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Measurement of the Level of Knowledge of the Sands Used in Constructions in Togo

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Abstract

Faced with the proliferation of quarries extracting silty sand and river sand used in the building and public works sector in Togo, recognition of the granular properties of these materials remains a major challenge for builders. This study aims to take stock of the use of sand in construction in Togo. One hundred and eighteen (118) sand quarries in operation, including thirty-eight (38) silty sand quarries and eighty (80) river sand quarries, were identified following surveys carried out among stakeholders involved in the chain of construction on 40% of the national territory. It appears from these surveys that river sands (59.43% to 84.68%) are prioritized over silty sands (15.32% to 40.57%). Three (3) main reasons are behind the choice of sand type; namely, proximity (28%), cleanliness (25%), good appearance (25%). These three (03) reasons partly explain the strong dependence of users on the sands located in their vicinity as well as the related expenses. Thus, making data available on the characteristics of sand, the materials most used in construction in Togo, would contribute to improving the housing conditions of the Togolese population.

Keywords

Sands, Togo, Reasons for Use, Construction

1. Introduction

The evolution of construction techniques has given rise over time to the use of various materials including wood, steel, aggregates, etc. However, the most widespread construction methods today are largely based on the use of aggregates which today represent the most consumed resources after water and the majority

of which is used in the construction industry. These aggregates are in fact used in numerous applications including roads, infrastructure and buildings as base materials for concrete, mortars for walls and coatings, surface coverings and as backfill materials. From a consumption point of view, whatever the field of construction, sand remains the most used material.

Togo, like several coastal countries, is full of several categories of sand in addition to marine sand. We distinguish in particular between river sand, sand from rock crushing and sand from quarries. Despite the abundance of sand extraction sites observed throughout the national territory, recognition of the granular properties of these materials remains a major challenge for local builders. Unlike the marine sands of the Togolese coast which are generally average sands (Mf~2.656) and very clean (ES~100 > 80) therefore very suitable for quality concrete [1] [2], sands from quarries and those taken from river beds are very fine (Mf~1.966) and slightly clayey (ES~66.32 < 70) [3]-[5]. As a result, the risk that these materials are unsuitable or inappropriate, thus compromising the stability, durability and safety of the structures, is high, hence the need to ensure their qualities through an in-depth study in order to examine the possibility of using them as materials in the field of construction. It is in this context that this study takes place, the present development of which concerns the inventory of sand extracted from quarries and river beds used in construction in Togo.

2. Materials and Methods

2.1. Materials

The materials and tools necessary for carrying out this study are as follows:

- Collection tools: a questionnaire and an instruction manual for career identification operations;
- A tablet with the integrated application (Kobotoolbox for digitizing survey data and GPS Waypoints for geolocation of sites housing quarries).

2.2. Methods

A survey is carried out among potential players involved in the construction chain.

The study is carried out over the entire extent of the Togolese territory which is located in West Africa and delimited by Benin, Ghana, Burkina Fasso and the Gulf of Guinea. For this study, Togo was subdivided into ninety-eight (98) elementary areas of 28 km on each side giving an area of 784 km^2 (**Figure 1**).

Five (05) categories of actors were interviewed during the investigation phase. These are mining services, sand operators, sand suppliers or sellers, professional users and non-professional users.

The collection tools used include: identification of the respondent (location and addresses); data relating to the investigating agent; information relating to the operating conditions of the aggregates as well as the techniques for processing the aggregates before their use; the reasons for preference and choice of the sands studied; the conditions for opening and operating aggregate quarries as well as the

related difficulties; information relating to the method of management of the site after exploitation, environmental protection as well as the future prospects of these quarries.

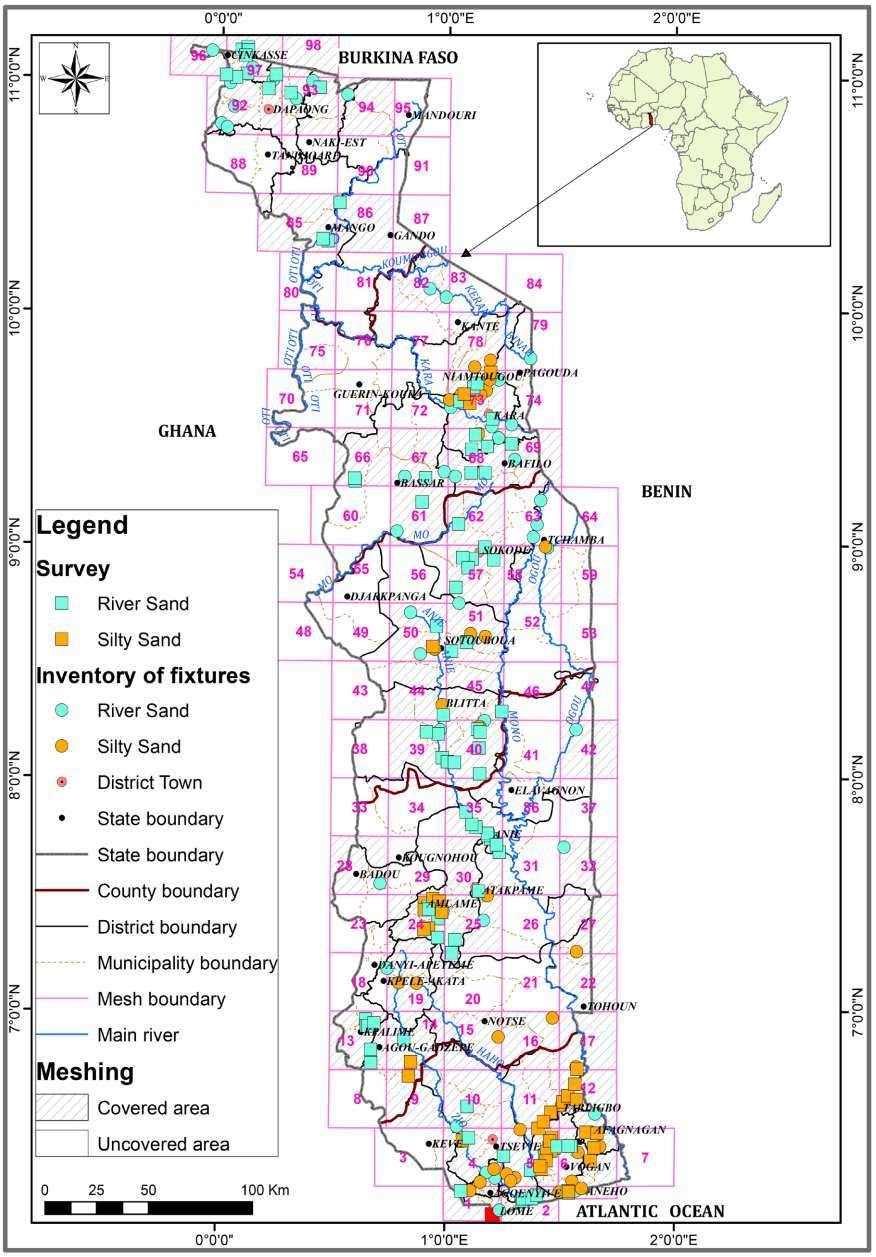


Figure 1. Map of Togo showing the sites covered by the study.

The size of the sampling frame varies according to the five (5) target actors, and considering the population of actors quite small for operators and suppliers, decentralized mining services and local authorities, the sampling route was discarded in favor of a systematic census. For the other actors made up of professional and non-professional users with a higher population, the sampling track was adopted. It was therefore retained:

- 10 people per location for professional users;
- 5 people per location for non-professional users.

The data collected was processed based on the following points:

- The origin of the sand and the type of sand as well as their geolocation;
- The physical or visual assessment parameters of the sands studied;
- The conditions for opening and operating quarries;
- The reasons for use according to the three categories of potential stakeholders targeted in the satisfaction surveys. These reasons for use are six (06) in number, namely: reason of proximity; reason of cleanliness; good appearance; demanded by the population; unique in the area; cheaper.

3. Results

Of the ninety-eight (98) elementary surfaces resulting from the grid of the study area, thirty-nine (39) were covered by the surveys, *i.e.* a coverage rate of 40%. The results on the different types of sand encountered in the area, their operating condition as well as their reasons for use by the population are given in Tables 1-3. The detailed results of the reasons for use of these sands by category of actors targeted by this study are presented in Table 4.

Table 1. Distribution of quarries studied according to operating titles/permits.

Quarries (Silty sand + river sand)		Operating condition	
Effective	%	With permit (%)	Without permit (%)
118	100	7.62	92.38

Table 2. Distribution of types of sand used as well as their conditions of use in the study area.

Type of sand	Careers		Operating condition	
	Effective	%	With permit (%)	Without permit (%)
River sand	80	67.80	48.05	50.16
Silty sand	38	32.20	51.95	49.84
Total	**118**	**100**	**100**	**100**

Table 3. Distribution of sand encountered in the study area according to reasons of use.

Reason for use	Total number of responses	Type of sand	
		River sand (%)	Silty sand (%)
Reason of proximity	9 029	69.04	30.96
Reason for cleanliness	8 168	83.13	16.87
Good appearance	8 252	84.68	15.32
Demanded by the population	1 935	59.43	40.57
Unique in the area	2 135	78.63	21.37
Cheaper	3 062	68.51	31.49

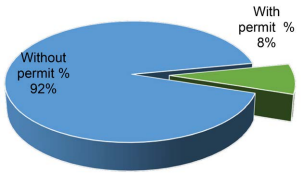
Table 4. Distribution of types of sand encountered by category of stakeholders surveyed in the study area according to reasons for use.

Category of actors	Reason for use	Total number of responses	Type of sand	
			River sand (%)	Silty sand (%)
Suppliers	Reason of proximity	646	84.98	15.02
	Reason for cleanliness	437	85.58	14.42
	Good appearance	614	87.13	12.87
	Demanded by the population	316	87.66	12.34
	Unique in the area	140	92.86	7.14
	Cheaper	234	67.95	32.05
Professional User	Reason of proximity	1688	78.38	21.62
	Reason for cleanliness	1339	97.46	2.54
	Good appearance	1487	89.31	10.69
	Demanded by the population	485	70.52	29.48
	Unique in the area	377	83.55	16.45
	Cheaper	594	93.43	6.57
Non-Professional User	Reason of proximity	6 695	65.15	34.85
	Reason for cleanliness	6 392	79.94	20.06
	Good appearance	6 151	83.30	16.70
	Demanded by the population	1 134	46.74	53.26
	Unique in the area	1 618	76.21	23.79
	Cheaper	2 234	61.95	38.05

The results of the surveys carried out throughout the Togolese territory covered one hundred and eighteen (118) sand quarries in operation, including thirty-eight (38) silty sand quarries and eighty (80) sand quarries, rivers, *i.e.* 32% from river sand quarries and 68% for silty sands (Figure 2).

Figure 2. Proportion of river sands and silty sands used in the study area.

Silt and river sands are practically exploited without authorization (92%) (Figure 3).



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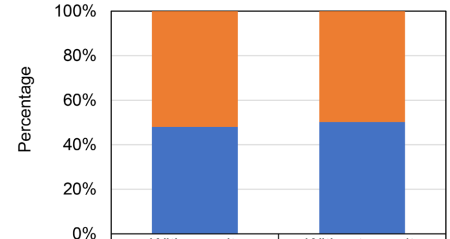

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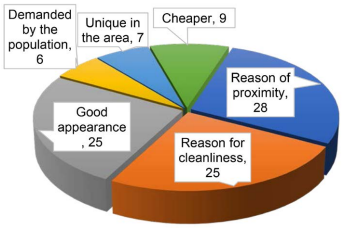
Figure 3. Distribution of sands studied according to operating conditions. (a) Distribution of sand according to titles or operating permits; (b) Distribution of sand types according to titles or operating permits.

Three (3) main reasons are the origin of choice of sand type; namely: proximity (28%), cleanliness (25%), good appearance (25%). River sands (59.43% to 84.68%) are prioritized over silty sands (15.32% to 40.57%) (**Figure 4**).



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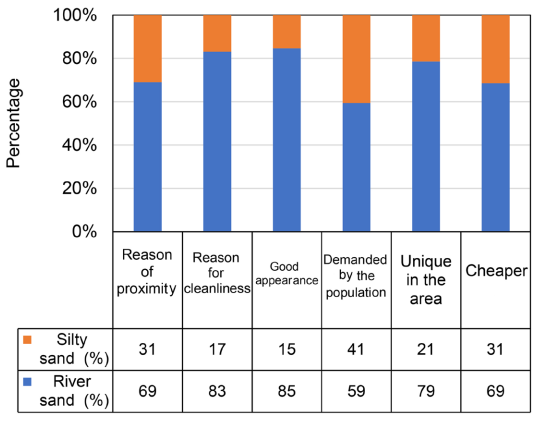

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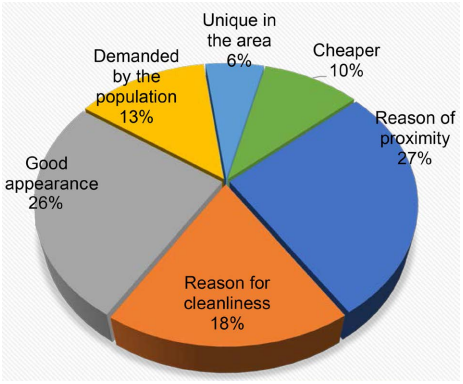
Figure 4. General distribution of sand according to reasons of use. (a) Overall distribution of sand according to reasons of use; (b) Overall distribution of sand types according to reasons of use.

Figure 5 shows that suppliers make more choices of sand types for reasons of proximity (27%) and appearance (26%). The proximity condition is 18%. This category of people uses river sands (67.95% to 92.85%) more than silty sands (7.14% to 32.05%).



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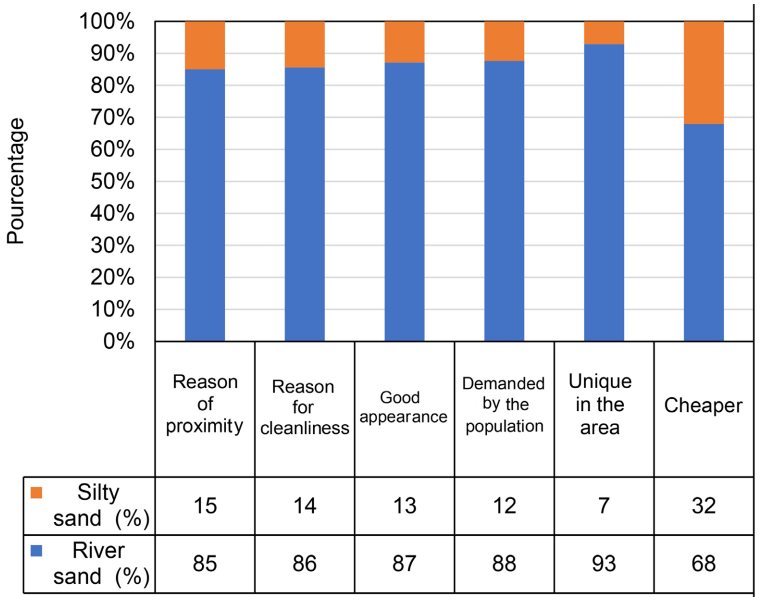


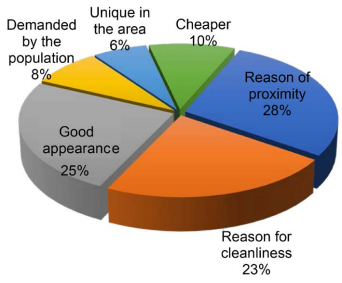
	Reason of proximity	Reason for cleanliness	Good appearance	Demanded by the population	Unique in the area	Cheaper
Silty sand (%)	15	14	13	12	7	32
River sand (%)	85	86	87	88	93	68

(b)

Figure 5. Distribution of sand by suppliers according to reasons of use. (a) Distribution of sand according to the reasons for use by suppliers; (b) Distribution of sand types according to reasons for use by suppliers.

Construction professionals opt for the use of sand because of the proximity to the location of the work (28%), their appearance (25%) and their cleanliness (23%). They also prefer river sands (70.52% to 97.46%) (Figure 6).

As for non-professional users, they prefer the sands closest to their areas of use (28%), clean sands (26%). The appearance of the sands is also part of their choices (25%) (Figure 7). The silty sands are more demanded (53.26%). However, river sands are often used for reasons of proximity (65.15%), cleanliness (79.94%) (Figure 7).



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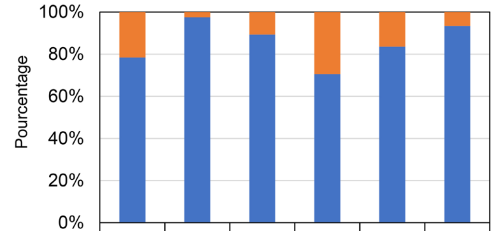
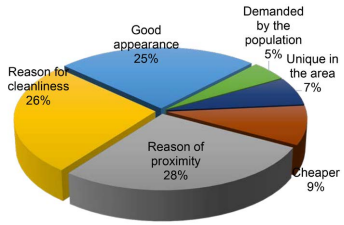


	Reason of proximity	Reason for cleanliness	Good appearance	Demanded by the population	Unique in the area	Cheaper
Silty sand (%)	22	3	11	29	16	7
River sand (%)	78	97	89	71	84	93

(b)

Figure 6. Distribution of sand by professional users according to reasons for use. (a) Distribution of sand according to the reasons for use by professional users; (b) Distribution of sand types according to the reasons for use by Professional Users.



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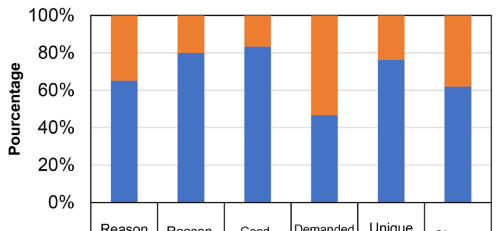

	Reason of proximity	Reason for cleanliness	Good appearance	Demanded by the population	Unique in the area	Cheaper
Silty sand (%)	35	20	17	53	24	38
River sand (%)	65	80	83	47	76	62

(b)

Figure 7. Distribution of sand by non-professional users according to reasons for use. (a) Distribution of sand according to the reasons for use by non-professional users; (b) Distribution of types of sand according to the reasons for use by non-professional users.

4. Discussion

The use of river sand dominates overall in the study area (68%) (**Figure 2**). The exploitation of this sand takes place mainly on the banks of large rivers such as the Oti, Kara and Mono.

A predominance of silty sand exploitation is noted in the maritime region of the study area (**Figure 1**). This results from the Togolese State's ban on the exploitation of coastal sand by interministerial decree n˚031/MME/MERF dated May 5, 2011 in order to effectively combat the phenomenon of coastal erosion. This coastline was for a long time the main source of sand supplying this part of the study area. Added to this ban is the strong urbanization of this region which alone concentrates more than 68% of the urban population and all the industrial centers of the country [6]. This strong urbanization is accompanied by vast infrastructure construction projects and consequently a high consumption of construction materials, thus leading to a multiplication of silty sand quarries in the area, some of which are being created in defiance of environmental rules and standards.

Regarding the operating conditions of the quarries identified in the study area, the results of the study crossed with those of the initiative for transparency in the extractive industries [7] show that 92.31% of sand quarries identified in the study area operate without authorization (**Figure 3**). The absence of authorizations is partly explained by the fact that most sampling zones are carried out at several points along the beds of watercourses or rivers and this in an informal manner. This predominance of quarries without authorization confirms the results of the study on artisanal and small-scale mining [8] according to which outside the maritime region, all the quarries identified do not have any rights mining allowing them to search for or exploit minerals. Under these conditions, environmental and social impact studies (ESIAs) making it possible to obtain operating titles or permits are almost rare or even non-existent for most of the quarries identified. Thus, the lack of studies leads to the abandonment of sites after exploitation. These data are confirmed by the same report [8]. Indeed, the study shows that 9.1% of sites after their exploitation are used as backfilling or waste recovery areas of all kinds while the sale of the site after exploitation is only observed at around 0.1% operating units. More than 90% of sites are abandoned in nature.

The reasons for choosing sand vary according to the different categories of actors (Supplier, Professional Users and Non-professional Users). Overall, for the entire area studied, the most predominant reasons for choosing river sands are respectively its appearance (84.68%), its cleanliness (83.13%) and its proximity (69. 04%) (**Figure 4**). For the different types of actors, notably suppliers, professional and non-professional users, these reasons for choice remain dominant for river sands as shown in **Figures 5-7**. The predominant choice of river sand based on its cleanliness and its appearance, is explained by the nature of its production. Indeed, just like marine sands, all samples from rivers are naturally clean because coming from moving rivers, it is practically impossible to have

clay impurities on the sand grains [1] [9]-[11]. This gives them a visually good appearance and good cleanliness. For silty sand, the proximity reason outweighs the other reasons. The silty sands being extracted from quarries close to the land, are subject to contamination and are often not clean [1] [12] [13]. Thus silty sands are avoided because of their cleanliness and appearance. Indeed, according to the work of Amey K. B. (2018) [1] [14] [15], 50% of these sands are slightly clayey (ES < 70%). Also 76% of these sands are fine (Mf < 2.1). They are therefore for the greatest proportion (50% to 76%) not suitable for concrete and hydraulic mortar work, which justifies that they are requested for construction work at 25% for their appearance and 25% for their cleanliness.

In Togo, three (3) main reasons are behind the choice for construction work: appearance, cleanliness and proximity. The choices linked to the quality of the sands (appearance and cleanliness) represent 50% while the sands are 50% to 76% suitable for construction work. These results clearly show that the Togolese population has a good culture and is aware of the quality of construction materials to be adopted for construction work.

Providing data on the characteristics of these materials, particularly sand, will be very beneficial for the works and would contribute to improving the housing conditions of the Togolese population.

5. Conclusion

This study aims to take stock of the silty sands and river sands used in construction in Togo in order to provide users with data on these materials intended for construction uses. We collected data through surveys of potential stakeholders involved in the construction chain. These data made it possible to identify in the study area a total of one hundred and eighteen (118) sand quarries in operation, including thirty-eight (38) silty sand quarries (*i.e.* 32%) and eighty (80) river sand quarries (*i.e.* 68%). The choices made by the respondents, which are essentially based in most cases on visual and physical observations, are mainly due to good appearance, cleanliness and proximity. Laboratory tests will make it possible to make available to the population data on the physical, geological and mineralogical characteristics of sands indicating the different possibilities of using said material.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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