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STATISTICS
RESEARCH DIVISION
WASHINGTON D.C. 20250

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EVOLUTION OF LAND COVER DEFINITIONS AND SURVEY FOR THE ECONOMICS AND STATISTICS SERVICE

GEORGE MAY

AgRISTARS
DOMESTIC CROPS AND LAND COVER
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I. Introduction

A. Purpose of a Land Cover Survey

The sampling strategy and techniques employed in the June Enumerative Survey (JES) provides a capability to obtain accurate crop acreage estimates. This approach is well established and is a main vehicle for obtaining state and national data for major crops.

During the last two decades land management and land use planning have become important factors in the American society. The loss of prime agriculture land, increased urbanization, and deforestation are only a few of the concerns facing this Nation. The type and amount of land covers currently positioned on the landscape are critical elements of land use management. From this need for land cover information arose the question as to whether or not the JES could be expanded to provide acreage estimates for non-crop land cover types.

In 1978 USDA Secretary Bergland announced what is called "The Secretary's Initiative" in which he outlined seven information requirements that were of major importance to USDA. One of these elements was land use classification and measurement. All seven requirements are addressed in a research program titled "Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS). A major project under AgRISTARS is the Domestic Crops and Land Cover Program (DCLC). One of its objectives is to determine what land resources information can be obtained using the JES ground data and Landsat data.

The first approach in meeting this objective is to determine if land cover acreage estimates can be obtained using JES techniques and direct expansion methodology. The JES crop codes would require expansion to include non-crop cover types. The second approach is to analyze the JES ground data with Landsat data and obtain regression estimates. This methodology has been proven in estimating crops in various states (3,4). The addition of Landsat data provides the capability to obtain land cover maps which display spatial information, and can be used in conjunction with statistical data to provide information for land use management systems.

USDA/ESS has no mandate to collect and report data on land cover types, except crops. Other federal and state agencies such as SCS, FS, and USGS have responsibilities to provide non-crop data. But, if ESS could provide land cover information to these users, then the basic "core costs" of materials and processing can be spread over a wider benefit base. As the Landsat crop area estimates move from the research mode into a production effort, the benefits anticipated for providing land cover data will help justify costs of Landsat regression estimates. For example, the estimated cost of the 1978 Iowa corn and soybean Landsat project was $300,000. If this methodology was modified to also produce land cover information, then the total expense could be shared by additional users. This would greatly improve the cost-benefit ratio.

B. 1980 Land Cover Study Objectives

A pilot study was conducted in Kansas using 86 segments from non-agricultural strata. The objectives were:

- o Test the feasibility of having regular enumerators and supervisors use land cover definitions to classify parcels of land.
- o Obtain preliminary variance information for direct expansions of cover types in the non-agriculture strata.
- o Determine the feasibility to use ground and Landsat data to provide land cover acreage.

Objective three is not discussed in this report.

II. Initial Selection of Land Cover Definitions

The short time period between the initiation of the DCLC program and the 1980 Kansas Land Cover Survey (LCS) required that land cover definitions be used that were readily available and accepted by other land classification systems. The categories also had to fit into the survey design of the JES. Because of these restrictions, the land cover classification system set forth in USGS Professional Paper 964 (1) was used as a basis for defining the land cover codes. This resulted in a scheme which combines the Level I and Level II classification system in the above paper.

The following land cover terms and definitions were used for the 1980 Kansas LCS.

10	URBAN	- primarily vegetative cover: parks, golf courses, house lots, cemetaries
11	URBAN	- residential; commercial & services; industrial; transportation, communication & utilities; industrial & commercial complexes
20	AGRICULTURAL	- cropland
21	AGRICULTURAL	- orchards, groves, vineyards, nurseries, & horticulture
22	AGRICULTURAL	- confined feeding operations
23	AGRICULTURAL	- pasture
24	AGRICULTURAL	- other ag. land: farmsteads, roads, ditches, small ponds, corrals
30	RANGELAND	- herbaceous, shrub, and brush
40	FOREST LAND	- deciduous and evergreen
50	WATER	- ponds, lakes, rivers
60	BARREN LAND	- forest clearings, bare land for residences, shopping centers & industrial sites, strip mines, exposed rock

III. Evaluation of Procedures, Acreage Estimates, and Definitions

A. Enumeration

Using the definitions given in section II, the enumerator went to each of the 86 segments and observed the land covers present. The terms "tract" and "field" were eliminated because the survey was not concerned with operatorship. A new concept called "unit" was employed. A unit is a continuous area of land devoted to one land cover type and at least one acre in size. A unit may extend beyond the ownership or operating boundaries of a typical farm, but must remain within the segment. Therefore, everything inside a segment was enumerated and placed into one of the defined land covers. The enumerator was not required to record acreage, because this was obtained during digitization of the unit boundaries. All of the enumeration was done by visual examination, except in problem areas, which may have necessitated an interview.

The enumerators did an excellent job in conducting the survey. Each segment was checked for completeness and very few unit boundaries had to be altered. In many instances the enumerator extracted more information than necessary, such as delineating ponds smaller than one acre or assigning crop type to individual fields within the cropland unit. Survey definitions for the LCS were less rigorous than the normal June survey, and the enumerators training and experience for the JES were apparent in the LCS.

B. Direct Expansion Estimates

There were 435 JES segments in Kansas. Of the 86 segments enumerated during the LCS, 43 were 1980 JES segments that were revisited and 43 were segments enumerated in earlier years but not 1980. Direct expansion estimates for rangeland/permanent pasture, woodland, cropland, and cropland pasture/pasture were made by combining the ground data from both surveys. Three different state level estimates were made for each of the four categories, using various combinations of the JES and LCS segments. The segment breakdown for each type of estimate is shown in Table 1.

Table 1. Definition of Segments by Strata and Estimator Type

STRATA	ESTIMATOR		
	478	Modified 435	435
Agriculture	392 JES	392 JES	392 JES
Non-Agriculture	43 JES substituted by LCS	43 JES substituted by LCS	43 JES
Non-Agriculture	43 LCS		

Table 2 contains the acreage estimates and coefficient of variations (C.V.) for the direct expansion estimates. The C.V.'s for rangeland/permanent pasture and cropland were quite low. Of particular interest is a comparison of the three expansions for a given land cover type. Estimates from the Modified 435 segments were close to estimates obtained using all 478 segments. This is not the case when comparing the Modified 435 to the 435, except for cropland. These comparisons suggest that sampling of the additional 43 segments did not yield much more information that was not already contained in the 435 JES segments.

The cropland, woodland, and rangeland/pasture direct expansions can be compared to estimates obtained from other Kansas surveys. The Forest Service conducted a state woodlands survey in 1965 using data compiled at the county level (2). The Conservation Needs Inventory (CNI) was conducted by the Soil Conservation Service in 1967 and 1977 (5,6). Table 3 is a comparison of these survey estimates to the direct expansions. Table 4 gives a brief description of each land cover type that was used to conduct the survey. Definition problems between JES and LCS and ESS versus SCS and FS, clearly shows a need for better defining categories for future land cover studies. This problem will be discussed in the next section.

Table 3. Comparisons of Direct Expansion Estimates to Forest Service and Soil Conservation Service Estimates.

Survey	Cropland	Woodland	Rangeland/Pasture
LCS	28,822,187	1,235,046	18,929,673
SCS (1967)	29,623,793	1,323,000	17,974,005
SCS (1977)	28,808,000	786,000	18,975,000
FS (1965)	29,476,900	1,349,800	18,403,100

Table 5 lists the direct expansion estimates for the other land covers enumerated from the 86 LCS segments. They are included here to give completeness to this report. Data for these categories were not obtained from the JES; therefore, no state level estimates can be made. The high C.V.'s indicate obvious problems with the sampling approach.

Table 5. Direct Expansion Acreage Estimates of Minor Cover Types for the 86 LCS Segments.

Cover	Acres	C.V.%
Water	90,477	42.57
Farmsteads	37,919	18.47
Urban/Res.	460,200	8.27
Orchards	948	99.5
Wasteland	58,324	68.81
Confined Feed Lots	1,918	99.76

Table 2. Direct Expansion Estimates for Combined 1980 JES and LCS

Land Cover	478		Modified 435		435	
	Acres	C.V.%	Acres	C.V.%	Acres	C.V.%
Rangeland/Perm Pasture	18,929,673	3.12	18,842,922	3.29	18,840,063	3.52
Woodland	1,235,046	22.91	1,148,698	23.60	1,033,547	29.48
Cropland	28,822,187	1.78	28,280,046	1.75	28,050,200	1.74
Cropland Pasture/Pasture	256,204	28.22	207,899	34.59	73,541	29.79

Table 4. Description of Land Cover Types in Table 3.

Cropland	CNI - row crops, close grown, summerfallow, cropland pasture, hayland, idle, orchards, vineyards
	ESS - same as CNI, except orchards and vineyards excluded
	FS - similar to CNI
Woodland	CNI - $\geq$ 10% stocked
	ESS/JES - $\geq$ 5 acres, grazed woodland included
	ESS/LCS - $\geq$ 10% crown closure
	$\geq$ 1 acre
	FS - $\geq$ 10% stocked
	$\geq$ 1 acre
	$\geq$ 120 feet crown width
Rangeland	CNI - native grasses, forbes and shrubs, managed primarily by regulating the intensity of grazing
	ESS/JES - permanent pasture category, but majority rangeland with some pasture
	ESS/LCS - same as CNI
	FS - similar to CNI
Pasture	CNI - mainly introduced plants managed by reseeding, mowing, liming, or fertilizing
	ESS/JES - permanent pasture category, but majority rangeland
	ESS/LCS - same as CNI
	FS - similar to CNI

C. Land Cover Types

Analysis of the Kansas land cover study indicated several problems with the defined land cover terms. These problems can be grouped into three categories:

- o non-specific definitions
- o catch-all terms
- o definitions inconsistent with JES

Each one of these categories will be discussed separately.

The two urban categories were insufficient in capturing the land cover information needed for urban and suburban areas. For example, Code 11 included all urban cover types except grass covered areas. For urban data to be useful it needs to be categorized according to its specific use such as residential, commercial, and industrial.

Code 24 (other agriculture) and Code 60 (barren land) were used as waste categories. Cover types such as limestone quarries, farmsteads, and transitional were placed in these codes. The enumerators were correct in their classification, but these types of land covers should be individually identified. Codes 24 and 60 were heavily used because of the criteria that everything inside the segment must be enumerated and placed in a defined land cover. The above problem indicates a need for additional land cover terms.

The LCS definitions of pasture, rangeland, and forestland were inconsistent with JES definitions. Forestland, in the JES, was defined as any continuous woods or grazed woodland greater than five acres or more. This criteria eliminated all forestland occuring in strips and areas less than five acres. The JES definition of pasture includes rangeland. The LCS defined pasture and rangeland as two separate cover types. These definitional problems made it difficult to combine the JES and LCS segment data to produce a state level estimate for forest, pasture, and range.

The experience gained during the 1980 Kansas LCS indicates a need for increasing the number of land cover types for enumeration and for better defining the terms.

IV. Development of 1981 Land Cover Classification Scheme

A. Terms and Definitions

The approach taken in developing terms and definitions for the 1981 Kansas survey was to solicit inputs from federal and state (Kansas) agencies that gather, analyze, and/or disseminate land cover information. The U.S. Forest Service is currently conducting their state forestland inventory for Kansas. During 1981-82, the U.S. Soil Conservation Service will be conducting their Multi-resource Inventory for the state. Definitions used for these two surveys were incorporated into the land cover definitions for the 1981 ESS land cover survey.

Eight Kansas agencies were contacted for input and review of land cover terms. Several of these agencies requested land cover information that were in accordance with the Level II Land Cover Classification System discussed in USGS Professional Paper 964 (1). These categories were added to the 1981 land cover definitions.

Definitions for cropland pasture, farmsteads, and crops were taken from the JES manual. The definition of permanent pasture was modified because rangeland will also be enumerated.

In summary, land cover types were defined that are pertinent to the landscape of Kansas. This will eliminate the need for categories like wasteland and barren. Various potential data users had input in developing the cover type categories. The following is a list of land cover terms and associated definitions. The individual crop types are part of the JES and therefore are not included.

RANGE

Land on which the potential natural vegetation (climax) is predominantly grasses, grasslike plants, forbs or shrubs suitable for grazing and browsing use. Also includes areas seeded to native or adapted species which are extensively managed like native vegetation. If any of the natural vegetation is cut for prairie hay then these acres, only, should be included in cropland as "other hay".

PERMANENT PASTURE

Grasses, legumes, and other forage crops which were solely planted or were interplanted with natural covers for the purpose of grazing. Intensive management may include such things as reseeding, renovation, mowing, and fertilizing. Excluding the following items:

- Pasture acreages cut for dry hay (include as "other hay" in cropland)
- Pasture acreages in crop rotation
- Small grains pastured
- Woodland grazed or pastured

CROPLAND PASTURE

Cropland in rotation pasture and all other cropland used or to be used for pasture or grazing during current year, excluding cropland grazed after harvest.

FOREST

Land stocked by forest trees of any size, or land dedicated for forest production which has been temporarily cleared, eg., logged. The minimum area of classification to forest land is one acre and the minimum dimension is at least 120 feet wide.

GRAZED FOREST

Land that meets the forest category, except the area is grazed by livestock.

WOODED STRIPS

Land that meets the forest category, except the minimum dimension is less than 120 feet wide. Examples of wooded strips are shelterbelts and hedgerows.

RESIDENTIAL

Land used for single and multidwelling family residences. Residential land ranges from high density, as found in urban cores, to low density, where houses are located on lots of more than one acre. Many residential areas, such as housing subdivisions, display uniform spacing of buildings, lawns and driveways. Housing situations existing on military bases, colleges, or living quarters for laborers near a work base should be placed within either the Industrial or Commercial and Services classification.

COMMERCIAL AND SERVICES

Areas used predominantly for the sale of products and services such as central business districts, shopping centers, commercial strip development, junkyards, and resorts. Institutions, such as schools, churches and military bases are also included.

INDUSTRIAL

Land used for light manufacturing to heavy manufacturing plants. Examples of such plants range from assembly or packaging plants to lumber mills, power generating stations, and chemical plants. Commercial feedlots, greenhouses, and broiler facilities are included.

TRANSPORTATION, COMMUNICATION AND UTILITIES

These categories are often an integral part of a more dominant land use. Unless they can be readily mapped separately, they should remain a part of the larger land use. Railroads, airports, and major surfaced roads are typical examples of transportation. The communication and utility category should include substations, sewage treatment plants, gas and oil pumping stations, etc.

MIXED

Where two or more of the above categories (Residential, Commercial, Industrial, Transportation) occur together and when the area for the smallest

category exceeds 1/3 of the total area being delineated then it should be classified as mixed. If the smaller category is less than 1/3 the area delineated, then the category appropriate to the dominant land use is applied.

OTHER URBAN

This category should be used for such things as zoos, golf courses, parks, cemeteries, waste dumps, etc. Lots and open grassland areas which are not considered a part of a residential dwelling should be included in other urban.

WATER (<2 ACRES)

Ponds or impoundments that contain water and are approximately one or two acres in size.

WATER (2 TO 40 ACRES)

Ponds or lakes that contain water and are greater than two acres but do not exceed forty acres.

WATER (>40 ACRES)

Lakes and reservoirs that contain water and are greater than forty acres.

PERENNIAL STREAMS (66 to 660 FEET)

Streams that contain flowing water and are wider than sixty-six feet but less than six hundred and sixty feet wide. This measurement should be taken from bank to bank.

PERENNIAL STREAMS (>660 FEET)

Streams or rivers that contain flowing water and are wider than six hundred and sixty feet. This measurement should be taken from bank to bank.

SAND DUNES

Sandy areas which have resulted from accumulations of sand transported by the wind. This land has limited ability to support life and has less than ten percent vegetation cover.

STRIP MINES, QUARRIES, GRAVEL PITS

Include all extractive mining activities that have significant surface expression. Unused pits or quarries that have been flooded should be placed in the appropriate water category.

TRANSITIONAL

This category is used for areas which are in transition from one land use activity to another. The enumerator should avoid interpreting the past or future use. Examples of transitional areas are forest lands being cleared for agriculture, bare ground in development of a residential subdivision, and land being altered by sanitary landfills.

FARMSTEADS

That part of a farm or ranch that is occupied by the dwellings, buildings, corrals, gardens, and family orchards. Dwellings do not have to be occupied to be categorized as a farmstead.

ORCHARDS, VINEYARDS, GROVES

Land used for production of fruits and nuts. Nurseries and horticultural areas which produce seeds, sod, or seedlings are also included.

B. Survey Approach

Results from the 1980 pilot study indicates that the JES may have the potential for providing state level acreage estimates for non-crop cover types. To further explore this potential, a land cover survey will be conducted as part of the 1981 JES for the 435 Kansas segments. Most of the JES procedures are applicable to a land cover survey.

A 1981 land cover survey manual was written and will be a stand alone document to be used during the JES. It is anticipated that the city and urban areas can be enumerated during the pre-screening activities. Land cover information for non-agriculture tracts during the JES can be listed on the Part-ID. Data on non-crop cover types, within an agriculture tract, will be captured on Section A.

V. Summary

At the beginning of this report it was stated that the purpose of the land cover research is to determine whether or not useful non-crop land cover information could be obtained as a regular part of the JES. The 1981 Kansas LCS will bring the research closer in answering this question. If this approach is operationally feasible, it is anticipated that a land cover survey, within a specific state, would not be conducted every year. A survey would be made periodically, for example every five years, or when it is determined that the state needs a new land resources inventory.

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