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Mapping in Semi Arid Developing Countries Using Orbital  
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- II. Principal Investigator : Dr. J.L. van Genderen
- III. Authors of Report : Lock, B.F. and Genderen, J.L. van
- IV. Address of Organization : Department of Geography  
The University  
Sheffield  
S10 2TN  
United Kingdom
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Code TF6  
NASA, Johnson Space Centre  
Houston  
Texas 77058  
USA

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(E76-10338) A METHCLOGY FOR SMALL SCALE  
RURAL LAND USE MAPPING IN SEMI-ARID  
DEVELOPING COUNTRIES USING ORBITAL IMAGERY.  
1: INTRODUCTION (Sheffield Univ.) 7 p HC

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## I. SUMMARY OF SIGNIFICANT RESULTS

This research programme has developed a viable methodology for producing small scale rural land use maps in semi-arid developing countries using imagery obtained from orbital multi-spectral scanners. At present no such methodology is available and it is felt that there is an urgent need for a detailed description of all the stages involved in the production of small scale land use maps using MSS data similar to the methodologies that have been developed for use with conventional aerial photography.

### 1.1. INTRODUCTION

This is the first of a series of reports culminating in a proposed new methodology for carrying out small scale rural land use surveys in semi-arid developing countries using orbital imagery. This first report provides the background information to the research project, reviews the various alternatives, and shows the urgent need for a simple to operate, low cost methodology for rural land use surveys.

### 1.2. THE NEED FOR SMALL SCALE RURAL LAND USE MAPS

Nunnally (1974)<sup>\*</sup> and other researchers (Howard, 1974; Estes et al., 1974) have asserted that remote sensing technology can make one of its biggest and most significant contributions in the area of land use data collection. This has been due to a variety of reasons, including the development of many different types of sensors, data storage devices and recording platforms.

Until the 1960's, detailed rural land use surveys have been mainly carried out in developed countries and land use maps have been produced for a range of purposes with a wide variety of scales and classifications. The primary purpose of these surveys has been to determine the spatial

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\* All references will be quoted separately in a subsequent report

distribution of land use at a particular time. The resultant land use maps have provided planners with useful analytical tools for general or reconnaissance evaluations as well as establishing a permanent data base as part of a continual monitoring system of the landscape. These surveys have been carried out using time-consuming and often expensive methods involving the collection of information from various statistical agencies, field reports and vertical black and white panchromatic aerial photography (Kriesman, 1969).

With the emergence of many new independent nations since World War II, the planning of their economic development policies has often necessitated the use of medium-small scale land use maps which have permitted broad overviews of regions and have provided the bases for more detailed and diverse investigations at larger scales. Also, with the ensuing changes in agricultural products and land management procedures, they have provided a system for establishing permanent and systematic records of landscape changes.

However, there have been problems in the production of these medium-small scale land use maps in both developing and developed countries mainly associated with the collection of base data (Thaman, 1974). The introduction of panchromatic vertical aerial photography allowed a comparatively rapid method of recording the land use characteristics of the landscape but certain problems became obvious with this type of data collection technique. Essentially, the problems have been concerned with time and cost factors. In order to produce medium-small land use maps the task of handling and interpreting large numbers of photographs became a major barrier to the rapid production of the completed map. Also, the costs involved in providing adequate, consistent and repetitive coverage over large areas by conventional

vertical aerial photographic surveys in a wide range of weather conditions have added to the production problems (King and Blair Rains, 1974).

When the Earth Resources Technology Satellite (ERTS - 1 now named Landsat - 1) was launched in July, 1972 a new system of rapid data collection became available which permitted consistent coverage of the earth's surface through a variety of sensors. For the first time, regular synoptic overviews could be used in plotting man's utilization of the earth's surface. This was particularly encouraging for the developing countries where the costs and other problems associated with the collection of agricultural data on a repetitive basis by conventional methods have often been the major deterrents against the production of land use maps. Also, in some countries it was the first time that complete areal coverage had been available (Rijnberg and van den Broek, 1975).

Since 1972 there has been a virtual explosion in the amount of research carried out on data obtained from Landsat 1, Landsat 2 and Skylab. But, according to Nunnally (1974) there has been no attempt by anyone to systematically evaluate the relative effectiveness of all of the different sensors capable of recording land use data. Many investigators have considered the comparatively conventional photographic processes including black and white panchromatic and 1R, colour and colour 1R photography in land use studies (Colwell, 1970; Vink et al., 1965). More recently, other researchers have investigated the use of multi-spectral scanners, radar and thermal 1R with varying degrees of success (Allen, 1975; Smith, 1975; Easams, 1972; Nunnally, 1974; Henderson, 1975).

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Although the development of techniques for collecting remotely sensed data has progressed very rapidly, many problems still persist in the utilisation of the information. These include the correct selection and calibration of sensors for specific purposes as well as an understanding of their design capabilities and functions. Also, the identification of image characteristics and the lack of clarity caused by the quality and resolution factors of the remotely sensed data have presented difficulties in the interpretation of land use at medium to small scales (Landgrebe, 1972). Seasonality or the time of imagery is another important factor that can affect the nature of the data collected (Owen-Jones, 1975).

Other problems include the lack of appropriate techniques for establishing ground truth using satisfactory sampling techniques (Kelly, 1970; Zonneveld, 1974; Allan, 1975), the lack of a proven and versatile land use classification scheme suitable for use with small scale imagery (Anderson, 1971; Anderson et al., 1972; Dodt van der Zee, 1974) and the lack of adequate training for persons involved in interpreting this imagery (Nunnally, 1974). Also, the high costs incurred in using many of the computer based interpretation systems that have been evolving during the last two or three years will probably preclude their future use in many countries (Sweet et al., 1974; Lietzke and Stevenson, 1974).

### 1.3. THE NEED FOR A METHODOLOGY FOR PRODUCING SMALL SCALE LAND USE MAPS USING ORBITAL IMAGERY

It has, therefore, become apparent that a detailed outline of a methodology for producing small scale rural land use maps from data obtained by remote sensing techniques could have immediate practical applications. The methodology would be particularly beneficial if the

suggested techniques could be applied using relatively accessible equipment and materials, as many developing countries lack suitably qualified staff, technology and equipment. In addition, it appears that adequately tested automatic systems for interpreting land use patterns from orbital imagery will not be functional in the foreseeable future (Hempenius, 1975; Savigear, 1975). These systems need to incorporate spatial, spectral and temporal factors in order to interpret land use under a wide range of conditions and, although much research has been carried out, no completely successful system has been developed.

It is envisaged that the methodology will include an outline of relevant remote sensing techniques including their scope and limitations, guidance on pre-processing procedures, selection of correct data bases, discussion of map scale selection, interpretation procedures, the development of suitable land use classification schemes, clarification of ground truth procedures, especially sampling methods and the production of the final land use map. This methodology should present a basis from which medium-small scale rural land use maps could be produced without resorting to exhaustive background research and training or the use of expensive equipment and technologies.

#### 1.4. OBJECTIVE

The development of a methodology for producing small scale rural land use maps in semi-arid developing countries using remote sensing techniques, especially orbital multi-spectral scanners.

The areas that will receive particular attention are:-

- a) a critical evaluation of the uses and limitations of remote sensing devices that can be utilised in carrying out land use surveys;

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- b) a resume of relevant pre-processing techniques;
- c) a description of various interpretation procedures that may be used;
- d) the development of a suitable rural land-use classification system for use with small scale orbital imagery;
- e) clarification and assessment of ground truth procedures.

The next report will review the capabilities of various remote sensing techniques for land use surveys using orbital imagery.