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LAND USE INVESTIGATIONS IN THE CENTRAL VALLEY AND CENTRAL COASTAL TEST SITES, CALIFORNIA

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The Geography Remote Sensing Unit (GRSU) at the University of California, Santa Barbara is responsible for investigations with ERTS-1 data in the Central Coastal Zone and West Side of the San Joaquin Valley. The nature of the investigative effort involves the inventory, monitoring, and assessment of the natural and cultural resources of the two areas. Land use, agriculture, vegetation, landforms, geology, and hydrology are the principal subjects for attention. These parameters are the key indicators of the dynamically changing character of the two areas. Monitoring of these parameters with ERTS-1 data will provide the techniques and methodologies required to generate the information needed by federal, state, county, and local agencies to assess change-related phenomena and plan for management and development.

In conducting these investigations, close cooperation is being maintained with various agencies to define information requirements and establish mechanisms for information flow. Among the groups already cooperating are the Department of Water Resources, Division of Highways, Farm Advisors (Santa Barbara and Kings Counties), and the Kern County Water Agency. In the Coastal Zone, GRSU is cooperating with the Forestry Remote Sensing Laboratory (U.C. Berkeley) and the Geography Department at U.C. Riverside. The three groups are working in concert to develop resource classification schemes that are applicable along the entire California coastline. These activities will lead to the development of a relatively uniform (i.e., standardized) Coastal Zone data base from ERTS-1 imagery.

In preparation for receipt of ERTS-1 data, considerable effort was placed on establishing a solid data base for the Central Coastal Zone. Detailed classification systems were devised for the resource parameters of interest, and maps were prepared from existing RB-57 color infrared photography imaged in April, 1971 (NASA Mission 164). The data base is being used to evaluate the information content of ERTS-1 imagery. As continued ERTS-1 data is received, the classification systems will be modified to make them compatible with the information content of ERTS-1 imagery. A solid data base already exists for the West Side of the San Joaquin Valley as a result of previous research by GRSU, and it is being used in the same fashion as the Central Coastal Zone data base. The balance of this paper will deal with results obtained in the conduct of land use analysis in these test areas.

Evaluation of land use features from ERTS-1 imagery has concentrated on determining the feasibility of ERTS as a data source for identifying, delimiting and mapping various land use types. In order

to assess the capability of ERTS-1 data to provide land use information within a data base context, investigations have concentrated on identification of specific land use parameters within diverse environmental and cultural settings. More specifically, cultural features which have been under close examination are: 1) urbanized areas (extent and location: both absolute and relative); 2) transportation routes and networks; and, 3) agricultural development and extent.

Three sets of ERTS-1 MSS positive transparencies (frame numbers: #1002-18140, North Central Coastal Region; #1073-18064, South Central Coastal Region; and, #1019-18062, Central Valley Region) were used to evaluate specific land use information potential of ERTS data for diverse environments. For each of the ERTS-1 frames utilized, each of the MSS bands (Channels 4-7) was evaluated for information content and feasibility for land use studies. An example of the type of results achieved in this investigation can be seen in Table 1. In all, some ten pages of this type have been prepared indicating the relative interpretability of various land use parameters on the ERTS-1 imagery. An example of a land use map generated in this study is shown in Figure 1.

PROBLEMS ENCOUNTERED

Several problems were encountered in the overall conduct of these investigations. While major interpretation difficulties centered around the resolution levels of the various MSS bands, several other problems were encountered. For instance, where certain tone and/or texture signatures exhibited low object to background contrast ratios, it was very difficult to make basic land use categorization decisions. In the Central Valley Test Site, difficulties were encountered in feature identification in areas of idle lands (i.e., those lands not developed for agricultural or urban uses). In such areas it was difficult to identify both urban and transportation features. Problems due to low contrast ratios in the Central Coastal Test Site made it difficult to locate certain urban centers in areas of rangeland/grassland, especially in those areas where transportation features exhibited weak signatures on the imagery. Steep, mountainous topography also made certain features difficult to interpret.

ANALYSIS AND RESULTS

Central Valley Region:

In addition to a thorough evaluation of the four MSS Bands for the identification of urban, transportation and agricultural features, a basic land use map of the entire Central Valley Region from frame #1019180625 was produced on acetate. Gross scale features were identified, classified, and mapped. These included: urban areas; agricultural land; idle land; natural vegetation and land forms (selected); highways; canals; airports; and, in one case, a portion of a railroad line. Particularly significant was the ability to delineate the shapes and extents of urban area boundaries and to map agricultural land, as opposed to non-agricultural (especially idle land).

URBAN AREAS

Sixteen (16) urban areas were identified on the image. Nearly one-third were located along U.S. 99, the established transportation route

thru the valley, while the others were located on secondary transportation arteries. The major focus of the majority of cities is as a regional/local center for surrounding agricultural hinterlands.

Identification was facilitated by tracing linear highway routes, especially along U.S. 99. Here the characteristic greyish, mottled signatures of the urban areas contrasted well with the surrounding environment. Several other communities of varying sizes were also accurately identified owing to their location in areas of heavy cultivation and secondary road networks. Again, the urban signatures contrasted well with the darker tone and rectangular pattern of the agricultural hinterlands.

The only major city in the area not identified was Corcoran (1970 population 5,249), located south of Hanford and west of Tulare on California 43. Reasons for this lack of an identifiable signature are being evaluated. Also, the absence of significant urban development along Interstate 5 is a result of the relatively underdeveloped agricultural state and geographic isolation of the area. This in itself is a result of non-availability, until recently, of adequate water for irrigation (now being changed by construction of the California Aqueduct) and isolation caused by inadequate transportation access (prior to the completion of Interstate 5).

In all cases, the cities were first located and identified by their mottled grey signature, and then the boundaries were mapped by determining the areal extent of the signature. Initial results appear to be fairly accurate (both in shape and extent) as verified by comparison with NASA high flight CIR imagery (March, 1971; 1:60,000 and 1:120,000 scale) and U.S.D.C. Coast and Geodetic Survey Sectional Aeronautical Charts.

AGRICULTURE/NON-AGRICULTURE (IDLE LAND) IDENTIFICATION

Basic land use mapping indicates that the major portion of land in the San Joaquin Valley (bounded by the Coast and Temblor Ranges on the West and the Sierra Nevadas on the East) comprises Ac (agricultural, crops) and Ni (idle land). While it has not been possible thus far to identify individual crop types within the Ac classified areas (or to further sub-divide between row and orchard crops on a gross scale), it was possible to recognize agricultural land use owing to rectangular field signatures and/or the presence of extensive, regular vegetation tone/texture. Ni land was identified on the basis of the absence of field boundaries and presence of uniform vegetation/soil tonal responses. However, it should be noted that it is possible that small areas of fallow land may have been included in the Ni classification, where field boundaries blended with the similar light signature of the bare soil.

Regardless, a high degree of mapping accuracy is possible. The following specific example is an indication of the reliability of mapped data for the study area. During the Summer, 1972, an agricultural land use map of a portion of Kern County (radiating from Bakersfield N, W, & S) was constructed from 1971 NASA high flight 70mm black and white negatives (enlarged to a scale of 1:290,000), and cross-checked with 1:120,000 scale CIR imagery. This was sent to the Kern County Water Agency (K.C.W.A.) for verification of agriculture acreage estimates. When K.C.W.A. figures were received, the same area was mapped from

ERTS-1 with an estimated error for ERTS data of less than 0.5 percent:
The results of these studies can be seen below:

<u>Source</u>	<u>Agriculture Acreage Estimate (acres)</u>
1. 1969 Crop Survey(Kern County)	746,104 (excluding fallow)
2. NASA High Flight (70mm)- 1971	753,369
3. ERTS-1	748,050

Central Coastal Test Site:

An evaluation of the four MSS bands was completed for the North portion Coastal test region, specifically examining the signatures of the urban, transportation, and agriculture land use categories on each band. Urban concentrations and transportation routes were located by scanning the images with a 10x magnifier to identify the typical tone/texture responses of each, and then the gross outlines and/or linear patterns interpreted from the imagery were compared with U.S.D.C. Coast and Geodetic Survey Sectional Aeronautical Charts for verification purposes. Agricultural signatures were generally quite satisfactory, with fields as small as 40 acres visible. Furthermore, tonal differences in field plots (both on the macro and micro level) were noted and their significance is being analyzed.

An examination of the four MSS bands for the South portion of the Central Coastal test region was also completed. The evaluation again examined three major categories: urban concentrations; transportation networks; and, agricultural development. Further identification was completed of gross scale features such as urban areas, agricultural land, natural vegetation, highways, airports, and military installations. Once again, the ability to identify and delineate the shape and extent of urban areas and developed agriculture from ERTS-1 imagery was found to be of particular significance. The application of this identification capability of specific features to future regional planning appears feasible.

URBAN AREAS

Nine (9) urban areas were located within the South portion of the Central Coastal Region. The majority identified were along the immediate coast or within coastal valleys. Smaller urban areas located inland were virtually unidentifiable owing to low contrast ratios between transportation arteries (highways specifically) and the areas they traversed. This made identification of urban areas using these indicators impossible. However, the characteristic greyish, mottled signatures of the urban areas along the coastal areas, which contrasted well (in most cases) with the surrounding areas of agriculture, lessened this identification problem.

In all cases, cities were first located and identified by their mottled grey signature, and then boundaries were mapped by determining the areal extent of the signature. Initial results appear to be fairly accurate (both in shape and extent) as verified by comparison with NASA high flight CIR imagery (March, 1971; 1:60,000 and 1:120,000 scale) and U.S.D.C. Coast and Geodetic Survey Sectional Aeronautical Charts. Precise, mathematical verification as to actual accuracy is planned.

AGRICULTURE LAND IDENTIFICATION

The basic land use map of this area which was constructed indicates that the majority of land in other than urban concentrations may be classified either as natural vegetation or rangeland. While the amount of cultivated land is relatively insignificant when compared to total land area, its importance should not be overlooked. Predominantly located along coastal river valleys or nestled between the coast and mountains, these areas are sites of intensive cultivation of specialized or high yield/high cash value crops. Identification of such sites of intense agricultural production was facilitated by the regularity of field patterns and tonal contrasts exhibited by areas of such activity. In addition, range and natural vegetation were identified, in the main, by their lack of regular boundaries and tonal responses and textures exhibited (light grey/mottled and dark grey/solid respectively). The existence of large areas categorized as Ar (rangeland) in the Santa Ynez Valley, Lompoc, and Santa Maria areas in the western portion of Santa Barbara County indicates the importance of the cattle industry in this region of the Central California Coastal Zone. These large areas of essentially open space, on the fringe of the greater Los Angeles metropolitan area, are also quite attractive to developers, and the ability to provide synoptic information in this dynamic environment is important.

SUMMARY AND CONCLUSIONS

Experimental results to date indicate that ERTS-1 type data can be a valuable source for environmental resource information needs. The resolution of ERTS-1 data places constraints upon the detail to which specific environmental phenomena can be investigated. Furthermore, resolution limitations create certain problems for investigation of environments in which a diversity of phenomena are localized in small areal units (e.g., as the Central Coastal Zone of California). These limitations, however, are mitigated to a large degree through the synoptic perspective afforded by ERTS-1. ERTS-1 data provides a capability to inventory resources over extensive areas, and generate data for these areas at essentially a single point in time. Although the detail of information may be insufficient for specific user requirements, the advantage of this synoptic view is that large scale environmental resource information can be: 1) obtained within a standardized format for a single date; and, 2) monitored and updated with comparative ease to reflect changing resource conditions. This is not feasible utilizing conventional data collection methods. The implications are highly significant for resource management and planning.

With respect to the specific land use studies which the Geography Remote Sensing Unit has conducted in the Central Valley and Central Coastal test sites, California, the following conclusions can be made:

1. Urban areas can be differentiated best on MSS bands 4 and 5.
2. Transportation linkages (highways, roads, airports, canals) are most readily defined from MSS band 7.
3. Agricultural field boundaries are adequately identifiable on MSS bands 4 - 7, and most clearly defined on band 7.

4. Cultivated land can be mapped accurately (under 5% error) from MSS band 5. Fallow land identification explains the majority of error.
5. Land use is difficult to map in the California coastal environment because many individual use categories occupy very small areal units; land use mapping is easier and capable of more sophisticated refinements in the arid California Central Valley.

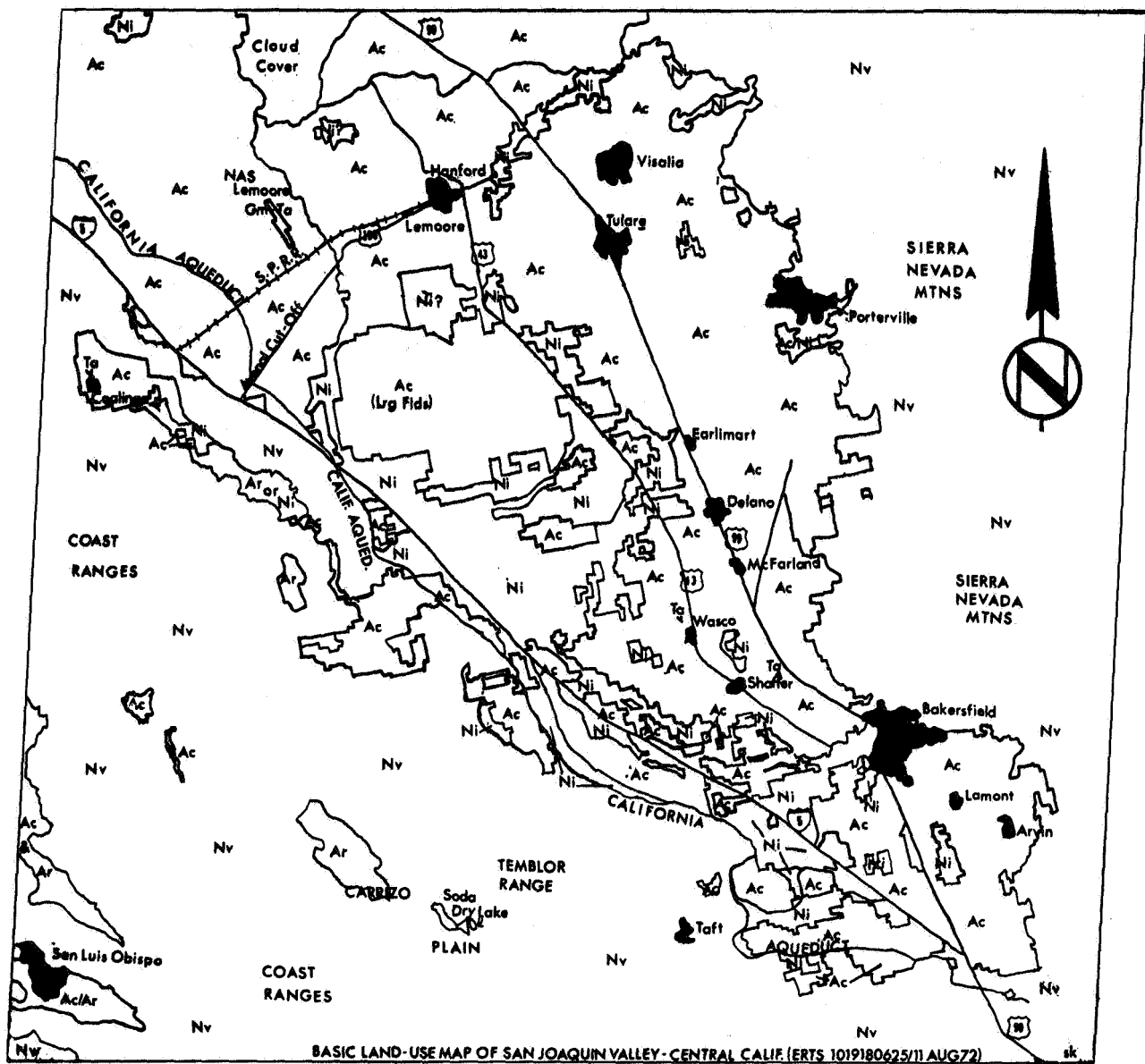


Figure 1. Example of Basic Land Use Map derived from Earth Resource Technology Satellite Data

TABLE 1. An Example of the Type of Evaluation of MSS Bands 4 - 7: Transportation Features Conducted by Personnel of the Geography Remote Sensing Unit, University of California, Santa Barbara.

LOCATION	BAND 4	BAND 5	BAND 6	BAND 7
U.S. 99-4 lane	Good response along entire route except when passing thru urban areas, where road signature blends with urban. Stands out well in areas of intensive agriculture, as well as areas of low-lying, sparse natural vegetation. Linear regularity aids in identification as does light signature.	Fair to Good. Same as for Band 4, except that signature fades to the Northwest in an area of small fields and bare soil (highway and fields both display light tone)	Poor to Fair. Road shows dark response which tends to blend with surrounding land along highways.	Fair to Good. Dark, linear response against lighter agriculture signature. Also, unlike Band 5, it is well defined along entire ERIS-1 image.
Inter-state 5-4 lane	Poor to Good. Major portion of route well defined. However, as much of the surrounding land remains undeveloped, the signature tends to fade when this occurs on both sides of Interstate 5. Light response of road good against agriculture (dark), but poor against open land (also light).	Poor to Fair. Generally same as Band 4. However, more fade out in undeveloped areas.	Poor. Tends to blend with light signature of surrounding land along majority of route.	Poor. Light signature against light background-majority of route traced on Figure 1 not visible.
Calif. 43-2 lane	Poor to fair. Irregular response. Visible in areas of agriculture where regular field patterns lend good contrast. However, in several large sections (figure 2) identified as Ni areas or Ac with bare soil, the road tends to blend.	Same as Band 4.	Not visible.	Fair. Dark response is well defined against agricultural regular patterned background. Slight loss of resolution in bare soil and idle land areas.
Calif. 198-2-4 lanes	Poor. Visible thru Hanford although small field apttens tend to disrupt signature. Contrast is poor. Cannot be traced thru the idle land east of Hanford and west of U.S. 99.	Same as Band 4.	Not visible.	Poor. Dark tone only visible against agricultural background with great difficulty.
Avenal cut-off-2 lane	Poor to Fair. Light pattern contrasts in areas of varying toned agriculture. Fades when encountering homogeneous light responses of bare soil, etc.	Same as Band 4.	Poor to Fair. Due to dark, linear pattern against lighter signature of agriculture.	Good. Dark linear response against regular agricultural patterns.