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THE LAND USE AND LAND COVER DICHOTOMY: A COMPARISON OF TWO LAND CLASSIFICATION SYSTEMS IN SUPPORT OF URBAN EARTH SCIENCE APPLICATIONS

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Introduction

One is likely to read the terms "land use" and "land cover" in the same sentence, yet these concepts have different origins and different applications. Land cover is typically analyzed by earth scientists working with remotely sensed images. Land use is typically studied by urban planners who must prescribe solutions that could prevent future problems. This apparent dichotomy has led to different classification systems for land-based data. The works of earth scientists and urban planning practitioners are beginning to come together in the field of spatial analysis and in their common use of new spatial analysis technology. In this context, the technology can stimulate a common "language" that allows a broader sharing of ideas.

The increasing amount of land use and land cover change challenges the various efforts to classify in ways that are efficient, effective, and agreeable to all groups of users. If land cover and land uses can be identified by remote methods using aerial photography and satellites, then these ways are more efficient than field surveys of the same area. New technology, such as high-resolution satellite sensors, and new methods, such as more refined algorithms for image interpretation, are providing refined data to better identify the actual cover and apparent use of land, thus effectiveness is improved. However, the closer together and the more vertical the land uses are, the more difficult the task of identification is, and the greater is the need to supplement remotely sensed data with field study (in situ). Thus, a number of land classification methods were developed in order to organize the greatly expanding volume of data on land characteristics in ways useful to different groups. This paper distinguishes two land based classification systems, one developed primarily for remotely sensed data, and the other, a more comprehensive system requiring in situ collection methods. The intent is to look at how the two systems developed and how they can work together so that land based information can be shared among different users and compared over time.

Modern Land-Based Classification Lineage

Two streams of land-based classification systems have separate histories based on either an urban or a rural emphasis. The urban stream begins with the Standard Land Use Classification Manual (SLUCM) developed in 1965 through support from the U. S. Urban Renewal Administration, since absorbed into Housing and Urban Development (HUD); and the Bureau of Public Roads, now the Federal Highway Administration (FHwA). It was designed for land use analysis, typically done by urban planners. A direct descendent of SLUCM is the Land Based Classification System (LBCS) designed by the American Planning Association (APA) under research supported by six federal agencies.

The rural stream begins in 1971 with Anderson and others [2], working for the U. S. Geological Survey (USGS). Other agencies supporting this system were the National Aeronautics and Space Administration (NASA), the Soil Conservation Service (SCS), and two professional organizations, the Association of American Geographers (AAG) and the International Geographical Union (IGU). Anderson observed that SLUCM contained eight of its nine classes for urban land types, while only five per cent of the country's land at that time was urban [2]. To study rural lands, the Anderson team developed a new system where Level I (most generalized scale) contained one urban class and eight rural classes. This effort in the 1970s established a land use and land cover (LULC) classification system for remotely sensed data at a time when the digitizing of spatial data was just emerging. The Anderson system was initially designed for land cover analysis for a new nationwide digital mapping of LULC based on high altitude photography at a scale of 1:250,000. A survey of users of land use and land cover data by the USGS in 1992 found that the Anderson system was the most commonly used classification (approximately 25 per cent of the respondents) [1].

Figure 1 gives some insight into the derivation of the major national land-based classification systems and their federal agency involvement. Not surprisingly, urban oriented agencies seem to favor the LBCS and its derivative systems. Joining FHwA and HUD are the Federal Aviation Administration (FAA), the Bureau of Transportation Statistics (BTS), Federal Emergency Management Agency (FEMA), and the Air Force. In addition, national classification systems have mostly evolved, indicated by lines, rather than developed anew. The North American Industry Classification System (NAICS), used by the Census Bureau to organize data collected by its economic censuses every five years, is a specialized classification system. NAICS is also used to monitor the North American Free Trade Agreement. Nevertheless, both the Anderson system and LBCS, the completely redesigned version of SLUCM, should dominate their respective areas of emphasis because of their comprehensive design.

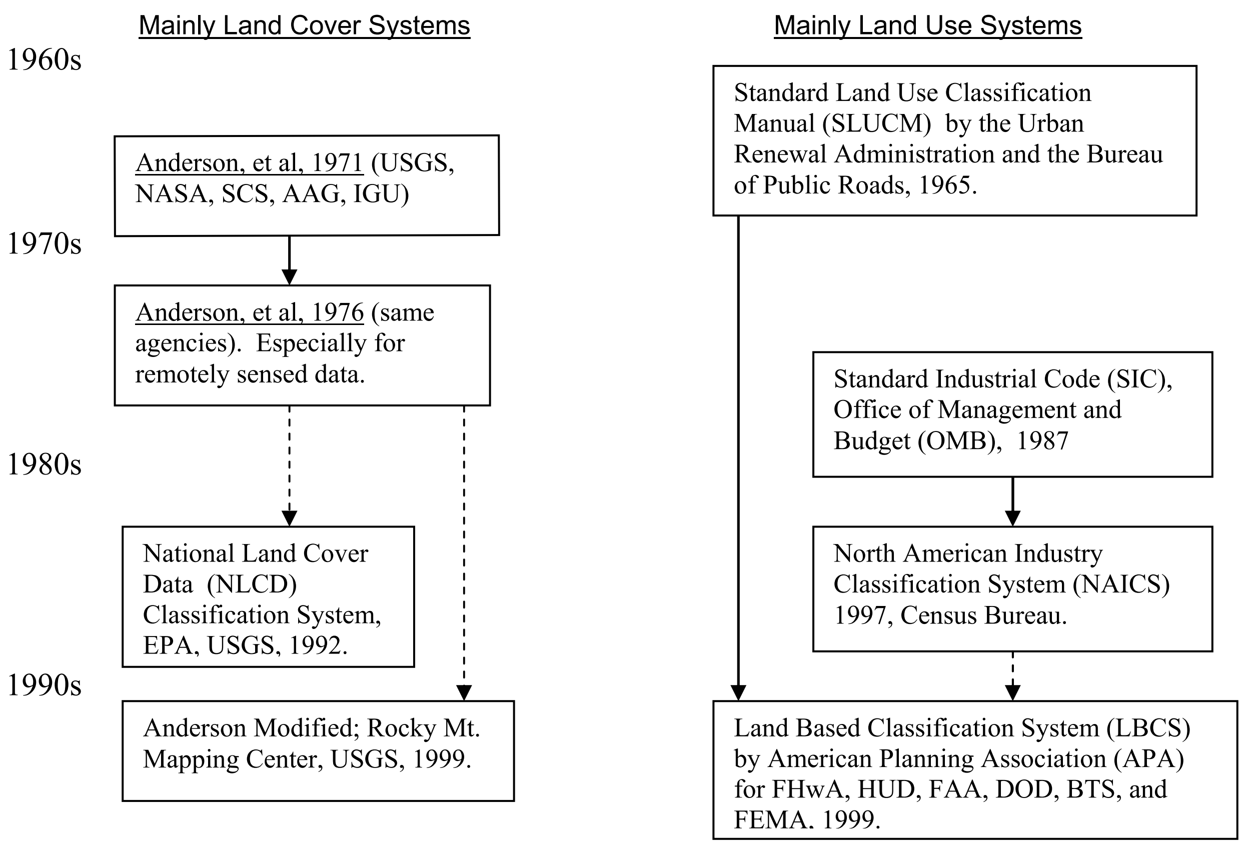

Figure 1. National Land Based Classification Systems and Their Derivations

The advances in remote sensing technology have led to at least two refinements of the Anderson classification. The National Land Cover Data (NLCD) Classification System modifies Anderson Level II, both by combining and subdividing Anderson's original 37 classes, resulting in 21 classes suitable for remotely sensed data collected by the Landsat Thematic Mapper at a 30-meter resolution. The NLCD began in 1992 and was completed in 2000. For high-resolution imagery, a second refinement of Anderson was developed at the Rocky Mountain Mapping Center of USGS for the USGS national 1:24,000 scale mapping program using NLCD. Technology advances notwithstanding, aerial photography and some field confirmation might need to supplement even the latest high-resolution satellite data, especially in urban areas.

Land Cover and Land Use Distinctions

Land cover refers to the biophysical materials observable on the land, while land use refers to how the land is being used by humans [5]. For example, a state park may be used for recreation, but it can appear to have a forest cover from the air. The concepts are closely related, and sometimes intermingled. Remotely sensed data from airplanes and satellites record responses from the earth's surface, both natural and artificial. However, remote sensing image-forming technology does not record land use activities directly. These activities, as well as other dimensions of land use, are distinctions that conceptually set land use apart from land cover. In practice, the collection of land cover data, including an increasing amount of land use data, is ongoing through programs emanating from NASA's Earth Science Enterprise, as well as from many privately owned satellites. By varying the remote sensing devices to include certain non-visible and thermal wave lengths, additional indicators can help extract even more information about land cover and land use activities and their environmental impacts over time.

Anderson, et al and LBCS Distinctions

Even though the Anderson and LBCS schemes are both hierarchical in structure, thus offering flexibility for simple to complex applications, their distinctions are more notable. These comprehensive systems of classification are distinguishable in several important ways, including the dimensionality of the system of classifying; the spatial building blocks, e.g. pixels versus polygons; rural versus urban applications; and descriptive versus prescriptive purposes of the analysis. Each is addressed here. >The most fundamental distinction between these two classification systems appears to be their range of dimensionality. The Anderson system was designed for classifying remotely sensed data in dimensions available from current technology. [2] Guttenberg argues that urban planners will need several additional dimensions of land use information [3]. Largely due to Guttenberg's rational approach, the LBCS received sub classifications for dimensions representing activities, economic land use functions, structural uses, the status of site development, and the nature of land ownership [4]. Each of these dimensions is recorded as a separate field in a land use database. >The digital files of remotely sensed data are in the form of cells or pixels. These spatial building blocks are also useful to the spatial analysis done by planners, but in conjunction with other digital forms. Streams and their watersheds, for example, can be analyzed using geometry of points, lines, and areas, rather than adding together pixels. Areas are often called polygons, and these are useful for representing not only watersheds, but also a variety of oddly shaped pieces of real property in the form of land parcels. Parcels are one of the most important digital building blocks for planners. >Remotely sensed data seems to be more applicable for assessing change in rural areas and along the rural-urban fringe. Urban applications demand more information than remote sensing can currently provide, but the gap is shrinking. >One reason that urban planners need a large amount of information is because they prescribe change. Prescriptive practices might require knowledge of actual uses and even patterns of ownership [3]. Detailed classifications also can introduce errors during manipulation. [6].

The Confluence of Land Use and Land Cover Analysis

The merging of images from remotely sensed sources with other land-based data can be processed by geographic information systems (GIS). GIS are computerized spatial analysis tools used by planners and others to answer important land-based questions involving commonality of data, and to show this overlaid data on maps in various useful combinations. The resulting visual images can help analysts, administrators and elected officials make better decisions. Modern GIS can join both pixel (raster data) and polygon (vector data) files. Using GIS, earth scientists and urban planners can collaborate on analyzing a range of quality-of-life problems existing along the urban-rural continuum over time. To accomplish this, the "languages" of earth science and urban planning will need to communicate.

Conclusion

Classification is a form of abstraction of raw data. Carefully done it can lead to good science. And science results based on data and information that are organized under themes that are compatible with other classification systems can be shared amongst a broader audience. Sharing also can help contain costs, as well as improve the quality of research.

References

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