Original Research Article

Geographical environment and dynamics of farming systems in the commune of Korsimoro: An integrated approach to optimising farming practices

ABSTRACT

Korsimoro, a commune in north-central Burkina Faso, is located in a Sudano-Sahelian region where agriculture is highly dependent on biophysical conditions such as relief, soil type, vegetation and climate. This study examines the impact of these characteristics on farming practices, particularly in a context of increasingly marked climate change. The methodology adopted combines a geospatial analysis of environmental data with a detailed soil evaluation provided by the Bureau National des Sols (BUNASOLS). Topographical and climatic maps were used to analyze the influence of relief, vegetation and rainfall on agriculture. Historical climate data was used to understand the variability of rainfall and its impact on agricultural yields. The results show that the ferruginous tropical leached indurated soils (FLIPP), covering almost 47% of the area, have low agronomic potential due to their shallowness and water retention capacity. Degradation of the vegetation cover, exacerbated by deforestation and overgrazing, increases the vulnerability of the land.

Rainfall variability also poses a significant challenge to the stability of agricultural yields. To strengthen the resilience of farming systems in Korsimoro, it is crucial to adopt sustainable soil management practices, improve access to water and introduce technologies adapted to changing climatic conditions, in order to guarantee food security and the sustainability of farming practices in the region.

Keywords: Korsimoro, Agriculture, biophysics, climate variability.

1. INTRODUCTION

The commune of Korsimoro, located in the Centre-North region of Burkina Faso, is a rural area typical of semi-arid environments, where agriculture is both the main economic activity and the mainstay of local communities' livelihoods. The specific biophysical features of this region, such as the diversity of soils, the varied vegetation, the relief, as well as the particularities of the hydrography and climate, play a determining role in agricultural practices and crop productivity. According to Zougmore, Mando and Stroosnijder (2004), local conditions and biophysical elements, such as rainfall and temperature, are essential for adapting farming practices to climate change, thereby helping to improve food security for the people of Burkina Faso. However, these conditions are becoming increasingly fragile as a result of climatic variations, continuing demographic growth and the intensification of farming activities.

Faced with these dynamics, it is crucial to develop an in-depth understanding of the complex interactions between these biophysical characteristics and the various factors influencing agricultural production. Such an understanding is essential for designing effective and relevant adaptation strategies. As Mazzucato and Niemeijer (2000) point out, farmers, particularly those in vulnerable regions, are often the most sensitive to the effects of climate change.

2. MATERIAL AND METHODS

2.1. Study area

The commune of Korsimoro, located in the Centre-Nord region of Burkina Faso, was chosen for this research because of its agricultural importance and unique environmental characteristics. This region, with a semi-arid climate, has a great diversity of soils, varied vegetation, contrasting relief, as well as hydrographic particularities. These elements have a direct influence on agricultural practices and crop productivity in the area.

2.2. Data and sources

The data used for this study come from a variety of reliable sources. The soil information was collected from the National Soil Bureau (BUNASOLS), which provides detailed analyses on soil types and their distribution within the municipality of Korsimoro. The maps used were obtained from the Geographical Institute of Burkina Faso (IGB) and the National Topographic Data Database (BNDT). They made it possible to map the geographical characteristics of the municipality. In addition, socio-economic data was collected from the municipality's technical services, and supplemented by field surveys conducted among local populations, as well as by the results of the 2019 General Population and Housing Census (RGPH).

2.3. Methodology

The methodology used combines spatial analysis, field data collection, and secondary data exploitation. The objective is to understand how biophysical characteristics influence agricultural production in the commune of Korsimoro. The information provided by BUNASOLS was analysed to identify the different types of soils and their suitability for various crops, resulting in a detailed soil map of the study area. Maps from the IGB and the BNDT were used to represent geographical features, such as relief, hydrography and vegetation cover, thus facilitating the analysis of agricultural areas and ecological potentials. At the same time, socio-economic surveys were conducted to obtain information on farmers' agricultural practices, risk perceptions and coping strategies. These surveys, combined with data provided by the municipality's technical services and the RGPH 2019, were analysed to identify trends and make recommendations adapted to local realities. All of these analyses have made it possible to identify the vulnerable areas and the most resilient agricultural practices, thus providing avenues for sustainable management of natural resources and an improvement of agricultural resilience in the commune of Korsimoro.

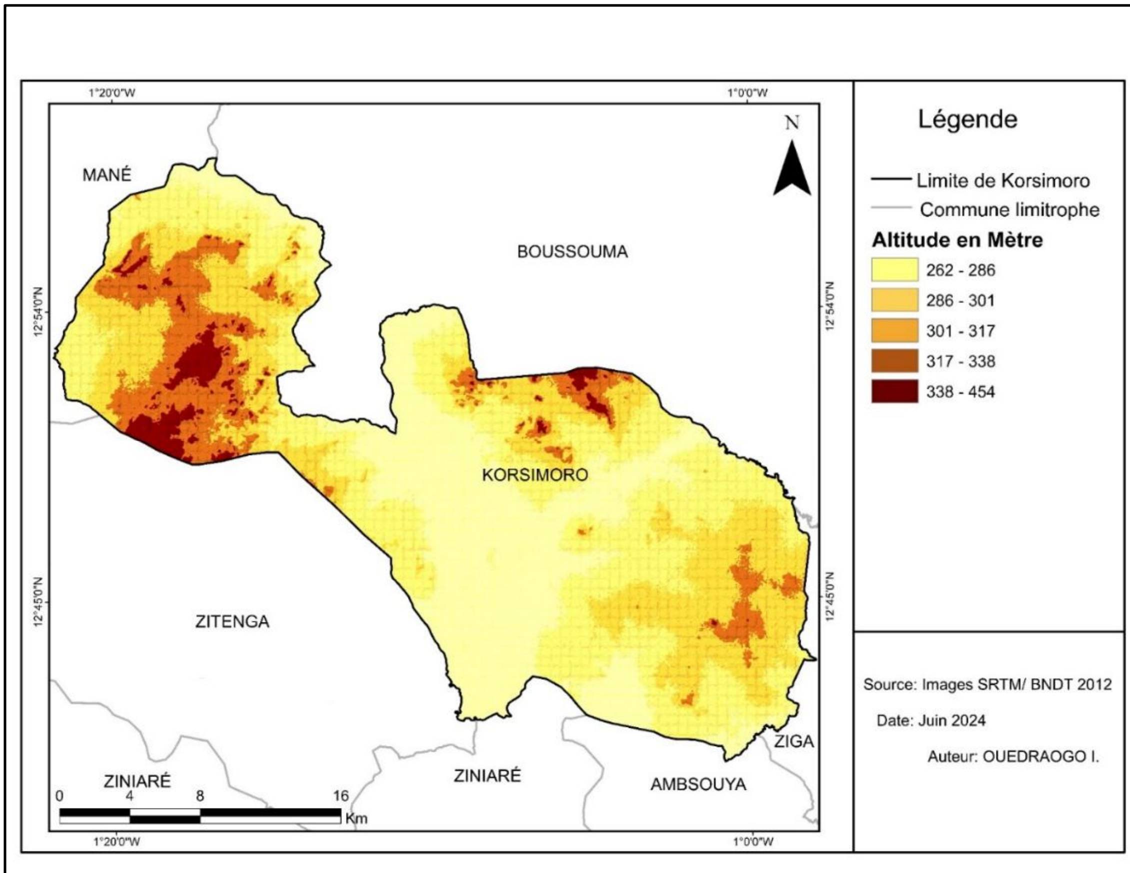
3. RESULTS AND DISCUSSION

3.1. Biophysical characteristics of the Municipality of Korsimoro

This part concerns the characteristics of the relief of vegetation, soils, hydrography and climate

3.1.1. Relief

The relief of the municipality of Korsimoro, characterized by a chain of lateritic hills with peaks up to 454 meters, directly influences the use of agricultural land. Tazi (1996) observed that in areas with moderate relief, such as Korsimoro, extensive production systems predominate. This situation is reflected in the distribution of agricultural land: 81.3% of the plots are on plateaus or plains, 5.8% in the lowlands, and 12.9% on slopes. According to Bationo et al. (2007), moderate relief, combined with a high land use rate, favours cultivation strategies adapted to local conditions, in particular to minimize the risk of erosion (Map 1 and Table 1).



Map 1*: Map of the altitudes of the municipality of Korsimoro*

Table 1*: Topography of agricultural plots*

Location of the plots	**Percentage**
Plain/Plateau	81,3
Depression	5,8
Side	12,9
Total	**100**

Source: EPA/DGESS/MAAH, (2020)

3.1.2. Soils and Agricultural Potential

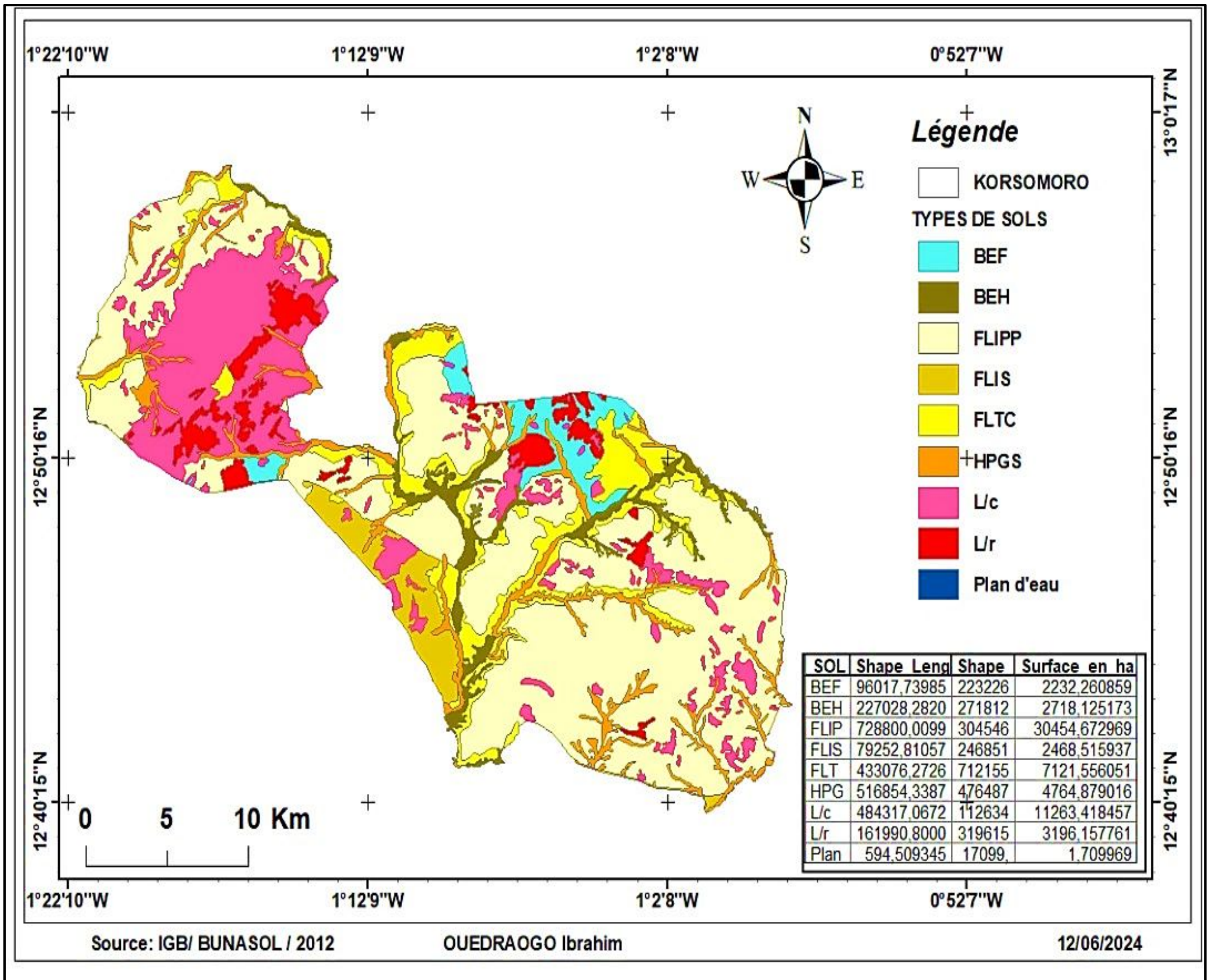
The soil study carried out in 1998 by the National Soil Office (BUNASOLS) identified eight types of soil in the municipality of Korsimoro. Shallow indurated leached tropical ferruginous soils (FLIPP) are the most widespread, covering 47.42% of the total area. These soils have a low water retention capacity (49 to 58.8

mm) and a useful depth of 40 to 60 cm, which limits their agronomic potential, making them only moderately suitable for cereal crops such as millet, sorghum and maize. Zougmore, Mando and Stroosnijder (2004) note that FLIPP soils are particularly vulnerable to erosion due to their shallow depth and low useful water reserve.

In addition to FLIPP, other soil types have been identified (Map 2):

- **Lithosols on cuirass (LC):** representing 17.53% of the soil, these gravelly and stony soils are unsuitable for agricultural production due to their low water retention capacity and high gravelly load.
- **Lithosols on rock (LR):** covering 4.97% of the area, these soils are characterized by a very shallow depth (often less than 10 cm), thus limiting their agricultural use.
- **Tropical ferruginous soils leached with spots and concretions (FLTC):** these soils, representing 11.08% of the soil, are moderately suitable for cereal crops such as sorghum, maize and upland rice, but marginally suitable for millet cultivation.
- **Tropical ferruginous soils with shallow indurated leaching (FLIS):** covering 3.84% of the area, these soils are poorly to moderately suitable for cereal crops, but unsuitable for upland rice and vegetable crops.
- **Brown euthroph ferruginised soils (BEF):** representing 3.47% of the soil, these soils are moderately suitable for cereal crops and poorly suitable for vegetable crops.
- **Hydromorphic euthrophic brown soils (HEBs):** Covering 4.23% of the area, these soils are ideal for growing rice, maize, vegetables and tubers thanks to their high water-holding capacity.
- **Hydromorphic soils with low humus with pseudo surface gley (HPGS):** these soils, which represent 7.41% of the soils of the commune, are moderately suitable for rainfed crops such as sorghum, maize and upland rice, and poorly suitable for millet.

These data show that although FLIPP soils are the most common, their agronomic potential is limited, while hydromorphic and brown euthroph soils, although less common, provide better conditions for some crops (Roose, 1996).



SOL	Shape Leng	Shape	Surface en ha
BEF	96017,73985	223226	2232,260859
BEH	227028,2820	271812	2718,125173
FLIP	728800,0099	304546	30454,672969
FLIS	79252,81057	246851	2468,515937
FLT	433076,2726	712155	7121,556051
HPG	516854,3387	476487	4764,879016
L/c	484317,0672	112634	11263,418457
L/r	161990,8000	319615	3196,157761
Plan	594,509345	17099,	1,709969

Map 2: *Soil types in Korsimoro*

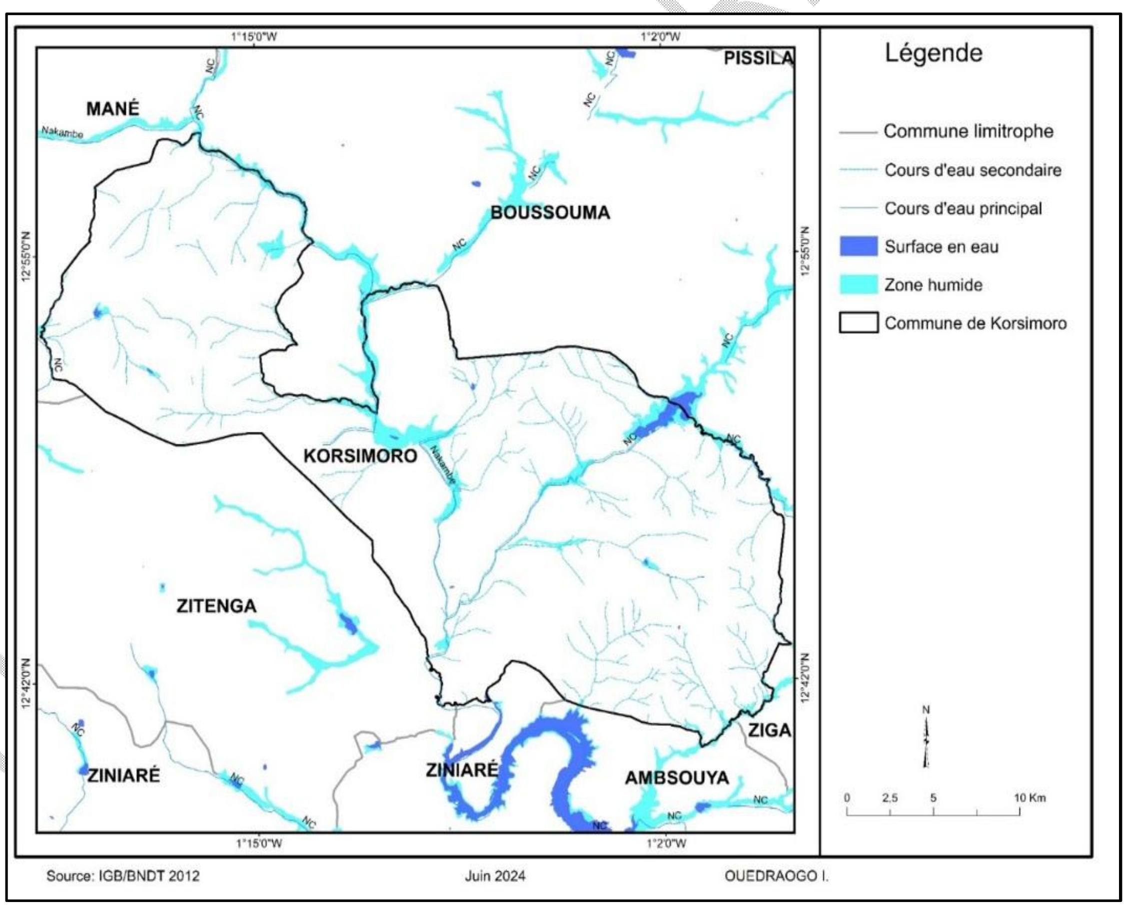
3.1.3. Vegetation

The vegetation of Korsimoro, typical of the Sudano-Sahelian zone, is dominated by shrub savannah (mainly on the plateaus and plains, which represent 81.3% of agricultural land) and grassy savannah on the slopes of hills and armoured mounds. Fontès and Guinko (1995) described this vegetation as representative of the central regions of Burkina Faso, where the shrub savannah is composed of species such as *Combretum micranthum* and *Anogeissusleiocarpus*. However, deforestation and overgrazing have led to a significant degradation of vegetation cover, reducing the availability of natural pastures, which affects the local population, 90% of whom depend on agriculture and livestock. Maitre and Albrecht (2000) have pointed out that this degradation has direct consequences on the ability of land to support agricultural and pastoral activities.

To counter this degradation, reforestation initiatives have been undertaken, particularly with exotic species such as *Eucalyptus camaldulensis*. Kaboré and Reij (2004) note that while these efforts may have immediate benefits, they also pose long-term ecological challenges, such as competition for water with local crops.

3.1.4. Hydrography

The Korsimoro river network is mainly composed of non-perennial rivers (Map 3) that dry up quickly after rains, due to high infiltration and evaporation, which reached an average of 2133 mm per year between 1998 and 2020. This high evaporation poses a crucial problem for the management of water resources, especially in the dry season, limiting the availability of water for crop irrigation. Sawadogo, Zombre and Bationo (2010) explain that this situation is typical of Sudano-Sahelian regions, where water resources are often insufficient to support agriculture throughout the year. Ouedraogo, Sawadogo and Paré (2015) suggest that the construction of water reservoirs could be a solution to improve water management and mitigate the impacts of prolonged periods of drought.



Map 3: *Hydrography of the municipality of Korsimoro*

3.1.5. Generality of the climate

The climate of Korsimoro, of the Sudano-Sahelian type, is marked by a long dry season that extends from October to May, and a relatively short rainy season from June to September. Annual precipitation varies widely, from 509.6 mm in 1991 to 858 mm in 2020. According to Nicholson (2001), this inter-annual variability in precipitation makes agriculture vulnerable, especially in years with below-average precipitation. Sultan and Janicot (2003) confirm that this variability, coupled with high temperatures that often exceed 34°C in April, exacerbates the challenges for rainfed crops, which depend heavily on regular rainfall for their yield.

3.2. Dynamics of Agricultural Systems in the Municipality of Korsimoro

3.2.1. Rainfed Crops

Rainfed crops, such as sorghum, millet and maize, are at the heart of Korsimoro's agricultural system. These crops are highly dependent on rainfall, which varies greatly from year to year, exposing farmers to significant risks. Zougmore, Mando and Stroosnijder (2004) showed that water management practices, such as improving soil structure and using conservation techniques, are crucial for maintaining productivity in Sahelian regions, where rainfall is erratic. These practices include the zaï technique, which is widely adopted in Burkina Faso to improve water retention and soil fertility.

Table 2*: Main agricultural speculations in tonnes*

Speculation	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Sorghum	5106	4851.45	8642	1506	5694
Thousand	1491	1309	4335	1130	2541
Maize	345	331	667	628	491
Rice	391.5	394.5	377	365.7	439.8
Cowpeas	2971	2434	3127	1976	2018
Voandzou	255	236	317	204	399
Total	**10559.5**	**9555.95**	**17465**	**5809.7**	**11582.8**

Source : Korsimoro Department of Agriculture (2022)

3.2.2. Cash crops

Cash crops, including sesame, groundnuts, and cowpeas, are also essential in Korsimaro commune. These crops, which are mainly for sale, provide crucial income for local farmers. According to Ouedraogo, Reij and Larwanou (2006), rainfed cropping systems in Sahelian areas benefit greatly from the introduction of cash crops, as they diversify income sources and increase household resilience to climate shocks. The authors also highlighted the importance of integrated soil and water resources management to optimize cash crop yields in a changing climate.

3.2.3. Agricultural Innovations and Practices

In response to climate and environmental challenges, Korsimoro farmers have adopted various innovations to improve the sustainability of their farming systems. The zai technique, mentioned above, as well as stone barriers, are examples of practices that have shown great effectiveness in combating erosion and improving soil productivity. Roose and Rodriguez (1991) documented the positive impact of these techniques on the management of degraded land in Burkina Faso, showing that these practices can significantly improve agricultural yields even under difficult climatic conditions.

In addition, the adoption of more drought-tolerant crop varieties has allowed farmers to better adapt to fluctuating climatic conditions. Fatondji et al. (2006) studied the effectiveness of improved cereal varieties in the arid regions of the Sahel, finding an increase in yields during periods of drought compared to traditional varieties.

4. CONCLUSION

Agriculture in Korsimoro is intimately linked to the biophysical characteristics of the region, such as the relief, soil types, and vegetation of the Sudano-Sahelian zone. These elements directly influence the distribution of agricultural land and crop productivity, especially in a context of high dependence on variable rainfall. The region's soils, although diverse, present agronomic challenges, particularly in terms of water holding capacity and fertility, which sometimes limit the potential of rainfed crops.

Despite these constraints, the farming population of Korsimoro demonstrates a significant capacity to adapt to climatic hazards and environmental challenges. Cash crops, in particular, play a key role in diversifying income sources and strengthening farmers' economic resilience. However, to ensure the sustainability of these agricultural systems, it is crucial to continue to manage and develop natural resources effectively.

In sum, the future of agriculture in Korsimoro will depend on the ability to integrate local biophysical realities into sustainable land and resource management, while strengthening farmers' capacities to adapt to changing conditions. With appropriate support and informed management, the municipality of Korsimoro has the potential to maintain and develop a resilient and sustainable agricultural system.

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