PAPERS

Spatial characterisation of non-timber forest products markets in the humid forest zone of Cameroon

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SUMMARY

The paper analyses the structure of non-timber forest products (NTFP) markets in the humid forest zone (HFZ) of Cameroon from a spatial perspective. A characterisation of 25 markets based on a set of products, traders, and marketplace attributes was produced. The combination of the attributes size and self-sufficiency results in four main types of markets (national, provincial, local and frontier), whereas clustering based on all the attributes clearly distinguishes the northern and southern areas of the HFZ, and an urban-rural, core-periphery relationship within each area. This separation reflects different product specialisations and diversity, as well as market size. *Dacryodes* and *Gnetum* predominate in the northern markets, which tend to be larger, whereas *Garcinia lucida*, *G. kola* and *Irvingia* are relatively more abundant in the southern markets. In general, larger markets are more diversified and their traders are more specialised than the smaller ones. There are also differences in product storage time, distance from source of products, level of taxation, and transportation problems. The need to understand the multiple, non-linear interactions among these factors is stressed.

KEYWORDS: Cameroon, NTFP markets, spatial analysis.

INTRODUCTION

Non-timber forest products (NTFP) have played a dual role in forest dwellers' livelihoods, as subsistence products to meet daily and seasonal needs and to cover demand in years of poor harvest, and as commercial products that contribute to the household cash economy (Arnold 1995). NTFP market research has gained in popularity in recent years following recognition of the importance of their contribution to both local and national economies (Falconer 1990, Ruiz Pérez and Arnold 1996, Scoones, Melnyk and Pretty 1992, Townson 1995). This has been reinforced by the apparent coincidence of conservation and development objectives that they provide (Fearnside 1989, Myers 1988, Panayotou and Ashton 1992, Plotkin and Famolare 1992), which has resulted in the formulation of a 'conservation by commercialisation' hypothesis (Clay 1992, Evans 1993, Stiles 1994) observed by a number of international initiatives (BCN, Cultural Survival, Conservation International, People and Plants, WWF).

All these activities have relied strongly on assessments of NTFP markets that have been carried out from one or more of the following perspectives:

- Market description and quantification. This includes the general operation of the market, type and qualities of the products being traded, market channels from producers to consumers, trade volume and value (see Falconer 1992, Lim, Vincent, and Woon 1994, Padoch 1988).
- Performance and conduct. Includes studies on different components of the cost structure (such as purchasing, transportation, storage, financial), profit margins, degree of competitiveness among traders, and efficiency in matching supply and demand (see Ammour, Ocampo and Robles 1994, Goletti and Badiane 1994, Ndoye, Ruiz Pérez and Eyebe 1997, Simmons, Gordon and Cropley 1994).
- Product and market development. Centres on assessment of potential demand, exploration of new products, improved technologies from production to processing, standards, grading and quality control, advertising (see Clay and Clement 1993, Coppen *et al.* 1995, de Silva and Atal 1995, Hyman 1996).
- International trade and regulations, particularly volume and value of trade, factors affecting it, main international trade channels, national and international regulations affecting the trade of NTFP (see Anderson 1993, Iqbal 1993, 1995, LaFleur 1992, Lintu 1995, Manokaran 1990, Raintree and Francisco 1994, Townson 1992).

For the vast majority of markets their spatial relationships are essential components of their overall functioning. The

analysis of these relationships is based on three basic models developed in the 19th and early 20th centuries by von Thünen (zonal model along transportation axis), Weber (isocost surfaces based on different production factors) and Christaller (central place theory, based on a spatial hierarchy from villages to metropolis) (Healey and Ilbery 1990). Four main market features are particularly affected by their spatial characteristics: supply, demand, transportation costs and different types of relationships among market players that are normally termed 'linkages' in economic geography (Berry, Conkling and Ray 1976, Healey and Ilbery 1990).

Yet, although NTFP production and market studies normally discuss some spatial characteristics that influence the commercialisation of NTFP (like distance, transport infrastructure, forest distribution, population size), this is achieved in an *ad hoc* way and is very rarely formally incorporated in the analysis (see Dufournaud *et al.* 1995, Gunatilake 1994, Ntamag 1997, Wickramasinghe, Ruiz Pérez and Blockhus 1996 for some examples mainly related to distance). Therefore, most of the results from NTFP market analysis tend to be non-spatial, and their conclusions and recommendations often fail adequately to account for the spatial structure of markets, the factors characterising different types of markets, their links, and areas of influence. A proper understanding of the above features not only complements the above studies of forest products markets and their potential, but also allows for more targeted policy interventions, which are crucial in reconciling livelihood improvement and forest conservation.

In the present paper we develop a characterisation of NTFP markets from the humid forest zone (HFZ) of Cameroon with an explicit spatial component. The first section offers an overview of the importance of NTFP and their markets in the region. Section two presents the methodology of the study. Section three uses a network and market size analysis to categorise different markets. Section four conducts a cluster and ANOVA analysis to classify the markets and identify their differentiating variables. The last section combines the different analyses to provide a joint perspective for a spatial characterisation of NTFP markets in Cameroon, and discusses some of its implications.

THE HUMID FOREST ZONE OF CAMEROON AND NTFP MARKETS

The humid forest zone (HFZ) of Cameroon is part of the Central African Tropical Humid Forest that covers about 280 million ha, and constitutes the second largest humid forest in the world after the Amazon (FAO 1995, Talbott 1993). The Cameroonian forest is considered the most diverse of all Central African forests (Alpert 1993, Tchoungui *et al.* 1995) and this diversity has offered opportunities for the people to use a wide variety of resources both of plant and animal origin (Doucet and Koufani 1997, Koppert *et al.* 1993, Ngala 1997, Shiembo 1995).

However, the availability of these resources has been reduced owing to high deforestation rates resulting from a combination of internal (population growth, agricultural development, new transport infrastructure) and external (economic crisis, devaluation of the Franc CFA (Communauté Financière Africaine), structural adjustment) factors (Ndoye and Kaimowitz 1998, Oyono 1997, Talbott 1993). The competition between traditional users and loggers, who tend to leave part of the forest damaged and unavailable for the extraction of NTFP, has also had a negative effect on NTFP harvesting (Nef 1997). Furthermore, there are trees that are valuable both for NTFP and timber thereby creating conflicts between traditional users and logging companies. The case of moabi (*Baillonella toxisperma* Pierre) is very revealing as described by several authors (Schneemann 1995, Verhagen and Enthoven 1993).

Given the cultural and ecological affinities of the Central-West African region, some of these resources like the wild mango (*Irvingia* spp.), African pear (*Dacryodes edulis* (G. Don) H.J. Lam.), koko leaves (*Gnetum* spp.), kola nut (*Cola acuminata* (P. Beauv.) Schott et Endl. and *Cola nitida* (Vent.) Schott et Endl.), bitter kola (*Garcinia kola* Heckel), njansang (*Ricinodendron heudelotii* (Baill.) Pierre ex Heckel), and palm fruits (*Elaeis guineensis* Jack.) are frequently found and consumed in most countries (see Chabot 1997, Falconer 1992, Herzog, Gautier-Béguin and Müller 1996, Lahm 1993, Okafor 1980, Shiembo, Newton and Leakey 1996). Biogeographical, phenological and socioeconomic factors create the conditions for a complementarity in supply and demand of products, giving rise to a thriving regional market with spatially and temporally specialised exchanges (Ndoye and Ruiz Pérez 1999, Oyep and Kamanda 1996, Silou 1996). Certain forest commodities with relatively high value by volume and strong cultural significance (like *Dacryodes edulis*, *Gnetum* spp. and *Irvingia* spp.) enjoy a transcontinental market, being regularly traded between Central-West African countries and the major European cities with populations of this descent (Ladipo 1998, Mialoundama 1993, Tabuna 1999).

The NTFP markets in the HFZ of Cameroon revolve around the buyam-sellam (literally buyers-sellers) in their various categories. These tend to be women who may specialise in a few NTFP or may deal with a large variety of NTFP and agricultural commodities. They organise both the physical arrangement of the marketplace (through the 'market cheftaine' or traditional leader, normally a woman trader from the town where the market is located), as well as the informal financing (and sometimes market information) networks, called 'tontines' (a type of rotating credit; see Nzemen 1993) in francophone Cameroon. The buyam-sellam play an intermediary (linking supply with demand) role and, in most cases, also do sorting, grading, and some degree of processing (Fereday, Gordon and Oji 1997, Ndoye, Ruiz Pérez and Eyebe 1997).

The HFZ of Cameroon includes 60% of the total population of the country (Pokam 1997), and most of its medium and large cities have markets with some level of specialisation on NTFP. Frequency and regularity of these markets depends on the size of the town. They formally fall under the responsibility of the local authorities, but in

practice the traders manage them informally through rules and allocation of space mutually agreed by all traders. They have to pay a market entrance fee and, when they use a permanent storage-selling facility, a stall fee. A survey of a large number of markets in the HFZ of Cameroon estimated that the half year value of transactions (recording part of the seasonal variation of the market) amounted to at least US$1.75 million, of which around 6% is exported to neighbouring countries (Ndoye, Ruiz Pérez and Eyebe 1998). This trade, referred only to half year value in the Humid Forest Zone, is larger than the total yearly sales for the whole country of agricultural commodities like pineapple, watermelon or green beans, and smaller than the yearly country trade of avocado, mango or tomatoes (Temple 1999).

METHODOLOGY OF THE STUDY

In order to secure a wide coverage of the HFZ a total of 31 markets from the 5 provinces (Centre, South, East, Littoral and South-West) were selected based on criteria of significance, representativeness and accessibility. These markets were surveyed in two consecutive years, 1995 and 1996, each time during the period January–July. On average, the markets were visited twice during 1995 and three times during 1996. Due to logistic difficulties and a reduced number of interviews in some cases, comparative data for the two years were obtained for only 25 markets, and these were retained for the present analysis. However, since the questionnaires included information about the original place of purchase of the product, these 25 selling markets can be spatially related to 120 localities of origin, or buying places.

Two large cities, Douala and Yaoundé, have more than one NTFP market in their metropolitan area. The market studied in Douala was the large market of New Bell, whereas in Yaoundé the large urban market of Mfoundi and the suburban market of Mokolo were selected; they play different roles and their data have been maintained separately for the analysis.

The number of traders interviewed in the 25 markets was 253 in 1995 and 315 for 1996. They were selected randomly and, after explaining the purpose of the study, a questionnaire was administered to those traders willing to cooperate. Those who, for various reasons (mainly suspicion of government officials or tax collectors), were not willing to cooperate were replaced using again a random sample approach. Data were checked during the interview against standardised values (such as prevalent prices and costs) and in the case of strong departures traders were asked to explain the reasons. The total number of traders operating in these markets (based on an estimate provided by each of the traders interviewed) was 1101 (S.E. of the mean = 27.1), with the average number interviewed representing 26% of the traders operating in the markets studied.

The questionnaires included general information about the market and its operations (*e.g.* number of traders, size, frequency, taxes, years of operation), about the traders themselves (*e.g.* age, gender, family status, education level, ethnic origin), and detailed information for each of the products being sold (*e.g.* amount, buying price, different components of the cost structure, selling price, date and place where bought, type of supplier, transport arrangements, financing, storing, spoilage, processing, etc). In order to improve the projections, several recall questions related to quantity and price of previous months were included.

Each product was recorded separately for each trader in order to allow for product-based calculations. In this way, a total of 1568 valid records were obtained, and the following results are based on their combined analysis.

MARKET SIZE AND NETWORK

Nine products comprise the bulk of the NTFP trade in these 25 markets of the HFZ of Cameroon, accounting for more than 95% of the total NTFP trade (see Table 1). This refers to products commonly traded in the marketplace. There are some products, such as the bark of *Prunus africana* (Hook. f) Kalkman which is used in the treatment of prostate problems, that can be economically very important (see Cunningham and Mbenkum 1993), but are usually exported and traded through direct arrangements. Others, like rattan (*Laccosperma*

TABLE 1 *The nine dominant NTFP in the markets of the humid forest zone of Cameroon*

Product	Uses	Habitat
Dacryodes edulis (G. Don) H.J. Lam.	food	secondary forest, farms, fallow
Garcinia kola Heckel (fruit)	medicine, stimulant	primary & secondary forest, farms
Garcinia kola Heckel (bark)	medicine, palm wine	primary & secondary forest, farms
Garcinia lucida Vesque (bark)	medicine, palm wine	primary & secondary forest
Gnetum africanum Welw. *Gnetum buchholzianum* Engl.	food	secondary forest, fallow
Irvingia gabonensis (Aubrey-Lecomte ex O. Rorke) Baill.	}condiment	primary & secondary forest, farms, fallow
Irvingia wombolu (Vermoesen)	}	
Cola acuminata (P. Beauv.) Schott et Endl.	}medicine, stimulant	secondary forest, farms, fallow
Cola nitida (Vent.) Schott et Endl.	}	
Elaeis guineensis Jack.	food, palm wine	farm, fallow, secondary forest
Ricinodendron heudelotii (Baill.) Pierre ex Heckel	condiment	primary & secondary forest, farm, fallow

Sources: based on survey results, Ntamag 1997, Vivien and Faure 1985, Wilkie and Buccowich 1998.

spp.) used for basketry and furniture, are sold through specialised market channels and do not pass through these types of markets (Sunderland 1997). The same species can provide two different products treated separately at the market place (as in the case of *Garcinia kola* fruit and bark). Conversely, a product considered as a single commodity in the market can come from different species, as in the case of Gnetum leaves. The nine products range from food and condiments to medicines, stimulants and ingredients in the processing of other products like palm wine. They are planted or gathered from fallow lands, secondary forests and primary or little disturbed forests.

Analysis of the 25 markets indicates three separate levels of market size (represented by the diameter of the circle in Figure 1) based on the importance of the NTFP traded. Very large markets (corresponding to Douala, the large industrial port of Cameroon, and Yaoundé, capital of the country) handled estimated half year sales of more than 100 million CFA (average exchange rate US$1=480 CFA in 1995; US$1= 510 CFA in 1996). Medium-sized markets had average half-year sales between 10 and 100 million CFA, and half-year sales totalled less than 10 million CFA in small markets. The orders of magnitude coincide with market studies conducted in neighbouring countries during the same period (see for example Chabot 1997 for a study of the NTFP sector in Gabon). A cursory view of Figure 1 indicates a spatial differentiation in the type of products being traded in different regions. We shall explore this in more detail in the next section.

Spatial links between markets can be seen by examining the network connections between buying and selling localities (Figure 2). For this purpose buying and selling points were considered to be the same locality if they were less than 6 km apart. This is regarded as the maximum distance covered on foot by farmers or traders to undertake their transactions. Seventy per cent of the total volume and 65% of the total value correspond to transactions where the buying and selling localities are different, highlighting the importance of the spatial links between NTFP markets in the HFZ of Cameroon.

Six major routes can be identified in Figure 2. The axis between Douala and the West is dominated by the trade of *Dacryodes* (the most important product in the West Province), which represents 25% of the total value of the products being transported between buying and selling places. The link between Yaoundé and the South (Mbalmayo, Ebolowa and Abang Minko) represents 14% of transactions among different localities. The route between north of Yaoundé and Douala absorbs 13% of the transactions, with the Ebolowa–Abang Minko–Frontier South link also deal-

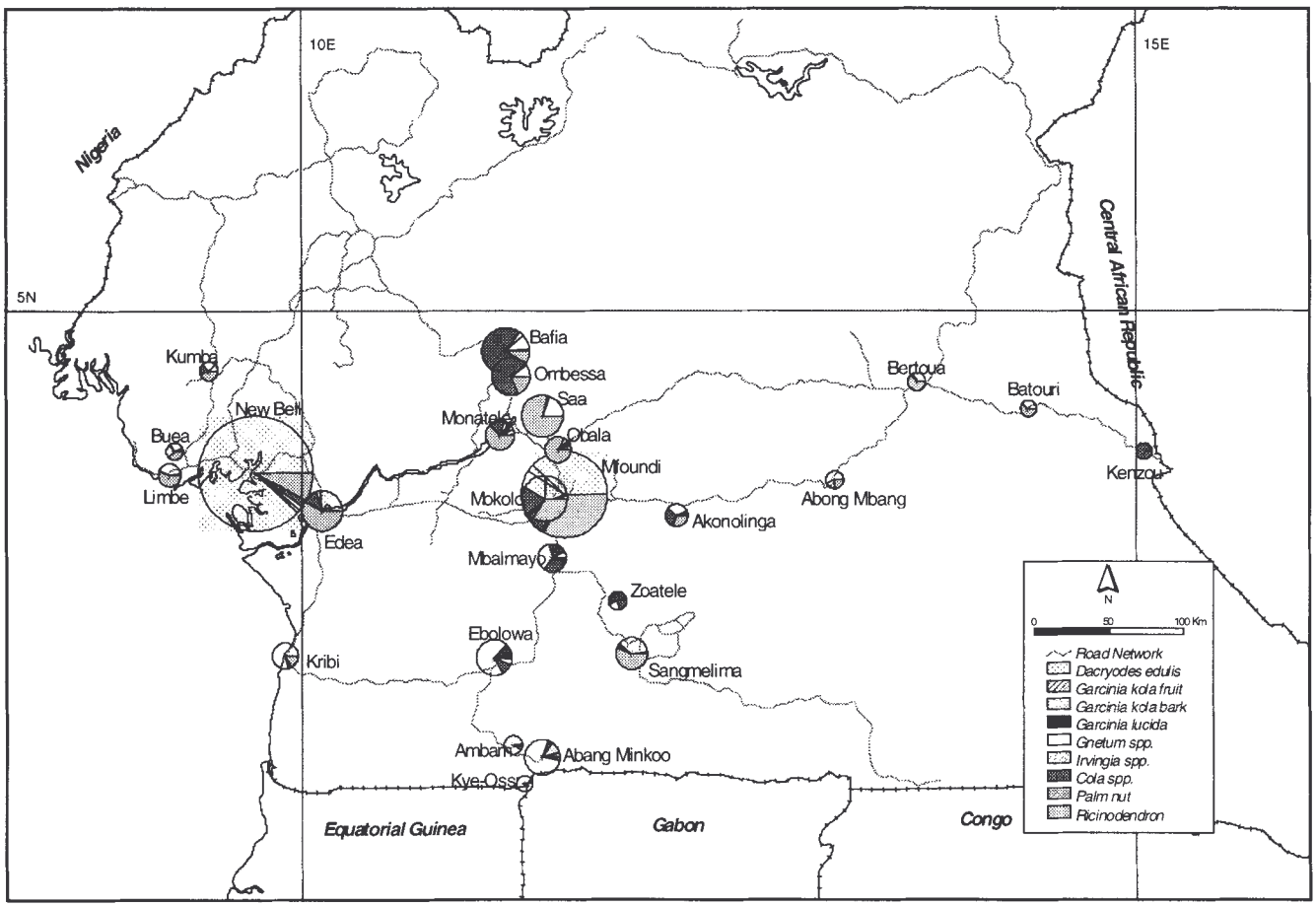


FIGURE 1 *Distribution of NTFP in the 25 core markets*

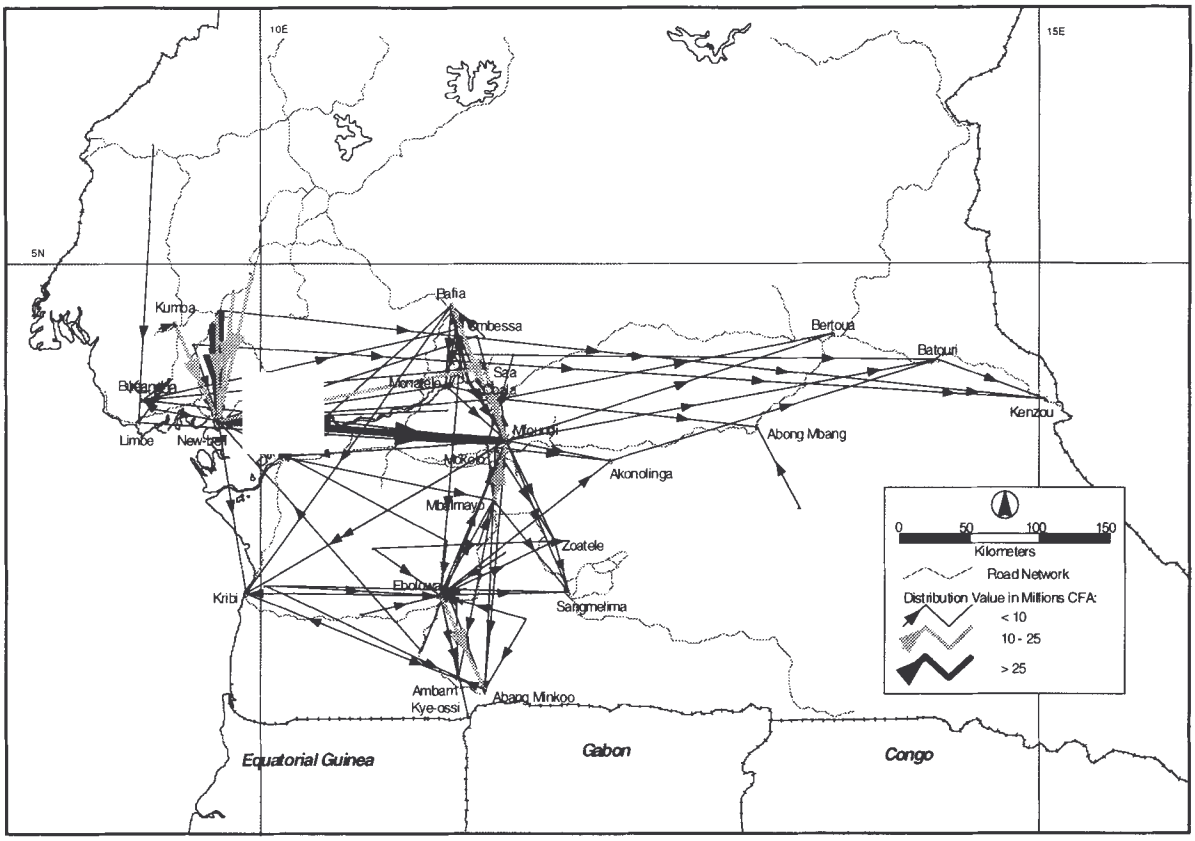


FIGURE 2 *Spatial links between the main NTFP markets in the HFZ of Cameroon.*

ing with 13% of the value. The Yaoundé–Edea–Douala axis absorbs 9% of the total value of movement of NTFP in the markets studied. The Bafia to Yaoundé link joins the main markets of the North province (Ombessa, Saa and Obala) with the capital, and represents 6% of NTFP transactions.

Figure 2 also shows several shorter, secondary links, like the connections between Kribi and the southern frontier, with 4% of transactions value, and the axis between Yaoundé and the East (Akonolinga, Abong Mbang, Bertoua and Kenzou) accounting for 0.4% of transactions.

From these data New Bell (Douala) and Mfoundi (Yaoundé), the largest markets in the HFZ, also appear as the main assembly points for NTFP, linking directly the West, Centre and South provinces. As can be seen, the effects of the large urban markets are felt more strongly in the western part of the HFZ. The concentration of trade clearly indicates the strong relationship between both cities. The eastern section, with a lower population density and more forest resources, is generally less influenced by the axis Yaoundé–Douala. Its main markets are more autarchic (with the exception of the frontier market of Kenzou, which acts as an export gate to the Central African Republic). However, because of the sparse settlement, when they interact with other markets the distances tend to be rather large.

A scatterplot of the size of a market and its degree of self-sufficiency (as a percentage of supply from the same area) can synthesise the information shown in Figures 1 and 2, further clarifying the structure and spatial organisation of markets (see Figure 3). Four main categories can be identified:

i) The frontier markets of Abang Minko, Kenzou and Kye-Ossi, with small to medium value of transactions and very high dependence for their supply on other areas. Zoatele is an exception in this group, not being a frontier market and yet having a high level of dependence on other areas. The reason is the specialisation of this market in two products, *Garcinia lucida* and *Irvingia* spp., both coming from less disturbed forests already rare in the vicinity of Zoatele.
ii) The two large urban markets of New Bell (Douala) and Mfoundi (Yaoundé), whose size and spread of linkages give them a national projection. They are characterised by a weak degree of self-sufficiency, having to rely to a large extent on more distant supply areas. These two markets combined can be considered as the key hubs of spatial organisation of the HFZ around which the rest of the markets gravitate.
iii) A group of medium-sized markets of regional importance, with a medium level of self-sufficiency, acting as secondary nodes for the small local markets and as intermediate assembly points for the two large urban markets.
iv) The small, local markets with a high level of self-sufficiency that act as local exchange places as well as suppliers of the regional and national markets.

Douala and Yaoundé represent the top of a pyramid of markets linked through a hierarchy of networks, complemented by some markets with specific features that occupy a frontier niche.

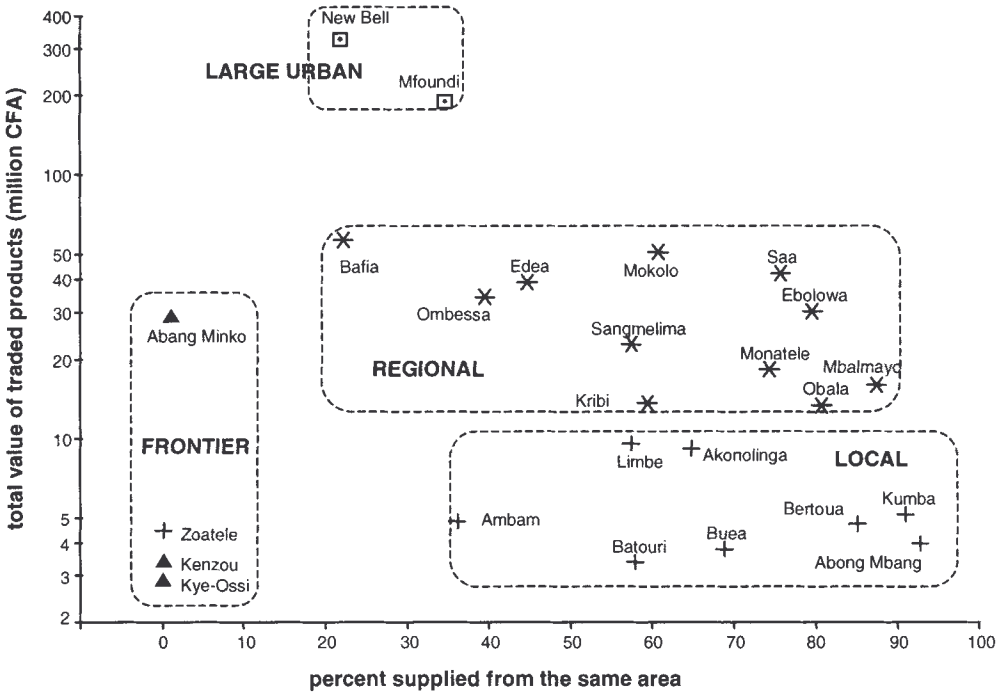


FIGURE 3 *Scatterplot of size of market and degree of self-sufficiency*
⊡ Large urban markets ; ∗ Regional markets ; + Local markets ; ▲ Frontier markets

TABLE 2 *List of variables used in the characterisation of markets*

Variable	Description
Dacryodes edulis	value, volume, net profits of *Dacryodes*
Garcinia kola fruit	value, volume, net profits of *Garcinia kola* fruit
Garcinia kola bark	value, volume, net profits of *Garcinia kola* bark
Garcinia lucida	value, volume, net profits of *Garcinia lucida*
Gnetum spp.	value, volume, net profits of *Gnetum* spp. leaves
Irvingia spp.	value, volume, net profits of *Irvingia* spp.
Cola spp.	value, volume, net profits of *Cola acuminata* and *C. nitida*
Eleais guineensis	value, volume, net profits of Oil Palm nuts
Ricinodendron heudelotii	value, volume, net profits of *Ricinodendron heudelotii*
Total value	total value of NTFP sold in the market
Total quantity	total volume of NTFP sold in the market
Total net margins	total net margins obtained from selling NTFP in the market
Number of traders	number of traders operating in the market
Distance	average distance from selling market to the market where the product was bought
Storing days	average number of days for products stored
Costs at origin	transaction costs at origin per unit of product
Transportation costs	transportation costs per unit of product
Costs at destination	transaction costs at destination per unit of product
Taxes	taxes paid per trader
Sex ratio	% of female traders
Household status	% traders as household head
Education level	% traders with medium to high education (versus illiterate or low education)
Level of spoilage	% of traders that have suffered spoilage of their products
Product processing	% traders doing some processing (sorting, grading, cleaning)
Seasonal transport problems	% traders with seasonal transportation problems
Participation in tontines	% traders participating in tontines
Market knowledge	% traders knowing prices and functioning of local and nearby markets
Financing	% traders needing financing for their purchases

CLASSIFICATION OF NTFP MARKETS

The information contained in the questionnaires was used to prepare a matrix describing the markets based on a combined set of attributes. These included features of the traders, the products and the markets themselves (see Table 2).

In order to classify the markets a cluster analysis was conducted. Cluster analysis is a multidimensional analysis technique that groups cases based on their commonalities for a set of attributes. The steps to conduct a cluster analysis include the preparation of a matrix of cases described by a common set of variables, the calculation of a matrix of similarity by pairs of cases (using correlation, Euclidean distance or other similarity index) and the grouping of cases following a set of mathematical rules (algorithm).

In our study the markets were characterised using the average value for each of the variables recorded in the questionnaire. Data for the value, volume, and net profit of each of the products were entered as the percentage market share that a given product represents in the total being sold in that market. This step was undertaken in order to represent the product specialisation of each market and to avoid a trivial classification based only on absolute market size, although information about market size was also included in the variables total value, volume, net margins and number of traders. The data were z-standardised for each of the variables. The cluster analysis was based on a Pearson correlation coefficient as similarity matrix and UPGMA (Unweighted Pair Group with Mathematical Average) as grouping algorithm, commonly used in cluster analysis and producing robust classifications (Everitt 1993, Sneath and Sokal 1973).

The North and South markets

The cluster analysis separates two groups of markets based on the combined attributes. The projection of these two groups onto the map of the HFZ (Figure 4.1) clearly indicates a spatial split along a NE–SW line passing below the Yaoundé–Douala axis, with the exception of Limbe. For the sake of simplification we shall refer to them as the North and South groups.

An ANOVA test comparing the values of the variables for each of the two groups identifies the variables with statistically significant mean differences (Table 3). This is used to find out which variables are responsible for the split between the North and South group of markets identified by the cluster analysis. In order to analyse the product differentiation and its spatial distribution we calculated an index of product diversification for each of the markets based on the Shannon-Weaver entropy formula (Shannon and Weaver 1963). In the present case the index would rank between 0 for a market that only deals with one product an 3.17 for a market with exactly the same contribution to the total value of NTFP by each of the nine products. This product diversity index was also compared using the ANOVA test.

As is shown, the two groups of markets have a strong spatial specialisation on different types of products. Thus, *Dacryodes* and *Gnetum* dominate in the northern markets, which tend to be larger, whereas *Garcinia lucida*, *Garcinia kola*, *Irvingia* and palm nut are relatively more abundant in the southern markets, which tend to be smaller. This product differentiation directly reflects the abundance and quality of forests in each of the areas. In the northern half of the HFZ of Cameroon there is less primary or little disturbed forest (see Sayer, Harcourt and Collins 1992, Thenkabail 1995), and more products that are mainly planted, as in the case of *Dacryodes*, or that are common and easily harvested in secondary forests or fallow lands like the climber *Gnetum*. Conversely, *Irvingia*, *Garcinia kola* and especially *Garcinia lucida* come from less disturbed forests (Ntamag 1997), more abundant in the southern part of the HFZ of Cameroon. This differentiation also has a cultural base, as for *Gnetum* that can

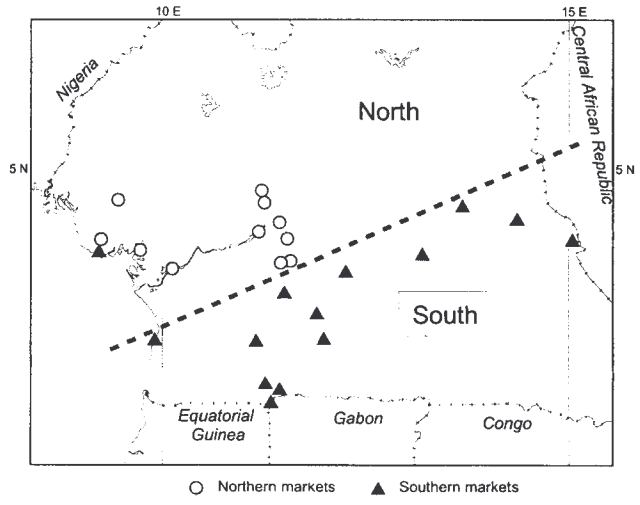


FIGURE 4.1 *Spatial projection of the two main cluster groups of markets*

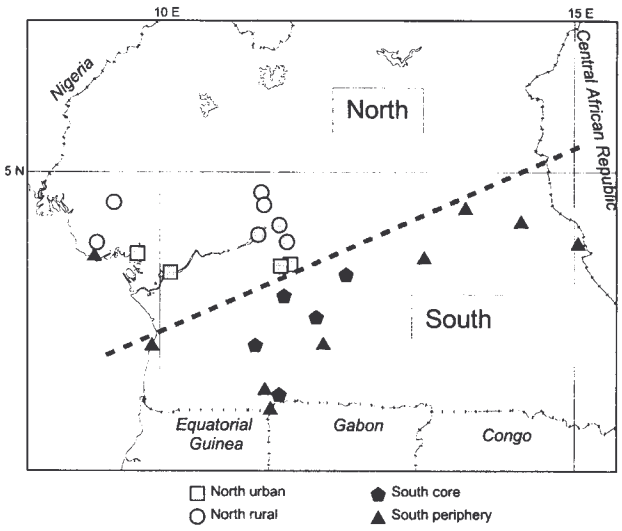


FIGURE 4.2 *Spatial projection of the six cluster subgroups*

TABLE 3 *ANOVA of the North and South groups of markets*

Variable	North group (mean)	South group (mean)	F value	Probability
Dacryodes value	17.6	1.2	5.299	0.031
Dacryodes quantity	19.6	2.8	6.284	0.020
Garcinia kola margin	2.2	0.4	4.616	0.042
Garcinia lucida quantity	0.0	19.0	4.332	0.049
Gnetum value	6.6	0.0	7.155	0.014
Gnetum quantity	51.8	0.0	18.894	0.000
Gnetum margin	11.3	0.0	8.155	0.009
Irvingia value	6.7	51.0	24.943	0.000
Irvingia quantity	3.8	34.5	14.048	0.001
Irvingia margin	8.6	49.2	18.457	0.000
Palm nut quantity	3.0	16.5	4.703	0.041
Total value (million CFA)	71.1	11.3	5.065	0.034
Total quantity	13,234	359	9.023	0.034
Number of traders	61.7	30.2	4.347	0.048
Distance	79.7	181.3	5.641	0.026
Storing days	8.0	16.6	6.188	0.021
Taxes	138.5	258.6	5.121	0.033
Transport problems	55.5	32.0	5.818	0.024
Product diversity	1.25	0.78	7.732	0.011

Note: only variables with probability ≤ 0.05 are included in the table.

be found in the southern part but is frequently ignored by the local population, being used there mainly by outsiders or migrants from other regions (Nef 1997).

Product differentiation affects storage time, with more perishable products such as *Gnetum* and *Dacryodes* that are commonly traded in the North group of markets having a faster turnover than products like the kernel of *Irvingia* spp. that, properly treated, can be stored for more than one year.

The differences in average distance from the source of supply to the selling place are the combined result of the more perishable products (common in the North) being transported a smaller distance, and spatial factors related to concentration of population and towns/villages. The noticeably higher concentration of population and settlements in the northern than in the southern part results also in shorter travel distances.

In spite of the above spatial characteristics, and the fact that the South has a generally poorer infrastructure than the North, more than half of the traders interviewed indicated they have seasonal transportation problems in the North. In the South this was mentioned by fewer than one-third of the traders interviewed. This difference, however, does not necessarily imply that the transportation system is better in the South than in the North. Rather, it indicates difficulties in hiring transportation by traders, who almost always rely on paying for the service of vans or small trucks to meet their needs. From the explanations given by traders, supplemented by our own experience, this seems to be related to a more specialised transportation system in the North, with a significant part devoted exclusively to transporting people. The generally larger size of business in the North tends to require special chartered arrangements to transport the products, resulting in more competition between transporting people and different agricultural and forest products. The result is transport bottlenecks in the peak season for some NTFP. The southern part, less populated and with poorer infrastructure, has a less specialised transportation system, where people and goods are frequently carried in the same vehicle. In addition, the size of trade is smaller and there is less competition between different types of commodities. It is therefore easier to find suitable transport for the NTFP being traded in this area, and the responses of traders reflected this situation.

The taxes paid per trader are also significantly higher in the South than in the North despite the fact that the latter is considerably richer than the South. This is a result of the taxation system, rather than a geographical differentiation in taxation policies in Cameroon. In fact, taxes are normally collected per day of entry in the marketplace and, since the products in the South tend to have slower turnover, they are ultimately taxed more heavily than the products in the North. This is because they stay in the market longer and traders need to attend more regularly to try to sell their products. A comparison of the taxes being paid with average turnover days of the products shows the opposite distribution, with higher taxes per day for the product staying in the market in the North (average of 43.2 CFA per day) as compared with the taxes in the South (average of 25.2 CFA per day), although the difference is not statistically significant owing to high variability within each group.

Product diversity

The ANOVA test shows that the North group of markets has higher product diversity than the South. This difference in product diversity could be due to spatial differences of forest

quality and coverage, but it could also reflect the structural difference in size of the markets, which is significantly greater in the North group than in the South. Larger markets would be expected to have a wider range of products, the larger number of traders allowing for some intra-market specialisation. To test this, we have used two non-linear regression models (see Figures 5.1 and 5.2). Product diversity as dependent variable and number of traders (as an indication of the size of the market) can be related through an exponential model of the type

$$\text{Diversity} = e^{(a/\text{size} + b)}$$

($a = -17.42$ and $b = 0.49$) showing a good fit ($R^2 = 0.640$, $F = 40.91$, $p < 0.001$). The regression has been tested for sensitivity to outliers. We considered four outliers, two on each extreme of the curve, and regressions were run removing the two extremes and one by one from high to low values. The model is moderately sensitive to outliers, maintaining its shape and high R^2 and significance values (albeit with a gradual decrease) when we remove the two extremes and one, two and three outliers, and changing shape and losing statistical significance when we remove four. Based on this model, larger markets appear to offer a more diversified supply than smaller ones, again supporting the predictions of central place theories.

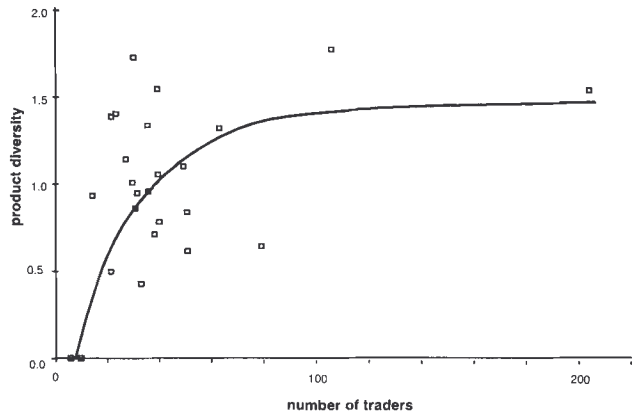


FIGURE 5.1 *Non-linear regression of product diversity on market size*

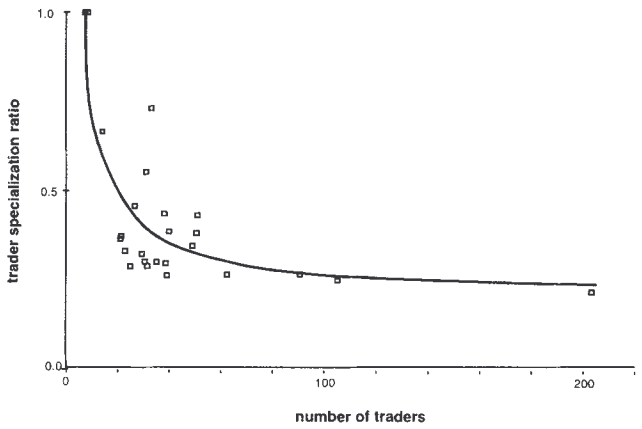


FIGURE 5.2 *Non-linear regression of trader specialisation on market size*

The degree of trader specialisation can be measured as the ratio between the number of products that a given trader sells and the total number of products being sold in that market. This ratio shows an inverse relationship of the type

$$\text{Specialisation ratio} = a/\text{size} + b$$

($a = 5.48$ and $b = 0.21$) also with a good fit ($R^2 = 0.738$, $F = 64.74$, $p<0.001$). This model has also been tested for sensitivity to outliers. It shows a more robust response, not changing shape and maintaining high R^2 and significance (again with a gradual decrease) when removing up to three outliers, and the same shape but on the limit of statistical significance when removing the four outliers. The model shows that as the size of the market grows, traders tend to become more specialised with regard to their reference market, dealing with a smaller subset of the total number of products being sold in the market.

Thus, the higher degree of product diversity in the North group of markets seems to be adequately explained by their generally larger size (which favours demand segmentation, trader specialisation and diversity of supply) rather than by the availability of forest resources in the surrounding areas. This availability in the case of large markets can be partially offset by travelling further to access a larger range of products.

Urban – rural and core – periphery divisions

Each of the two main groups of markets identified in the cluster analysis can be divided into three other subgroups. The projection of these subgroups onto the map of the HFZ of Cameroon appears in Figure 4.2. In the North group there is a clear distinction between the large urban markets of the Yaoundé–Edea–Douala axis and the rest, dominated by the regionally important markets of the Centre province (Bafia, Saa, Ombessa, Obala) and Buea, in the vicinity of Douala. The ANOVA test (Table 4) indicates that, for the split between the two main subgroups in the North markets, two products, *Dacryodes* (relatively more important in the large urban markets) and *Gnetum* (relatively more important in the rest), are significantly different. This does not mean that *Gnetum* is not sold in the large urban markets, but rather that its weight in them is overshadowed by the much greater importance of *Dacryodes*, a typical urban product considered a delicacy.

Likewise, the large urban group has higher total taxes, although again, due to different product storage periods, this difference is not significant when comparing the taxes paid per day in the market. The cost at the origin also shows a significant difference between the two groups, indicating that in large urban markets traders face higher handling costs at the source where products are collected. Finally, there is also a significant difference in level of knowledge about the market, being substantially lower in the larger urban markets than in the rest.

The clustering of markets in the South separates a group of markets which is closer to the centre and generally larger

TABLE 4 *ANOVA of the two main subgroups in the North markets*

Variable	Large urban markets (mean)	Other markets (mean)	F value	Probability
Dacryodes quantity	49.0	0.4	80.481	0.000
Gnetum value	0.4	14.2	9.074	0.020
Gnetum quantity	24.0	94.7	31.870	0.001
Gnetum margins	1.1	24.0	11.033	0.013
Taxes	181.9	105.6	10.095	0.016
Cost origin	235.6	17.7	6.956	0.034
Market knowledge	38.7	74.7	6.015	0.044

around the regionally important Ebolowa–Mbalmayo–Abang Minko axis (we shall call them core) from the more peripheral markets of the South and the East, plus Limbe. Kenzou, a distant, small market in the East group specialised in the trade of *Cola* spp. with the Central African Republic, clearly appears as an outlier. The comparison between the two main subgroups of the South (Table 5) indicates a predominance of *Garcinia lucida* and *Cola* spp. in the core markets compared with *Irvingia* spp. and *Ricinodendron* in the peripheral markets. The core group has a statistically significant higher product diversity than the periphery group, which is consistent with the above discussion on product diversity. The core group also has larger markets, with more traders being household heads and having a better knowledge of the market than the group at the periphery.

TABLE 5 *ANOVA of core versus periphery markets in the South group of markets*

Variable	Core (mean)	Periphery (mean)	F value	Probability
Garcinia lucida quantity	52.5	0.5	28.885	0.000
Irvingia spp. quantity	17.1	49.7	8.021	0.016
Cola value	18.4	1.13	18.322	0.001
Cola margins	19.6	1.6	19.838	0.001
Ricinodendron value	6.3	34.6	4.983	0.047
Total quantity	769.3	138.4	19.616	0.001
Household status	25.5	4.9	12.588	0.005
Market knowledge	58.2	29.4	5.591	0.038
Product diversity	1.20	0.62	12.532	0.005

Market knowledge

Knowledge of the market by traders, consistently regarded as one of the key elements to improve market functioning and its potential development, was measured using a four-class ordinal scale (0 = lack of knowledge of local prices and traders; 1= detailed knowledge of local prices and traders; 2 = knowledge of local market, plus identification of neighbouring markets selling NTFP, but no detailed knowledge of them; and 3 = knowledge of local market and neighbouring markets' prices, with regular visits to them). For each of the 25 markets, we calculated the average market knowledge of the traders interviewed, and used this average to analyse spatial differences.

Market knowledge shows significant differences between groups in both comparisons, and seems to behave in opposite ways. In the two main subgroups of the North cluster, traders from the large urban markets generally have less knowledge than those from the smaller ones about the surrounding areas. In contrast, in the South cluster the larger core markets have more knowledge than the smaller, peripheral ones. We have explored the behaviour of this variable using multiple regression models. Following the current understanding of market functioning, several independent variables have been tested, including market size (number of traders and value of sales), average distance from where the products were obtained, level of education, gender composition of the traders and their age, as well as their household status. Table 6 shows the results of the model of best fit. Given the heteroscedasticity of the data with regard to market size, a weighted least square regression (weighted by total value sold in each market) has been used. A size/distance ratio interaction variable has been included in the model to account for non-linear interactions between these two variables.

TABLE 6 *Regression model for the degree of market knowledge*

N = 25 R^2= 0.525 Adjusted R^2 = 0.430 F = 5.534 p = 0.004

Variable	B coefficient	Beta standardised B)	t	Probability
Log number of traders	-52.309	-0.870	-3.392	0.003
Log distance	-31.693	-0.499	-2.080	0.051
Education level	0.429	0.333	1.433	0.167
Size/distance ratio	2.804 E-05	0.793	3.198	0.005
Constant	209.014		4.506	0.000

From Table 6, it can be seen that size of the market and distance the products are transported have a negative influence on the level of knowledge, whereas the level of education has a positive, though smaller, impact. The size/distance interaction variable also has a positive effect. This model helps to understand the apparently contradictory behaviour between the North and South markets with regard to the degree of market knowledge. Thus, although the urban markets in the North group are larger than the surrounding markets of the same region, this is compensated by the greater distance needed to transport the product. This situation is actually the reverse in the South group of markets, whereas the smaller, peripheral markets at the same time rely on more

distant supply sources than those at the core. Moreover, larger markets tend to have traders with a higher level of education, although the difference is not statistically significant.

CONCLUSIONS

NTFP markets epitomise the link between forest resource endowments and socio-economic demands on them. The present study has shown that a market characterisation using spatial components can be a valuable tool in analysing those links. Four main types of markets based on size, role and functional connections have been identified. The markets can be depicted as part of a hierarchical network, fulfilling different roles along a chain that connects the producer, closer to the forest, with the rural and urban consumer. The small rural markets tend to focus on their surrounding areas, while the medium-sized, regional markets play both a supply role for their hinterland regions and an assembly role for the two large urban markets of Douala and Yaoundé. The frontier markets are almost exclusively focused on exports to neighbouring countries, specialising in a greatly reduced number of products. The study highlights the role of Douala and Yaoundé, which could be considered as the axis around which the whole HFZ of Cameroon is organised, extending their influence over hundreds of kilometres by bringing together NTFP from distant parts of the zone.

Different factors such as market size, diversity of products (measured by their number and relative contribution to total sales), distance from supply and degree of market knowledge interact to produce a multiple, non-linear relationship. The type of products that distinguish the main group of markets are generally related to the availability of forest resources in their vicinity, whereas the diversity of products traded in a given locality has more to do with the size of the market and the associated level of specialisation of traders.

This differentiation results in a complex pattern that, nevertheless, can be categorised in groups of similar markets with a spatial differentiation. The cluster analysis used to achieve this aim separated two main groups of markets based on their dominant products and some market features. This separation seems to indicate a differentiated endowment in forest resources, combined with varying population size and some cultural differences. Each of the two main groups can be further subdivided into clusters that tend to reflect an urban–rural, core–periphery relationship, with the larger urban, core markets being more diversified, and the smaller periphery markets and frontier markets tending to specialise in a reduced set of products.

Among the market features with policy implications that distinguish the two main groups, it is worth noting the different levels of taxation between the relatively more developed northern part of the HFZ and the less developed southern part. Ndoye, Ruiz Pérez and Eyebe (1997) describe the current flat-rate taxation system as regressive, having the greatest impact on the lower income group of traders. The income-related regressiveness combines with a geographically related regressiveness, producing a somewhat unbalanced system. This seems to result from a lack of understanding of how NTFP markets operate rather than a conscious policy to achieve such an objective.

Similarly, the key issue of transportation shows a spatial differentiation, with frequent seasonal bottlenecks in the North despite a more developed infrastructure in the region. Such problems are apparently due to increased competition between people and different goods for transport services in the context of a larger volume of trade in the northern markets. This illustrates the need for a clear understanding of spatial differences. Thus, the classical intervention aimed at improving the road infrastructure, although playing a positive role, may not be sufficient to secure trader access to suitable transportation for NTFP if other limiting factors, such as scarcity of vehicles to transport bulky commodities in peak season, are also in play.

Finally, the study stresses the need for improved understanding of local market conditions in order to optimise the impacts of policy changes and development actions. Thus, if we want to intervene in a given forest, it could be most efficient to channel this intervention through the markets that are interacting with it. Such actions require a good deal of knowledge about how these markets work, including their spatial features and linkages.

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TRANSLATIONS : SUMMARIES

FRENCH

Propriétés d'un nouveau panneau MDF à triple pli fait de bois et de matelas de sisal non tissé

P. R. GILLAH, M. A. IRLE et K. MAHER

Une série de nouveaux types de panneaux de fibres de densité moyenne (MDF)à triple pli, de 550, 650 et 750 kg m^{-3} de densité, ont été fabriqués en laboratoire en appliquant un matelas non tissé de chaque côté d'un pli central en fibres de bois. Ce matelas est formé d'un réseau aiguilleté de fibres de bois et de sisal mélangées. On a comparé les propriétés dimensionnelles et la résistance des panneaux MDF à triple pli à celles des panneaux MDF standards fabriqués sous les mêmes conditions. Les valeurs des modules de rupture (MOR), d'élasticité (MOE), de cohésion interne (IB) et d'intégrité superficielle des panneaux MDF à triple pli se sont révélées supérieures à celles des panneaux MDF standards. Par ailleurs, certaines caractéristiques du panneau MDF à triple pli, comme le gonflement en épaisseur, l'absorption d'eau, le gonflement en épaisseur irréversible, la stabilité linéaire et la stabilité en épaisseur, montraient une nette amélioration par rapport au panneau MDF standard. En outre, le panneau MDF à triple pli conservait mieux que l'autre ses propriétés de résistance.

L'exploitation et la gestion des champs communs dans les monts Aravalli, en Inde

A. KUMAR , L. BREN et I. FERGUSON

Cet article analyse le degré de dépendance de diverses catégories de ménages des villages des monts Aravalli, dans l'État d'Haryana, en Inde, par rapport aux champs communs qui sont leur source de bois de chauffage et de fourrage, ainsi que la perception qu'ont les villageois des « comités forestiers de village», la structure mise en place pour assurer la cogestion de la forêt. Les auteurs analysent les différentes utilisations des ressources pratiquées par les gros et les petits agriculteurs, les agriculteurs marginaux et les paysans sans terre. Dans les villages, tous les groupes dépendaient des champs communs et en favorisaient l'usage réglementé, indépendamment du degré de dépendance. Les auteurs examinent les ambiguïtés dans les formules de cogestion des champs communs.

Les empiétements sur les réserves forestières : le cas de la réserve de Tano-Ehuro, dans l'Ouest du Ghana

C. E. OWUBAH, N. T. DONKOR et R. D. NSENKYIRE

Une étude a été menée sur l'agriculture illégale et l'établissement permanent de fermiers dans la réserve forestière de Tano-Ehuro, dans l'Ouest du Ghana. L'étude visait à évaluer les anciennes politiques gouvernementales de protection des forêts, les causes des empiétements, et les réussites et échecs de la campagne gouvernementale anti-empiétements nommée Opération Halte. Le caractère sporadique et inconsistant des anciennes politiques a fait augmenter les empiétements. Ceux-ci sont principalement dus aux collusions entre agriculteurs et chefs de village, aux amendes insuffisantes, à la recherche de terres fertiles et à une surveillance inadéquate. L'Opération Halte n'a pas eu d'effets dissuasifs : à ses débuts, en 1990, 40 % du territoire de la réserve étaient toujours intacts, alors qu'il n'en reste plus que 20 %. Seulement 200 des 1 000 ha de fermes de cacao détruites dans le cadre de l'Opération Halte ont été reboisés. Par ailleurs, le programme ne prend aucunement en compte les conséquences dramatiques des évictions. On recommande donc de rechercher une solution permanente basée sur la cogestion de la forêt.

Caractérisation spatiale des marchés de produits non forestiers dans la zone de forêt humide du Cameroun

M. RUIZ PERÉZ, O. NDOYE, A. EYEBE et A. PUNTODEWO

Cet article présente une analyse spatiale de la structure des marchés de produits forestiers non ligneux (PFNL) dans la zone de forêt humide (ZFH) du Cameroun. Les caractères de 25 marchés ont été définis à partir de plusieurs types de produits, de commerçants et d'attributs des marchés publics. Un regroupement suivant la taille et le degré d'autosuffisance fait apparaître quatre grands types de marchés : national, provincial, local et pionnier. Un regroupement par attributs montre une nette distinction entre les régions nord et sud de la ZFH et, à l'intérieur de chacune, l'existence de liens ville-campagne et centre-périphérie. Cette différenciation s'explique par la taille des marchés, leur spécialisation et la variété de leurs produits. *Dacryodes* et *Gnetum* prédominent dans les marchés généralement plus grands du nord, alors que *Garcinia lucida*, *G. kola*, et *Irvingia* sont relativement plus abondants dans les marchés du sud. On trouve en général une plus grande diversité de produits et des marchands plus spécialisés dans les grands marchés. La durée d'entreposage des produits, la distance de leur lieu de provenance, le niveau des taxes et les difficultés de transport varient également. Les auteurs insistent sur l'importance de bien comprendre les interactions multiples et non linéaires entre ces facteurs .

La Convention sur la diversité biologique: vue d'ensemble et enseignements tirés de l'expérience zimbabwéenne

E. M. SHUMBA et D. MARONGWE

Bien que la biodiversité contribue de façon significative au revenu national du Zimbabwe, ses éléments (forêt, faune terrestre et aquatique, agriculture) disparaissent à un rythme alarmant. Cette situation a incité le Zimbabwe à signer et à ratifier la Convention sur la diversité biologique (CBD) en 1994. Celui-ci devient ainsi le premier pays d'Afrique méridionale à compléter avec succès l'élaboration de sa stratégie et de son plan d'action en matière de biodiversité (SPAB), tel qu'exigé par la CBD. Le plan d'action constitue un cadre plutôt qu'un plan détaillé d'intervention à court terme. Les organismes nationaux disposent ainsi d'une certaine latitude pour préciser leur rôle et leur participation dans la mise en œuvre du plan d'action. Les leçons du processus d'élaboration du SPAB sont multiples : nécessité d'un cadre institutionnel souple pour lancer et coordonner le processus, disponibilité de personnes aptes à élaborer le document, clarté des rôles et responsabilités des divers participants et groupes intéressés, déboursement opportun des sommes nécessaires et exécution flexible de certaines activités.

La lutte contre la désertification : l'expérience asiatique

SEN WANG, RUI ZHENG et YOULIN YANG

La désertification est un fléau qui afflige des millions de gens dans plusieurs régions arides, semi-arides et sèches subhumides à travers le monde. Face à ce problème, la communauté internationale a adopté diverses mesures au cours des dernières décennies, surtout depuis l'adoption par l'ONU de la Convention sur la lutte contre la désertification, au milieu des années 90. Cet article examine l'expérience des pays asiatiques dans la mise en œuvre de cette convention. Il décrit l'étendue de la désertification en Asie, résume, en citant l'exemple de la Chine, les mesures et programmes principaux adoptés par les gouvernements nationaux de la région, et met en lumière les programmes d'action de plusieurs réseaux régionaux. Les auteurs discutent des défis que l'Asie aura à relever et des besoins futurs de la région dans son combat contre la désertification.

Comparaison de deux cycles de croissance de *Pinus radiata* dans le centre de North Island, en Nouvelle-Zélande

R.C. WOOLLONS

Le remplacement de placettes datant de 1933 par une série de 33 nouvelles placettes a permis de comparer deux cycles de croissance de *Pinus radiata* dans des forêts entourant Tokoroa, au centre de North Island, en Nouvelle-Zélande. Le secteur forestier de la Nouvelle-Zélande doit maintenant démontrer son aptitude à pratiquer une exploitation durable, d'où l'importance particulière de disposer de données sur la croissance des arbres. La deuxième série de placettes a été établie au début des années 70, sur le site exact des premières. Les analyses de la croissance en hauteur maximale moyenne montrent indéniablement que la croissance est plus avancée dans le second cycle, soit de plus de trois mètres à l'indice de station de 20 ans. Les données de surfaces terrières sont difficiles à analyser, mais leur développement est très probablement supérieur dans le second cycle. La croissance des sujets de la seconde récolte n'a pas été favorisée par l'utilisation de fertilisants, d'herbicides ou de meilleures pratiques forestières. Elle n'était pas non plus attribuable à un stock génétique supérieur. De tels résultats ne s'expliquent pas par une amélioration des sols ; la croissance plus rapide dans le second cycle serait due à des conditions climatiques plus favorables.

SPANISH

Propiedades de un novedoso panel aglomerado de tres capas (MDF) hecho con madera y acolchados no tejidos de henequén

P. R. GILLAH, M. A. IRLE y K. MAHER

Se produjeron bajo condiciones de laboratorio, una serie de paneles aglomerados de densidad media de tres capas (MDF), con densidades de 550, 650 y 750 kg m^{-3}, un acolchado no tejido a cada lado de una capa central de fibras de madera. El acolchado no tejido es una red de fibras interrelacionadas hechas de una mezcla de madera y fibras de henequén utilizando un telar. Se evaluaron las propiedades dimensionales y resistencia de los paneles aglomerados de tres capas (MDF) y se compararon con paneles MDF estándares producidos bajo condiciones similares. Se encontró que los modulus de ruptura (MOR), elasticidad (MOE), fortaleza de enlace interna (IB) y valores de solidez de la superficie de los paneles aglomerados de tres capas MDF fueron más altos que aquellos de los paneles MDF estándar. El espesor del hinchamiento, la absorción de agua, el espesor y linearidad irreversible del hinchamiento y las características de estabilidad del panel de tres capas (MDF) eran mucho mejores que los paneles MDF estándares. Además, los paneles de tres capas (MDF) presentaron un valor de fortaleza de retención más alto que la de los paneles MDF estándar.

El uso y administración de tierras comunales en Aravalli, India

A. KUMAR , L. BREN y I. FERGUSON

Este artículo analiza la dependencia relativa de diferentes categorías de en las tierras comunales en las Colinas de Aravalli del estado de Haryana, India de sus necesidades de leña y forraje, así como suón de los "Comités Forestales de la Aldea" que forman la basepara la práctica de la Administración Forestal Conjunta. Se discuten las razones que para las diferencias en el uso de recursos entre agricultores grandes, pequeños y marginales y sin tierra. Se encontró que todos los grupos en las aldeas eran dependientes de la tierra comunal en algún grado y que favorecián el uso regulado de las tierras comunales apesar de las diferencias en la dependencia relativa. Se describe y discuten las ambigüedades en arreglos institucionales para la administración de tierras comunales.

Invasión de Reserva Forestal: El caso de la reserva forestal Tano-ehuro en Ghana Occidental

C. E. OWUBAH, N. T. DONKOR y R. D. NSENKYIRE

Se llevó a cabo un estudio con enfoque la producción agrícola y establecimiento ilegal de granjeros en la reserva forestal Tano-ehuro en Ghana occidental, con el fin de evaluar políticas gubernamentales anteriores para proteger el bosque, las causas de la invasión, los alcances y fallas de la campaña gubernamental para evitar la invasión de los bosques denominada "Operación Detener". Las políticas gubernamentales han sido intermitentes e inconsistentes y han contribuido a incrementar la invasión en la reserva. Las mayores causas de la invasión incluyen conjura entre granjeros y jefes, baja multas en la corte, la búsqueda por tierra fertil e inadecuado monitoreo. La operación detener no es un disuasivo, porque sólamente el 20% de la reserva sobrevive hasta hoy, de cerca de un 40% al principio de la operación en 1990. Sólamente 200 de las 1000 ha de cacao destruidas bajo el programa han sido plantadas con árboles. La flaqueza del programa consiste en que no se dirige a las drásticas ramificaciones que acompañan los despojos forzados. Se recomienda que se busque una solución permanente a través de la administración colaborativa forestal.