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RESEARCH ARTICLE

CHARACTERIZATION OF THE TEXTURE AND USABLE WATER RESERVES OF SOILS AROUND THE LOWLANDS IN THE MUNICIPALITY OF REO (BURKINA FASO)

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Abstract

Soil is generally composed of clay, silt, and sand. Soil texture is therefore the relative proportion of these different grain sizes in a horizon. It is an indicator of the physical and chemical fertility of the soil. The objective of this study is to determine the texture classes and useful water reserves of soils for agriculture around the lowlands in the municipality of Reo. The methodology is based on documentary research, soil sampling followed by laboratory analysis, and data processing. Soil samples are analyzed in the laboratory using the hydrometric method for three-fraction grain size analysis and the pressure chamber method for available water reserve analysis. The results show that the silty-sandy texture is the most representative and covers 37% of the total area of the study zone. It is followed by clayey texture (36%) and silty-clayey texture (20%). This textural composition influences the soil's usable water reserve. Thus, silty-sandy soils (leached tropical ferruginous soils) on glacis have low usable water reserves (between 3 and 9%). On the other hand, clay soils (tropical eutrophic brown soils), located in the depression and lowlands, are well drained, with high useful reserves (between 13.10 and 23.60%). Ultimately, the soils around the Goundi-Djoro lowlands have textural and water properties that are not very favorable for agriculture. Farmers should make sufficient use of organic matter, as it improves soil texture, increases its water retention capacity, and mitigates the effects of water erosion.

Introduction:-

Agriculture in sub-Saharan African countries is dependent on rainfall and soil fertility. However, climate variability and declining soil fertility are leading to reduced agricultural yields (A. M. Tondro-Mamam & al., 2019, p. 776).Faced with these soil and climate constraints, many Burkina be farmers are moving to the lowlands, which are more fertile than the highlands (T. P. Zoungrana. 2010, p. 598).

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However, the influx of farmers to the lowlands could lead to the overexploitation of their resources, particularly the soil. Continued exploitation of soils can alter their textural characteristics and accentuate their physical and chemical degradation (B. Koulibaly & al., 2014, p. 2882). Meanwhile, the agricultural productivity of soils also depends on their granulometric composition. In terms of texture, soil is composed of clay, silt, and sand. Soil texture is therefore the relative proportion of different grain sizes (sand, silt, clay) in a given horizon (Jean-Yves M., 2013, p. 2). It is an indicator of a soil's physical, chemical, and biological fertility. Clay strengthens soil aggregates and makes it more resistant to water erosion (Da D. E. C & al., 2008, p. 310). It also improves soil aeration and its ability to retain water and nutrients for plants. Silt is also beneficial for crops. However, a large amount of silt in the surface layers of cultivated soil can promote the formation of a crust, thereby reducing its ability to infiltrate and store water (AGRHYMET., 2001, p. 18, Väderstad., 2022).

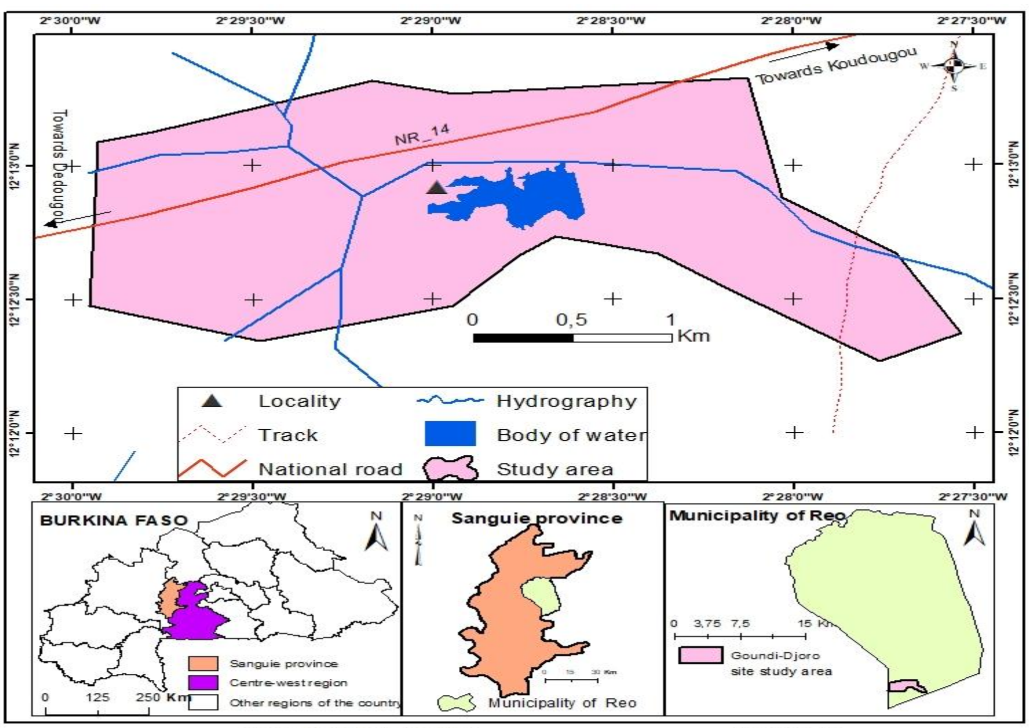
Under these conditions, a better understanding of soil texture in low-lying areas is necessary. This allows for an assessment of their capacity to store water and nutrients essential for crop growth (FAO, 2022). It also allows farmers to make informed choices about which crops to grow. Some crops are better suited to clay soils, while others thrive in clay and/or loamy soils. The objective of this study is to determine the texture classes and useful water reserves of soils for agriculture around the lowlands in the municipality of Reo, Burkina Faso.

Materials and Methods:-

Presentation of the study area:

The municipality of Reois the geographical setting for the study. Located in the central-western part of Burkina Faso, this municipality is situated between 12°11' and 12°28' north latitude and between 2°24' and 2°37' west longitude (Reo Town Hall, 2019). It consists of nine city districts and 12 administrative villages, including Goundi-Djoro.

The actual geographical area covered by this studyis the agricultural zone around the lowlands of the village of Goundi-Djoro. Located south of the municipality of Reo, this area covers a total of 526.52 hectares. It islocated between 12°12' and 12°13' North Latitude and between 2°3' and 2°27' West Longitude (Figure 1, below). The lowlands cover approximately 75.04 hectares of the area. They are crossed by a well-defined watercourse and include a floodplain and a flooded area. The terrain around the lowlands consists mainly of hills, rocky and armored buttes, and functional and armored glacis.

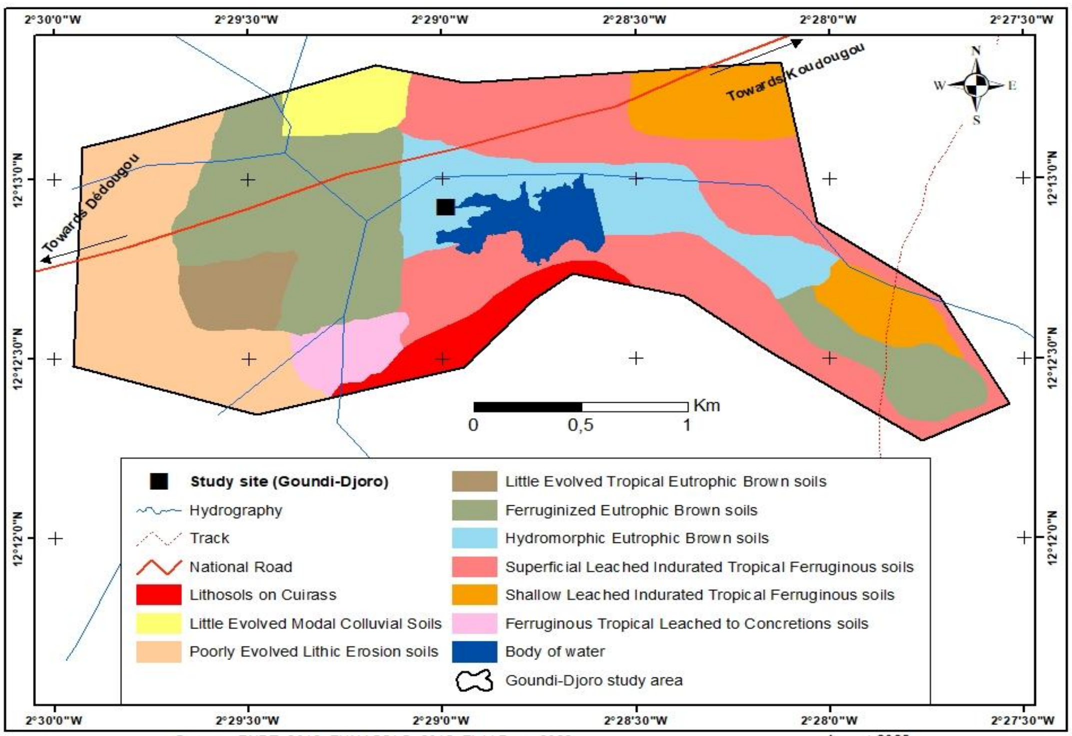


Source: BNDT_2012, Field data August/2025

Fig. 1. Geographical location of the study area Goundi-Djoro)

Geologically and pedologically, the Goundi-Djoro study area is located on a granitoid bedrock and has nine soil types (Figure 2, below). The dominant soils are superficial hardened tropical ferruginous soils (26.72%), tropical ferruginous eutrophic brown soils (20.97%), poorly developed lithic erosion soils (16.71%), hydromorphic tropical eutrophic brown soils (10.8%), and shallow leached tropical ferruginous soils (8.35%).

These different types of soil are used for rain-fed and irrigated agriculture in a tropical, Sudano-Sahelian climate. During the rainy season, local populations produce cereals (sorghum, millet, rice), legumes (peanuts, beans, cowpeas), and tubers (cassava, potatoes). During the dry season, vegetable crops (onions, tomatoes, cabbage, carrots, cucumbers) are mainly grown in low-lying areas and along the edges



Sources: BNDT_2012, BUNASOLS_2015, Field Data_2022 August 2025

Fig. 2: Types of soil around the Goundi-Djoro shoal

Data and tools:
The primary data concerns the results of laboratory analyses of soil samples. These include the different proportions of grain size fractions (clay, silt, sand) and the available water reserve. The equipment used for this purpose consists of a GPS, an auger, a pickaxe, plastic bags, marker pens, jute bags, and reagents.
The secondary data used includes documentary data, the 2012 national topographical database (BNDT) from the Burkina Geographic Institute (IGB), and the 2003 national soil database from the Burkina National Soil Office (BUNASOLS). These vector data were used to produce the various maps used in this study.

Methods:

Soil sampling:
The systematic grid technique is used for soil sampling. It consists of first creating a square grid of the study area. A single soil sample is then taken from the center of each 500 m square. The distance between sampling points is 500 m. Finally, the geographical coordinates of the points are marked on the survey map (Figure 3, below). The total area sampled is 526.52 ha for 31 sampling points, which corresponds to one observation per 16.98 ha. The scale of this study is therefore 1:20,000, in accordance with BUNASOLS standards. These standards stipulate that for a semi-detailed study at a scale of 1:20,000, one observation is required for every 4 to 8 ha for complex terrain and one observation for every 8 to 16 ha for less complex terrain (BUNASOLS, 1989).

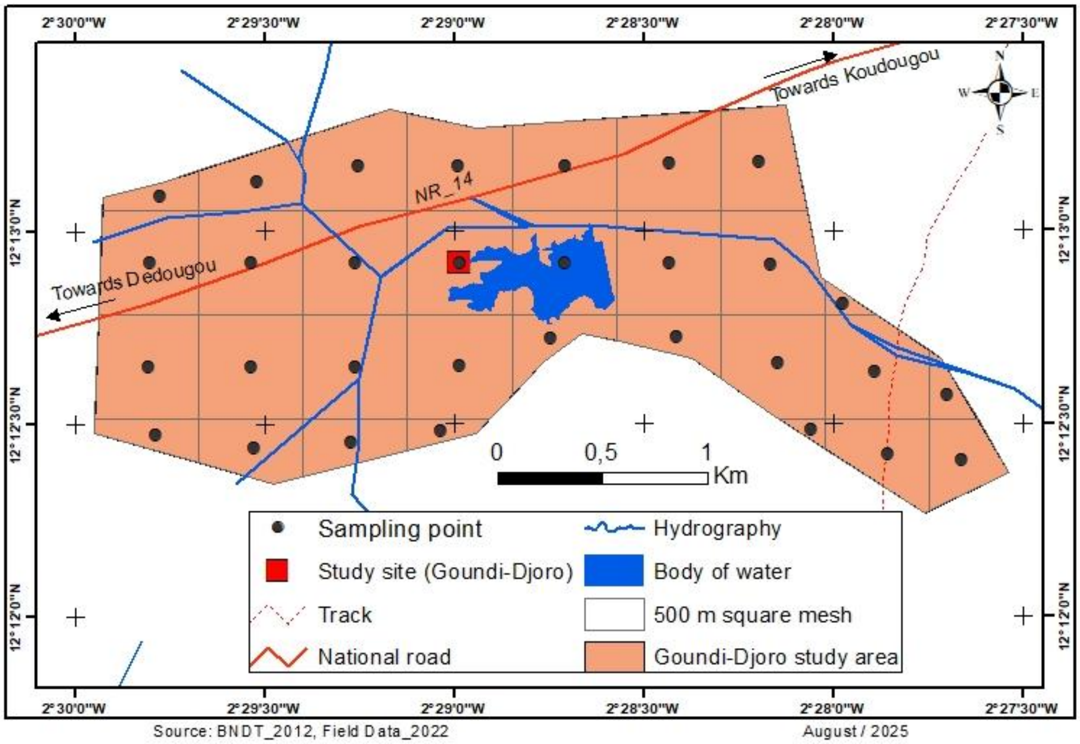


Fig. 3. Soil sampling plan for the Goundi-Djoro site

Analysis of soil samples in the laboratory:
Determination of grain size fractions"
The soil texture was assessed in the field by rubbing moistened soil samples between the fingers. This process allows the clay, sand, and silt content to be evaluated. To confirm these raw results, a three-fraction particle size analysis was performed in the soil analysis laboratory using the hydrometric method. This involves separating the different particle size fractions according to particle size and then calculating their proportions (Table 1 below).

Table. 1.Grid for determining particle size fractions

Particle size fractions	**Dimensions in microns (μ)**
Clay	<2 μ or 0,002 mm
Silt	2-50 μ or 0,05 mm
Sand	50-2000 μ or 2 mm

Source: BUNASOLS.,2022

The determination of grain size fractions made it possible to categorize texture classes (e.g., clay texture, clay-loam texture, loam texture). These are determined using the percentages of the different fractions and a texture triangle.

Determining the useful water reserve of soils:-
The effective water reserve or the water constants pF 2.5 and pF 4.2 are determined using the pressure chamber method. First, the soil samples were saturated with water before being subjected to a pressure of 0.3 bar for pF 2.5 and 15 bar for pF 4.2. Second, the water reserve was calculated using the following formula:

$\boxed{\textbf{RU} \text{ (mm)} = \textbf{pF } 2{,}5 - \textbf{pF } 4{,}2 \times \textbf{da} \times \textbf{E}}$, with :

RU, useful water reserve (in millimeters)
da, estimated bulk density of 1.7 for soils in Burkina Faso,
E, soil thick ness (in decimeters).

The levels of water saturation are determined using an assessment grid. Very low and low levels indicate that the soil is only slightly saturated with water. On the other hand, high and very high levels indicate a high level of water saturation in the soil (Table 2, below).

Table. 2.Interpretation grid for soil water reserve values

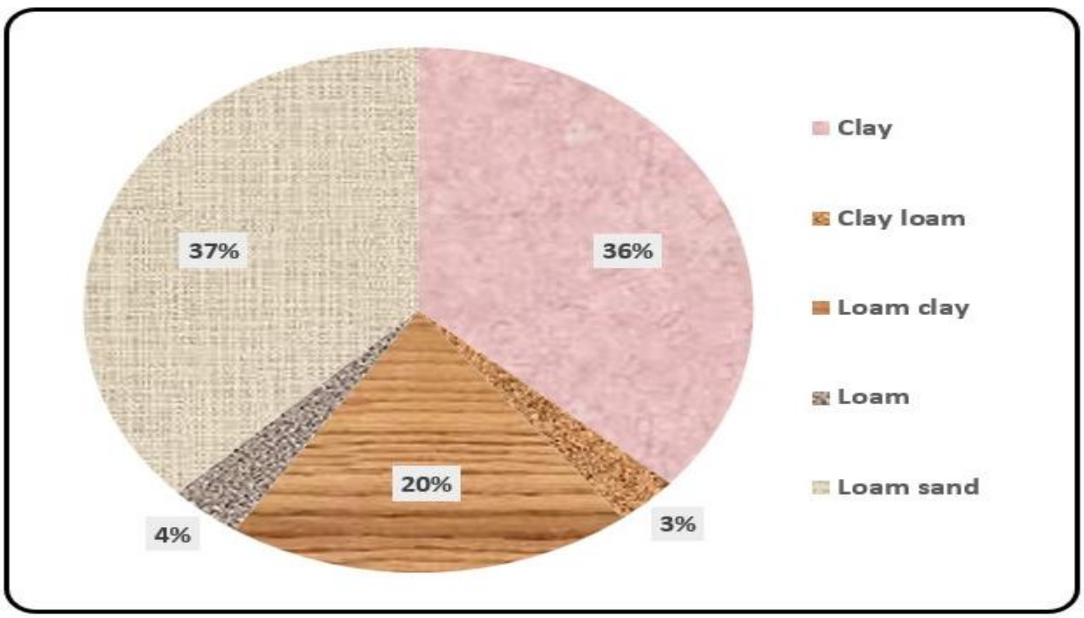
Levels	**Very low**	**Low**	**Medium**	**High**	**Very High**
Useful Reserve(%)	<3	[3-5[	[5-10[	[10-15[	> 15

Source: BUNASOLS, 2022.

Technique for spatializing textural classes:
The spatial distribution of texture classes is done using ordinary kriging on ArcGIS. There are several spatial interpolation techniques that generally give varied and different results. However, for soil data, the most reliable and commonly used technique is ordinary kriging (N. Rebai et al. 2007, p. 21; P. Bosser, 2012, p. 48). For this study, a single soil sample was taken from the center of each 500 m square, i.e., a radius of 250 m. The value of a soil sample is therefore valid for an area of 25 ha. The technique consists of assigning estimated values to unsampled sites based on those with known values within the same study area.

Results:-

Textural classes at the Goundi-Djoro site:
The results show that coarsesilty-sandy texture is the most representative around the Goundi-Djoroshoal. It accounts for 37% of the total number of sampling points. It is followed by very fine clay texture (36%) and silty-clay texture (20%), classified as fine. Silt and clay-silt textures account for 4% and 3% of the sampled sites, respectively (Figure 4, below).



Source : Field data, June 2022, August 2025
Fig. 4. Proportion of textural classes at the Goundi-Djoro site.

In silty-sandy texture, sandis the dominant grain size fraction, with a percentage rangingfrom 58.82 to 64.71%. The silt percentage ranges from 19.6 to 23.53%. This texture is found in lithosols on crust and leached tropical ferruginous soils.

Regarding the clay-loam texture, the silt content varies between 38.37 and 41.17%, while the clay content isaround 43.14%. This texture is found in tropical ferruginous and hydromor phiceutrophic brown soils.
As for clay texture, it concerns soils with little lithic erosion and tropical eutrophic brown soils with little evolution. The clay content ranges from 41.18 to 54.9%.

Table 3. Particle size fractions according to soil types

Types of soil	Particle size fractions			Texture
	Clay (%)	Silt (%)	Sand (%)	
Little Evolved Tropical Eutrophic Brown soils	41,18	33,33	25,49	Clay
Poorly Evolved Lithic Erosion soils	54,9	37,26	7,84	Clay
HydromorphicEutrophic Brown soils	43,14	41,17	15,69	Clayloam
Ferruginized Eutrophic Brown soils	43,14	38,37	18,49	Clayloam
Little Evolved Modal Colluvial Soils	17,65	23,53	58,82	Loamsand
Ferruginous Tropical Leached to Concretions soils	15,69	19,6	64,71	Loamsand
Shallow Leached Indurated Tropical Ferruginous soils	14,69	20,6	64,71	Loamsand
Superficial Leached Indurated Tropical Ferruginous soils	13,73	21,56	64,71	Loamsand
Lithosols on Cuirass	17,65	19,6	62,75	Loamsand

Source : Field data, june 2022

Spatial distribution of texture classes:

The spatial distribution of texture classes shows that sandy loam and clay textures are the most representative. They occupy 37% and 36% of the total area of the Goundi-Djoro study area, respectively. Silt-clay texture covers barely 20% of the mapped area. The rest of the area is occupied by silt and clay-silt textures, with very low proportions.

The silty-sandy texture is found in lithosols on armored soils on armored hills. It is also identified in leached tropical ferruginous soils located on high slope glacis, north and south of the site.

The silty-clay texture covers the southwest, northwest, and east of the area, on the medium-slope glacis. In contrast, the clay texture occupies the west, west-central, and central parts of the Goundi-Djoro site. It is identified in poorly developed lithic erosion soils and eutrophic browns oils. These are located on the lowslopes and in the low lands. As for the silty texture, it is found in the center and east of the low lands (Figure 5 below).

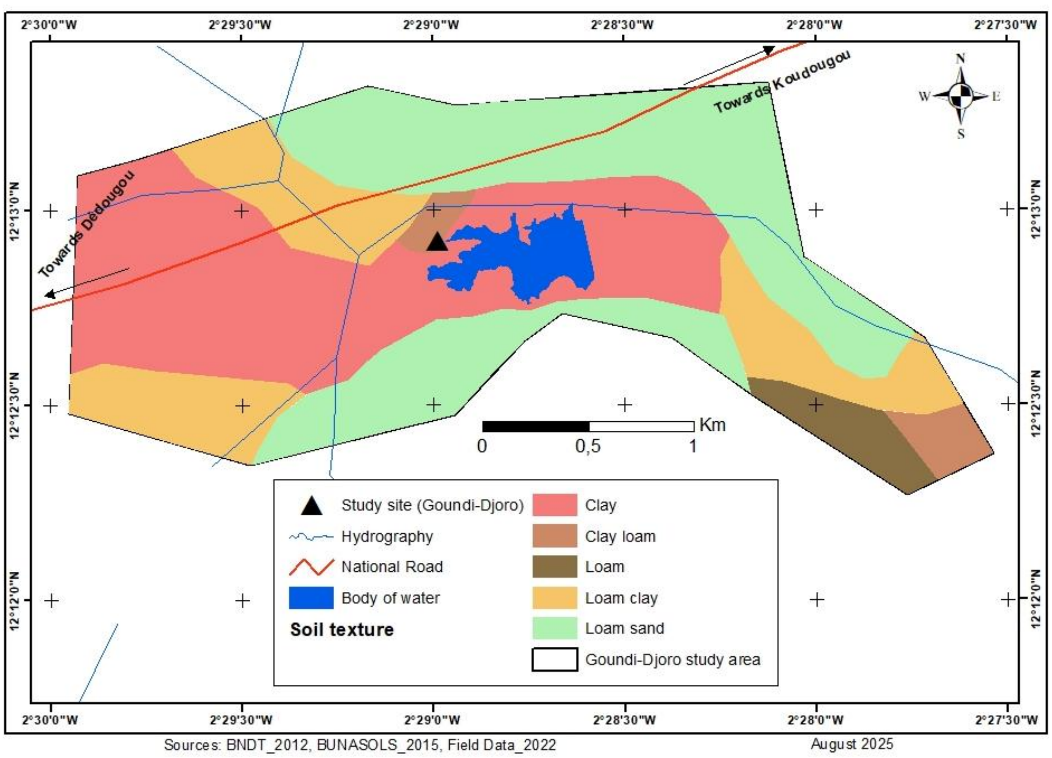


Fig . 5. Spatial distribution of soil texture around the Goundi-Djoro shoal.

The spatial distribution of soil texture depends on the geological substrate, geomorphological units, soil type, agricultural practices, and erosion dynamics.

The presence of sand in soil can be linked to pedogenicprocesses (particularly disintegration and alteration) under the influence of factorssuch as rock type. The geological composition of the Goundi-Djorostudy area consists of biotite granite, porphyroid granite, quartzite, and someschist.These rocks are covered with ferruginous materials. Chemical degradation (weathering) of granite and quartz can produces and, while the transformation of schists can lead to the formation of silt.

The sandy texture of soil can also beex plained by water erosion and farming practices (plowing). Two phenomena can then occur:either the removal of fine particles (clay and silt), or the addition of sand through rain water run off. Bothprocesses lead to an increase in the sand content of the surface layers of the soil. These processes are generally observed in depressions and low-lying areas.

The importance of clay in the brown surface horizons of the Goundi-Djorolow lands can beexplained by the deposition of alluvium from the upper slopes towards the accumulation zones. This alluvium will evolve through the process of sedimentation to form detritalse dimentary rocks such as clay and sand.

Relationship between soil texture and available water reserves:
The analysis in Table 4 below shows that texture influences the useful water reserve of soils. Clay and clay-loam soils have very good water retention capacities thanks to the clay. Thus, tropical eutrophic brown soils and poorly developed lithic erosion soils, which are clayey, have high and very high water reserves, ranging from 13.10 to 22.60%.

On the other hand, silty-sandy or sandy-silty soils have low rain water stora gecapacity. This is the case for lithosols on armor, poorlydevelopedsoils of modal colluvial origin, and leached tropical ferruginoussoils. They have average useful reserves (between 5.82% and 9.64%) and some time slow or very low reserves (< 3%) (Table 4, below).This is due to the presence of sand, whichdoes not have good water retention properties, despiteits good infiltration qualities. As for silt, it has a high water stora gecapacity. However, under the effect of rain, crusts can form on the surface of siltysoils, thus limiting their ability to in filtratera in water (AGRHYMET, 2001, p. 17).

Table 4.Useful water reserves (RU) according to soil type

Soil types	Texture	RU		Interpretation
		(mm)	(%)	
Little Evolved Tropical Eutrophic Brown soils	Clay	92,922	18,22	**Very High**
Poorly Evolved Lithic Erosion soils	Clay	80,631	15,81	**Very High**
Hydromorphic Eutrophic Brown soils	Clayloam	115,26	22,60	**Very High**
Ferruginized Eutrophic Brown soils	Clayloam	66,81	13,10	**High**
Little Evolved Modal Colluvial Soils	Loam sand	47,838	9,38	**Medium**
Ferruginous Tropical Leached to Concretions soils	Loam sand	49,164	9,64	**Medium**
Shallow Leached Indurated Tropical Ferruginous soils	Loam sand	29,682	5,82	**Medium**
Superficial Leached Indurated Tropical Ferruginous soils	Loam sand	-	<3	**Very low**
Lithosols on Cuirass	Loam sand	-	<3	**Very low**

Source : Field data, june 2022

Discussion:-

Soil particle size fractions and texture classes:

The spatial distribution of soil texture classes in Goundi-Djoro shows that coarse, silty-sandy texture is the most common, accounting for 37% of the site's total area.This result is similar to that of J. Konkobo & al., (2022, p. 13), who found that limono-sandy texture accounts for 30.89% of the municipal area of Kouka, Burkina Faso. It is also consistent with that of D. Hassimiou Halidou& al., (2020, p. 1473).These researchers found that sandy loam texture accounts for 72.32% of the soils at the Sakey koira Tegui site in Niger. The work of A. Assih & al., (2022, p. 1452) also noted the predominance of sandy loam texture in the soils of the savannah region of Togo.

In the Goundi-Djoro study area, the silty-sandy texture is mainly found in lithosols on crusts and leached tropical ferruginous soils located on high slopes. These results corroborate those of K. Coulibaly & al. (2020, p. 75), who mentioned the silty-sandy nature of ferruginous soils. However, this result contradicts that of D. E. C. Da & al. (2008, p. 310), who reported that in north-central Burkina Faso, lithosols on crusts located on summits and slopes contain sufficient clay, particularly on the surface.

The sandy texture or sand content of a given horizon maybe due to erosion and leaching caused by agricultural practices (types of plowing, clearing, deforestation). Research by B. Koulibaly & al. (2014, p. 2882) found that, compared to fallow soils, motorized cultivation or tractorplowing resulted in a remarkable reduction in the clay content and increased the sand content by 12% in the surface layer (0 to 20 cm) of ferruginous soils.The same observation is made by D. J. B. Ettien et al., (2022, p. 87), who report that, unlike fallow soils, cultivated soils have experienced a 67% decrease in clay content and a 53% improvement in sand content on the surface (0-20 cm).

The results of this studyalso show the predominance of clayey texture, which covers 36% of the total area. It is found in poorly developed lithic erosion soils and tropical eutrophic brown soils. Clay content ranges from 41.18% to 54.9%. These results corroborate those of Y. G. Kimba (2014, p. 55), who found that the soils of the Houeli-Gaba lowlands in Benin have very high clay contents, ranging from 57.75 to 70%. They are also similar to those of E. F. Akassimadou & A. Yao-Kouame (2014, p. 6978), who mention the importance of clay in the soils of the lowlands in central Ivory Coast. Similarly, S. Tahirou & al. (2022, p. 846) also noted the high clay content of the soils. However, research by G. J. Gbeto Dansou (2017, p. 10736) shows that the lowland soils of Awokpa in Benin are silty-sandy.

Impact of texture on the useful water reserve of soils and their productivity:

The results of this study show that the usable water reserve depends on the nature of the soil and geomorphological units. Thus, sandy soils (leached ferruginous soils), generally located on glacis, have average and/or low usable reserves (between 5.82 and 9.64%) and some times very lower serves (< 3%). On the other hand, loamy and clayey soils (eutrophichy dromorphic brown soils), located in depressions and low lands, are well drained, with high and some times very high usable reserves (between 13.10 and 22.60%).

These results corroborate those of Väderstad (2022), who estimates that soils with approximately 40% clay content have high water stor age capacity that isuse ful for plants. These results are also similar to those of AGRHYMET (2001, pp. 17-18) and A. Epolyste & al. (2014, p. 2123). These authors mention that the useful water reservei slow in sandy soils, while it is high in clayey and loamy soils.

Soil texture influences it sphysical and chemical quality and its production capacity. Clay improves soil structure and protect tsit from water erosion (D. E. C. Da & al., 2008, p. 310). It is recognized that a good amount of clay or silt in the soilis an agricultural asset.

Conclusion:-

The spatial distribution of soil texture classes and usable water reservesis linked to geological substrates, soil and geomorphological units, farming practices (types of plowing, land clearing), and water erosion.

This study notes that silty sand texture is the most representative and covers 37% of the total agricultural area of Goundi-Djoro. It is followed by clay texture (36%) and silty clay texture (20%). Sand and clay are the dominant granulometric fractions in the soils. This textural composition influences the useful water reserve of the soils. Sandy soils (leached ferruginous soils) on glacis have low usable reserves (between 3 and 9%), while clayey and silty soils (eutrophichy dromorphic brown soils), located in depressions and lowlands, are well drained, with high and sometimes very high useful reserves (between 13.10 and 23.60%).

The different grain sizes (sand, silt, and clay) influence the physical, chemical, and biological quality of soils. Clay improves soil structure and protects it from water erosion. It also has the ability to absorb water and nutrients that are essential for crops. Unlike sand, clay and silt are therefore favorable for agriculture.

Ultimately, the soils around the Goundi-Djoro lowlands are not very suitable for agriculture due to the predominance of silty-sandy texture and sand particles in the surface horizons. Farmers should focus on organic soil fertilization. Organic matter improves soil structure and texture, increases it scapacity to in filtrate rain water, and thus mitigates the effects of water erosion.

Thanks
Our thanks go to the people of Goundi-Djoro for the fruitful exchanges and for makingtheir land available to us for soil sampling. We would also like to thank the staff of the Bureau National des Sols du Burkina Faso for analyzing the soil samples in their laboratory.

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