



# **NBRI REPORT NO. 19**

**ENGINEERING SOIL AND MATERIALS SURVEY IN PARTS  
OF NORTH EASTERN NIGERIA USING REMOTE SENSING  
TECHNIQUES**

As part of its programme to help professionals in the road construction industry, the Nigerian Building and Road Research Institute (NBRRRI) initiated a long term programme to produce an engineering geological map of Nigeria for use in the planning, design and construction of highways. Such maps were hitherto not available in Nigeria. In view of the large area of the country to be covered, it became clear that the most effective method of executing this programme quickly and economically was to use the new technology of remote sensing techniques. Accordingly NBRRRI decided to acquire the expertise in the use of remote sensing techniques.

This report illustrates the successful use of remote sensing techniques to evaluate a terrain for road design and construction. By this success, NBRRRI has acquired a technology of great value and importance for the road industry.

NBRRRI is readily willing to share this technology with any professional who seeks its assistance in this field.

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Director

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## 1. INTRODUCTION

### 1.1 General

The mapping of soils and construction materials in parts of North Eastern Nigeria, through the interpretation of aerial photographs and SLAR Imageries covering an area of about 3,800km<sup>2</sup> and 132,000km<sup>2</sup> respectively, was carried out. The area under study is comprised of clay soil (black cotton soil), sandy soil and dunal terrain. Sample ground verification was also conducted to verify some of the interpreted maps.

The maps thus produced for the first time in the country, will be useful for initial planning of road routes and judicious utilization of locally available materials, thereby effecting economy in the cost of road construction. The technique is of great interest not only to Nigeria but also to other developing countries in the African continent where the potential for vast road construction works is great.

### 1.2 Background and Methodology

An inventory of soils and materials is a pre-requisite for the planning of highways. By judicious utilization of locally available materials, economy can be achieved on the design and construction of highways. This is significant particularly in developing countries, where large number of roads have to be constructed to meet the need of a developing economy.

Hitherto in Nigeria, Engineering Geological maps, showing the distribution of soils and construction materials are not available. With a view to assisting the construction industry for readily available terrain data, the Nigerian Building and Road Research Institute undertook this project. Since the area of the country to be mapped is 923,000km<sup>2</sup>, comprising regions of different geology soil types, climate and ecology, advantage has been taken of the scientific technique of "Remote Sensing", for rapid survey of the area. The survey is to be conducted systematically to cover the whole of Nigeria. This report covers the first area surveyed.

## 2. REMOTE SENSING TECHNIQUE

Remote sensing involves the collection of data by systems which are not in direct contact with the objects or phenomena under investigation. These data are often made available on photographs or satellite images which are interpreted according to the type of information and analysis required.

The interpretation for inventory of material resources is limited to three types of remote sensing techniques:

- i. Aerial photographs
- ii. SLAR (Side Looking Airborne Radar) imagery;
- iii Landsat imagery.

### 2.1 Aerial Photographs

Photographic remote sensing technique is the oldest and well established. The conventional method of using the panchromatic (black and white) aerial photographs (23cm x 23cm size) have continued to gain acceptance as a research and planning tool in Nigeria. This is mostly due to the large scale (as large as 1: 10,000) and ability to overlap photographs. The 3 - Dimensional view can be studied using a Mirror stereoscope. This instrument with its diagrammatic sketches is shown in photo 1 and figures 1 and 2.

In engineering soil survey, elements of the topography, drainage and erosion are typical features that provide information on the soil type and construction materials, and these are observed on aerial photographs.

The panchromatic photograph is produced on a film emulsion that is sensitive to radiation in the visible band of the electromagnetic spectrum.(EM) Although the system is passive and dependent on solar illumination, it provides the best source of quantitative data extraction for rapid soil survey.

### 2.2 SLAR (Side Looking Airborne Radar) Imagery

SLAR is the development of the second World War. It is an active radar system and operates in the microwave portion of the electromagnetic spectrum. It is independent of solar