

Review

The transportation and marketing implications of sand and gravel and its environmental impact in Lome-Togo

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Proper infrastructure is a crucial factor for the socio-economic development of a country. Suburbs of Agouényivé, Adidogomé, and Banguida in Lome once sparsely populated, are now experiencing large influx of people causing environmental problems. Throughout Togo, sand and gravel is widely exploited as aggregate for construction. If river mining of sand is not carefully controlled it can cause significant damage to the ecosystem and the environment as a whole. The socio-economic and environmental impact of sand and gravel mining in Togo is not well known and there is little research work on selected river systems. Here a method is proposed for an effective regulation of in stream sand and gravel mining operations so as to balance and reduce the conflict between the gains of sand and gravel extraction and the environmental management. The activities of miners, transporters, and laborers who are involved in quarrying of sand and gravel in the cantons of Adétikopé, Mission Tové of Zanguéra and Kégué that supply sand and gravel to Lome and its surroundings are critical evaluated. However, this research reveals the vast inequalities and social injustices that lie behind this lucrative activity of sand gravel quarrying.

Key words: Sand and gravel, transporters, miners, environment, socio-economics.

INTRODUCTION

Transportation is a vital to urban life and to life in other places as well because it is an absolutely necessary means to an end: It allows people to carry out the diverse range of activities that make up daily life (Susan, 1995). The state of a country's infrastructure, especially transport plays a key role in the stability of its economic development of a country. Bourrieres (1964) states that transportation is a vital especially in the field of information and technology. It can significantly influence many levels of the economy (Wolkowitsch, 1982). Amongst the various modes of transportation: sea, road air, and rail, it is road mode of transport which is the most widely used due to its remarkable versatility which allows "door to door" connections. This is more particular in most African countries south of Sahara where road is used to transport people, goods and industrial products. In Benin, for example, the transport of sulfur is exported by road to Niger despite the potential environmental hazards like of

air pollution, soil and groundwater contamination. Hence, good roads are regarded as almost the engine for African of socio-economic development.

The area of transport is however not a new ground for research but to neglect this area before tangible methodologies are developed might mean an adverse influence effect on the economic, social, technological and cultural development of a country. This is why Wolkowitsch (1982) describes transport as a "core business" for the survival of individuals and states, because they serve to ensure the movement of people and goods delivery.

In countries like Togo, road transport is like the only means of transportation by which the bulk of economic activities take place. This included heavy goods like sand and gravel especially in Lome (Maritime area). The transportation of such products can have detrimental effects on the economy and environment if the guided policies are not sustainably managed especially in developing countries (Yang, 1996; Yang and Molinas, 1982). The city of Lome is supplied with sand quarry from the outskirts located in the townships of Mission Tové and

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Adétikopé and also in the quarries of the coastline. The peripheral quarries mainly located in the city of Tsévié and its surroundings supply the city of Lomé with silica sand only. This sand is increasingly appreciated by customers because of its quality and affordable rates creating competition between the sea sand (the most exploited of the city) and silica sand. The transportation of sand in the city of Lomé uses vehicles purchased at the Authority Port of Lomé (APL). These activities have significant environmental influences which include the degradation of land topography quality dust and a disturbance of the groundwater usage. These surface and groundwater quality impacts from such mines are relatively benign in Lomé due to the semi-arid and tropical climate and lack of perennial streams. Other environmental impacts include increased traffic on new, improved or existing roads; cumulative impacts as construction materials are hauled, stockpiled, and spread on highway and building construction projects; and aesthetic degradation caused by both active and abandoned aggregate, sand and industrial mineral mines in major view sheds. Sand and gravel mining produce materials that are used in road construction like aggregate, base course, crushed rock, sand and gravel alongside building construction and landscaping (topsoil, fill dirt, rip rap, scoria, travertine, dimension stone); and other general construction uses. Because the economics of construction materials depend heavily on the proximity of the mine to the point of use, aggregate sand and gravel mines are found in the highest concentrations in urban areas where most home and office construction and general highway construction occurs. However, these mines are located in every region in the country and many of the largest mines producing road construction materials are situated immediately adjacent to highways in order to reduce haul costs. Because haul costs (i.e., fuel, labor, and maintenance) are the single largest variable in determining the cost of material in road construction, sand and gravel mines are often opened near to a specific road project and then abandoned once the project is completed. Consequently, the majority of both active and inactive sand and gravel mines are located along intercity highways or major towns and provincial roads.

Lomé has a large number of permitted quarrying activities (e.g., sand) in recent years. This has created employment opportunities for all industrial mineral and aggregate mines, and has increased the revenues base for industrial mineral and aggregate production of the Directorate General of Mines and Geology (DGMG). Most operations occur at a range of one to twenty acres. Several hundred abandoned or inactive mines that are produced construction materials are scattered across the country. Few of these mines have been formally reclaimed, although some have been naturally re-vegetated to some extent like the one in Mission Tové.

The city of Lomé is faced with a phenomenon urban

sprawl where there is a growing housing need. The need to look for new operating locations arises so as to meet the ever increasing population need of sand and gravel. This paper analyzes the state of road transport and sale of sand and gravel in the coastal regions of Togo and then focuses on the city of Lomé, and its impact on the miner's economy and the environmental impact consequences.

The physical and climatic conditions of the study area

Togo consists of basically two savanna plains separated by a chain of hills extending from the Atakora Massif in the northeast to Ghana border in the southwest. The southern plain is cut by a system of coastal lagoons; and the northern plain is traversed by the Oti River.

The Maritime area is characterized by three sets of relief: the coast, continental shelf and the Precambrian peneplain. The coast (west-east direction) includes the lagoon system and the barrier beach. The lagoon system regroups discontinuously along Lomé Lagoon at the side of Aflao and Bè, and Lake Togo and Lake Zowla. The coastal strip includes the barrier beaches that form a series of depressions and low sandy coast. The plateau is traversed diagonally by the depression of the soil Lama gray-black and the valleys of Zio, Lili, Haho and Mono, which drain the crystalline and sedimentary units of "earth bar" (Gnandi, 2006).

The geological formation of the Maritime area is divided into two main units (UNDP, Togo, 1985), the basement (crystalline) and the sedimentary basin. According to surveys conducted under the Coastal Erosion project in 1986, these deposits consist of sand (yellow to beige) on the coast (hence its exploitation), and layers of silt (gray-white) in swampy areas; such set is based on ten feet of clay.

Maritime area is influenced by two wind movements coming from two centers of high pressure and going to low pressures at different times of the year. The climate is of Guinean type, that is to say bimodal with alternating rainy seasons and dry seasons covering the following periods: i) March-July: great rainy season; ii) July-September: short dry season; iii) From September to November: Short rainy seasons; iv) From November to March: long dry season.

Flora vegetation

Roadside land-scaping is often intentionally undertaken with introduced species as well, thus leaving little opportunity for slower-growing, native vegetation to reestablish itself. This disruption of the natural ecological succession in the plants community is equally disruptive to the animal community (Frederick, 1995). Vegetation

provides shelter for people mining sand and gravel. For example they rest under trees in bloom during the rainy season and parallel to sand activity, they can have access to plant residue, wood and charcoal as a source of energy fuel for lighting and cooking. The distribution of vegetation is more or less linked to the large amounts of relief. Overall, the Maritime region is an area of savanna composed of coconut trees (the legacy of colonization) and a few shreds of mangroves (on the beach barrier) of *Mitragyna inermis* (depressions in the soil hydromorphic) and baobab or *Adansonia digitata* (on earth bar). This pressure results from the people's needs for firewood, charcoal and timber. The coastline of Togo is part of the ecological zone V (Ern, 1979) or ecofloristic zone II of Vanpraet FAO / UNEP (1980). The vegetation of the coastal plain is of mosaic character. Based on work done on the barrier beach (Batawila, 1997; Kokou 1998), the flora of this part of Togo can be estimated to 265 taxa grouped into 74 families of angiosperms. Other groups are often associated with these environments and their dynamics depend on the duration of submergence (Afidégnon, 1999; Kokou et al, 2002). In general, the algal flora of the Togolese coast is composed mostly of Chlorophyceae and Bacillariophyceae or Diatomophyceae (Bandje, 2004). However measures have been undertaken to increase the supply of fuel wood by reforestation (peri-urban planting project conducted by the Office of Development and Exploitation of Forest Resources) and reduce firewood consumption by extension programs of improved stoves and butane gas.

Sand and gravel mining in Togo

Sand mining is a practice that is becoming an ecological problem in Lome as the demand for sand and gravel increases for industry and construction. Sand is mined from beaches and inland dunes and dredged from ocean beds and river beds. It is often used in manufacturing abrasives, for example, concrete. Surprisingly as the communities grow, the construction activities are requiring less wood and more concrete, hence leading to a demand for low-cost sand and gravel.

A related process is the mining of mineral deposits, grain, and wheat, diamond which contain industrial useful minerals, mainly gold and silver. These minerals typically occur combined with ordinary sand. The sand is dug up, the valuable minerals are separated in water by using their different density, and the remaining ordinary sand is re-deposited.

Sand mining is a direct and obvious cause of erosion in the coastal regions of Togo, and also impacts the local wildlife. For example, sea turtles depend on sandy beaches for their nesting. Disturbance of underwater and coastal sand causes turbidity in the water, which is harmful for such organisms as corals that need sunlight.

It also destroys fisheries, causing problems for most people who live in the coastal towns of Togo who rely on fishing for their livelihoods.

Removal of natural physical coastal barriers such as dunes leads to flooding of beachside communities, and the destruction of beaches causes tourism to dissipate. Sand and gravel mining is regulated by law in Togo, but is still often done illegally. It is the law No.2003-012/PR October 14, 2003 amending and supplementing Act No.96-004/PR February 26, 1996 mining code of the Republic of Togo in particular article 22, gives permission of artisan exploitation of sand and gravel. The costs of investigation (250,000 CFA francs) payable to the DGMG. Fixed costs (200,000 CFA francs) and surface fees (100,000 CFA francs / ha) are payable to the treasury according to Directorate General of Mines and Geology in Togo.

Lome Togo's capital city, is located in the Maritime area. The city of Lome was wedged between the lagoon to the north, and the Atlantic Ocean to the south, the village of Bè to the east and the border of Aflao-Ghana's West. Currently, it has undergone an expansion and is defined under Decree No. 71/63 of April 1st, 1971 by the authority of Togolese Group Insurance (TGI) in the North Atlantic Ocean to the South Refinery Oil Lome to the east and the border of Togo and Ghana to the west (Aflao) (Kougnigan, 2009). Lome has an area of 333 km² of which 30 km² is lagoonal (Kougnigan, 2009). It is located at the seaside and hence it facilitates and encourages the exploitation of coastal sand, gravel and other minerals. Lome is a city of immense economic activities; therefore people from other regions of the country want to have houses or stores for commercial activities. Due to this, there is intensive transport and marketing of sand and gravel in this area. According to the (National Report, Togo, 2007), the balance of the physical shoreline is a special character because of the interrelationships that exist between different elements of this fragile environment, the rate of population growth and of the modifications therein. The expansion of Lome is extended beyond the original site and reached the suburbs of Adakpamé, Hédranawoé, Agoényivé, Agbalépédo and Adidogomé. Residents of Lome tend move to the outskirts of the city showing urban sprawl. This is characterized by uncontrolled construction of houses (Marguerat, 1993). Lome is a city whose urban space has always been controlled by its people because Togo has no policy of urban planning (Marguerat, 1993). Lome is the most affluent in road infrastructure with the main axes being the Lome-Cinkasse (650 km) which serves as a corridor for the countries of the hinterland (Burkina Faso, Mali, Niger) across the country from south to north; then the coastal road Ghana-Benin (50 km) and the Lome-Kpalime connection which is 112 km provide transport services inside and outside the country. It also houses key rail infrastructure and a deepwater port which was established in 1968 and an international airport

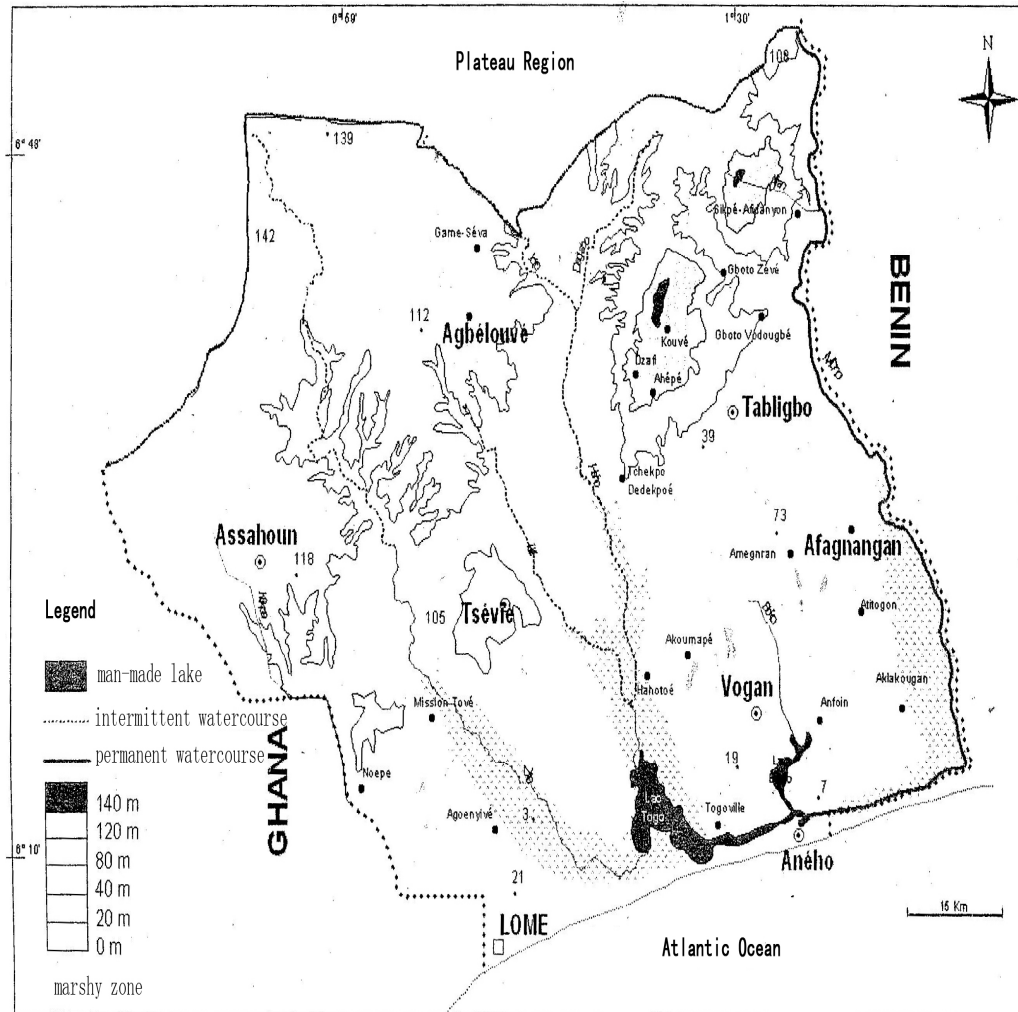


Figure 1. The Maritime area where Lome is located making it the fastest growing town and a fast corresponding environmental decline. Source: UNDP/DTCD/TOG/84/86, Regional Development Atlas of Togo (1985).

(Figure 1).

Environmental issues and problems remain of global concern, despite the difficulty in reaching full consensus in signing agreements and treaties to pursue a common approach in implementing strategy to achieve a more sustainable world. Lome, like the other cities in developing countries is experiencing a rapid urban growth this translates into a growth of suburbs. In these areas, new buildings are rising rapidly. The transportation of construction materials including sand is done exclusively by road by dump trucks of different capacities, from all kinds of quarries to the construction sites. For example, the city of Lome is supplied with sand quarry from Mission Tové, Adétikopé, Zanguéra and of Kégué (all the four quarries are located in the nearby city of Tsevié) and the coast. The lack of maintenance of the fleet operating in the area cause many traffic accidents. This situation is exacerbated by the unmaintained roads in Lome.

Sand and gravel mining in Lome

The majority of the mining of sand and gravel in Lome is done by individuals who have acquired land in the area of mining activities. In the quarry of Adétikopé, some of the farmer had acquired land at 150,000 CFA francs in the year 2000; the quarry at Mission Tové however acquired 10 lots in 2007 the price of 1,500, 000 CFA francs. According to this survey, some of the miners families could not support any going to school activities. These miners, in addition to performing other business activities they are engaged in motorcycle-taxi driving from Mission Tové.

After the acquisition of land, the environmental exploitation of these "valuables" begins after obtaining an operating license issued by the Directorate General of Mines and Geology, which ensures the effective presence of sand in the soil and the remoteness of the areas.



Figure 2. Young men manually loading of a truck in a quarry using shovels.

Mining activities starts at the quarries from 07.00 h and ends at 16.00 h or 18.00 h depending on the demand. Truck loading is provided by laborers (Figure 2). These are organized into small groups of 5 or more people and their leaders in charge. In the township of Mission Tové, the number of quarries is up to 14 in all, the laborers were formed into groups of 100 to 150 members.

In Adétikopé the owners of land employed 10 laborers specifically for the extraction of sand and gravel. Teachers in primary schools were also part of the sand and gravel miners. In the quarry at Mission Tové furrowed, the farmers are always at the mining site. This situation is favored on the one hand, by its activity and on the other through the programming made by the union of transporters, called the Transporters Union of Sand and Gravel (TUSG) to meet the 14 existing quarries. This programming is that all 14 quarries could have an activity one day after three weeks. It should also be noted that in the quarry of Mission Tové, the owner employs from time to time sharecroppers for clearing the land, allowing them to get an idea of the extent of untapped quarry. The Directorate General of Mines and Geology intervenes only at the level of the operating permit and later, in the samples of mineral royalties from the transporters.

Sand mining activities in Mission Tové and Adétikopé

The total number of miners at Mission Tové and Adétikopé were between 250 and 300 per day and about 17 and 40 trucks come to the quarry. Farmers were also being engaged in farming activities in these areas were they the sole landowners. The miners are organized in groups consisting of about 100 to 150 persons. In the quarries of Mission Tové and Adétikopé, the major problem in these mining is the accessibility to the sites.

The poor conditions of roads leading to these quarries and sharing of such roads with trucks have had negative impact on the roads. However, this work is more difficult on the coast than in other quarries.

There are limited quantities of compatible sediment available from dredging to meet the needs of construction projects in Lome. Furthermore, the availability of cost-effective onshore sand resources to meet beach replenishment needs is limited. As such, nearshore sand resources have been identified and used to meet growing needs (Davison et al., 1992); however, the physical environmental impact of sand extraction from borrow sites within the Mission Tové transport zone (typically 5 ft and shallower) have focused sand resource searches offshore in water depths 30 ft and greater (Carter, 1988: 475-480).

Due to the significant interest regarding the use of offshore sand and gravel resources for construction around Lome (e.g. Adétikopé, Mission Tové and Adidogomé area that is close to Ghana), this area was selected for baseline review of offshore sand and gravel resources and as a case study analysis in Togo. In addition, this portion of the country's waters has been the focus of significant efforts to define potential offshore mining sites.

People that are engaged in sand and gravel mining in Lome

Lome for several years and especially before the 1990s has been an attractive center for huge economic activities. It is a city where there is a concentration of population caused mainly by the rural-urban migration. A large proportion of population because of poverty is forced to engage in other economic activities such as

Table 1. Summary of targeted groups in the sample size.

Sites	Farmers	Transporters	Laborers	Total
Littoral	02	15	40	57
Mission Tové	02	10	28	40
Adetikopé	02	10	13	25
Total	06	35	81	122

Source: Targeted groups in the sample size Report (2009).

Table 2. Summary of groups surveyed of sample size.

	Sites	Farmers	Transporters	Laborers	Total
Gulf area	Littoral	02	12	40	54
	Mission Tové	01	06	15	22
Zio area	Adetikopé	01	05	13	19
	Total	04	23	68	95

Source: Groups surveyed Report (2009).

transportation and marketing of sand and gravel. In addition, two surveys of household M.I.C.S. (Multiple Indicator Cluster Survey), on more specific issues in smaller population samples, were conducted in 1997 and 2000. According to population estimates made by the Directorate General of Statistics and National Accounts (2000-2005), the Togolese population has increased (from data provided by the 1981 census and the agricultural census of 1996) from 2,719,569 inhabitants in 1981 to some 4,406,000 inhabitants in 1998. The crude birth rate in 1997 was 45‰ against a crude mortality rate of 13‰. This implies a rate of natural increase of 3.2 % per year and consequently doubling the population every 22 years. Hence, the Togolese population was estimated at 5,598,000 inhabitants in 2008 (IFM, 2010).

The age range of people engaged in sand and gravel mining is between 15 and 60 years. The target population is from the city of Lomé and its surroundings area, including a minority number of people from the city of Tsevié and its surroundings. We have chosen 15 years old because, according to the International Labor Organization (ILO), this is the age at which a person can enter within the margins of the workforce. And, we have also chosen 60 years of age because it is currently the official age of retirement in Togo (Table 1).

Moreover, due to limited resources, the choice of respondents was done at random, at a rate of 10% which will apply to different group for each quarry.

One of the difficulties faced during this survey was retrieving accurate information on the sector's assets. Due to the informal sector, numbers were not available at the Directorate of General Statistics and there was also the problem of site accessibility. Given these challenges

we had to refer to approximated numbers of Unions and officials of the Directorate General of Mines and Geology (Table 2). The size of the targeted population surveyed was 78% or 95 individuals instead of 122 individuals.

This result in an error margin of 1.3 calculated as follows:

$$SE = (S / \sqrt{n}) \times (\sqrt{1 - n/N})$$

Where,

S = standard deviation

n = sample size investigated (95),

N = population size determined before the survey (122)

and n / N = fraction of the sample.

The standard deviation which is the sum of squared deviations is in this case: $S = 27.42$. The average is about 48.

Furthermore, with the rate of 10% that we fixed for validation of our study, we should at least surveyed 55 individuals. This number is determined using the following formula:

$$N = (n \times n') / (n + n')$$

Where,

N = threshold at which the study can be considered valid,
n = inverse of the standard error squared which is simply the inverse square of the rate that we set ($n = 1 / E^2$) that is to say $1 / (0.1)^2 = 100$ individuals, and

n' = sample size fixed before the survey (122)

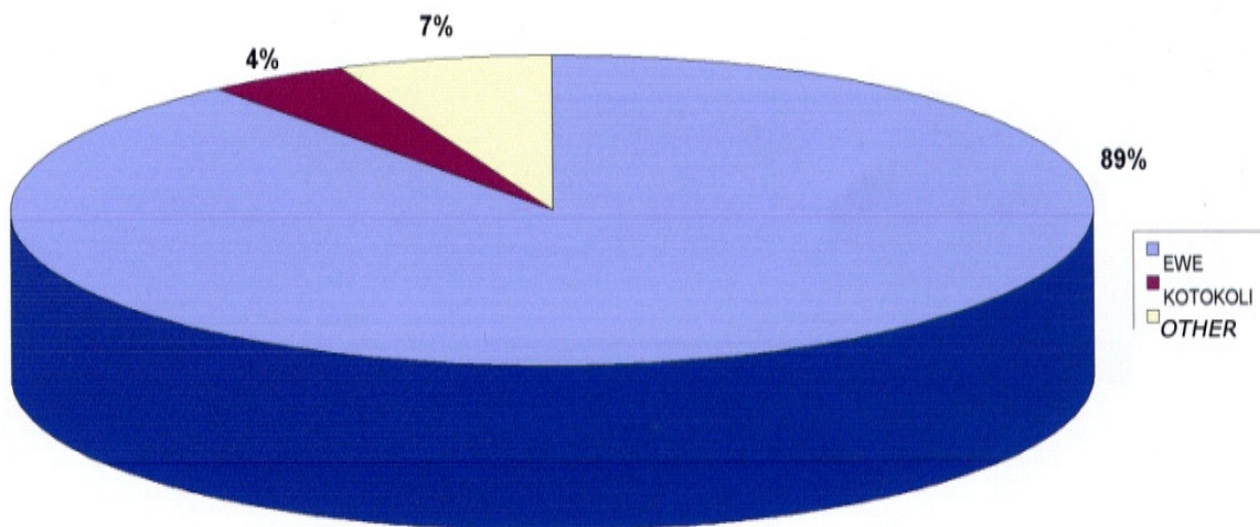


Figure 3. Distribution by ethnic groups in the activity of sand.

Table 3. Summary of Gender and marital status of active population in activity of sand.

Gender	Married	Singles	Divorced	Total	Frequency (%)
Male	53	32	01	86	91
Female	09	-	-	09	09
Total	62	32	01	95	100
Frequency (%)	65	34	01	100	

Source: Gender and Material Status of Active Population in the activity of sand report (2009).

individuals).

It follows from this last analysis, with a number of 95 surveyed being higher than the threshold needed (55 individuals), our study may therefore be validated at 95%.

The Ewe ethnic group dominates the sector with 89%. Kotokoli ethnic follows with 4% and others share the remaining 7% (Figure 3). The dominance of the sector by the Ewe is because it is in their zone of occupation. The Kotokoli, are mainly involved in the transport sector in Togo. The study also revealed that in the 95 respondents, men dominate the activity with 91% of assets leaving only 9% of women (Table 3). The educated people of this population represent 86% against 14% for the uneducated. Among the educated, there is a student (worker to the coast) and those who stopped studying in primary education represent 49% of the educated, 37% reached the secondary and finally 13% the third degree.

The laborers conditions

The laborers are the principal actors in loading sand. They are characterized by their effectiveness at work. out

of the 93% of these laborers 82% are from the Ewe ethnic group, most of them are not educated. However some of them on the mining sites are students. Despite their respective level of education they invest themselves fully in this sand and gravel business. Some of the reasons young people go into quarrying (especially in outlying areas) is that they are from poor family, they don't want to enter apprenticeship and they prefer the loading of sand than furthering studies or learning a trade. Early marriage amongst young people is very common and to raise a family, hence the obligation to support the family. Amongst the 68 laborers interviewed, 60% were married as against 38% for singles and 2% divorced.

The economic situation is worsening. Living conditions of poor laborers, because among them there are people who have learned a trade but due to lack of jobs, they are engaged in loading sand. They work in primitive conditions with the use of archaic tools (shovels, hoes, buckets) and with no guarantee of support in case of accident. They earn an average of 3,000 CFA francs per day. These revenues are used to meet basic needs: food, rent, medical care and those responsible for family,

children's schooling. Concerning health conditions, it should be noted that for all furrowed sites, there is a lack of infrastructure including convenience toilets, shelters constructed for resting, drinkable water. The shelters are mostly made of branches of palm oil, but failing that, they just use shade of trees this applies to all sites on the periphery. In addition, laborers from these sites are exposed to constant risk of collapse of land (often fatal for them) during mining exploitations.

These conditions are the cause of certain diseases such as malaria; stomach disorders, hernias as well as sexual and physical weaknesses are also caused by the difficult working conditions. However, of the 68 respondents, 60% attested to having consulted a doctor but the purchase the prescribed drugs was almost impossible because of the poverty level. To such conditions are compounded with the various social injustices in the distribution of income or accession of new members to groups. This is especially the case at Adétikopé where laborers require newcomers to submit a resume.

Institutions responsible for regulating the mining of sand and gravel

The office of Directorate General of Mines and Geology is responsible for granting permits and licenses to sand and gravel miners, controls and collects mineral royalties. Because of the clandestine nature of many quarries in the periphery, these charges are levied on drivers instead of the farmers or miners at the time of loading the sand. Regarding the quarry of the coastline, there is a reserve state entirely within the jurisdiction of the Directorate General of Mines and Geology. The Ministry of Environment and Forest Resources ensures compliance with existing rules for the use of natural resources while the Ministry for Transport responsible for the control of trucks involved in the activity of sand. Some unions are also involved in the field of sand, but remain subject to the recommendations of the Ministries involved.

Due to the lack of the means to operate, the management is entrusted to Transporters Union of Sea Sand. The Transporters Union of Sea and Sand is responsible for the environmental protection and to ensure the smooth running of activities to avoid confusion. The Directorate General of Mines and Geology is responsible in ensuring that the rules of environmental protection are respected. This exploitation is essential for the survival of the Authority Port of Lome to the extent that it avoids the silting of the harbor and saves on the same blow huge sums to the country for dredging.

Fleet or dump trucks operating in the quarrying areas

According to the Transporters Union of Sea Sand and

Transporters Union of Gravel and Sand, sand truck chargers are actually dump trucks of different sizes about 5 to 12 m³. The majority of these trucks are used vehicles. The trucks are mostly MAN (usually 2 bridges, that is to say 8 rear wheels) which cost around 15 million CFA francs. The price of 6 million CFA francs concerns vehicles on the BERLIET and RENAULT trademark (usually 1 bridge that is to say 4-wheel rear). To this end, our study revealed that of the 23 drivers surveyed, 52% of trucks taking part in this activity are too old to last the next 5 years. Thus, on the coast, these trucks account for 30% (the record of this category). Trucks in good condition are needed in this quarry due to the difficulties encountered by vehicles leaving the quarry after loading. Therefore powerful and good engines are needed on the coast so as not to get bogged down. Old trucks (10 years and more) have more difficulties and do not venture into certain areas. The BERLIET brand vehicles dominate the sector about 52%. This rule is explained partly by the fact that these vehicles are less expensive, and secondly by the fact that spare parts, besides being cheaper, are available. The RENAULT brand vehicles follows with 26% trucks (Figure 4). If we look at the body of trucks, it should be noted that these trucks are almost write offs especially those who attend the quarry of the periphery. However, drivers have responded that they do not rely on the bodywork but rather to engines (Figure 5). Regarding the technical maintenances, most of the drivers reported that they do it regularly. This contrasts with the condition of vehicles/trucks. We found that most trucks are without head lights, some without a "stop light" and others with a defective braking system, worn out tires, etc but continue to run despite the many risks they pose to the rest of road users.

Demand of sand in Lome

The demand of sand in Lome is high. Doe-bruce and Kuevi (2002) have so clearly shown through the Tables (Tables 4 and 5) that in Lome and its surroundings through its urban centre, Lome is the consumer zone of sand. Analysis of these tables shows that urban centers are the main consumers of modern materials for construction of permanent structures. The Maritime region alone takes almost half of housing needs with 12,053 households. The phenomenon of urban sprawl has increased the demand further. Distance is no longer barrier; people prefer more peripheral areas instead of downtown. This explains the fact that these suburbs are home to 65% of the population of Lome. This explains the rapid emergence of new constructions in these neighborhoods.

Supply of sand in Lome

To meet this growing demand, two types of sand are

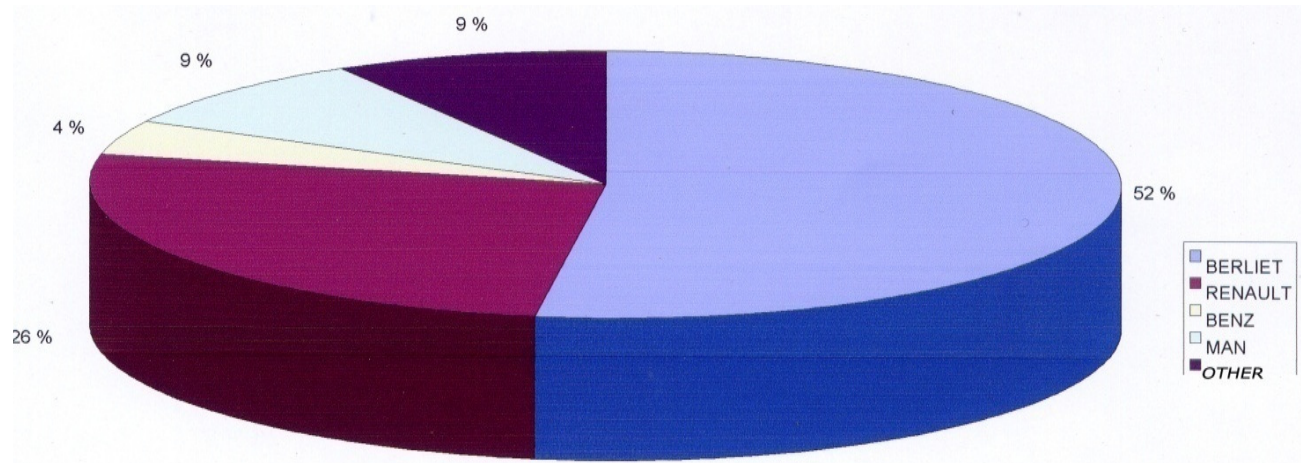


Figure 4. Distribution of different brands of vehicles in the activity of sand.



Figure 5. The state of a dump truck from the activity of sand in Mission Tové.

marketed in Lomé. These are sea sand and silica sand. The sea sand for long appreciated, however, lost some of its value due to high tariffs. Another factor is that it contains some salt. According to the builders the salt crystals rust the iron bars used for construction. This is the why it is advisable to primarily desalt it before use. Even though the sea sand has lost its value, it still remains in high demand the city of Lomé. As for the silica sand it does not contain salt, but has the propensity to consume more cement. This sand is increasingly appreciated by customers because it's affordable.

Socio-economic benefits of sand and gravel mining

The quarrying industry, and associated other transport and related service industries have had an important role

in the local economy of Togo for many years. On a national basis quarrying has traditionally been probably second only to agriculture as a source of rural employment. The industry has been particularly important in the Lomé area since at least independence. However, the total range of skills is considerable and in 2007 one large employer identified a lot of jobs associated with the quarry ranging from farm manager to laborers' and truck drivers. Although the industry is still male dominated, there are a number of women who are engaged in small business enterprises. The mining of sand and gravel in Togo has created jobs for youths. Social and economic parameters that can improve social conditions (such as income and local revenue generation), these revenue is used in most part to meet the basic needs of the family including food, to pay tuition for children especially since all farmers surveyed were married and had a lot of

Table 4. Housing needs in Togo, Maritime area, urban and rural areas compared to the population estimated in 2000.

Regions	Total population	Annual growth (%)	Estimate per year	Household estimate
Maritime Gulf	1, 907, 000			
Lome town	1 ,130, 000	6.4	72,320	12,053
Urban areas	5,540, 000	2.3	12,742	2 ,124
Rural areas	2, 945, 000	7.6	76,570	12,762
Nationwide	4, 629, 000	-	161,632	26,939

Source: KUEVI AKOE D. and DOE-BRUCE (April 2002: 14); used also by TCHAMBA T.T. (2006).

Table 5. Allocation of concessions by the materials used for wall construction.

Observation	Hard (concrete, stone, cinder block)	Semi hard	Clay uncooked brick	Other
Together (%)	33	11	52	4
Urban population (%)	62	16	18	4

Source: KUEVI AKOE D. and DOE-BRUCE (April 2002: 12); used also by TCHAMBA T.T. (2006).

Table 6. Daily earnings of laborers in the functions of various careers.

Sites	Maximum revenue (CFA francs/day)	Minimum revenue (CFA francsday)	Average (CFA francs/day)
Coast	2 ,800	1,600	2, 200
Adétikopé	3, 650	2, 000	2 ,825
Mission Tové	5, 500	2 ,350	3, 925
Total	11, 950	5, 950	8, 950

Source: Daily Earnings of Laborers in the Functions of Various Careers Report (2009),

responsibility by looking after their family.

Table 6 shows that the daily laborers earn almost the same income as that of transporters unless they make more effort.

Then, the incomes of other loads are distributed proportionally among the group of people including those pioneers. With regards to Adétikopé, as stated above, the subgroups (five or more), there are also small businesses that are organized around the quarries. They include sales of food and pharmaceuticals from Nigerians beverages ("Sodabi" or local drink "Tchoucoutou") containing stimulants.

Environmental impact of sand and gravel mining in Lome

Research results from this survey, shows that there are significant environmental costs associated with quarrying, including noise, dust, visual intrusion, loss of amenity and

damage to biodiversity (Figure 6). The Government believes that there is a case, in principle, for a tax on the extraction of aggregates. Draft legislation for a tax on, sand and gravel used as aggregates is not well coordinated. Sand and gravel mining is necessary to provide much of the materials used in traditional buildings. However, like many other man-made activities, sand and gravel mining causes a significant impact on the environment. In particular, the method of mining and proximity to the capital city of Lome gives rise to including noise pollution, air pollution, damage to biodiversity and habitat destruction.

Air pollution

According to (Matt Kallman, 2008), outdoor air pollution alone causes an estimated 800,000 deaths each year (an additional 1.6 million premature deaths are attributable to indoor air pollution, the subject of a previous (Earth Trends



Figure 6. State of the feeder road during dry season at a site in Adétikopé.

Monthly Update). In many urban areas, especially in the developing world, air pollution is the single greatest environmental threat to human health (WDI, 2007).

Dust from mining sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry, for example limestone quarries produce highly alkaline (and reactive) dust. In Togo, most of the roads are not tarred, they are dusty and bumpy during transportation of sand and gravel a lot of dust particles which sometimes can lead to road accidents.

The air pollution is not only a nuisance (in terms of deposition on surfaces) and possible effects on health, in particular for those with respiratory problems but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival. Hence patients prone to heart disease may one day be told by physicians to avoid not only fatty foods and smoking but air pollution too (Science daily, 2008).

Noise pollution

Some countries more than others, some cities more than others, some streets more than others... yet noise is everywhere and noise problems will continue to increase in time (Hans, 2006). No one on earth can escape the sounds of noise- an unwanted, disturbing sound that causes a nuisance in the eye of the beholder. Noise is a

disturbance to the human environment that is escalating at such a high rate that it will become a major threat to the quality of human lives (Daniel, 2002). Unfortunately, quarrying involves several activities that generate significant amounts of noise. It starts with the preparatory activities, such as establishing road or rail access, compound and even mineral processing facilities. Next is the process of exposing the mineral to be extracted and this is usually done by removing the top soil and other soft layers using a scraper, or hydraulic excavators and dump trucks. The excavation of the mineral itself will involve considerable noise. Following this, the use of powered machinery and dump trucks to transport the materials to the construction sites as well as possibly processing plants to crush and grade the minerals, all contribute even more noise to the environment.

Although noise is a significant environmental problem, it is often difficult to quantify associated costs. An OECD report on the social costs of land transport identified four categories of impact from transport noise (OECD, 1995): i) productivity losses due to poor concentration, communication difficulties or fatigue due to insufficient rest; ii) health care costs to rectify loss of sleep, hearing problems or stress; iii) lowered property values iv) loss of psychological well-being.

Damage to biodiversity

One of the biggest negative impacts of quarrying on the environment in Togo today is the damage to biodiversity. Biodiversity essentially refers to the range of living



Figure 7. Effect of an exhausted quarry runoff that threatens the rails of Adétikopé.

species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. Biodiversity conservation is important as all species are interlinked, even if this is not immediately visible or even known, and our survival depends on this fine balance that exists within nature.

Quarrying carries the potential of destroying habitats and the species they support. It is causing such damage to the bio-diversity as well as catastrophically resulted into pollution, Islandisation, introduction of alien species, over-harvesting of natural resources and destruction of habitats (Roda, 2008). Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts – such as changes to ground water or surface water these has caused some habitats to dry out and others has become flooded. Even noise pollution has had a significant impact on some species and affects their successful reproduction. If the authorities that are concerned with mining activities in Togo had carefully planed and manage the daily activities of these miners, this would have minimize the effect on biodiversity and in fact, quarries would have also provide a good opportunity to create new habitats or to restore existing ones.

Quarry waste

Again, like many other man-made activities, quarrying involves the production of significant amounts of waste. Some types of quarries do not produce large amounts of permanent waste, such as sand and gravel quarries, whereas others will produce significant amounts of waste material such as clay and silt. The good news is that they are generally inert and non-hazardous, unlike the waste from many other processes. However, there is still potential for damage to the environment, particularly with water contamination. For example, suspended particles may imbalance freshwater ecosystems. Large amounts of solids can also exacerbate flooding, if it is dumped on the flood plains. The accumulation of waste by-products

will still need to be stored and managed somewhere that will not affect the environment in an adverse manner. Furthermore, the treatment and disposal of the waste may produce more negative impacts on the environment.

While quarries can cause significant impact to the environment, with the right planning and management, many of the negative effects can be minimized or controlled and in many cases, there is great opportunity to protect and enhance the environment, such as with the translocation of existing habitats or the creation of new ones.

Sand mining in quarries on the outskirts has damaged in the landscape. It leaves a chaotic landscape with isolated knolls in some places. The vegetation is completely destroyed. The soil becomes vulnerable to erosion and runoff waters as a result of the destruction of layers this has also threaten rail tracks (Figure 7).

These quarries, mostly underground, remain as such after depletion. No filling process accompanies the post exploitation. This results in large areas which serve as points of accumulation for runoffs. These are potential breeding grounds for mosquito larvae during the rainy season; these mosquitoes can cause malaria which is a killer disease.

The exploitation further accentuates the problem of coastal erosion which continues to the Eastern Port. Indeed, the swell drops items which it carries towards Western Port. It became more violent beyond the dam and through breakers (waves) it proceeds in undermining the coast in the areas to the east of the port. This is the consequence of the deficit coastal sedimentary (sand and gravel) related to development work and sampling of materials on the rivers especially the Volta.

CONCLUSIONS AND RECOMMENDATIONS

Sand and gravel mining is an important sector for the development of the Togolese economy. These resources (sand and gravel) could be widely used if the conditions are favourable. According to (Neil and Alexandra, 2007),

a key tenet of sustainable development is that resources and opportunities should be widely shared in the society. However, the trade of sand and gravel is faced with the challenges of transportation which is influencing pricing. The poor state of roads is somewhat of a hurdle for this particular activity that puts the trucks to the test. In monitoring the exploitation, DGMG has a monopoly on all quarries but the organization of the activities and functioning of each depends on unions. It exerts to this effect its authority through levying taxes on miners. It appears clearly that the disengagement of the state in the exploitation of sea sand allows for better monitoring of activities although the Transporters Union of Sea Sand manages the quarry as a business. However, the sustainability and environmental implications can only be addressed through governmental policies which will balance between the business and the sustenance of the environment. Recent studies have shown that the planning for extraction of aggregates requires the consideration of both sand extraction in relation to available sediment resources and also environmental impacts within the context of future demand for sand (Leeuw et al, 2010).

The exploitation of sand and gravel has adverse effect on the environment. The many scars of after- exploitation outlying areas pose many problems for residents in transforming itself indirectly in artificial lakes during the rainy season. Also note that in these sites, trucks encounter more difficulties with regards to transporting sand. Indeed in these areas, feeder roads were of dirt and do not facilitate the movement of these trucks. This slows slightly supplies of sand and affects pricing. As for the exploitation of sandy coastline, it should be noted that it is essential to ensure the effectiveness of the port. However the main problem is the operating frequency. In this regard, no study has yet been undertaken to accurately determine the quantities harvested annually and the threshold to be taken so as not to threaten the stability of the coast through coastal erosion. With the phenomenon of urban sprawl, we witnessed an increase in the demand for sand. This explains the high operating frequencies of sea sand in recent years. This has as consequence of increasing aggressiveness of the sea vis-à-vis our coasts (West of Autonomous Port of Lome). Good transport network improves living conditions.

"Nowadays with the tarring of the section Sokodé - Kaboli, transporters from Kaboli -Koussountou pass through Tchamba City to join the National Highway No. 1 from Sokodé" (Agbere,2006). The present study also showed to this effect that feeder roads are essential for the transport and distribution of sand in the city of Lome and the surrounding area, especially since the urban sprawl has taken on considerable proportions more than three decades ago.

The primary environmental impact from aggregate, sand and gravel mining in Togo-Lome is the degradation of the air quality from stack emissions and disturbed

areas on the mine. Surface and groundwater quality impacts from such mine are relatively benign in Lome due to the tropical climate and lack of perennial streams. Other environmental and social impacts include increased traffic on poor conditions of roads; cumulative impacts as construction materials are hauled, stockpiled, and spread on highway and building construction projects; and aesthetic degradation caused by aggregate, sand and gravel mines in major viewsheds.

Mitigating the environmental impacts of aggregate, sand, and gravel mines could be improved by making some changes to existing regulations and, most importantly, by controlling development and sprawl in both urban and rural areas in Togo. The purpose of environmental policy is to change consumption and production patterns in ways that enhance welfare, broadly interpreted (Geoffrey and Bengt, 2007).The following recommendations are made to better manage environmental problems and mitigate the effects of aggregate, sand and gravel mines in Togo:

1. Deny operating permits to new operations if inactive or abandoned mines could be re-opened to provide the same resource. New operations should be permitted only if no other suitable materials are available in a given area. This would make better use of existing resources in areas where disturbance has already occurred and prevent the random and incoherent development of aggregate sand and gravel mines.
2. Enforce existing mine and mill air quality permits strongly and consistently. This would require state inspectors and making certain "problem" mines and mills to come into compliance and set an example for all operations.
3. Deny permits to mines that propose locating in areas unsuited for mining. Mines should not be allowed to operate near Lome and "sacred sites," residential neighborhoods, historic rural communities, or in areas where the resulting "scar" will ruin a scenic viewshed.
4. The assessment of environmental impacts of any transportation project is usually required by law in order to promote optimal development planning, that is, planning that maximizes benefit but minimizes adverse effects on the environment (Frederick,1995) The proliferation of illegal quarrying in the peripheral areas constitutes a shortfall to the state. It would be wise for the state to take in hand not only the exploitation but also the sale of land. This implies that the state should resume the sale of land since it has been for a long time been controlled by the lineage communities in Togo. This will allow the state to have full control of the distribution of sites operating in the country. The agrarian and land reform (ALR, Act of 1996) stipulates that land belongs to the state.
5. There is no specialized body to control all channels of sand and gravel mining. This is because of lack of sufficient staff. At Adétikopé, there are two officers for the

office of the Directorate General of Mines and Geology. It is recommended that equipping the DGMG in all-terrain with vehicles to make surprise raids and travel around all areas of exploitation will minimize illegal mining.

6. After-exploitation constitutes a problem in the quarries of the periphery because of the filling problem. At this stage the Ministry of the Environment and the Directorate General of Mines and Geology should conduct joint operations to track down the owners of these clandestine quarries so that they take their responsibility with respect to the marks left on the landscape. Regarding the coastal erosion which continues to the eastern port of Lomé, it would be good if a new dike constructed to retain the sand and push erosion to other horizons.

Finally, although it is obvious that sand harvesting can not be completely stopped, the government and other stakeholders should develop new laws and policies which should aim at promoting sustainable harvesting by striking a balance between environmental conservation and business proceeds (Ayoti, 2008). These endeavours should also include any organization that will be involved in sand mining and should be registered with the relevant government and international monitoring institutions. The miners should be given a license for business only if they are legally committed to carry out pre and post harvest environmental impact assessment.

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