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IS RURAL MIGRATION A THREAT TO ENVIRONMENTAL SUSTAINABILITY IN SOUTHERN BURKINA FASO?

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ABSTRACT

There is growing evidence that population pressure on the land has become the most intractable problem in the developing countries where demand for food exceeds the food production capacity of the land. Southern Burkina Faso has experienced rapid population growth, mostly driven by immigration of farmers. This study was carried out in Sissili Province and used satellite images acquired over 31-year period, census and survey data to capture migration patterns and its impacts on land use change. Results showed that migrant population which accounted for only 3 per cent in the study area in 1976 shifted to 57 per cent in 2007. Migrant people were using improved technology to progressively convert forest land to cropland. Cropland increased at an annualized rate of 0·46 per cent to the detriment of the dense forest and woodland which decreased at 0·57 per cent per annum. Population growth was highly correlated with increasing area of cropland ($r^2 = 0{\cdot}95$, $p = 0{\cdot}014$) and declining dense forest ($r^2 = 0{\cdot}78$) and woodland ($r^2 = 0{\cdot}95$) covers. It can be concluded that rural migration, driven by the relatively good soil and rainfall conditions in the recipient area, is accounted for deforestation in the study area. If rural migration is not checked, it will seriously degrade the environment. Copyright © 2009 John Wiley & Sons, Ltd.

KEY WORDS: Burkina Faso; migration; land use change; population growth; wood cutting; fuel wood

INTRODUCTION

Thoughts on population–environment interactions have many historical antecedents, but neo-Malthusian and Boserupian notions are pre-eminent (Perz *et al*., 2005; Perz *et al*., 2006). Malthus (1798) argued that population growth leads to agricultural expansion and ultimately to land degradation and famine. This statement was later supported by Ehrlich (1968), Hardin (1968) and Meadows *et al*. (1972). Alternative approaches have emerged since Boserüp (1965) and Simon (1980) showed that population growth leads to sustainable land use via intensification due to technological improvement. More recently, Bilsborrow (2002) articulated the third possibility of a demographic-economic response via migration from crowded or degraded environments to frontier zones. New thoughts also emerge that the effect of population on environment depends on many things, including a gamut of cultural and political factors as well as the scale of observation (Gibson *et al*., 2000; Wood, 2002; Perz *et al*., 2005).

In the tropics, rapid population growth constitutes the main force of change in land use (Ramankutty and Foley, 1999). Population growth in developing countries is generally associated with increased demand for food and fuelwood and also increased rural migration, which lead to high rates of forest losses (Lambin *et al*., 2003). Migration, in its various forms, is known to be the most important demographic factor causing land use change at time scale (Geist and Lambin, 2001; Lambin *et al*., 2003), operating as a significant driver with other non-demographic factors such as policies, consumption patterns, economic dynamics and globalization (Fearnside, 1997).

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In Burkina Faso, the total population shifted from 5·6 million inhabitants in 1975 to 13·7 million inhabitants in 2006 (INSD, 2007); out of this, 90 per cent practice rain-fed subsistence agriculture (Krämer, 2002). Under such rapid growing population, demand for arable land to produce food may exceed the capacity of the country to provide land. The country is phytogeographically divided into four zones, namely the north-Sahelian, south-Sahelian, north-Sudanian and south-Sudanian zones. In the Sahelian zones, soils are generally poor with an unreliable distribution of the rainfall in space and time (400–600 mm y^{-1} within 2–3 months y^{-1}). It is mainly in the Sudanian zones that are located in the southern, south-western and south-eastern parts of the country, where soils are fairly fertile and rainfall relatively abundant that agriculture is expanding due to an amplified rural–rural migration in search of available non-degraded land (Reenberg and Lund, 1998; Gray, 2005).

During the last few decades, southern Burkina Faso has experienced a rapid population growth driven by high growth rate, declining mortality and mainly immigration, which was believed to have boosted the rapid growth of the population in this area (Howorth and O'Keefe, 1999; Henry *et al*., 2003). Migration to southern Burkina Faso started in the 1980s when the severe drought affected the northern and central regions of the country, inflicting significant losses in terms of crops and livestock to farmers (Reenberg and Lund, 1998; Gray, 2005; Ouedraogo, 2006a; Paré *et al*., 2008). From that period onwards, migrating to less drought affected areas (south, east and west of the country) has become *per se* an important livelihood diversification strategy. It allows to supplement subsistence economy and to have access to money, therefore, migrants can support their families' education, health and building activities. In southern Burkina Faso, the size of cropland increased at an annualized rate higher than 1 per cent during 1986–2002 and believed to be driven by migrant population size and distribution (Ouedraogo, 2006a,b; Paré *et al*., 2008). Given the unquestionable contribution of increase population to environmental degradation in southern Burkina Faso, research that examines demographic drivers and particularly the impact of rural migration on land use change at spatial and temporal scales is of utmost importance to unravelling detail features of land use change.

The main objective of the paper was to analyse to what extent land use patterns can be described by a rural–rural migration. To this end, a multi-scale, -spatial and -temporal analysis of land use patterns in Neboun village, including demographic and socio-economic activities was performed. The specific objectives of the study were to (i) estimate the trend in human population (both migrant and indigenous people) at different periods from 1976 to 2006, (ii) identify socio-economic activities, production tools, acreage and motives of migration and (iii) quantify land use change in time series as a result of migration.

MATERIALS AND METHODS

Study Area Description

The study was carried out in the surroundings of Neboun village, located in Sissili Province (10°57′N to 11°55′N and −2°48′W to −1°24′W), southern Burkina Faso (Figure 1). This study site was chosen for a variety of reasons. In particular, the site is flat, removing undesired topographic influences in the remotely sensed response and it is located in a junction of two main roads, thus providing better accessibility to migrant people. Improvement of road networks in a rural area amplifies rural migration and land use change (Verburg *et al*., 2004; Ningal *et al*., 2008). It covers about 95 km^2 and is characterized by a low relief with an average altitude of 300 m a.s.l. The unimodal rainy season lasts for about 6 months, from May to October. Based on data collected from the *in situ* mini-weather station at the province city (Leo) located at 30 km from the study site, the mean annual rainfall during the study period (1975–2007) was 883 ± 147 mm. Mean daily minimum and maximum temperatures ranged from 16 to 32°C in January (the coldest month) and from 26 to 40°C in April (the hottest month). According to the FAO soil classification system (Driessen *et al*., 2001), most frequently encountered soil type is Lixisol (tropical ferruginous soils), which is poorly to fully leached, overlying sandy, clayey-sandy and sandy-clayey material.

Phyto-geographically, the area belongs to the south-Sudanian zone (Fontes and Guinko, 1995). The natural vegetation comprises of a cluster of mostly dry forest and tree savannas. The flora is dominated by perennial grass species such as *Andropogon gayanus* Kunth, *A. ascinodis* C. B. Clarke and *Schizachiryum sanguineum* (Retz.) Alston (Fontes and Guinko, 1995). The ligneous species are represented mostly by *Afzelia africana* Sm., *Khaya*

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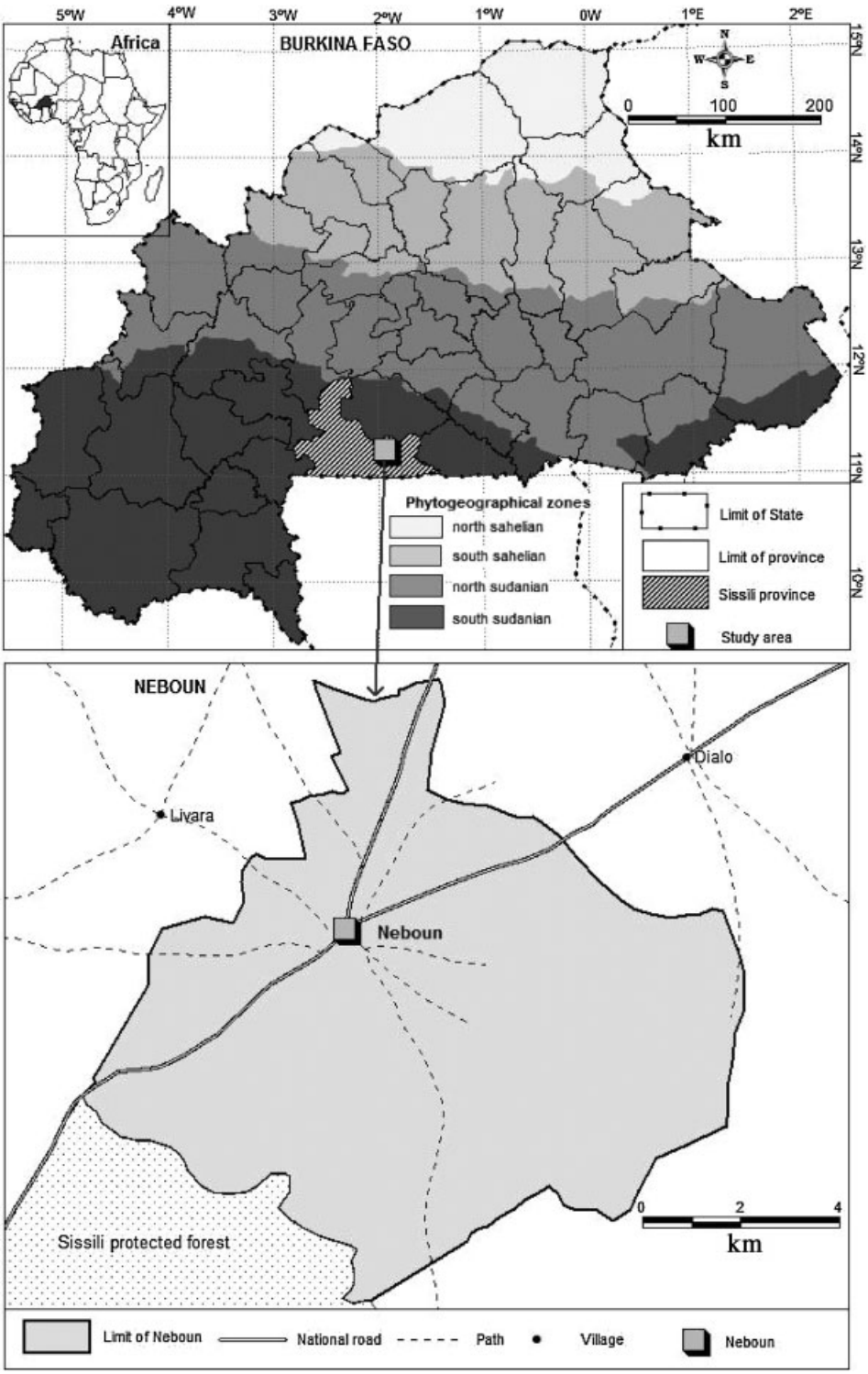

Figure 1. Location of the study area.

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senegalensis A. Juss. and *Pterocarpus erinaceus* Lam. The occurrence of scattered trees on croplands, such as *Vitellaria paradoxa* C. F. Gaertn, *Parkia biglobosa* (Jacq.) R. Br. ex G. Don and *Tamarindus indica* L., is also a common feature in the study area. The different types of forest encountered in the study area included: State forest reserve (Sissili protected forest) edging the southern part of the village, unprotected forests and forests managed by cooperatives (Forest Management Units). The dominant farming system in the study area is traditional subsistence cultivation of cereals (such as sorghum, millet and maize) and tubers (yam and sweet potatoes) and animal husbandry. Since a decade ago, there has been a high competition between the traditional farming system and the lucrative productive system; involving extraction of fuelwood and non-wood forest products, cultivation of cash crops (with cotton and fruit-tree plantation) and ranching (Paré *et al*., 2008). Croplands are mainly located around human settlements.

The population of Neboun was estimated at 1926 inhabitants in 2007. It is composed of four main ethnic groups: Nuni, Mossi, Fulani and Wala. Nuni and Wala are assumed indigenous people of the village because they have been living in the area for centuries. Mossi (originating from the central plateau in Burkina Faso) and Fulani (herders from the northern region of the country) are called migrants because they were attracted to Sissili Province during the 1980s in search of arable land and green pasture, respectively (Howorth and O'Keefe, 1999). Land tenure system in the village is being controlled by customary law arrangements managed by land-chiefs of the indigenous populations (Howorth and O'Keefe, 1999; Ouedraogo, 2006a). The principal roles of the land-chiefs are to oversee and supervise everything that has to do with the land, including the bush, the farms and wildlife.

Study Method

Demographic and socio-economic survey

In Burkina Faso, like in most of the developing countries, reports from the national population censuses do not provide data at the village level. Furthermore, data related to internal population mobility among ethnic groups are not reported (INSD, 1998, 2007). To estimate current data on the population and migration in the village, we conducted a complete population census in August 2007. Information recorded in the census included name of the household head, sex, birth date, profession, ethnic group, province of origin, date of arrival and residence status (migrant or indigenous). The same information was recorded from all members of the households. Data collected from the census were processed with MapInfo 7·5®. Structured Query Language (SQL) module of MapInfo was used to distribute all population recorded into residence status, ethnic groups, ages, provinces of origin and date of arrival for all time series.

To estimate the historical data of the population (1976, 1986, 1992 and 2000), we first computed the population data of each of these time series based on cohorts of the recorded population living in the village at the census date. These data do not take into account people who passed away or migrated out of the village during these periods. Secondly, we adjusted the data taking the deaths into consideration, by using the following equation:

$$P = P_{\mathrm{n}} + P_{\mathrm{n}} D_{\mathrm{r}} t$$

where P is the population number taking into account the deaths, P_{n} the population on cohorts, D_{r} the mean death rate at the national census date and t the number of years after the census date.

We could not unfortunately include the out-migration (Om) in the final estimation of the population because Om rate was missing as stated above. But during the interviews, people argued that Om concerned very few people who seasonally go to Ghana or Côte d'Ivoire in seek of cash money. This information is in line with Henry *et al*. (2003).

A household survey was also done from February to March 2008 using semi-structured questionnaire. A total of 175 household heads, corresponding to 56 per cent of the total count, were randomly selected for the survey. From the respondents, 50 per cent were migrants and 23 per cent were educated from primary to secondary school. All respondents were supposed to be at least 30 years old and to have been living in the village since the 1980s. The assumption was that people who satisfied these conditions were qualified enough to provide accurate information related to the purpose of the study. The following information was recorded for each respondent: income generating activities from forest exploitation or agriculture including livestock husbandry, farming technology (tools and practices), production acreage and reason for migrating to the study area if the respondent was a migrant. To avoid

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Table I. References and date of acquisition of Landsat and ASTER images used in the present study

Scene references	Date of acquisition	Satellite
p210r52_2m19760330	30 March 1976	Landsat MSSS
p195r52_5t861118	18 November 1986	Landsat MSSS
L4_1992101819450	18 October 1992	Landsat TM
L71195052_05220001031	31 October 2000	Landsat ETM+
AST_L1B_00311172006104325	17 November 2007	ASTER

bias on the production acreage estimation, we usually go to the respondent croplands for measuring with GPS. Some key issues were also discussed with the respondents during the interviews; especially farming techniques at the home provinces and also grazing practices in Neboun Village.

Detection of land use change

Four Landsat images and one ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) image of the study area acquired over a period of 31 years (1976–2007) were used to detect land use change (Table I). Each image was geo-rectified to UTM WGS 84 Zone 30 North coordinates using ground control points (Focardi *et al*., 2008). A first-order affine transformation was applied to all data, resulting in a root mean square error below 15 m for the Landsat images (Braimoh, 2004). The visible and the near-infra-red bands (1–3) of the ASTER image were resized to a resolution of $30 \times 30\,m^2$ to fit the Landsat scenes. Land-cover classification for the images was carried out based on training sites, available topographic maps and *in situ* observations. The procedure first involved radiometric rectification of the 1976, 1986, 1992 and 2002 images to the 2007 image (Hall *et al*., 1991), followed by a tasselled cap orthogonal transformation of the original six bands in each image into three new dimensional spaces, corresponding to soil brightness, green vegetation and moisture indices. Apart from yielding relevant training data for land use classification, the transformation also improved visual discrimination of land use types. Classification was carried out on three bands of the tasselled cap transformation using the maximum likelihood algorithm. The accuracy of the classification ranged from 86 to 94 per cent for all images, which is considered to be much acceptable according to Jansen *et al*. (2008). Six classification schemes (cropland, dense forest, woodland, shrubland, plantation and settlement) were used to assign pixels to land use classes (Table II). All image processing was done using ENVI (ENVI Version 4·2, Copyright 2005, Research Systems, Inc. 4990 Pearl East Circle)® and the vectorized data were processed with MapInfo 7·5 (MapInfo Professional Version 7·5, Release Build 23, Copyright 1985–2003 MapInfo Corporation)®.

Data Analyses

Repeated measurement ANOVA was performed to determine the statistical significance of the inter-annual variability of both land use types and migrant and indigenous population. The magnitude of the variation was

Table II. Land use classification schemes

Land use class	Description
Cropland	Farmland, harvested agricultural land, pastures and young fallow with signs of human induced disturbances, such as felled tree trunks or stumps.
Shrubland	Land covered by shrubs, bushes, grass and young broadleaf plantlets (<50 trees ha^{-1}).
Woodland	Open woodland with an upper stratum of deciduous trees of small to medium size, with their crowns more or less touching above a sparse woody stratum. The ground layer consists of undergrowth of shrubs and grasses (75–150 trees ha^{-1}).
Dense forest	Forests and closed woody vegetation, gallery forest and close lowland woody vegetation.
Plantation	Land covered with planted trees such as cashew, mango, orange, banana and *Ecalyptus* trees.
Settlement	Built up area, roads and bare surfaces.

Adapted from Lamprecht (1989).

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determined by a statistic called partial eta squared (η_p^2), and was considered as small, moderate or large if the value of this statistic was 0·01, 0·06 or 0·14, respectively (Cohen, 1988). Data collected from the household survey were grouped into four main categories: income generating activities, dynamics of farm size, the evolution of production tools with regards to residence status and finally the reasons for migrating to the study area and further subject to descriptive statistics. Changes in land use types were first determined by computing the difference in land use statistics over two consecutive periods. Second, overall change during the entire study period (1976–2007) from one land use type to another was determined by pixel-to-pixel comparison resulting in land use change matrix in which each element was the proportion of total land area of its class in 1976 that was changed to the other class in 2007. To investigate whether the change in land use types was related with the population, Pearson's product-moment correlation coefficient was computed.

RESULTS

Population Dynamics and Socio-Economic Patterns

There was a significant inter-annual variation in both migrant and indigenous populations ($F_{1,1} = 239{\cdot}7$, $p = 0{\cdot}04$), and the magnitude of the change was large ($\eta_p^2 = 0{\cdot}99$). From 1976 to 2007, the population increased tenfold (Table III). In 1976, the Nuni people accounted for nearly 88 per cent of the population of the village; but this proportion decreased progressively through the years and finally dropped to 39 per cent in 2007. Conversely, the Mossi people who represented 2 per cent of the total population in 1976 increased rapidly and reached 46 per cent of the population in 2007. The annual rate of increase of the Mossi people from 1976 to 2007 was about 5 per cent while for the Nuni, Wala and Fulani People, the rates were similar (3 per cent). The Lele and Kassena people were minority and they started coming into the village in the late 2000s. The migrant population which accounted for only 3 per cent of the total population in 1976 became the dominating group (57 per cent) at the end of the study period.

Results from the population census showed also that migrant population was from different origins. In general, migrants were coming from 14 different provinces from the central (409 migrants), the northern (650 migrants) regions of the country and from Côte d'Ivoire (17 migrants). Home provinces from the central regions included Kadiogo, Boulkiemdé, Sanguié, Ganzourgou, Kouritenga, Oubritenga, Kourwéogo, and the northern provinces included Soum, Bam, Yatenga, Passoré, Zondoma, Sanmatenga and Namentenga (Figure 2). From the central regions, migrants were predominantly coming from Boulkiemdé (33 per cent) and Oubritenga (29 per cent) while from the northern regions they were mostly coming from Yatenga (24 per cent), Sanmatenga (22 per cent) and Bam (21 per cent). The main reasons provided by the respondents for migrating to Neboun included declining soil fertility in the home village (92 per cent of the respondents), scarcity of arable land (76 per cent) and erratic rainfall (73 per cent). Migrant from northern region mentioned that some efforts were made to improve soil quality and water conservation at the home province by using plant-pit system (**Zaï**), but this technique was so laborious and time consuming in a way that they could no longer maintain it. Among other reasons, the respondents cited the need

Table III. Population dynamics from 1976 to 2007 at Neboun Village

Ethnic group	Status	1976		1986		1992		2000		2007	
		No.	%	No.	%	No.	%	No.	%	No.	%
Nuni	Native	170	88	298	65	398	59	569	52	757	40
Wala	Native	19	10	39	8	49	7	64	6	93	5
Mossi	Migrant	3	2	72	16	138	20	321	30	891	46
Fulani	Migrant	2	1	51	11	96	14	133	12	175	9
Kassena	Migrant	0	0	0	0	0	0	2	0·2	5	0·3
Lele	Migrant	0	0	0	0	0	0	0	0	5	0·3
Total	—	194	100	460	100	681	100	1089	100	1926	100

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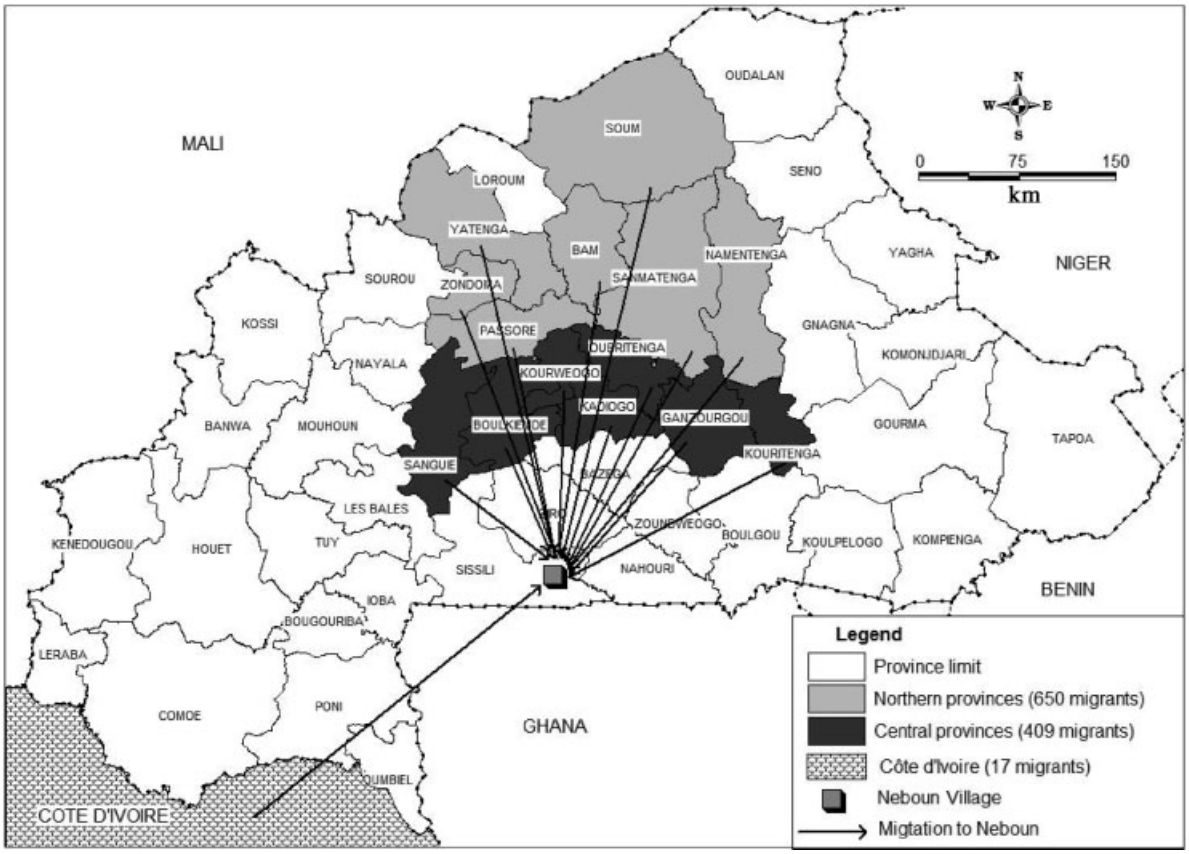

Figure 2. Migration routes from central and northern regions to Neboun village in southern Burkina Faso.

to produce more food to help parents left at home, need to make income, seek for pasture to graze their cattle and the politico-economic unrest in the neighbouring Côte d'Ivoire started in 2000, which caused the return of Burkinabé from the coffee, cocoa and banana plantation areas. All respondents mentioned that grazing was practiced everywhere in the village territory apart from the Sissili protected forest and, during the dry seasons, some tree species were cut to feed cattle.

The household survey revealed four main sources of income generation in the study area, namely crop production (63 per cent), livestock husbandry (27 per cent), non-timber forest products (6 per cent) and wood/charcoal production (4 per cent). The mean farm size of the migrants changed from 3·0 to 3·7 ha during the period from 1986 to 2007 for a mean household size of 6 ± 2 persons. During the same period, the farm size of the indigenous population, with the same household size, changed from 2·0 to 3·1 ha. The main agricultural tools in use were '*Daba*' (local traditional tool based on human force) and plough (based on animal force). In the 1980s, about 95 per cent of the respondents were using '*Daba*', but they shifted progressively to the use of plough. The change was more pronounced among migrants; more than 83 per cent of the migrants were using the plough in 2007 while this figure was only 59 per cent among indigenous people.

Land Use Change

Results from the image processing revealed an important change in the spatial distribution of land use types in the study area from 1976 to 2007 (Figures 3). In 1976, croplands formed a continuum around the settlement, but were

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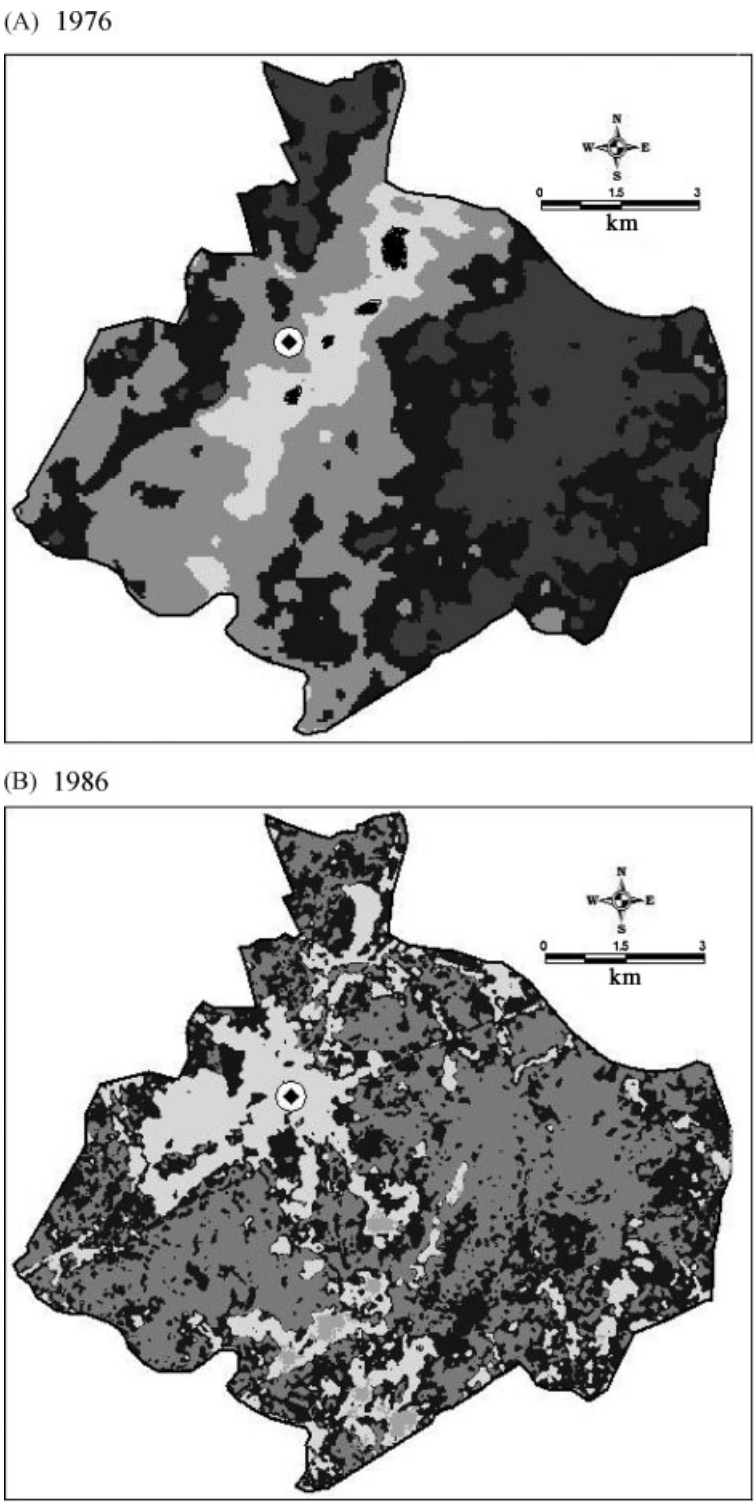

Figure 3. Pictorial representation of land use dynamics in Neboun village during the study period.

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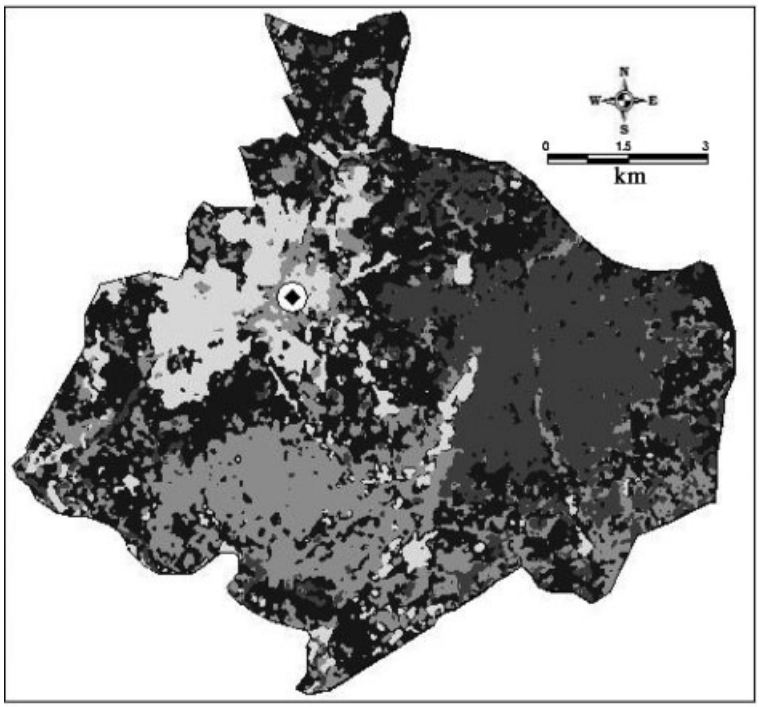
(C) 1992



(D) 2000

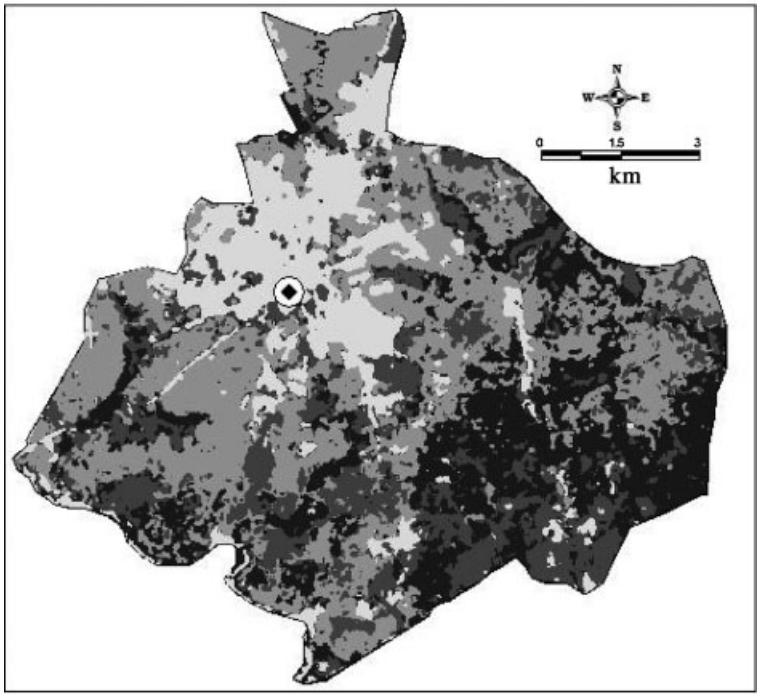


Figure 3. (Continued).

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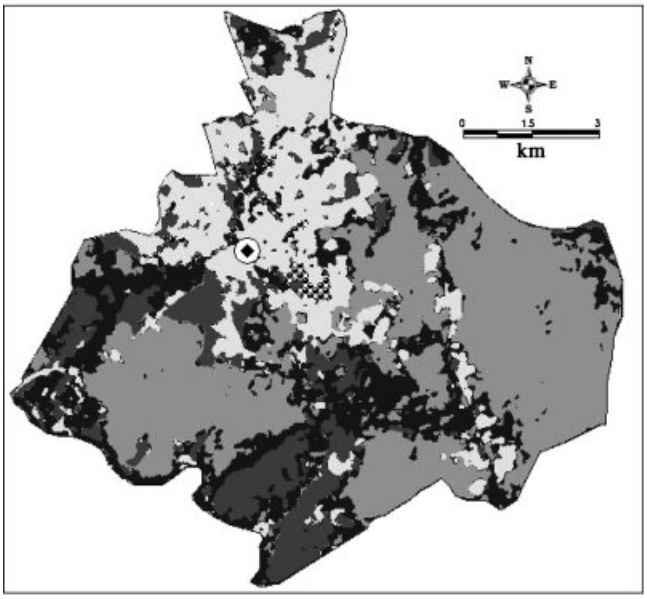
(E) 2007



(F) Legend

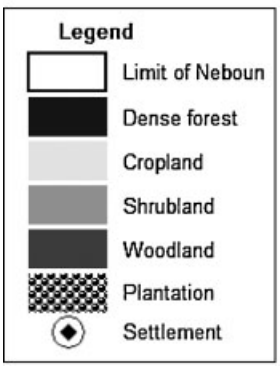


Figure 3. (Continued).

more scattered from 1986 to 2007 in the entire region of the study area. Dense forest, woodland and shrubland were also aggregated in 1976 but from 1986 to 2007, these land use types were scattered. There was a significant inter-annual variation in the area covered by different land use types ($F_{1,5} = 8{\cdot}04$, $p = 0{\cdot}036$), and the magnitude of the change was also large ($\eta_p^2 = 0{\cdot}62$). The area of cropland increased fourfold during the study period with *ca.* 0·46 per cent increase *per annum* (Table IV). In 1976, the croplands formed a continuum around the settlement, but were more scattered in 1986 in the entire region of the study area. From 1992 croplands were expanding from the settlement. Dense forest and woodland decreased at the rates of 0·39 and 0·18 per cent per year, respectively. Tree plantation, mostly cashew and mango trees, started in the 2000s, increased slightly at 0·1 per cent per annum. The settlement was also intensified as the population was increasing. Results also showed a noticeable increase in dense forest in the 1990s at the detriment of shrubland but it dropped in the 2000s while shrubland was increasing.

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Table IV. Change in land use types (both in size and proportion) from 1976 to 2007 in Neboun village of Sissili Province, Southern Burkina Faso

Land use types	Change from 1976 to 1992		Change from 1992 to 2007		Change from 1976 to 2007		Annual change	
	Ha	%	Ha	%	Ha	%	Ha	%
Cropland	653	7	625	7	1278	14	41	1
Dense forest	388	4	−1477	−16	−1089	−12	−35	−1
Woodland	−275	−3	−219	−3	−494	−6	−16	<1
Shrubland	−777	−9	908	10	131	2	4	<1
Plantation	<1	<1	139	2	139	2	5	<1
Settlement	13	<1	24	<1	36	1	1	<1

Table V. Pearson's correlations between land use types and population

Scale	Correlation	Native pop.	Migrant pop.	Total pop.
1. Cropland	Pearson correlation	0·988	0·914	0·949
	p-value	0·002	0·030	0·014
2. Dense forest	Pearson correlation	−0·789	−0·777	−0·788
	p-value	0·113	0·122	0·114
3. Woodland	Pearson correlation	−0·984	−0·927	−0·955
	p-value	0·003	0·024	0·011
4. Shrubland	Pearson correlation	0·317	0·353	0·343
	p-value	0·604	0·560	0·572
5. Plantation	Pearson correlation	0·907	0·979	0·961
	p-value	0·033	0·004	0·009
6. Settlement	Pearson correlation	0·981	0·986	0·992
	p-value	0·003	0·002	0·001

Relationship Between Land Use Change and Population

There was a strong correlation between land use types and population changes (Table V). The change in size of cropland was strongly and positively correlated with both migrant population and indigenous population ($p < 0{\cdot}05$). Dense forest was strongly and negatively correlated with population but the correlation was not significant ($p > 0{\cdot}05$). Woodland was also strongly and negatively correlated with population ($p < 0{\cdot}05$). Plantation and settlement were positively and strongly correlated with population while shrubland was weakly correlated with population.

DISCUSSION

Results from the present study showed that the population in the study area increased tenfold and indicated that the increase was amplified by rural migration estimated at 5 per cent per annum. This figure is fairly higher than the one found at the province level which was 3·7 per cent (Ouedraogo *et al*., unpublished data). This difference could be explained by the variation of the spatial scale of the study. Previous studies indicated that migration differed significantly among districts in Sissili Province (Ouedraogo *et al*., unpublished data). Farmers' migration to southern Burkina Faso and its environmental effects have been studied previously. Howorth and O'Keefe (1999) reported earlier that migrants and indigenous population in Sissili Province had a peaceful coexistence and practiced an environmentally friendly agriculture. In their recent studies, Henry *et al*. (2003), Ouedraogo (2003),

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Ouedraogo (2006a) and Paré *et al*. (2008) showed however that if the migration flow continues unabated, the area will ran out of forest reserve in the near future due to agricultural expansion, which in turn could lead to inter-ethnic conflicts over the control of land.

Results from the image processing revealed that in 1976, land use types in the region around the village were aggregated while from 1986 to 2007, they were scattered. Explanation to this could be the increasing population in the study area, resulting in the increase and the diversification of the activities. With the increasing migration, land around settlements could no longer meet the need of the farmers in terms of arable land, thus forcing farmers to go beyond settlements in search of more suitable lands. Firewood extraction, charcoal production and grazing could also justify the patchy distribution and the reduction in size of the dense forest and the woodland in the village.

The case of Neboun where migrant population shifted from 3 per cent in 1976 to 57 per cent of the total population in 2007 illustrated the pessimistic view of environment and human population relationships (Maltus, 1798; Hardin, 1968; Meadows *et al*., 1972). Population growth highly correlated with the area of cropland during the study period. Obviously, the annual increase in area of cropland (0·46 per cent) in the village was below the recent estimations at the district and provincial levels (Ouedraogo, 2006a; Paré *et al*., 2008). However, if the population growth and the production system (extensive production) remain unchanged, the rate of increase in area of cropland could reach 1 per cent in the near future. Population growth was also coupled with the decrease in area of dense forest and woodland (strong negative correlation). This may signify the important role played by the population in the deforestation process. Besides agriculture, farmers were producing charcoal and extracting fuelwood from the forest and also grazed their livestock in the forest. Fuelwood extraction and charcoal production in the village were, on one hand practiced at a large scale (personal communication) to meet the energy requirement of the capital city of the country (Ouagadougou) where wood contributes for more than 90 per cent to the domestic energy (Krämer, 2002). On the other hand, grazing was practiced everywhere in the village apart from the Sissili protected forest and the croplands (during the cropping season). During the dry season, when feed became increasingly scarce, livestock relies on straws and foliage of wood species such as *A. africana*, *P. erinaceus*, *K. senegalensis* and *Adansonia digitata* L. (Ouedraogo, 2006a,b). The apparent increase of dense forest in 1990s at the detriment of the shrubland could be the result of the environmental policy introduced during 1983–1987. A strong interest in environmental protection led to the institution of three fights: fight against illegal cutting, fight against bushfires and fight against free mobility of livestock (Yameogo, 2005). These rules were strongly observed and could have contributed to the regrowth of shrubland to dense forest. Furthermore, enhancing food self-sufficiency through agricultural intensification put most fallows (which constitute shrubland) back into production, thereby accounting for reduced area of the shrubland. The decrease in dense forest area in 1990 could be explained by the relax environmental protection and expansion of commercial agriculture such as cotton (Ouattara *et al*., 2008) and thus contributing to reduction in previously gained forest area.

Migrant people in Neboun came mainly from the central Plateau and northern region of the Country. Explanation to this could be that these two regions have specific demographic and ecological characteristics which push people to migrate as pointed by migrant respondents. The central regions accounted for more than 46 per cent of the total population of the country (INSD, 2007) from which more than 90 per cent were farmers (Breusers, 1998). This region is nowadays crowded and the capacity of the lands to sustain agriculture and grazing under extensive subsistence practices is almost exceeded (Gray, 1999, 2005; Reij *et al*., 2005). In such conditions, the easiest way is to migrate towards new frontiers where land is still available (Boserüp, 1972; Bilsborrow and Carr, 2001). In the northern region, the rains are insufficient and unreliable resulting in an increasing aridity. The mean annual rainfall ranges from 400 to 600 mm within a rainy season which does not exceed 4 months (Reenberg and Lund, 1998). To face this environmental condition, farmers from this region developed secular techniques known as *Zaï* or *Demi-lunes* (plant-pit system) (Slingerland and Stork, 2000; Sorgho *et al*., 2005), but their success was a function of the spatial and temporal distribution of the rains. These techniques were seen as more and more laborious and hazardous by some local farmers. Therefore, they see Om of one or more family members as a mean of earning cash income and reducing risk (Youl *et al*., 2008). Unfortunately, during their first years of settlement in the attracted area, the first activity they practice to make rapid income for survival is to cut wood for charcoal production. This could impact the sustainability of forest in the village.

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The results indicated that migrants had relatively larger farmlands compared to indigenous. The justification for this could be that the indigenous people have a strong and secular relationship with their ever-changing environment developed over several years (Howorth and O'Keefe, 1999). Therefore, despite the recent introduction of cash crop productions (cotton mainly), indigenous people have been inventive and adaptive in their resource use patterns and survival strategies. In contrast, the migrant people who came to work in a new environment have two main objectives. On the one hand, they had to secure their income and domestic food; on the other hand, they had to produce more to meet also the food shortages and chronic food insecurity that their parents face in their home villages. To do so, migrants use improved technology (ploughs), thus, cutting large forest areas to make space for agriculture as compared to the indigenous. Our observation corroborates that of Howorth and O'Keefe (1999), who found differences in farmland size between indigenous people and migrant population in the province.

CONCLUSIONS

The area under agriculture at Neboun village increased by fourfold while population almost increased by tenfold between 1976 and 2007. Migrant people which accounted for 3 per cent in 1976 shifted to 57 per cent of the total population of the village in 2007. Croplands were aggregated around settlement in the 1970s, but were scattered alongside the village territory in the 2000s. The change in land use types correlated with change in population, which in turn is driven by migration. In the absence of rural migration control, agricultural intensification and alternative source of energy or plantation of rapidly growing tree species for energy use, the current trend of increasing agricultural area as a result of human population growth is likely to continue. This eventually will contribute to environmental degradation and spread of desertification.

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