01

II

Progress Report RSC 3018-5

E7.6-10.400
CR-148219

APPLIED REGIONAL MONITORING OF THE VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN THE GREAT PLAINS CORRIDOR

N76-27625
HC $3.50
Unclas
00406
G3/43

(E76-10406) APPLIED REGIONAL MONITORING OF THE VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN THE GREAT PLAINS CORRIDOR Progress Report, Feb. - Apr. 1976 (Texas A&M Univ.) 22 p

Principal Investigator
John W. Rouse, Jr.
Remote Sensing Center
College Station, Texas 77843

In cooperation with:

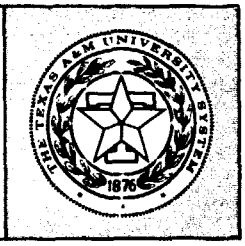
Texas Agricultural Experiment Station
Texas A&M University
College Station, Texas 77843

May 1976
Type II Report for Period February 1976-April 1976

Prepared for:
Goddard Space Flight Center
Greenbelt, Maryland 20771

Contract No. NAS5-20796

TEXAS A&M UNIVERSITY
REMOTE SENSING CENTER
COLLEGE STATION, TEXAS



APPLIED REGIONAL MONITORING OF THE VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN THE GREAT PLAINS CORRIDOR

Principal Investigator
John W. Rouse, Jr.
Remote Sensing Center
College Station, Texas 77843

In cooperation with:

Texas Agricultural Experiment Station
Texas A&M University
College Station, Texas 77843

May 1976
Type II Report for Period February 1976 - April 1976

Prepared for:
Goddard Space Flight Center
Greenbelt, Maryland 20771

Contract No. NAS5-20796

TABLE OF CONTENTS

PROGRESS REPORT RSC 3018-5

APPLIED REGIONAL MONITORING OF THE VERNAL ADVANCEMENT AND RETROGRADATION (GREEN WAVE EFFECT) OF NATURAL VEGETATION IN THE GREAT PLAINS CORRIDOR

1.0 BACKGROUND & SUMMARY

1.1 Background

This 18-month-long study, Landsat Follow-On Investigation 20540, is a regional expansion of the Landsat-1 investigation entitled "Monitoring the Vernal Advancement and Retrogradation (Green Wave Effect) of Natural Vegetation". The initial study was restricted to evaluating the discrimination of land use patterns and recognizing the phenological development at sites of known plant/soil composition. As expressed in the work statement of contract NAS5-20796, three tasks are to be addressed during the course of this follow-on study. The first task involved the acquisition and analysis of satellite imagery and computer compatible data from natural vegetation systems in the Great Plains Corridor (GPC). The second task involves the acquisition of aerial photography, certain coordinated ground truth data, and environmental data in support of the satellite imagery and data. The third task relates to the correlation and analysis of

satellite and support data for testing certain specific hypotheses important in evaluating the feasibility of an operational system for monitoring the status of natural vegetation in the Great Plains. The hypotheses to be tested are:

Hypothesis Number 1--Time is an important factor in the discrimination of broad landforms, soil associations, vegetation types and other natural resource features.

Hypothesis Number 2--The vernal advancement and retrogradation of vegetation (Green Wave Effect) can be discriminated on a regional basis using repetitive multispectral imagery.

Hypothesis Number 3--Vegetation systems parameters are adequately unique to provide a new information source for regional agri-business use.

To test the three hypotheses and to evaluate the application of Landsat data within the Great Plains region, the following specific objectives are to be addressed:

Objective Number 1--To develop a data analysis methodology that will facilitate the extension of regional satellite data from the Landsat follow-on.

Objective Number 2--To chart the vernal advancement and retrogradation of natural vegetation on a regional basis using Landsat data.

Objective Number 3--To record the phenological events and collect specific biological and environmental data using an effective test site network for ground observations.

Objective Number 4--To apply Landsat sensor measurements for identification of rangeland vegetation and soil types, measuring short term and seasonal vegetation reflectance changes, and evaluating the impact of environmental conditions on dominant vegetation.

Objective Number 5--To evaluate the feasibility of using Landsat-type data in conjunction with geographic and climatological parameters for modeling a range forage index and indexes of plant growth conditions.

1.2 Summary

A first look Landsat-derived map of range forage conditions for the Extended Test Site Area (ETSA) has been produced. The TVI6 parameter provides data that are closely correlated with the quantity of green herbaceous vegetation and its moisture content on the areas investigated. A TVI6 isoline map of the 6.25 million hectare ETSA in north central Texas and southern Oklahoma has been produced during this reporting period and a comparison has been made of this map with a map of the same area published by the U. S. Department of Agriculture Statistical Reporting Service. Both maps show similar areas of drought stress and good to excellent

forage conditions, but preliminary indications are that the Landsat-derived map more accurately depicts the areal extent of each condition class.

During the next reporting period a large number of secondary sampling sites will be selected for use in final analysis to plot TVI6 or other parameters to produce isoline maps of forage conditions. The techniques developed for the ESTA will be applied throughout the GPC using Landsat data for the test areas. A map of forage conditions in the GPC will be produced using the Landsat data from one time period for the secondary sites to demonstrate the techniques for regional monitoring. The feasibility of using Landsat-type data in conjunction with physiographic and climatological parameters for modeling a range forage index and indexes of plant growth conditions will be determined. The concept for an operational system will be described.

2.0 ACCOMPLISHMENTS AND PROBLEM AREAS

2.1 Accomplishments During the Reporting Period

Primary emphasis during this reporting period has been given to the generation of a first look Landsat-derived map of range forage conditions for the Extended Test Site Area (ETSA). This product was compared to the published report of pasture and range feed conditions prepared by the USDA Statistical Reporting Service.

2.1.1 Preparation and Interpretation of TVI6 Isoline Map

ETSA sampling sites were located on frosted acetate overlays on computer-generated 20 mile by 20 mile (32 kilometers) greyscale printout maps. The activity was begun during the last reporting period using Landsat CCT's already on file, which were acquired during the initial Landsat GPC investigation.

Upon receipt of the Landsat CCT's that provide ETSA coverage during late September 1975, greymaps which contain the sampling site data were generated for this data set. The acetate overlays were then used to identify the sampling site locations and to obtain the line and cell coordinates. Standard site processing reports were then generated to extract, transform, and summarize the MSS data for each site.

Using Universal Transverse Mercator (UTM) map coordinates to identify the 17 sampling site locations within the ETSA, the TVI6 parameter values obtained for each sampling site were plotted with the contouring programs previously

developed. The development of these techniques is described in four previous quarterly progress reports. The isoline map of TVI6 data is shown in Figure 2-1.

The results from the initial Landsat investigation clearly indicate that TVI6 is very closely correlated with the quantity of green herbaceous vegetation and its moisture content on these rangelands. High values of TVI6 indicate good moisture content and considerable amounts of green biomass; conversely, low TVI6 values reveal the absence of much green plant material and generally poorer vegetation moisture content. Although accurate "forage condition" bounds have not been defined at this time, TVI6 values above about .800 generally indicate good to excellent forage conditions. From .800 down to about .750 forage conditions are generally fair to poor. As TVI6 decreases below approximately .750 the herbaceous vegetation will be under stress, resulting in increasingly poorer forage conditions. These limits will undoubtedly vary for different response zones (see Progress Report RSC 3018-3 for a discussion of response zones), but this approach remains to be tested.

As reported during the previous quarter, the Rolling Plains experienced a very wet early summer and an abnormal proliferation of Annual Broomweed in many areas. This was particularly true in the western half of the ETSA, which accounts for the extremely high TVI6 values (>.850).

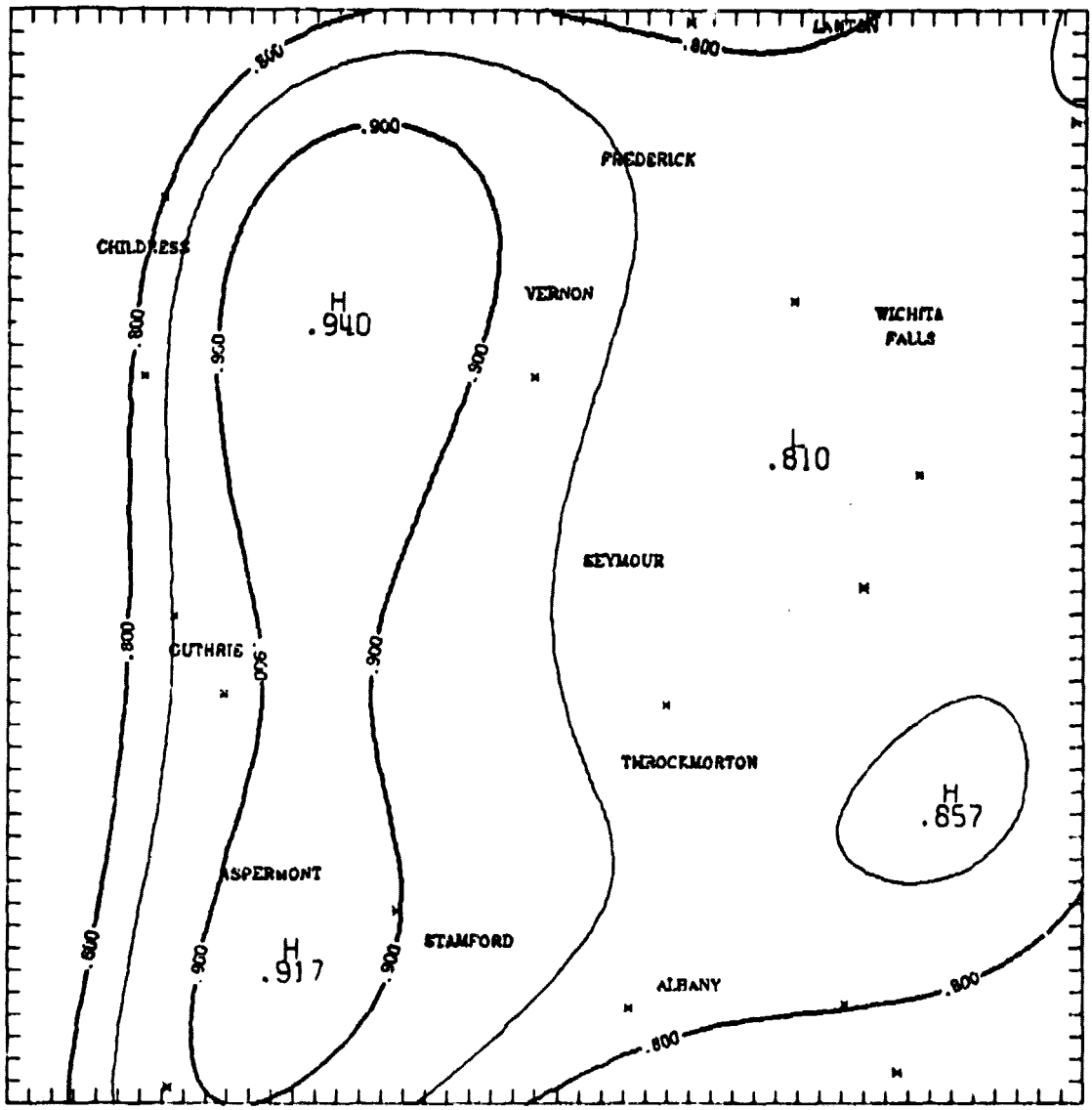


Figure 2-1. Isolines of TVI6 for the ETSA from Landsat MSS data obtained on September 22 and 23, 1975. This map was generated using data for the 17 sampling sites.

PASTURE AND RANGE FEED CONDITIONS

OCTOBER 1, 1975

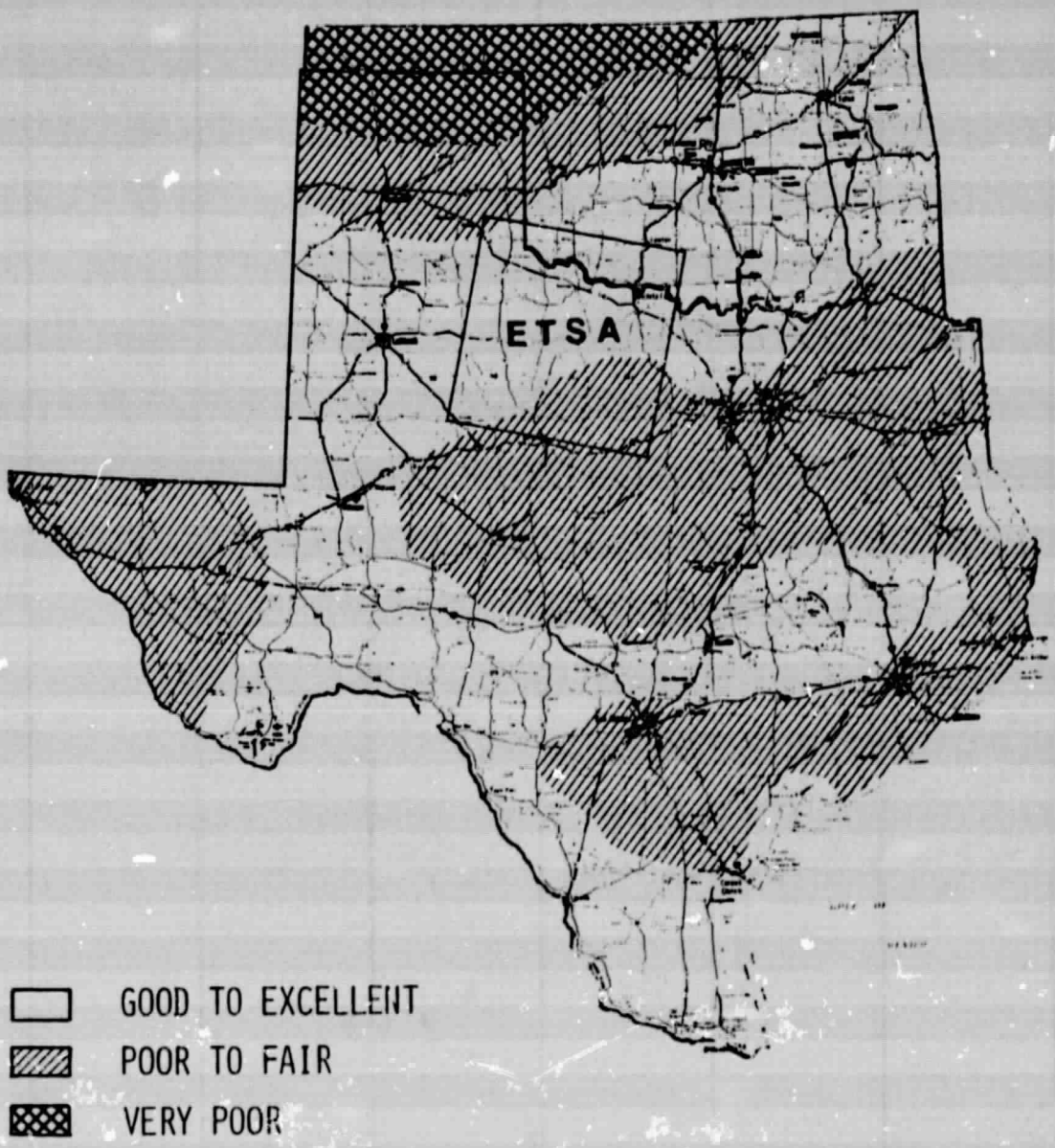


Figure 2-2. Pasture and range feed conditions in Texas and Oklahoma on October 1, 1975, as reported by the USDA Statistical Reporting Service. The Extended Test Site Area is also delineated.

This preliminary map generated from the limited data set reveals that forage conditions were generally good to excellent across the ETSA. The exceptions to this are found in the extreme northwest corner and western edge and the south to southeast corner, where fair to poor conditions are indicated.

2.1.2 TVI6 Map vs. SRS Report and Comments

The USDA Statistical Reporting Service publishes "Pasture and Range Feed Condition" maps for the continental U. S. on a monthly basis from April through December in "Crop Production" and the National Weather Service's (NOAA) "Weekly Weather and Crop Bulletin".

The pasture and range feed conditions in Texas and Oklahoma on October 1, 1975, as reported by the Statistical Reporting Service (SRS) are depicted in Figure 2-2. This map also reveals that forage conditions were generally good to excellent across the ETSA, but the northwest, and particularly the south to southeast, corners were in fair to poor condition which agrees with the TVI6 map.

Both the TVI6 map and SRS map, therefore, show similar areas of drought stress and good to excellent forage conditions. However, it is anticipated that the Landsat-derived maps will more accurately classify and reveal the areal extent of each condition class. This "first look"

TVI6 map indicates that this is possible. More intensive analyses with maps produced from a more extensive data base (secondary sites) and for additional dates will be undertaken in the next quarter.

The ground truth data collected within the ETSA coincident with Landsat overpasses in 1975 must be used in the final analysis of the accuracy of Landsat MSS-derived forage condition maps, however, rather than the SRS maps. J. R. Gray summarized the process involved in preparing the SRS maps and described some of the deficiencies in the data in the June, 1975 Rangeman's Journal (pp. 81-82).

The SRS maps are based on mailed responses of ranchers who estimate current conditions as a percentage of what they would be under very favorable weather conditions. The ranchers consider the current range feed conditions in their local areas, feed prospects, moisture conditions, livestock conditions, and whatever else they wish to include in making their report. The percentages are plotted by location on state maps and the areas are delineated according to condition categories. According to Gray, delineating these areas is similar to the meteorologist drawing lines of equal pressure on a weather map.

Gray listed the following deficiencies that exist in the pasture and range feed condition reports:

- The report is based on opinion. Opinions may be influenced by a variety of unrelated situations.
- The report is generalized for broad areas. Individual ranches may be experiencing extreme drought even though the general area (which may be an entire state) is reported as good to excellent. The report is based on averages.
- A condition considered and reported as severe drought in one area...may be considered and reported as good to excellent in another...
- The exact boundaries, particularly near state boundaries, of the condition classes are usually based on compromises.
- In some areas, sampling problems persist, with large areas not being represented by reports from local respondents.
- Current conditions may change more rapidly than the monthly interval of the report.

Despite these deficiencies, however, Gray relates that a report such as this is useful to ranchers in deciding about feed purchases, culling, and livestock buying and selling. A more accurate, unbiased and timely report, such as might be produced from Landsat MSS data, should be more readily accepted and certainly more useful to the rancher and others in agribusiness.

2.1.3 Associated Project Tasks Accomplished

The final version of the range site map (consolidated soil association map) has been completed and is ready for photo-reduction to the base of 1:1,000,000 scale. The Level III vegetation classification map produced through manual photo-interpretation techniques with ground verification has been reduced and transcribed onto frosted acetate as an underlay to the 1:1,000,000 scale four-image Landsat mosaic of the ETSA.

The process of selecting a large number of secondary sites that will be well distributed within the ETSA was initiated. The Landsat MSS data from these sites will be used in the final analysis to plot TVI6 or other parameters to produce isoline maps of forage conditions. Twenty-mile by twenty-mile (32 kilometers) computer-generated greymaps of Landsat Band 5 data were produced for 26 selected areas scattered throughout the ETSA (Figure 2-3). Using Landsat color composite imagery for several dates and NASA high-flight aerial photography, where coverage is available (Figure 2-3), desirable rangeland areas are selected and located on the 26 greymaps. The greymap coordinates are used to identify and extract the secondary site MSS data. Currently, greymaps have been produced and assembled for all three 1975 study periods (June, July and September). Approximately one-third of the secondary sites have been selected.

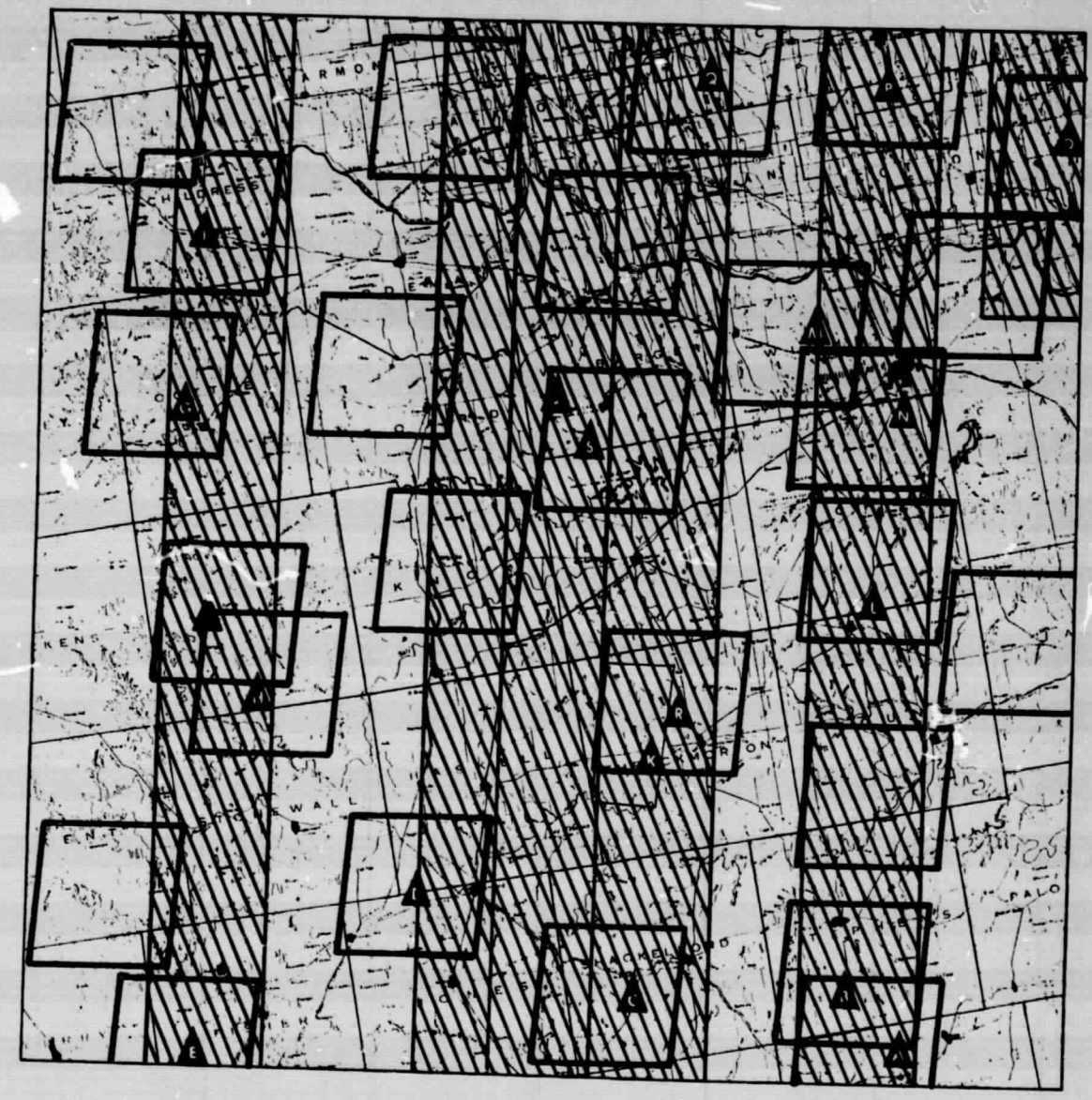


Figure 2-3. Location of 20 mi. x 20 mi. (32 kilometer) "greymap areas" & NASA highflight coverage (hatched lines) within the Extended Test Site Area.

Daily weather data on temperature and precipitation for January through November, 1975 for the 61 ETSA weather stations have all been transferred from Department of Commerce "Climatological Data" records onto keypunch code sheets. These data are currently being keypunched and verified.

Software has been developed at the Remote Sensing Center's Data Analysis Facility (RSDAF) to use tapes that are normally generated for operating the Calcomp plotter in TAMU's central computer facility to produce plots on the RSDAF's versatic electrostatic printer/plotter. Resolution for both types of plotting is the same at one hundreth of an inch. However, turn around time is greatly increased and the versatility in plotting is improved. This capability has simplified the generation of the isoline contour maps.

Techniques for creation of the N^{th} order function representing different parameters (e.g. green biomass and TVI6) under study is in the process of being improved. The least squares technique currently being used to give the coefficients of the N^{th} order function smoothes the curves as it fits the function to the data. The highs and lows representing extremes in conditions of the ETSA are brought too close to the mean value for the data set. Higher order fits will prevent this loss of contrast, but the "edge effects"

(discussed earlier in RSC Progress Report 3018-3) where there are no data, are more pronounced. The solution is to find the high and low data points and place around them similar values. This forces the least squares fit to include the extremes at lower orders to reduce, in most cases altogether, effects produced at the edges. This is done by locating an extreme point, its nearest neighbors, and by interpolation place values on a sliding line between the two points. This procedure is being tested.

2.1.4 Date Requests and Receipts

During this reporting period, retrospective data requests for Landsat images and CCT's were placed with ASCS and EROS Data Center, respectively.

There were 75 Landsat image products ordered from ASCS in February, and 73 Landsat image products were received on March 15, 1976. Imagery products for Landsat observation I.D. number 2253-16335 were out of registration. Consequently, products could not be reproduced from the Landsat image to completely satisfy the Landsat image product request submitted to ASCS. An additional request for three Landsat image products was submitted to ASCS on March 29, 1976. These data had not been received by the end of this reporting period.

On April 15, 1976, a request for four sets of CCT's was placed with EROS Data Center. These data had also not been received by the end of this reporting period.

2.1.5 Aircraft Data

RSC personnel performed a microfilm evaluation of the aerial photographic coverage of GPC test sites acquired by NASA WB57F aircraft on mission 310. Forty-four frames of alternate coverage of aerial photography of GPC test sites were selected for 9.5" x 9.5" positive transparency reproduction from ASCS. At the end of this reporting period all forty-four frames of the above requested aerial photography had been received.

2.2 Problem Areas

Processing of Landsat computer compatible tapes (CCT's) has been more expensive as well as time consuming recently because of an increase in the occurrence of "data checks" on the tapes. As a result of data checks or bad spots that exist on the EROS produced CCT's, the TAMU computer cannot accurately read an information record. This results in the loss of part or all of the record currently being read, depending on where the data check occurred. These tapes must be recopied to another tape to remove the data checks. This special purpose program reads the tapes, and

upon encountering a bad spot on the tape, salvages what good data it can and continues on. This additional program must be run for every CCT that is found to have data checks.

2.3 Recommendations

A good relationship was shown to exist between the preliminary TVI6 isoline map of forage conditions in the ETSA and the SRS Pasture and Range Feed Condition report for the same time period. However, based on the limited nature of the data set and currently incomplete analysis, no recommendations are made at this stage of the analysis phase of the investigation.

2.4 Accomplishments Expected During the Sixth Quarter

The final reporting period of the investigation will include the production of Landsat-derived parameter isoline maps of forage conditions for three dates in 1975. for the ETSA using secondary site data. The accuracy of these products will be evaluated using ground truth data collected at the time of satellite overpass.

The response zone concept will be tested. If significant response zone influences are indicated, then models will be modified to increase the accuracy of the estimates.

The techniques developed for the ETSA will be applied throughout the GPC using Landsat data for the test areas. A map of forage conditions in the GPC will be produced using the Landsat data from secondary sites for at least one time period to demonstrate the techniques for regional monitoring. This product will be evaluated against ground truth data and also compared with the SRS condition report.

The feasibility of using Landsat-type data, in conjunction with physiographic and climatological parameters for modeling a range forage index and indexes of plant growth conditions, will be determined. The concept for an operational system will be described.

3.0 SIGNIFICANT RESULTS, PUBLICATIONS, AND PRESENTATIONS

3.1 Significant Results

A TVI6 isoline map at the 6.25 million hectare Extended Test Site Area in north Central Texas and southern Oklahoma has been produced during this quarter. The map was compared to a published USDA Statistical Reporting Service map, which shows pasture and range feed conditions, as reported by rancher respondents. Both maps show similar areas of drought stress and good to excellent forage conditions, but preliminary indications are that the Landsat-derived map more accurately depicts the areal extent of each condition class. More intensive analyses are under way to assess the accuracy and adequacy of this type of map.

3.2 Publications and Presentations

R. H. Haas presented a paper entitled "Mapping Rangeland Vegetation in North Central Texas from Landsat Space Imagery" at the annual meeting of the Society for Range Management in Omaha, Nebraska on February 18. The paper was coauthored by K. C. McDaniel and D. W. Deering.

On April 22 J. C. Harlan and D. W. Deering gave a presentation to NASA administrators in Washington, D. C. The presentation summarized the accomplishments of the rangeland Landsat investigations at TAMU and the rangeland management uses of Landsat data that are being developed.