View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Embry-Riddle Aeronautical University

The Space Congress® Proceedings

1974 (11th) Vol.1 Technology Today for Tomorrow

Apr 1st, 8:00 AM

ERTS-1 and Data For National Land Use Planning

James R. Anderson
Chief Geographer, U.S. Geological Survey, Reston, Virginia 22092

Follow this and additional works at: https://commons.erau.edu/space-congress-proceedings

Scholarly Commons Citation

Anderson, James R., "ERTS-1 and Data For National Land Use Planning" (1974). *The Space Congress® Proceedings*. 2.
https://commons.erau.edu/space-congress-proceedings/proceedings-1974-11th-v1/session-3/2

This Event is brought to you for free and open access by the Conferences at Scholarly Commons. It has been accepted for inclusion in The Space Congress® Proceedings by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.

EMBRY-RIDDLE Aeronautical University
SCHOLARLY COMMONS

ERTS-1 and DATA FOR NATIONAL LAND USE PLANNING

James R. Anderson
Chief Geographer
U.S. Geological Survey
Reston, Virginia 22092

ABSTRACT

Many responsible public officials and prominent authorities on land resource planning, decision making, and management have stressed the need for more information about existing land use. To be most useful such information must be timely and it must be kept current. An Earth Resources Technology Satellite can provide such information at a relatively generalized level of presentation on a repetitive basis.

Experiments related to the acquisition of land use data being funded by the National Aeronautics and Space Administration have indicated that most of the nine more generalized Level I categories of land use and land cover data can be obtained with sufficient consistency to provide useful data for nationwide planning activities. Both visual interpretation of ERTS-1 imagery and the use of computer compatible tapes have been employed in research projects being carried out in the U.S. Geological Survey and preliminary results are now available.

Further refinements in the use of ERTS-1 data to obtain land use information are needed if such data are to be effectively used in the planning process. Also needed is a better general understanding of what ERTS data can be most appropriately used for among those engaged in national and interstate regional planning activity.

INTRODUCTION

Many responsible public officials and prominent authorities on land resource planning, decision making, and management have stressed the need for more information about existing land use. To be most useful such information must be timely and it must be kept current. An Earth Resources Technology Satellite can provide such information at a relatively generalized level of presentation on a timely repetitive basis.

The growing population of this country coupled with a widening horizon of demands being made on land resources has brought an expanding array of pressures on the available resource base. These pressures have brought conflicts in many parts of the Nation that urgently need attention. Some examples include agricultural production in conflict with real estate development and resulting urbanization; environmental protection versus production of energy to meet increasing demands for power; recreational development versus the use of the land for forestry, grazing, and extractive uses; conservation of coastal areas for recreational uses in the face of needs for more port facilities and shoreline industrial sites; preservation of wetlands for natural wildlife and fisheries habitat in the face of new demands for development of such wetlands for urban uses, agricultural production and other uses.

Marion Clawson, former Director of the Bureau of Land Management, author of numerous books dealing with land resources, and for several years with Resources for the Future, Inc., makes the following statement in the Foreword to a report published in 1965 on Land Use Information: A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity:

> "In this dynamic situation, accurate, meaningful, current data on land use are essential. If public agencies and private organizations are to know what is happening, and are to make sound plans for their own future action, then reliable information is critical."(1)

Pending legislation in the 93rd Congress recognizes the need for Federal participation in the collection of land use data. In Senate Bill 268, Title II, Section 202, the Secretary of the Interior, "Acting through the Office (of Land Use Policy Administration), shall:

> "a) Maintain a continuing study of the land resources of the United States and their use:
>
> b) Cooperate with the States in the development of standard methods and classifications for the collection of land use data and in the establishment of effective procedures for the exchange and dissemination of land use data: ..."(2)

Presently there is no systematic compilation of information on existing land use and its changes on a national basis. For detailed planning at the local level, ground surveys, occasionally supplemented by aerial photography, are used. In some cases, land use information is hypothesized on the basis of data on utility hookups, school population, building permits, and similar information. Transportation planners collect the necessary information using similar techniques. Some states such as Connecticut,(3) New York,(4) and Minnesota(5) have land use information available on maps at scales ranging from 1:24,000 to 1:500,000, but in most cases these states have not been able to update the

land use maps, therefore, they have decreasing utility. Some Federal agencies, such as the Forest Service, Soil Conservation Service, and Bureau of Land Management, collect some land use information, but it is for a specific need and is difficult to adapt to other uses. In 1958, and again in 1967, a National Inventory of Soil and Water Conservation Needs was carried out by the U.S. Soil Conservation Service.(6) The inventories have provided much useful general information about land uses by countries, but since the inventory was based on a two percent sampling of the total area of the United States it is deficient with respect to specific geographic distributions of various land uses.

Some of the major problems with these existing data sources are the lack of consistency, the age of the data, spotty coverage, and the use of incompatible classification systems. The data have been collected on a one-time basis so the data are of marginal utility for other applications. Furthermore, it is nearly impossible to aggregate the available data because of the differing classification systems used.

A step to develop a framework for the meaningful classification of land use on a nationwide basis has been taken by the U.S. Geological Survey. In the Geological Survey Circular 671, "A Land Use Classification System for Use with Remote Sensor Data,"(7) published in October 1972, a land use classification system is proposed for testing and review. (See Table I) This classification system has been developed to meet the needs of Federal and state agencies for an up-to-date overview of land use throughout the country on a basis that is uniform in date, scale, and categorization at the more generalized first and second levels. Remote sensor data will definitely be the most cost effective method of acquiring such land use information. Data from ERTS-1, from high altitude aircraft platforms, and from other sources are available for obtaining land use information. The classification system utilizes the best features of existing widely used classification systems to the extent that they are amenable to use with remote sensing, and it is open-ended so that regional, state, and local agencies may develop more detailed land use classification systems, at third and fourth levels, to meet their particular needs and at the same time remain compatible with the national system. This proposed classification system is being widely tested by various users at the present time. State planning officials, Federal agencies, and interested persons and organizations are also being given an opportunity for discussion and review.

ERTS-1 CAPABILITIES FOR OBTAINING LAND USE DATA

ERTS-1 has the capability of providing the generalized first level of land use categorization as presented in the USGS land use classification system for extensive areas in the United States. Experiments dealing with the interpretation of land use data from ERTS-1 imagery to date have used conventional interpretation techniques employing both black and white imagery from individual bands and color composites combining two or more black and white images (usually bands 4, 5, 7). The results of these experiments indicate generally that Level I categories in the USGS land use classification system can be identified although some difficulties in certain areas have been reported. For example, the differentiation of wetland and rangeland in southeastern Texas as reported by researchers at the NASA Johnson Space Center in Houston. This identification is at a reasonable level of accuracy and probably has sufficient consistency throughout the United States to be useful in preparing a synoptic or generalized overview map of land use at 1:500,000 showing the nine Level I categories of land use at the minimum mapping units appropriate to that scale. In some areas, maps at 1:250,000 can also be prepared with Level I categories with appropriate minimum mapping units.

In addition to the Level I categories, some of the Level II and even some of the Level III type categories have been identified from ERTS-1 imagery. Generally the greatest difficulty occurs in the identification of Level II land uses in the Urban and Built-up areas. The urban uses have been interpreted from imagery at levels of accuracy ranging from 60 to 90 percent, with some Level II categories, such as the separation of "Industrial" and "Commercial" much more difficult to interpret than "Residential" for example. There has also been considerable difficulty in some areas but very little problem in other areas in identifying the boundary between Urban and Built-up Land and Agricultural Land and sometimes Forest Land. Forest-covered suburban subdivisions abutting areas of Forest Land are troublesome. Likewise some kinds of Agricultural Land appear quite similar to Urban and Built-up uses on ERTS-1 imagery.

Several investigators who have worked with both imagery and digital tapes are enthusiastic about the capabilities of using digital data to obtain land use data. Surface features whose spectral differences are not detectable on the imagery may be identified from digital data derived from computer compatible tapes. The use of the digital data permits the classification of each individual data element, which is also referred to as a pixel or picture element that is about 1.1 acres in extent. In general, better results have been obtained by using digital tapes rather than conventional interpretation in urban areas.

A recent Information Note (No. 101573) released by the Laboratory for Applications of Remote Sensing, Purdue University contained a report on the work of Ellefsen, Swain, and Wray in urban land use mapping by machine processing of multispectral data in the San Francisco Bay area. A classification of land use was achieved by grouping 28 spectral classes into 8 categories of land use within the urban part of the scene being used and 3 in the rural sector of the area. The uses identified in the urban areas were: commercial-industrial, mobile homes, residential, (other than mobile homes), parking lots, unimproved bare open space, improved irrigated open space with trees, and water. In the rural sector: grazing and cropland, tree covered land and water areas

were identified. With some modification in terminology these categories correspond fairly well with Level II categories.

The authors have come to the following conclusion at this stage of their work:

> "Results of the experiment to date demonstrate that producing land use maps of a large scale by machine processing of ERTS-1 scanner data is feasible. By keeping land use classes fairly broad, a remarkable level of accuracy is attained despite the relatively coarse resolution and the inherent complexities of man-made cover."(8)

SUMMARY

The synoptic or overview value of ERTS-1 imagery for obtaining land use and related information has been demonstrated. Such a perspective can be a useful tool in national, interstate, and statewide planning activities and perhaps at the sub-state planning level too, particularly in larger states. The repetitive coverage of the ERTS system, which permits land use data to be obtained at different times during the year, is likely to be a useful advantage for regional-type planning activity.

Greater use of digital data from ERTS may open up additional use of ERTS data at the metropolitan and sub-state regional levels of land use planning. Dr. John DeNoyer, Director of the Earth Resources Observation Systems (EROS) Program of the U.S. Department of the Interior, has frequently stated that only about a tenth of the ERTS data is available from the imagery used alone. Thus, further research plus additional computer capability suitable for handling ERTS computer compatible tapes available to users may enhance the use of the ERTS system in the more localized planning situations.

REFERENCES

(1) Clawson, Marion and Charles L. Stewart, 1965, Land Use Information: A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity, Resources for the Future, Inc., 402 p., index.

(2) U.S. Congress, Senate, 1973, Senate Bill 268, 93d Congress, 1st sess., 55 p.

(3) Connecticut, Dept. of Finance and Control, Office of State Planning, 1970, 1970 Land Use Study for Connecticut, unpub. report.

(4) New York, Office of Planning Services, 1972, Land Use and Natural Resource Inventory of New York State, LUNR Classification Manual, Albany, June 1972, 23 p.

(5) Minnesota, Univ. of Minnesota Land Management Information System Study, 1971, State of Minnesota Land Use, 1969, Minnesota Land Management Information System Study Map, prepared under contract with the Minnesota State Planning Agency, scale: 1:500,000.

(6) U.S. Dept. of Agriculture, Basic Statistics: National Inventory of Soil and Water Conservation Needs, 1967, Statistical Bulletin No. 461, Washington, D.C., 211 p.

(7) U.S. Geological Survey, Circular 671, A Land-Use Classification System for Use with Remote-Sensor Data, 1972, Washington, D.C., 16 p., refs.

(8) Ellefsen, R., P.H. Swain, and J.R. Wray, 1973, Urban Land-Use Mapping by Machine Processing of ERTS-1 Multispectral Data: A San Francisco Bay Area Example, Laboratory for Applications of Remote Sensing, Purdue Univ., West Lafayette, LARS Information Note 101573, 22 p., illus.

TABLE I

LAND USE CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA

Level I		Level II	
1	Urban and Built-up Land	01	Residential
		02	Commercial and Services
		03	Industrial
		04	Extractive
		05	Transportation, Communications and Utilities
		06	Institutional
		07	Strip and Clustered Settlement
		08	Mixed
		09	Open and Other
2	Agricultural Land	01	Cropland and Pasture
		02	Orchards, Groves, Bush Fruits, Vineyards, and Horticultural Areas
		03	Feeding Operations
		04	Other
3	Rangeland	01	Grass
		02	Savannas
		03	Chaparral
		04	Desert Shrub
4	Forest Land	01	Deciduous
		02	Evergreen (Coniferous and Other)
		03	Mixed
5	Water	01	Streams and Waterways
		02	Lakes
		03	Reservoirs
		04	Bays and Estuaries
		05	Other
6	Nonforested Wetland	01	Vegetated
		02	Bare
7	Barren Land	01	Salt Flats
		02	Beaches
		03	Sand Other than Beaches
		04	Bare Exposed Rock
		05	Other
8	Tundra	01	Tundra
9	Permanent Snow and Icefields	01	Permanent Snow and Icefields