ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

Contribution of geeographic information systems (GIS) in the management of hydro agricultural, livestock and fodder production areas: the case of the mayo-banyo division

Aimé ELIME BOUBOAMA [1]* WOUNBA Jean François[2]** BOLIONG BILOGO Rosvelt [3] *** BIDIAS NGUIMBIS Luc Frank [4] ****

1, Departments of Industrial and Mechanical Engineering, National Advanced School of Engineering, University of Yaoundé I, P.O. Box. 8390, Yaoundé, Cameroon

2, National Advanced School of Public Works, Ministry of Public works, P.O. Box. 510, Yaoundé, Cameroon

3, Centre d'Enseignement, de Formation et de Recherche en Agroécologie de L'Institut Supérieur des Sciences Agronomiques, de L'Environnement et de l'Entrepreneuriat Rural de Sa'a, P.O. Box. 103, Sa'a, Cameroun

4, Departments of Industrial and Mechanical Engineering, National Advanced School of Engineering, University of Yaoundé I, P.O. Box. 8390, Yaoundé, Cameroon

ABSTRACT— Geographic Information Systems (GIS) are increasingly being used as governance and decision-making tools due to their events spatial visualization capabilities. In Cameroun, the Adamaoua region is presently experiencing a major wave of migration of people and cattle coming from neighbouring countries, due to terrorist attacks by the Boko Haram sect for instance. This situation has led to overgrazing, thus raising the need to develop new spaces for agricultural and fodder production. Therefore, Cameroonian authorities set up a Triennial Emergency Plan (PLANUT), which aims in one of its components to develop and manage one hundred and twenty thousand (120,000) hectares of hydro-agricultural areas in the Region. However, these hydro-agricultural areas cover huge surface areas and involve many stakeholders thus requiring large amounts of resources which are often limited. In such a context, these areas need a particular set-up for their management. Therefore, GIS appear as the most appropriate land management and decision-making tools. The aim of this article is therefore to show the contribution of GIS tools in the management of agro-pastoral areas, with special focus on the Mayo-Banyo Division. This led us to develop an integrated database within GIS software (QGIS) in order to manage these areas, design a python plugin used to make some basic requests within the area and open access to data using dynamic maps.

Key words: **Geographic Information System (GIS), management, hydro-agricultural areas, database, python plugin, dynamic maps.**

I. INTRODUCTION

This article attempts to show the overall importance of GIS tools in the management of hydro-agricultural, agro-pastoral and fodder production areas, taking inspiration from the project for the development and improvement of agricultural, cattle-rearing and fodder production areas in the Adamaoua Region, lot 3. Before presenting the detailed work methodology used in this analysis, we deemed it necessary to first of all review the key words selected above.

Manuscript received: 23 March 2020
Manuscript received in revised form: 20 April 2020
Manuscript accepted: 06 May 2020
Manuscript Available online: 15 May 2020

GIS is a database management system for the capture, storage, retrieval, questioning, analysis and display of localized data. It is a set of data identified in the area, and structured in a way as to enable the easy retrieval of syntheses that are useful for decision-making (BOUKLI H Chérifa, RABAH F Amina, 2010). As illustrated in figure 1**, a GIS** is a set of computer equipment, software and methodologies for the capture, the validation, the storage and the use of data, most of which are referenced in space, and used to make simulations of the behaviour of a natural phenomenon, for management and as decision-making tool.

Fig 1: components of a SIG (http://www.afigeo.asso.fr/les-sig.html)

A hydro-agricultural area is defined as an irrigated agricultural area, including a number of farmers and collective irrigation systems.

A cattle-rearing area refers to plots of land where stockbreeders are settled, and who live and cultivate enough surface areas to feed their families and keep their cattle as an asset. The aim is to practice extensive cattle-rearing on grazing areas.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

Fodder is, in the agricultural domain, a crop or a mixture of crops used to feed animals such as cattle, sheep, horses, but also pigs, camels, ducks, geese, rabbits, etc. A fodder area is therefore a space put aside for the cultivation of these fodder crops.

The use of Qgis makes it possible to add more functions. A **plugin** can be defined as the extension of an application (in our own case: **plugin for Qgis**) which gives the possibility to create new functionalities, or to merge existing functionalities. As suggested by its name, a **Python plugin** must be written and developed using Python, a script language that is easy to write. An added advantage is that many programmes written using C++ or Java offer the possibility to develop extensions in Python version, such as OpenOffice.org or GIMP. The definition of desired functionalities of the plugin tend to render our database (DB) intuitive, which means that the user must not necessarily have to master the SQL language in order to communicate with the DB.

Producing a dynamic map means viewing the data of a space table without accessing its allotted table, without even owning a Qgis or a GIS generally speaking. What you need is just a computer and a connection to a data publication server. Then you have to use another plugin available in the plugins installation depot of Qgis called « **qgis2web** ».

II. METHODOLOGY

The methodology used here included field trips in order to collect information necessary for modeling a database for the management of agricultural, cattle-rearing and fodder production areas (PAPPF) whose steps are described below.

A. Analysis of Need

Les données utiles nécessaires pour faire une modélisation de la BD de nos périmètres agropastoraux ont été d'origine diverses. We had to identify vital data and subsidiary data for the management of PAPPFs.

Therefore, for the optimal management of our areas, we selected the following twenty one (21) main variables: Canal, water tower (or drill), operator, crop, machine, maintenance, farmer, hydrography, input, warehouse, plot, partition, pump, access road, site, habitat, water tower check, machine check, input check, partition check, pump check.

The summary of all these variables, as well as their functions, are provided in table1 below.

ENTITIES	ATTRIBUTES	DESIGNATION
1- Canal	Id_canal, type_canal, description_canal, length	Informs on irrigation canals of each site involved, and in a hierarchical order.
2- Water tower	Id_water tower, name_water tower, height, diameter, contents	Informs on elements such as water drillings and reservoirs of each site.
3- Operator	Service N°op, name _op, first name_op, telephone	Informs on the operators of the various machines who will intervene on our sites
4- Crop	Id_crop, type_crop, level_developement, water_needs	Informs on the type of crops grown.
5- Machine	Number plate_mach, type_mach, name_mach, use, capacity	Informs on the list of all machines used in our area
6- Maintenance	Id_check, type_check, description_check, date	List of various maintenance actions carried out
7- Farmer	Id_frmr, name_frmr	Manager of each plot
8- Hydrography	Id_hydrography, type_hyd, description_hyd	Informs on each type of relief found (river, …)
9- Input	Id_input, type_inp, description_inp	List of inputs (fertilizers, …)
10- Warehouse	Id_warehouse, description_whse	Place where to keep Equipment and offices
11- Plot	Id_plot, surface area, name_plot, description_plot	Subdividing a site according to the activity carried out (agriculture, fodder, stockbreeding)
12- Partition	Id_partition, surface area, nom_part, description_part	Subdividing each plot.
16- House	Id_house, numher_occupants	Informs the population around a site
17- Water tower heck	Id_water tower check, date, volume, comments	Follow-up of each water tower
18- M	Id_machine check, date, fuel level, oil level, battery level, comments	Follow-up of each machine
19- Input check	Id_input check, date_of use, quantity, justification	Follow-up of each input
20- Partition ccheck	Id_partition check, date, step_dvlpm, height, comments	Follow-up of each partition
21- Pump check	Id_ pump check, date, oil level, malfunction, comments	Follow-up of each pump

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

NB : The underlined functions specifically identify the entity to which they belong. They are the identifiers of each entity.

B. Data conceptual model (DCM)

In order to normalize the reading, we adopted a conventional grading method that enables everyone to read our diagrams; the method is « **UML grading** ».

The DCM is as follows:

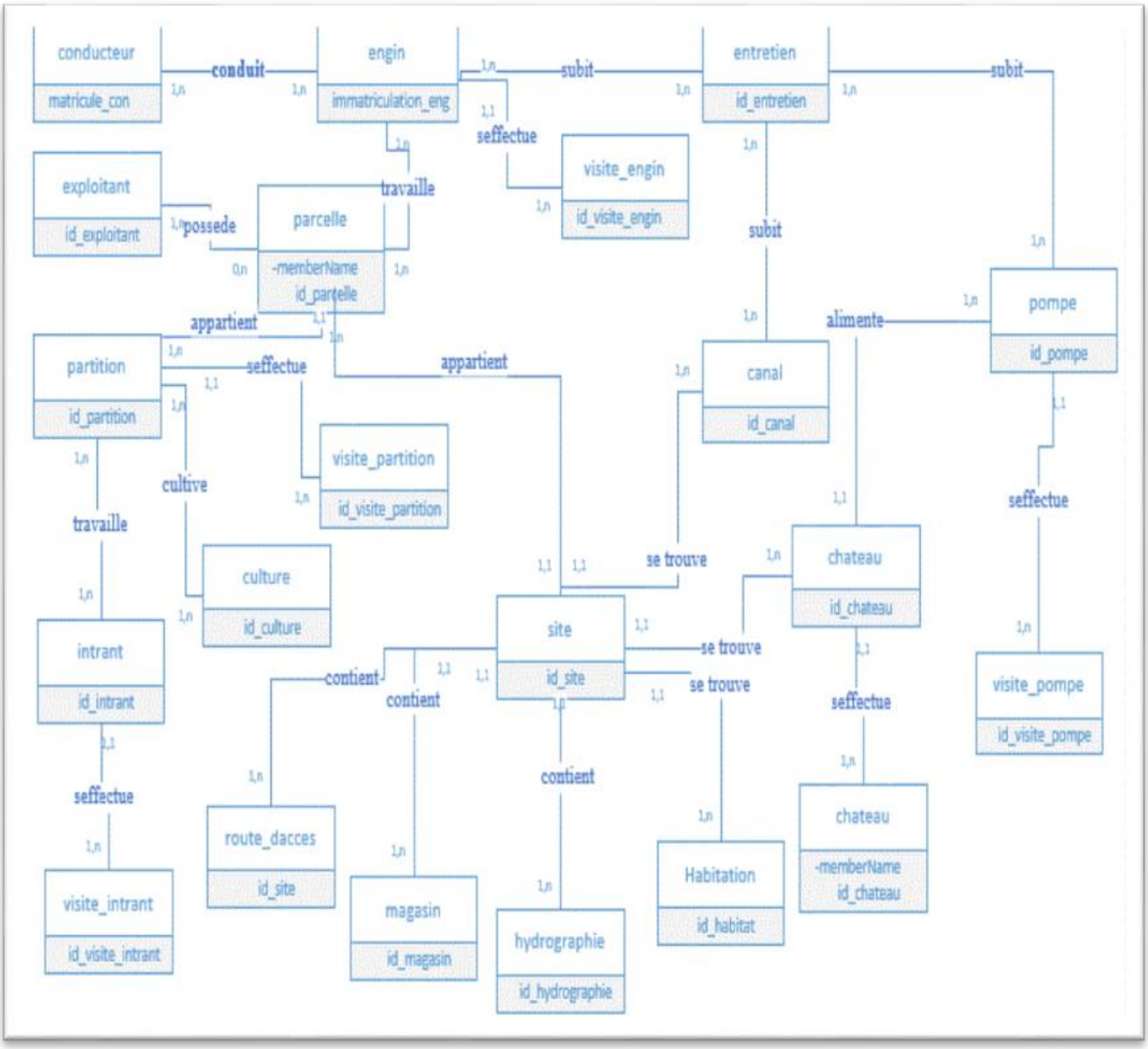

Fig 2: MCD

C. Data logical model (DLM)

The DLM of our DB which we obtained following the UML rules is as follows:

Table 2 : DLM

ENTITIES	ATTRIBUTES
Canal	Id_canal, **#id_site**, type_can, description_can, length, geom
Water tower	Id_tower**, #id_site**, name_tow, height, diameter, contents
Operator	Service no. op., name_op, first name_op, telephone no.
Crop	Id_crop, type_crop, developement_stage, water needs
Machine	Plate number_, type, name, use, capacity
Oper_drives_eng	**#Matricule no.op**, **#plate number machine**
Maintenance	Id_maintenance, type_maintenance, description_maintenance, date
Machine under maintenance	**#Immatriculation_eng**, **#id_entretien**

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

Can_under maintenance	**#id_canal**, **#id_maintenance**
Exploitant	Id_exploitant, nom_exp
Hydrography	Id_hydrography, **#id_site**, type_hyd, description_hyd, geom
Input	Id_input, **#id_site**, type_input, description_input
Warehouse	Id_ **Warehouse**, description_whs, geom
Plot	Id_ **Plot**, **#id_site**, **#id_frmr**, surface area, name plot, description plot, geom
mchine_works_in_plot	**# plate number machine, #id_plot**
Partition	Id_partition, **#id_plot**, surface area, name plot, description_plot, geom
Input deployed on plot	**#id_input**, **#id_partition**
Cul_grown over plot	Date, **#id_crop**, **#id_partition**
Pump	Id_pump, **#id_water tower**, type_pump, description_pump, temperature, power
Pom_under maintenance	**#id_pompe**, **#id_entretien**
Access road	Id_road, **#id_site,** length, width name rd_, description_rd, geom
Site	Id_site, name site, description_site, surface area, geom
Water tower check	Id_tower check, **#id tower**, date, volume, comments
House	Id_house, **#id_site,** number inhabitants
Owns	Date, **#id_farmer**, **#id_plot**
Machine check	Id_machine check, **#number plate**, date, fuel level, oil level, battery level, comments
Input check	Id_input check, **#id_input**, date of use, quantity, justification
Partition check	Id_partition check, **#id_partition**, date, level od_development, height, comments
Pump check	Id_pump check, **#id_pump**, date, oil level, malfunction, comments

D. Implementation of the database within a GIS software

After designing our Database for the management of PAPPFs, We are now goint to put in place a management system for this DB using the GIS software. To tha end, we decided to chose a Relational Database Management System (RDBMS) and a GIS software. The **PostgreSQL / Qgis** combination was also chosen not only for its fuctional complementarity, but also for the following reasons:

- **PostgreSQL** : functionally very rich, notions of tables inheritance, several modules ; user-friendly and easy to administer.
- **Quantum GIS ou QGIS:** Free and flexible software, based on the Qt library, available under Linux, Mac OS X, or Windows. Makes it possible to view and modify shapefiles. It also enables to produce folders to be published on MapServer. Its ergonomy makes it user-friendly with an intuitive interface.

III. RESULTS AND COMMENTS

A. Creation of the database

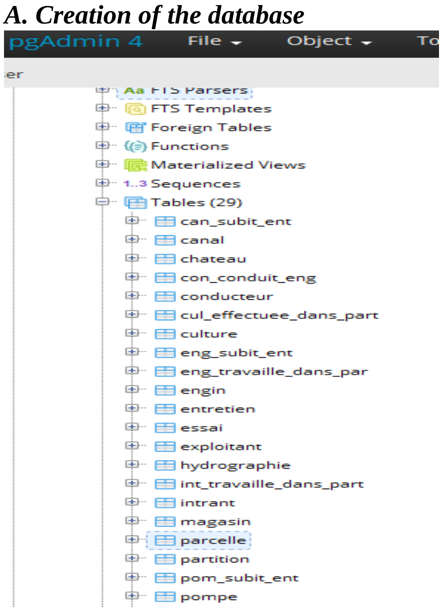

Fig 3 : Tables under PostgreSQL

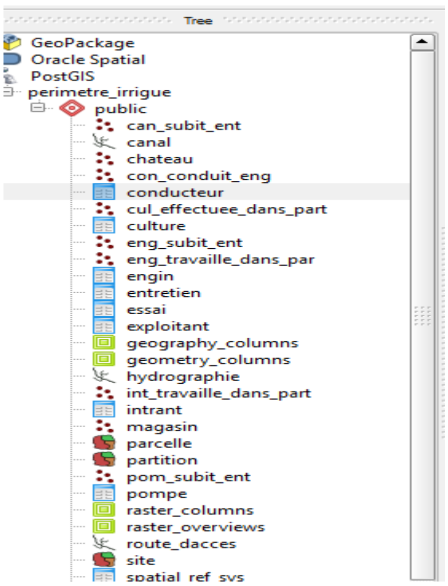

Fig 4 : Tables under Qgis

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

B. Manipulation of data under Qgis

The following request (figure 4) makes it possible to obtain the **« list of the ten (10) smallest reservoirs of our zones as well as their volumes and sites in question** ». We can see the reservoir contains, the name, the description and the surfaace area of the site where it is found. We notice that we have six (06) sites which host our ten (10) smallest reservoirs of all the sites in the Mayo-Baaaanyo Division.

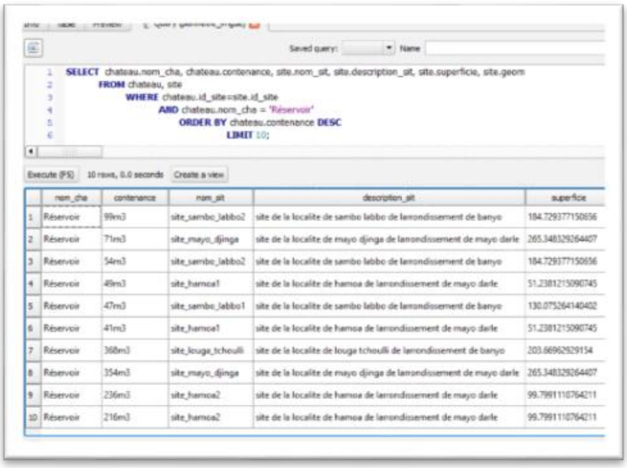

Fig 5 : Spaace request

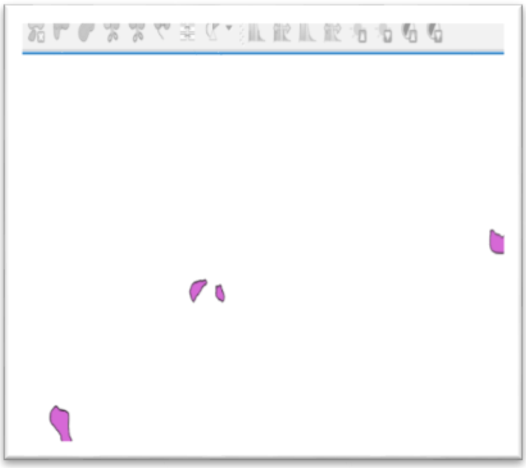

Fig 6 : Sptial request view on Qgis

<u>NB</u> : For visibility purposes, only four (04) strata appear on the screen.

C. Creation of the plugin

The python plugin thus developed on Qgis will be used to manipulate our data without needing the SQL language ; this is more appropriate for everybody given that it is not only experts in this language that will need a tool for the management of agro-pastoral areas.

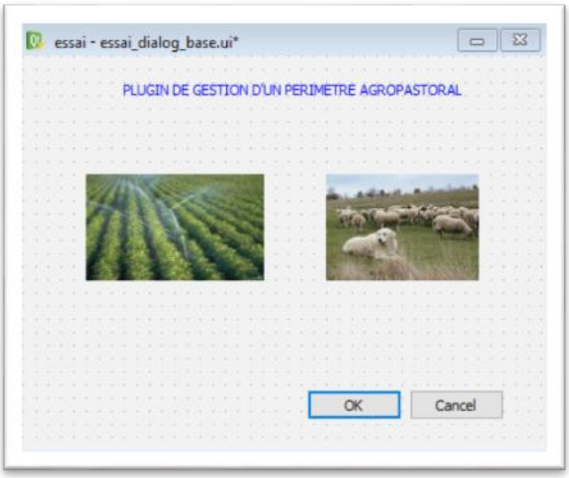

Fig 7 : Home page of our plugin

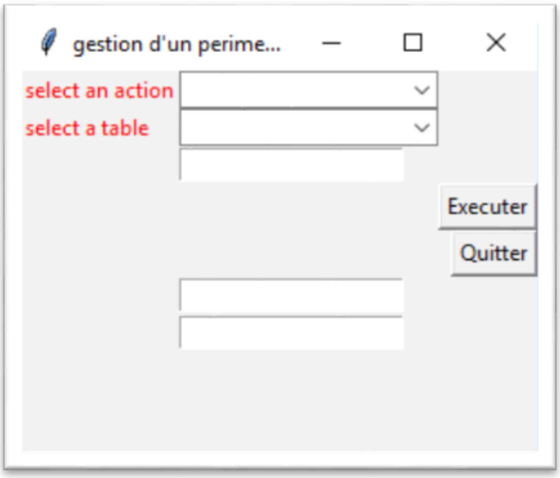

Fig 8 : Main interface of the plugin

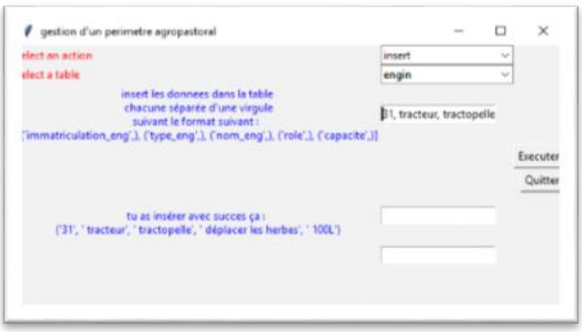

Fig 9 : Insertion of data

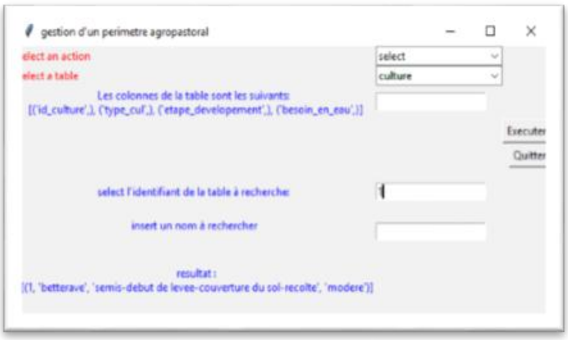

Fig 10 : Result of a selection

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

D. Publishing of data: dynamic maps

To access information published in the server by the system manager, a user will need just a computer and an installed web browser. Given its visual nature, this tool will go a long way in helping decision-makers in managing their respective areas.

Fig 11 : dynamic map of the Ndieki site on Microsoft Edge

NB : On the map above we can read the name and description of the sit in question just when the user clicks on the picture and the text «area» displayed by the computer here refers to the volume of the reservoir found on the site, that is 93m^3. All this space requests can be published as a dynamic map.

IV. CONCLUSION

The aim of this article was to demonstrate how a GIS tool (software) could help us make decisions that would be used to develop an agro-pastoral area. After having carried out a study on the various available GIS and the management model of an agro-pastoral area, we created a Database under the PostgreSQL software. Having included these data (after comparing them with parameters of our stody areas) into our GIS Qgis, we were able to manage our areas, through space and alloted requests. Tosolve the problem we had in manipulating our data using only a SQL langage, we had to develop a small python plugin for Qgis to manage our areas in a basic manner using alloted requests, as well as open up the publication of our space requests with dynamic maps that could be published through a server for easy access. From this study, we can thus conclude that a GIS can largely contribute in decision-making for the management of an agropastoral area.

REFERENCES

[1] BOUKLI H Chérifa, RABAH F Amina, (2010). GEOGRAPHICAL INFORMATION SYSTEMS COURSES AND PRACTICAL WORKS, chap.1, pp.2-20.

[2] BENSALEM Imane & BOUHENNA Nadia, (2017). FEASIBILITY STUDY OF THE EXTENSION OF THE IRRIGATED PERIMETER OF MAGHNIA, Final Project, ABOU BEKR BELKAID University, Algeria, 135p.

[3] CORINNA Ravilious, LISEN Runsten and MATEA Osti, (2014). USE OPEN SOURCE GIS SOFTWARE TO SUPPORT REDD + PLANNING, UNEP, France, 31p.

[4] Élisabeth HABERT, (2000), WHAT IS A GEOGRAPHIC INFORMATION SYSTEM? Institute for Research and Development (IRD), Laboratory of Applied Mapping, p13.

[5] https://fr.wikipedia.org/wiki/Pastoralisme (accessed March 15, 2019).

[6] https://fr.wikipedia.org/wiki/Fourrage

[7] http://info.blaisepascal.fr/gerer-une-base-de-donnees-avec-python

[8] https://fr.wikibooks.org/wiki/Programmation_Python/Bases_de_données

AUTHOR BIOGRAPHY

[1]Elime Bouboama Aimé: Professor in Civil Engineering, Teacher / Researcher at the National Advanced School of Public Works and at the National Advanced School of Engineering currently, Head of Department of Surveying and Cadastre at ENSTP.

Membership:

- Ministry of Higher Education

- National Order of Engineers of Mechanical Engineering of Cameroon; Engineering, calculation of structures and modeling, project management, Management and management of companies, studies and achievements of Electrical installations;

Lessons: since 2007, several courses have been taught until now in several schools (ENSTP, ENSP, etc.)

Publications: 12 articles published in international scientific journals in the field of ACV, Civil Engineering and Mechanical Engineering;

Consultations:

- Consultant at the African Development Bank in the study of urban and Rural transport systems in the Far North region for BUURSINK / RCM International Consultants in Environmental Management;

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 9, Issue 10, April 2020

- UNDP consultant for the development and drafting of a manual on Industrial risk management procedures in Cameroon

Animation and supervision of the work: about seventy memories (Baccalaureate +3, Baccalaureate +5 and Masters) supervised in the Universities of State and Private;

Areas of expertise: design and maintenance of electromechanical systems, drying and cold conditioning and air conditioning, civil Engineering, ACV.

WOUNBA Jean François: Teacher / Researcher at the National Advanced School of Public Works Doctorate / PhD in Engineering Sciences and Technology [Engineering, Economics of Transport]

Membership:

Ministry of Higher Education

- National Order of Engineers of civil Engineering of Cameroon;

Lessons: since 2016, several courses have been taught until now in ENSTP.

Publications: 03 articles published in international scientific journals in the field of Transport, Civil engineering, Road safety, Management.

Consultations:

Consultant at the African Development Bank - a. Responsible for activities supporting the development of national skills in transport planning and management in Cameroon.

b. Head of the operation team in charge of monitoring the update of the Master Plan Cameroonian truck driver.

vs. Responsible for the Project Monitoring Team developing the Integrated Strategy for Multimodal Transport Infrastructures in Cameroon.

d. Responsible for road safety activities

Animation and supervision of the work: about twenty memories (Baccalaureate +3, Baccalaureate +5 and Masters) supervised in the

Universities of State;

Areas of expertise: Transport, Civil engineering, Road safety, Management, Didactics;

Boliong Bilogo Rosvelt: Fisheries Engineer Option Oceanography / Limnology from the Institute of Fisheries Sciences of the University of Douala, Trainer / Researcher and Head of the Teaching, Training and Research Center in Agro ecology of the Higher Institute of Agronomic Sciences , the Environment and Rural Entrepreneurship (ISSAEER) of Sa'a.

Membership :

-Consultant in agro-pastoral entrepreneurship and environmental management in the Support Program for the Renovation and Development of Vocational Training in the Agriculture, Livestock and Fisheries Sectors (AFOP)

BIDIAS NGUIMBIS Luc Frank, Industrial Engineer, graduated from the National Advanced School of Engineering, University of Yaoundé I.

Membership:

- Junior Consultant in the BET ITIS Sarl, Equipment maintenance, inventory management, automation, electrical engineering, mastery of Quality and HSE tools and adaptation to the industrial environment.