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Summary

John E. Estes and Jeffrey L. Star

SUMMARY

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This document represents a final report of work conducted under grant NASA NAGW-455 during the period May 1, 1985 to April, 1986. This document includes material on research undertaken and some indication of directions we propose will go in the coming year of this fundamental and applied research effort.

The Information System Research Group research continues to focus on improving the type, quantity, and quality of information which can be derived from remotely sensed data. As we move into the coming year of our research, we will continue to focus on information science research issues. In particular, we will focus on the needs of the remote sensing research and application community which will be served by the Earth Observing System (EOS) and Space Station. Research conducted under this grant has been used to extend and expand existing remote sensing research activities at UCSB in the areas of georeferenced information systems, machine assisted information extraction from image data, artificial intelligence, and vegetation analysis and modeling.

The program of research, documented in this progress report, is being carried forward by personnel of the University of California, Santa Barbara. The report documents our accomplishments in what we consider to be a five to ten year effort to prepare to take full advantage of the system's capabilities of the platforms and systems associated with Space

SUMMARY

Station (e.g., EOS). Through this work, we have targeted fundamental research aimed at improving our basic understanding of the role of information systems technologies and artificial intelligence techniques in the integration, manipulation and analysis of remotely sensed data for global scale studies. This coordinated research program is possible at UCSB due to a unique combination of researchers with experience in all these areas.

Several of our projects have used this grant as a catalyst to aid other NASA offices in the research, in the integration of remotely sensed and other data into an information sciences framework. During this year we have received funds from NASA Code E/I to supplement ISRG activities. These funds were proposed in September, 1985 (and received in late March, 1986) to cover a range of tasks. In addition, we have received partial funding from the World Bank to aid in their image processing and information systems activities.

The research currently being performed under this grant is significant. The committees in which Grant personnel are involved are also important. As we move into the Space Station era, we must constantly be aware that sensor systems being proposed for the Space Station Complex are, by in large, information systems. For them to achieve their full interdisciplinary potential, a great deal of fundamental and applied research is needed. This grant is facilitating this research.

Appendices

APPENDIX 1

**Methodologies of Mapping and Accuracy Determination
for Regional Assessments of Natural Vegetation**

**(Please see January 1, 1986 Progress Report for
complete report).**

Large Area Vegetation Mapping

Methodologies of Mapping and Accuracy Determination for Regional Assessments of Natural Vegetation

John E. Estes
Michael J. Cosentino

The multi-resolution capabilities of the proposed Earth Observing Satellite (EOS) require that a conceptual framework for large area mapping needs be established in order to realize the information potential of such a system. Within such a conceptual framework, techniques, procedures, and methods need to be developed: 1) to rapidly map large portions of the earth's surface; and 2) to quantify map accuracy and confidence intervals. Towards this end, we have produced several large area vegetation maps derived from satellite imagery and verified their accuracy by comparing mapped classes at selected sample points with direct observations (of actual vegetation) from the ground and low altitude aircraft.

We tested the usefulness of Landsat data in constructing accurate vegetation maps by developing maps for two study sites, Mt. Washington, N.H., and the Superior National Forest, MN. The results of these studies are discussed in detail in Appendices III and IV. Multidate Landsat scenes were used to manually identify and map vegetation cover classes in order to determine the spatial extent of vegetation patterns in the forest. The methodology developed for producing the vegetation maps involved two basic steps: classification and mapping of the Landsat images, followed by subsequent accuracy verification. Two Landsat scenes (winter and summer) were acquired for each area.

APPENDIX 2

**A Knowledge Based System for the Classification
of Agricultural Lands**

**(Please see January 1, 1986 Progress Report
for complete report).**

A KNOWLEDGE-BASED SYSTEM
FOR THE
CLASSIFICATION OF AGRICULTURAL LANDS

by

Charlene T. Sailer and John E. Estes

One of the main interests of the Remote Sensing Information Sciences Research Group, University of California, Santa Barbara, has been the use of machine-assisted processing of satellite data. As discussed in previous progress reports, there are a number of areas in which the field of artificial intelligence may be applied to the analysis problem. The rest of this chapter outlines a development effort, in which we are attempting to develop an expert system to classify Landsat data for agricultural lands. Such an expert system could significantly reduce a human analyst's time and cost in this specific problem domain. We believe this kind of approach has generality, and will be particularly useful in the years ahead when systems such as EOS will be able to provide orders of magnitude more data for us to use.

The objective of this research is to demonstrate the feasibility of incorporating reasoning into the computer-assisted classification of digital images. The model being developed will be structured as a rule-based production system which will simulate interaction with a digital image processing package. The system will focus on the digital classification of agricultural

APPENDIX 3

**Evaluation of Thematic Mapper Simulator Data
for Commercialization and Time Dynamics**

**(Please see January 1, 1986 Progress Report
for complete report).**

Evaluation of Thematic Mapper Simulator Data for Commercialization and Time Dynamics

by

L.J. Mann, C.T. Sailer, and J.E. Estes

INTRODUCTION

This section of this report summarizes research evaluating Thematic Mapper Simulator (TMS) data for an improved understanding of the potential commercial agricultural applications. The thrust of the research was to examine processing techniques and improved information potential available from multispectral data acquired with high temporal frequency. Such work will be valuable in analyzing the overall high resolution imaging system which is planned as part of the Earth Observing System (EOS) sensor compliment (e.g. High Resolution Imaging Spectrometer (HIRS)).

Our approach in this research was to examine the TMS data for two diverse and highly productive agricultural areas in southern and central California. Supervised and unsupervised classifications were performed and evaluated in an effort to monitor change through time of the agricultural crops in the study site. The information potential inherent in the temporal dimension of TMS data was addressed in this study to examine agricultural management issues which arise during farm operations. The commercialization aspect of the study was addressed by identifying the potential market for data of this type, the market's data frequency requirements, and anticipated product needs. Product need was examined both from a hardware and software standpoint, with emphasis placed on remote sensing data products.

TMS data used in this evaluation was simulated by a Daedalus 074 high-altitude multi-spectral scanner flown on a U-2 and ER-2 aircraft at an approximate altitude of 65,000 ft. above ground datum. The Daedalus system has an IFOV of 1.3 mr and a ground resolution of 28 m.

APPENDIX 4

**Evaluation of Thematic Mapper Simulator Data
for Commercial Application to Natural Vegetation
of Southern California**

**(Please see January 1, 1986 Progress Report
for complete report).**

EVALUATION OF THEMATIC MAPPER SIMULATOR DATA FOR COMMERCIAL
APPLICATION TO NATURAL VEGETATION OF SOUTHERN CALIFORNIA

by

Michael Cosentino and John Estes

This report briefly summarizes an evaluation of Thematic Mapper Simulator (TMS) data for commercial application to natural vegetation of southern California. The approach was to examine the TMS data for several dates (7/2, 8/6, 9/17) over the same area and to determine whether phenological changes in natural vegetation could be detected. Species discrimination within the chaparral brush stands of southern California has typically been extremely difficult using 80m resolution MSS data. Stands of one type of green shrubs are very difficult to discriminate from another type of green shrubs using 80m resolution data. The increased spatial and spectral resolution of TMS data, coupled with knowledge of phenological cycles of natural vegetation, could provide new and valuable data concerning the spatial distribution of key vegetation species.

The temporal sequence of TMS data for this study was acquired during a period (July - September) when the flowering heads of the chamise plant (*Adenostoma fasciculatum*) began to dry and harden and turn a distinctive red/brown. Chamise is an important chaparral species with a broad range over all of California. Spectral discrimination of the spatial distribution of stands of chamise would be highly desirable for

APPENDIX 5

Geographic Information Systems for Scholars

**(Please see January 1, 1986 Progress Report
for complete report).**

Geographic Information System for Scholars

Prof. John E. Estes
Dr. Jeffrey L. Star

The Research Libraries Group Inc. (RLG) convened a meeting in January, 1986, at the University of California, Santa Barbara, to discuss the problems of managing geographic information. RLG is a corporation of 35 major research universities, which is owned by the member universities. RLG has experience in the design and operation of information systems and networked communications, which has been directed at problems of access to research materials for scholars.

RLG has been active in the development and implementation of standard descriptive formats for information about a range of research materials, as well as systems for the retrieval of information. In addition, RLG has an outstanding record in obtaining extramural funds for designated development projects, largely from private not-for-profit institutions.

The meeting focused on the growing need within the research library community to provide scholarly access to geographic or spatially distributed data, including satellite digital data, photography, and map data in both digital and analog formats. Important collections of such material are found at many universities which are part of RLG, as well as federal and state organizations. Representatives from NASA (M. Devirian), NOAA (J.

APPENDIX 6
Committee Memberships

APPENDIX 6 -- Committee Memberships

- NASA Pilot Land Data System
Science Steering Group: John E. Estes
Technology Working Group: Jeffrey L. Star
- NASA Earth Observing System Data Panel
John E. Estes, Jeffrey L. Star
- National Academy of Sciences
Committee on Data Management and Computation: John E. Estes
- National Bureau of Standards
Initial Graphics Exchange Standard: Jeffrey L. Star
- NASA Data Interchange Formats
Jeffrey L. Star
- Geocarto International
International Editorial Board: John E. Estes
- International Conference on Advanced Technology for Monitoring
and Processing Global Information
1985 Workshop Leader and Session Chairman: Terence R. Smith
- Research Libraries Group
Task Force on Geographic Information: Jeffrey L. Star

APPENDIX 7
Presentations and Symposia

APPENDIX 7 -- Presentations and Symposia

J.E. Estes. Improved Information Systems in Support of Global Science. AIAA/NASA Earth Observing Systems Conference, October 1985, Virginia Beach.

J.L. Star. Recent Advances in Large Area Vegetation Mapping. Man's Impact on the Global Environment. October 1985, Venice, Italy.

Terence R. Smith. Invited Lecturer, Workshop on Brain Research, Cognition, and Artificial Intelligence, Abisko, Sweden.

Terence R. Smith. Invited Lecturer, Jacob Marshak Interdisciplinary Colloquium on Mathematics in the Behavioural Sciences, UCLA.

Terence R. Smith. Invited Lecturer, Workshop on Modelling Complex Systems. I. Prigogine Center for Studies in Statistical Mechanics, Univ. Texas, Austin.