ALTERNATIVES TO SLASH-AND-BURN

Is there deforestation by slash-and-burn agriculture in South Cameroon?

ASB Technical Report no. 4

TECHNICAL REPORT SERIES

Is there deforestation by slash-and-burn agriculture in South Cameroon?

Jacques Imbernon

South Cameroon from Yaounde to Equatorial Guinea is a forest area where slash-and-burn agriculture is practised. The area is characterized by a north-south vegetation gradient. Population density and land-use intensity are both high. Vegetation is mostly semi-deciduous forest, but the north *of* the region is characterized by *Imperata cylindrica* savanna, and the south by the dense Congolese rain forest. Population densities, according to the 1995 census, vary greatly from 65.9 inhabitants per square kilometre in the Monatele arrondissement north of Yaounde to only 3.8 in the Ambam arrondissement south of Yaounde near Equatorial Guinea. Fallow length is still high in the south (around 20 years) but is decreasing to less than 3 years in the north. This gradient was the main reason for selecting the area as an Alternatives to Slash-and-Burn[1] benchmark site (Manga 1994).

Deforestation within the benchmark area takes different forms and has different impacts, with a number of different slash-and-burn practices. Here we look at how these practices are influencing the landscape, as observed by satellite sensors. And therefore we look both at the process involved from a historical perspective and at the actual landscape pattern.

Historical perspective

At the beginning of the 20th century, South Cameroon was mainly forest. However, humans were already putting it under threat. On Moisel's map (1913) savanna stretched from the north to Yaounde, to the orient side of the Lekie River and to the left bank of the Sanaga River. Between savanna and primary forest there was the 'Parklanschaft', a degraded forest. Thus those landscapes, which resembled Letouzey's vegetation maps (1968), had already been humanized.

At this time, immigration came mainly from the north, as part of the vast movement of population from savanna (north) to forest (south), which started 2 centuries ago. Cultivation was based on slash-and-burn practices.

Within the forest, settlers avoided the rivers, both because they were unhealthy and because the swamps and their many tributaries were an obstacle to movement. However, where easy fords were found, there were settlements. Thus the traditional settlements and their areas of cultivation were not distributed along rivers but were spread throughout the landscape.

The French colonial administration in 1916, following German colonization, changed this landscape pattern by opening roads and encouraging small-scale farmers to cultivate cocoa along them. In this way the colonial administration could increase exports, collect income taxes more easily and settle the farmers who were practising shifting cultivation.

However, when we examine population changes from 1916 to the present, instability and heterogeneity appear to be characteristic: population increased in some arrondissements and decreased in others. More surprising is the fact that over the past decades, the demographic balance in the less inhabited areas—mostly forested—has been negative, while in the most inhabited areas around Yaounde, it has been positive (ORSTOM 1995).

[1] Alternative to Slash-and-Burn (ASB) is a systemwide programme of the Consultative Croup for International Agricultural Research; it is convened by the International Centre for Research in Agroforestry (ICRAF).

Thus the landscape of the forest area of South Cameroon has been mainly shaped by the opening and asphalting of roads. These roads have offered access to markets, particularly for cocoa production. But demographic figures show that they have not attracted as many new immigrants looking for land as would have been expected.

In this study we try to better characterize the landscape and its changes over time using low-resolution and high-resolution remote sensing data. We look particularly at slash-and-burn practices and try to identify if they are leading to deforestation in South Cameroon.

The actual landscape: towns, street villages, corridors, agroforestry ... and shifting cultivation

Whether in a low-resolution NOAA-AVHRR image (fig. 1) or a high-resolution SPOT-HRV image (fig. 2), towns and roads appear to be the main features around which deforestation has occurred. Around the capital, Yaounde, land use is intensive, and its influence can be noticed many kilometres away. This is the main feature in the landscape, because of the major effect of its own market (1.2 million people). Figure 3 shows the impact of towns in the different departments. We can easily notice the large impact of Yaounde (Mfoundi Department), near where most of the land is cultivated. The other towns—M'Balmayo (Nyong et So), Ebolowa and Ambam (Ntem)—are small and have very little influence on the surrounding landscape. But they also consist of features around which land use is more intensive[2]. The towns in Lekie and Mefou regions in the north show that land-use intensity is higher between 4 and 12 km from towns (fig. 3). There the farmers have to go farther afield to get better soils than do the farmers working near settlements. In the southern regions (Nyong et So and Ntem), towns have no impact on land-use intensity, and over 40% *of* the total cropland is located more than 20 km from a town.

Land use is also intensive along the tarmac road that joins Obala, Yaounde, M'Balmayo and Ebolowa, and even farther along the untarmacked road to Ambam and the border. Most of the settlements, 'street villages', are located along these roads. The houses are 1st surrounded by homegardens, dominated by banana. Behind them are the cocoa plantations, mostly more than 40 years old and under dense and regular tree cover. This cultivation can be considered agroforestry. Farther are old fallow lands where the forest is regenerating, and then young fallow. Finally we reach the food-crop fields and the new fields in the forest, called 'esep'. Food-crop fields are small, less than 1 hectare, with many mixed crops—cassava, sweet banana, groundnut, cocoyam, maize, vegetables.

The cultivated land along the road networks creates corridors in the spatial distribution of land uses, from roads to forest. These corridors are less than 5 km wide on either side, and within these corridors land-use intensity decreases exponentially from the roadside. There are few differences in land-use intensities between administrative provinces (fig. 4). Only Ntem region is different, with lower land-use intensity near the roads and more farther from them. This difference may be due to a higher fragmentation of croplands within the forest, but it is also the result of lower density in the road network. On average over the whole area, 63% of the total cropland is less than 1 km from a road.

However, the landscape is still dominated by forest. About 65% of the total area is forested, comprising 30% degraded forest and 35% dense forest, mainly in the south (Imbernon 1996). Cropland repiesents only 25% of the total area, but overall there are many differences in land use intensity between regions—56% in Lekie region and 14% in Ntem. Thus slash-and-burn agriculture takes different forms from area to area, even if as a whole it can be considered as part of a shifting cultivation system.

[2] Land use intensity is considered here as the proportion of cropland area in relation to total cropland.

The main difference between north and south is the length of fallow, according to the availability of land. Manga (1994) cites 7.5 years for the Ebolowa region, 5.4 years *ior* M'Balmayo and 3.9 years for Yaounde.

In Lekie Department (north of Yaounde), fallow is mainly herbaceous. The lack of available land has become a serious threat for the shifting cultivation system, and it is leading to degraded soils. This is also the only department where the food supply grown does not cover the needs—only 87% are covered—because of high population densities (66 inhabitants per square kilometre in 1995) and transfers to the market in Yaounde.

In Mefou and Nyong et So departments (in the centre of the area), fallow length is higher. After burning a fallow 5 to 7 years old, the main crops during the 1st 2 years are cassava and groundnuts. After the forest is slashed and burned (in this area the forest is secondary), 'ngon' *(Cucumeropsis manii)* and plantain are preferred during the 1st year ('essep' field). In these departments, food-crop production is based on shifting cultivation. But when farmers want to extend their cropland, they have to cultivate far from roads, and access becomes a major constraint.

In Ntem, in the south *of* the area, fallow is often more than 20 years old and can be considered like a secondary forest. The primary forest is still very extended and the 'essep' field is frequent. Thus in this area there is room for shifting cultivation, and it is a sustainable system.

Monitoring deforestation by remote sensing

We used the spatial data available, which unfortunately were heterogeneous: a 1 : 500 000 vegetation map (Letouzey 1968, 1985), a set of NOAA-AVHRR cloudless images (1991 to 1994) and a set of 4 SPOT images (1995). Out of the set of 11 NOAA-AVHRR images, only 1 (January 1993) was cloud free enough for us to process a land-cover classification[3]. The land-cover map obtained from this AVHRR image (1-km resolution) was then compared (fig. 5) with Letouzey's map based on 1968 data.

Land-cover changes compared at this scale (table 1) are nearly balanced.

Table 1. Land covers compared between Letouzey's 1968 map and a 1993 AVHRR image

Letouzey map	AVHRR 1993	Area (km^2)
Agroforest[4]	agroforest	5 606
Forest	forest	47 698
Forest	agroforest	9410
Agroforest	forest	10 774

A large proportion of forest was undisturbed during this period—62.84% of the total area. Part of the agroforest became forest—13.88%—and part of the forest was converted in agroforest—12.12%. Thus it appears that 1.76% of the total area was again covered by forest. However, these results have to be considered with extreme care, and they do not consider the deforestation process. They do indicate shifting cultivation practices and agroforest returning to forest (secondary forest) as forest is being converted to agroforest.

The classified mosaic of the 4 SPOT images in 1995 (fig. 2) has a much better resolution (20 m) and gives us more accurate information about fragmentation of cropland and

3 We processed an unsupervised classification and then merged clusters by photointerpreting this classified image, using 45 ground control points picked out in 1994 with a GPS (global positioning system).

4 Agroforest here is a land-cover unit that we have defined as a non-continuous tree canopy cover.

forest. It was not possible to classify cocoa plantations using these SPOT data because their radiometric signature was too close to the signature of the degraded forest. Therefore, comparing land-cover statistics on the area covered by the SPOT mosaic with the AVHRR classified image shows huge differences (table 2).

Table 2. Comparison of land cover between 1993 (AVHRR) and 1995 (SPOT)

	AVHRR 1993 (ha)	SPOT 1995 (ha)
Forest	660 200	849 724
Agroforest	487 800	-
Cropland	-	230 966
Other (roads, clouds ...)	-	67 310

Within this comparison, the main difference comes from the classification of the agroforest unit. With NOAA-AVHRR resolution (1 km), agroforest is a mosaic of forest and non-forest that includes cocoa plantations. With SPOT-HRV resolution (20 m), land cultivated in food crops and young fallow within the forest are better identified, but cocoa plantations under tree shadow are seldom recognized and as a result are often classified as forest.

As the extent of cocoa plantations is nearly the same as that of land in food crops, the huge difference between remotely sensed results can be explained:

- SPOT-HRV underestimates cropland because it does not identify cocoa plantations
- NOAA-AVHRR overestimates cropland because it averages fragmented patches of forest and non-forest

Thus in this study, the remote sensing data that we used did not allow an accurate evaluation of the extent of cultivated land. Until new sensors with better geometric and radiometric resolution are available, we recommend extreme care when using satellite images on this landscape, which includes cocoa plantations under tree shadow.

But even if this is a strong limitation, deforestation by slash-and-burn agriculture occurs mainly for food crops. There are very few new cocoa plantations because farmers go back to cultivate the old ones. Thus deforestation can be identified by a high-resolution sensor like SPOT-HRV, and deforestation monitoring is therefore possible. Unfortunately our heterogeneous data set (AVHRR and HRV) does not allow us to do this monitoring in this situation.

Is the South Cameroon forest a frontier?

As we were not able to monitor deforestation with the available satellite data, we examined demographic changes. These data are not directly linked to deforestation (Imbernon 1997) because many other factors, such as integration with markets, urbanization and land speculation, could relate to the change in land use. But population change can be a good indicator if, at household scale, driving forces do not change land-use intensity.

Farming systems in the South Cameroon forest are identical to those at the beginning of the 1970s (Weber 1974, Leplaideur 1985). They are based on cocoa plantations and on shifting cultivation for food crops, as described above. During the period from 1976 to 1987, stagnant cocoa prices with rising prices for the goods consumed by farmers led to a decline of agricultural terms of trade (Jim Gockowski, IITA-Cameroon, personal communication). One consequence was that farmers did not plant any more cocoa and that parts of

replace cocoa benefits and give access to goods, the food cropland extent remains the same.

Another consequence of the decline, in agricultural terms, was the movement to urban centres, mainly to Douala and Yaounde. For rural people, and for young people as well, towns are a symbol of progress. But also, the bureaucracy in these urban areas during this period created a demand for jobs.

So population has been always moving, as part of the ancient flux from savanna to forest, or as part of the shifting cultivation system, or more recently as part of the urbanization process. These have never been mass movements.

When we look at table 3, high heterogeneity between departments appears to be a characteristic. And we notice that population is decreasing in the forested area (-0.29% growth rate in Ntem Department, -3% in Nyong et So), but on the other hand, population is increasing in the Yaounde area (+7.34% growth rate in Mfoundi Department).

Table 3. Population density and growth rate in the area, between 1976 and 1987

	Rural population density (hab/km^2)		Rural population growth (%)
	1976	1987	1976-87
Mfoundi	86.46	193.88	+7.34
Lekie	63.34	64.82	+0.21
Mefou	25.11	24.68	-0.16
Nyong et So	15.54	14.83	-0.43
Ntem	6.67	6.46	-0.29

Source: Jim Gockowski, IITA-Cameroon

Thus, the South Cameroon forest does not seem to be a frontier. In the study area, from Yaounde to Ambam, there is no significant colonization of uninhabited forest areas by migrants, and indeed no significant dynamic of the landscape at the forest margin, except around Yaounde. As long as the Cameroon government does not implement policies promoting the colonization of this forest area, by opening roads and offering new incentives, deforestation through slash-and-burn agriculture will remain very low.

References

Imbernon J. 1996. Visions of landscapes and vegetation changes. Nairobi: ICRAF.

Imbernon J. 1997. Population growth and deforestation: the case of Rondonia in the Brazilian Amazon. Nairobi: ICRAF.

Leplaideur A. 1985. *Les systemes agricoles en zone forestiere : les paysans du Centre et du Sud Cameroun.* Paris: CIRAD-IRAT. 615 p.

Letouzey R. 1968. *Etude phytogeographique du Cameroun.* Paris: P. Lechevalier.

Letouzey R. 1985. Notice de la carte phytogeographique du Cameroun au 1/500 000. *Institut de la carte Internationale de la vegetation,* Fasc. 3-4:63-142.

Manga T. 1994. Alternatives to Slash-and-Burn project: Cameroon benchmark site annual report. Yaounde: IRA.

Moisel M. 1913. Karte von Kamerun. Berlin: D. Reimer.

[ORSTOM] Institut francaise de recherche scientifique pour le developpement en cooperation. 1995. *Atlas regional du Sud-Cameroun.* Paris: ORSTOM.

Weber J. 1974. Structures agraires et evolution des milieux ruraux. Le cas de la region cacaoyere de Centre-Sud Cameroun. *Cahier ORSTOM, Sciences Humaines* 14(2):113-141.

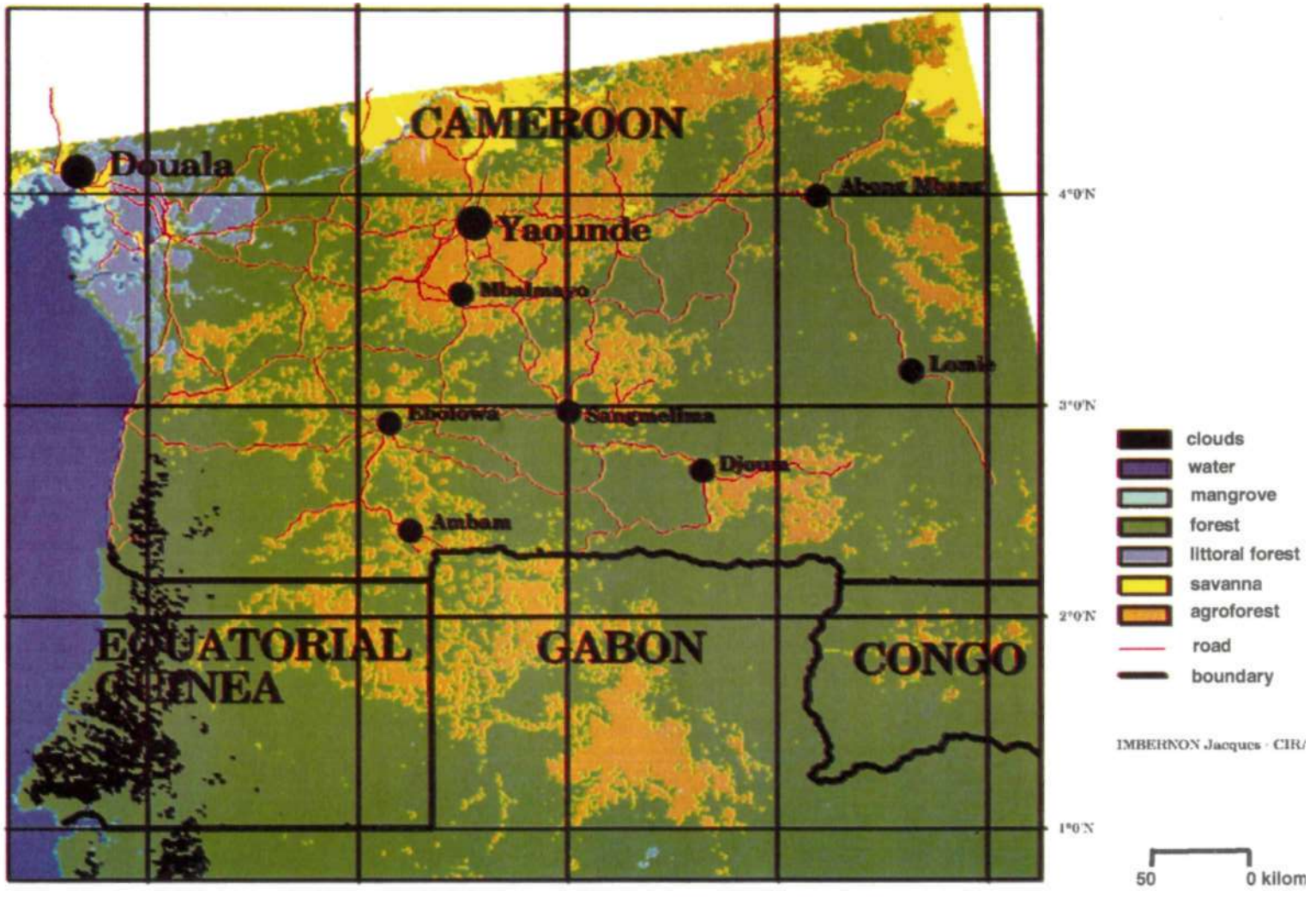

Figure 1. Land-cover image derived from a 1993 NOAA-AVHRR image.

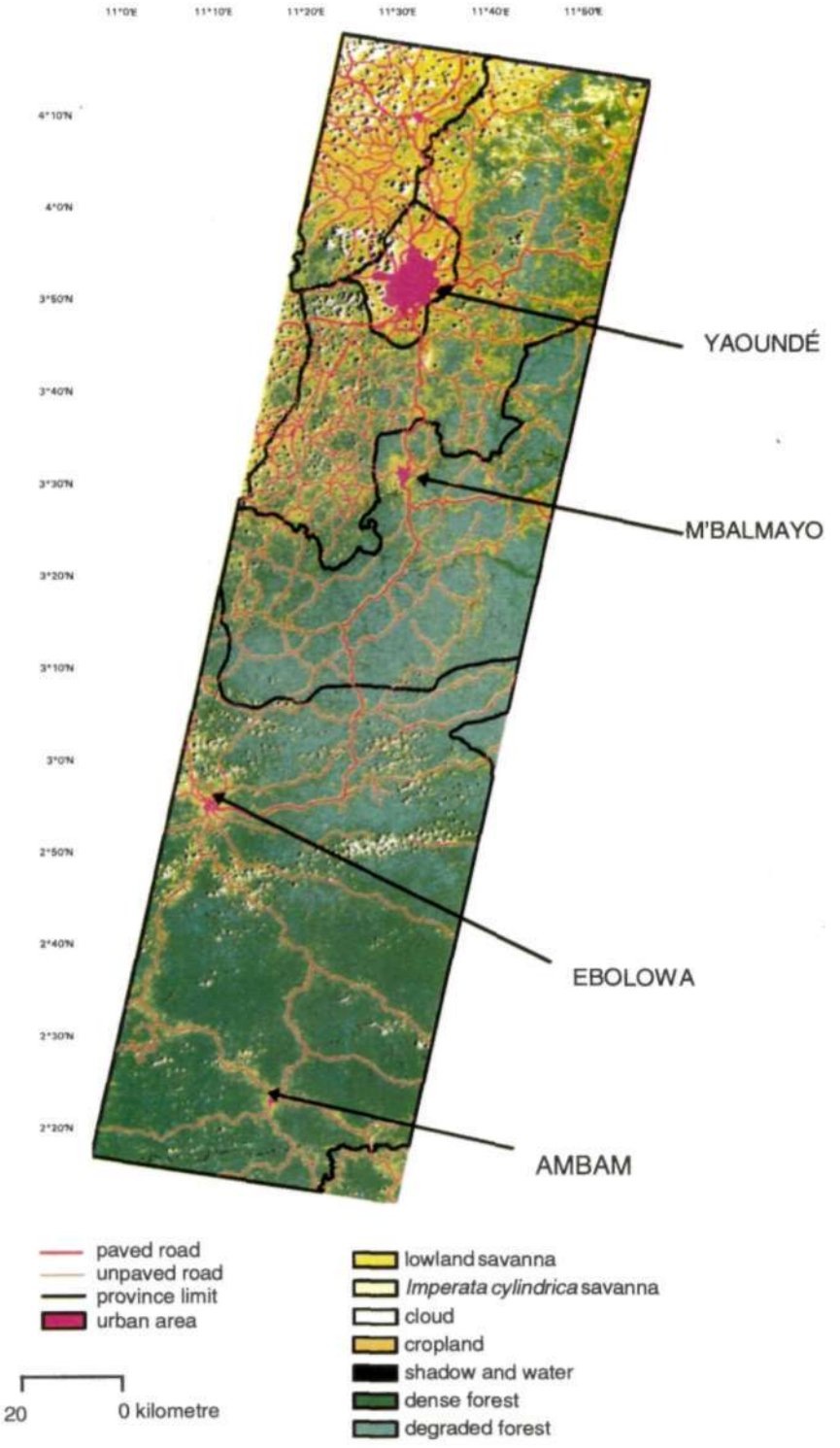

Figure 2. Land-cover image derived from a 1995 SPOT-HRV mosaic.

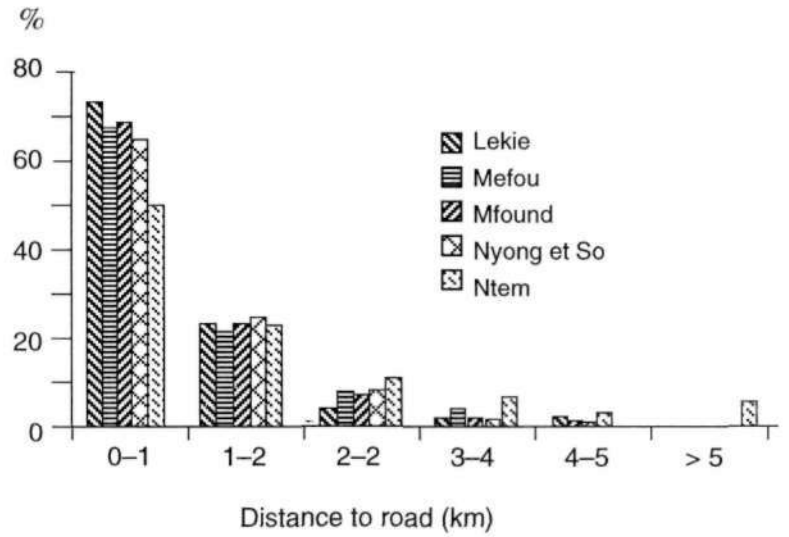

Figure 3. Percentage of cropland area in the total cropland area of the province, as a function of distance to the road

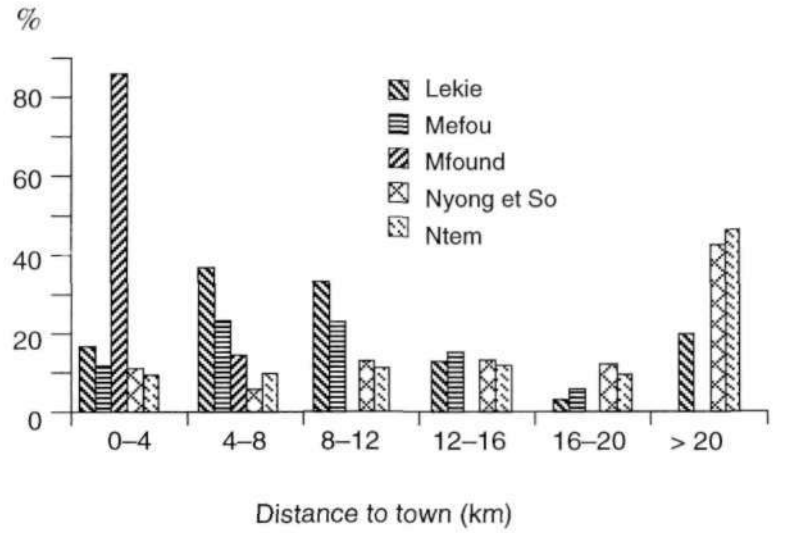

Figure 4. Percentage of cropland in the total cropland area of the province, as a function of distance to town

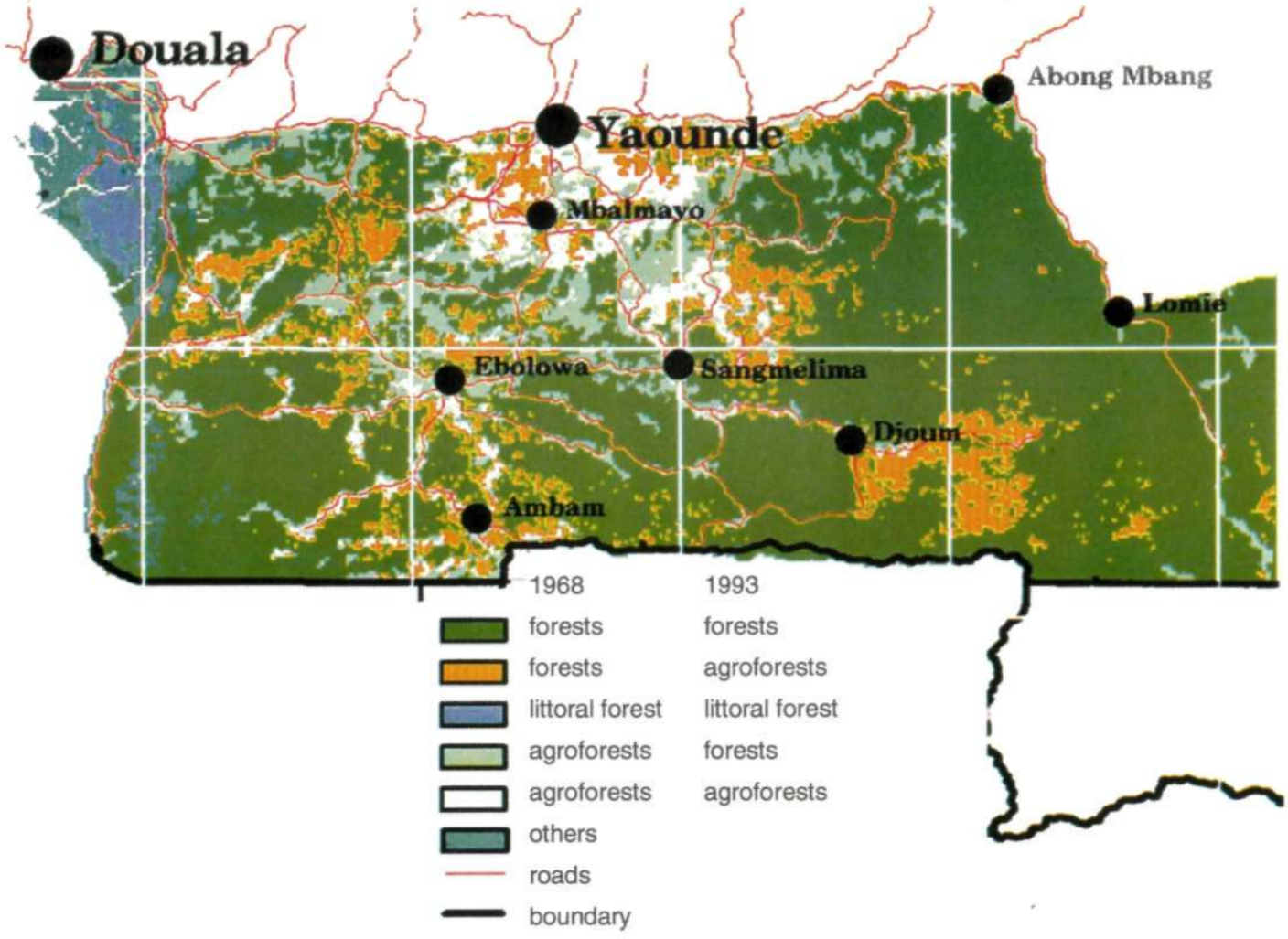

Figure 5. Land-cover changes between 1968 and 1993 in South Cameroon.