# REMOTE SENSING AND RATIONAL INTERVENTIONS FOR THE URBAN DEVELOPMENT IN AFRICA. THE CASE OF YAOUNDE IN CAMEROON (CENTRAL AFRICA)

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**ABSTRACT**:

To Cameroon, as well as to other countries of Africa, the good management of the cities must bring many advantages and appreciably improve the living standard of the populations. All the planners know it. However, when they try to put this logic into practise, they are facing with many difficulties which prevent the harmonious development of the cities in Africa. These difficulties are for example, the lack of credible data, the conflicts of competences between the Ministries intervening in urban environment, the conditions to fill to be authorized to reach some data. In this paper we present initially some problems of urban development of Yaounde, the political Capital of Cameroon. We are showing thereafter that, when other reliable sources of information do not exist or when they are difficult access, Remote sensing brings suitable solutions to these problem: it thus increases the chances of success of the various interventions in urban areas because the decisions are made rationally.

**RÉSUMÉ**:

Au Cameroun, comme dans d'autres pays africains, la bonne gestion des villes présente d'énormes avantages et augmente sensiblement la qualité de vie des populations citadines. Tous les planificateurs le savent. Cependant, quand ils tentent de mettre en pratique cette logique, ils font face à d'énormes difficultés qui empêchent le développement harmonieux des villes en Afrique. Ces difficultés sont par exemple le caractère douteux des données, les conflits de compétences entre les ministères chargés des affaires urbaines, les conditions préalables imposées à tout chercheur désirant accéder aux sources d'information. Dans ce travail, nous abordons quelques problèmes qui empêchent le développement de Yaoundé: la capitale politique du Cameroun. Nous montrons par la suite que, en cas d'inexistence de sources d'information crédibles, ou quand ces dernières sont difficilement accessibles, la télédétection devient une source d'information très fiable. Elle permet aux planificateurs urbains de faire des choix rationnels : ce qui augmente les chances de succès de leurs diverses interventions.

## 1. INTRODUCTION

Remote sensing makes easier observation and the action on space, in detail or on the whole. Numerous problems of development which prevented the populations from blooming are pep to be solved thanks to information increasingly found fine coming from the sky and from the space. From two applications, we show that, even without being a specialist in remote sensing and in sophisticated processing of images, an attentive observation of the urban environment can allowed to ameliorate decision-makers' action in the cities of Cameroon and of Africa by using easiest methods of remote sensing. To achieve this goal, the geographical space that the air photographs and the images from satellites revealed must be regarded as an interface between nature and human societies. It is constructed from the system of objects and the system of actions. It is in the same time natural and anthropogenic. The remote sensing which integrates the most recent developments of space research, computer science, data processing, sciences of nature and those of the society, makes it possible today to quickly and better apprehend the complex urban problems. Stakes are at the same time political, economic, strategic and socio-cultural. We are showing that by applying remote sensing on sanitation and demography. As far as we know, many researchers began and they continue developing methods of evaluating urban populations found on the use of air photographs and satellite. Here is the not exhaustive list of studied cities and of their authors: Dakar (Vernière, 1973); Tokyo (Lusaka and hegedus, 1982); Leicestershire, (LandFord and al 1991); Taiwan (Lo and Welch, 1977); Harare (Webster, 1996); Boulder in USA (Watkins, 1985); Quito and Bogota (Dureau, 1982 - 1985); Yaounde (Dureau on 1997; Cogneau and Roubaud on 1997, (Nancy, 1999) and (Enimelie, 2004). Used methods are presenting advantages and disadvantages (Harvey, 1999) and (Enimelie Ndiomo, 2004).

In this paper, after a brief overview of the Town Yaounde, we innovate by proposing two methods adapted to the context of the Cameroonian city and being able to be suitable for other African cities.

We will use: an air photograph of Yaounde (IGN, 1976); An image from SPOT XS (CNES, 14 -02-1992); An image from IKONOS (Spaceimaging, 14-11-2004).

## 2. A BRIEF OVERVIEW OF THE TOWN YAOUNDE

A stay in central Africa can give opportunity to the persons who feel the need to discover Yaounde: seat of institutions and political capital of Cameroon since 1922; Country that many observers think it condenses the major sides of the African

Continent. Yaounde actually appears at the same time as a confusing and curious, splendid city. By its names of quarters (mango trees, palm tree,green City); its agrarian activities and its socio - cultural composition, this city resembles a big village stretched on 15 km from the north to the south and covering a surface of 260 km2. By its modern equipment and the services which it offers, it is also a showcase of European civilization. The overlap of the aspects of the rural and urban milieu is a key element of this city which seems to grow infinitely, without precise orientation definite and by defying the basic rules of modern town planning (Nkolo, 2002). Its current development does not answer the general objective which must be the improvement of the people life within the town by creating an environment more salubrious, more functional, attracting and comfortable.

This situation is the result of a combination of factors: it can be understood if one locates it in agreement with the historical and geographical references marks, with the African definition of life, and with the non control of the urbanization by state services.

Located between 347' - 366' N and 1110' - 1145' E, and initially occupied by people of the Bantu Group, this space entered history on November 30th, 1889 when the soldiers of Kaiser Otto Von BISMARK established their base in this site - interfluve belonging to the Cameroonian south tray. Its altitude high (750 m on average) made profit with its occupants from the climatic conditions much more pleasant than those from the coastal zone which is in more than 200 km. For instance, a yearly average precipitation of 1670 mm and an average temperature 24 °c. The terms of security and advantages related to the geographical and strategic position of the site are later going to attract the German tradesmen and administrators but also the indigenous populations. One can therefore say that, the history of Yaounde is related to that of inked to that of Cameroon old German Protectorate (schutzgebiet) (1884 - 1914).

Since its foundation this city did not cease from growing as well in space as on demographic level. The relief is hilly: it conditions the unequal occupation of the inhabited space. This fragmented space occupation depends on socio – economic and cultural status of the dweller. The slopes were initially inhabited before the valleys. It is thought, at the present time, that the size of population in Yaounde doubles every seven years.

| Year | total area ( ha) | available area per household (m2) |
|---|---|---|
| 1957 | 1100 | 189 |
| 1968 | 2400 | 150 |
| 1974 | 3500 | 115 |
| 1979 | 4300 | 107 |
| 1990 | 11000 | 90 |
| 2000 | 20000 | 85 |

Table 1. Evolution of the urban perimeter of Yaounde from 1957 to 2000

The size of the city was also multiplied by ten, in thirty three years, from 1957 till 1990. This evolution also drew away the diminishing of the surface occupied per head by half; surface which passed from 189 m2 in 1957 to 90 m2 in 1990.

"Courtesy of Space Imaging"

Figure 1. Yaounde from IKONOS (14 – 11 – 2004: scene ID 2000025812300thc).

On this Ikonos image, the municipal lake appears with dark color (in north-west). The space organization of the process of urbanization privileging the highest parts of the relief is also definitely visible. The valleys appear in the shape of green corridors.

Photo by : Mengue Mbom (11-2003)

Figure 2. View of the summit layer of (interfluve) preferentially occupied by the rich and medium social classes

This image proves that the richest social classes do not have the same problems as those of the poor classes: it is for this reasons that there is not a great diversity of fruit trees around their houses. The rationality of the rich person it is not always that of poor or poorest people (Mengue et al., 2003).

Photo by Mengue Mbom (11-2003)

Figure 3. View of the depression layer (valley) occupied by the poor and very poor classes

This photo is showing that poor and poorest populations are obliged to maintain the fruit trees around their houses to nourish and obtain a little more money necessary to solve problems occurring in their households.

To solve numerous problems which put down a city as Yaounde, collection and data processing must be done by using more modern techniques and while making the skilled people to work: that is not always the case in Africa. We are now going, through two fields of application, to show that remote sensing is an instrument which need planning in Africa to improve living standard in the big cities. The first door over demography and the second on sanitation.

## 3. TWO APPLICATIONS OF URBAN REMOTE SENSING TO HELP DECISION – MAKING :

### 3.1 Social accounting:

The quick production of reliable, flexible, comparable demographic information in space and time, at lower cost, directed towards the realization of social accounting, for better decision – making as regards development, preoccupies the politicians. The demographic data acquisition, by the practice of exhaustive censuses, poses many epistemological, practical and ethics problems of numerous problems which skews the results and considerably reduce their practical effectiveness. To decrease these insufficiencies, a renovation of old techniques and methods are to be encouraged. Our approach grants the biggest importance in the taking into account of urban context (relief and other factors of the physical and human environments) for a better estimate of people number and a suitable spatialisation of demographic facts from remote sensing.

#### 3.1.1 From the simple areal method to the stratified and contextualized areal method

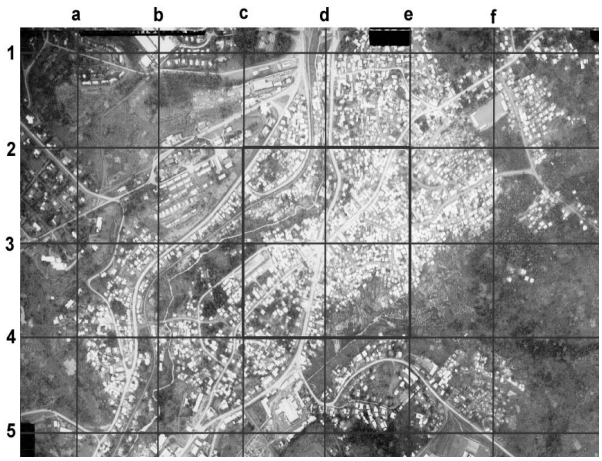



Figure 4. The simple areal Method

We can apply the same methods using Ikonos image.
A Grid of size 3*3 cm is superimposed here on the selected image zone. The total number of houses contained in each square is multiplied by the average number of occupiers (average size of the households in Yaounde is 7 inhabitants). For the central zone of this image (of coordinates 2c – 2nd, 4c – 4th), 644 houses were listed: the number of inhabitants estimated is therefore 644 x 7 that gives 4508 inhabitants. The simple areal method, that we have just described, presents the disadvantage of offering very global results and consequently it does suites revealing the disparities related to contextual factors. To ameliorate such insufficiencies and to produce valuable estimates much closer to observations made on the ground, the application of the stratified and contextualized areal method (next image), gives better results: 3979 inhabitants in the same zone.

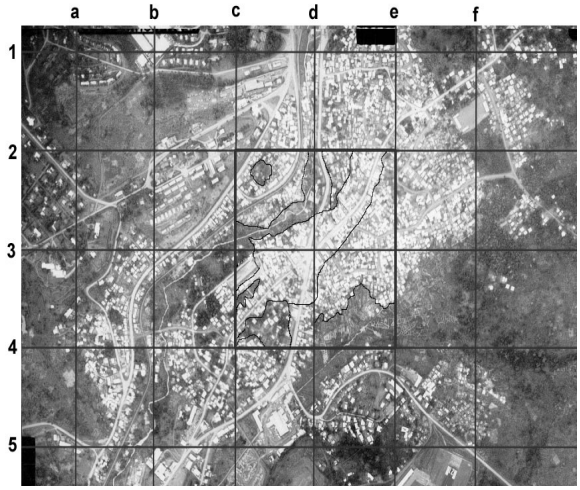



Figure 5. The stratified and contextualized areal method

In this method the estimation of the number of people is made starting from the topographic units identified in each grid square. We located three differently occupied layers:
- The summit layer of (interfluve) preferentially occupied by the rich and medium social classes;

- The slope layer of the earth occupied by the medium and poor classes;
- The depression layer (thorough habitat of valley) occupied by the poor and very poor classes.

The procedure consists: of determining the average size of the household in each layer, to count the number on houses of each layer, and to multiply this number of houses of each layer by the average specific number of occupiers in the layer. To conclude, the different acquired results are summed.

**3.2 Remote sensing and urban sanitation:**

The municipal lake of Yaounde had been created by European promoters in 1950 for the following reasons: aesthetics (embellishment of the city); sporting (to provide a place for nautical sports); economic (to offer fishes to populations); medical (to fight against the proliferation of the mosquitoes responsible for malaria); entertaining (to provide a space for relaxation). The surface of the lake, from 1950 till 2002, decreases from 7.8 ha to 3 ha and its depth from 6m to 3 (Yachin Nguiamen H., 2002). The water is very polluted because it is an outfall of organic matter and polluted waters from its vicinity. Consequences are huge: eutrophisation (enrichment of water in organic matter, its impoverishment in oxygen, alteration of the flora and lake fauna); deterioration of life of the population; olfactory harmful effect; worsening of health sanitation (malaria and bilharzia).

Remote sensing makes it possible to detect abnormal state of water:
The research undertaken in remote sensing laboratories of in France made it possible to know the radiometric behavior of not polluted water detected by the satellite SPOT. The spectral signature characterizing the not polluted water reaction is a curve built starting from the very low values of reflectance. The slope of this curve goes down very quickly from visible (channel XS1) to the infra-red (channel XS3). We start from this model of normal behavior of water to study and qualify the state of water in the municipal lake of Yaounde in 1992.

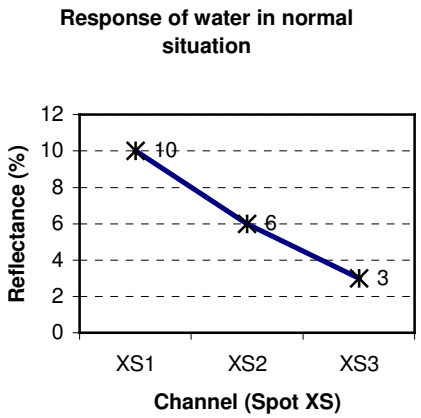
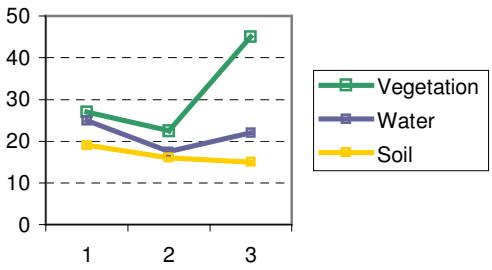



Figure 6. Response of water in normal situation

The study of the values of pixels in the water of the lake made it possible to establish three curves of the following figure. These curves are showing that the behavior of the municipal lake is different from that which is characteristic of water: These radiometric values are very strong what makes believe that this water is not pure. They give curves out of V which make believe that there is much vegetation in this lake.




source : Assako Assako (2001)

Figure 7. The detection of anomalies in the water of municipal lake spectral signatures (1992)

The analysis of the water samples taken in the lake in 1997 confirmed the results obtained by Remote sensing. In the following figure, the water of the lake concentrates in a very abnormal way certain substances. Organic matter, sulphide, calcium, sodium, nitrate are with proportions much higher than the standards. In this example,Remote sensing image analysing made it possible to the planners of Yaounde to identify a problem and currently (in 2005), the municipal lake is to be managed.

| Water composition | Measuring unit | Limit values | Values from the lake | Difference |
|---|---|---|---|---|
| Suspended Matter | mg/l | 30 | 1000 | 970 |
| Sulphide | mg/l | 10 | 160 | 150 |
| Calcium (Ca) | mg/l | <50 | 112 | 62 |
| Sodium (Na) | mg/l | <12 | 72.45 | 60.45 |
| Chlore (Cl) | mg/l | <30 | 51 | 21 |
| Nitrate (NO3) | mg/l | <0.5 | 12 | 11.5 |
| Nitrogen (NTV) | mg/l | 1 | 10 | 9 |
| Temperature | °C | <25°C | 30°C | 5°C |
| Amoniaque (NH4) | mg/l | [05-2] | 6 | 4.75 |
| Nitrite (NO2) | mg/l | <0,5 | 1.4 | 0.9 |
| pH | pH | 5.5-8.5 | 7.1 | 0.1 |
| Dissolve Oxygene (O2) | mg/l | >7 | 1.2 | -5.8 |
| Sulphate (SO4) | mg/l | 100 | 92 | -8 |

Source : Assako Assako R.J.

Figure 8. Confirmation of observed anomalies in the water of Yaounde municipal lake by field test (laboratory)

**4.CONCLUSIONS:**

All in all it emerges from our communication that certain sides of African demography can be better known thanks to the possibilities which gives remote sensing. The stratified and contextualised Areal Method opens the way to the more harmonious and sustainable social development of cities in developing countries. It not only makes it possible for us to focus our attention on administrative authorities and on actors of development on the need for promoting the use of remote

sensing as true instrument of decision making; but also, to spatialise the results of a social survey by improving its precision, to make the decision more efficient. To conclude, it also makes easier, the actualisation of demographic, by using a modern and autonomous means of recognition and demographic inventory; means in addition opening a new way to build electronic databases making easier the investigations in urban area. Remote Sensing also appears very efficient in detecting sanitation Problems.

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