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Mapping and land use in Kouh-Est in the Eastern Logone (Southern Chad)

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ABSTRACT

Understanding the spatial distribution of soils and their cartography is a challenge important both the ecosystem services provided by soils as well as their fundamental role in current agro-environmental issues. This work establishes the maps of the surface states of the department of Kouh-Est. These maps include the relief map, the hydrographic network map, the soil map and the land use map. These different maps made it possible to know that the ground is relatively flat and are gradually recovering, the hydrographic network converges from the outside towards the center, three types of soils are identified including ferrallitic soils, ferruginous soils and soils. alluvium. Bare soils occupy the large part of the study area, the highlands are reserved for agriculture and finally the vegetation, the body of water and the forest occupy a tiny area, mostly low.

Keywords: **Cartography, soils, East-Kouh, Eastern Logon**.

1. INTRODUCTION

It is now recognized that soil knowledge and protection are major pillars in order to respond to major global challenges (food security, climate change, land grabbing, urbanization and artificialization). Therefore, it seems more than ever necessary to have database to understand variations in the nature, properties and functioning of soils from the global scale to the local scales [18].For several decades, Earth observation has provided a better understanding our planet. At the heart of global change issues is the characterization of the dynamics associated with the transformation of continental surfaces - agricultural consumption, deforestation or urban sprawl are essential. In this context, space remote sensing offers the possibility of frequently mapping the entire planet. More specifically, satellite acquisition images provide maps that provide a graphical representation of land surfaces such as land use [20].

Generally, for a global view of soil behavior, it is necessary to use digital soil mapping. This mapping plays an essential role in enriching knowledge about soils and in particular their distribution laws in the landscape. As a result, the computerization of soil data collected on the ground provides a powerful tool that is a valuable asset for better taking into account the nature of soils at the local level in various fields (agronomy, environment, land management, etc)[1][2], and thus better respond to issues of sustainability of agricultural activities, management and land use planning, or conservation of resources and ecosystems [5]. Remote sensing and the Geographic Information System (GIS) are essential for applied mapping [17][11][13][23][18][1][2][14].

A regional agronomic approach must address the spatial variability of these behaviors. However, the study of a behavior involves knowledge of the state

of the soil at the beginning of the action, and monitoring over time the parameters of this action [14] [7].

The main objective of this study is to map the surface states of Kouh-Est in order to giveas accurate a picture as possible of the nature, location and distribution of the soil categories studied and then identify areas with agricultural potential. The specific objective is to make available to decision makers a map of land use in Kouh-Est.

2. OVERVIEW OF THE STUDY AREA

Chad is a country located in central Africa (Figure 1) between 7° and 24° north latitude and 13° and 24° east longitude, with an area of 1,284,000 km2, extending 1,700 km from north to south and 1,000 km from east to west [15].

Chad is considered the Sahelian country with the greatest agricultural potential: 55% of the land has high potential, allowing an agricultural season of more than 50 days.

Farmable land is concentrated in the southern half of the country [20].

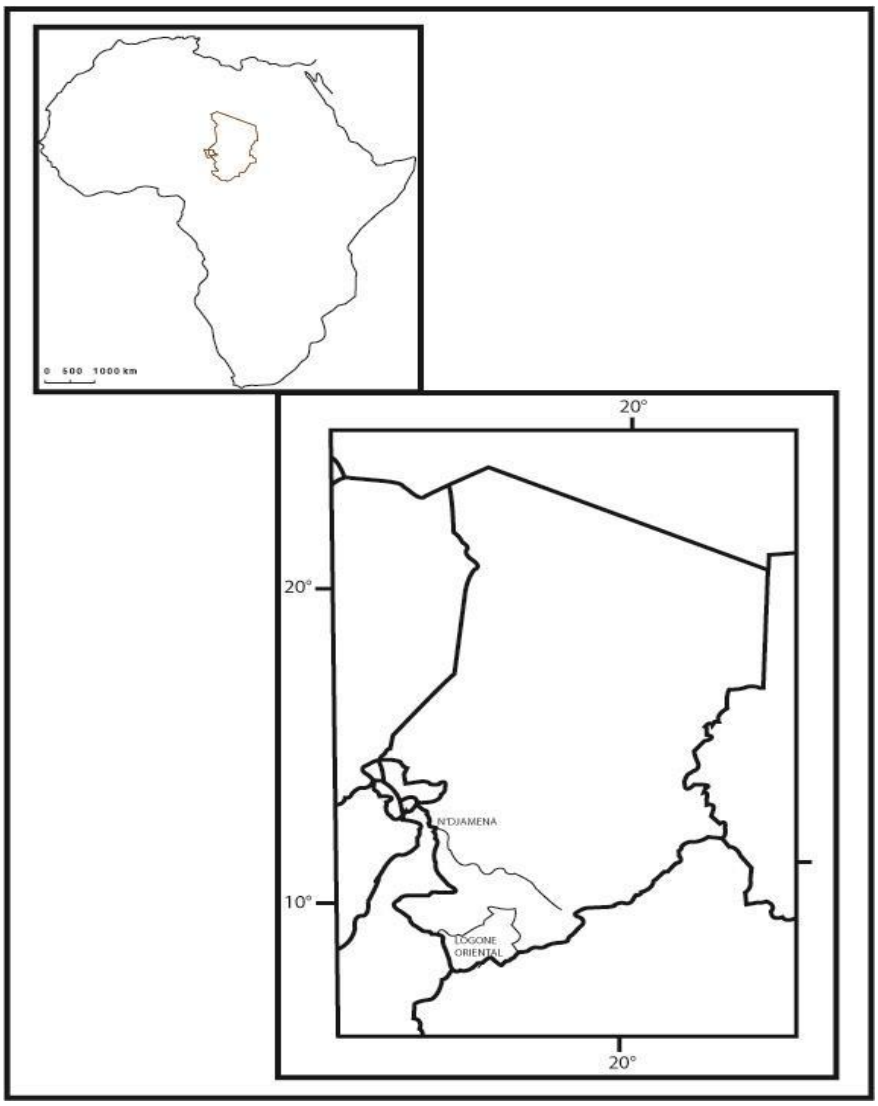
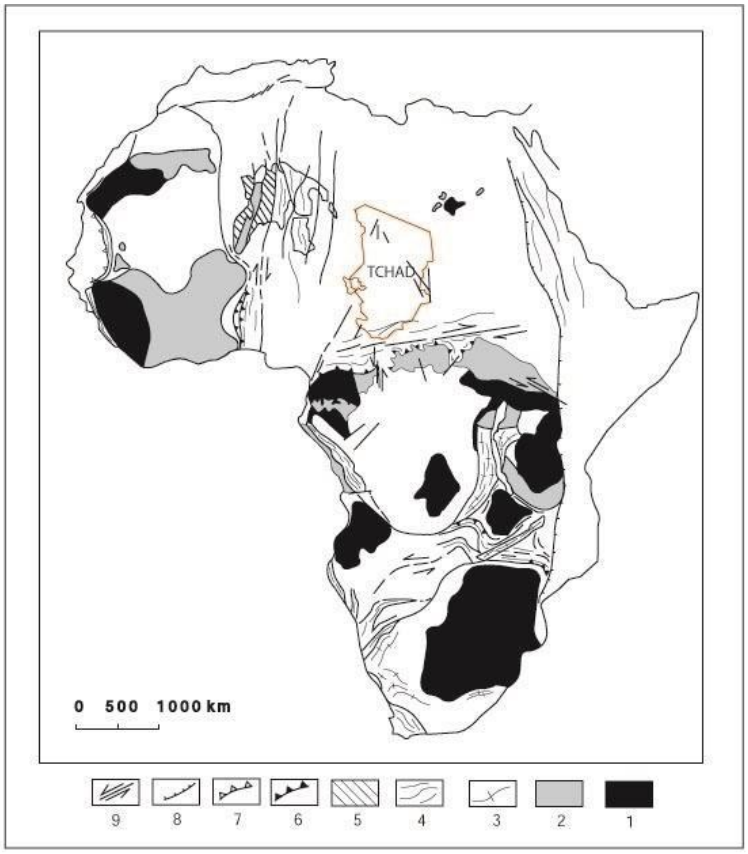


Figure 1. Regional Location Map

3. GEOLOGICAL CONTEXT OF CHAD

Chad is located in the middle of a vast area called the "Pan-African Mobil Zone" [5], formed during an orogeny, which took place towards the end of the Precambrian (700 – 540). This set of chains is located between the West African Craton in the West, the Congolese Craton in the South and the Nile Craton in the North-East. the North-East (Figure 2).



1. Archean formations ; 2. Paleoproterozoic formations ; 3. Kibarian formations ;
4. Panafrican formations ; 5. Pharusian formations ; 6. Panafrican overlaps ;
7. Hercynain overlaps ; 8. Mozambic belts boundaries ; 9. Shear zone.

Figure 2. Map of African cratons, Chad in the Central African Mobile Zone

Due to a lack of detailed studies, the stratigraphy of secondary education in Chad is not developed.

In terms of lithostratigraphy, Chad's geological formations include:
- the crystallophiliac and granitoid rocks
forming the Precambrian base which are
mainly flush with the periphery of the Chadian basin : in the extreme north (Tibesti), the east (Ouaddai), the central massif (Guéra), in the south-west (Mayo-Kebbi) and in the extreme south in the region of Mbaibokoum (Mount Lam) [24][22][6]. In terms of lithostratigraphy, Chad's geological formations include:-the crystallophiliac and granitoid rocks forming the Precambrian base, -sediment from the post-primary platform,- recent and subrecent volcanoes.

3.1. Geographical and geological context of the study area

The Eastern Logone is between 8th and 11th parallel, located in the extreme south of Chad and covers an area of 130,000 km^2[12].
The entire Logone Oriental is subjected to a rainy cycle that lasts 4 to 5 months, rarely 6. The rainy season generally starts in April and May, the month of October is less rainy and marks the end of the rainy season. The months of April and May receive a certain amount of water, but this water is practically irrelevant to agriculture [8].
The department of Kouh-Est is located in the Sudanian zone of Chad, a strip subjected to a rainfall greater than 800 mm in normal period and distributed over 5 to 6 months of rainy season, from May to October. This humidity of the rainy season brings a softening of the temperature below 30°
during the month of August [3][19][20][9]. The entire Eastern Logone is marked by the Pan-African orogeny between 700 and 600 Ma. The subsequent fundamental geological

phenomenon corresponds to the opening of Large upper Jurassic lower Cretaceous ditches at about 150-120 Ma on Pan-African. These ditches can reach depths of several
thousand meters [22].

The bedrock consists essentially of the tertiary alluvial deposits of the Continental Terminal dominated by ridges and clays [9]. In the southern part of Chad, including the department of Kouh - Est, the waters cut through ancient sedimentary formations and the landscape is in the form of very extensive plateaus alternating wide, deep valleys. Throughout the Logone Oriental there is an ancient series of clays with limestone nodules [19].
It occurs in highly eroded outcrops that mark areas of passage in old or current waters. It often disappears under the thin sandy interlayer or is covered by the present silt sedimentary series. In the exempted areas the sandy series takes on all its importance, coarse at the base, it ends with fine sandy formations that can reach a thickness of 3 to 4 meters. The flood zone is the domain of the sandy or sandy- clay series on clays. Recent silty alluvial deposits of very small extent and generally small thickness are limited to the shoreline portions of the Logone. There is also a rigging series, which, with the exception of lateritic or ferruginous cuirasses of various dates, constitutes the only resistant base of the post-Cretaceous formations. It is found throughout the koro region, either in cross sections in wells or outcrops [22].

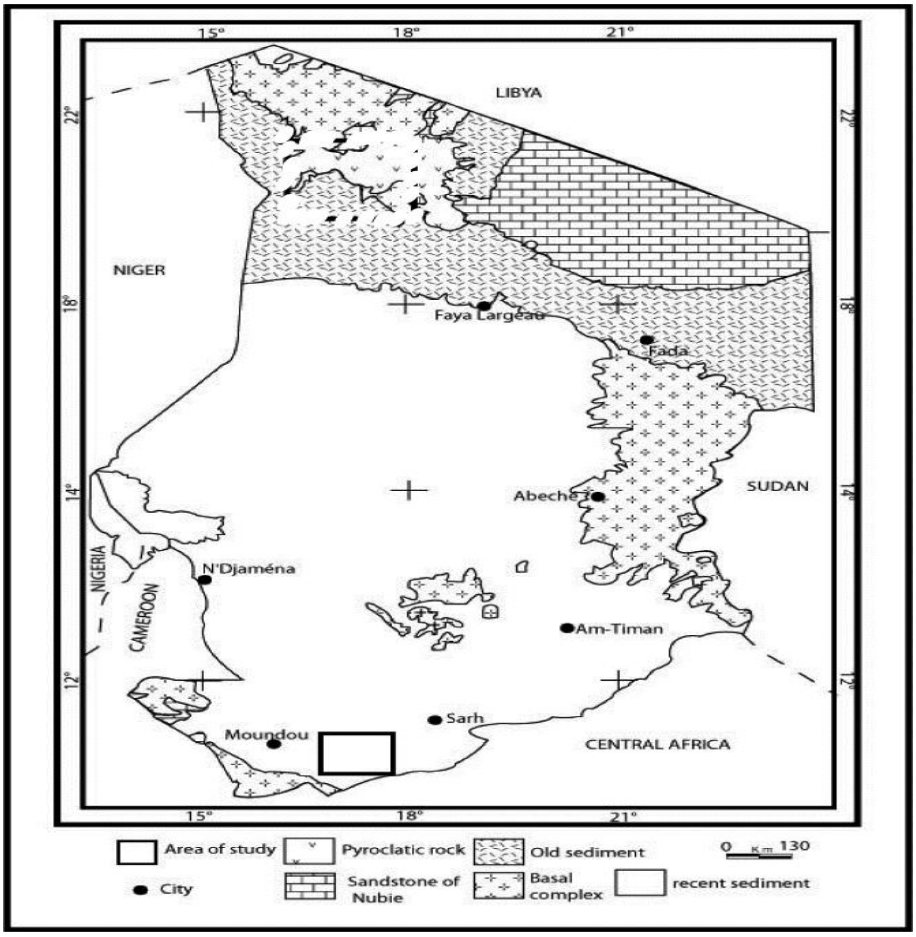


Figure 3. Geological map of Chad showing the study area

The Logone Oriental has six (6) departments including Pendé, Nya, Nya Pendé, Mount Lam, East Kouh and West Kouh. This study is devoted to the department of Kouh-Est. The department of Kouh-Est is located in the south of Chad and covers an area of 1017.3 km^2. It is located between 8°08'and 8°20'N latitude and between 16°80'and 17°20'E longitude (Figure 1).

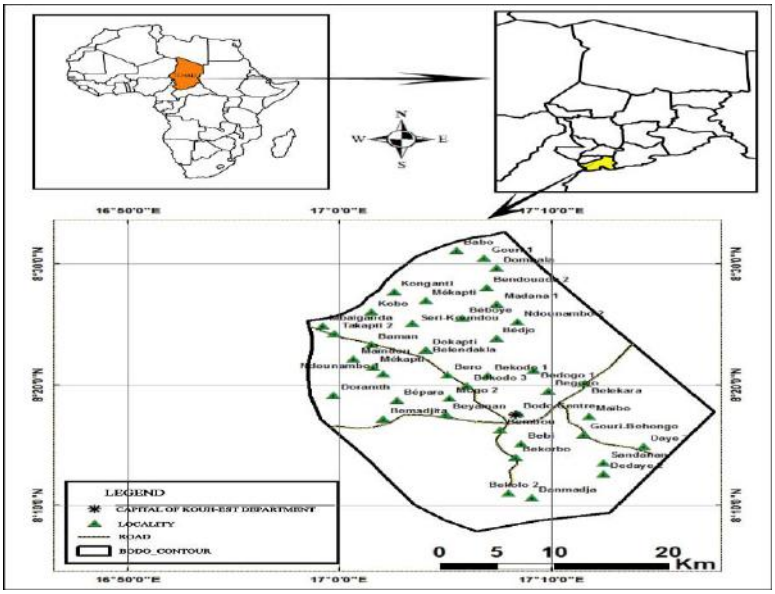


Figure 3. Map of the Kouh - Est situation

4. MATERIALS AND METHODS

4.1. Materials

The required data are:

- Bibliographic data
- Landsat 7 satellite images, downloaded
- Existing soil maps
- Image processing software (ENVI 4.5, QGIS 4.3, ArGis 10.3.1)

4.2. Methods

Remote sensing techniques in conjunction with GIS have made it possible to make maps of soil surface conditions in the department of Kouh-Est. The basic data available in the form of very varied GIS layers were used, including the geological map of Africa, the geological map of Chad, the soil map, the Digital Terrain Model (DTM) and the Landsat 7 image of 2021. The ArcGis 10.3.1software enabled the production of the various thematic maps. The method used in this study is illustrated in Figure 2 below

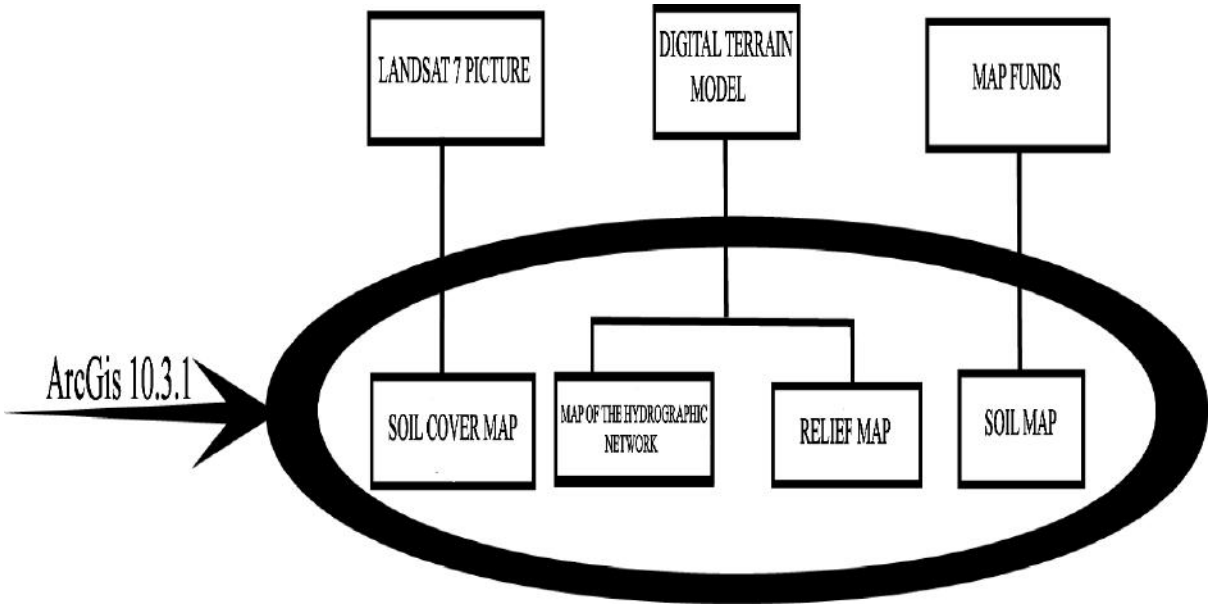


Figure 4. Illustration of the method used to map the surface states of the study area.

5. RESULTS AND DISCUSSION

5.1 Kouh Est Relief

The department of Kouh-Est presents a relief in the form of two contiguous and convex orange half-lives, oriented NE-SSW. The SE- NW ends and the median part of the relief constitute a depression. The terrain rises from 370 m in altitude in the southern and northern borders to 546 m.

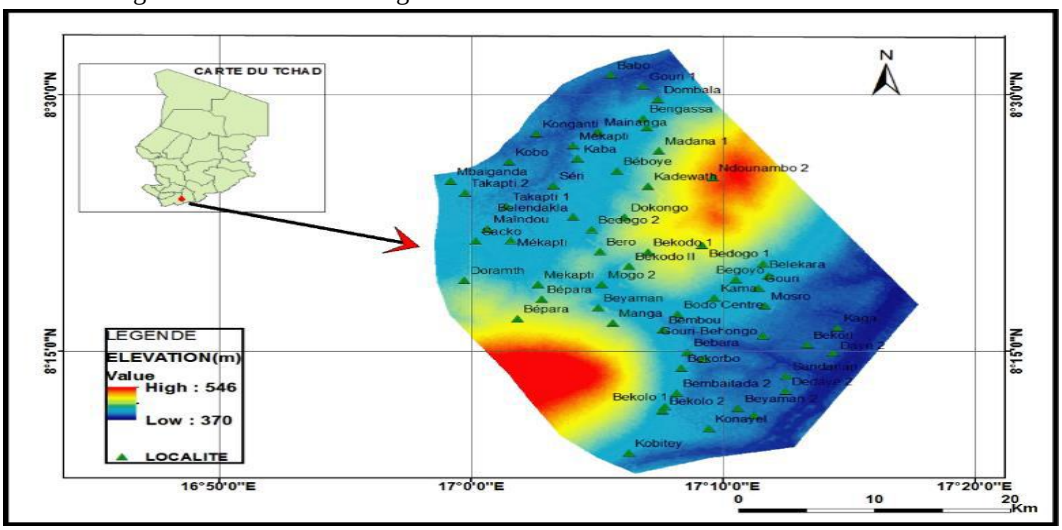


Figure 5. The relief map of Kouh Est from the NCD treatment

5.2 Kouh Est Hydrographic Network

The Eastern Logone is fed by two main rivers including the Logone and the Pendé [20].

The Logone is 1,000 km long and originates at 1,200 m altitude in the Adamaoua plateau (Cameroon), it bears the name of Vina in Cameroon, receives the M'Béré grossie of the Ngou and the Lim.

La Pendé is made from the crystalline massif of the Central African Republic. Like the Logone, it is coarse from Bakassi and receives no tributaries to the right bank.

The Pendé has three tributaries on the left bank, including La Nyan (a permanent river in the vernacular) of Béreoumana, the Nyan of Donia and the Loule de Béro.

There are also Kouh (Kouh river in vernacular) in Logone Oriental, which drain the region and some relic pools of therivers. Overall, the Logone Basin hydrography is closely dependent on rainwater collected during short rainy seasons.

The department of Kouh-Est requires only a few seasonal rivers, including the Daye, the Kouh and the Mbo. These temporary streams depend on the topography of the environment and are generally drained in the southeast and northwest directions and in the center in the study area, which are considered to be the lowest parts of the community (Figure 3).

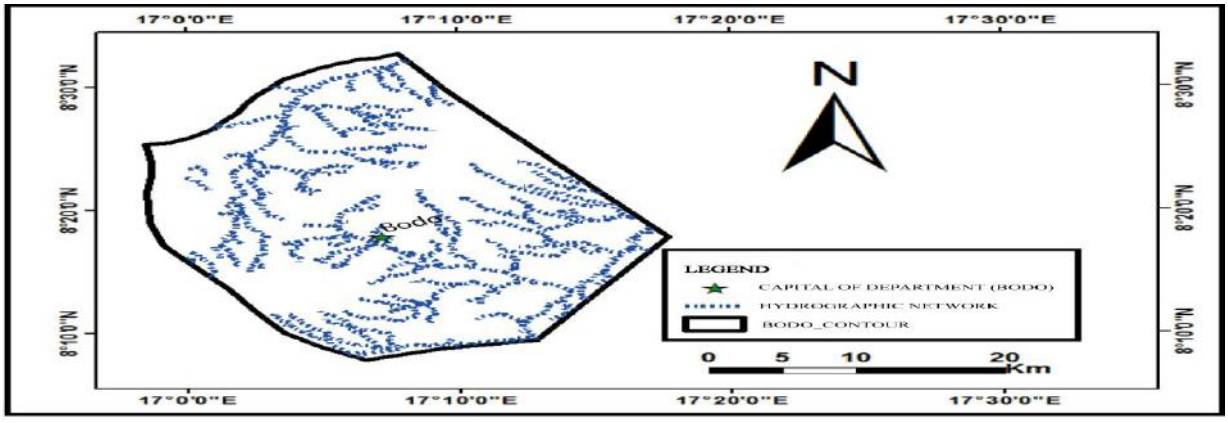


Figure 6. Map of the river system of the department of Kouh-Est from the MNT treatement

5.3. Kouh Est soils

The landscape of the Sudano-Guinean zone is made up of vast trays of densely forested red land into which the rivers sink by deeply encased valleys [21].

Soils in the southern part of Chad developed on tertiary alluvium of the Continental Terminal dominated by often exempt rigger and clays [9]. Thus, depending on the topography, there are three (3) types of soil in the department of Kouh-Est: Low red ferrallitic soils: They are of two types namely red modal ferrallitic soils and red ochre modal ferrallitic soils. These soils occupy the high part of the study area, outcrops of cuirasse or of indurated red material is observed in the high position and more locally on flats in the center of the plates. The population generally stands on the edge of these and cultivates cotton and various food crops (sorghum, small millet, peanuts, cassava, maize). This concentration of the population on these soils most often results in short fallow periods and initiates soil degradation and loss of fertility.

Leached ferruginous soils: Two types of ferruginous soils are found in the study are: tropical ferruginous soils, which occupy a larger part of the soil, and truncated ferruginous soils. These different ferruginous soils are covered by vegetation that often becomes brighter. Portions of these are sometimes occupied by large swamps favored by downstream thresholds.

On these soils, the water table is deep and uncultivable [9]. Raw mineral soils: These are materials that have been brought upstream or either remobilize and deposit. This class consists of three (3) soils:

1 - rough, armored erosion soils;

2 - raw mineral filler soils;

3 – alluvial soils with hydromorphic characteristics. These soils occupy the shallow and narrow areas between ferrallitic soils and ferruginous Soils. Given the very low topography and often floodable during the rainy season. Cultivable areas are scarce in comparison with the total area. Rice is mainly grown on these soils. Figure 7 below illustrates the different soils described.

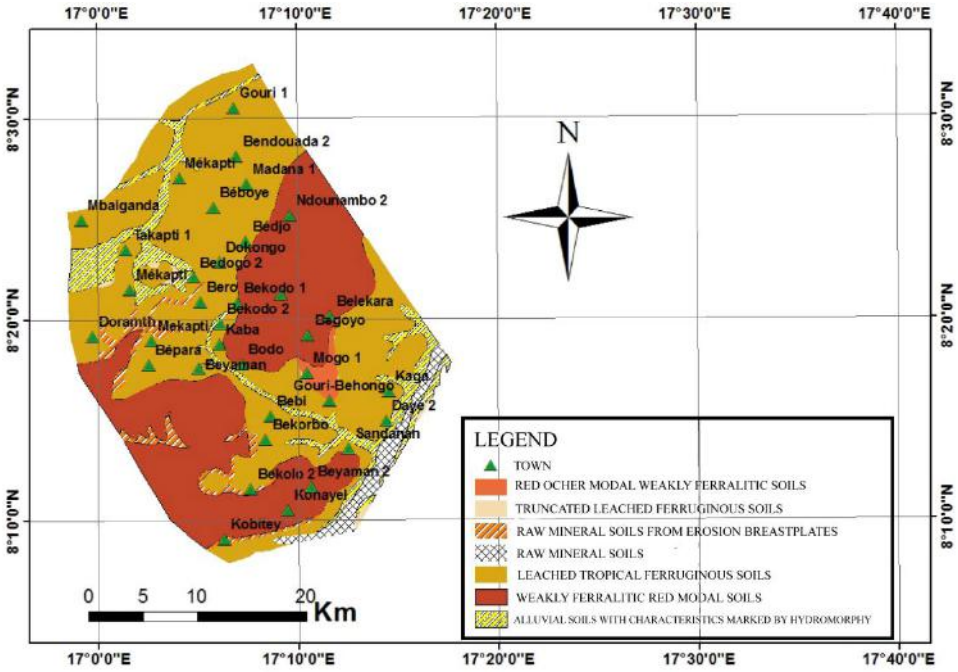


Figure 7. Kouh Est soil map

5.4. Kouh-East Land Occupancy

A land use map represents the physical (bio) cover observed on the surface of the area study, it is confined to describing vegetation and buildings human. It reports on land use and forecasts. These forecasts are variable because they depend on the nature of soils, populations, economic infrastructure and market conditions [21]. The supervised classification technique made it possible to produce the thematic map (Figure) of land use. Analysis of this map shows the following

characteristics: the predominance of bare soils of 517,99 km^2 over a total of 1017,3 km^2 (area of the department of Kouh-Est), i.e. 50.92%; or 13.57%, the forest covers 32.31 km^2, or 3.17%, and finally the water is represented by the strings of pounds which extends over 1.29 km2, or 0.28%. The different elements of land use are classified according to the elevation of the land. Cultivable land occupies the raised part of the study area, in particular the NNE-SSW oriented part. The concentration of peasants in this part of the soil as a cultivable plot is explained by the fact that it is an exempt part during the rainy season. Bare soils, vegetation, forest and water occupy the NW-SE part which is considered to be floodplains (Figure 2).

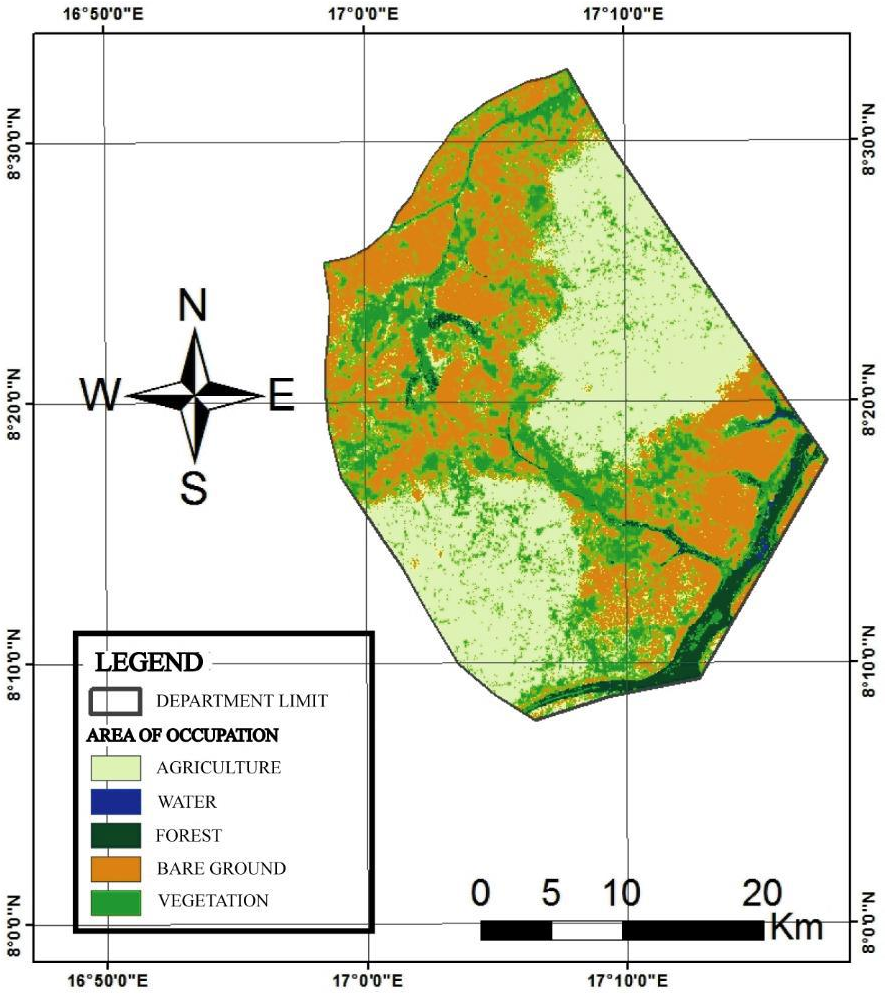


Figure 8. Landscape map of Kouh-Est, Department from Landsat image processing

6. CONCLUSION

At the end of the study, the main objective of which was to map the surface states of the soils of Kouh-Est, it appears from the various thematic maps produced by remote sensing and GIS tools that areas with agricultural potentials are the highlands and represent 32.21% of the surfaces of the study area.

Three types of soils are present in the study area, including ferrallitic soils, ferruginous soils, and alluvial soils. The soils of Kouh-Est is mainly ferrallitic soils. These soils are on relatively flat terrain that drains rainwater from the southeast and northwest borders and the center, considered the lowest parts.

7. ACKNOWLEGEDMENTS

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