LAND USE AND MAPPING

John Hanson Room

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CARTOGRAPHIC QUALITY OF ERTS-1 IMAGES

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ABSTRACT

In order to establish the potential of an imaging system for cartographic applications related to studies of the earth's resources, reasonable standards of image quality must be known. Although the two imaging systems employed for ERTS-1, the return-beam vidicon (RBV) and multispectral scanner (MSS), have produced images of excellent apparent quality, it has not yet been established that adequate levels of detail have been recorded for cartographic tasks nor has the measurability of small detail been determined.

Since the minimum size of recorded detail and the limits of measurability will influence the types of cartographic products that can be produced from ERTS images, a study was conducted to determine image quality values meaningful to the earth scientist/cartographer. Both simulated and operational images were analyzed and values determined for several parameters including ground-resolution, and the detectability and measurability of image detail. These values are discussed in relation to the requirements for preparing various types of cartographic products, including thematic, topographic and photo-maps.

PROGRESS IN CARTOGRAPHY, EROS PROGRAM

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ABSTRACT

With ERTS-1 in orbit, the cartographic potential of such a system demands critical and constant evaluation. Image quality and geometric properties of the imagery are being analyzed. The production of sample cartographic products and a careful evaluation of user reaction are also involved. Although ERTS-1 is an experimental satellite, its imagery is being applied towards such operations as the production of orthophotoquad coverage of the U.S. For the first time in history mapmakers now have the source material from which image (photo) maps of small scale can be produced efficiently and accurately.

Two types of products are involved, those formatted by the image and those formatted by a standard quadrangle or a state. In both cases scales of 1:250,000, 1:500,000 and 1:1,000,000 are being tested. On such products a reference (UTM)* grid is being added and the products are evaluated for accuracy. Examples of image maps derived from ERTS are expected to be placed on public sale in the near future.

*Universal Transverse Mercator

CHANGE IN LAND USE IN THE PHOENIX (1:250,000) QUADRANGLE, ARIZONA BETWEEN 1970 AND 1972: SUCCESSFUL USE OF A PROPOSED LAND USE CLASSIFICATION SYSTEM

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ABSTRACT

Changes in land use in the Phoenix (1:250,000 scale) Quadrangle in Arizona have been mapped using only the images from ERTS-1, tending to verify the utility of a land use classification system proposed for use with ERTS images. The period of change investigated was from November 1970 to late summer or early fall, 1972. Seasonal changes also were studied using successive ERTS images. Types of image enhancement equipment used included a color additive viewer, a twenty-power magnifier, a density slicer, and a diazo copy machine for making ERTS color composites in hard copy. Types of changes detected have been: (a) cropland or rangeland developed for new residential areas; (b) rangeland converted to new cropland; and (c) possible new areas of industrial or commerical development. A map of land use previously compiled from air photos was updated in this manner.

This information on changes can be of value to planners and resource managers at Federal, state, and regional levels, in monitoring environmental change and in developing resources in broad regions of the United States. Planners need land use maps as an early step in planning both in the Governmental and private sectors. Managers utilize successive maps of land use to monitor change in the physical and man-made environment. The ERTS images focused attention on those areas of greatest change requiring more intensive study.

Intended for presentation at the ERTS-1 Review, NASA Goddard Space Flight Center, March 5-9, 1973.

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

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ABSTRACT

Evaluation of land use features from ERTS-1 imagery in the Central Coastal and Central Valley Test Sites, California, has concentrated on determining the feasibility of ERTS as a data source of 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 the diverse environmental and cultural settings constituting these test areas. More specifically, cultural features under 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 were used to evaluate specific land use information potential of ERTS data for these diverse environments. For each ERTS-1 frames utilized, each individual MSS band (Channels 4-7) was evaluated for potential information content and feasibility for land use studies.

With respect to the specific land use studies which the Geography Remote Sensing Unit has conducted in the Central Regional 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.

LAND USE IN THE NORTHERN COACHELLA VALLEY

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ABSTRACT

ERTS-1 imagery has proved to have great utility for monitoring land use change and as a data source for regional planning. In California, open space desert resources are under severe pressure to serve as a source for recreational gratification to individuals living in the heavily populated southern coastal plain. Concern for these sensitive arid environments has been expressed by both federal and state agencies. The northern half of the Coachella Valley has historically served as a focal point for weekend recreational activity and second homes. Since demand in this area has remained high, land use change from rural to urban residential has been occurring continuously since 1968. This area of rapid change is an ideal site to illustrate the utility of satellite imagery as a data source for planning information, and has served as the areal focus of this investigation.

Specific sites include the resort community of Palm Springs and an unincorporated part of the Coachella Valley to the southeast. Base information for change comparisons are provided by work previously done in the Valley in 1966 and 1969. The classification system used is an adaptation of the one used in 1966 to map the entire Valley.

Mapping was accomplished using 70 mm ERTS-1 positive black and white multispectral transparencies of bands 4, 5, and 7. False color infrared representations were then reconstructed using the transparencies and an I^2S Mini-Addcol Additive Color Viewer. Then 35 mm slides of these recombined ERTS-1 images were copied as enlarged positives or projected at an approximate scale of 1:62,500 for interpretation. Resolution on the best image extends to 80 acre (1/8) sections. Better resolution occurs where intense signatures associated with specific uses are found in isolated portions of the Valley.

Obvious potential for applications lie in the realm of land use change monitoring to aid resource management decisions. More useful, perhaps is the regional perspective provided by the individual ERTS-1 image, and the utility of this perspective as a regional tool. The indicators in the Coachella Valley show not only a serious loss of open space, but also a concentration of land use change and environmental impact along the northwest southeast axis of the Valley in an area dominated by blow sand. Implications of such determinations for studies required by federal and state legislation concerning environmental impacts are more than apparent.

LAND USE CLASSIFICATION AND CHANGE ANALYSIS USING ERTS-1 IMAGERY IN CARETS

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ABSTRACT

ERTS-1 imagery of the Norfolk-Portsmouth Standard Metropolitan Statistical Area, a test site within the U.S. Geological Survey CARETS demonstration project, was analyzed for discrimination of land use classes and change analysis. The land use detail obtainable from ERTS exceeds the expectations of the Interagency Steering Committee and the USGS proposed standardized land use classification, which developed Level I categories thought suitable for use with ERTS data and Level II categories for use with high altitude aircraft data. Using that classification scheme, it was found that even some Level III land use categories can be identified and mapped with ERTS data. A proposed extension of the land use classification as applied to the CARETS region is presented, along with a plea that all ERTS land use investigators cooperate in describing and mapping land use so that standards for verification and exchange of land use data can be developed. Significant land use changes that took place in the Norfolk-Portsmouth test site since the time of the 1970 CARETS data base were identified and mapped using a combination of procedures employing ERTS and high altitude aircraft underflight data.

Intended for presentation at the ERTS-1 Review, NASA Goddard Space Flight Center, March 5-9, 1973.

ERTS REGIONAL-SCALE OVERVIEW LINKING LAND USE AND ENVIRONMENTAL PROCESSES IN CARETS

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ABSTRACT

A mosaic of ERTS images of the CARETS region has been used to partition the region into zones on the basis of similarity of tones and textures visible at a regional-scale overview. The resulting patterns were compared with existing small-scale maps of the region representing relief, land surface forms, geology, soils, vegetation, forest types, and land use. The ERTS-derived zones most closely resemble the patterns on the small-scale land use map, suggesting that, at least in a highly-developed region such as CARETS, "land use" is an indicator or resultant surface expression of several interacting environmental processes. These results lend support to the CARETS model of inter-disciplinary regional analysis, whereby remote sensor-derived data sets on land use and land use change become the basic data entry into a regional information system to serve regional planners and land managers. User retrieval of the land use data is made compatible with correlative information on geology, topography, hydrologic factors, and population and economic data so that the land use patterns can be "calibrated" in terms of their probable environmental impact and their relationships to other factors that the planners must consider in allocating portions of the region to future land use changes. Bringing remote sensor-derived land use information together with the other data sets as required by the analytical and forecasting models of the planners calls for a computer-based geographic information system, which is being provided as part of the CARETS investigation.

The ERTS-derived zones of similarity are hypothesized to be sub-regions of similar land use characteristics; if so, regional-scale ERTS analysis may provide a sampling strategy for selecting sites for more detailed field measurements at a great saving in time and cost over present methods of regional environmental analysis.

Intended for presentation at the ERTS-1 Review, NASA Goddard Space Flight Center, March 5-9, 1973.

EVALUATION OF LAND USE MAPPING FROM ERTS IN THE SHORE ZONE OF CARETS

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ABSTRACT

ERTS imagery of the Atlantic shoreline zone of the Central Atlantic Regional Ecological Test Site (CARETS) was evaluated for classifying land use and land cover employing the USGS Geographic Application Program's land use classification system (Geological Survey Circular 671). It was concluded that ERTS data and this classification system can provide a basis for land cover and land use mapping within the shoreline zone but, because of the dynamic nature of this environment, two additional terms need to be considered for the system: vulnerability of classes to storms and progressive erosion, and sensitivity of the classes to man's activities. A study of undeveloped barrier islands is being conducted to map land cover classes from ERTS imagery and high altitude aircraft imagery. This study is identifying areas of varying environmental sensitivity and vulnerability to extreme events. This information can then be used in land use planning on undeveloped beaches and barrier islands, and it can also be useful in identifying potential problem areas on developed barrier islands.

Intended for presentation at the ERTS-1 Review, NASA Goddard Space Flight Center, March 5-9, 1973.

INVESTIGATIONS USING DATA FROM EARTH RESOURCES TECHNOLOGY SATELLITE IN THE FIELDS OF AGRICULTURE/GEOGRAPHY (TIMBER INVENTORY - LAND USE) IN THE PROVINCE OF HUELVA-SPAIN

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ABSTRACT

A test-site was chosen in the area object of this study, with the purpose of elaborating the patterns for the future total use of the satellite photographs.

The election of the test-site was made having in mind the following criteria.

- A flat terrain for eliminating the dangers of - shadows produced by a difficult topography.
- Searching of well defined natural limits for - the test-site.

The elaboration of a card showing the different uses of the terrain at a 1:100,000 scale, the agrarian structures of the same at a 1:100,000 scale, both purposes as a - reduction of the cartography of the inventory.

The study of the remission curves of the various species and phytological associations, of the soil and the - hydrography of the zone.

Due to the lack of satellite-photographs from the study-area, a number of photos from the northern area of Spain have been studied, these from the point of view of - obtaining answers from the spectra of the vegetation masses.

GEOGRAPHIC APPLICATIONS OF ERTS-1 DATA TO LANDSCAPE CHANGE

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ABSTRACT

The ERTS–1 capabilities of sensing the same geographic point every 18 days and providing a 13,225 square mile view from each image has challenged us to the task of analyzing landscape change from a regional perspective. The investigation focuses on the East Tennessee Test Site, a 20,000 square mile region in which landscape change elements such as forest alterations, strip mines, urban–suburban growth and cyclic seasonal changes in agricultural land-use are being analyzed. Specifically, microdensitometric and computer techniques are being used to analyze the ERTS imagery for gray tone signatures, comparisons, and ultimately for landscape change detection and monitoring. Applications toward earth resources management problems involve the generation of enhanced ERTS imagery for emphasizing areas of potential and current landscape dynamics. In this regard, three photomorphic regions are examined: (1) surface moisture on the windward slopes of the Great Smoky Mountains; (2) settlement and agriculture lands in the Ridge and Valley Province; and (3) surface mining signatures on the Cumberland Plateau.

IDENTIFICATION OF SOIL ASSOCIATIONS IN SOUTH DAKOTA ON ERTS A IMAGERY

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ABSTRACT

Soil association maps show the spatial relationships of land units having characteristic soil depth and textures, cation exchange capacities, organic matter contents, plasticity indices, liquid limits, and the like, from which broad interpretations can be made such as land use capabilities, range stocking rates, crop production capabilities, suitability for irrigation, suitability for septic tank absorption fields, and suitability for dwellings. Film color composites of bands 4, 5, and 7 viewed over a light table with magnification show the soil associations of western South Dakota that are now recognized, and, in addition several new soil association areas have been brought to light. Finally, ERTS images show the actual size and configuration of soil associations like badlands and alluvial plains. Acreages can be determined for soil associations using the planimeter feature of the Spatial Data equipment.

LAND USE OF NORTHERN MEGALOPOLIS

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ABSTRACT

At the first-look seminar last September we presented a preliminary urban-type land use map of the State of Rhode Island, and concluded that the project objective (mapping and subsequently analyzing the land use of the northern third of Megalopolis) was feasible, provided timely cloud-free coverage became available. Progress during the ensuing five months has confirmed that conclusion. Orbits in mid-October produced essentially cloud-free imagery and these became available in proper form to begin mapping on 9 January 1973.

Working basically with CIR composite transparencies, and with occasional reference to MSS band 5 images, a land use legend has been derived which is in accord with the guidelines set down by the Department of Interior. It includes 11 categories rather than the eight used in the Rhode Island map of September 1972. The seven non-builtup categories are being recorded with considerable accuracy, and will be aided by the availability of redundant, multiseasonal ERTS coverage as this becomes available. The four built-up categories are more difficult to discriminate, with the residential categories providing the greatest degree of difficulty. In areas where high-altitude aircraft coverage is available the degree of mapping accuracy is improved and the need for field checking virtually eliminated.

Speed has dropped slightly from that cited earlier for the preliminary Rhode Island map, but it appears that cost efficiency of land use mapping with ERTS is an order of magnitude greater than that based on conventional aircraft mapping methods. Thus although individual metropolitan areas or small intra-state county groups formerly were the major units for land use mapping and analysis, the basic evaluation units now can become, and almost certainly will become, states, groups of states, and megalopolitan clusters.

REMOTE SENSING APPLIED TO LAND-USE STUDIES IN WYOMING

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ABSTRACT

Impending development of Wyoming's vast fuel resources requires a quick and efficient method of land-use inventory and evaluation. Presently, little or no land-use information or cartographic control is available for many areas of concern. Proper control of development depends upon land-use and physiographic information representing all aspects of the affected area, including agricultural and urban development, natural vegetation, hydrology geology, topography, and mineral resources development. Preliminary evaluations of ERTS–1 imagery have shown that physiographic and land-use inventory maps can be compiled using a combination of visual and automated interpretation techniques.

Test studies in the Powder River Basin showed that ERTS image interpretations can provide much of the needed physiographic and land-use information. Water impoundments as small as one acre were detected and water bodies larger than five acres could be mapped and their acreage estimated. Flood plains and irrigated lands were successfully mapped, and some individual crops were identified and mapped. Coniferous and deciduous trees were mapped separately using color additive analysis on the ERTS multispectral imagery. Gross soil distinctions were made with the ERTS imagery, and were found to be closely related to the bedrock geology. Several broad unstable areas were identified. These were related to specific geologic and slope conditions and generally extended through large regions. Some new oil fields and all large open-cut coal mines were mapped.

The most difficult task accomplished was that of mapping urban areas. Most Wyoming towns are surrounded by agricultural land, natural flood plains, and/or rangeland. With these widely varying settings, the populated areas are often difficult or impossible to delineate by visual photointerpretation techniques. Densitometry proved to be of considerable aid in making the subtle distinctions necessary in urban mapping. Four-color isodensitracings were made for each of the four ERTS-MS bands. Interpretation of these isodensitracings permitted accurate mapping of the populated area, and usually allowed segregation of new and old residential, industrial, commercial and business, and open segments within the towns. Larger features such as airstrips, factories, schools, golf courses, parks and cemeteries were mappable as individual installations but most could not be identified.

Areas of new development can usually be defined, allowing a capability for change detection and updating of obsolete maps. Snow-cover provides a considerable degree of enhancement of the urban areas by increasing the contrast between the populated areas and the surrounding country. Work in the Laramie area provides a striking example of this snow-enhancement and the detail available from a snow-enhanced image.

ERTS-1 APPLICATIONS TO MINNESOTA LAND USE MAPPING

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ABSTRACT

State wide information on land use in Minnesota is presently available for 9 classes of land use. Agencies having responsibilities in land management and planning at various levels in the state will soon be faced with managing their operations within the framework of a statewide land use plan. ERTS-1 imagery is being examined as a tool to update the needed land use data and to develop operational definitions for subclasses that better fit the data users in the field and in the office. Class definitions and subclasses are being developed for forest, urban, extractive, and wetlands, with the assistance and cooperation of personnel from several state, regional and local federal agencies working within the state and the University of Minnesota. Other classes of land use await adequate seasonal or quality of coverage and are only discussed briefly.

Using a variety of bulk and processed products of late summer and autumn imagery, several general statements about the ability to define classes can be made. It seems feasible to subdivide the forest category into deciduous/nondeciduous and further into density groups and upland and lowland types. The two urban classes as defined in the state data system are neither suitable for use with ERTS imagery nor are they useful for metropolitan planning. Using ERTS imagery, it seems feasible to subdivide three subclasses of commercial/industrial land, two or three subclasses of residential and one or more classes of urban open space. Based on a sample of 5184 forty acre cells in N. W. Minnesota, wetlands were overpredicted by 18% and water by 8%. This was based on poorly registered 1:250,000 EROS color prints of July 29 coverage which followed a two week period of very heavy rains. Subsequent bulk image analysis indicates that possibly three or more classes of wetlands in the big bog area can be detected. Upon examination of eight townships in the Mesabi Range area it is possible to separate extractive land use into dry pits, wet pits, tailing piles, tailing ponds, and at least in this area separate the gravel from the iron/taconite operations. Accuracy of measurement of extractive features varies directly with size and indirectly with age.

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A MULTIDISCIPLINARY SURVEYS FOR THE MANAGEMENT OF ALASKAN RESOURCES UTILIZING ERTS IMAGERY

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ABSTRACT

The ERTS program provides an opportunity to narrow an environmental knowledge gap which impedes planning at a critical time in one of the richest, yet most underdeveloped, regions in the United States - Alaska. ERTS-1 data have been applied to a coordinate multidisciplinary survey which have the overriding purpose to provide updated resource inventory data to land use planning groups and government agencies concerned with resource management. Of particular emphasis in this survey are vegetative, hydrological and geological analyses of the proposed trans-Alaska transportation corridor, and lands to be selected by the State of Alaska, the native corporations, and the Department of Interior. Our preliminary analyses are demonstrating that ERTS data are satisfying these objectives on a regional scale.

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THE USE OF ERTS-1 DATA FOR THE INVENTORY OF CRITICAL LAND RESOURCES FOR REGIONAL LAND USE PLANNING

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ABSTRACT

The State of Wisconsin has embarked upon a Critical Resources Information Program (CRIP) aimed at establishing the definition, units of measurement, inventory, and monitoring of the critical natural and cultural spatial resource elements which are essential to a balanced economic, cultural, and ecological environment in Wisconsin. The CRIP program is to be coordinated with the Wisconsin Land Use Information System (WLUIS) development program which was initiated in 1972. Both programs will require the input of vast amounts of land resource data in a variety of formats.

There are many applications of the use of ERTS data for statewide critical land resources planning and management. Potential applications include: (1) detection and inventory of critical land resources; (2) the input of additional resource data, such as phenological data, into statewide land use information systems; and (3) the monitoring of statewide land resources, with special emphasis on the detection of pending environmental impacts.

This ERTS-1 project deals with the use of ERTS data for the regional land use planning process and, therefore, deals with certain critical land resource data. This paper presents an example of the use of ERTS imagery to inventory one critical resource - "wetlands." There are many other critical resources being inventoried using the process described here. Wetlands data extracted from both ERTS imagery and 1:120,000 scale color infrared photographs (RB-57) are compared with the best existing wetlands data (a 1930's vegetation map) for a test site in eastern Wisconsin. Data are compared using spatial computer printout format and also computer-generated statistical crosstabulations of data. Illustrations covering the test site include an ERTS image, a b/w copy of a color infrared photograph, the 1930's vegetation map, and the USGS topographic map.

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INVESTIGATION OF AN URBAN AREA AND ITS LOCALE USING ERTS-1 DATA SUPPORTED BY U-2 PHOTOGRAPHY

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ABSTRACT

An urban area in central Pennsylvania and the surrounding locality were investigated separately at first by photointerpretation of ERTS-1 imagery and by computer processing of MSS tapes. Each of these independent approachs had shortcomings. Next the photo-interpretation and processing were coordinated. The results of the cooperative effort of photointerpreters and computer processing analysts were much improved over independent efforts. It was found that single frames of U-2 photography could be projected onto printer output maps with little recognizable distortion in areas 10 to 25 cm square. In this way targets could be identified for computer processing training areas for signature identification. In addition, at any stage of category mapping, the level of success in correct classification could be assessed by this method. Between 10 and 20 signatures and identifiable targets have been found from ERTS-1 data ranging from metropolitan to open land. Other features have been recognized, such as bridges, but signatures for these have not been found. The results of the classification of the study area will be discussed.

'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 of ERTS coverage, available for the first time to LA County planners, has permitted (a) preparation of inputs to the LA urban growth regulation process derived from direct visualization and mapping of the spatial extent of urban development intensity, and (b) redefinition of new subregion delineations (which were previously abstracted from many data sources) based on direct observation of the macrophysiography of the region.

Photointerpretation of ERTS images has produced 1:1,000,000 image overlays depicting 177 selected topographic features, 250 streams, 26 parks, 51 golf courses, 60 grading sites, 24 cemeteries and several hundred other linear and areal features.

GEMS analysis of the ERTS products has provided new or improved information in the following planning data categories: Urban Vegetation; Land Cover Segregation; Manmade and Natural Impact Monitoring; Urban Design; Land Suitability. This information is not only directly useful for the indicated planning functions but also is key to obtaining current and synoptic information about the condition of urban development and urban ecology of the LA area.

An ERTS image, 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!

It has been shown that ERTS data allows planners to establish trends that directly impact planning policies. For example, detectable grading and new construction sites are efficient quantitative indicators of the rate of consumption of undeveloped land which enable planners to forecast future demand and growth patterns for urban land on a regional scale.

The results to date have immediate utility: direct inputs are being provided to the County Comprehensive General Plan required by California law and to the County Land Use Plan and Urban Design Program. In conclusion, it has been found that ERTS data produces information never before available to planners. This new source of information will not only assist current methods to be more efficient, but permits entirely new planning methodologies to be employed.

PREPARATION OF URBAN LAND USE INVENTORIES BY MACHINE-PROCESSING OF ERTS MSS DATA

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ABSTRACT

ERTS-1 MSS digital data were analyzed to classify Milwaukee County, Wisconsin into several broad land use classes. Computer-implemented pattern recognition programs were used to obtain the following spectrally separable classes: "road-central business district", "grass" (green vegetation), "suburban", "wooded suburb", "heavy industry", "inner city", and "water". Small samples from each of these classes of earth surface phenomena were used to train the computer to recognize and separate these features throughout Milwaukee County. The class "inner city" correlated with the areal extent of multiple-family housing, most of which was constructed prior to World War II. "Suburban" corresponded with the post World War II, single-family residences. Older, upper income areas were usually classified as "wooded suburb".

To test the classification scheme developed, the Milwaukee statistics were used to classify the Chicago metropolitan area within the same ERTS frame. The classification results were nearly as accurate as those obtained for Milwaukee. In another ERTS frame, similar spectral classes were obtained for Marion County (Indianapolis), Indiana.

Supplementing and supporting the analysis results from the ERTS MSS data were classification results from data obtained with an airborne multispectral scanner at an altitude of 650m along the West Fork of the White River in Indianapolis. The eight spectral classes obtained from the analysis of data from this 12-channel scanner included "rooftop", "road", "trees", "fine grass", "coarse grass", "water", "bare soil", and "shadow".

The automatic classification of urban/suburban phenomena permits timely monitoring of land use changes in metropolitan areas. Continuous operation of aerosapce remote sensing systems will provide periodic updating of land use inventories. Seasonal variations in the spectral characteristics of earth surface features may allow refinements of an successively better land use classifications. The urban and regional planner should welcome such inputs into his sytem.

A COMPARISON OF LAND-USE DETERMINATIONS USING DATA FROM ERTS-1 AND HIGH ALTITUDE AIRCRAFT

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ABSTRACT

A manual image interpretation of ERTS-1 MSS bulk imagery has been performed on a study area within the Houston Area Test Site (HATS) to classify land-use using the Level I categories described by Anderson. The two types of imagery used included (1) black and white transparencies of each band of the imagery (ID No. 1073-16244) enlarged to a scale of 1:250,000 and (2) simulated color IR transparencies composited from bands 4, 5, and 7 of the computer compatible tapes using a multispectral analysis ground data station. The results of this interpretation have been compared with the 1970 land-use inventory of HATS which was compiled using color ektachrome imagery from high altitude aircraft (scale approximately 1:120,000).

Data from the same scene was analyzed using an unsupervised computerized clustering technique. The clustering technique utilized, ISODATA, partitioned the numbers representing the measured reflectance of each resolution cell in a four-dimensional space. The resulting clusters were analyzed and compared with existing land use patterns in Houston.

DIGITAL LAND USE MAPPING IN OAKLAND COUNTY, MICHIGAN

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ABSTRACT

The objective of this investigation (MMC # 086) is to use and evaluate ERTS-1 data in continuing studies of land use in and surrounding Oakland County. Major emphasis is being placed on computer processing of MSS imagery to observe and map a number of fundamental factors which determine the suitability of land for recreational use or open space. Mapping of woodlands, wetlands, water bodies, shorelines, and built up areas is of interest in this investigation. Although the development of digital computer methods of land use mapping is concentrated on test sites in Oakland County, it is expected that the developed methods will eventually be used for studies of regional scope.

Initial efforts in this investigation were concentrated on the processing of ERTS-1 coverage obtained on September 28, 1972 (Observation ID 1067-15643). The usefulness of this frame is limited by partial cloud cover, but at least some sections of Oakland County are cloud-free and usable. For initial study an area was selected containing Pontiac Lake and the Pontiac Lake State Recreation Area.

Preliminary steps in the data analysis were concentrated on preparing digital computer printout of gray maps prepared by level-slicing individual bands of the MSS data. Level slicing of Band 7 provided good discrimination of water surfaces. Band 5 provided additional detail for vegetated areas and built up areas. These printouts were used to recognize major surface features, such as lakes and wooded areas. Training sets were then selected for use in recognition mapping. Nine training sets were used representing water surfaces, residential areas, and wooded areas. This first recognition map recognized about 85% of the total area studied. The unrecognized areas consisted primarily of water and urban areas. The recognition map resulting from this first effort has been evaluated as a basis for planning additional computer analysis and mapping of surface features.

MAPPING OF AGRICULTURAL LAND USE FROM ERTS-1 DIGITAL DATA

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ABSTRACT

A study area was selected in Lancaster and Lebanon Counties, two of the major agricultural counties in Pennsylvania. This area was delineated on positive transparencies of MSS data collected on October 11, 1972 (1080 - 15185). Channel seven was used to delineate general land forms, drainage patterns, water, and urban areas. Channel five was used to delineate highway networks. These identifiable features were useful aids for locating areas on the computer output.

Computer generated brightness maps were used to delineate broad land use categories, such as forest land, agricultural land, urban areas and water. Attempts are being made to produce a type of soil association map of bare soil areas using computer classification techniques. These digital maps have a scale of approximately 1:24,000 thereby allowing direct comparison with U.S.G.S. 7.5 minute quadrangle sheets. Comparisons with soil association maps have also been made through projection techniques.

Data collected by the University of Michigan aircraft and the NASA NC-130B aircraft were used as a form of ground truth useful for the delineation of land use patterns.

THE USE OF THE TEMPORAL DIMENSION IN CLASSIFYING AND MAPPING ERTS-1 MSS DATA

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ABSTRACT

ERTS-1 MSS data from two scenes of the same central Pennsylvania area were brought into registration by translation and then merged. The two scenes were viewed on different dates, but from adjacent ground tracks as frequent cloud cover in Pennsylvania made it impossible to choose two scenes from the same track.

Targets selected to be mapped included river water, railroad yards, creeks, urban areas, industrial areas, and vegetation. Signatures were obtained for these targets by selecting locally uniform training areas and computing the mean signatures. To compensate for possible misregistration, areas were chosen well within larger uniform boundaries. Cluster analyses were used to obtain signatures for targets, such as for a creek, for which no sufficiently large uniform areas could be defined.

Equivalent training areas were chosen from each of the original scenes and from the merged data. Classification maps were produced for each, and a comparison study was made of all three maps. Reasons for greater mapping success using the merged data, along with a discussion on the registration problem, are presented.

IDENTIFICATION AND MAPPING OF COAL REFUSE BANKS AND OTHER TARGETS IN THE ANTHRACITE REGION

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ABSTRACT

An area in central eastern Pennsylvania, which includes parts of the Eastern Middle Coal Field and the Southern Coal Field of the Anthrocate Region, was investigated using ERTS-1 MSS data collected October 11, 1972, The objective was to determine how well accumulations of coal refuse and associated targets could be identified and mapped by computer analysis and processing.

Three major kinds of coal refuse targets exist - culm piles, silt piles, and silt sedimentation basins. These targets are predominantly black to the eye. They were found to have spectral signatures which had relative reflectances in channels four through seven in the order of 4>>5>6>>7 with channel seven having slightly higher reflectance than water targets.

Correlation of the placement of the coal refuse targets with an existing map of their locations was made. At this time no underflight photography was at hand with which to judge the mapping success. Correlation was made with 1:24,000 scale USGS maps dated 1947 and 1948. The mapping results are discussed as well as the changes which have taken place since 1948.

Other targets of interest in the area which could be identified by signatures were an upland swamp, water impoundments, communities, bare land related to strip mining for coal, and vegetation. Traces could be recognized for two-lane and wider highways, multiple-track railway right-of-ways, and a gas line right-of-way.

Paper L 25

AUTOMATIC LAND USE CLASSIFICATION IN MINNESOTA

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ABSTRACT

Automatic classification of land use from ERTS data provides both inventory and change information. Initial results show achievable classification accuracies from multispectral data. An application to water inventory is illustrated.

LAND RESOURCES SURVEY FOR THE STATE OF MICHIGAN

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ABSTRACT

This study, funded by the State Planning Division, is designed to document the usefulness of ERTS-1 satellite imagery as an information source for a statewide inventory of Michigan's land resources. The project is currently relying on photointerpretation of MSS photography although some computer processed results are now available for evaluation.

The first task of the project was a review of existing materials which could be used to map land use/land resources on a statewide basis. The goal was originally five categories: urban, forest, water, agriculture and other. However, there was only sufficient materials to map four categories: urban, forest, water, and agriculture and other (combined). The finished land use map, then, represents the most current information depicting statewide land uses and resources.

We are in the process of improving upon this map and the ERTS-1 satellite imagery offers a data source that is both temporally and spatially uniform. It is this characteristic that now makes such large area inventories possible.

Examples of photointerpreted results and computer processed results are now being assembled to expand both the number of categories and accuracy of our current inventory.

TERRAIN CLASSIFICATION MAPS OF YELLOWSTONE NATIONAL PARK

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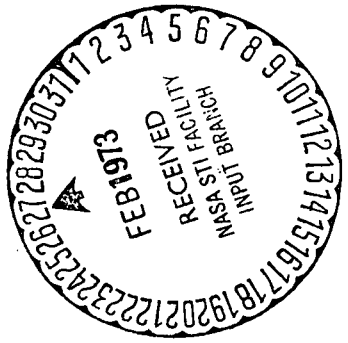
ABSTRACT

A cooperative ERTS-1 investigation involving U.S. Geological Survey, National Park Service, and Environmental Research Institute of Michigan (ERIM) personnel has as its goal the preparation of terrain classification maps for the entire Yellowstone National Park. Excellent coverage of the park was obtained on August 6, 1972 (frame 1015-17404).

Preliminary terrain classification maps have been prepared at ERIM by applying multispectral pattern recognition techniques to ERTS-MSS digital taped data. Training sets for the study were selected by Dr. H. Smedes and Mr. Ralph Root (a Colorado State University student assisting Dr. Smedes). The color coded digital terrain maps will be presented and discussed. The discussion will include qualitative and quantitative accuracy estimates and discussion of processing techniques.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