**Abstract**

As part of the competition "Quarry Life Award" organized by the Heidelberg Cement Group, we implemented on a small scale project entitled " Environmental education as a tool of biodiversity sustainable conservation at Lokossa, Benin ". The project was implemented in Benin in the city of Lokossa which shelters the Fongba quarry. The overall objective of the project was to strengthen the conservation of biodiversity in Lokossa through the involvement of the population especially of youth. Specifically, it consisted of: conducting information and sensitization activities with stakeholders (local populations, local authorities, school children, etc.); design an environmental education booklet and implement a school program in the city of Lokossa for a better understanding and attention to biodiversity. We organized 5 awareness sessions on biodiversity for the population, local authorities, Fongba quarry employees, teachers and NGOs staff. In order to design the environmental education booklet and the lessons of the program we have conducted surveys on the wildlife (mammals, birds, amphibians, insects) at the level of the quarry thanks line transects surveys ans the use of camera traps. The environmental education program which consists of 6 lessons (theory, practice and field trip) has been designed and implemented to increase children's empathy for wildlife and nature. We conducted 5 sensitization sessions for all stakeholders, and proceeded to the restoration of Fongba quarry using native plant species produced in the nursery we established with the school children involved in our education program at Fongba. Data were collected on wildlife at the quarry level and resulted in the development of an environmental education program and booklet. The surveys revealed 58 bird species, 1 mammal, 4 amphibians, 3 reptiles and 11 butterflies. 50 students in the 5th grade class benefited from the program implemented. Through this program, they followed five practical and theoretical lessons and an excursion to the quarry. The comparative analysis of the marks obtained by the school children during the tests before the lessons (pre-tests) and during the tests after the lessons (post-tests) shows a significant increase of their level of knowledge in relation to the taught topics.

## Introduction

Everyday biodiversity is confronted with multiple aggressions due to human activities. Despitethe many efforts made so far, we are still witnessing the disappearance of certain species. In Benin, the Mono Department has been for a long time neglected area of biodiversity conservation although it contains threatened species. Located in the Mono department, the city of Lokossa, that shelters Fongba quarry, has suffered significant loss of biodiversity due to human pressure. We are convinced that biodiversity sustainable conservation is not possible without the involvement of all actors, particularly youth. This justifies our project, **‘‘Environmental education as a tool of biodiversity sustainable conservation at Lokossa, Benin’’** that we have implemented on a small scale as part of the "Quarry life award" competition. This report describes project objectives, the material and method used, the results obtained and the added value of the project.

## 1. Objectives

The main objectivewas to strengthen biodiversity conservation at Lokossa by involving population especially youth.

Specifically, we have:

- conducted information and awareness sessions among all stakeholders (local people, local authority, schoolchildren, etc. )
- designed and produced an environmental education booklet;
- implemented school program in Lokossa district to foster understanding of and affection toward biodiversity

## 2. Material and methods

### 2.1. Conducted information and awareness sessions

We organized 5 awareness sessions with the local population, local authorities, Fongba quarry officers, teachers and NGOs to raise awareness about the importance of biodiversity, the threats to biodiversity and the possibilities of promoting quarry biodiversity. To do this, we designed a poster that highlights the wildlife of Fongba quarry and its importance for human wellbeing.

As part of the celebration of the International Biodiversity Day, a conference debate on the theme "Biodiversity and quarry, was organized and brought together, NGOs, students and researchers.

For the celebration of the National Tree Day, we reforested a part of the quarry using seedlings from nurseries set up by the students of the Private Primary School involved in our environmental education program.

### 2.2. Designed and produced an environmental education booklet;

In order to design the environmental education booklet, we collected data on wildlife (mammals, birds, amphibians, insects) at the quarry level. We conducted interviews with the local community and conducted inventories of different taxonomic groups, including mammals, birds, and butterflies.To document the diversity of fauna of Fongba quarry, we

conducted interviews with local community and surveys on different taxonomic group including the mammal, bird and butterfly.

- Three camera traps (1 Bushnell, 1 Maginon and 1 Medion) were randomly set in the quarry to document the small mammal's species. The cameras were moved every month to another location to increase the chance to record the maximum species. For the security of the camera (to avoid thief), the equipment were set up close to quarry offices.
- For bird census, line transects and point count methods were used to document the diversity of birds in Fongba quarry. We conducted one survey in the rainy season and another one in the dry season. The surveys were repeated twice accordingly to habitat type.
- Butterflies nets were used to capture butterflies along 3 line transects of about 1 km. All wildlife species were also systematically recorded and photographed during these surveys.

### 2.3. Implemented school program at Lokossa

The goal of our environmental education program is to increase children's empathy toward nature, which will lead them to be active wildlife ambassador and nature protector. The beneficiaries of the program were school childreen of 5$^{th}$ grade of the Private Primary School "*La Difference*" in Fongba. These students followed five lessons (theoretical and practical) and a sixth lesson was the visit of the quarry and the discovery of its biodiversity. The tittles of the lessons are:

1. Lokossa is habitat for many species
2. Seeds, trees, forests: protecting life on earth!
3. The choir of the nature: Birds of Fongba quarry !
4. Butterflies
5. Biodiversity and quarry
6. Outdoor activity: Visit Fongba quarry and discover its biodiversity

The lessons were designed using the results of the wildlife surveys in the quarry. At the beginning of each lesson, we conducted a pre-test survey to assess the level of learners' knowledge. After each lesson, we conducted a post-test to evaluate the increase of knowledge about wildlife and the associated attitudes changes toward wildlife.

## 3. Results

### 3.1. Conduct awareness to different stakeholders

- **Awareness sessions**

The 5 sessions organized for the population, local authorities, teachers, Fongba quarry employees and NGOs have raised the awareness of the various stakeholders about the importance of biodiversity and the initiative of the Heidelberg Cement Group to celebrate

biodiversity in quarry and its sustainable conservation. 76 people were involved in these activities. The poster designed and used during the awareness is illustrated by photo 1.


**Photo 1. Pooster designed for awareness about Fongba quarry biodiversity**

**Photo 2 & 3. Participants of an awareness session at Lokossa**

- **Célébration of the International Day for Biological Diversity**

The celebration of the International Day for Biological Diversity was an opportunity for us to communicate about the Quarry Life Award competition, the wildlife of Fongba quarry, the Heildelberg Cement Group, the activities of our project and to present a communication on the theme: "Biodiversity and quarries, case study of Fongba quarry in Lokossa, Benin". A total of 15 participants, representatives of NGOs, youth organization platform, start-ups and young researchers took part in conference. The following photos illustrate the activity.

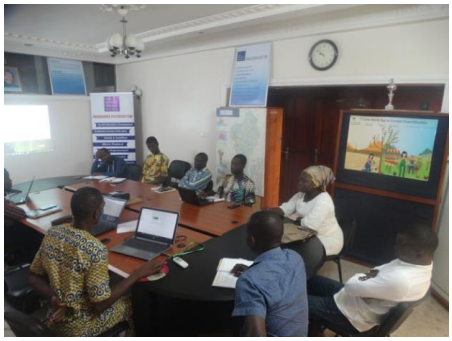


**Photo 4. Participants during the conference**


**Photo 5. Family Photo**

- **Reforestation to celebrate the National Tree Day**

The reforestation of the quarry and trees planting in the school and surroundings was carried out by the project team and the teachers of the school "*La Différence*". A total of 100 plants (*Ceiba pentandra* and *Afzelia africana*) were planted. The two species chosen are indigenous species that are very popular among the populations. *Afzelia africana* is an endangered species according to the Benin Red List and vulnerable according to the IUCN status.

**Photos 5 & 6. Seedlings replanting at Fongba quarry**

### 3.2. Design and produce an environmental education booklet

In order to design the environmental education booklet, we conducted wildlife surveys in the quarry.

Due to the past intensive hunting activities and habitat loss, large mammals are not found at the quarry level and surroundings environment. Only small mammals were reported by the people during interviews (see Table 1).

**Table 1. Wildlife species reported by local people during interviews**

| Species | | International UICN Red List | Benin IUCN Red List |
|---|---|---|---|
| Common name | **Scientific name** | | |
| Gambian Rat | *Cricetomys gambianus* | LC | |
| African Savanna Hare | *Lepus victoriae* | LC | |
| Large-spotted Genet | *Genetta maculata* | LC | DD |
| Greater Cane Rat | *Thryonomys swinderianus* | LC | |
| | *Arvicanthis sp* | | |
| Striped ground squirrel | *Xerus erythropus* | LC | |

The large mammals have been already extirpated from the Fongba quarry and immediate surroundings due to intensive hunting and habitat destruction. Only small mammal's species were reported by local people during interviews. Table 1 summarized the species reported. In total, 2880 hours (4 months) of data were recorded. 45% of the detection were related to African Savanna Hare occurrence, 15% related to bird's activities. Human activities occurred at a rate of 27% and 13% of the detection contain no information.

The diversity of wildlife documented in Fongba quarry with the camera traps are summarized in table 2.

**Table 2. Espèces détectées par les pièges photographiques**

| Zoological group | Species | |
|---|---|---|
| | **Common name** | **Scientific name** |
| Mammals | African Savanna Hare | *Lepus victoriae* |
| Birds | Piapiac | Ptilostomus afer |
| | Double-spurred Francolin | *Francolinus bicalcaratus* |
| | Senegal coucal | *Centropus senegalensis* |
| | Northern Fiscal | *Lanius humeralis* |
| Amphibians | Unidentified | |

Les photos suivantes illustrent deux espèces détectées par les pièges photographiques.

**Photo 7. African Savanna Hare photographed with camera trap**


**Photo 8.Piacpiac photographed with camera trap**

58 bird species have been recorded during survey on Fongba quarry. The Fomgba quarry shelter migratory bird like the yellow billed kyte (*Milvus migrans parasitus*) and black winged kyte (*Elanus caeruleus*). The list of bird recorded at Fongba quarry were presented in appendix 1.

11 butterfly species have been captured at Fongba quarry. Among them, 8 have been identified (appendix 2). We recorded 4 amphibian species (appendix 3) and 3 reptil species (appendix 4).

The environmental education booklet was designed, using, among other things, data from our surveys. Chapters discussed in the booklet include the notion of biodiversity, its importance, the notion of endangered species and good practices for the sustainable conservation of biodiversity, biodiversity and quarries. The booklet can be used for environmental education courses at local, national and regional level.

### 3.3. Implementation of a school education program in the city of Lokossa

#### 3.3.1 Lessons of the education program

50 school children from Fongba participated in our school program.

Lesson 1 taught children the concept of biodiversity, its importance. The practical phase was the identification of the components of biodiversity in their environment.

Lesson 2 introduced the concepts of seeds, trees and forests, as well as their importance. The practical phase include the establishment of a nursery of native plante species which seedlings were used for the reforestation of the Fongba quarry. The species used for nurseries were *Ceiba pentandra* and *Afzelia africana*.

**Photo 10.Preparing the pots in the school nursery**

**Photo 11. Nursery established by involved school children of the education program**

Through Lesson 3, school children about birds, their importance in the ecosystem and for ecotourism promotion. The practical phase consisted of observing and identifying birds nearby the school.

**Photo 12. Bird observation with binoculars**

**Photo 13. Identification of bird species using a field guide**

The lesson related to butterfly helped to draw the attention of children to this group of insects that are quite present at the quarry level. The life cycle of butterflies and the role they play in their ecosystems has been highlighted. The participants have been then busy coloring butterfly drawings.


**Photos 14 & 15. Students coloring butterfly drawings**

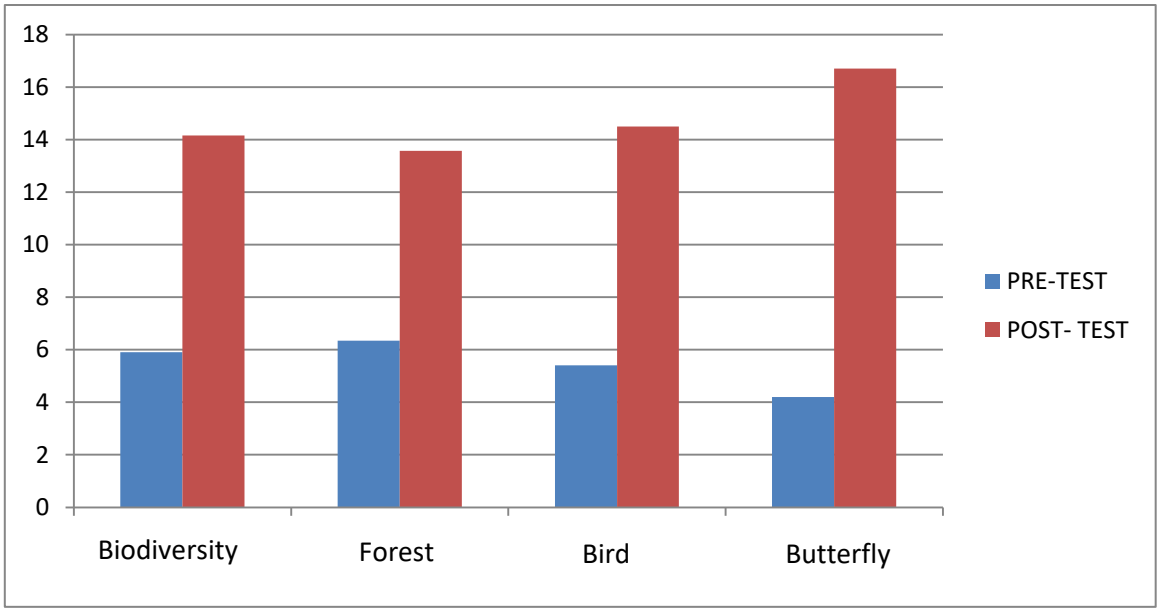
In Lesson 5, we explained to the children that quarries are not lifeless places but rather a place where biodiversity exists and can be preserved for the future generation.

Lesson 6 allowed the children to discover Fongba quarry, the activities that take place there and at the same time appreciate its biodiversity through direct observation in the field.

**Photo 16 & 17. School children visiting Fongba quarry**

### 3.3.2. Impact of our environmental education program

The tests done by the students before and after the lessons of our environmental education program made it possible to evaluate the impact of the program. The results of these tests are reflected in the following graph.




**Graph 1. Comparison of pre-test and post-test scores for different lessons**

The average score for the biodiversity assessment prior to the lesson is 5.9 and 14 after the lesson. With regard to trees and forest seed, the average pre-test is 6.34 and the post-test average is 13.57. The pre-test for the bird concepts averaged 5.4 and the post-test averaged 14.5. The average of the pre-test for the butterfly lesson is 4.2 and 15.7 for the post-test. Overall, we note that the averages of the marks obtained for the post-tests are much higher than the averages of the marks obtained for the post-tests. This mean that the program implemented has considerably improved the knowledge of beneficiaries.

## 4. Added value of our project

### 4.1. Value for biodiversity

The project has contributed to improve the knowledge on the diversity of wildlife that Fongba quaary shelters. It inprove the understanding of biodiversity by the general population and by young people in particular. Students who have benefited from the environmental education program now have an interest in biodiversity and will be protective of it wildlife. Through our project, an environmental education program and a booklet that focuses on Fongba quarry biodiversity have been developped and communicated to different stakeholders for the first time. This project highlighed that the quarries are also important place for biodiversity protection and valorization. Stakeholdres involved in our project are now aware that Fongba quarry shelter many wildlife species and that local population of Lokossa have their role to promote it. Furthermore, a database on the wildlife of the quarry is available.

### 4.2. Social value of the project

At the social level, youth has been intensively involved in the different activities of our project. Through the different lessons of the environmental education program, students were given theoretical and practical lessons. The project introduces to the participant the relationship between human, plants and animal. The associated activities enable young people to interact with adults and increase selfconfidence in school children.

### 4.3. Added value for the company

Awareness campaigns have helped to improve the perception of the population with regard of the company. The strategy adopted for the restoration of the quarry (nursery carried out by the students and planting of seedlings by the teachers) considerably reduces the cost of restoration of the quarry for the company. The project also highlighed that the company really care about the conservation of biodiversity on their site and worldlwide.

### Conclusion and perspectives

In view of the results from the implementation of the project, we can conclude that the various stakeholders could show an interest in the conservation and the valorization of biodiversity if they are informed and sensitized. There are opportunities for collaboration between local people and business company for a better preservation of biological diversity. Despite the strong anthropization of the city of Lokossa, the Fongba quarry is still home to many wildlife species, some of which are endangered. The birdlife is quite diverse on the site. There are migratory species, making the site an important site for conservation. In addition, youth is an important pillar for the sustainable conservation of biodiversity. We therefore suggest to:

- strengthen outreach activities to reach more people and have a better impact;

- continue the collection of biodiversity data and extend it to other zoological groups and flora in order to have a more complete database for the quarry and its surroundings;

- implement environmental education programs in other schools to increase the number of beneficiaries and hence the number of biodiversity ambassadors.

## References


- Nik Borrow & Ron Demey (2012). Guide des oiseaux de l'Afrique de l'ouest.
- Neuenschwander, P., Sinsin, B. Gorgen, G. (2011). Protection de la nature en Afrique de l'Ouest: une liste rouge pour le Bénin.365p.

## Appendix

## Appendix 1. List of bird recorded during survey in Fongba quarry

| N° | Species |
|---|---|
| | Scientific name |
| 1 | *Bubulcus ibis* |
| 2 | *Elanus caeruleus* |
| 3 | *Milvus migrans* |
| 4 | *Accipiter badius* |
| 5 | *Kaupifalco monogrammicus* |
| 6 | *Falco tinnunculus* |
| 7 | *Francolinus bicalcaratus* |
| 8 | *Vidua macroura* |
| 9 | *Amblyospiza albifrons* |
| 10 | *Crinifer piscator* |
| 11 | *Lagonosticta rufopicta* |
| 12 | *Chrysococcyx caprius* |
| 13 | *Spermestes cucullata* |
| 14 | *Streptopelia senegalensis* |
| 15 | *Streptopelia vinacea* |
| 16 | *Streptopelia semitorquata* |
| 17 | *Turtur afer* |
| 18 | *Centropus senegalensis* |
| 19 | *Passer griseus* |
| 20 | Cypsiurus parvus |
| 21 | *Ploceus aurantius* |
| 22 | *Ploceus cucullatus* |
| 23 | *Corvus albus* |
| 24 | *Ceuthmochares aereus* |
| 25 | *Cisticola erythrops* |
| 26 | *Alcedo cristata* |
| 27 | *Merops albicollis* |
| 28 | *Halcyon senegalensis* |
| 29 | *Tockus nasutus* |
| 30 | *Hirundo aethiopica* |
| 31 | *Hirundo rustica* |
| 32 | *Platysteira cyanea* |
| 33 | *Motacilla flava* |
| 34 | Dicrurus modestus |
| 35 | *Eurystomus glaucurus* |
| 36 | *Anthus leucophrys* |
| 37 | *Chlorocichla simplex* |
| 38 | *Pycnonotus barbatus* |
| 39 | *Turdus pelios* |
| 40 | *Cisticola juncidis* |
| 41 | *Camaroptera brachyura* |
| 42 | *Melaenornis edolioides* |
| 43 | *Terpsiphone rufiventer* |

| | |
|---|---|
| 44 | Centropus senegalensis |
| 45 | *Nectarinia venusta* |
| 46 | *Cinnyris chloropygius* |
| 47 | *Lanius collaris* |
| 48 | *Corvinella corvina* |
| 49 | *Ptilostomus afer* |
| 50 | *Euplectes franciscanus* |
| 51 | Motacilla aguimp |
| 52 | Cinnyris cupreus |
| 53 | *Lagonostica rufoptica* |
| 54 | *Cossypha niveicapilla* |
| 55 | Pachyphantes superciliosus |
| 56 | Saxicola rubetra |
| 57 | Lamprotornis purpureus |
| 58 | Muscicapa striata |

**Appendix 2 : Butterflies recorded during survey in Fongba quarry**

| N | Scientific name |
|---|---|
| 1 | *Aterica galene* |
| 2 | *Papilio demodocus* |
| 3 | *Junonia sophia* |
| 4 | *Junonia terea* |
| 5 | *Hamanumida daedalus* |
| 6 | *Graphium angolanus* |
| 7 | *Junonia orithya* |
| 8 | *Hamanumida daedalus* |
| 9 | *unidentified* |
| 10 | *unidentified* |
| 11 | *unidentified* |

**Appendix 3 List of amphibian documented in Fongba quarry**

| **N** | Scientific name |
|---|---|
| 1 | *Phrynomantis microps* |
| 2 | *Sclerophrys regularis (Bufo regularis)* |
| 3 | *Phrynobatrachus latifrons* |
| 4 | *Non identiifiée* |

**Appendix 4 List of reptil species documented in Fongba quarry**

| N | Scientific name |
|---|---|
| 1 | *Philothamnus sp* |
| 2 | *Agama parafricana* |
| 3 | *Psammophis sibilans* |