

## Original Research Article

### Evaluation of environmental and social impacts of the extraction quarry of raw materials: case of the ETOA clay quarry, Yaounde 3

#### Abstract

This research work is based on the evaluation of environmental and social impacts of the extraction quarry of raw materials at the Etoa clay quarry in Yaounde III and to propose measures aimed at reducing the different negative impacts.

This work was carried out during the period of June 2015 to February 2016 followed by an appropriate methodology to meet the outlined objectives: (1) using the matrix of Leopold and Martin fecteau for the identification and evaluation of impacts, (2) cartography of study zone using ERDAS and QGIS and (3) questionnaire surveys to acquire water consumption demographics were all part of our study. It consisted of under taking site visits to the clay quarry, take pictures, and make household surveys and direct observations, analysis and interpretation of collected data.

The results show that, extraction of clay from this area has negative impacts of 76.2 % with the most significant on the environment being soil degradation, loss of biodiversity and farmland. Globally, most of the negative impacts are irreversible. The positive impacts are of 23.8 % and the most important are, construction of acces road to the clay quarry, protection of the entire clay quarry, creation of job opportunities and increase in economic activities. As a measure to mitigate the negative impacts, shrubs will be planted round the site and exploitation will follow an exploitation plan to create acces in to the quarry. At the end of the extraction of clay this area will be transformed in to fish farming and those whose crops will be touched will be compensated.

The different mitigation measures proposed are to reduce or if possible repair all the negative impacts (all the residual negative impacts will all have a minor importance) and this will lead to the acceptance of this project in the area on an environmental point of view and will contribute to the promotion of the sustainable development of Etoa and its environs.

Key words : Evaluation, environmental impact, social, clay quarry, Etoa.

#### Introduction

As the world's population grew, the need for more resources also increased. In order to meet the increasing demand for these resources, more industrial activities also grew around the world both in developed and developing countries. These increased industrial activities over the years did not consider the resulting environmental degradation such as water, air and land pollution. The degradation was not considered along with the intended industrial growth, thus, the value proposition of much economic activity ignored these "costs".

Typically, the enterprises that produced these negative effects on the environment were not held accountable for them. They externalized these costs and the society suffered the impacts. Many ecosystems have been adversely affected to the point where they can no longer withstand or recover from natural disasters resulting from human activities and such disasters include global warming, flooding and extreme weather conditions, land degradations etc. These negative consequences on our environment have drawn a lot of attention on a global scale (Nkechinyere, 2010).

Quarrying activities are crucial components of socioeconomic development, as they provide the key material required for building and infrastructure, as well as decent incomes through numerous job opportunities. However, although these activities constitute an important pillar of economic sustainability, quarrying is a short-term action with long term impacts affecting soil, water, and other natural resources, not to mention the negative effects on human health (Carlaet *al.*, 2014).

The Local Materials Promotion Authority (MIPROMALO) was created by decree n° 90/1353 of September 1990 and is a public establishment with juridical or legal and financial autonomy under the technical supervisory of the Ministry of Scientific Research and Innovation. MIPROMALO is incharge of the present extraction of clay material at the Etoa clay quarry in Yaounde III sub-division and extraction of clay in this area has been going on since the discovery of clay material in this area (Ngon, 2007).

In Cameroon, and especially in Yaounde, studies carried out so far by researchers in the domain of geology has led to the increase in awareness in the mining industry. The raw material such as clay is extracted in clay quarries and used as local materials in the construction of houses, ceramics, pottery, etc. This has brought concern to the MINEPDED, MINRESI, MINEE and Yaounde urban council as of how each quarry must be restored and rehabilitated during and after exploitation. The presence of abandoned quarries with an increase in size of clay pits leads to a change in the aesthetics of the area, environmental degradation and other environmental impacts on man as well.

The city of Yaounde cannot really boast of a well-defined land use by 2035 if all the exploitation quarries are abandoned and no rehabilitation and restoration works are done. This may lead to several negatives impacts on the environment.

This study is to contribute to the restoration and rehabilitation of the quarry for better management of raw materials in the capital city of Yaounde, and it is based on the evaluation of environmental and social impacts on extraction quarries of raw materials in the Etoa clay quarry of Yaounde III sub-division. This extraction of raw materials is carried out by the enterprise MIPROMALO. The extraction of raw material can be associated to positive and negative impacts of man and the environment.

The general objective of this study is to bring out the environmental and social impacts resulting from the exploitation of clay material in the Etoa clay quarry of the Yaounde III sub division.

This general objective will be realized through the following specific objectives :

- to identify impacts of the project on the environment;
- to characterise and evaluate impacts of the project and land use on the environment;
- to elaborate an environmental management plan.

## **Material and methodology**

### **Identification of project impact**

The maps were collected and the study area delineated based on limits. Visual interpretation led to false colour composition and assigning the zone of interest leads to training site identification. Maximum likelihood classification was done which gives supervised classification and post classification process. Separability test was also done in conformity to the GPS reading collected from field work and ground verification was done. Maps of required zones were obtained from 1989 and 2015 which gives the great change for over 26 years in this area.

Identification of impacts was done using Leopold's grid based on the potential interaction (positive and negative) that could exist between the activities of the project (summary project) and environmental components. Impact receptors, valorised elements of the environment that could be affected by the construction work.

These valorised elements are grouped into three components :

- physical milieu;
- biological milieu;
- human milieu (economic activities, employment, health and security).

The sources of impacts are the different activities of the project that can affect valorised elements. The descriptions of impacts consist in presenting for each identified impact the cause, manifestation and eventually the effect. Identification of impacts was also done during the excavation of clay material in this zone.

### **Characterization and evaluation of impacts**

Characterisation of impacts involves the description of impacts using well defined criteria to evaluate them in a way to determine their magnitude and order of priority in which these impacts could be avoided, mitigated or compensated. To this, the criteria used for characterisation of impacts are:

- the nature of impact which could be positive or negative;
- interaction of impacts which could be direct (D) or indirect (ID);
- the extension of impact, linked to spatial dimension such as the surface area affected. The three levels to measure this indicator are: a) regional extension (R), characterise an impact that can touch 100 % of the zone of project site or above; b) local extension; describe an impact that is limited on the site and c) punctual extension; characterise impact localized on a precise point;
- the intensity of impact is relative to the degree of disturbance in the milieu, sensibility, vulnerability and scarcity of the affected components, it could be low, average, or high;

- the occurrence of impact determines the probability in which an impact can be produce, it could be certain or probable;
- the reversibility of an impact indicates whether an impact is reversible (RE) or irreversible(Irr).

The gravity of an impact which is determined by the superposition of these indicators below permits the evaluation of each impact of the project. These three levels are used to describe an impact ; major (M), average (Av) and minor (Mi); major impacts are those that cannot be neglected. There is an obligation to provide mitigation and /or compensatory measures, average impacts are noticed thus mitigation measures are provided, and minor impacts are not very important but there is need for compensation. Impacts are classed into significant (Sig) and insignificant (insig). This classification is a result of a strict way of identification and evaluation. Thus, significant impacts are those that have major effect on the environment and for which mitigation measures are to be provided. The following table illustrates parameters for impact characterization.

Table 1. Parameters for impact characterization.

| Criteria for characterization | Value of characterization |
|-------------------------------|---------------------------|
| Nature                        | Positive                  |
|                               | Negative                  |
| Duration                      | Short term                |
|                               | Medium term               |
|                               | Long term                 |
| Intensity                     | High                      |
|                               | Average                   |
|                               | Low                       |
| Reversibility                 | Reversible                |
|                               | Irreversible              |
| Interaction                   | Direct                    |
|                               | Indirect                  |
| Extension                     | Regional                  |
|                               | Local                     |
|                               | Punctual                  |
| Gravity                       | Major                     |
|                               | Average                   |
|                               | Minor                     |
| Occurrence                    | Certain                   |
|                               | Probable                  |

The evaluation of each impact was done by crossing three of the above criteria (intensity, extension and duration) using the evaluation grid adopted by Martin Fecteau because of its simplicity (Table 2). The aim of this evaluation is to give absolute importance to an impact, thus impact evaluation permits the attribution of a relative value to an impact which could be major, average or minor which occur during the exploitation and construction phases.

Table 2. Evaluation matrix of impacts (Martin Fecteau, 1997).

| Intensity | Extent   | Duration  | Significance of impact |         |       |
|-----------|----------|-----------|------------------------|---------|-------|
|           |          |           | Major                  | Average | Minor |
| High      | Regional | Permanent | +                      |         |       |
|           |          | Temporary |                        | +       |       |
|           | Local    | Permanent | +                      |         |       |
|           |          | Temporary |                        | +       |       |
|           | Punctual | Permanent |                        | +       |       |
|           |          | Temporary |                        |         | +     |
| Average   | Regional | Permanent | +                      |         |       |
|           |          | Temporary |                        | +       |       |
|           | Local    | Permanent |                        | +       |       |

| Intensity | Extent   | Duration  | Significance of impact |         |       |
|-----------|----------|-----------|------------------------|---------|-------|
|           |          |           | Major                  | Average | Minor |
|           |          | Temporary |                        |         | +     |
|           |          | Permanent |                        | +       |       |
|           | Punctual | Temporary |                        |         | +     |
|           |          | Permanent |                        | +       |       |
| Low       | Regional | Permanent |                        | +       |       |
|           |          | Temporary |                        |         | +     |
|           | Local    | Permanent |                        | +       |       |
|           |          | Temporary |                        |         | +     |
|           | Punctual | Permanent |                        |         | +     |
|           |          | Temporary |                        |         | +     |

The proposed environmental measures regroup actions, corrective dispositive, alternative management modes and alternative measures to correct, mitigate, compensate, eliminate every negative impact or enhance positive impacts. Efficiency, cost, adaptation to the Cameroonian context and feasibility are among the development of these criteria measures.

Indicators and monitoring of auditors/supervisory. The indicators and verifiers have been defined. An indicator is a quantitative variable for measuring the disturbance caused by an activity in a location and during a given period. An auditor is a source that provides the information necessary for obtaining objectively verifiable indicators.

***Environmental and Social Management Plan***

This is a set of specifications that lists all environmental measures and practices that the company responsible for carrying out the work must observe scrupulously. These measures are developed in consultation with stakeholders (public consultation).

**DATA ANALYSIS**

In this study, information gathered through interviews, observations, questionnaires and from the maps of 1989 and 2015 was analysed using spread sheet program such as Microsoft word 2010, Excel 2010, QGIS 2.8.1 and ERDAS to come out with maps, averages, percentages, tables and others. The mapping of the study area is made using QGIS 2.8.1 and ERDAS software. The analysis of the data will be to bring the results on : Identification and description of impacts, characterization and evaluation their importance, propose mitigation measure and finally the elaboration of the environmental and social management plan.

**Results**

**Identification of impacts of the extraction quarry of raw materials**

The analysis of questionnaire shows that most of the inhabitants of Etoa and its neighbourhood are natives of the center region, the Yandas (about 70 % of respondent) and are owners of land and houses. The present land of the clay quarry is owned by the natives of this zone. The analysis of the 1989 and 2015 maps of this zone shows that since the start of the exploitation of clay in this zone, there has been some environmental degradation.

Before the exploitation of clay quarry in this area, this zone was considered a natural area with the presence of high cover of vegetation, low build up houses and hydrological network intact in this area. After the analyses of the map of 1989 which was before the start of project in this zone (using the remotely sensed method) it was discovered that, out of the 288.81 hectares of total surface area of study zone, vegetation cover was 400 hectares, build up area was 200 hectares and hydrology was 80hecters. This could be seen in the fig.1 below.

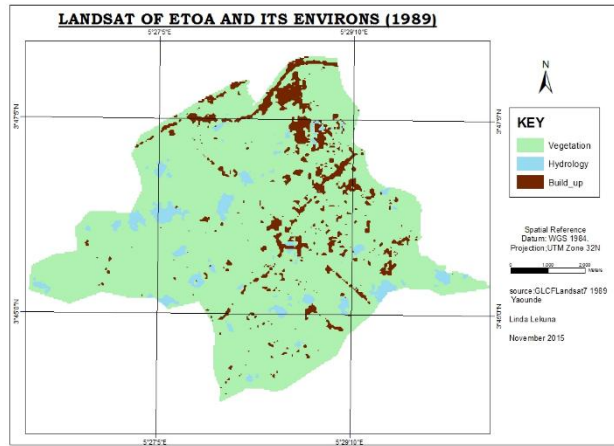


Fig.1. Landsat image of Etoa and its environs of 1989.

The histogram below in Fig.2.shows the results from the evaluation of the landuse pattern in the Etoa and its environs on various components of the environments (vegetation, buildup and hydrology).

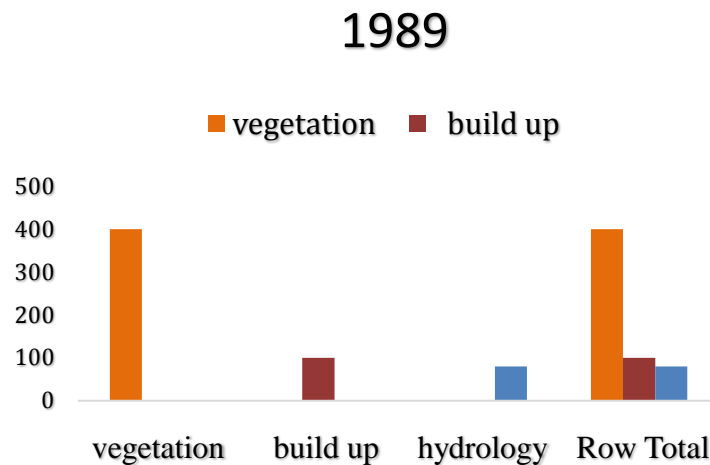


Fig.2. Evaluation of vegetation cover, build up area and hydrology of Etoa and its environs of 1989.

The analyses of the area with the present exploitation of clay material permits to bring out all the possible impacts that are generated by the project to its immediate environment. The environmental component analysed is the physical, biological and the socio-economic milieu. The study area is analysed using the remotely sensed method of analysing the map of 2015. Vegetation cover shows that it covers 200 hectares of land, buildup area covers 240 hectares of land and hydrology covers 185 hectares of land. Fig.3. Below gives a clear view of the present situation.

Land use of the urban growth is estimated by time series analysis of satellite Landsat images. Spectral indices calculated from the images are used to evaluate change in buildup area, vegetation and hydrology. Due to rapid urban growth in developing countries (Cameroon) buildup areas have been dramatically expanded to suburban area. From the comparison between the time series Landsat images of 1989 and 2015, many vegetated areas and bare ground area of the 1989 images are changed to buildup areas in the 2015 newer images.

Vegetation cover has reduce from 69 % to 32 % causing a great loss of biodiversity, hydrology increase from 14 % to 30 % as excavation of clay materials increases every year leaving behind many clay pits filled with water. Build up area increases from 17 % up to 38 % as the population also increase and this is a factor that should not be neglected in the analysis of socio-economic. The inhabitants of this zone (the Yandas) practice subsistence agriculture, based on the production of food crops (cassava, plantain, maize, banana, okro,...) for local consumption and not for exportation. Agriculture constitute the principal source of revenue, hence expropriating people on a land of 5hectares will be a handicap to the population of this locality if appropriate measures are not taken.

The presence of this clay pits are just about 5m away from the river Mefou which joins to the River Mfoundi and goes round to Mbalmayo where it is captured and treated as source of drinking water to the population of Yaounde town.

Exploitation of clay here is done in a disorderly way making the zone a risk zone. Heavy woods are destroyed including the destruction of raphial palm found in the area. (Fig.3 below shows landsat image of Etoa and its environs of 2015).

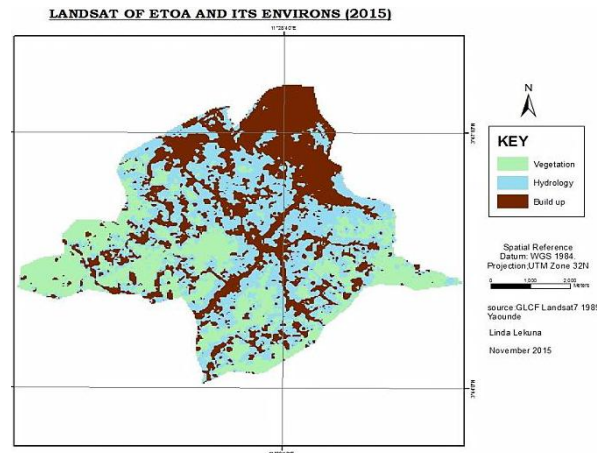


Fig.3. Landsat image of Etoa and its environ of 2015.

The histogram below in Fig.4.shows the results from the evaluation of the landuse pattern in the Etoa and its environs on various components of the environments (vegetation, buildup and hydrology) on the present situation.

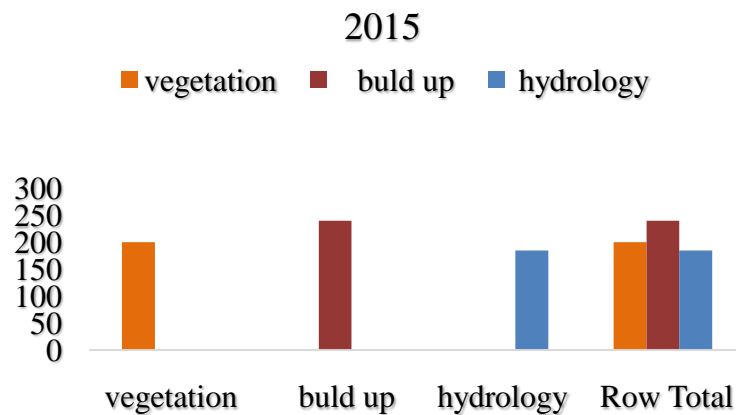


Fig.4.The evaluation of vegetation cover, build up area and hydrology of Etoa and its environs in 2015.

The evaluation of the landuse pattern (vegetation, build up and hydrology) of this area shows a great change in the different environmental components. Vegetation in this area has drastically reduced due to deforestation and mans activities in the area. Build up area (houses, roads, schools, ...) has increase while the high demand for clay material for burnt bricks has also lead to the increase in excavation of clay and consequently an increase in the water surface in this area. The table below shows the various percentage change in the different environmental components from 1989 to 2015 (Table 3.).

Table. 3. percentages of landuse of 1989 and 2015 in Etoa and its environs.

| component<br>Year      | vegetation | Build up | hydrology |
|------------------------|------------|----------|-----------|
| 1989                   | 69%        | 17%      | 14%       |
| 2015                   | 32%        | 38%      | 30%       |
| 1989-2015(%<br>change) | 37%        | 21%      | 16%       |

Spectral indices calculated from the combination of multi-bands images have been widely used to calculate vegetated and bare ground area in remote sensing technology. The normalized difference vegetation index (NDVI) which is one of the powerful indices to evaluate vegetated areas in satellite images is used. Below is Fig.5 that shows the landuse in Etoa and its environs of 2015.

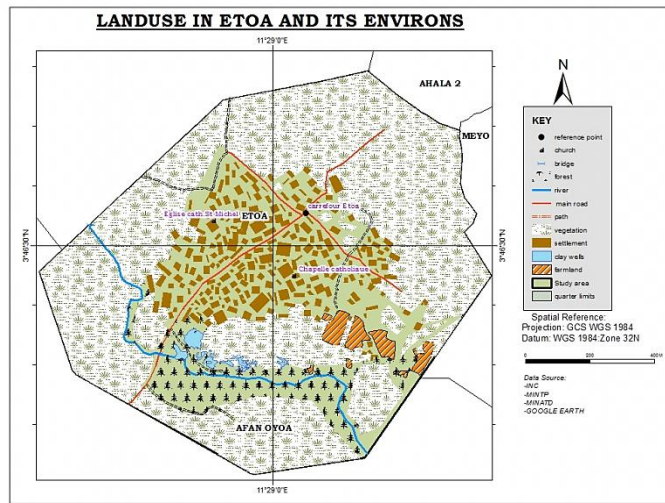


Fig.5. Land use pattern of Etoa and its environs (2015).

**Characterisation and evaluation of impacts**

Table 4. Characterization of impacts.

| Components of the milieu | Source            | Impacts   | Nature                                   | Inter action | Du ration | Ext ent | Inte nsity | Occ urrence | Rev ersibilit y | cum ulative Effect | relat ive Import ance |    |
|--------------------------|-------------------|---|--|--------------|-----------|---------|------------|-------------|-----------------|--------------------|-----------------------|----|
| PHYSIC AL MILIEU         | Air               | -Production of gas, smoke and other polluting substance (co,co <sub>2</sub> ,pb...)                                       | Air Pollution                            | -            | ID        | Lt      | L          | lo          | Cer             | Rev                | No                    | Mi |
|                          | Soil              | Ground works  | -Soil erosion<br>-Loss of soil fertility | -            | ID        | Lt      | P          | lo          | Cer             | Rev                | No                    | Mi |
|                          | Surface water     | -Use of fuel from excavators<br>-fuel washed by water in to the clay pits and river<br>-Maintenance of machines(vehicles) | -Pollution of surface water              | -            | ID        | Lt      | L          | Av          | Cer             | Rev                | Yes                   | Mi |
|                          | Underground water | -Use of fuel<br>-Maintenance of machines  | -Pollution of underground water          | -            | D         | Lt      | L          | lo          | Cer             | Rev                | Yes                   | Mi |

| Components of the milieu |                      | Source   | Impacts  | Nature | Interaction | Duration | Extent | Intensity | Occurrence | Reversibility | Cumulative Effect | Relative Importance |
|--------------------------|----------------------|--|--|--------|-------------|----------|--------|-----------|------------|---------------|-------------------|---------------------|
|                          | Acoustic environment | -Excavation of clay  | -Noise during working hours                        | -      | D           | S        | L      | lo        | Cer        | Rev           | No                | Mi                  |
|                          | Landscape            | -Use of fuel engines, presence of workers clearing the site<br>-Removal of wood from the clay pits | -Loss of natural beauty of area (Aesthetic)        | -      | D           | Lt       | L      | lo        | Cer        | Rev           | No                | Mi                  |
| BIOLOGICAL MILIEU        | Flora                | -Presence of workers clearing the site<br>-Exploitation of clay and deforestation                  | -Destruction of crops, vegetation and biodiversity | -      | D           | Lt       | L      | Av        | Cer        | Rev           | No                | Ma                  |
|                          | Fauna                | -Presence of workers<br>Exploitation of land   | -Destruction of habitat and biodiversity           | -      | D           | Lt       | L      | lo        | Cer        | Irr           | No                | Av                  |

Table 5. Characterization of impacts.

| Components of the milieu |                     | Source  | Impacts                                      | Nature | Interaction | Duration | Extent | Intensity | Occurrence | Reversibility | Cumulative Effect | Relative Importance |
|--------------------------|---------------------|---|--|--------|-------------|----------|--------|-----------|------------|---------------|-------------------|---------------------|
| SOCIO-ECONOMIC MILIEU    | Job opportunities   | -Recruitment of workers from different domains    | Job creation                                 | +      | D           | Lt       | Re     | lo        | Cer        | Rev           | No                | Av                  |
|                          | Economic Activities | -Workers from other areas                         | Increase in economic activities and revenues | +      | D           | Lt       | Pro    | lo        | Cer        | Rev           | Yes               | Av                  |
|                          | Health and Security | -Circulation of heavy vehicles and the excavators | Risk of accident                             | -      | D           | Lt       | L      | Lo        | Cer        | Irr           | Yes               | Mi                  |
|                          |                     | - Presence of workers from other areas            | respiratory infection during the dry seasons | -      | I           | Lt       | L      | Av        | Cer        | Irr           | Yes               | Av                  |

| Components of the milieu |                              | Source   | Impacts   | Nature | Interaction | Duration | Extent | Intensity | Occurrence | Reversibility | cumulative Effect | relative Importance |
|--------------------------|------------------------------|--|---|--------|-------------|----------|--------|-----------|------------|---------------|-------------------|---------------------|
|                          |                              | Source of water                                | Pollution of underground water                                  | -      | D           | S        | L      | lo        | Cer        | Rev           | Yes               | Mi                  |
|                          | Social security and conflict | -Recruitment of workers from other areas       | Risk of conflict between the population, workers and land owner | -      | I           | Lt       | L      | lo        | Cer        | Rev           | No                | Mi                  |
|                          |                              | -Liberation of farm land                       | Conflict link to compensation                                   | -      | D           | Lt       | L      | Av        | Cer        | Rev           | No                | Mi                  |
|                          | Livelihood                   | -Transportation of clay material to enterprise | Improvement of Livelihood                                       | +      | D           | Lt       | L      | Av        | Cer        | Rev           | No                | Av                  |
|                          | Education                    | -Exploitation of clay materials                | Scientific Research   | +      | ID          | Lt       | Re     | Hi        | Cer        | Rev           | No                | Ma                  |

Key: D: Direct, ID: indirect, L: local, lo: low, Av: average, Pro: probable, Cer: certain, Mi: minor, Ma: major, Rev: reversible, Irr: irreversible, Re: Regional, Lt: long time, Hi: High.

### Environmental management plan

The objective of an EMP is to describe the measures, actions and means that will be required during the construction and exploitation phases of a project. It also considers the worries or preoccupation of the population during public consultations.

An EMP is a tool that aims at preventing environmental risk, respect of norms, regulations, realization of projects following the principles of good management and implement measures of survey and control of environmental risk. Preventive and or corrective measures are also provided for potential impact that may touch health or environment. The table 6 below present the principal elements in the implementation of an EMP and the responsibility of the different participants on the project and the cost of all the recommended environmental measures.

Table 6: Environmental management plan(EMP).

| Mitigation Measure                             | Impacts  | Objective  | Activities   | Measurable Indicators  | Means of verification  | Person or enterprise in charge                      | Period   | Cost (FCFA) |
|--|--|--|--|--|--|---|--|-------------|
| Sensitization of workers and nearby population | N°:1,2,3,5, 6,7,8,9,10, 11,12,13,14,15, 16,17,18,19,20,21. | -Awaken the conscience of the population on environmental issues;<br>-sensitize workers and local population on the mitigation measures of negative impacts. | -Evaluate the sensitization campaigns and provide a reliable exploitation plan for the clay quarry;<br>-elaborate with competent administration and local population on the protection of the clay quarry;<br>-elaborate a plan of sensitization | -Number of sensitization campaigns organized with workers and the population;<br>-attendance list and conformation from sensitization persons;<br>-reports from meetings;<br>-Presence of danger signs at dangerous points in the quarry | -Consultation of results on sensitization;<br>-observations;<br>-written documents | -Recruit a consultant or a competent sub-contractor | -Before the exploitation of clay material and till the end of exploitation | 5.000.000   |

| Mitigation Measure   | impacts                     | Objective  | Activities   | Measurable Indicators  | Means of verification   | Person or enterprise in charge | Period   | Cost (FCFA) |
|--|-----------------------------|--|--|--|---|--------------------------------|--|-------------|
| Protection of workers, local population, and the clay quarry | N°:1,9,10,11,12,15,16,17,20 | Reduce risk encountered during working hours and seasons of exploitation;<br>-ensure the protection of workers, local population and raw materials | -Provision of PPE to workers;<br>-register workers under the social insurance;<br>-technical control of heavy duty vehicles and excavators;<br>-follow a well design exploitation plan to extract raw material;<br>-creation of acces roads for workers and heavy duty vehicles;<br>-scientific research on aquaculture. | -Number of PPE given to workers;<br>-presence of an exploitation plan on site;<br>-a report on the quantity of clay extracted per season and per year. | -Direct observations;<br>-consultation of company's documents | Enterprise<br>-MINSANTE        | From the beginning of extraction of clay up to the end of project. | 8.000.000   |

| Mitigation Measure                  | impacts                  | Objective   | Activities  | Measurable Indicators  | Means of verification                          | Person or enterprise in charge     | Period                                    | Cost (FCFA) |
|-------------------------------------|--------------------------|---|---|--|--|------------------------------------|---|-------------|
| Management of quarry                | N°:8,2,3,4,7,9,13,17,20. | -Keep the quarry clean and protected from the population;<br><br>-prevent soil and underground water pollution from oil leakages from heavy duty vehicles;<br><br>- | -Extraction of sufficient quantity of clay material per season;<br>-employ periodic workers to keep site clean;<br>-fencing of the exploited site to prevent accidents;<br>-construction of acces roads in the quarry | -List of persons in charge of the clearing site;<br>-number of clearing done per year;<br>-presence of accessible roads in the quarry. | -Consultation of documents from the enterprise | -Quarry contractor;<br>-enterprise | -Throughout the existence of the project  | 18.000.000. |
| Rehabilitation and Restore the area | N°:1,2,3,4,8,9,17.       | -Limit the loss of biodiversity;<br>-limit the cause of climate change and soil erosion in the area   | -Rehabilitate the already exploited zone of the quarry;<br>-planting of trees along the river bangs   | -Contract signed for further research on fish farming  | -Number of trees planted at the river sides.   | Enterprise;<br>-NGO;<br>-MINEPDED  | - Throughout the existence of the project | 6.000.000.  |

## Discussion

The present study required for this project is a detailed environmental and social impact assessment. This is so because it does not only involve the execution of the project alone but also involves public consultation in the project. The different results were obtained from the initial state of the environment during the exploitation of clay material and the identification of potential impacts.

The most important aspect that is linked to environmental degradation in this area is the disorderly exploitation of clay in this zone and the absence of an exploitation plan. The land use pattern in this area has greatly change leading to an increases in the surface of water bodies from 14% to 30% giving a change of 16 % increase in the surface area of water body and in the number and size of clay pockets over the years. The vegetation cover has reduced from 69% to 32% (from 1989 to 2015) thus giving a change of 37% vegetation cover. Rehabilitation and restoration works must be done in order to avoid complete land degradation by 2035. The mitigation measures must be followed to avoid the great change detection of the evaluated zone by 2035 (Fenet *et al.*, 2014). The degradation of this area has led to numerous accidents in this area and at times the zone is flooded by water from the nearby river which can lead to loss of valuable clay material in the near future, loss of exploitation land and even loss of job opportunities.

Considering the situation of the study zone with the presence of the new project of fish farming, the positive impacts will be implemented. Some of the positive and most important impact are ; job opportunities, increase in state fund, and source of scientific research. The same results were obtained by Delphine (2013) working on urban controlled landfill of hospital and industrial waste who confirm the positive socioeconomic impacts on the construction of a landfill in Ngomba. Also from Anonymous (2014) similar results were obtained who evaluated the evolution of the forest cover in the

Douala reserve using the remotely sensed method. In the report, for an area to be determined whether it is degraded or not, it has to be analyzed over a period of more than ten (10) years.

During the exploitation of clay in this area, the negative impacts include the following; air pollution by smoke from heavy duty vehicles, noise and dust particles', water pollution, Pollution of soil, loss of vegetation and crops (loss of biodiversity), Change of natural landscape, Migration of birds and reptiles in this area, Risk of accident, flooding, migration of birds, pollution of surface and underground water ,risk of conflict, risk of proliferation of mosquito parasites, risk of degradation of transportation pathways and poor management of resources. The presence of all the above correspond to the work of Rebel (2014) realized in Lom Pangar. All the negative impacts were evaluated to 76.2 % while the positive impacts were evaluated to 23.8 %.

The environmental management plan will enable stakeholders of projects, notably the MINTP, MINEPDED, MINRESI, MINSANTE and YUC to take into consideration all the necessary measures needed to manage the environment during the exploitation and construction phase. This was also mentioned by NANA (2014) on the project of environmental and social impact on the abduction of portable water supply in Jikejem-oku.

The loss of biodiversity in this area can also be compensated through the rehabilitation and restoration of this area. The construction of fish farming will help improve on the aesthetics of the area. The consequence is the destruction of biodiversity, loss of animal habitat and farm land which is already partly covered by water and clay pits. The clay quarry show that the site is partly occupied with crops and cocoa plantation of about 5% and part of the quarry covered with natural vegetation to about 50 % of its surface area. The farmers will be deprived of their source of subsistence.

The real impacts are those whose manifestation is already visible while potential impacts are those impacts which are likely to occur over time. Twenty-one (21) impacts were identified and evaluated. From this work only five (5) were positive impacts and of which we had four average positive impacts and one major positive impact. The sixteen (16) other impacts are all negative impacts with two major negative impacts.

## Conclusion

This study was based on the evaluation of environmental and social impacts of the extraction quarry of raw materials and the case of the Etoa clay quarry in Yaounde III sub-division. To attain this objective, it was necessary to identify each impact, characterized the impacts and proposed mitigation measures, compensation measures or bonifications measures. As the exploitation of clay material is on-going, it is observed that the biophysical and human components of the environment in this area is already being affected based on the analysis of land use by the remotely sensed method. The different components of the environment such as; air, soil, water, flora, fauna and population is already affected and will be affected at different rate if the mitigation measures are not employed at the appropriate moment.

This study brings out some negative impacts on the biophysical milieu which include essentially air pollution by dust from the transportation pathways, emission of gas from heavy duty vehicles, contamination of water in clay pits and the nearby stream by spillage of oil from heavy vehicles, destruction of habitats of some animals, soil pollution and the disappearance of certain plant species. Workers driving the heavy duty vehicles might develop occupational diseases over a long period of time ; conflict between land owner and the enterprise. The project also have positive impacts like the creation of jobs to newer worker and researcher and the increase in economic activities of the enterprise.

The project could be accepted in this area because of the following environmental justifications :

- the presence of an underground water source from the open clay pits.
- there is the possibility of rehabilitating the area by transforming it into fish farming.
- the topographical and morphological layout of this area is a guarantee that pollution of surface water will be minimised.

However, the different proposed mitigation measures will permit to solve or reduce the damages caused during the exploitation of raw materials. If all the mitigation measures are applied and within the given period of time and that the EMP is used properly, then the impacts will have negligible effects as the clay materials and the environment will be protected.

Integrating the local population and the land owner in to the newer project of fish farming is a means of integrating the project in its own environment and most importantly the use of an exploitation plan during exploitation. We can conclude that the project is largely interesting for the people of this area, who also eagerly wait.

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