Research Introduction

Introduction of Remote Sensing and Geoinformatics Researches at Omar Bongo University (Gabon)

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1. Introduction

The Gabonese national university (GNU), now Omar Bongo university (UOB), is the oldest higher education institution in Gabon. Founded in July 1970 after the break-up of the foundation for higher education in Central Africa (FESAC) established in 1961 with French support. The purpose of this foundation was to meet needs training for senior executives from newly independent states issued from former French Equatorial Africa (AEF).

In 1971, national school of engineers of Libreville (ENSIL) opened, replacing university institute of technology (IUT) of Central Africa, a former FESAC located UOB site. Next in 1973, a second large school, national institute of management sciences (INSG) opened. In 1986, UOB was divided into two institutions. The first was creation in Franceville, the University of Sciences and Techniques of Masuku (USTM), which brought together the Faculty of Sciences and ENSIL, and the second was Polytechnic Engineering School. Both were neighboring mining engineering school newly opened in Moanda, southeast of Gabon. In 2002, the former center for higher education of sciences, which was composed of the faculty of medicine (FM) and the school health science (SS) became a University of Health Sciences (USS), moved from actual UOB site to Owendo, neighboring Libreville.

Since 2002, UOB became a university oriented with human and social sciences, which had only two faculties: faculty of letters and human sciences (FLSH) and faculty of law and economic sciences (FDSE). UOB is under direct scientific supervision of the Ministry of Higher Education, Scientific Research and Technology Transfer and under the presidency of Professor Marc-Louis Ropivia.

UOB is working with two faculties: faculty of law and economic sciences (FDSE) and faculty of letters and human sciences (FLSH). Faculty of FLSH has twelve departments such as anthropology, anglophone studies, German studies, Iberian and Latin American studies, geography, history, modern literature, African literatures, philosophy, psychology, language and communication science. In addition, there are two departments in the faculty of FSDE, department of economics and management and department of law. Each department has as many masters in economics as those in law.

With regard to scientific and technological development, UOB always wants to create an effective academic environment adapted to the needs of public or private employment sector. Various academic programs have been prepared for students and professional in capacity building of knowledge and skills. UOB then provides training adapted to sustainable and social development to graduates in various fields. UOB is also committed to providing elements of innovation in various fields.

Administrative office of Omar Bongo University.

Omar Bongo University (UOB) organization was based on four higher education institutions such as the center for higher education of letters and human sciences; the center for higher education in law and economics; the center for higher education of sciences and university institute of technology (IUT) of Central Africa.

Professor Marc-Louis Ropivia, President of Omar Bongo University.

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of scientific researches. Serious methodologies for development of science and knowledge, sustainable development and solving of social problems that are challenges of UOB.

UOB enrolls about 35,000 students in 21 bachelor’s programs, and 500 master/doctor degrees in the first-class disciplines.

2. Space Science Application Researches

Remote Sensing, GIS, and Geoinformatics have been carried out in FLSh by geography department. It contains three laboratories: the laboratory of geomatics applied research and consulting (LAGRAC), the center for studies and research in political and prospective geosciences (CERGEP), and the laboratory of spatial analysis and tropical environments (LANASPET). LAGRAC works mostly in remote sensing, GIS, and Geoinformatics fields such as science, cartography, mangroves, forestry, fisheries, and pollution; water flooding, health, agriculture and arts. This article focuses only on a summary of main researches.

Professor Jules Djeki established that laboratory in 1994 after the return from his PhD awarded from Laval University Québec, Canada. I introduced remote sensing GIS and geostatistics tools to solving environmental issues developed at Kumamoto University, Japan after getting Doctor of Engineering (PhD). In 2010 after integrating LAGRAC in geography department, FLSh, UOB, in Gabon, four fields of research attracted my interests.

Research focuses on environmental applications of the space technology to solve pressing problems such as soil salinization, pollutions (air, and soils, subsurface and groundwater, and mining), water flooding, land-use and land-cover (LULC), coastal erosion, household garbage (waste), renewable energy assessment, natural resources evaluation, and natural hazard assessment appraising the use of large-scale remote sensing imageries, geostatistics tools and GIS. LAGRAC at UOB cooperated with many local and world institutions and universities from Japan, Canada, France, Poland, Cameroun, Congo Brazzaville, and Unites States of America.

An example of the LAGRAC researches conducted is a temporal LULC change in the Kumamoto plain, southeast Japan (Moukana Libongui and Koike, 2008; Fig. 1).

LULC was applied to a mining city, Moanda, southeast Gabon where manganese minerals are exploited (Fig. 2), by using an advanced method, support vector machine (SVM) instead of traditional classification methods.

Studies of pesticide pollution of subsurface water (Fig. 3) and water flood (Fig. 4) in the Gue-Gue basin were achieved for Libreville City, the capital of Gabon.

In addition, detection of potential zones for intermediary or deep groundwater resources was implemented by lineament analysis. Optical satellite images and field data were used for the lineament extraction and structural features from digital data were extracted using an image analysis software, Geomatica (Fig. 5).

A similar study of groundwater levels fluctuations detected...
by combing satellites images and geostatistical analyses on regionalized variables was implemented using cokriging for the Kumamoto plain as shown in Figure 6 (Moukana Libongui and Koike, 2013).

Water flooding is a major problem occurring in coastal cities such as Libreville. Because Gabon is located in the tropical equatorial zone with abundant rainy season over the year, the coastal climate controls evapotranspiration inducing long hours of raining. During the rainy season, Libreville is mostly covered by water floods. Sometimes fatality, disasters and landslide have occurred as shown in Figure 7 (Menie Ondo et al., 2016).

Soils pollution is also one of research fields in LAGRAC, as demonstrated by a work on soil recovering through natural process after several years of contamination (Mombo et al., 2018). This pollution was caused by hydrocarbures infiltrated into an electrical thermic station in Oyem City, northern region

**Figure 7.** Water floods in Gabon during the rainy season. The top left is the annual rainfall map. Dark blue colour shows high level over 3500 mm of rainfall. It means abundant subsurface water in Libreville City corresponding to typical tropical humid and hot climate. The top middle shows hydromorphic soils and the top right shows typology soils explaining causes of water floods. Bottom is photos showing situations of water floods.

**Figure 5.** Extracted lineaments from optical satellite images (top) and potential mapping of groundwater resources (bottom) with four ranks, the best (blue) and good (green).

**Figure 6.** Correlation between ground water declines and land cover changes using cokriging tools occurred in the Kumamoto plain.

**Figure 8.** Experimental semivariograms (black circles) and their models (dotted lines) of hydrocarbons pollutants (top) and pollutants recovery patterns using ordinary kriging (middle) and sequential Gaussian simulation (bottom) in Oyem City, northern region in Gabon.
in Gabon. A geostatistical tool, sequential Gaussian simulation, was used to clarify hydrocarbons pollutant patterns.

Figure 8 shows experimental semivariograms (black circles) and their models (dotted lines) of hydrocarbons pollutants patterns and spatial variability of pollutant recovery patterns using ordinary kriging and sequential Gaussian simulation. The kriging maps reveal a punctual variability of hydrocarbons over the study area, showing how the pollutants are infiltrated and moving from the subsurface to deep underground. The maps also show the recovery of soils as punctual over a period of four years (2010-2013). The result of sequential Gaussian simulation shows the variability of pollutants patterns more in detail. Dark blue means the recovery of soils by natural process. Red color indicates high levels of pollutants. This simulation is a suitable method and can be applied to solve this type of environmental pollution issue.

Gabon is limited by Atlantic Ocean with about 850 km of coastal line. Hydrodynamic and sedimentary particles such as lemons, sands silt and argyles are moved from deep ocean to border using wave forces by seawater to transport those materials to the coast. The hydrodynamic processes cause erosion and change of the costal line. Border houses and social infrastructures hotels etc. are destroyed and should be removed as shown in severely eroded or deposited zones in Figures 9 and 10.

3. Future Projects

LAGRAC future projects will focus on assessing the renewable energy potential integrating hyperspectral remote sensing and in-situ measurements in a GIS environment, solving water distribution issue. This is because reservation and management of drinkable clean water is a big issue for Gabonese people.

Coastal erosion is also important and should be considered with integrating various methods for sustainable solutions. Remote sensing, GIS, and Geoinformatics tools are valuable sources for developing knowledge and skills.

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