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**SUMMARY OF FIRST SPATIAL ANALYSIS OF  
PART OF FORT BENNING**

Third Interim Report (RSSUSA - 3)

by

Dr Margaret A. Oliver and Professor Richard Webster

May 1995 to July 1995

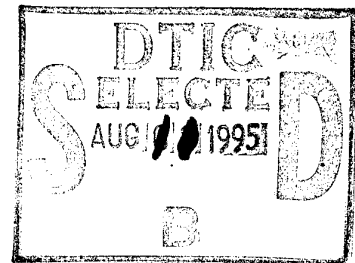
United States Army

ENVIRONMENTAL RESEARCH OFFICE OF THE U.S. ARMY

London, England

CONTRACT NUMBER - N68171 - 95 - C - 9007

Contractor - Approved for Public Release; distribution unlimited



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REPORT DOCUMENTATION PAGE

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1. AGENCY USE ONLY (Leave blank) 2. REPORT DATE 3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE  
Summary of First Spatial Analysis at Fort Benning  
Optimizing Fixed Sample Design and Data Compression from Remote  
Image(s)

5. FUNDING NUMBERS  
PR - N68171  
95 - C - 9007

6. AUTHOR(S)  
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  
The University of Reading  
Whiteknights, Reading, RG6 2AH, UK

8. PERFORMING ORGANIZATION REPORT NUMBER  
RSS USA-3

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)  
USARDSG - UK  
Environmental Sciences Branch,  
Edison House, 233 Old Marylebone Road  
London, NW1 5TH, UK

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES  
Variogram analysis of study area from SPOT  
Image of Fort Benning

12. DISTRIBUTION STATEMENT  
No limitations on distribution/availability

13. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The digital SPOT image data from the study area chosen by TEC within Fort Benning comprise three wavebands, near infrared, red and green. The standard vegetation index, NDVI, was computed from the first two channels. The pixel data for the four variables were mapped, and the summary statistics were computed. Wavebands 2 and 3 were strongly skewed and so the values were transformed to logarithms. Variograms were computed in two directions, along the rows and down the columns, for the three wavebands using both raw and transformed data, and for NDVI. Several mathematical models were fitted to the variograms. The double exponential model provided the best fit in all cases. The parameters of the models were different for the different directions and for the different variables. Two distinct scales of spatial variation are present in each case, a short range one of about 9 pixels and a long range one of over a hundred pixels. The scale of variation is greater in the N-S direction. Based on these results we have recommended a reconnaissance sampling plan comprising a series of transects over the study area for obtaining field data to correlate with the image.

14. SUBJECT TERMS  
Fort Benning. Geostatistics, Spatial scale, Variogram analysis, Modelling.

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT  
18. SECURITY CLASSIFICATION OF THIS PAGE  
19. SECURITY CLASSIFICATION OF ABSTRACT  
20. LIMITATION OF ABSTRACT

NSN 7540-01-280-5500

Standard Form 298 (Rev. 1-89)  
Prescribed by ANSI Std. Z39-18  
298-102

## REPORT OF FIRST SPATIAL ANALYSIS OF PART OF FORT BENNING

**ABSTRACT** This report is a summary of a more detailed report submitted to Kevin Slocum (TEC) of the results of our first analysis. We have analysed the data comprising the image of the Fort Benning study region. The pixel values of the three wavebands and the standard vegetation index NDVI were mapped and the summary statistics computed. The values for wavebands 2 and 3 were transformed to logarithms because they were strongly skewed. Variograms were computed for all of the data and models were fitted. The double exponential model provided the best fit in every instance. It shows that there are two definite spatial scales of variation; a short range one of about 9 pixels and a long range one of over 100 pixels. The scale of variation is greater in the N-S direction. Based on these results we have recommended a reconnaissance sampling plan comprising a series of transects over the study area for obtaining field data to correlate with the image.

### INTRODUCTION

This is a summary of the report of the results submitted to Kevin Slocum (TEC) in June 1995. The purpose of this analysis was to describe the spatial pattern in the study area from the SPOT image so that a reconnaissance sampling scheme for a field survey could be designed. The variogram analysis showed that there are two distinct scales in the pattern of the spatial variation, and that the scale is greater in the N-S direction. It seems likely that it is the short range variation that is of interest and the transect sampling scheme proposed has focussed on this. Once we have some ground information we shall be able to determine whether the scale of variation on the ground matches that of the image. If so then it should be possible to design sampling schemes directly from the information in the image.

### SUMMARY OF RESULTS

The pixel maps of the three wave bands were made so that the grey scales showed approximately the same amount of detail in the variation in the wavebands. The standard vegetation index, NDVI, was computed from the first two channels by  $NDVI = (NIR - R) / (NIR + R)$ , where *NIR* and *R* are the values in the near infra-red and red channels respectively. The statistical distributions of the three wavebands and NDVI were determined. The data in channel 1 and NDVI were approximately symmetrical, but those in channels 2 and 3 were strongly positively skewed, and so were transformed to stabilize their variances for further analysis.

The correlation coefficients were computed. The information in channel 1 is moderately correlated with that in channels 2 and 3, but not so strongly as to represent serious redundancy. The data in channels 2 and 3, however, are strongly dependent.

Variograms were computed for the rows and columns separately and also as

averages of the rows and columns. For channels 2 and 3 the transformed values were used. Authorized models were then fitted to all the sets of experimental results using the program MLP.

### General Comments on Variograms

The variograms for the three channels and NDVI have a similar form—they all show strong evidence of spatial correlation. The best fitting model in every instance was the double exponential or nested exponential. Several other models, including power functions, spherical, double spherical, single exponential, pentaspherical, Whittle, and circular, were tried. None of these provided such a good fit as the double exponential model.

The fitted model shows clearly that there are two ranges of spatial variation, a short-range one averaging 9 pixels and a long one of over a hundred pixels. The pattern in the variation of these wavebands and of NDVI occurs on two very distinct spatial scales. The results are consistent, which suggests that they are reflecting a real pattern in the ground cover. When the variograms were averaged over the rows and the columns the same two ranges of spatial structure emerged. The model parameters for the rows and columns are somewhat different, showing that there is some short-range anisotropy in the variation which should be taken into account when planning sampling in the long term. In all cases the range for the columns is greater, i.e. longer in the N-S direction.

### Sampling Strategy

We have recommended a sampling scheme using several transects for obtaining ground data based on the above analysis. It assumes that the image is a reflection of ground cover, and that ultimately the aim is to use remote imagery of the same kind to aid routine survey of ground cover and management decisions. At this stage the aim is to determine to what extent the pattern of vegetation or ground cover matches the pattern in the image. It was suggested that the dominant cover should be recorded in squares that match the size of the pixels on the ground, e.g. grass, bare ground, broad-leaved trees of kind *x*, coniferous trees of kind *y*, and so on.

We have recommended sampling along ten transects, five in the E-W direction, i.e. along the rows of the image, and five in the N-S direction. We have given the starting points for them. For each pixel the dominant ground cover will be recorded using a code. Each transect should be 100 pixels long. This will pick up the short-range pattern in detail, and as there are ten transects spread fairly evenly over the image it will represent the region well. We believe that it is the short-range component that is most important at this stage.

The information provided by this survey will be used to compute indicator variograms to assess the pattern in the ground information.

M A Oliver R Webster July 1995

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