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REMOTE SENSING RESEARCH FOR AGRICULTURAL APPLICATIONS

NASA Cooperative Agreement NCC 2-205

Principal Investigator: Robert N. Colwell

Remote Sensing Research Program

Louisa H. Beck
Paul R. Ritter
Randall W. Thomas
Sharon L. Wall (Project Manager)

Semi-Annual Progress Report
1 August 1982 - 31 January 1983
Space Sciences Laboratory

University of California, Berkeley

UNIVERSITY OF CALIFORNIA, BERKELEY

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REMOTE SENSING RESEARCH FOR AGRICULTURAL APPLICATIONS

I. Introduction

Since August 1, 1982, the University of California at Berkeley has been cooperating with NASA/Ames Research Center on a variety of research tasks of mutual interest. Each group has provided a unique contribution to a varied series of on-going research items including:

1) Landsat Thematic Mapper/Thematic Mapper Simulator research,
2) Inventory design work for the Idaho Department of Water Resources,
3) Organization and presentation of results for a final evaluation of research conducted on the estimation and mapping of irrigated land and crop type in California, and
4) Development of a microprocessor image display and software package.

II. Progress on the Experimental Design Component

A. Sub-Task 1 - Landsat Thematic Mapper

The role Landsat Thematic Mapper (TM) data will play in agriculture is in the initial research stage. Improved measurement of small fields, separation of irrigated and non-irrigated crops and the differentiation of crops previously indistinguishable are important topics the improved band widths and spatial resolution of TM may provide. Given the relatively limited access to real TM data, we are cooperating with NASA/Ames on research using Thematic Mapper Simulator (TMS) flown by the U-2/ER-2 aircraft as a surrogate for Landsat-4TM data. When TM data becomes available we will have had the opportunity to research, classify and test similar data and identify both problems and promises inherent in the new sensor.

Progress during this reporting period has concentrated on spectral data acquisition including TMS, color infrared high altitude aerial photography and Landsat 3 MSS and ground data collection to support classification and testing. Selection of a test site in San Joaquin County for detailed analysis has also been completed. Each of these topics is discussed below.

1. Spectral Data Acquisition

During 1982, several types of data were acquired for portions of the Central Valley. Included were TMS (12 channels), CIR Highflight photography (1:130,000-scale), and Landsat 3 MSS CCT's (with associated imagery). Although data were acquired for Colusa, Yolo, Napa, and San Joaquin counties, work centered on portions of San Joaquin county where an extensive network of ground data observations had been maintained throughout the growing season. Table 1 indicates the data type and date of acquisition for the San Joaquin area. Figure 1 shows the approximate location of the TMS, and ground data collection transects.

2. Ground Data Collection

In support of the spectral data, an extensive ground data collection effort was developed and maintained by personnel from RSRP and NASA/Ames-Technicolor Government Services. The two types of transects used in San Joaquin county are described below.

a. 18-day transect

This transect, laid out and maintained by personnel from RSRP, was designed to sample maximum crop variation in concert with Landsat 3 overpasses. Fields were selected on different major soil types, and included variation within crop type as well as variation between crops. In all, 72 fields were monitored every 18 days from April to December, 1982. The types of data collected included:

- crop type
- irrigation practice
- row width
- row direction
- soil moisture
- percent canopy cover
- weediness
- crop biostage
- plant height
- planting/emergence/harvest dates (if observed)
- other factors that might contribute to spectral response

Examples of the initial and periodic observation forms are shown in Figures 2a and 2b.

TABLE 1

SAN JOAQUIN SPECTRAL DATA SET

1982	TMS	CIR	MSS
3/06			X
4/22		X	
6/04			X
6/22	X		X
6/23	X		
7/14		X	
8/04		X	
8/15			X
8/16			
8/25	X		
9/07	X		
9/10	X		
10/08	X		

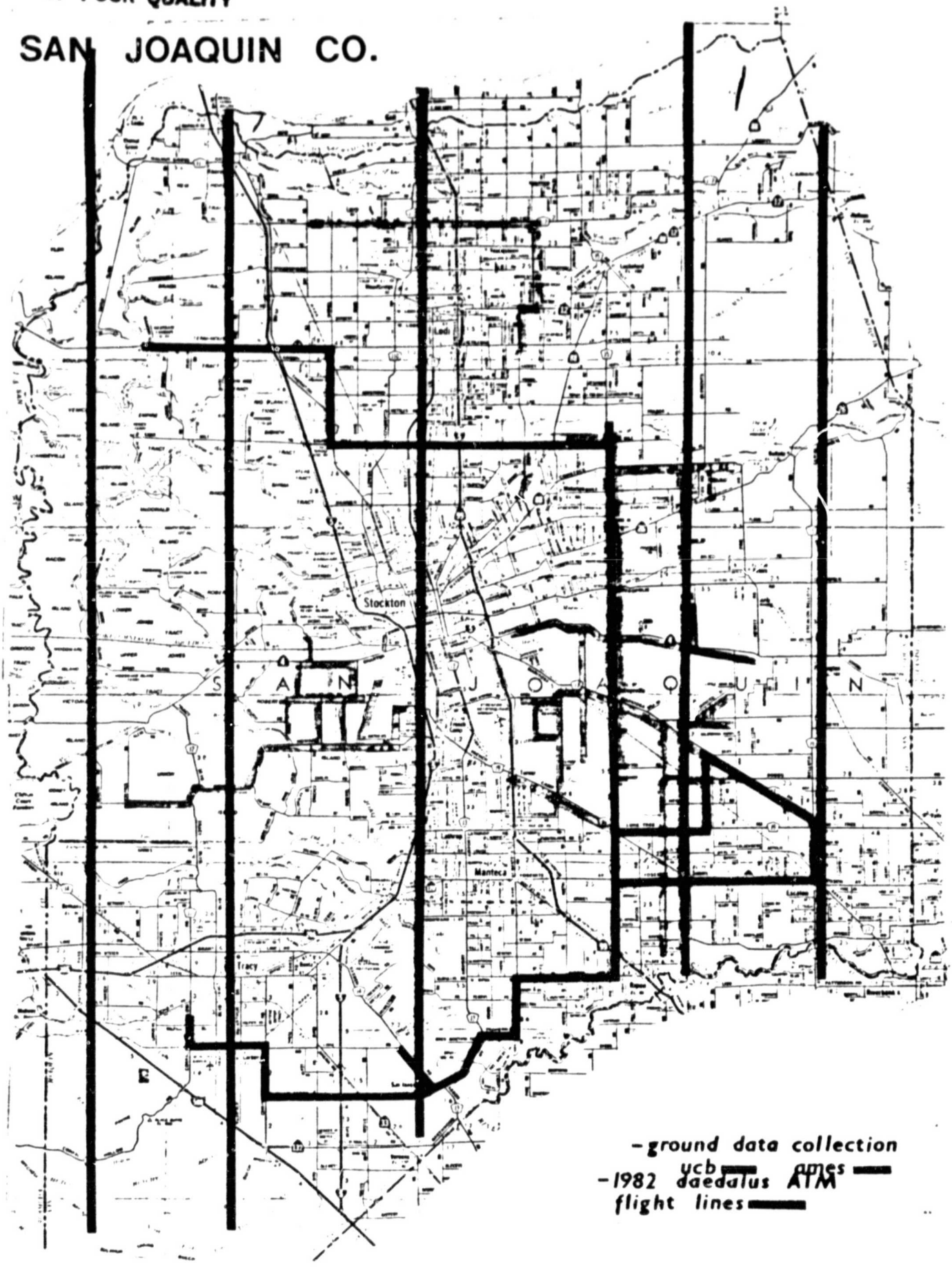

Figure 1. Approximate location of TMS (dark vertical lines) and ground data transects

INITIAL OBSERVATIONS

COUNTY:
OBSERVATION DATE:
OBSERVER:

FIELD NUMBER	CROP CODE	ACRES PLANTED	PLANTING DATE*	EMERGENCE DATE*	PREVIOUS USE CODE*	IRRIGATED 1=yes 2=no	ROW WIDTH (INCHES)	ROW DIRECTION	COMMENTS

* If known

A

PERIODIC OBSERVATIONS

COUNTY:
OBSERVATION DATE:
OBSERVER:

FIELD NUMBER	CROP CODE	CANOPY HEIGHT (INCHES)	GROUND COVER CODE	GROWTH STAGE CODE	SURFACE MOISTURE CODE	WEEDINESS CODE	ADDITIONAL CODES	COMMENTS

B

Figure 2. Initial Observation and Periodic Observation forms used for ground data collection.

b. wall-to-wall transects

Personnel from RSRP and NASA/Ames-Technicolor Government Services collected wall-to-wall field data on two lengthy transects on three separate dates. Both transects were located in the area of Jack Tone Road, east of Stockton. The types of data that were collected were nearly identical to those observed on the 18-day transect. A sample of one of the wall-to-wall observation forms is shown in Figure 3.

In all, over one thousand field observations were made throughout San Joaquin County during 1981. A breakdown of crop type by transect is shown in Table 2.

4. Initial Test Site

For purposes of intensive analysis and research, an initial test site has been selected in San Joaquin County. This site consists of a swath along Jack Tone Road, starting just north of Eight Mile Road as one road and running south to Ripon. The site is approximately 23 miles long, and 8-9 miles wide.

B. Sub-Task 2 - State and Local Resource Assessment

Significant potential exists for the application of remote sensing techniques in renewable resource assessment at the state level. The development of large-area, remote sensing-aided inventory procedures with an emphasis on the experimental design and sampling aspects is an area we continue to address in a variety of projects. Currently, in conjunction with NASA/Ames Research Center, we are working with the Idaho Department of Water Resources (IDWR) in designing an agricultural crop-type classification and inventory procedure for that state. This is to be done using a recently completed 28 class land use inventory of the Snake Plain Aquifer in southern Idaho derived from the digital classification of Landsat MSS data (1980) as input to U.C. Berkeley's Survey Planning Model. Progress to date follows.

Several meetings were conducted with NASA/Ames, and Technicolor Government Services (TGS) personnel in consultation with IDWR during the past six months. These exchanges were used to define the plan for development of a Landsat-aided crop inventory system in Idaho. Particular attention was focused on defining the inventory components subject to tests and the method by which these tests will be performed.

PERIODIC OBSERVATION

COUNTY: San Joaquin
OBSERVATION DATE: 7/27/82
OBSERVER: L. Beck / B. Wood

FIELD NUMBER	CROP CODE	CANOPY HEIGHT (INCHES)	GROUND COVER CODE	GROWTH STAGE CODE	SURFACE MOISTURE CODE	WEED-INESS CODE	ROW WIDTH	ROW DIRECTION	IRRIGATION TYPE	COMMENTS
91	SF	16-20"	4	bloom	1	1	—	—	—	
92	AH	12"	4	mature	1	2	—	—	—	
93	OH	12"	4	mature	1	1	—	—	—	
94	CR	6"	1	4 leaves	1	1	24"	EW	Furrow	
95	CR	4-8'	4	pre-tassel	3	1	24"	EW	Furrow	
96	Asparagus	3-4'	2	Fern	1/2	1	48"	EW	Furrow	
97	SF	16-18"	4	bloom	1	1	—	—		
98	DB	3"	1	2 leaves	1	1	24"	NS	Furrow	
99	Fallow	—	—	—	—	—	—	—	—	
100	B. Soil	—	—	—	—	—	—	—	—	
101	TO	20-24"	2	fruit	1	1	48"	NS	Furrow	
102	SB	18"	3	mature	1	1	24"	EW	Furrow	

CROP IDENTIFICATION CODES

CODE	CROP
AH	Alfalfa
BR	Barley
CR	Corn
CT	Cotton
DB	Dry Beans
GR	Grain (undifferentiated)
MP	Mixed Pasture
OT	Oats
OR	Orchard
RI	Rice
SB	Sugar Beets
SF	Safflower
SR	Sorghum
SU	Sunflowers
TO	Tomatoes
VY	Vineyards
WH	Wheat

GROUND COVER CODES

CODE	PERCENT COVER
1	0 - 20
2	20 - 50
3	50 - 75
4	75 - 100
5	not observed

WEEDINESS CODES

CODE	CONDITION
1	none or few
2	moderate
3	heavy
4	not observed

SURFACE MOISTURE CODES

CODE	CONDITION
1	dry
2	moist
3	wet
4	saturated
5	standing water/irrigated
6	not observed

ROW DIRECTION

CODE	DIRECTION
NS	North-South
EW	East-West
NW	Northwest-Southeast
NE	Northeast-Southwest
CL	Circular
CN	Contour
BC	Broadcast

Figure 3. Examples of wall-to-wall observations made in San Joaquin County in support of TM/TMS research.

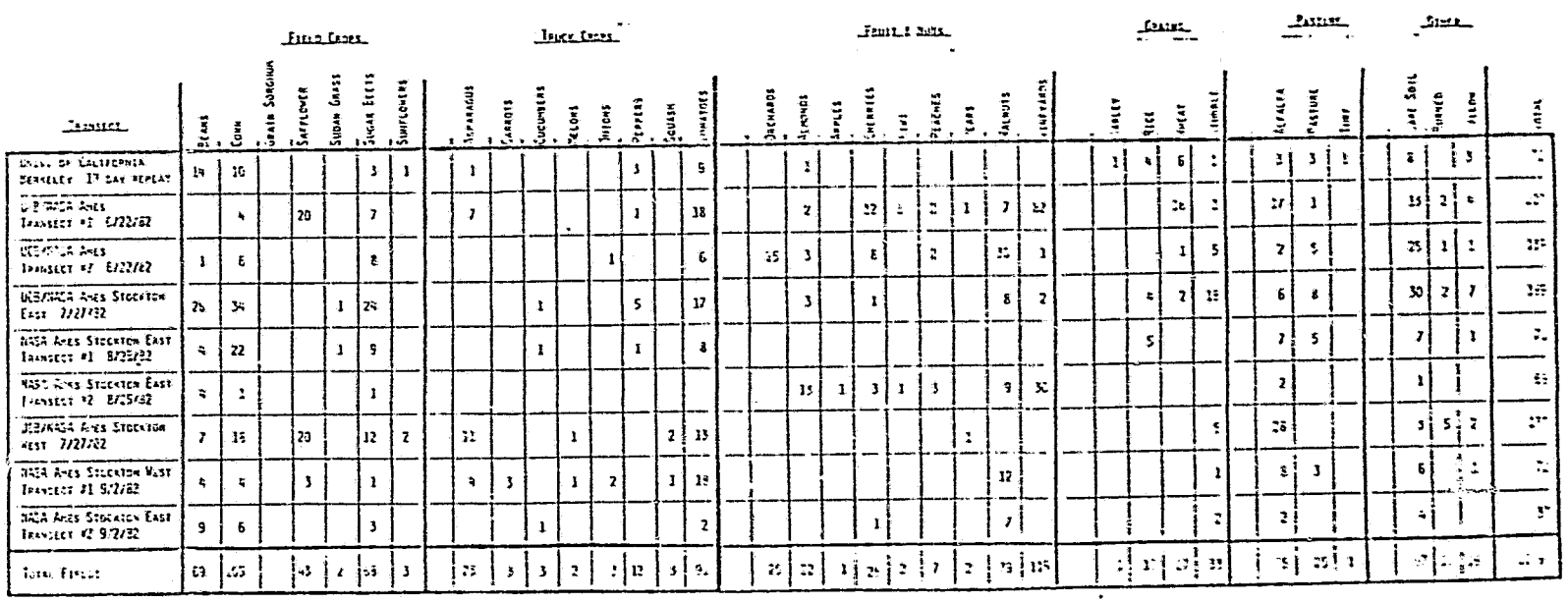

Table 2. San Joaquin County field data collected during 1982 growing season.

It was agreed that the first step in this effort will be the use of the results of the 1980 Idaho crop group classification as a planning base for the definition and test of more advanced techniques during 1983. Subsequent discussion was directed to this task. The approach adopted is to use the U.C. Berkeley Survey Planning Model (SPM) to evaluate acreage estimated variance and cost resulting from alternative stratification strategies and sample unit sizes. The SPM input data was defined and generated by NASA/Ames, TGS and the Idaho DWR. These data were to include the IDWR 1980 Landsat class map, sampling strata (those used by the IDWR in their 1980 inventory and those used at present by the U.S. Department of Agriculture, Statistical Reporting Service) registered to the class map, crop acreage means and variances for each stratum, expected ground sample unit measurement costs by stratum, and expected Landsat-to-ground correlations by crop type or crop group by stratum.

At present, preparations are being made by U.C. Berkeley, TGS and NASA/Ames personnel to run the SPM on three representative study sites within the Snake River Plain in Idaho. These runs are scheduled for the March-early April, 1983 period. Results from the SPM analysis of the 1980 data set are expected to enable the design of a sample frame for a test of more advanced inventory techniques over three or four test sites during the remainder of 1983.

III. Progress on the Evaluation Component

Considerable effort was expended during this reporting period on the organization and presentation of results of the "Irrigated Lands Assessment for Water Management" Joint Research Project (NASA Cooperative Agreement NCC 2-54) for final evaluation. The Final Review was held at the Asilomar Conference Center, Pacific Grove, California on September 21-24, 1982. Seventy people from California state government, NASA, U.S. Department of Agriculture, U.S. Department of Interior, universities and private corporations attended and participated in the review. Presentations at the review were made by personnel from the University of California (Berkeley and Santa Barbara), NASA/Ames, NASA/Headquarters, TGS and the California Department of Water Resources.

Major topics discussed at the Final Review were 1) project overview, 2) historical perspective on the project's development, 3) manual analysis of irrigated land (including sampling design, sample segment allocation, stratification, Landsat and ground measurement, estimation procedures and final evaluation and recommendation for an operational system), 4) digital analysis of irrigated land (including techniques and results of Tulare and Sacramento Basin Test sites, evaluation and recommendations for an operational system), 5) techniques and results of the manual small grains mapping procedure, 6) digital analysis for multicrop estimation and mapping (including small grains procedure, a case history of Tulare County work, discriminant analysis of Fresno County results, classification procedures in Fresno County), and 7) a summary of the Irrigated Lands Assessment for Water Management project - "where we were to where we are, what we learned", 8) California Department of Water Resources perspective and evaluation, 8) future work (outlining NASA/USDA/DWR/U.C. Berkeley Cooperative research, 1982 ground data collection, Thematic Mapper/Thematic Mapper Simulator research topics, new hardware and software developments) and 9) group evaluation and discussion.

IV. Progress on the Microprocessor Image Display and Software Package

Recently, NASA/Ames and U.C. Berkeley have acquired new, virtually identical microprocessor-based computer systems (MIDAS). Image processing software needs to be installed on the new system either by implementing some existing software package or by developing a new package. There is a need to provide something quickly so the new hardware can be used in the near future and work must begin on a more comprehensive, complete system that will be fully operational during 1985. Personnel at NASA/Ames and U.C. Berkeley have, between them, many years of experience writing image processing and display software for use in geographic information systems. The University of California personnel have special expertise in the development of "user friendly" software for research in remote sensing.

Since January 1, 1983, UCB and NASA/Ames personnel have been working together to produce the image processing and display software package for the new microprocessor system. Work in this first month has concentrated on a review of currently available software packages (EDITOR, ELAS, ------), discussion on either modifying one of these existing programs or writing something

new and discussion of the programming language to be used. Several meetings between the cooperators have been held to discuss these issues as well as initiate thinking on the long term objectives.

V. Summary and Future Work

The TM/TMS research has concentrated on collecting and preparing a detailed ground data set over San Joquin County, acquiring and pre-processing Thematic Mapper Simulator data for 4 date-periods and selecting a test site for detailed analysis. Future work will be devoted to the actual testing, classification analysis and evaluation of the TMS data. Work with the Idaho Department of Water Resources has centered on defining a plan for development of a Landsat-based crop inventory system. The focus has been on defining inventory components to be tested and test methodologies. In the next reporting period UCB's Survey Planning Model will be run on three test sites; the results of these runs will enable the design of a sample frame for future classification and estimation to proceed. The organization and presentation of results from the Irrigated Lands Assessment for Water Management JRP was held at Asilomar in September, 1982. This review and evaluation session was the official final presentation of research results developed over the past seven years in the "Irrigated Lands" series of NASA awards to the University of California. The microprocessor image display and software package work officially began only one month ago. Research has been confined to studying available packages, deciding on modifications and new software, programming languages and discussing long term planning objectives. The next six months to one year will see significant development of this task.