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(E74-10091) KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL Progress Report, Aug. - Sep. 1973 (Kansas Univ. Center for Research, Inc.) 38 p HC $4.00 CSCL 08F

N74-12140 THRU N74-12146 Unclas G3/13 00091

THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2385 Irving Hill Rd.— Campus West Lawrence, Kansas 66044

N74-12141

KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL

OCTOBER 1973

Type I Progress Report for the Period
August and September 1973

Prepared for:

National Aeronautics and Space Administration
Goddard Spaceflight Center
Greenbelt, Maryland 20771

Contract No. NAS 5-21822

THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.
2385 Irving Hill Rd.—West Campus Lawrence, Kansas 66044

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KANSAS ENVIRONMENTAL AND RESOURCE STUDY:
A GREAT PLAINS MODEL

Use of Feature Extraction Techniques for the Texture and Context Information in ERTS Imagery

R. M. Haralick, Principal Investigator
University of Kansas Center for Research, Inc.
Remote Sensing Laboratory
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2291 Irving Hill Dr.-Campus West
Lawrence, Kansas 66045

October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2261-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 1

BIMONTHLY ERTS-A USER INVESTIGATION REPORT

Type 1 Progress Report
for the period ending: September 30, 1973

NASA Contract NAS 5-21822

Title of Investigation: Use of Feature Extraction Techniques for Texture Context Information in ERTS imagery

ERTS-A Proposal Number: 60-1

Task Number: 1

Co-Investigators: R. M. Haralick and G. L. Kelly

NASA-GSFC PI ID Number: UN 094

Report Prepared by:

Robert J. Bosley
Research Assistant

Report Approved by:

R. M. Haralick
Co-principal Investigator

I. RESEARCH OBJECTIVES

The main objectives of this investigation is to study the spectral-textural features of selected frames of ERTS imagery over Kansas as the basis for the discrimination between various land use categories.

II. PROBLEMS

None

III. WORK PERFORMED DURING THIS REPORT PERIOD

During this report period, we have written and modified the textural-spectral feature extraction programs and continued our study of these features on multi-image classification.

IV. PLANNED WORK FOR THE NEXT REPORT PERIOD

During the next report period we will analyze in detail the textural-spectral features of ERTS multi-images over Kansas.

V. RELIABILITY EFFORTS

None

VI. SIGNIFICANT RESULTS

The land use category of subimage regions over Kansas within an MSS image can be identified with an accuracy of about 70% using the textural-spectral features of the multi-images from the four MSS bands.

VII. COST BENEFITS OF SIGNIFICANT RESULTS

None

VIII. PUBLISHED PAPERS, ARTICLES, REPORTS

None

IX. RECOMMENDATIONS REGARDING MAXIMUM UTILIZATION OF ERTS SYSTEM

None

X. CHANGES IN STANDING ORDER FORMS

None

XI. ERTS IMAGE DESCRIPTOR FORMS

None

XII. DATA REQUEST FORMS SUBMITTED

None

XIII. FUNDING

Funding is adequate.

XIV. CHANGE IN PERSONNEL

None

N74-12148

KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL

Interpretation and Automatic Image Enhancement Facility

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University of Kansas Center for Research, Inc.
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October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2262-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 2

BIMONTHLY ERTS-A USER INVESTIGATION REPORT

Type 1 Progress Report
for the period ending: September 30, 1973

NASA Contract NAS 5-21822

Title of Investigation: Interpretation and Automatic Image Enhancement Facility
ERTS-A Proposal No.: 60-2
Task Number: 2
Co-Investigators: R. M. Haralick and G. L. Kelly
NASA-GSFC PI ID Number: UN 317

Report Prepared by:

Robert J. Bosley
Research Assistant

Report Approved by:

R. M. Haralick
Co-principal Investigator

I. RESEARCH OBJECTIVES

The main objective for the ERTS data processing facility is to provide the opportunity to use the analog and digital processing available at the University of Kansas for all ERTS investigators. The work under this task consists of: 1) developing user oriented digital software package for processing digital MSS data and 2) developing analog/digital package for processing transparencies of ERTS imagery on the IDECS/PDP-15 facility.

II. PROBLEMS

None

III. WORK PERFORMED DURING THIS REPORT PERIOD

During this report period, we have continued to provide data processing support for ERTS investigators in Kansas. Also, we continued development of user oriented software packages for reading and displaying selected portions of digital ERTS imagery from NASA supplied CCTS to the IDECS color monitor. A program was developed to read ERTS data tapes using the PDP-15/7094 facility.

IV. PLANNED WORK FOR NEXT REPORT PERIOD

The participants of this module will continue to provide data processing support for ERTS investigators in Kansas and also continue to develop user oriented software packages for digital/analog processing of ERTS imagery data.

V. RELIABILITY EFFORTS

None

VI. SIGNIFICANT RESULTS

None

VII. COST BENEFITS OF SIGNIFICANT RESULTS

None

VIII. PUBLISHED PAPERS, ARTICLES, REPORTS

None

IX. RECOMMENDATIONS REGARDING MAXIMUM UTILIZATION OF ERTS SYSTEM

None

X. CHANGES IN STANDING ORDER FORMS

None

XI. ERTS IMAGE DESCRIPTOR FORMS

None

XII. DATA REQUEST FORMS SUBMITTED

None

XIII. FUNDING

Funding is adequate.

XIV. CHANGE IN PERSONNEL

None

N74-12143

KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL

Wheat: Its Water Use, Production and Disease Detection and Prediction

E. T. Kanemasu, Principal Investigator
Evapotranspiration Laboratory
Waters Hall
Kansas State University
Manhattan, Kansas 66502

October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2263-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 3

BIMONTHLY ERTS-A USER INVESTIGATION
REPORT

TYPE I PROGRESS REPORT
for the period ending: September 30, 1973

NASA CONTRACT NAS5-21822

Title of Investigation: Wheat: Its Water Use, Production and Disease Detection and Prediction

ERTS-A Proposal Number: 060-3

Task Number: 3

Principal Investigator: Edward T. Kanemasu

NASA-GSFC PI ID Number: UN 661

Report Prepared by: Edward Kanemasu
Edward T. Kanemasu
Assistant Professor, Microclimatology

Report Approved by: Edward Kanemasu
Edward T. Kanemasu
Principal Investigator

I. Summary of research objectives

Objectives of the investigation are: (1) to evaluate the effect of water stress, disease, and leaf area on the reflectance characteristics of wheat, (2) to evaluate disease losses in terms of yield and water use, and (3) to predict disease severity and economic loss.

II. Statement of problems

1. Delays in obtaining complete retrospective orders
2. Delays in obtaining computer printout from CCT at University of Kansas

III. Accomplishments during reporting period

1. Analyzed leaf area and soil moisture data on test site in Finney and Riley Counties.
2. Analyzed reflectance data from Riley County Sites.
3. Processed CCT and printed out grey scale maps.
4. Prepared manuscripts for publication

IV. Planned accomplishments during next reporting period

1. Develop a computer program to test the hypothesis that the reflectance ratios using band 4 and 5 will allow growth stage and disease discrimination.
2. Process CCT for the Garden City and Riley County areas.

V. Efforts to achieve reliability

1. Define registration to plus or minus one resolution cell
2. Determine effect of geometric correction.

VI. Significant results

Ground truth measurements indicate that reflectance ratios of the 545 and 655 nm wavebands provide an index of plant development and possibly physiological stress.

VII. Estimates of costs benefits

None

VIII. List of published articles

None

IX. Recommended changes in operation

Have returned DCP to NASA

X. Changes in standing order form

No longer receiving imagery

XI. Number of ERTS Image Descriptor Forms

One

XII. List of Data Request Forms

July 2, 1973

XIII. Discussion of Adequacy of Funds

Until recently, we were not advised of the two scheduled meetings at GSFC (October 23 and December 2); hence, our project no longer has travel funds and makes attendance at these meetings difficult.

XIV. Personnel Changes

Melvin Newman - left KSU

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE September 30, 1973

PRINCIPAL INVESTIGATOR Edward T. Kanemasu

GSFC U661

ORGANIZATION Kansas State University

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Wheat	Rangeland	Clouds	
1311-16455-4.5			X	
1327-16341-4.5	X		X	
1328-16393-4.5	X		X	
1328-16400-4.5			X	
1328-16402-4.5			X	
1330-16513-4.5	X			
1330-16515-4.5	X			
1331-16573-4.5	X			
1345-16343-4.5		X		
1346-16392-4.5	X			
1346-16395-4.5	X			
1346-16401-4.5		X		
1347-16453-4.5	X			
1347-16455-4.5	X	X		
1348-16511-4.5	X			
1348-16514-4.5	X			
1349-16570-4.5	X			
1349-16572-4.5	X			
1366-16512-4.5	X			
1367-16571-4.5	X			
1382-16385-4.5			X	
1382-16392-4.5	X		X	Stubble
1382-16394-4.5	X	X		Stubble
1385-16563-4.5	X			
1385-16565-4.5	X			

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

N74-12144

KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL

Extraction of Agricultural Statistics from
ERTS-A Data of Kansas

S. A. Morain, Principal Investigator
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October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2264-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 4

BIMONTHLY ERTS-1 USER INVESTIGATION REPORT

Type 1 Progress Report
for the period ending: 30 September 1973

NASA Contract NAS 5-21822

Title of Investigation: ERTS-1 Agricultural Statistics
ERTS-A Proposal Number: 060-4
Task Number: 4
Principal Investigator: Stanley A. Morain
NASA-GSFC PI ID Number:U664

Report Prepared by:

Donald L. Williams
Research Assistant

Report Approved by:

Stanley A. Morain
Principal Investigator

I. Summary of research objectives:

The long-term objective of this project is to develop remote sensors, particularly for use at orbital altitudes, as data sources for agricultural statistics. The immediate objectives are to identify wheat fields in Finney County, Kansas, and to make an assessment of acreage and crop vigor. A variety of methods for yield prediction is already employed by agricultural statisticians in government and industry, and the relationship between yield and weather is well established. Based on ERTS data and available weather records, an assessment of the feasibility of predicting yields will be made. This feasibility will be assessed in terms of accuracy and timeliness vis-a-vis present systems. If successful, the project will provide a model for estimating basic crop statistics and crop yields at regional, national and international scales. Under present strategies these data become available long after they are of practical use.

The objectives of this project are closely related to two other ERTS projects: a probabilistic crop type identification study by R. M. Haralick at the Center for Research, Inc., University of Kansas, and a study of wheat disease and pest recognition by E. T. Kanemasu at Kansas State University. Data and techniques developed in these two projects will materially assist in the solution of the agricultural statistics project.

II. Statement or explanation of problems impeding progress of investigation (i.e., explanation of any nonconformance with work schedule).

No impediments to the investigation have developed during this period and preparation of the final report has begun.

III. Discussion of accomplishments or work performed during reporting period:

An analysis of ERTS-1 wheat yield prediction was undertaken and the results were compared to estimates published by the U. S. D. A. Statistical Reporting Service. Estimated acreage and yield figures are summarized in Table 1.

The algorithm originally used to estimate wheat acreage by human interpretation of the imagery was structured for use in automatic data processing. This algorithm is presently being implemented so that automatic and human methods may be presented in the final report.

Table 1

Estimates of 1973 crop of winter wheat acreage in southwestern Kansas counties

County	Estimate from ERTS (Acres)	SRS Estimate (Acres)
Finney	239,000	205,000
Grant	74,000	81,000
Gray	174,000	157,000
Haskell	110,000	104,000
Kearney	115,000	117,000
Meade	151,000	141,000
Morton	72,000	91,000
Seward	78,000	83,000
Stanton	108,000	135,000
Stevens	86,000	85,000
Total (10 counties)	1,207,000	1,199,000

Alfalfa has been detected and successfully mapped in Finney County from ERTS-1 imagery acquired during May 1973. A total of 28,000 acres of alfalfa were mapped in the county. In the areas for which surface observations were available, 4475 acres of alfalfa were recorded in these surface observations. Of this acreage, 4325 acres were correctly identified from the imagery. Thus, 150 acres of alfalfa were not detected. In addition 280 acres were identified as alfalfa on the imagery which were not recorded during the surface observations. The net error was over-prediction of alfalfa acreage by 2.9 percent. A report explaining the methods and results in detail is in preparation.

Mapping of major agricultural land use categories has been completed for the state of Kansas and a full report is in preparation. From these maps it has been determined that various major types of agricultural land use occupy the acreages listed in Table 2. Where comparable statistics are available from other sources, good agreements have been observed.

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IV. Discussion of planned accomplishments or work during next reporting period:

Two technical reports are in preparation and work will continue on these reports, which deal with (1) the study of alfalfa in Finney County and (2) the collection of land use statistics for the state of Kansas. In addition, preparation of the final report has commenced and will be continued in the next reporting period.

Table 2

Area of major agricultural land use types in Kansas

Land Use	Area (Acres)
Grassland	18,780,000
Woods	1,200,000
Irrigated cropland	3,150,000
Dry cropland	28,670,000

V. Discussion of efforts to achieve reliability:

In our human interpretations, we employ a team approach. One interpreter analyzes the image. Then a second interpreter checks the work. Results are then checked against surface observations, available aerial photography and published data to determine the magnitude and causes of errors.

VI. Discussion of signigicant results and relationship to practical applications or operational problems:

Agricultural consultants have expressed substantial interest in our work on center pivot irrigation and have inquired as to how they may use ERTS-1 imagery to aid those in the irrigation field.

Results of the land use mapping experiment indicate that ERTS imagery has major potential in regionalization. The ways in which land is utilized within these regions may then be studied more effectively than if no adequate regionalization is available.

VII. Discussion and estimates of the cost benefits of any significant results:

Cost benefit analyses are not yet complete and will be included in the final report.

VIII. List of published articles, papers, pre-prints, in-house reports, abstracts of talks that were released during the reporting period after receiving notice of compliance with the provisions of Article IX of the contract:

None.

IX. Recommendations concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as to maximum utilization of the ERTS system:

None.

X. List by date of any changes in standing order forms:

None.

XI. Number of ERTS Image Descriptor Forms (Attachment B) as required by Article VII of the contract:

These forms are being attached to the reports currently in preparation.

XII. List (by date) of any Data Request Forms (for retrospective data) submitted to NASA-GSFC/NDPF during the reporting period:

None.

XIII. Discussion of adequacy of funds to complete task:

All funds are presently adequate.

XIV. Description of any significant changes in operating personnel during the reporting period or anticipated during the next reporting period:

Ms. Barker's association with the project has terminated.

N74-12145

KANSAS ENVIRONMENTAL AND RESOURCE STUDY:
A GREAT PLAINS MODEL

Monitoring Fresh Water Resources

H. L. Yarger, Principal Investigator
Kansas Geological Survey
Moore Hall
1930 Avenue "A" - Campus West
University of Kansas
Lawrence, Kansas 66045

October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2265-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 5

BIMONTHLY ERTS-A INVESTIGATION REPORT

Type I Progress Report
for the period ending: Sept. 30, 1973

NASA Contract NAS 5-21822

Title of Investigation: Monitoring Fresh Water Resources

ERTS-A Proposal Number: 060-7

Task Number: 5

Principal Investigator: Harold L. Yarger

NASA-GSFC PI ID Number: ST045

Report Prepared by:

Harold L. Yarger
Principal Investigator

Report Approved by:

Harold L. Yarger
Principal Investigator

I. Summary of research objective(s):

It is the objective of this study to determine the feasibility of monitoring fresh water bodies in Kansas using ERTS-1 imagery. This is to be accomplished by attempting to correlate spectral reflectance with water properties and analyses measured at the time of overflight on two reservoirs under intensive study (Tuttle Creek and Perry Reservoirs).

II. Statement of explanation of problems impeding progress of investigation (i.e., explanation of any nonconformance with work schedule).

None.

III. Discussion of accomplishments or work performed during reporting period:

We are now in possession of CCT's for eleven cloud free passes with ground truth. Computer printout gray level maps have been generated for nine of the eleven reservoir scenes. Sampling sites are identified on the gray level map which then allows extraction of the corresponding digital levels from the CCT.

Comparison of digital levels with suspended solids for three passes, which occurred within a 33 day period, display similar curves. To achieve improved statistics for a least squares fit, the three passes were added together (fig. 1). The point scatter in each band occurs within each pass and is not produced by adding separate passes together. The greater point scatter in bands 4 and 5 may be associated with the fact that green and red light penetrate deeper water than does IR. If the suspended material was not uniformly distributed in the water column from site to site a point scatter would occur in the green and red bands. IR, on the other hand, is scattered by a very shallow water column which would decrease the chance of stratification occurring within the scattering volume. Probably equally important in explaining the point scatter in bands 4 and 5 is the atmospheric haze effect on the wavelengths.

From figure 1 it is clear that both bands 4 and 5 become saturated beyond 75 ppm. Band 6 exhibits a smoothly varying curve with good discrimination up to 125 ppm. Band 6 appears to be reaching saturation beyond 125 ppm. Band 7 (not shown in figure 1) displays no response (digital level = 1 or 2) for suspended load below 100 ppm. From previous IDECS analysis Band 7 does respond to loads $\geq$ 100 ppm.

Conclusions based on CCT data from three passes is that Band 6 is most useful for predicting suspended loads in the region 0 to 125 ppm. Bands 4 and 5 can be used below 75 ppm. Band 7 is the only useful band beyond ~ 125 ppm. A second order curve was fitted to suspended load (dependent variable) versus Band 6 digital levels

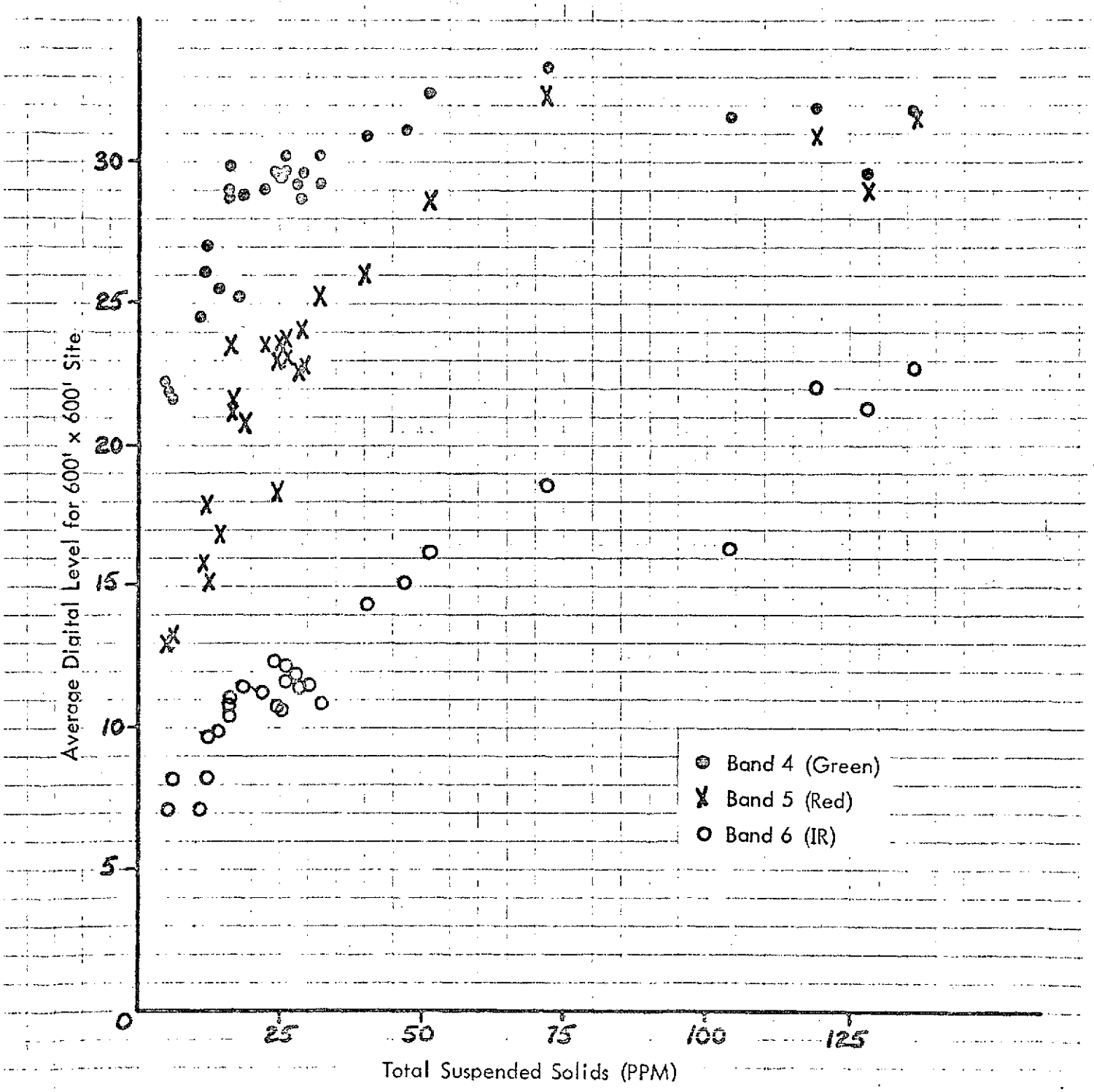

Figure 1. CCT Digital Level vs. Suspended Solids for Perry (August 13, 1972) and Tuttle Creek (August 14, 1972, and September 19, 1972).

(independent variable) with an RMS residual of 5 ppm. Higher order curves do not significantly improve the fit. Curves were also fit to bands 4 and 5 for suspended load ≤ 75 ppm. The RMS residuals were 7 and 6 ppms respectively.

IV. Discussion of planned accomplishments or work during next reporting period.

Sampling of Perry and Tuttle Creek reservoirs will continue with each ERTS overflight. In addition, Milford reservoir will be sampled when possible. These three reservoirs are the largest in the state.

Experimentation with digital tapes will continue including more comparisons of results with those obtained using the IDECS system.

V. Discussion of efforts to achieve reliability:

No change.

VI. Discussion of significant results and relationship to practical applications or operational problems:

None.

VII. Discussion and estimates of the cost benefits of any significant results:

None.

VIII. List of published articles, papers, pre-prints, in-house reports, abstracts of talks that were released during the reporting period after receiving notice of compliance with the provisions of Article IX of the contract:

None.

IX. Recommendations concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as to maximum utilization of the ERTS system:

None.

X. List by date of any change in the standing order forms:

None.

XI. Number of ERTS Image Descriptor Forms (Attachment B) as required by Article VII of the contract:

Attached.

XII. List (by date) any Data Request Forms (for retrospective data) submitted to NASA-GSFC/NCPF during the reporting period:

None.

XIII. Discussion of adequancy of funds to complete task:

Funding is adequate for completion of task.

XIV. Description of any significant changes in operating personnel during the reporting period or anticipated during the next reporting period:

None.

N74-12146

KANSAS ENVIRONMENTAL AND RESOURCE STUDY: A GREAT PLAINS MODEL

Ground Pattern Analysis in the Great Plains

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Lawrence, Kansas 66045

October 1973
Type I Progress Report for the Period August and September 1973
Report No. 2266-7

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACEFLIGHT CENTER
GREENBELT, MARYLAND 20771

Contract No. NAS 5-21822, Task 6

BIMONTHLY ERTS-A INVESTIGATION REPORT

Type I Progress Report
For The Period Ending: September 30, 1973

NASA Contract NAS 5-21822

Title of Investigation: Ground Pattern Analysis in the Great Plains

ERTS-A Proposal Number: 60-8

Task Number: 6

Co-Investigators: John C. Davis and Fawwaz T. Ulaby

NASA-GSFC PI ID Number: UN 657

Report Prepared by: _____

Report Approved by: F. T. Ulaby

Fawwaz T. Ulaby
Co-Investigator

I. Research Objectives

The two program objectives of this study may be defined as:

A. Use of multispectral imagery to map the areal geology of selected sites in Kansas, and to identify anomalous patterns;

B. Search for large-scale ground patterns by spatial frequency analysis.

II. Problems:

None.

III. Work performed during this report period:

Work was completed during the last report period on the initial phase of this investigation. This included obtaining spatial frequency data from approximately 150 sample areas in Kansas and the manual interpretation of these data. The method used to choose these sample areas and the information obtained from them was described in the ERTS-A Type II Report No. 2266-4 for July 1973. The method used in the collection of the ground pattern spatial frequency data from the ERTS-A images is described in the appendix to this report.

The current phase of this investigation consists of quantitative analysis of these spatial frequency data, the study of image feature enhancement techniques which may result in more useful spatial frequency data, and the comparison of specific results obtained from this investigation with results from other investigations.

Specific work performed during this report period with respect to the data obtained during the first phase of the experiment involves the following:

A. Determination of parameters from orientational plots (intensity vs. angle curves described in the appendix).

B. Attempt to enhance the ability of the spatial frequency plots (intensity vs. spatial frequency curves described in the appendix) to display significant ground pattern information.

C. Investigation of the ability of the parameters in A to provide reliable physiographic classification of regions in Kansas in conjunction with the manual determination of distinctive ground pattern parameters.

D. Comparison of information contained in orientational plots with information contained in "rose diagram" curves from another geologic study.

IV. Planned work next report period:

During the next report period, the following studies will continue:

A. ERTS-A image enhancement studies

B. Analysis of ERTS-A representation of seasonal changes with respect to the spatial frequency analysis

C. Comparison of ERTS-A study results with results obtained from other studies

D. Quantitative data analysis

1. Assemble parameter sets to be used in classification of physiographic regions in Kansas and determine "best" set. (This involves the number of parameters needed and the type)
2. Determine the accuracy of the classification schemes or algorithms

V. Reliability efforts:

None.

VI. Significant results:

None.

VII. Cost benefits of significant results:

N. A.

VIII. Published papers, articles, reports:

None.

IX. Recommendations regarding maximum utilization of ERTS system:

None.

X. Changes in standing order forms:

None.

XI. ERTS image descriptor forms (Attachment B):

Attached.

XII. Data request forms submitted:

None.

XIII Funding:

Funding is adequate.

XIV. Change in personnel:

None.

APPENDIX

Optical Processing System Description

In this section we will present a description of the optical processing system used for spatial frequency analysis of the ERTS images. The optical processor has three main elements: a laser, optics, and a Recognition Systems Inc., Diffraction Pattern Sampling Unit (DPSU). The system configuration is shown in Figure 1. An ERTS-A 70 mm positive transparency is used as the input for this system. The optical processing system can be regarded as a two step system. First, an area of the ERTS transparency (sample area) is illuminated by the incident laser beam. This beam is focused by the lens (dashed lines, Figure 1) so that the point source produced by the spatial filter is imaged at a distance z + f in front of the lens. The resulting light intensity distribution at this point is the optical Fourier transform or amplitude frequency spectrum of the portion of the ERTS image illuminated by the beam. Second, the intensity distribution (frequency spectrum) of the ERTS image is sampled by the DPSU.

The DPSU consists of a 64 element photodiode array (shown in Figure 2) used to detect the light intensity incident upon each element, and electronics which amplify and digitize the output from each diode in the array. The diode array is composed of 32 wedge-shaped photodiodes and 32 annular ring photodiodes. The intensity distribution across each photodiode is recorded. The data from the optical processor are then used in a computer program and are calibrated, printed and plotted.

The spatial frequency in the transform plane is related to other system parameters by:

$$s = r/d\lambda$$

where s = spatial frequency in transform plane

r = distance in transform plane measured from optical axis

d = distance from image transparency to detector

λ = wavelength of laser radiation = 6328 Angstroms

The spatial frequency obtained from this calculation is converted to ground spatial frequency using image to ground scale. The resulting curves which are plotted by the computer program are then $|c(f)|^2$ or intensity vs. frequency and $|c(\phi)|^2$ or intensity vs. angle. These are plotted in terms of ground spatial frequency in cycles per mile and direction in compass degrees from north.

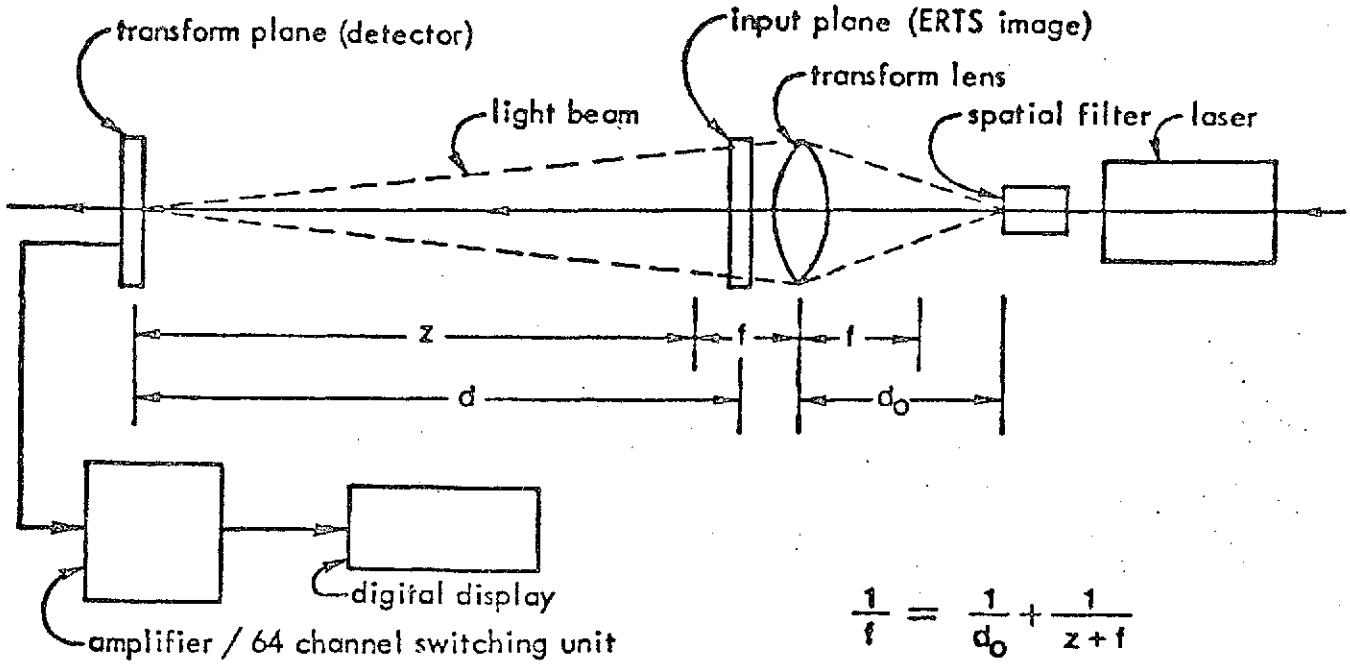

Figure 1. System configuration

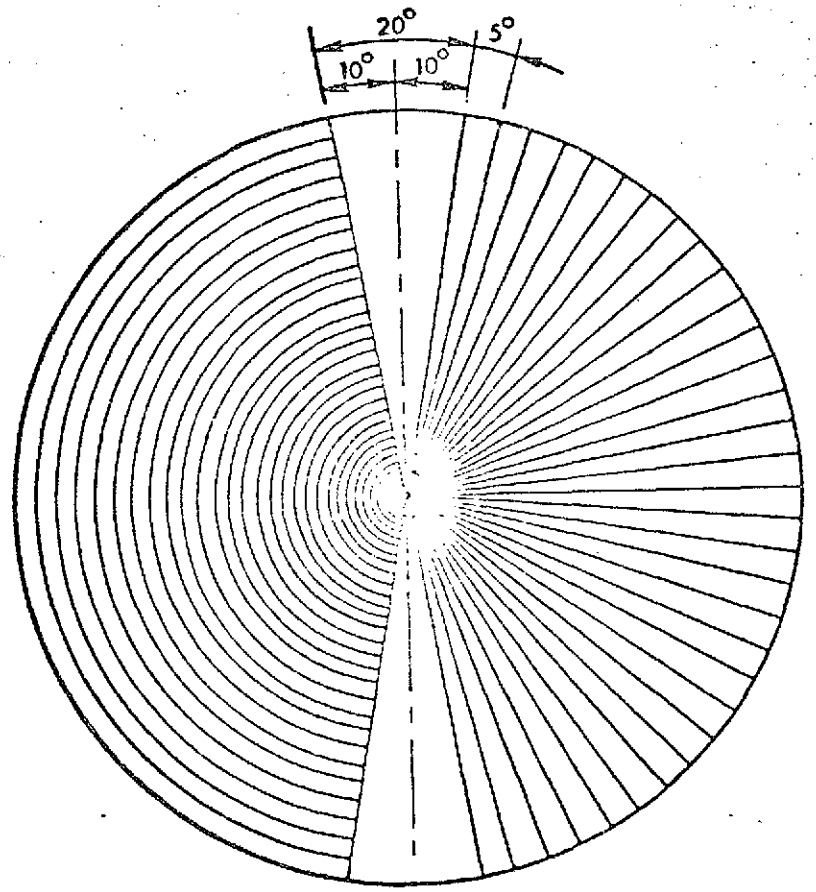

Figure 2. Detector geometry

CRINC LABORATORIES

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Remote Sensing Laboratory

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Chemical Engineering Heat Transfer Laboratory

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