Remote Sensor and other Data Sources for Timber Use-Value Assessment

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ABSTRACT: A productivity-based income capitalization system of property tax assessment for private commercial timberland was developed in Texas. The research defined an integrated system to utilize existing map products, public inventory data, and private price and cost information for mass appraisal of east Texas timberlands. Key elements in the system are county maps of forest types interpreted from high altitude color-infrared aerial photographs and soil productivity classes derived from general soil association maps.

INTRODUCTION

THIS IS THE STORY of how a data base was derived for an income capitalization system of *ad valorem* tax assessment of timberland in Texas. The data base was produced by combining public and private information and new records interpreted from remote sensor imagery.

HISTORY

Ad valorem tax assessment of timberland based on market value is undesirable if tax payments must be met by cutting the timber before it reaches financial maturity. A more realistic tax assessment system has been promulgated based on the present value of the site's capacity to produce annual timber growth. The system has been named "productivity" or "use-value" assessment. The case for adopting this assessment system was proposed by the Texas Forestry Association and the Texas Society of American Foresters beginning in the 1950s.

In 1976 the Department of Forest Science, Texas Agricultural Experiment Station, entered into a research contract with the Texas Governor's Office of Education Resources. The research developed a system to determine the taxable wealth of the private commercial timberland in Texas under the use-value concept (Baker, 1978).

In 1978 Texas voters endorsed the timber use-value concept and in 1979 a bill (Texas House Bill 1060) was passed and signed into law. Also, in that year central appraisal districts were authorized in Texas, resulting in a statewide system for administering use-value assessment. To date over 2.8 million hectares (seven million acres) of the state's 4.5 million hectares (11 million acres) of private commercial timberland have qualified to be assessed.

House Bill 1060 specified by agency name some of the providers of data which made the system operational. These are U. S. Geological Survey, USDA Forest Service, and USDA Soil Conservation Service. Some Texas providers of data and assistance—the Texas Forest Service and the public colleges and universities—were also named in the bill. The same sources are cited in the current timberland appraisal manual for Texas (State Property Tax Board, 1987).

TIMBERLAND PRODUCTIVITY

Soil is a predictable component on the land and is a stable element of the forest site. It is predictable because it is a function of geologic substratum, topography, and climate. Soil is directly associated with forest crop productivity (Davis, 1966).

When the USDA Forest Service inventories each timbered state's forest land and timber resources, all commercial timberland is classified by forest site class. Forest site classes are defined as "a classification of forest land in terms of inherent capacity to grow crops of industrial wood" (Earles, 1976). Site classes used in the 1975 survey of Texas forests ranged from an annual productivity capability of under 50 to over 165 cubic feet growth per acre (under 3.5 to 11.5 cubic metres per hectare) per year.

In forestry, defining and mapping areas of potential timber growth are performed using a concept called site index, expressed as the expected height of the tallest trees in the stand at an index base age, usually 50 years (Wenger, 1984). Site index is correlated with the kind of soil a tree is growing in and thus can be mapped. For each site class in the study, a range of site indexes for loblolly pine— the principal cash crop tree in Texas—was developed.

The soil associations, series, and phases in each county are named, classified, and mapped by the USDA Soil Conservation Service. Because the use-value study employed broad categories and mass appraisal techniques, general soil association maps were used (Harding and Baker, 1983). Each soil association was assigned a site class category and site index range.

This interchangeability of timber growth and productivity data between timber and soil inventory classification systems was a strong point of the approach used in the study.

METHODS

The formula for calculating timber use-value is the one for income capitalization. This method employs use-value as annual net income divided by the appropriate interest rate.

For perishable crops, which cannot be stored on the plant, the annual net income is evident. For trees, where annual growth can be stored on the stem, the annual net income increment is more difficult to determine.

To apply the income capitalization formula for timberland in Texas and to produce timber use-values, the following elements were needed:

- A timberland classification system and maps,
- A soil productivity classification system and maps,
- Major types of forest products manufactured and their annual growth rates,
- Prices for the types of forest products,
- Timberland management costs, and
- A suitable income capitalization rate.

Data for all elements existed, or they could be derived. Both public (federal and state) and private data were utilized.

THE DATA BASE

The income capitalization formula adapted to apply to assessment of private commercial timberland in east Texas relied on the compatibility of the input data from divergent sources. It is no coincidence that public agencies map to a single standard, employ a uniform system of soils and vegetation inven-

PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING,
Vol. 55, No. 6, June 1989, pp. 901–902.

0099-1112/89/5506–901$02.25/0

tory, or utilize common data. It is the responsibility of scientists in the agencies to build inventories using compatible classification systems from which data users may derive their own applications.

Small scale, NASA color-infrared positive transparencies from high altitude were an especially useful tool for developing generalized forest type data for Texas' private commercial timberlands. Forest types were interpreted on approximately 500 of these aerial photographs. The forest types were the three Level II forest land sub-categories employed in the LUDA Program of the U. S. Geological Survey (1975). The sub-categories as described using the Anderson et al. (1976) land-use/land-cover system for remote sensor imagery were amended to become pine, hardwood, and mixed timberland for the mapping project. Interpretations were transferred to overlays of 1:63,360-scale county highway maps for 37 counties on which school district boundaries had been drawn.

Four soil productivity classes, derived from USDA Soil Conservation Service general soil association maps, were employed. These were compatible with the means for expressing forest growth potential developed in the Texas forest survey of 1975. Boundaries were transferred to overlays of the same county highway maps.

Areas were calculated for each combined category of forest type and soil productivity for each school district in each county. This produced a 12-category data set applicable to both school districts and counties, since each of these types of jurisdictions is a primary user of *ad valorem* taxes in Texas.

The area data for the 12 categories were converted to dollar values by the following means.

Average annual volume of timber growth by forest type was derived from data published by the USDA Forest Service (Murphy, 1976). Using the commercial forests of southeast Texas as a "starting point," soil productivity mutlipliers were calculated for each soil productivity class. These were based on the ratio of mean growth potential for each class to mean growth potential for all classes. The value of that growth was supplied by a private price reporting service. The annual management costs were furnished by forest industry firms and private timberland owners.

These four data sets were combined by multiplying the volume of timber growth for each forest type by the multiplier for each soil productivity class and timber price to derive "gross income per acre (ha)." Management cost was then subtracted to derive "net to land per acre (ha)." "Net to land" values were then capitalized to produce per acre (ha) "use values." Total use-value for each jurisdiction was determined from area data.

The forest type maps, soil productivity maps, and the use values constituted a data base which could be used to institute the timber use-value assessment system.

RESULTS

The project demonstrated that public and private data, in a variety of formats, could be combined to develop a new method for assessing private commercial timberland in Texas.

The land-use/land-cover mapping system using high altitude remote sensor imagery was adapted to classify and interpret private commercial timberlands by forest type.

The research defined an integrated system to utilize existing map products, public inventory data, and private price and cost information for mass appraisal of east Texas timberlands. Maps of forest types and soil productivity classes were produced for 37 counties in 1976 and 11 additional counties the following year.

From the maps, inventory, and financial data, dollar-per-acre (ha) schedules of timber use-value by school district and county (and eventually by appraisal district) were prepared. The schedules are updated and refined annually.

The law authorizing timber use-value assessment passed by the Texas legislature in 1979 included the essentials of the system developed in the research project.

The system which was developed is now used in Texas for the *ad valorem* assessment of qualifying private commercial timberland.

DISCUSSION

The Texas timber use-value assessment system has operated smoothly. Annual updates of timber use-value by school district and appraisal district are submitted to the Texas State Property Tax Board for equalization studies. Refinements and updates have been made in the data base and the information sources.

Texas Forest Service bi-monthly prices of standing timber have replaced those from an out-of-state price reporting service. Ten forest industry firms have supplied ownership maps from which areas for the 12 categories were computed by county and school district (Baker, 1982). Annual management cost data are obtained from forest industry firms and by questionnaire from Texas' non-industrial tree farmers. Thus, management cost is weighted by category of ownership for each appraisal district. Revised school district boundaries produced by the Texas Natural Resources Information System (TNRIS) are being used to recalculate area by category. The USDA Forest Service has reinventoried Texas forests and new timber growth data are being introduced.

To update the remote sensor data base, forest types are being remapped in selected counties using NHAP color-infrared aerial photographs. An east Texas appraisal district is instituting a geographic information system and a microcomputer application to produce combined forest type/soil productivity class polygons by ownership.

SUMMARY

The Texas timber use-value study demonstrated the utility of a combination of remote sensor and other data from public and private sources. The approach has been successful and is now operational. The project shows the value of long-standing, well-defined, and compatible inventory and map data.

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(Received 21 September 1988; revised and accepted 1 February 1989)