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(RESEARCH ARTICLE)

Technical and granulometric study of a sand sample from the Kissidougou commune and the Faranah urban commune

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Abstract

This research is part of a technical granulometric study of a sand sample from the municipality of Kissidougou and the urban municipality of Faranah. The results of the survey show that the sand sampled in Kissidougou is estimated at 71.5% and that of Faranah at 71.36%. However, 1.39% clay was found in Kissidougou compared to 0.38% in Faranah, which proves that the soil is more clayey in Kissidougou than in Faranah. Therefore, this study also allowed us to describe and perform a granulometric analysis in order to determine the weight proportions of grains of different sizes in the sand from these two cities. Furthermore, it helped us to characterize the sand, evaluate its quality for specific fine applications, such as in construction and as fill for uneven terrain, and deduce information about its geological origin and environment.

Keywords: Sand; Particle Size; Technique; Kissidougou; Faranah

1. Introduction

Around the world, the history of particle size analysis dates back to the early 19th century, with the work of German and Swedish scientists such as Wanschaffe and Atterberg, who sought to classify particle size fractions. [2]

In Guinea, the particle size analysis of sand using a sieve follows the international standard principle. This principle consists of using a series of sieves with decreasing mesh sizes to separate the grains by size (dry or wet). Each fraction is weighed to determine the percentage retained, and then a particle size distribution curve is plotted to classify the sand and calculate indices such as Cu and Cc.

Local laboratories use equipment such as sieving machines (Roto-Lab) and ovens for these analyses, which are essential for civil engineering and geotechnics, with standards adapted to local contexts (e.g., grain size distribution of Guinean coastal sand). [2]. However, in the Guinean context, studies exist on local sands (e.g., estuarine sands), often classified according to their origin and sand content (70-80%), using these techniques to characterize the available materials. Laboratories (such as those cited in theses) use standard equipment (oven, FRITSCH sieving machine, Roto-Lab) for analyses adapted to local needs. To contribute to potential solutions for the construction of our buildings, especially our road infrastructure in major Guinean cities, we deemed it necessary to conduct research on the topic of "a technical

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granulometric study of a sand sample from the municipality of Kissidougou and the urban municipality of Faranah." To carry out this study, we structured it as follows: methods and materials, results and discussion, followed by a conclusion.

2. Materials and methods

2.1. Materials

2.1.1. Study areas

Geographical situation of the kissidougou prefecture

Kissidougou is a prefecture of Guinea located approximately 600 kilometers from the capital, Conakry, in the Faranah administrative region. It lies between 9° 11′ North latitude and 10° 06′ West longitude and covers an area of 8,872 km² with an average altitude of 525 meters. According to the Köppen-Geiger classification, Kissidougou has a dry Harmattan savanna climate characterized by two main seasons: a dry season and a rainy season. The Kissidougou prefecture experiences significant rainfall almost year-round, with an average of 1083.9 mm of rain per year. The dry season lasts from November to March. The average annual temperature in Kissidougou is 26.2°C. From a hydrographic point of view, the main watercourse that crosses the prefecture is the Niandan river followed by small streams. [4, 5, 7].

The population of the urban commune of Kissidougou, as recorded in the 2014 census, is estimated at 109,959 inhabitants, with an average annual growth rate of 5.10% over the 12-year period.

Meteorological data for the kissidougou prefecture

- a-Temperature: Daily maximum temperatures increase by 2°C, ranging from 27°C to 29°C, rarely falling below 25°C or exceeding 34°C.
  Daily minimum temperatures decrease by 2°C, ranging from 20°C to 18°C, rarely falling below 15°C or exceeding 22°C. The highest average daily minimum temperature was 21°C on October 11th.
  For reference, on March 21, the hottest day of the year, temperatures in Kissidougou generally range between 21°C and 33°C, while on January 1, the coldest day of the year, they range between 16°C and 29°C. [6, 7].
- b-Cloud Cover: Autumn in Kissidougou is characterized by rapidly decreasing cloud cover, with the percentage of total or partial cloud cover decreasing from 78% to 48%.
  The clearest day in autumn is November 30th, with clear, mostly clear, or partly cloudy skies 52% of the time.
  For reference, on August 15th, the cloudiest day of the year, the probability of mostly or mostly cloudy skies is 80%, while on January 6th, the clearest day of the year, the probability of mostly or partly cloudy skies is 64%. [6, 7, 8].
- c-Precipitation: A day with precipitation is defined as a day with an accumulation of at least 1 millimeter of water. In Kissidougou, the probability of precipitation during autumn decreases rapidly, starting the season at 85% and ending at 7%.
  For example, the highest probability of precipitation in the year is 88% on August 22 and the lowest is 1% on January 1. [7].
- d-Rainfall: To show the variation throughout the season and not just the monthly totals, we show the rainfall accumulation over a 31-day moving average centered on each day. The average rainfall over a 31-day period in autumn in Kissidougou decreases very rapidly, beginning the season at 362 millimeters and rarely exceeding 622 millimeters or falling below 84 millimeters, and ending the season at 14 millimeters and rarely exceeding 37 millimeters or falling below 0 millimeters. [6, 7, 8].
- e-Sun: During autumn in Kissidougou, the length of the day decreases. From the beginning to the end of the season, the length of the day decreases by 39 minutes, which corresponds to an average daily decrease of 26 seconds and a weekly decrease of 3 minutes and 4 seconds.
  The shortest day of autumn is November 30 with 11 hours and 38 minutes of daylight, and the longest day is September 1 with 12 hours and 17 minutes of daylight.
  The earliest sunrise in autumn in Kissidougou occurs at 6:28 a.m. on October 13, and the latest sunrise occurs 12 minutes later at 6:39 a.m. on November 30.
  The latest sunset occurs at 6:49 p.m. on September 1, and the earliest sunset occurs 33 minutes earlier at 6:16 p.m. on November 15. For reference, on June 21, the longest day of the year, the sun rises at 6:22 a.m. and sets 12 hours and 40 minutes later at 7:01 p.m., while on December 22, the shortest day of the year, it rises at 6:51 a.m. and sets 11 hours and 35 minutes later at 6:26 p.m. [6, 7].
- f-Humidity: The probability of a given day being humid in Kissidougou decreases very rapidly during the autumn, dropping from 100% to 37% over the course of the season.

For reference, on August 16, the most humid day of the year, the climate is humid 100% of the time, while on January 1, the least humid day of the year, the climate is humid 5% of the time. [6, 7].

- Wind: In Kissidougou, the meteorological service reports wind speed and direction at 10 meters above ground level. The wind observed at a given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more than hourly averages.
  The average hourly wind speed in Kissidougou decreases during the autumn season, dropping from 10.1 kilometers per hour to 7.8 kilometers per hour.
- h-Solar Radiation: The average daily incident shortwave solar radiation at Kissidougou increases gradually during autumn, rising by 0.5 kWh from 4.7 kWh to 5.2 kWh over the course of the season. [4,5,6].
- i-Topography: The geographic coordinates for Kissidougou are: 9.185° latitude, -10.100° longitude, and 530 m altitude. The topography within 3 kilometers of Kissidougou shows only slight variations in altitude, with a maximum variation of 56 meters and an average altitude above sea level of 524 meters. Within 16 kilometers, there are only slight variations in altitude (268 meters). Within 80 kilometers, there are very significant variations in altitude (1072 meters).

The area within a 3-kilometer radius of Kissidougou is covered by cultivated land (47%) and artificial surfaces (45%), within a 16-kilometer radius by trees (51%) and cultivated land (25%), and within an 80-kilometer radius by trees (65%) and pastures (25%). [7, 9].

2.1.2. Geographical situation of the faranah prefecture

The Faranah Prefecture is located between 10°02' and 11°10' north latitude and between 10°12' and 10°50' west longitude, with an average altitude of 340 meters. It covers an area of 13,000 km^2 with a population of 147,743 inhabitants, representing a population density of 11 inhabitants per km^2 (General Population and Housing Census, RGPH, December 1996). [6,7].

It is bordered:

- North by the Dabola Prefecture
- South by the Kissidougou and Guéckédou Prefectures and the Republic of Sierra Leone
- East by the Kouroussa Prefecture
- West by the Mamou Prefecture and the Republic of Sierra Leone.

Meteorological data for the faranah prefecture

The prefecture's latitude and longitude significantly influence its physical landscape.

- Relief: The Faranah prefecture has a relatively flat topography, consisting of a vast plateau, a monotonous plateau, indented by large plains and dotted with hills.
- Climate: The climate of the Faranah prefecture is of the Sudanese-Guinean type, characterized by two types of seasons: a dry season (November - April) and a rainy season (May - October).

With an average annual rainfall of 564.9 mm and a relative humidity of 97.00% in July, and 98.00% in July and August. [6].

Table 1 Climate data for the Faranah prefecture for the period 2005-2008

Month parameter	**Rainfall (mm)**		**Temperature °C**		**Humidity Relative %**		**Evaporation (mm)**	**Wind speed and direction**
H (m)	Max	Min	Max	Min	Max	Min	Min	
January	0,3	-	31.9	11.7	76	17	202.5	4 N-E
February	0.9	2	35.9	14,75	74	16	22.8	4 S
March	143.7	3	36.7	18, 33	88	33	156.0	13 W
April	91.4	9	36.5	19,42	88	34	100.1	10 E
May	69.1	9	32.6	18,75	96	57	93.1	8 E

June	263.3	7	30.9	17,88	97	61	78.9	11 E
July	564.9	19	29.9	17,40	98	67	56.8	6 S
August	354.8	23	29.4	17,77	97	68	59.3	7 N - E
September	301.9	20	30.4	17,34	97	67	62.5	6 E
October	184.4	18	31.1	17,33	96	12	73.2	6 N
November	17,88	2	32.4	15,36	94	46	99,00	6 E
December	1,62	1	32.7	11,34	88	40	98.9	7 E

Source: [6]. Legende: Max: maximum; Min: minimum; N-E: Northeast; S: South; W: Ouset; E: East; N: North

c-Temperature: During the period from 2005 to 2008, the average temperature was 11.7°C, with a maximum of 36.7°C in March.

- d-Relative Humidity: During the same period, the highest humidity was recorded in July (98.00%) and the lowest in November 2008 (12.00%).
- e-Winds: The prevailing winds are the Harmattan (dry and hot), which blows from east to west during the dry season, and the Monsoon (cool and humid), which blows from west to east.

The highest wind speed was observed in March 2003 at 13 m/s.

- f-Rainfall: It varies from year to year. The highest rainfall was recorded in July 2008 (564.9 mm) over 24 days, and the lowest in February (0.2 mm) over two days.
- g-Vegetation: The vegetation of the Faranah prefecture is of the wooded and grassy savanna type, varied and composed of grasses of various families, trees, and shrubs that dry out completely during the dry season. There are patches of forest along the waterways.
- h-Hydrography: The Faranah prefecture is watered by numerous rivers, the most important of which is the Niger, which originates in Kobikoro and extends for 4,200 km. Its tributaries include:
  - -The Milly: which originates in the urban commune of Faranah;
  - -The Faliko River: which originates in the sub-prefecture of Tiro;
  - -The Banian River: which originates in the sub-prefecture of Bagnan;
  - -The Balen River: which originates in the sub-prefecture of Hèrèmakono;
  - -The Mafou River: which forms the border between Faranah, Kissidougou, and Kouroussa.

The plains bordering the Niger River and its tributaries are subject to seasonal flooding in August and September.

- i-Soils: The soils found in the Faranah prefecture are:
  - - Skeletal soils: These are most often found on mountain slopes.
  - - Hydromorphic soils
  - - Poorly developed soils: These generally contain a low organic matter content.

Ferralitic soils: These are located on hillsides, plateaus, and slopes. They are favorable for agriculture, especially for upland rice, maize, peanuts, and fruit trees.

Alluvial soils: Characteristic of soils in lower valleys and plains along waterways.

Note: The last three (3) soil types—hydromorphic soils, ferralitic soils, and alluvial soils—are suitable for growing rice, maize, cassava, peanuts, market garden crops, and fruit trees. [6, 7].

Figures 1 and 2 show photos of the map of the urban commune of Faranah and the urban commune of Kissidougou.

Figure 1 Map of the urban commune of Faranah

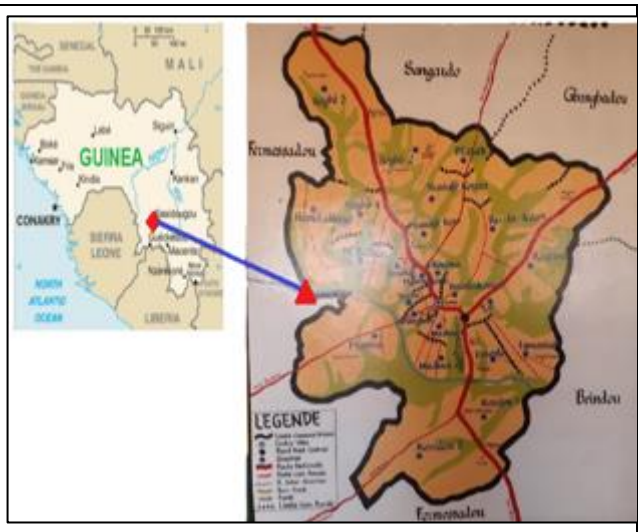

Figure 2 Map of the urban commune of Kissidougou

2.1.3. -Sampling of sand from the niandan and niger rivers

For sand sampling, we collected two samples from two different locations: one from the Niandan River in Kissidougou and the other from the Niger River in Faranah. Particle size analysis of these two sand samples was performed at the soil science laboratory of the Higher Veterinary Institute of Faranah-Valérie Giscard d'Estaing (ISAF/VGE).

For this analysis, we used the following equipment:

- The two sand samples;
- An electric sieve shaker;
- An electronic balance, calibrated to 100 grams, to weigh the sand sample;
- 500 grams of the sand to determine its geological composition;
- A sieve shaker with eight (8) sieves ranging in diameter from 4 mm to 45 µm to homogenize the sand sample;
- A 500-gram jar filled with sand before being placed on the scale;
- A small spoon;
- The lab coats and gloves were used solely for our protection.

2.2. Methods

We applied the dry sieving method using an electric sieve shaker. This method involved using nested sieves to separate the grains by size. It includes sieving (using sieves with decreasing mesh sizes). The electric sieve shaker we used consists of eight (8) sieves of different diameters and operates 16 times every 10 seconds, with a sieving capacity of 1.20 mm/g. We then calculated the mass of the geological elements in each case, namely gravel, coarse and fine sand, coarse and fine silt, and coarse and fine clay contained in the sample. It should be noted that the sieve used consists of a wire mesh with square holes.

The results obtained are recorded in Tables II and III.

3. Results

3.1. Particle Size Parameters of Niandan River Sand

Table 2 Sample taken from the Niandan River at Kissidougou

No	Sieve	Diame-ters	Elements	Mass (g)	Total mass (g)	Percentage (%)	Sieving time (min)	Amplitude (mm/g)	Number of revolutions (1/s)	Frequency (1/rev)
1	Sieve 1	4 mm	Gravel	47,8	47,8	9,56	3	1,20	16	10
2	Sieve 2	2 mm								
3	Sieve 3	1 mm	Coarse sand	163, 3	323,4	71,5				
4	Sieve 4	500 µm	Fine sand	160,1						
5	Sieve 5	250 µm	Coarse silt	95,3	118,1	26,11				
6	Sieve6	125 µm	Fine silt	22,8						
7	Sieve 7	63 µm	Coarse clay	4,2	6,3	1,39				
8	Sieve8	45 µm	Fine clay	2,1						
9	Total				499,6	99,5				

Source: 2024-2025 Survey

3.2. Particle Size Parameters of Niger River Sand

Table 3 Sample taken from the Niger River at Faranah

No	Sieve	Diameters	Elements	Mass (g)	Total mass (g)	Percentage (%)	Sieving time (min)	Amplitude (mm/g)	Number of revolutions (1/s)	Frequency (1/rev)
1	Sieve 1	4 mm	Gravel	32,7	32,7	6,54	3	1,20	16	10
2	Sieve 2	2 mm								
3	Sieve 3	1 mm	Coarse sand	168, 3	333,5	71,36				
4	Sieve 4	500 µm	Fine sand	165,2						
5	Sieve 5	250 µm	Coarse silt	76,1	99,3	21,24				
6	Sieve6	125 µm	Fine silt	23,2						
7	Sieve 7	63 µm	Coarse clay	1,25	1,8	0,38				
8	Sieve 8	45 µm	Fine clay	0,55						
9	Total				467,3	99,52				

Source: 2024-2025 Survey

4. Discussion

From these two tables, the results show that the quantity of sand sampled in Kissidougou is estimated at 71.5% and that in Faranah at 71.36%. However, 1.39% of the clay was found in Kissidougou compared to 0.38% in Faranah. This result indicates that the soil is more clayey in Kissidougou than in Faranah.

• Regarding the layers, after analyzing the results, we observe that the sands from the two rivers only meet the conditions of the second layer: 0.2-0.6 mm, that is, sieve 4 (500 µm = 0.5 mm) and sieve 5 (250 µm = 0.25 mm).

Layers 4 and 5 are not met by these two samples.

5. Conclusion

This research demonstrated the technique of separating agglomerated grains from a known mass of material by underwater agitation, fractionation of the soil after drying using a series of sieves, and successive weighing of the residue accumulated on each sieve. The mass of residue on each sieve is then expressed as a percentage of the total dry mass of the sample submitted for analysis.

Furthermore, particle size analysis of sand is a fundamental analysis in construction and geology that aims to determine the size and distribution of particles in a sand sample. It is primarily carried out by sieving, where the sample is filtered through a series of sieves with increasingly finer meshes in order to separate and weigh grains of different diameters. Finally, this study revealed that the soil is more clayey in Kissidougou than in Faranah, with a clay content of 1.39% compared to 0.38%.

Finally, it should be noted that the declaration of conflicts of interest in particle size analysis can influence the objectivity of results on particle size or materials, by filling out a standardized form (often provided by universities or publishers), specifying the interests (even potential ones), and describing how this does not affect the research or measurements, in order to ensure transparency and scientific integrity.

References

[1] Article: Geomorphological systems: renewing themes, tools and methodand distribution laws, October 12, 2013, Jean-Luc Mercier, pp. 379-392 https://doi.org/10.4000/geomorphologie.10357, article submitted March 12, 2012, accepted October 12, 2013.

[2] Thesis: Sedimentological, palynological, geochemical and paleoenvironmental characterization of sedimentary formations associated with the Lagoon Fault (eastern onshore basin of Côte d'Ivoire). Paul Fori Yao Assalé, publicly defended December 14, 2013.

[3] Provisional Report July 2015: Ministry of the Environment and Sustainable Development, Directorate of the Environment and Classified Establishments, Coastal Management Division, Integrated Coastal Zone Management Project (ICZM), Bathymetric Study of the Somone Lagoon

[4] Management, Treatment and Valorization Possibilities of Septic Tank Sludge from the Urban Commune of Kissidougou, Guinea, by Yakouba TRAORE - PhD - LEREA - UGANC - 2024, Republic of Guinea, West Africa. June 13, 2024.

[5] Republic of Guinea, Ministry of Planning and Economic Development. The Faranah Administrative Region in Figures, 2018 edition.

[6] Project to improve the drinking water supply using a mini-water supply system powered by photovoltaic energy at ISAV - VGE in Faranah, Guinea.

[7] Feasibility study for the establishment of a sludge treatment plant for the city of Houndé in Burkina Faso. Presented and publicly defended on July 1, 2019, by Bintou SYLLA (20150121).

[8] DATU Project for the treatment of sludge from the city of Conakry, Technical Study.

[9] Excerpt from the Wastewater Treatment Technology course, "Master's in Sustainable Agriculture," by Baba Diogo DIALLO, under the supervision of Dr. Cellou Kanté, Faranah, July 2012.

[10] Biological treatment of waste by Rémy GOURDON. Laboratory for Environmental Analysis of Industrial Processes and Systems – National Institute of Applied Sciences of Lyon.

[11] Study of a domestic wastewater treatment model for the university campus of the Higher Institute of Agronomy and Veterinary Medicine of Faranah (ISAV), DEA thesis presented and defended by: Baba Diallo, April 2005.