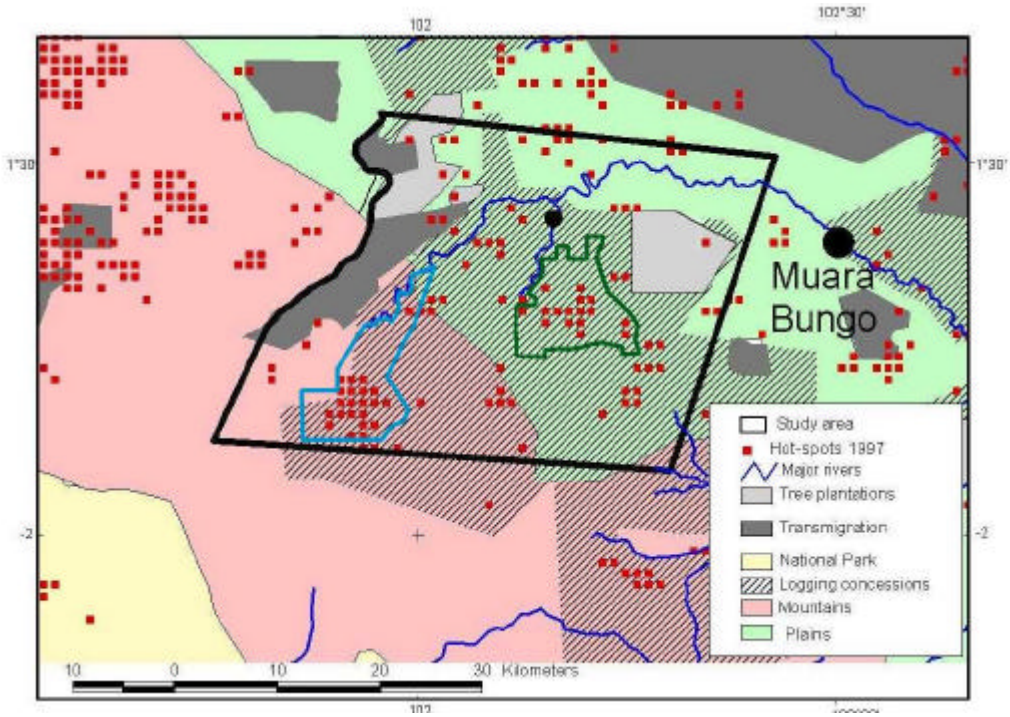

Figure 4-4 Tanah Tumbuh site and the 1997-hot-spot distribution

4.2 Land Cover and Land Use Changes

Until 1980, forest was still abundant on this site. Almost 78 % of the PT Mugi Triman concession area was still covered in forest in 1976. The remainder of the area consisted of settlements, rice fields, smallholder rubber gardens, and upland rice fields under shifting cultivation. Between 1976 and 1994, however, PT Mugi Triman logged their 165,000 ha forest concession. According to our informants, the logging company exploited almost all natural forest in the Tanah Tumbuh area, including parts of the community forests. In 1979, the Government constructed a reservoir to irrigate wet rice fields in this area, and about half of the Sungai Sarap village area disappeared underwater because of this. At that time, 71 households, or around 250 people lived in Sungai Sarap village. In 1980 and 1981, the Sungai Sarap people were resettled through a local transmigration program to the Rimbo Bujang transmigration settlement area. Rimbo Bujang, which is located around 40 km from Sungai Sarap village, is one of the largest transmigration settlement areas in Jambi and was established in 1976. In 1981, the Sungai Sarap village was removed administratively from the Tanah Tumbuh sub-district. After having lived in the transmigration area for about 3 years, the Sungai Sarap people gradually returned to their villages. In 1985, almost all Sungai Sarap people had returned

to their village, where they began to harvest rubber. In addition to this, logging activities had by then facilitated the access to land around the village, and thus more logged-over forest could be opened and planted with rubber.

The Indonesian Government generally issues 20 year logging concessions. However, PT Mugi Triman had logged almost all the forest within their concession within 18 years of commencement, and during the operational logging years, a considerable part of the concession had already been converted to oil palm. This is generally not permitted in an active logging concession within Production Forest.

Four private firms had established oil palm plantations in the areas of the PT Mugi Triman concession (see Table 4-4). The first two companies, PT Tebora and PT SMA, only started to operate in 1994 and 1996, while the other two, PT JR and PT TKA, started earlier, as also indicated by their higher percentage of planted area.

Table 4-4 Concession areas and their realization of oil palm planting

Name of Company	Government Degree	Concession areas (ha)	Realization of planting areas (%)
PT. Telentam Bungo Raya (PT Tebora)	01/PIL/460/PBT/1994 02/PIL/460/PBT/1994	11,900	35
PT. Sukses Maju Abadi (PT SMA)	16/PIL/460/PBT/1996 28/PIL/460/PBT/1997	9,500	55
PT. Jamika Raya (PT JR)	188.53/263/1985	15,000	60
PT. Tidar Kerinci Agung (PT TKA)	525/2684/Bappeda (17 March 1988)	3,000	78
Total Areas		**39,400**	**53**

Beside the utilization of former logging concessions by oil palm companies, about 50,000 ha area of PT Mugi Triman were allocated to the State company Inhutani V in 1998. The main task of Inhutani V in this area is to reforest the logged-over forest. However, illegal logging activities organized by rich residents with support from some Government officers have occurred in this area, while at the same time the establishment and improvement of infrastructure by oil palm plantation increasingly facilitates access to forest. It remains therefore to be seen to what extent a natural forest cover can be re-established in this area.

5. UNDERLYING CAUSES

Although government regulations have been issued in 1995 banning the use of fire for land clearing, slash-and-burn techniques are still practiced by large companies. In the Tanah Tumbuh site, the use of fire by large-scale companies for the establishment of oil palm plantations significantly contributed to the total fire problem in the area.

Due to an inequitable land allocation policy, the development of oil palm plantations has often created a land tenure conflict between companies and local communities that live in and around the oil palm plantations. As a result, both large-scale companies and smallholders used fire as a weapon in these tenure conflicts.

Slash-and-burn techniques are also used by smallholders for the establishment of rubber plantations. A high rate of newly established rubber gardens in the areas with limited areas of wet rice was found, possibly suggesting that rice shortages are compensated by opening up more forest for other economic activities. Claims of “private” ownership in the communal land also leads farmers to open more forest and plant trees such as rubber.

6. POLICY IMPLICATIONS

Based on the analysis of the underlying causes of fire in the Tanah Tumbuh site, some policy implications for both the national and provincial level are outlined.

A. Review the zero burning policy

A total ban of the use of fire in land clearing is currently impractical. An alternative, intermediate-level regulations and policy change appears to be more feasible, which would include the following policy alternatives:

- A total ban of the use of fire in land clearing can only apply during El Niño years or at other critical times. Fire in land clearing can still be allowed in normal years.
- Apply techniques of using fire in land clearing that reduces smoke and haze.
- Applied and adaptive research on zero or less burning technology and its impediment to the use of such wide spread technology

B. Reduce the amount of timber that is burned

- Develop a more transparent method of selling the residue timber both from large and small scale logging industries to Medium Density Fibreboard (MDF) or pulp factories.
- Review policy incentives (tax/levy) at national and regional level in marketing timber residues and identify cost efficient techniques to increase the use of the residue.

C. Reduced land tenure conflict between companies and smallholders

- Large-scale plantations, including oil palm, must take into account the existing land claims of local communities. Recognizing communal land claims would help minimize conflicts over land allocation.
- Review land allocation policy and the processes of land use allocation (*RTRWP* (= provincial land use planning) and Agrarian law) to take communal land tenure into consideration.

D. <u>Promote sustainable land use by smallholders</u>

- Promote rubber agroforest systems as an alternative sustainable land use for shifting cultivation by reviewing markets, and plantation policies.
- Provide technical assistance by improving the agricultural extension system, and provide good quality planting material to improve rubber productivity.
- Adopt and improve the recycling techniques used in traditional rubber agroforestry.

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APPENDIX I: Overview of Oil Palm Development in Indonesia

The oil palm industry in Indonesia was developed by large-scale (private and State enterprise) companies. In 1999, the total area planted with oil palm in Indonesia amounted to almost 3 million ha (see Figure I-1). Around 50 % of all Indonesian oil palm plantations is owned by private firms. Four Indonesian cartels, Sinar Mas, Astra, Salim and Raja Garuda Mas, controlled around 68 % of the privately owned oil palm plantations (Cohen and Hiebert, 1997); State enterprises control only around 17 % of all oil palm plantations, and the rest of the oil palm area is in the possession of smallholders.

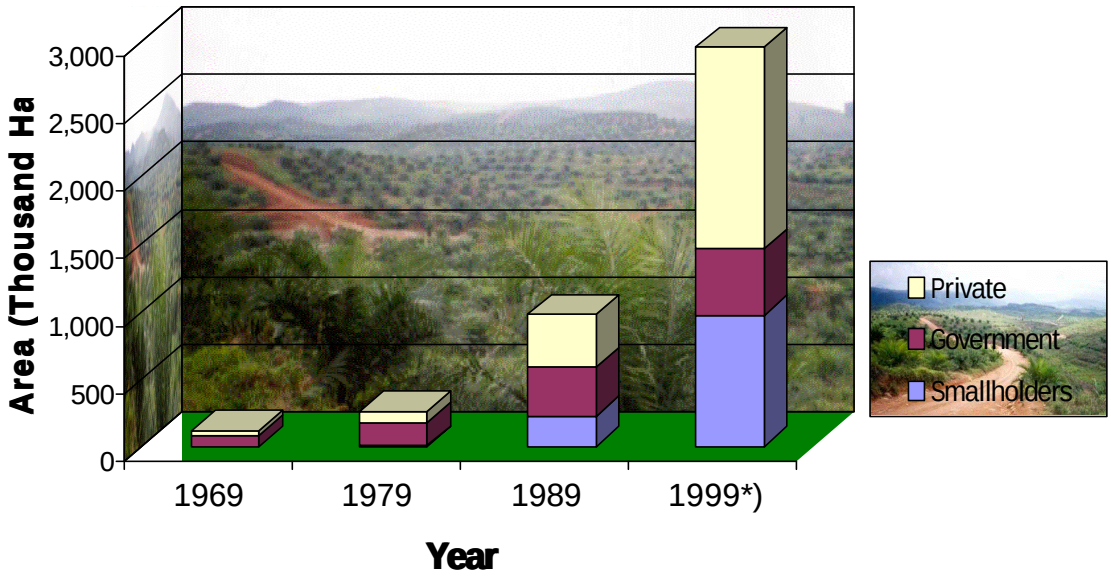

Figure I-1 Oil palm plantation area in Indonesia

In 1999, Indonesian smallholder rubber and coffee plantations accounted for respectively 85 % and 95 % of the countries total area. Unlike in the former two tree crops that were developed on a smallholder basis, the involvement of smallholders in oil palm is low. Before 1979, there was no smallholder involvement in oil palm plantation, at all, while, in 1979, the area of smallholder oil palm was only 3,000 ha or 1 % of total oil palm area. Since the early 1990s, the involvement of smallholders in oil palm has considerably

increased to 973,000 ha or 33 % of the total oil palm plantation area in 1999. Most of the smallholder activities were arranged under the NES (Nucleus Estate and Smallholder) system and PIR Transmigration Programme.

Figure I-2 shows the distribution of oil palm plantation by island in Indonesia. The biggest area of oil palm plantation is located on Sumatra. In 1997, the oil palm plantation areas in Sumatra amounted to almost 1.9 million ha or 79 % of the total oil palm area in Indonesia. The second biggest area of oil palm plantation, 411,000 ha or 17 % of the total, is located in Kalimantan.

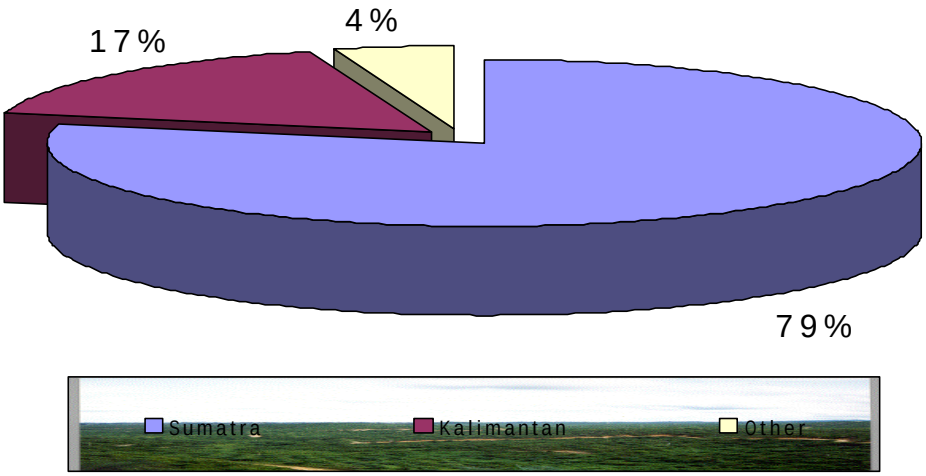

Figure I-2 Distribution of oil palm plantation area by island (1997 data)

The first oil palm plantations were established in North Sumatra in the early 1900s, and the industry developed rapidly in the 1930s (Potter and Lee, 1998). Currently, North Sumatra Province has the largest area of oil palm in Sumatra, accounting for 576,000 ha, or around 30 % of the total oil palm plantation area in Sumatra. Because of the long history of oil palm plantation in North Sumatra, this province also has the largest area of mature trees, i.e. about 87 % of the oil palm trees were mature in 1997. The second most rapid development of oil palm plantation occurred in Riau Province; the total area of oil palm in 1997 was 522,000 ha, with 67 % of the trees being mature.

More recently, an oil palm industry was developed in South Sumatra and Jambi Provinces. Table I-1 provides an overview of the oil palm areas in 1990 and 1997 in each Sumatran province, and the percentage of immature trees in these provinces in 1997.

Table I-1 Oil palm plantation by province in Sumatra (in thousands of hectares).

Province	Oil Palm areas				
	1990	**1997**	**Change (ha)**	**Change (%)**	**% immature trees in 1997**
Aceh	91	180	89	99	36
North Sumatra	490	576	86	17	13
West Sumatra	36	125	89	252	50
Riau	238	522	284	119	33
Jambi	46	190	144	318	50
South Sumatra	62	220	158	256	41
Bengkulu	23	46	23	97	38
Lampung	15	38	23	157	53
Sumatra	**1,001**	**1,897**	**896**	**90**	**31**

Source: Direktorat Jenderal Perkebunan (1996)

A high proportion of immature trees indicates newly established oil palm plantations. Since almost all oil palm development uses fire in land clearing, it is suspected that the new establishment of oil palm significantly contributed to the fire and smoke problem in Indonesia. Based on the absolute increase in oil palm area (see Table I-1), Riau, Jambi and South Sumatra Provinces are likely to have contributed most to the fire and smoke problems related to oil palm development.

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APPENDIX II: Sources for Hot-Spot Data

Source	Dates	Analytic technique
EU-Palembang station	1997: 11 Sep – 31 Dec 1998: 18 Jan – 20 Oct 1999: 26 Mar – 26 Oct	see below [1.]
EU-JRC	1996: 19 Jan – 28 Dec 1997: 2 Feb – 15 Oct	processed by a contextual algorithm
ESRIN	1993: 3 Jan – 3 Dec	processed by a contextual algorithm; day time images
CNRM	1992: 26 Apr – 31 Dec 1993: 1 Jan – 28 Mar	processed with same contextual algorithm as EU-JRC data
ATSR	1996: 1 Nov – 31 Dec 1997: 1 Jan – 31 Dec 1998: 1 Jan – 31 Dec 1999: 1 Jan – 31 Dec	background value of 308 Kelvin used; night time data
DMSP	1997: 1 Jun – 31 Dec	various extraction methods

[1.] These hot-spot data were hand processed. Both night and daytime images were used. Initially, several objects that might be fire were calibrated to establish background temperatures, after which fire locations were extracted. Subsequently, limited tests were carried out to check data and consistency.

APPENDIX III. Hot-Spot Densities in the Jambi, South Sumatra and Riau Provinces

Jambi Province has a low fire density compared to its neighboring provinces (see Table III-1). In all years, except 1996, it has the lowest hot-spot density values. Figure III-1 shows the 1997 distribution of fire hot-spots in Jambi Province and those surrounding it.

Table III-1 Fire density (per 100 km2) in three Sumatra provinces

Year	Jambi Province	South Sumatra	Riau
1992	0.28	0.21	1.26
1993	0.09	0.38	0.19
1996	4.40	2.97	6.76
1997	5.67	8.35	6.86
1998	0.95	0.32	10.23
1999	2.30	3.32	6.68
Average	**2.28**	**3.00**	**5.00**

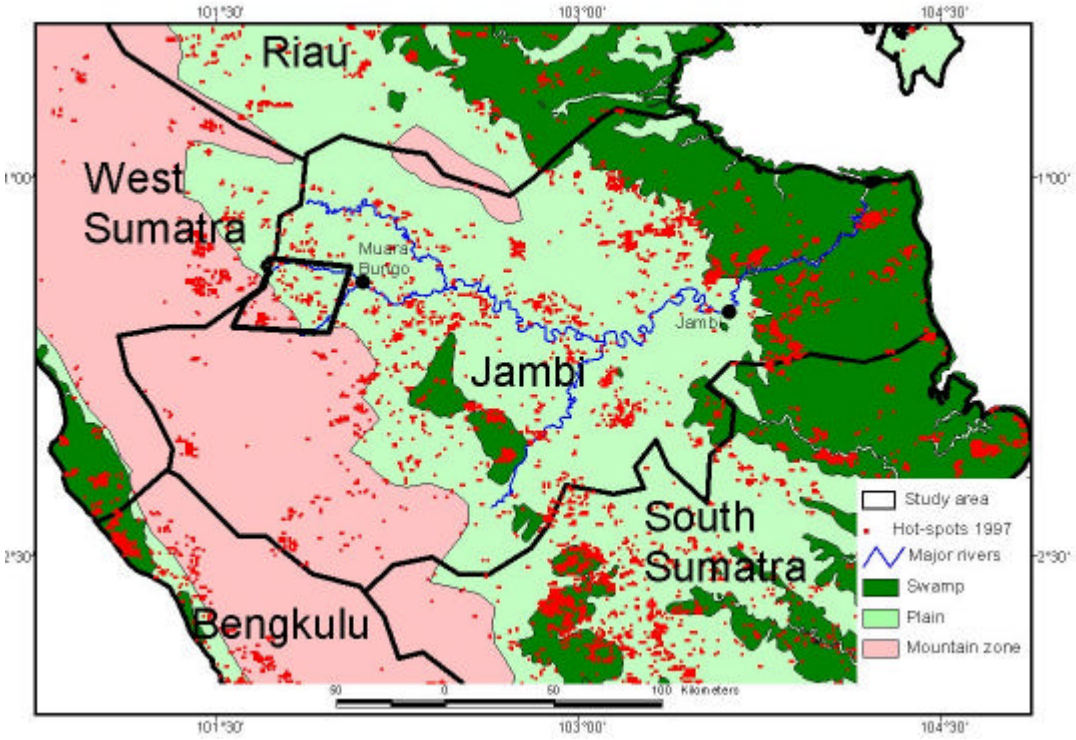

Figure III-1 Central Sumatra provinces and the 1997 hot-spot distribution