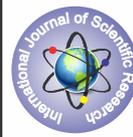


Dynamic of land-cover and sustainability of agro-system in local level: case of Safi in Burkina Faso



Geography

KEYWORDS: Land-cover dynamic; Land-use planning; agro-system sustainability, Safi; Burkina Faso

Yezeuomin
Stephane Corentin
SOME

Département de géographie, Université de Koudougou

ABSTRACT

As a village of farmers and herders in Burkina Faso, Safi has a strong dynamics of land use that raises questions about its sustainability. The objective of this work is to characterize the dynamics of land use between 1955 and 2010 in relation to those of climate and demographic. The methodology is based around the literature review, photogrammetry, geographic information systems, and data analysis. The land use is characterized by a reduction of natural ecosystems by more than 50% between 1955 in 2010. The impact of demography is characterized by a tripling of cultivated area and those of climate by using more of the lowlands as agricultural area. The solutions recommended to the sustainability the agro-system of Safi are the intensification of production systems, the improving of soil fertility management, the using of improved varieties and the training for farmers.

INTRODUCTION

Defined as a space of life, of socio-economic production and as the spatial projection of systems of representation, the territory is the synthesis of the livelihoods of populations (Fortin, MJ, 2008). This is most evident in Burkina Faso where over 80% of the population lives of extensive subsistence agriculture. Sustainability in agriculture assumes balanced relations with the environment on the economic, ecological, social and intergenerational plan (Landais, É., 1998). These relations with environment make of sustainability in agriculture a system. An evolution of one of its components can modify the dynamic of the whole system. It materializes in space by an evolution of the land use. With global changes, characterized by climate change, demographic change and its corollaries (growing water needs, food supply, raw materials supply for industries etc.), the dynamics of land use that was local, becomes a marker of the global ecological balance (Alonso, W.; 1964). If these global changes often helped to solve problems both at global and local level, they also carry their attendant environmental problems (ecosystem degradation, reductions of soil fertility, biodiversity erosion, etc.). Agricultural Local communities are most vulnerable, hence the need to monitor the sustainability of the village agro-systems through an analysis of the dynamics of land use. This article is devoted to the study the dynamics of the land use in the village of Safi, between 1955 and 2010, in relation with the trends of the climate and the population.

PRESENTATION OF THE STUDY AREA

Safi is a village of the region of Centre-Nord, province of Namentenga, in the department of Boala. It is approximately 40 km from Boulsa, administrative center of the province and approximately 102 km of the city of Ouagadougou. It is located between 12° 56' and 12° 50' of north latitude and between 0° 47' 0" 43' of west longitude. Its area is 40 km². Its population was 2189 inhabitants in 2006 (INSD, 2006).

It is inhabited mainly by farmers and ranchers. The production systems are characterized by their low level of intensity, their itinerant character and the more or less regular use of slash and burn cultivation. Fallow is the main technique of restoration of soil fertility and ecological balances. The main crops are: sorghum, and millet, maize, groundnuts, beans, rice. The material used is usually rudimentary and consists of daba, pickaxes, machetes... As far as livestock farming is concerned, it is the preeminence of the common pasture. It is an extensive breeding with seasonal transhumance from February to May and from June to September. The livestock consists of bovine, ovine, caprine, porcine, donkeys and poultry (Onadja, 2011). These techniques of agro pastoral production, formerly efficient, have lost balance, because of the growing need of farmlands bound to the demographic dynamics. Village of farmers and ranchers, Safi depends heavily on these natural resources. Safi is a peneplane of an average height of 325m. It has 70 % of undeveloped

mineral soils (gravel or hydromorphic soil) and 30 % of tropical ferruginous soils. It is drained by three small intermittent streams with a tropical regime heavily dependent on precipitations. It is a wooded savannah to shrubby savannah. The dominant species of shrub layer are *combretum sp*, *Guiera senegalensis*, *Piliostigma reticulatum*, *Ziziphus mauritiana*, *Acacia senegal*, *Acacia seyal*. The tree layer in the form of agro-forester parks is dominated by utilitarian species that are: *Vitellaria paradoxa*, *Parkia biglobosa*, *Lannea microcarpa*, *Faidherbia albida*, *Sclerocaria birrea*, *Tamarindus indica*, *Balanites aegyptiaca*, *Anogeissus leiocarpus*, *Khaya senegalensis* (Fenton et al, 2008). Its climate is that of Sudano-Sahelian tropical type with two contrasting seasons. The first one dry and the second one rainy during which, the agricultural production activities are mainly developed.

OBJECTIFS OF THE STUDY

This work falls under the problematic of the efficiency of land use in a context marked by an evolution of the biophysical and human environment. How are the demographic and climate dynamics projected into space? Is this space dynamics sustainable? If not what are the possible solutions? These are research questions addressed in this paper. In a territory dependent on natural resources, a modification of an important variable such as the climate that affects water availability an essential factor of production motivates initiatives taken by populations for self-adaptation. The same argument holds for demography. An increase of population brings an increase of needs, in particular food and their satisfactions can echo in the space.

The global objective of this study is to contribute to a better understanding of the evolution of land use, essential element of land planning. Its specific objective is to analyze the dynamic of Safi's land use in connection with two main factors of evolution: demography and climate.

MATERIAL AND METHODS

The materials used are essentially:

- aerial photographs, administrative database and land use database of the Geographic Institute of Burkina,
- Landstat ETM+ images,
- Ancillary database (climate data, demographic, administrative and soil). The climate database of the General Directorate of National Meteorology. The population database are provided by the National Institute of Statistics and Demography
- data collection materials,
- Data processing and analysis geographic data software.

Administrative databases and aerial photographs are from the Geographical Institute of Burkina. The collecting, processing and analysis of geographic data, is composed of stereoscope, GPS receivers, GIS software (ArcGIS 10), Microsoft office 2007 pack.

Several methods were combined. The first one is document retrieval which allows to collect secondary data, collect information for refining the methodology and discussion of results. The second method is photogrammetry. It is articulated around the visual interpretation of the Arian photography of the zone of study of 1956, 1980 and a Google Earth image of 2010, the demarcation and the mapping of land-cover on the three periods. The nomenclature for the interpretation is based on 6 classes of land-cover: shrub savannahs, wooded savannah, riparian forests, fallow, cultivated fields and degraded land/bare soil to which he was deputy, housing, stream and roads. This nomenclature is based on the Corine Land-cover nomenclature adapted to Burkina Faso by the Geographical Institute of Burkina, as part of the implementation of Database of tenure (BDOT). The third method is the geographic information system. It enabled the digitization of the results of photo interpretation, the production of statistics on land use, the mapping and the spatial analysis. The fourth method is the statistical analysis of demographic data from 1975 to 1996 and climate trends (temperature and precipitation) of the synoptic station of Ouagadougou, the closest station to the study site, between 1956 and 2009.

FINDINGS AND DISCUSSION

Diachronic analysis of land use shows two major developments: The first is a very significant change in the contribution of different units of land-cover to local landscape. The following table shows the area in hectare of each land-cover units. The areas of natural formations diminish and contribute to the openness of the landscape by reducing trees and shrubs. Wooded savannah lost more than 87% of area, from 882,01ha to 107,46ha between 1956 and 2010; riparian vegetation areas decreased from 333.33ha in 1956 to 64.34 ha in 2010. It is more than 80% reduction of its area.

Table 1 : Evolution of Land-cover area of Safi between 1956, 1980 and 2010

Land-cover units	1956	1980	2010
Wooded savannah	882,01	493,92	107,46
Shrubby savanna	1837,73	1882,66	791,16
riparian vegetation	333,33	199,06	63,34
fallows	38,41	41,34	663,18
fields	833,80	1304,34	1845,58
bare soil	37,08	40,96	483,54

The areas lost by natural formations are occupied by farming production areas. These are fields, fallow and bare soil. Fallows had the biggest gain in space. As abandoned areas to allow natural reconstitution of soil fertility after a period of farming, fallow suggests a decline in soil fertility. The persistence the trend in the absence of new land to be cleared conducts to a reduction in the duration of the fallow. The consequence is an increase in degraded soils, with 483,54ha of bare soils in 2010 against 37,08ha in 1956.

Indeed, fields establish the biggest modality of land used with 1845.58 ha while they did not represent more than 833.80 in 1956. It is an increase of more than 120 %. In summary, the dynamics of land tenure is marked by a decrease in natural formations. Those occupied 70% of land in 1956 and not occupy less than a third in 2010.

The second major evolution is the birth of an agropastoral front. Surfaces exploited for agricultural purposes get closer to stream beds. Bottomland soils are perceived to have the best land for agriculture. Figure 1 below allows the observation of this reality. We noted the almost total disappearance of riparian formations and their replacement by fields and fallow. We also note a colonization which leaves the upstream of streams on the West towards the downstream in the East. Two associated factors explain the

dynamics of land use in Safi. Its population growth combined with inefficient agro-pastoral production systems and climate through desiccation.

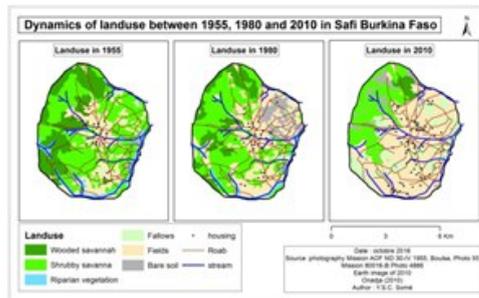


Figure 1 : Spatial dynamic of Land-cover area of Safi between 1956, 1980 and 2010

The population of Safi increased by more than 230 %, going from 1325 inhabitants in 1975 to 3064 inhabitants in 2015. The densities went from 33 inhabitants in Km² in 1975, to 55 inhabitants / Km² in 2006. Today, it has more than 77 inhabitants / Km². This demographic situation, combined with extensive systems of production, itinerant, in low yield and using the technique of slash-and-burn field, with the fallow as the main technique of restoration of soil fertility can only increase the consumption of the space (Fenton et al, 2008). The increase of the agricultural surfaces is due to the increase of the food needs related to the increase of the population and to the weakness of the agricultural yields. This is consistent with the results of Marshal (1983),Lassonde(1996).

The second factor is the aridification of the climate. The precipitations know a trend reduction between 1956 and 2009, with a maximum au 1200mm of rainfall in 9 months in 1962 and a minimum 900mm of rainfall in 6 months 1981 and 2009. We observe however a resumption of the raining activity since the 1990s. The average temperatures always superior to 25°C, know the inverse dynamics. The annual average decreased overall between 1956 and 2010, and varies between 28.5°C and 28°C. Between 1980 and 2010, the trend increased and is even more marked from 1990s when it achieves 29.5°C. In so doing, the aridity index of De Martone is decreasing regularly, suggesting a process of current aridification. This is consistent with the results of Somé, Y. S. C. (2016) in the same geographic region. This climatic situation contributes to a reduction in the already insufficient yields. The consequence of this aridification is the trend to use the shallows to face the problems of drought. The populations proven by the recurring droughts (1949, 1970, 1984) developed initiatives to answer the effects of drought by getting closer as much as possible to shallows, in order to guarantee, even in case of drought, tens of Kilograms harvests (Yameogo, on 2009). This change in land use highlights the obsolescence of farming production systems. The common pasture, the itinerancy as a means of access to fertile land, the fallow as means of recovery of degraded land/bare soil, are no longer adapted to the current environment. The agricultural intensification has to replace the increase of surfaces. For this, integration of agriculture and livestock through the use of animal manure as organic manure for fertilizing land, use of improved seeds more resistant to drought, the establishment of anti-erosion developments and the protecting banks, are all ways to improve production systems. The efficiency of these methods requires a change in representation systems. This involves raising public awareness on the issue of land use planning and their training in new practices to improve production systems.

CONCLUSION

This study highlighted the relationship between changes in environmental factors (climate and demography) and the dynamics of land use in Safi. Faced with this development, the communities have adopted coping strategies that have resulted in an increase of increasingly strong production surfaces and a more important

occupation of the shallows. This work has also highlighted the inability of production systems to cope with changes in the production environment. A better management of the fertility of grounds, use of improved varieties, agricultural intensification, raising awareness of the actors on the obsolescence of the systems of production, the training on more efficient techniques of production are solutions possible to face the problems of the planning of the use of lands in a context of evolution of climate factors and demography

REFERENCES:

1. Alonso W. (1964). Location and land use. Toward a general theory of land rent. Cambridge, Mass.: Harvard University Press, 204 pages.
2. Fortin, M. J. (2008). Du territoire de production au territoire habité (Production territory inhabited territory). *Sciences du Territoire: Perspectives Québécoises*, 10, 55.
3. INSD, (2006) Recensement Général de la population et de l'Habitat, Burkina Faso (General Census of Population and Housing), Ministère de l'économie et es finances.
4. Landais, É. (1998). Agriculture durable: les fondements d'un nouveau contrat social? (Sustainable Agriculture: the foundations for a new social contract ?) *Le Courrier de l'environnement de l'INRA*, 33(33), 5-22.
5. Lassonde L., (1996). Les défis de la démographie. Quelle qualité de vie pour le XXI siècle (The challenges of demography. What quality of life for the XXI century). *La découverte*, Paris, France, 191 p.
6. Marchal J.Y., (1983). Yatenga Nord Haute Volta. La dynamique d'un espace rural soudano sahélien. (Yatenga North Upper Volta. The dynamics of a rural area Sudano Sahelian) *Travaux et documents de l'ORSTOM N° 167*, Paris, 873 p + cartes.
7. Onadja John Remi, (2011), Influences de la température, de la pluviométrie et de la démographie sur l'occupation des terres dans le terroir de Safi, province du Namentenga, Burkina Faso, mémoire de master en ingénierie de l'eau et de l'environnement option : environnement ; (Influences of temperature, rainfall and Demography on the occupation of land in the land of Safi, Namentenga Province, Burkina Faso, master thesis in water engineering and environmental option: environment), Fondation 2iE.
8. Somé, Y. S. C., Dango, L., & Abdouramane, G. D. (2016). Arid Climate in the Sirba Basin in Burkina Faso: Causes for Better Decisions in Land Use Planning. *British Journal of Applied Science & Technology*, 14(6), 1.
9. Yaméogo G., (2009). Les ressources ligneuses et leur gestion dans le terroir de Vipalogo, Province du Kadiogo, Burkina Faso (Wood resources and their management in the soil of Vipalogo, Province of Kadiogo, Burkina Faso). Thèse de Doctorat, Mémoire de thèse Unique de Doctorat, Université de Cocody Abidjan, Abidjan, 224 p