N73-28362

Paper R 4

ASSESSMENT OF SOUTHERN CALIFORNIA ENVIRONMENT FROM ERTS-1

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ABSTRACT

ERTS-1 imagery is a useful source of data for evaluation of earth resources in Southern California. The improving quality of ERTS-1 imagery, and our increasing ability to enhance the imagery has resulted in studies of a variety of phenomena in several Southern California environments. These investigations have produced several significant results of varying detail. They include the detection and identification of macro-scale tectonic and vegetational patterns, as well as detailed analysis of urban and agricultural processes. The sequential nature of ERTS-1 imagery has allowed these studies to monitor significant changes in the environment. In addition, some preliminary work has begun directed toward assessing the impacts of expanding recreation, agriculture and urbanization into the fragile desert environment. Refinement of enhancement and mapping techniques and more intensive analysis of ERTS-1 imagery should lead to a greater capability to extract detailed information for more precise evaluations and more accurate monitoring of earth resources in Southern California.

1. INTRODUCTION

The research effort at the University of California, Riverside has consisted of attempts to determine the value of ERTS-1 and similar data for analysis of environmental problems in a variety of regions in Southern California. Initial findings dealt mainly with mapping land use changes from ERTS-1 9" x 9" Diazochrome false color transparencies, but advanced methods of displaying and enhancing the imagery have made it possible to conduct more detailed studies of specific environments. In addition, the data from the U-2 flights were of significant value for detailed interpretation and verification of patterns extracted from ERTS-1 data.

The general objectives of the investigations conducted by UCR under the ERTS-1 program are listed as: (1) mapping of general land use patterns in rural and urban regions of Southern California; (2) monitoring of changes in land uses, particularly in urban and rural/

urban locations and with additional emphasis placed upon analysis of wildland areas coming under urban and/or agricultural pressures; (3) monitoring environmental pollution in Southern California basins; and, (4) developing models defining "environmental quality."

Out of these goals have grown a series of specific studies. In some cases, the concepts of these individual studies are included under more than one of the four prescribed goals, lending greater importance to the studies and demonstrating greater utility of ERTS-1 data.

There are four studies that were considered important enough to be presented as separate papers. The studies include (1) Semi-Automatic Crop Inventory From Sequential ERTS-1 Imagery by Claude W. Johnson and Virginia B. Coleman; (2) New Fault Lineaments in Southern California by Robert W. Pease and Claude W. Johnson; (3) ERTS-1 Image Enhancement by Optically Combining Density Slices by Gerald O. Tapper and Robert W. Pease; and (4) Land Use in the Northern Coachella Valley by Jack B. Bale and Leonard W. Bowden, and appear elsewhere in this volume. In addition, there are other important studies that use ERTS-1 imagery and merit description.

2. MAPPING VEGETATION IN ORANGE COUNTY FROM ERTS-1 DATA

Vegetation mapping from high flight U-2 imagery at small scales (1:131,000) can be accomplished with proper methodological procedures. These same techniques can be applied to the ERTS-1 imagery for interpretation of (generalized) vegetation patterns on the landscape. However, the greater perspective gained from ERTS-1 at greater altitudes can both aid and hinder investigation and accuracy.

Using U-2, RC-10 high flight color infrared imagery, Orange County was mapped for vegetation and wildlife patterns. Development of a functional classification scheme is of primary importance. It must be coordinated with the capability of the imagery to record information as well as with the needs of the investigation. It was felt that the best accuracy could be achieved using ten vegetation classifications (Grassland, Coastal Sage, Chaparral, Oak Woodland, Pine Woodland, Riparian, Fresh Water Marsh and Salt Water Marsh) and five wildlife associations (large animals, small animals, upland birds, waterfowl, and saltwater birds) (Figure 1).

In formulating the classification system an intensive study of ERTS-1 imagery (Band 7) and the U-2, RC-10 CIR imagery was required to determine patterns of specific tonal and texture registration. Careful attention was given to locational relationships such as slope orientation, drainage patterns, accessibility of wind systems and moisture, and elevation. Broad general patterns can be determined in the ERTS-1 photos and more specific and accurate delimitations made with the U-2 imagery.

Field checking was required to identify the specific signature pattern and determine the vegetative type characteristic of that registration. After a signature has been identified then it can be applied to the entire study to delineate the vegetation type.

In this systematic development a functional classification system can be formulated based on observable data and geared to the photography. The methodology can be applied to any region for mapping vegetation and should yield accurate, comprehensive results.

Mapping of vegetation can provide a useful data base for planning, especially when introduced into a computer format with land use, landform, and hydrological data. Digital plotting of boundaries recorded from air photos can enable quantification of, heretofore, arbitrary information and quickly provide accurate, usable data.

3. IMPACT OF OFF-ROAD VEHICLES

The recreational use of off-road vehicles, especially in the arid regions of the western United States, has become an important and rewarding leisure time activity. As a result, off-road vehicular traffic, especially motorcycle traffic, has already caused considerable damage to these delicate desert environments, and this damage will certainly become more widespread unless regulatory action is taken promptly to prevent overuse and destructive uses of the terrain.

Location of damaged areas and the study of their proliferation would aid greatly in efforts to minimize the impact of this vehicular traffic. Such a study would also provide a rational basis upon which to establish regulatory policy for off-road vehicles. In this study the utility of remote sensing techniques for the dual purposes of location and study of damaged areas is explored.

Using imagery of California's northern San Gabriel bajada spanning nearly three years from July 1968 to July 1972, all major areas of off-road vehicular damage within the study region were located (Figure 2). Growth of areas subject to damage, for the time period in question, was also mapped for specific locations.

Small scale imagery, particularly from the U-2 and NASA Mission 164, was found to be most desirable for purposes of initial location of damaged areas. Larger scale photography (1:24,000-1:30,000) was found to be more appropriate for more intensive study once damaged areas had been located. CIR imagery, particularly under a stereoscope, was found to be especially valuable in this investigation. Imagery of damaged areas from more than one date is, of course, requisite for a temporal comparison for expansion of damage.

Remote sensing techniques have direct application to the tasks of locating and studying off-road vehicle damage. Aerial survey is clearly superior to ground survey for these purposes for several reasons. First, the use of air photographs allows vast areas to be rapidly examined. Second, the perspective offered by aerial photographs allows the interpreter to easily see spatial patterns not readily visible from the ground. Finally, the number of man hours required for ground survey and mapping of damaged areas probably renders that method prohibitively expensive.

4. IMPACT OF THE BARSTOW TO LAS VEGAS MOTORCYCLE RACE

The most recent high altitude imagery, utilizing the U-2 platform, the RC-10 camera, and color infrared film, clearly shows the traces of random off-road vehicle (ORV) activity in the Mojave Desert. From this imagery, the extent of the areas of usage can easily be determined, and, with proper ground study, can reveal the types of environmental changes that have resulted. Simply stated, the premise of this study is: if patterns of random ORV usage can be detected, then surely the traces and environmental modifications resulting from intensive use in a specific area could be determined.

In communicating with the Bureau of Land Management (BLM), it was found that the annual Barstow to Las Vegas Motorcycle Race (consisting of approximately 2,600 riders and 15,000-20,000 spectators) was to be held 25 November, as part of a four day affair. The BLM was greatly concerned with this event and was engaged in setting up a preliminary study to determine the effects of the race and decide whether it should be continued. At that time, no aerial coverage was planned by the BLM, their study sites being restricted to ground transects across the route of the race, subsequently our interest was welcomed and encouraged. The proposed study would monitor environmental changes incurred by the annual Barstow to Las Vegas Motorcycle Race from high altitude aircraft and ERTS-1 imagery. Conclusions would be supported by ground checks and low altitude photo comparison. Changes could also be monitored over time, as the race is run over a course that differs only slightly from year to year.

The areas affected included the most common types of Mojave terrain; alluvial fans, playas and washes. As will be seen, these areas vary in their ability to accommodate intensive (ORV) recreational usage and the amounts and nature of damage that they incur.

Damage that was anticipated, again, varied with the type of material involved. First, the surface soil was expected to be altered. A slight cementing of stable desert surface materials is to be expected because of the net upward movement of water, that carries with it dissolved minerals which are deposited at the surface. Any weight applied to this surface would necessarily break it, exposing the looser subsurface material. In this process, the surface material is broken, allowed to be transported, and the subsurface material is compacted. The result is a surface with high erosion hazard by both wind and water, underlain by a relatively impervious subsoil. The surface is therefore (allowed to be) denuded of its surface layer, the compacted subsurface promoting the lateral movement of water and preventing, in large part, the germination of plants that could promote erosion control.

This type of effect would be greatest upon alluvial fans. However, the degree of damage is largely dependent upon the portion of the fan that is used. This is necessarily a function of the depositional characteristics associated with stream velocity, slope, and channel width. Coarse debris is better able to withstand intensive usage, and is found at the head of the fan since it is the first deposited (a result of its greater weight). Materials increase in fineness and susceptibility to damage as slope decreases or distance from the source increases.

Desert pavement is subject to similar, though less intense, damage since it is a resistant surface but located on a relatively level area. Once the surface is broken, subsurface material is most susceptible to wind and water erosion.

Playas require a slightly different consideration. Soil textures are fine, but the area serves as the local base level, effectively eliminating water erosion hazards. The slightly structured playa surface is therefore only susceptible to wind erosion. Perimeters of playas, however, are some of the most likely archaeological sites in a desert environment, and may be subject to destruction.

Washes, in regard to usage, are blessed with instability. Sudden convectional showers that typify desert storms, and its resultant heavy runoff, greatly rework these ephemeral stream channels at frequent intervals. No desert surfaces can form and the coarseness of the sands in their beds resist compaction. Vegetation that inhabits stream courses is also adapted to frequent change.

Much of the damage that is inflicted on these areas results from the reaction of the riders to the particular surfaces over which they rise. Flat, or expansive vegetation free, firm surfaces are most attractive, because they allow greater speed. Also in these areas, trails widen dramatically, as passing is desirable. The qualities that are attractive, to the rider, are those which make it most susceptible to damage. These are, by and large, fans, playas, and pavement surfaces. Washes, those areas that can withstand heavy usage, are in slower, concentrated parts of the course. Because of its looseness, riders slow down, and tend to follow single-file.

Most of the changes observed are visible on U-2 imagery. From the ground sites that were monitored the extent of the types of change noted can be plotted and the types of change can be projected for those areas not covered in the ground survey. This change could prove to be beneficial in some respects (i.e. grazing enhancement) or detrimental in others, to surfaces, erosion potential, vegetation and possibly disease (valley fever).

In those areas that were damaged, there were alternate routes that would have resulted in diminished effects. Imagery of current U-2 scale and resolution will provide a valuable tool in planning future events in the desert that will result in a minimum amount of damage. This type of imagery will also lead to improved recreational planning of all types in areas where an environment may be so easily damaged. Most important, is that ERTS-1 imagery is as useful for planning future races as some of the U-2 data because those areas that can withstand heavy use are mappable.

5. URBAN REGIONAL LAND USE

The metropolitan area of which Riverside and San Bernardino form the core, has been selected by USGS as one of 26 sites for study of urban land use under the Urban Atlas Project. The basic data gathering system, of mapping land use information on USGS 1:24,000 sheets, is being continued until its completion. Computer maps are being prepared from the base data. Five quadrangles have been finished and are mosaiced together (Figure 3).

This large scale data base, while useful in its present condition, also allows rapid and useful correlation with ERTS-1 and ERTS-B imagery. The sequential nature of ERTS-1 imagery fits in well with the requirements of the project, those of monitoring urban and regional land use changes. The conversion of conventionally mapped data into a format for computer storage and manipulation allows quick comparisons of several dates, and thus rapid assessment and calculation of urban changes. The feasibility of such monitoring has already been established in the paper mentioned earlier (Bale and Bowden, "Land Use in the Northern Coachella Valley").

Present plans include the production of a technical report summarizing all the work of the project at UCR. It will include details on the methodology and techniques as well as analysis of data from selected sites in the study area. This paper will provide local county and city planners with quantitative data and adaptable techniques for their use in evaluating land use changes and processes occurring in the area. It also reflects the ability and intention of this research program to go beyond the limited objectives stipulated by USGS and make information available for practical, local agency utilization.

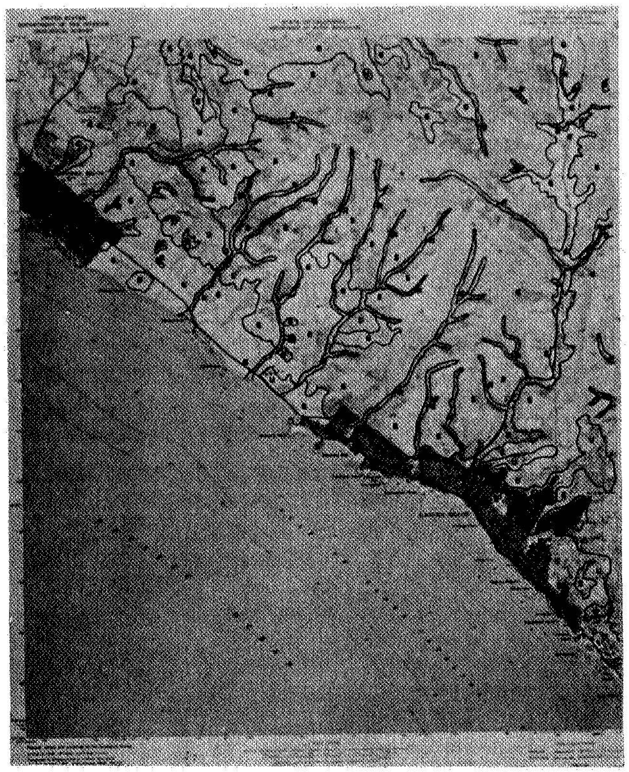

Figure 1

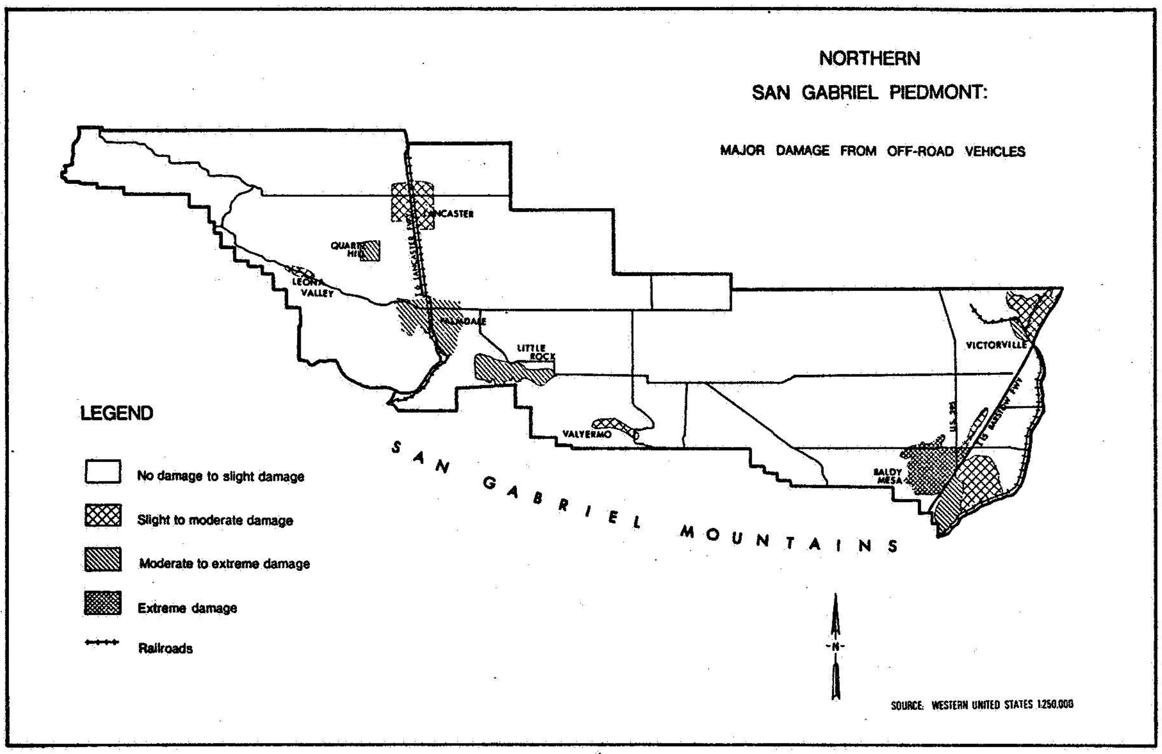

Figure 2

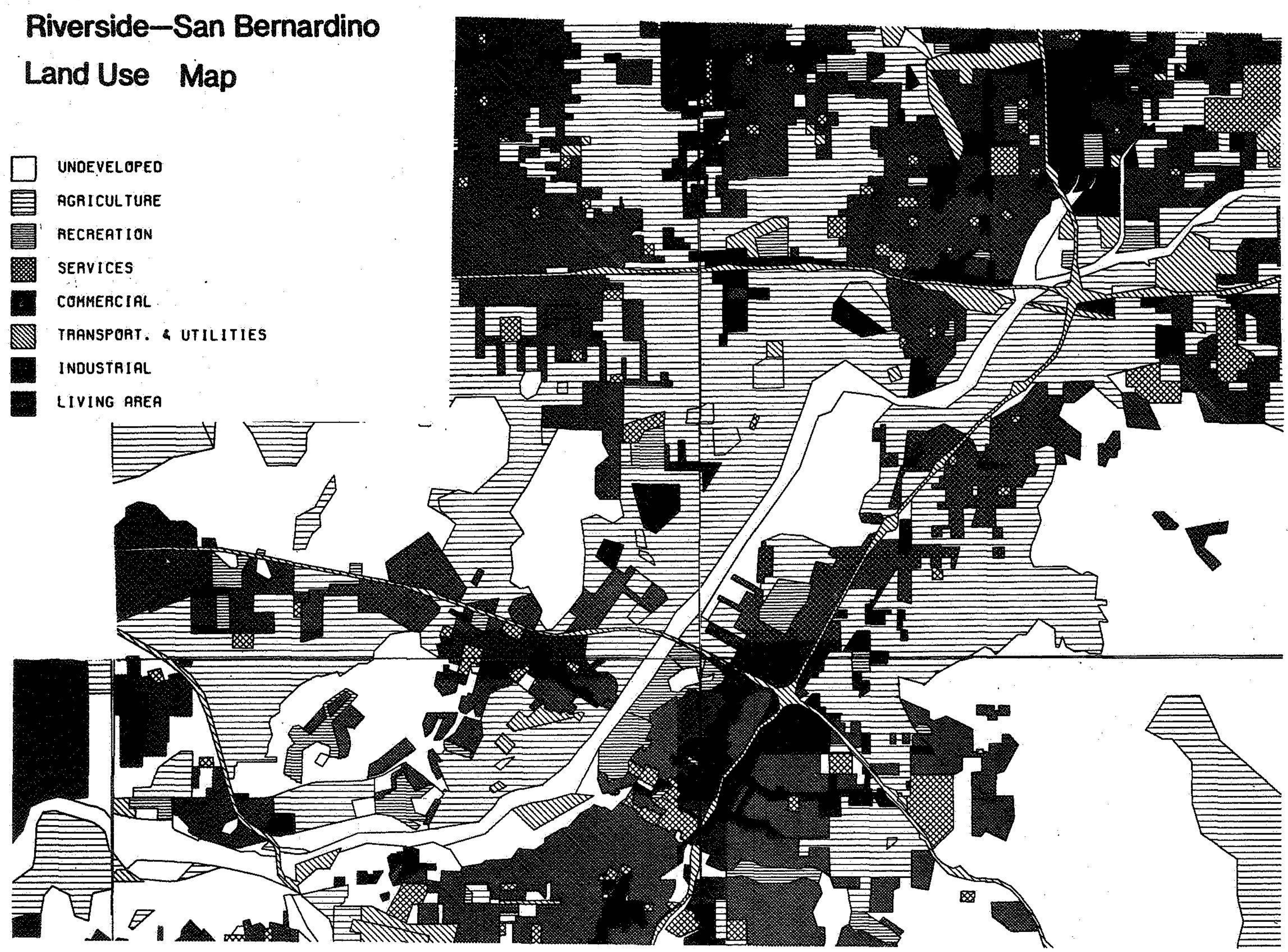
Riverside—San Bernardino
Land Use Map
UNDEVELOPED
AGRICULTURE
RECREATION
SERVICES
COMMERCIAL
TRANSPORT. & UTILITIES
INDUSTRIAL
LIVING AREA

Figure 3