Need for Geo-scientific Maps for a Reasonable Planning and Physical Development of Coastal and Wetland Areas of Nigeria

Meshida E. A. and Ayolabi E. A.

Department of Geosciences, University of Lagos, Nigeria

Corresponding author; E-mail: Terageo@yahoo.co.uk

Abstract

The provision of various categories of Land Use Maps is fundamental to the planning and physical development of any area worldwide. The recent spate of wetland area development in different parts of Nigeria due to pressure on land without maps for planning is very dangerous and objectionable. This paper highlights the need for an urgent Governmental Policy to embark on the scientific production of maps for planning. Geo-scientific maps, such as Engineering Geological, Geotechnical, Remote Sensing and Seismic monitoring Maps of Coastal and wetland areas in particular, are urgently required for reasonable and economical planning. Some of the dangers inherent in the non availability of these maps are highlighted, with examples from the mega city of Lagos.

Keywords: Geo-scientific maps, physical development, coastal and wetland areas

Introduction

The progressive growth of population in the mega city of Lagos has resulted in very serious pressure on land for development. Land that was previously regarded as waste or difficult has suddenly become targets of all sorts of 'improvement' for development and converted to housing or industrial estates without adequate or essential professional and technical planning. Natural canals and muddy flood plains are being reclaimed by local and unauthorized persons with substandard soil materials under the supervision or contractor-ship of unqualified artisans for the construction of unplanned homes and commercial centers. The current spate of the incidence of collapsed buildings and dilapidated engineering infrastructures is not unconnected with this unfortunate situation. The mega city of Lagos is located in a wetland environment that requires very effective professional planning and development. Figure 1 show the topography of the southern part of the mega city, consisting mostly of the coastal sedimentary deposits, lagoons and swampy lowlands.

Figure1: Map of Lagos showing its location in Wetland environment

Like in many old towns and cities all over the world, Lagos has been developed over a few centuries without modern planning. Planned and unplanned developed areas are closely juxtaposed, creating a jumble of incongruent cultural outlook. It therefore seems that a beginning of modern planning has to be made by the commencement of the Technical Mapping of the various land components that constitute the mega city of Lagos. In addition to the production of various categories of Land Use Maps, Engineering Geological and Geotechnical Maps to guide the professional planning of the city, together with a number of Seismic Monitoring Stations should be established in the Coastal and hinterland wetland areas to monitor their daily magnitudes of seismicity.

Importance of Maps

Maps should be regarded as one of the most fundamental documents needed for land planning and subsequent development. Without maps, development is haphazard, dangerous, wasteful and unreasonable. Useful maps are in essence, professionally produced. They are documents that result from field and laboratory research, and each category of maps has a specific theme to propagate. Land use maps for instance are needed for the planning of all development schemes such as agriculture, housing, recreation centers, and forest reserves among others.

The development of each scheme is subject to the establishment of State and bye-laws to prevent chaotic degeneration. In addition, special Technical Maps are essential to guide actual civil engineering planning, design and development. In the latter category of maps are Engineering Geological and Geotechnical Maps. Their functions relate to the accurate location, field categorization and utilization to guide the design and construction of safe and economical foundations for all civil engineering structures. All civil engineering structures are founded on the earth's surface, and it is only reasonable that the long term stability of the structures is assured by an effective understanding of the possible immediate and long term behavior of soil materials under engineering usage. It is well known all over the world that any structure that is constructed but not in harmony with its foundation material and general geological environment sooner or later goes to waste.

Engineering Geological Maps

The formal establishment of the concept of Engineering Geological maps is a modern phenomenon. A special Commission on Engineering Geological Mapping was appointed by the International Association of Engineering Geology (IAEG) in 1968. It published its report that has since become the classical guide to the production of Engineering Geological Maps in 1972. A symposium was subsequently held in the University of Newcastle upon Tyne in 1979 to provide an opportunity for engineering geologists and civil engineers to meet together to discuss the methods, application and usefulness of mapping in engineering geological terms to planning, design and construction in civil engineering (Dearman et al, 1979).

The symposium focused on many aspects of the mentioned category of maps, with the presentation of many technical papers. The following aspects were examined in detail:

1. Regional engineering geological maps for planning
2. Hazard Mapping in risk evaluation for engineering structures
3. Civil Engineering site mapping practice
4. Land and Sea-floor geophysical mapping for civil engineering structures
5. Terrain Evaluation and Remote Sensing
6. Engineering Geo-morphological mapping

Each map category is essentially a large scale map, such as 1: 5000, 1: 10,000 1: 25,000. to facilitate a reasonable inclusion of essential geological features and structures (Dearman et al, 1979).

In recent years, very remarkable progress has been achieved in the composition and production of Engineering Geological maps in the industrially developed countries of Europe, North America, Asia Australia and New Zealand since 1979. By contrast in Nigeria, only a few attempts have been made to coordinate site investigation test results for the production of Engineering Geological maps. Akpokoje (1979) produced some preliminary maps of the Niger Delta area from a summary of geo-morphological, hydro-geological and some soil mechanics test data. Malomo et al (1980) produced a preliminary Engineering Geological Map of the Federal Capital City, Abuja for the proposed development of the City through a Geological Mapping assignment

offered to the Geological Consultancy Unit of the Department of Geology, University of Ife. Madedor et al (1987) and Okogbue (1995) have similarly attempted to construct preliminary Engineering Geological maps of parts of the Niger Delta for civil engineering development projects. However, there is need to develop an understanding between the geological and civil engineering professions in Nigeria before Engineering Geological Maps can be acceptably produced and published to become regular documents in the planning and execution of development projects in the country. It is a most unfortunate scenario that despite the remarkable development of multi-disciplinary cooperation between the earth sciences and engineering professions in all other countries, Nigeria still operates an indefensible stance of segregation in the professional practice of the two respective disciplines. This is a serious setback that should be effectively addressed and jointly corrected by the respective professions nationally.

Engineering Geo-morphological Maps

In addition to topographical maps, Engineering Geo-morphological maps are also desirable for effective planning. These are also little known in Nigeria. Large scale geo-morphological maps are very fundamental to the successful planning, design and construction of roads and highways (Brunsden et al, 1975). It seems that the provision of topographical maps should be revisited in the country before emphasis can be reasonably put on geo-morphological maps. There has been little improvement on the series of Topographical maps produced in the country since the British Colonial era. It is even virtually impossible to obtain several of those maps in the country today. Some of those still available were produced in 1948 and revised in 1952 by the ''Department of Federal Surveys''. The present post Independence Nigerian Federal Ministry of Surveys is yet to revise the maps and endeavour to produce modern digitized topographic maps that would be the basis for the production of publishable engineering geo-morphological maps of Nigeria.

Geotechnical Maps

Geotechnical maps are constructed from coordinated results of field and laboratory test results of civil engineering site investigations. They show the spatial distribution and relationships of foundation soil bearing capacities, consolidation settlements, engineering soil or rock classifications, varying values of the California Bearing Ratios (CBR), and all other foundation engineering soil parameters characteristic of particular soil horizons that are of interest to structural engineers. In the United Kingdom for example, many counties have been geo-technically mapped to assist in the execution of engineering development programs (Dearman et al 1979).

Wetland areas being developed at present in Lagos mega city by private developers represent very alarming engineering mismanagement of land. Many of the developers employ the services of unqualified personnel to execute shell and auger drilling and offer foundation proposals. Very spurious recommendations are made, and proposed structures are constructed, with little or no input from trained geotechnical engineers. Within months of their completion, the buildings signify structural failures by tilting, ugly cracking or massive

subsidence. Several such examples are found at Ifako-Gbagada, Ogudu flood plain, Oyadiran Estate at Ebute Meta, Oto-Ido area, to mention a few. So far, many of the affected houses had to be demolished by the appropriate governmental Agencies. Almost in all cases, the structures were constructed haphazardly located to obstruct the drainage in canal zones.

In a very critical case of the structural failure of a nearly completed massive hotel building located in a natural canal terrain, the authors were invited (April, 2010) to conduct authentic engineering site investigation backed with the 2D electrical resistivity tomography to confirm the engineering subsoil conditions in the vicinity of the building. The results of the investigation showed that the sub soils were very heterogeneous. A section of the building was constructed over acceptably competent sandy stratum while about one third of the foundation stood over piles terminated in a soft clay stratum. The badly tilted building had to be demolished. Plate 1 shows the affected building and the commencement of the 2D geophysical tomography investigation, while Plate 2 shows the affected building at the initial stage of demolition.

Similarly, a structural development of a major residential housing estate also located in a canal area of Ebute Meta was commenced with little understanding of the Engineering Geological nature of the environment and its sub soils. The erected structures consisted of 4nos. six storey and 4nos. four storey blocks of flats. The initial soil investigation report was very inaccurate as it indicated that it was feasible to install bored and cast-in-situ reinforced concrete piles terminated at varying depths to sustain the proposed block of flats. Over 900 such piles were constructed and terminated within a very thick sequence of soft peat to sustain the buildings. Within a few weeks of their completion, all the structures failed by pronounced tilting and remarkable differential settlement. The executed post failure shell and auger borings and geo-electrical 2D tomography revealed the thick sequence of peat within which the bored piles were terminated. The only solution to the entire problem was a complete demolition of the entire blocks and a fresh commencement of the housing project with the adoption of appropriately designed precast reinforced concrete piles, driven to hard resistance at varying depths. It was a costly mistake that conclusively illustrates possible wastage that may accompany an inadequate understanding of the geotechnical environment.

Plates 1and 2 below show some completed buildings in a Housing Estate in a prime area in Lekki, a south-western part of the Mega city. The estate was completed for occupation in the dry season some years ago. At the onset of the rainy season, it was found that it was impossible to control the degree of flooding ravaging the estate, and most of the houses had to be abandoned. Planning during construction was so poor that the estate roads were constructed higher than the ground floor. Unfortunately also, this is illustrative of several such examples of ongoing engineering site mismanagement reported in some parts of the mega city.

Plate 1

Plate 2

Plates 1 and 2: Abandoned buildings due to poor planning against flooding

Seismicity Maps

The monitoring of seismic wave propagation has not been a regular aspect of engineering planning in Nigeria. It appears that the relative seismic quiescence so far enjoyed in the country has prevented the necessary awareness to prepare for any onset of earthquakes. Recent developments in the knowledge of 'Plate Tectonics' have shown that no part of the earth's crust is absolutely free from seismic vibrations. It is the intensity that varies from place to place. This means that seismic vibrations occur daily in different parts of Nigeria, but there are no seismic stations to monitor the vibrations. This lapse needs to be corrected as urgently as possible. In the Lagos mega city, Victoria Island and Ikoyi areas which are prime areas close to the sea should geologically be viewed as possible targets of seismic sensitivity.

A critical examination of the geological structure of South Eastern coastal area of Nigeria and the Cameroons shows that the group of rocks designated as 'effusives' (Aseez, 1975) are essentially relicts of ancient dormant volcanic city (Figure 3). The volcanic islands of Sao Tome, Principe and Fernando Po are aligned structurally with the volcanic, active Cameroon Mountains. Whiteman and Burke (1969) have speculated that the area might represent a zone of impending seismicity where continental fracturing might be initiated. Should this be possible, a tsunami (volcanic eruption in the sea) would be expected in the area as part of the possible tectonic process. Monitoring stations established in Port Harcourt would certainly be of tremendous advantage to monitor and predict the expected seismic vibrations.

Conclusion

The need for the planning of coastal and wetland areas of Nigeria with various categories of Maps for development purposes has been presented. Lack of maps for planning renders development proposals ineffective, wasteful and nonsensical. Land Use maps of various categories, Topographical, Engineering Geological, Geotechnical and Seismic Monitoring Maps

are essential technical documents that universally assist in the engineering planning and physical development of sensitive regions and local sites such as the Coastal and wetland areas. It is therefore strongly recommended to the Federal Government of Nigeria that adequate administrative, financial and relevant logistics provisions be made for the appropriate mapping of these sensitive terrains in Nigeria.

References

Dearman W.R., Money, M.S. Strachan nne D, Coffey J.R, Marsden Ann (1979), A regional Engineering Geological map of the Tyne and Wear County, N. E. England. Bull Eng Geol. (IAEG) No. 19, pp. 5-7

Akpokodje, E.G (1979), The Importance of Engineering Geological Mapping in the Development of the Niger Delta Basin Bull Eng. Geol (IAEG) No. 19, .pp. 101 – 108

Asseez, L.O (1976), Review of the Stratigratiphy, Sedimentaton and Structure of the Niger Delta Geology of Nigeria, Ed. C.A kogbe, Elizabethan Publishing Co., Surulere, Lagos, pp. 259-272

Denys Brunsden, John Charles Doornkamp, Peter George Fookes, David Keith Crozier Jones & John Michel Hunter Kelly.(1975), 'Large Scale Geo-morphological mapping and Highway Engineering Design', Quarterly Journal of Eng. Geol., Vol. 8, pp. 227 – 253

Malomo et al (1980), Report on the Geological mapping of the Federal Capital Territory, Abuja Clients: Fed. Cap. Dev. Authority, Lagos, Nigeria

Madedor, A.O Nnama, S.K, & Aitsebaomo (1987), An Engineering Geological Map of rivers State of Nigeria derived from conventional Soil Survey, Proceedings of 9th Reg. Conf. of ISSMFE for Africa, Vol. 1, pp. 521 - 528