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## IMPACTS SOCIO-ECONOMIQUES DE L'EXPLOITATION ARTISANALE DU SABLE SANAGA DANS LA LOCALITE DE NKOL'OSSANANGA (YAOUNDE, CAMEROUN) : VERS UNE EXPLOITATION SEMI-MECANISEE

### *Socioeconomic impacts of sand harvesting along the Sanaga River in Nkol'Ossananga locality (Yaounde, Cameroon): Toward a mechanized operation for sustainable exploitation*

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### RESUME

Cet article présente les impacts sociaux et économiques de l'exploitation artisanale du sable de Nkol'Ossananga sur la base d'enquêtes de terrain et d'analyses de données. L'analyse en laboratoire des échantillons de sable collectés sur le site a montré que la propreté du sable de Nkol'Ossananga avoisine 100%. Ce qui signifie que le sable de Nkol'Ossananga est approprié pour le BTP et le génie civil. L'activité génère des revenus importants à tous les acteurs de la chaîne de production et le gouvernement. Les revenus générés sont utilisés par les artisans pour se faire construire leur maison d'habitation, acheter des appareils électroniques, prendre soin de leur famille ou alors sont capitalisés dans le commerce. Malgré les impacts positifs susmentionnés, l'exploitation artisanale du sable de Nkol'Ossananga est également source du brassage culturel, de la délinquance juvénile et de l'abandon précoce des études. Pour une exploitation durable, l'exploitation semi-mécanisée est envisageable. Ce type d'exploitation est celui qui pourra améliorer les conditions de travail des artisans, augmenter leur production et leurs revenus au même titre que ceux du gouvernement, et réduira par ricochet les impacts négatifs.

**MOTS-CLES :** Nkol'Ossananga, exploitation du sable, impacts sociaux, revenus, exploitation semi-mécanisée, gouvernement.

### ABSTRACT

This paper presents the impacts of Nkol'Ossananga sand harvesting on social life and local economy based on field investigations and data analysis. Laboratory analysis of sand samples from the site has shown that the cleanliness of the Nkol'Ossananga sand nears 100%. This means that Nkol'Ossananga sand is pure and clean, most appropriate for house construction and building engineering. The activity produces incomes to all actors of the value chain and government. Income generated are used by craftsmen to build their houses, buy some electronic devices, and take care of their families or to finance their business ventures. In spite of the positive impacts presumed, Nkol'Ossananga sand harvesting also stands as the origin of cultural brewing, delinquency and precocious abandon of studies. The paper there suggests that, for sustainable exploitation to be achieved, a mechanized operation has to be implemented. This kind of exploitation is the one that will improve the working conditions, increase production and income of workers as well as that of government, and also reduce negative impacts.

**KEYWORDS:** Nkol'Ossananga, sand harvesting, social life, incomes, mechanized operation, government.

## 1. INTRODUCTION

The exploitation of construction materials has been developed for 5,000 years [Hooke, 2000]. In many African countries, this exploitation has been done, and often still is, using archaic methods and rudimentary tools, as far as sand, gravels and massive rocks are concerned. With the advent of industrialization, sand is now used in the manufacturing industry such as abrasives production and several other industries such as textile, glass, mirror and lasers industries. Because of its wide use, due to its relatively low cost compared to that of stones, its demand is growing up exponentially particularly in developing countries such as Cameroon (Langer and Glanzman, 1993). The exploitation of alternative resources, notably marine sand, is therefore developing in order to meet the demand.

Sand mining is of immense importance to the African economy (Manga et al., 2013). More generally, the practice of natural resource extraction is a global phenomenon which involves income streams along all strata of the value chain, from the extraction to haulage and end users. The activity enhances local economy (Muiruri and Meshack, 2017), irrespective of the remarkable negative issues which disturb the functionality of the ecosystem (Langer, 2003).

The Sanaga River is a stream of 918 km long and 20 m deep and reaching about 130 000 km<sup>2</sup> (Debreuil et al., 1975). Nkol'Ossananga sand harvesting activity is a source of certain social and economic impacts on the local community and the government.

The goal of this paper is to present the social impacts and economic profitabilities of the Sanaga River sand harvesting, at Nkol'Ossananga locality. Presence of such information will help draw the attention of investors toward a mechanized operation for sustainable exploitation. Prior to addressing this aspect in this study, the proposed site construction model has taken into account the setup proposed by Ekengoue et al., 2018, in the same study area, no matter some modifications due to environmental impacts which can be generated.

## 2. MATERIALS AND METHODS

### 2.1 Justification of the choice of the study area and sampling technique

The data used in the present study were obtained from a questionnaire survey conducted in Nkol'Ossananga sand harvesting site within a period of three months (from March to June). The choice of the site selected for our research resulted from the fact that almost all sand used in the Capital city (Yaounde) and neighboring towns come from the Sanaga River. On the field, a detailed field survey was carried out using

Global Positioning System (GPS) for the localization of the exploitation site (Ekengoue et al., 2018). To get great insight on social and economic impacts of the sand mining activity at Nkol'Ossananga, a structured questionnaire was used to conduct interviews both on the site and out of the site. On the site, the questionnaires were given to permanent and non-permanent craftsmen of the Nkol'Ossananga sand harvesting site including dwellers, loaders and truck drivers. For instance, out of the site, staffs of the local community members and government employee such as policemen were considered. On the field, we began with a brief identification of the prospect. The other questions asked were oriented towards a double objective: to know the income generated by the artisanal sand harvesting activity to all the actors of the production chain as well as the government and to assess firstly economic and secondly social impacts of the Nkol'Ossananga sand harvesting. One hundred and 45 questionnaires were printed and allocated to the different actors in the production chain.

### 2.2. Sample collection and analysis

Samples of sand were collected for analysis to determine some physical properties of Nkol'Ossananga sand, including particle size analysis, sand equivalent and absolute and apparent volumetric mass. 5kg of fresh sand was collected on the site and were equitably divided into 5 parts of 1kg each for various analysis. Two parts among the above five mentioned parts focused on cleanliness and equivalent sand were not dried before used in analysis. The others three parts were previously dried before being involved into analysis. The analysis were conducted in the Solution Afrique Centrale Laboratory.

*Particle size analysis:* the aim of this analysis was to find out the distribution of grains according to their size percentage. Theoretically, the cumulative percentages of rejection from each sieve are obtained by Eqn.1 below where  $M$  and  $M_i$  are the cumulative mass of rejection at the corresponding sieve mesh and the total mass of refusals, respectively.

$$\%Cu = \frac{M}{M_i} \times 100 \quad (1)$$

*Sand equivalent:* A fine aggregate characterization was conducted to determine the cleanliness of sand samples. The test was carried out according to the ASTM D2419 principle. The sample is shaken in a clear graduated cylinder containing a solution of flocculants and preservative. After shaking, the particles are allowed to settle for some twenty minutes. The SE value is taken as the ratio of the height of the sand column to the height of the sand and flocculated clay

multiplied by one hundred. Thus, higher percentage indicates lower amount of clay.

*Sand apparent volumetric mass:* This parameter was determined according to NFP 18-554 standard. It is defined as the mass of the unit of apparent volume of the body (Eqn.2). That is, the volume formed by the matter of the body and the voids it contains.

$$\rho'_s = \frac{M}{V} \quad (2)$$

*Sand absolute volumetric mass:* This parameter was determined according to NFP 94-053 standard. It is defined as the mass by unit of volume of the material constituting the aggregate without taking into account the voids between the grains. The formula used is given by Eqn.3 below where M is the material mass,  $V_2$  and  $V_1$  the volumes of the material and the voids, respectively.

$$\rho_s = \frac{M}{V_2 - V_1} \quad (3)$$

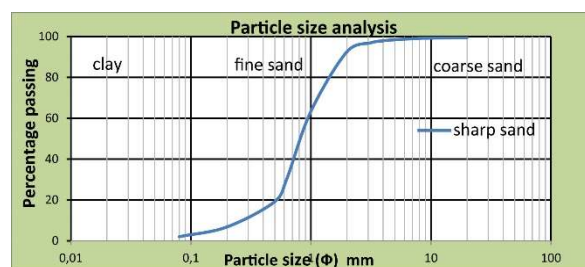
### 3. RESULTS AND DISCUSSIONS

Results of laboratory analysis of our samples at the Sol Solution Afrique Central laboratory are given in Table 1 below. The Table well indicates that  $SE > 90\%$ .

**Table 1. Physical properties of the Sanaga sand exploited from Nkol'Ossananga site**

Physical properties	Min	Mean	Max
<b>Absolute vol. mass</b> $\rho_s (kg / m^3)$	2560	2620	2880
<b>Apparent vol. mass</b> $\rho'_s (kg / m^3)$	1425	1509	1594
<b>Sand equivalent</b> SE (%)	95.3	95.8	96.3
<b>Water content</b> W (%)	3.1	3.2	3.3

Results of particle size analysis (as shown in Figure 1) demonstrated that, the major part of Nkol'Ossananga sand consisted of grains larger than 2mm, while only a few part consisted of particles up to or greater than 0.063mm. Furthermore, analyses showed that Nkol'Ossananga sand was thin and dense with low porosit and some coarse particles. The requirement of the latest European standard (EN ISO 14688-2, 2004) has established that pure sand includes sand, where larger than 2mm particles compose up to 20% and smaller than 0.063mm particles compose up to 15% of total mass (Dundulis et al., 2010).



**Figure 1. Sanaga River sand particle size distribution curve**

According to the above mentioned European Standard and following the recommendations of (BAD, 2014), it may be stated that in particular, Nkol'Ossananga sand is pure and clean sand, most appropriate for house constructions and building engineering.

In order to get the social and economic impacts of Nkol'Ossananga sand harvesting in the Sanaga River, field investigations were carried out. Several difficulties were faced. First, the reluctance to communication from the population surveyed. This was due to two fundamental reasons. For the craftsmen, they suspected that the investigators could be members of the government and in particular of the taxation domain who can be asking questions aimed at creating a daily tax on artisans, an amount to be paid to the government as a tax on artisanal sand harvesting in the Sanaga River. For the others, on the other hand (municipal employees, police, etc.), the survey could be a government survey assessing the quality of services provided to neighboring populations and to the government. In addition, the majority of divers were foreigners (Chadians, Congolese, Central Africans and Malians to cite a few) who had difficulty expressing themselves in French. The above mentioned raisons made investigations difficult. Another difficulty encountered during the collection of field data is the lack of time by the population surveyed. No matter the category of our sample, we noticed in the field a strong commitment of surveyed population by their activity, preventing them from answering the questions which were put to them or completing the questionnaire which was given to them. As a result, only 79 % of the surveyed population was able to complete the questionnaire (Table 2). In contrast, some questionnaires were partially fulfilled by respondents. This, as we noticed above, due to lack of time for some respondents and language (French) problems for others.

**Table 2. Distribution of survey sheets to actors in the Sanaga sand production chain for the Nkol'Ossananga artisanal sand harvesting site.**

	Nb surveyed	Nb responses
Permanent craftsmen	80	68
Non-perm. craftsmen	50	37
Municipality	15	8
Police checkpoint	3	1
Road toll	2	1
Total	145	115
Total in %	100	79

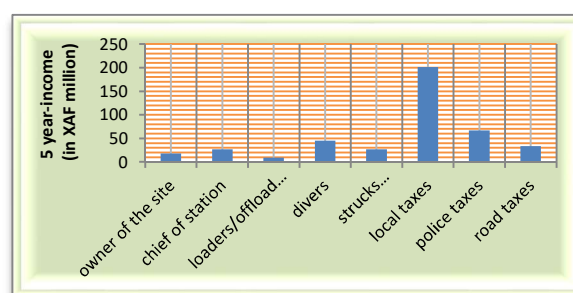
Data analysis showed that the yearly production of sand in Nkol'Ossananga was increasing progressively. This was due to the fact that Nkol'Ossananga sand is clean sand, well adapted for house and other engineering constructions. This result was firstly demonstrated by (Manga et al., 2013) who clearly showed that in Cameroon, building constructions, particularly those in the urban centers, applied the greatest demand on sand and particularly River channel deposits. In the same way, (Ayenagbo et al., 2011) stated that the phenomenon of urban sprawl has increased the demand for sand further. In the Centre Region of Cameroon, people prefer Sanaga sand, no matter the distance and the cost, because of its quality and affordable rates creating competition with other exploited types of sand. This explains the up-growing of Sanaga sand demand.

The potentialities offered by the artisanal sand harvesting constitute favorable assets that require active involvement of the government and local collectivities for more lasting activities. Data investigation analysis showed that Nkol'Ossananga sand harvesting has a considerable positive contribution to both national and local level, as well as domestic, no matter the high risks due to the exploitation revealed by (Ekengoue et al., 2018). Exploitation of Sanaga sand generates income at the national level at the different phases of the activity. These include exploration, exploitation and commercialization. In the first two phases, the competent administration collects revenue through the concession of prospector's card and business license. Nkol'Ossananga sand commercialization activity generates an amount of XAF 3 000 (4.6 €) per truck of elated sand from the site to the secondary selling places in the township of Nkol'Ossananga as local taxes. This represents a sum of XAF 40290000 (61240€), for a year, considering data collected from the Obala weighbridge.

Besides, other income sources that accrued directly or indirectly to the government as a result of artisanal harvesting of Nkol'Ossananga sand are road toll gate

and police taxes. The amount of XAF 500 (0.76€) is paid twice at the toll gate. Investigations opened to the dealers and essentially the truck drivers reveal that the cost of a truck of Sanaga sand in general vary in the market depending on the season. Therefore, they vary between XAF 165 000 and 230 000 (250-350 €) for corresponding values of XAF 45 000 (70 €) and XAF 80 000 (120 €), between dry and rainy seasons respectively. This represents an increase in margin of XAF 15 000 (23 €) for the dealers per day, for a total of XAF 450 000 (685 €) per month. In addition to the afore mentioned incomes that artisanal sand harvesting generates to craftsmen, this activity has several other impacts, especially with regard to the occupation and the remuneration for jobless as have been suggested by Sen and Fukuda-parr, (1989). Nkol'Ossananga sand exploitation activity improves the standard of life of craftsmen considerably. With the income that it provides, they can realize construction of new houses, often equipped with electronic devices and other needs such as televisions, computers, smart phones, and motorcycles to cite a few. Others use their income to finance their business ventures and to take care of children's school fees.

An estimation of craftsmen's incomes for a period of five years is shown in Figure 2.



**Figure 2. Evaluation of the incomes of elements of the value chain of exploitation of the sand in Nkol'Ossananga**

Figure 2 shows that Nkol'Ossananga sand harvesting is more profitable to government than craftsmen who carry out the activity, and who are exposed to various risks which could lead to death. These revenues generated by the activity to government such as local taxes at the end of five years of exploitation, correspond to three times the necessary budget needed for the Nkol'Ossananga sand exploitation to jump from artisanal harvesting to the semi-mechanized exploitation. On the site, we observed other economical activities developed by inhabitants of Nkol'Ossananga locality such as the merchandising of current consumption products including bread, palm wine, alcoholic drink, meat and food. This type of activity has also been mentioned by (Razack, 2012) for gold exploitation. Even clothes are commercialized in

the site. Finally, sand harvesting at Nkol'Ossananga does not only constitute an efficient means of struggle against poverty, but also a source of income. The activity can have enough geographical impacts coupled with the fact that the storekeepers sometimes get a stock in the distant villages and cities.

Information mentioned in the questionnaires filled both by craftsmen and government members have shown that, despite its wide range positive impacts such as improvement of people's lives and contribution to government finances, Nkol'Ossananga sand harvesting also stands as the origin of many negative impacts including demographic growth of the population which stands as the factor of the social imbalance. Nkol'Ossananga locality didn't escape the transfer of the populations from their area to Nkol'Ossananga locality where sand exploitation is practiced. One attends then to a cultural brewing capable to succeed to a new system of cultural values. Yet, a village or a community is endowed with a particular tradition characterized by beliefs, ideologies and considerations peculiar to the inhabitants. Transformation of Nkol'Ossananga locality in a regrouping point of several cultures, ideologies and behaviors has as direct consequence, the new life style installation. This is how one attends to the development of prostitution, delinquency and the consumption of narcotic drugs (alcohol, cigarette and tramadol). For certain artisans, the artisanal sand harvesting activity in general, is considered like a "trap to poverty", in spite of its potential effect for creation of employment. In fact, some artisans do spend their incomes in prostitution and alcohol, sometimes ending up getting into debt, mostly in the rainy season when the Nkol'Ossananga sand harvesting activity idled. Data analysis shows that Nkol'Ossananga sand harvesting involves both genders. Although the total activity of Sanaga sand exploitation is handled by men, women are involved most for food merchandizing. Nkol'Ossananga craftsmen constitute a young population. 25% of the population is less provided with schooling. This value is because students abandon their studies very early for the profit of sand harvesting in the Sanaga River. The abandonment of studies is also the consequence of lack of school infrastructures in the locality. Sanaga sand harvesting possesses negative impacts on education of pupils in primary school in Nkol'Ossananga locality, since major part of those student are involved in sand harvesting activities during school hours. Another important impact induced by Nkol'Ossananga sand harvesting activities concerns abandonment of agriculture. As a consequence, women are taking part in farming work just to maintain and take care of their families.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

Analytical results show that Nkol'Ossananga sand is a pure and clean sand, most appropriate for house constructions and building engineering. This explains why the population of the Capital city of Cameroon (Yaounde) and neighboring towns are highly interested in using the Sanaga sand. The exploitation of Sanaga sand stands as origin of several positive social and economic impacts to all actors of the value chain and government. In contrast, the activity also stands as a source of many negative impacts including cultural brewing, delinquency, precocious abandon of studies, abandon of agricultural activities to cite a few. For the activity to be most profitable to both artisans and local community and government, we propose a mechanized operation for Nkol'Ossananga sand harvesting. This is the type of exploitation that uses suction hopper dredger equipped with drag head as material. It is an exploitation method more effective and more efficient. It is the operational technique that can improve the working conditions, increase production and incomes of workers as similar as that of government. Annex 1 depicts therefore the organization of the Nkol'Ossananga sand harvesting site based on mechanized operation.

The artisanal harvesting of Nkol'Ossananga sand in the Sanaga stream is the most practiced exploitation activity of natural resources in the Central Region of Cameroon. This activity constitutes the main source of income for many inhabitants of the locality. It is an activity that has some considerable impacts on the national economy, from the incomes that it generates, but also contributes to the survival of increasingly numerous populations. Incomes earned by craftsmen are sometimes invested in other business or for education as school fees for their children. With such income, craftsmen build their houses and buy electronic devices. No matter its importance either for income generation or for employment offered, artisanal sand harvesting remains a poor activity, which uses classical techniques and rudimentary tools. This constitutes the origin of low production. For sustainable exploitation, we propose a mechanized operation. This kind of exploitation technique is the one which can improve the working conditions, increase production and incomes of workers as similar as that of government, and also reduces negative impacts. The finding in this research work ends up with a perspective that the investment cost of the proposed mechanized operation has to be investigated in order to have a lucid idea on both the payback period and financial profitability.

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