SESSION 2

Spatio-temporal extension of agroforestry systems in “Guinée Forestière” (Guinea, West Africa).

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Abstract :
“Guinée Forestière” is an administrative region located in the southern part of Guinea (West Africa). It is characterized by agro-ecological conditions suitable for most types of agricultural production typical of the low elevation humid tropics. The population is mainly rural and their livelihood depends on food crops and cash crops, cultivated in various combinations. A combination of high demographic growth rate, economic and political changes, return of displaced people, and a massive but temporary flood of refugees, has led to important land-use changes in the last decades. In terms of sustainable development of the region, one of the most exciting feature is the recent dynamic extension of agroforests around most villages. We report here on this extension, that we studied in detail in Nienh (8°59’N;7°54’W, Kobela CRD) which is representative of the agro-ecological and socio-economic conditions of most villages of “Guinée Forestière”. Two main cropping systems were characterized, that both have an important tree component: (1) Coffee-based agroforest, which are the main cash income system, and (2) *Elaeis* parkland dedicated to rainfed rice and food crops cultivation after slash and burn, combined with 2 to 10 year fallows. The village territory presented an organization into concentric belts. The coffee-based agroforest makes up the first belt, directly surrounding the village. It may be subdivided into a first ring, with old coffee trees in association with *Cola nitida* and an upper stratum mixing various primary forest tree species, surrounded by a second ring that corresponds to a recent extension of coffee-based agroforests. This second ring differs by its younger coffee trees and its upper stratum mixing *Elaeis guineensis* and various heliophilous tree species. Land-use changes were quantified using a GIS analysis to compare aerial pictures from 1979 and a SPOT image from 2003. The agroforest area increased by nearly 70 % in those 25 years (868 ha in 2003 versus 513 ha in 1979). This remarkable extension of the agroforest area occurred through the conversion of land under food crops and fallows into agroforests. This dynamics reveals that an increasing integration into the market economy may be achieved while increasing the ecological sustainability of the mixture of cropping systems at the village scale.
Keywords : *Coffee caenophora*, *Elaeis guineensis* Guinea, West Africa, GIS analysis, vegetation dynamics, agroforest systems

Resumen: Extensión espacial y temporal de los sistemas agroforestales en “Guinée Forestière”
La region florestal de Guinea “Guinée Forestière” situada en la parte sureste de Guinea es caracterizada por condiciones agro-ecológicas típicas de los trópicos húmedos de África del Oeste, que son favorables a los mayores cultivos. La población es en mayoria rural y los ingresos dependen de los cultivos alimenticios y los de renta, en varias asociaciones. Recientemente, los sistemas de cultivo estan cambiado por causa de la combinación de una alta tasa de crecimiento demográfico, del regresso de las poblaciones desplazadas devido a cambios económicos y políticos y del flujo massiso pero temporal de refugiados, los cuáles han conducido a cambios importantes en el uso de la tierra. Para tener un desarrollo sostenible de la region, la primera etapa fue de caracterizar las dinámicas locales de estos cambios de uso de la tierra. Estos han sido mas estudiados en el poblado de Nienh (8°59’N,7°54’O) que representa las condiciones agro-ecológicas y socio-económicas de muchos poblados de esta region de Guinea. Dos principales sistemas de cultivo fueron caracterizados, ambos con un componente árbustivo : (1) sistema agroforestal de café, formando un anillo alrededor del pueblo y (2) sistema de arroz y otros cultivos alimenticios con barbecho de 2 à 10 años associado con palma africana en un sistema de tala-quema. El pueblo tiene una organización en anillos. En el sistema agroforestal de café, un primero anillo, con viejos cafetales en asociacion con *Cola nitida* y un estrato superior de árboles de bosque, esta diferenciado de un segundo anillo locual correspónde a la extensión de las cafetales agroflorestales. Esta extensión tiene árboles de café más joven que crecen bajo sombra de un estrato de Elaeis guineensis y de numerosos especies heliofilos de árboles. Cambios en el uso de la tierra fueron medidos y quntificados gracias a una análisis con SIG que compara imágenes aéreos de 1979 y una imagen del stelite SPOT de 2003. Se pudo mostrar que entre 1979 y 2003 el area de los sistemas agroforestales aumento en unos 70%. En 2003, estos

sistemas ocupaban 868 ha (solo 513 ha en 1979), lo que representa ahora 26% del territorio del pueblo. Esta extensión que corresponde al 11% de la superficie deste territorio durante los últimos 25 años, incumbe a la conversión de la tierra utilizada por los cultivos anuales y los barbechos en sistemas agroforestales. Esta dinámica es reveladora del hecho que una integracion progressiva al economia de mercado pueda lograrse mientras crece la sustenabilidad ecologica de la mescla de sistemas de cultivos al nivel del territorio del pueblo.
Palabras claves: *Coffee canephora*, *Elaeis guineensis*, Guinea, África del Oesta, SIG, dinámicas de vegetación, sistemas agroflorestales

Introduction

“Guinée Forestière” is an administrative region located in the southern part of Guinea (West Africa). It is characterized by agro-ecological conditions suitable for most types of agricultural production typical of the low elevation humid tropics. The population is mainly rural and their livelihood depends on food crops and cash crops, cultivated in various combinations. Rice, the main food crop, is cultivated with other food crops (such as maïze, peanuts, orka) and native oil-palms (*Elaeis guineensis* var *dura*) using a slash-and-burn/fallow system. Coffee (*Coffee canephora*) and Cola (*Cola nitida*) are grown under the shade of forest trees in agroforests. Today, the relative importance of each system is changing due to a combination of a high demographic growth rate of 3,1% (Camara, 2007), the return of displaced people following economic and political changes, and the temporary but massive flood of refugees resulting from conflicts in neighboring states. These land-use changes need to be characterized in order to assess their role in terms of the sustainable development of the region: do farmers benefit from an increase in the profitability of their cropping system combinations? Are the the changes leading towards a better, more sustainable, natural resource management? In this communication, we report on the local dynamics of the spatial changes in the last 25 years in “Guinée Forestière” and discuss the sustainability of the current land-uses.

Study site: Nienh, a typical village of “Guinée Forestière”

The village of Nienh (8°59’N; 7°54’W,) presents agro-ecological and socio-economic conditions representative of most villages located in southern ”Guinée Forestière”. It was chosen as the main study site for investigating the local dynamics of cropping systems.

The climate is sub-equatorial, with 2000 – 2500 mm annual rainfall and a short, 2 to 3 month, dry season (Boulvert, 1992 quoted in Camara, 2007). The density of population is about 70 per km² with an endogeneous evolution, typical of most of the village of the Southern part of “Guinée Forestière” (Camara, 2007), with quite no effect of temporary refugies.

The current land use systems, floristic composition and vegetation structure

To characterize the land uses in the village of Nienh, the diversity of cropping systems was explored by making 5 transects distributed over the whole territory (figure 1). On each transect, we first localized the various cropping systems, then, for each cropping system, we recorded the vegetation structure as well as the dominant and associated species.

Two main cropping systems were identified (figure 1), both having an important tree component: (1) a coffee-based agroforest located in an about 3km width belt surrounding the village and (2) succeeding to this agroforest belt, a wide *Elaeis* parkland area that is dedicated to rice and other food crops cultivation in a slash and burn system with fallows during from 7 to 10 years (28 % of the observed plots) and some from 2 to 3 years (12 % of the observed plots). In the agroforest, a first ring (agroforest 1-a), standing right up against the village,

where cola and coffee dominate the intermediate stratum, was distinguished from a second ring (agroforest 1-b) corresponding to the recent extension of the coffee-based agroforest. This agroforest type (1-b) is characterized by an upper stratum mixing *Elaeis guineensis* with various heliophilous tree species such as *Albizia* spp. The proportion of fallow tree species such as *Albizia* is higher in this agroforest type than in the first ring of agroforests (1-a), where coffee trees are older and the proportion of primary rain forest tree species is higher (Diabaté et al., 2007).

The same spatial succession of cropping systems was identified on each transect, but their importance vary in relation with the toposequence, the soil characteristics and the history of land cultivation (figure 1 and 2). Apart from this concentric organisation of the agroforests around the village, agroforests were also recorded on abandoned settlement sites and along the rivers (e.g; cocoa dominated agroforests were preferentially found in the abandoned sites and near the rivers where the soil fertility and moisture are higher, and where the density of *Elaeis guineensis* is higher due a longer period of rainfed rice cultivation).

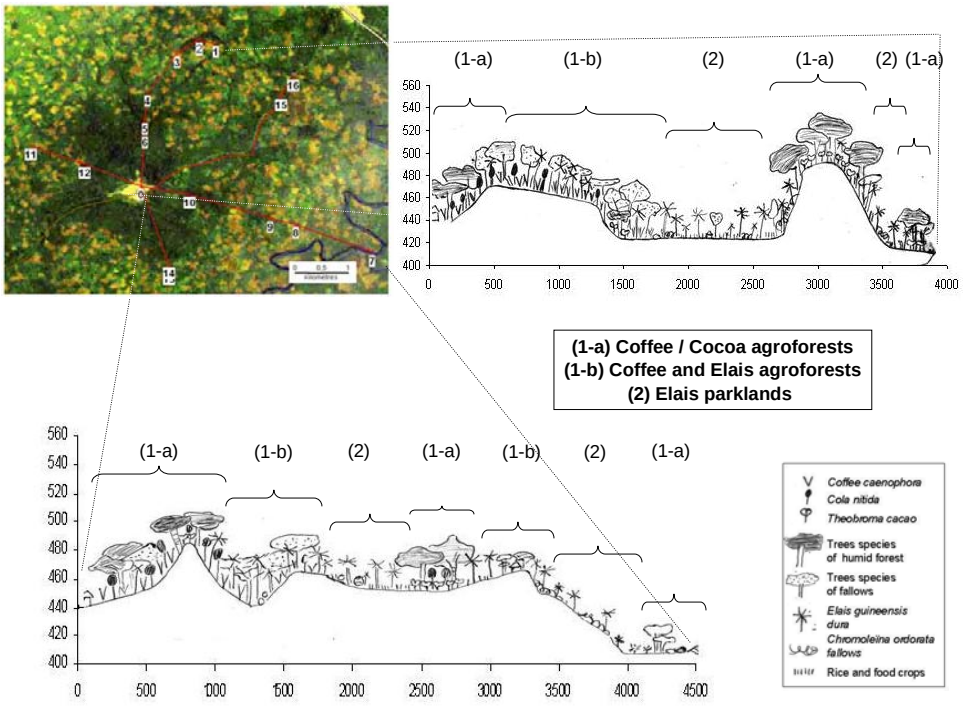

Figure 1: Vegetation structure in the village of Nienh (Transect Nord-South and West -East)

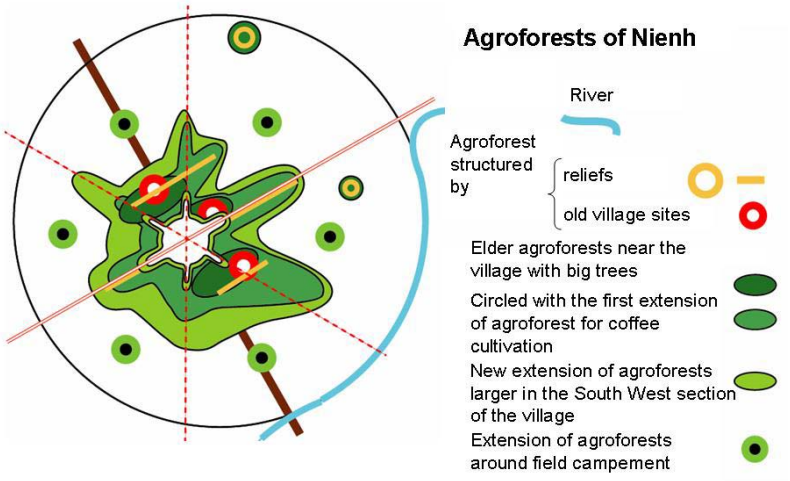

Figure 2: Schematic representation of the structure and the dynamics of extension of agroforests in the village of Nienh

GIS analysis of the land-use dynamics during the last 25 years

We quantified the spatial-temporal dynamics of land use using GIS analysis by comparing aerial pictures from 1979 and a 2003 satellite (SPOT) image, once the different land uses were identified and quantified with the same nomenclature for each date.

The comparison showed that between 1979 and 2003, the agroforest area increased by nearly 70%. In 1979, 513 ha were under agroforest, corresponding to 16% of the village area. In 2003, agroforests covered 868 ha, now representing 26% of the village land (Table 1). This extension of agroforests occurred through the conversion of land under food crops and fallows into agroforests (Table 1).

Table 1: Land Use changes between 1979 and 2003 in Nienh

	Houses		Agroforest		Rice & food crops		Fallows		« Natural » Forest		Total S_t
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	
S_o : Area in 1979	12	0,4	513	16	526	16	2217	68	0	-	3269
S_1 : Area in 2003 (ha)	24	0,7	868	26	491	15	1886	58	0	-	3269
Evolution (S_1- S_o / S_1)	12	103	354	69	- 35	-7	-331	-15	0	-	-
Evolution in % in the village (S_1- S_o / S_t)%	-	0,4	-	10,8	-	-1,1	-	-10,1	-	-	-

Extension of agroforests and the sustainability of land use in “Guinée Forestière”

Farmers of “Guinée Forestière” have built and developed agroforests for coffee cultivation as the main cash crop. Initially organized in a single ring around the village, those agroforests where recently extended, mainly by the conversion of the *Elaeis* parkland used for rice and food crops cultivation with fallows. This transformation, which is accompanied by a reduction of the fallow length for rice cultivation, raises questions about the sustainability of farmer’s practices. Which equilibrium will be chosen by farmer between the cash and the food crop systems? What are the performances of the current cropping systems and in particular of agroforests, that could be a sustainable way for farmers to produce coffee? What agronomical recommendations could improve the profitability of coffee production while ensuring the natural resource sustainable management?

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