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**'FIRST LOOK' ANALYSES OF FIVE CYCLES OF ERTS-1 IMAGERY OVER
COUNTY OF LOS ANGELES: ASSESSMENT OF DATA UTILITY FOR URBAN
DEVELOPMENT AND REGIONAL PLANNING**

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ABSTRACT

Significant results have been obtained from the analyses of ERTS-1 imagery from five cycles over Test Site SR 124 by classical photointerpretation and by an interactive hybrid multispectral information extraction system (GEMS).

The synopticity, periodicity and multispectrality of ERTS coverage, available for the first time to LA County planners, have opened up both a new dimensionality in data and offer new capability in preparation of planning inputs.

Photointerpretation of ERTS images has produced over 25 overlays at 1:1,000,000 scale depicting regional relations and urban structure in terms of several hundred linear and areal features. To mention only one such result, a possible new fault lineament has been discovered on the northern slope of the Santa Monica mountains in the scene 1144-18015, composited of MSS bands 4, 5, 6.

GEMS analysis of the ERTS products has provided new or improved information in the following planning data categories: Urban Vegetation; Land Cover Segregation; Man-made and Natural Impact Monitoring; Urban Design; Land Suitability.

An ERTS scene, 1036-18010, analyzed by GEMS to provide spectrally-derived object class patterns was directly overlaid on a current LA County land use pattern map prepared at 1:24,000 scale. The geometric and thematic content of the GEMS-derived patterns is sufficient for routine use at the 1:24,000 standard operating scale for county and regional planning. The significant point of this converging set of results is that the internal, fine structure of the inner city has been sub-classified spectrally-spatially.

ERTS data analysis has allowed planners to establish trends that directly impact planning policies. For example, detectable grading and new construction sites quantitatively indicated the extent, direction and rate of urban expansion which enable planners to forecast demand and growth patterns on a regional scale.

This new source of information will not only assist current methods to be more efficient, but permits entirely new planning methodologies to be employed.

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EROS Data Center
10th and Dakota Avenue
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1. INTRODUCTION

The County of Los Angeles is populated by 7 million people and covers 4,083 square miles. Another 13 million people live in the adjacent counties. The Test Site SR 124 is an extremely complex environment both physically and socially. It includes a vast metropolitan area of some 1500 square miles. Its natural environment includes desert, high mountains, and two large islands. The complexity of both the urban and the natural environments of the Los Angeles region was aptly pointed out by Professor Leonard Bowden respectively in papers L5 and R4 during two sessions at this symposium.

Los Angeles County is presently involved in the preparation of a Comprehensive General Plan as required by California Law. A vast amount of data on a wide range of subjects is needed to complete this task successfully. Traditional planning operations are becoming prohibitively time-consuming and expensive. Use of ERTS data in current planning operations will provide a less expensive and more timely product, based on the findings of this investigation through the 'first look'.

The objectives of this investigation are: i) To evaluate ERTS imagery utility for its urban and regional planning applications using the complex Los Angeles area as a testing ground and ii) To ascertain the effectiveness of the General Electric Multispectral Information System (GEMS) by representative analysts/users operation.

The project involves three major parties: NASA, the General Electric Company and the County of Los Angeles. NASA gathers and preprocesses data at 1:1,000,000, 1:125,000 and 1:36,000 scales. GE - Space Division analyses the data and conducts the investigation jointly with the County Regional Planning Commission who interpret and use the data products in its planning program.

The data extraction methodology basically involves classical photo-interpretation by County members on the team and interactive electronic analyses by GE investigators. The processes are mutually strengthened by progressive interaction both by remote means and in person. Figure 1 depicts the information flow for this study.

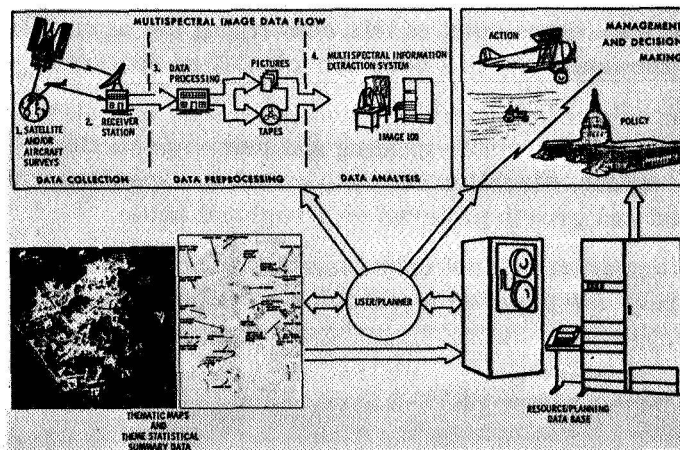


FIGURE 1 Data Analysis Flow

2. SIGNIFICANT RESULTS

The results of photointerpretation of ERTS transparencies at the 1:1,000,000 scale - both black and white as well as standard and non-standard color-composites - by the County investigators are most succinctly communicated in the course of the study effort by an ever-increasing series of theme overlays/recognition maps with exhaustive annotation and commentary. Here it is appropriate to show a selected few of such overlays, as in Figure 2.

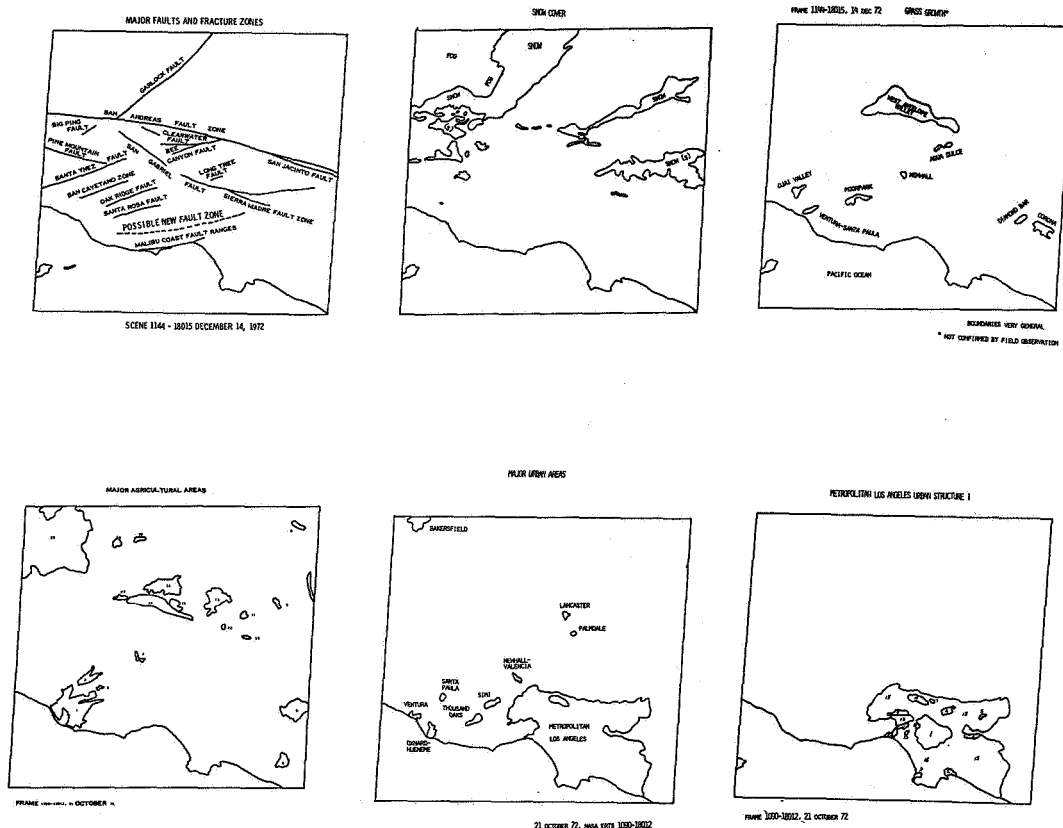


FIGURE 2 An assortment of photoreduced overlays constructed by photointerpretation of ERTS scenes of the LA County Mainland representing regional and urban overviews of problems for further analyses.

The on-going series of overlays, in addition to serving an orientation reference function, also gives a feel for the surprisingly vast data yield capability of the ERTS imagery. Our analysis indicates that ERTS data content exceeds the detail shown on the standard Army Map Service 1:250,000 scale plastic relief series of maps.

Major Faults and Fracture Zones: A fairly casual visual inspection of the latest CoLA ERTS scene 1144-18015, viz. the December 14, 1972 imagery, in the non-current combination of bands (4, 5, 6) -- composited for us by the GE-Beltsville Photolab -- shows an unusually straight alignment of topographic features along the north face of the Santa Monica mountains. This suggested to the Test Site Coordinator the possibility of a major new fault zone or lineament. The County Geologist, Mr. Arthur Keene, has been assessing this possibility. The ERTS 1 Symposium Program announced a paper by Professors Pease and Johnson titled, "New Fault Lineament in Southern California". The broad pattern they presented in the paper G33 in the 3/6/73 session flanks the fault under consideration here, shown in the upper left corner of Figure 2 by the dashed line - - -. Corroboration of the existence of such a feature would indeed impact land use allocation decision in the vicinity and its confirmed existence would have to be reflected in the mandatory Seismic Safety Element of the County General Plan. It should be pointed out too that in the imminent future, the Santa Monica Mountains will be increasingly the focus of much heated controversy with respect to their land use categorization!

Moving on to another overlay, the same December 14 print reflects major seasonal changes as compared to the previous ERTS scenes with the equivalent center point coordinates. Snow covers (upper center block in Figure 2) portions of the mountains and desert regions. Areas of new grass growth (upper right corner of Figure 2) mostly in the coastal lowlands are also seen for the first time in imagery over the Test Site. The simultaneous occurrence of Spring and Winter conditions illustrate the environmental diversity of Southern California. This is new information from direct observation -- valuable to a number of local agencies concerned with water management, agriculture, recreation and transportation. It is also needed over the longer range by the planning commission to prepare an effective open space and recreation plan which takes into account also the scenic quality. This data will enable regional recreation planners identify areas of scenic quality -- a troublesome problem in scenic quality surveys otherwise made conventionally.

Brush fire burns, not shown in a figure here, show up in the August 10 NASA product E1018-18010 clearly in a four-some clump in the southeast while the October 21 scene E1090-18012 brought out very clearly the Large Sespe burn which later could be just discerned under the cloud cover in the NASA item E1036-18010 of August 28, 1972. The fire was known to have been burned during mid-August. The brush fires in Southern California form one of the major man-induced 'natural' hazards. The large areas burned in a synoptic view should impress any careless fire-bug! Incidentally, data on topography, geology and fire hazard are used by planners in determining the use suitability of land. Suitability judgements are used, in turn, to allocate space for various types of land uses.

Major agricultural areas: lower left corner square in Figure 2. The very considerable variety and complexity of the introduced species of agricultural crops within the test site are readily discernable in all the ERTS scenes on hand today. A regional corroboration of the statement by Lt. Governor Reinecke of California -- that agriculture forms the biggest industry in the State -- can be made in that County in as much as almost 10% of the County area is in agricultural use. As pointed out in the mini-paper in the Preliminary Findings from ERTS Symposium of September 1972 dealing with Antelope Valley agriculture (area 13 in the overlay) the monitoring of

agricultural disinvestment and rural-urban conversion phenomena will be continued in what can be characterized as agricultural sub-systems study. The results of this work and the continued effort on water resources analysis from the ERTS imagery via the GEMS are reported in the study semi-annual report.

Major Urban Areas Intensive Analyses: The thrust of the effort underway in this investigation since the Preliminary Findings Symposium has been and will continue to be on the very complex urbanized regions within the Test Site (lower center, Figure 2). For the first time planners are able to directly observe the entire vast metropolitan area in a single scene on a repetitive basis. This experience is absolutely new and exciting. Again, we can directly see the shape and the general internal structure of the metropolis. An absolutely new data item is the extent and pattern of urban vegetation - a powerful clue to the physical and social segregation of the metropolitan area into subareas. (Lower right, Figure 2). It is necessary to have an accurate concept of these subareas for effective urban policy making and implementation.

Grading and New Construction Sites: Using U-2 aircraft imagery (Figure 3) for quasi-ground-truth we have been able to determine that we can identify from ERTS imagery (previous December 14 scene) all significant new grading and construction sites.

This is an emergent capability of major importance since it means we can cheaply monitor the extent and direction of new urban expansion and estimate the rate of expansion. This means we can now attack head-on a central problem of planning-- trend detection. Knowledge of trend is essential for effective land use allocation

and land use arrangement. The ability to identify new large construction from ERTS imagery means that it is now possible to monitor the extent, direction and rate of urban growth on a nationwide basis using only a single source data. Currently contribution to what fragmented policy in this field is made federally comes from a number of Federal Executive Departments: Commerce, Housing and Urban Development, Interior... formulated much as good deal of regional planning is done -- by abstraction, extrapolation etc. of data acquired from a multitude of sources, over a disparate time period and scale, at considerable expense. Monitoring of national urban growth could be done more cheaply by means of ERTS observation than any other on a very frequent (say, quarterly) basis. This monitoring would almost warrant a Super Cabinet charter!



FIGURE 3 One of the Vinten 70 mm frames from Ames, an area 14 X 14 naut. miles covering downtown LA - a mini-sub-site being most intensively studied using the GEMS.

Further series of 'urban' overlays, not shown again, were produced for identifying from ERTS imagery, using ground truth for discrimination as necessary, industrial and commercial districts and nodes -- shape and size factors help distinguish commercial from industrial user --; parks, cemeteries and golf courses -- these open space features are most visible on the October 21 scene composited of bands 4, 5 and negative 7.

Urban Ecology: The previous overlays help sort out the urban ecology of the City. The distribution of open spaces, commercial and industrial areas above with textured difference in the urban pattern define the central city areas. Health concentration of urban vegetation defines high quality single family housing areas. These observations have been corroborated by a number of speakers during the last couple of days. Where we appear to have made more specific advance in an analysis of a complex urban area is in the further sub-classification and delineation of intra-city structural patterns of what will be characterized here as intensities of cover-use. The problem we have addressed to is that defined by Mr. James Wray during the second of his two papers -- dealing with the Washington, D. C. metropolitan area over the last decade and half.

Concurrently with the classical photointerpretation, machine analyses utilizing the GEMS have provided greatly enhanced urban analysis capability. An initial experiment involved the measurement of the intensity of red band in a color composite image (8-28-72). The results were displayed for each quartile of histogram distribution of the red intensities. Use of a 35 mm camera and projector -- in Valley Forge and Los Angeles, respectively! -- enabled us after much painstaking and patient tracking and matching to bring this ERTS-GEMS output slide to overlay onto a current land use map of scale 1:24,000 which is our operating scale for general planning work. A careful examination of the underlaid 1:24,000 scale current land use map indicates that the very exciting result is actually a measure of use intensity--a new data item directly obtainable from ERTS and highly significant in urban policy making and implementation. Moreover, these analyses have brought out areas that may be inaccurately depicted on our current land use map (scale 1:24,000).

The next series of experiments utilize the GEMS interactive multispectral signature acquisition/classification techniques to extract various land coverage classes from ERTS color transparencies. Four and seven theme analyses were performed on ERTS image 8-28-72 (scene 1036-18010), bands 4, 5, 7. The four and seven theme results are shown in Figures 4 and 5 respectively

The seven theme map gives a broad and meaningful ecological pattern of the most complex area of central Los Angeles. It separates areas east of the Alameda Street - San Fernando Road corridor from those to the west. It broadly separates the west side low income area from the middle income area. East of Alameda, two other middle income areas (one basically suburban) are broken out. Also major industrial and commercial districts and nodes as well as individual plants are factored out. Major open spaces are recognized as well as several dozen major street alignments defined. The texture (grain) of the urban pattern is greatly discernable. Finally, the color pattern functions like a "contour map" to give strength to edges and boundaries in the ERTS scene.

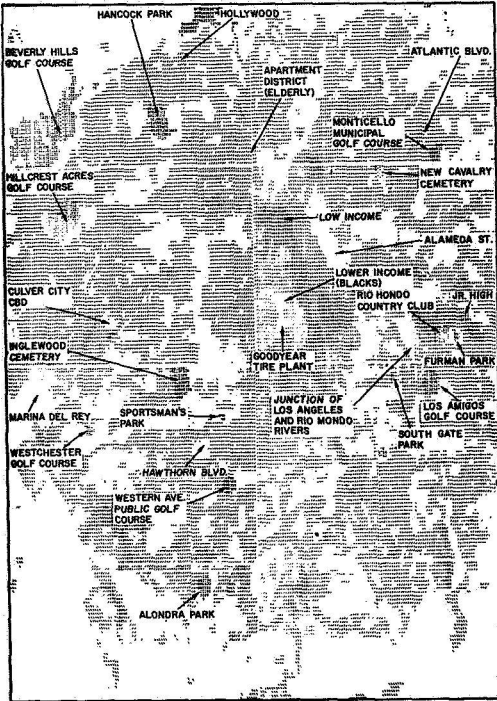


FIGURE 4 Four Theme Computer Printout from GEMS of Central Los Angeles, portion of the scene from Figure 3 above .

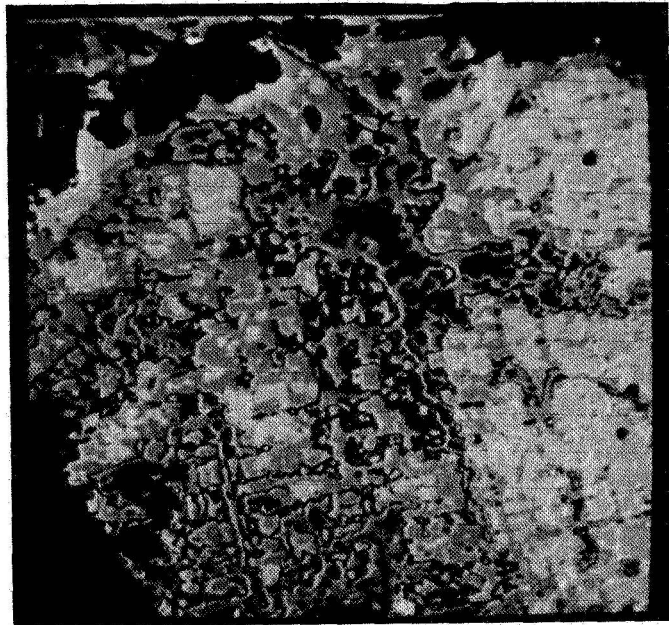


FIGURE 5 Seven Theme TV Display Picture off GEMS Screen from Scene E 1036-18010 at minimum zoom, viewing area same as in Figure 4.

This multiple theme presentation offers the potential for exciting urban design capabilities as well as providing the elements of a general design plan. This would be an absolutely new application of ERTS imagery. Even aircraft imagery is seldom applied to this use.

Preliminary GEMS histogram analyses of the Central LA Core indicates that land coverage can be segregated via GEMS into as many as 12 themes using ERTS color transparencies as inputs. With the completion of the new all digital GEMS/IMAGE 100 in July of this year, ERTS 4 channel digital data can be processed directly -- yielding significantly more land cover segregations. This better theme definition should provide even more effective information to the County of Los Angeles Regional Planning Commission.

A wide range of planning applications are presented above. There is rapidly growing interest expressed in ERTS-GEMS results being obtained by COLARPC by a variety of secondary users. The county geologist has strongly endorsed the use of ERTS for geological analysis. The county forest and fire warden has suggested establishment of a test sub-site and has made a helicopter available to project personnel on 3 occasions just since January 1, having had a first look at the ERTS imagery on hand. Personnel from the agricultural commission have verified the imagery and have repeatedly furnished ground truth. Outside the County, the Los Angeles City Department of Water and Power and the California State Water Resources Board personnel have furnished the surface water acreages as ground truth based on their routine capacity curve measurements of the surface acreages.

Presentations have been made to:

1. Los Angeles County Association of Planning Officials;
2. Southern California Association of Governments (SCAG) technical staff;
3. Land Use Committee of the Citizen Planning Council;
4. Land Use Committee of the County General Plan Policy Review Board (GPPRB);
5. Conservation and Open Space Committee of GPPRB.

A presentation is scheduled on March 12 to the GPPRB - 17 major county department chiefs. Presentations have been requested by:

1. SCAG,
2. City of Los Angeles Planning Department.

The County Parks Department wants to learn if ERTS-GEMS can monitor the condition of the larger parks.

There have been several requests to use ERTS imagery in publications.

3. CONCLUSIONS

Initial results show that data from ERTS imagery can be of immense benefit in the field of urban and regional planning. The impact of natural and man-made disasters can be determined timely and inexpensively.

Data on seasonal changes is available from a single source. The extent, direction and rate of urban growth can be effectively monitored. Generalized land use can be obtained at low cost and rapidly. Information on intensity of land use and urban form, neglected subjects in many planning operations, are readily available from ERTS imagery.

A range of exciting opportunities are opened up in the field of comparative urban studies. ERTS imagery will be widely useful in regional environmental impact analyses. Further analyses of ERTS imagery are certain to extend and deepen the benefits to primary users-investigators such as the County of Los Angeles Regional Planning Commission.