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# Land Clearing and Drainage Data From Airphoto Interpretation

By Henry W. Dill, Jr.

*The obtaining of quantitative data for economic analysis of changes in the agricultural use of land has been a problem in recent years. Field study is a slow and expensive method of providing information. Usually, it requires several experienced persons to collect the data needed. The airphoto interpretation method described in this article supplies suitable data for economic studies with considerable savings in time and cost. With this method, a minimum of personnel is needed.*

**L**AND IMPROVEMENT has been an important economic activity in the Southeastern Coastal Plain of the United States in recent years. In many instances, land clearing was accompanied by drainage. At the same time, land was reverting from crop and pasture use to forest, particularly in some of the more rolling sections. The magnitude of land development by clearing and drainage is indicated by reports of the U. S. Soil Conservation Service. They show that technical assistance for establishing or improving drainage has been furnished for more than 2 million acres in the Coastal Plain and that about 200,000 acres have been cleared annually in recent years for cropland and pasture.<sup>1</sup>

The Agricultural Research Service is making economic studies to provide more complete information about land development, including the extent of land clearing and drainage, changes in land use, and costs and returns from different land-improvement measures. Land clearing and drainage work is distributed widely throughout the Coastal Plain. These activities range from clearing of scattered brush and trees to clearing and drainage of forest. The task of obtaining information about land development and reversion is a formidable one. To obtain it through field surveys would involve much expense and the time of trained personnel. Therefore, the possibilities of obtaining data on land clearing, drainage, and use from interpretation of air photographs has been explored. Preliminary findings

indicate that much detailed information can be obtained at relatively low cost by this method.

## The Areas Studied

The North Carolina Coastal Plain is representative of an area in which much land clearing and drainage has been in progress. A check of scattered sample areas suggested the use of aerial photo interpretation to obtain data on land clearing as well as any reversion of the cropland to woodland. The requirements for economic data presented an opportunity for use of the "best estimate" approach in photo interpretation.<sup>2</sup> In using this procedure, an entire area can be studied on aerial photographs and classes of land use can be established by identifying features. Satisfactory data can be obtained for most classes of land, with error generally confined to the area occupied by categories with the least distinct identification characteristics.

Three townships in North Carolina were chosen for study using aerial photo interpretation. Choice of these townships was based on local reports of agencies concerned with land development, as well as some field reconnaissance. The areas selected were Long Acre Township, Beaufort County, Belvoir Township, Pitt County, and Alfordsville Township, Robeson County. Complete townships were selected for study since use of a minor civil division as a base provides a known

<sup>1</sup> Land Use and Development, Southeastern Coastal Plain, Agr. Inf. Bul. 154, May 1956.

<sup>2</sup> Dill, H. W., Jr., "A Classification of General Problem Types in Photo Interpretation," Photogrammetric Engineering, Vol. XXI, No. 4, September 1955.

area figure to which percentage data from photo interpretation can be applied to furnish acreage data.

The primary objective of the study at the outset was to identify, locate, and measure the extent of land clearing. But as the interpretation work progressed, it became evident that the amount of drainage ditch installed since the date of the early photo coverage could be identified and measured. This was done and the location, amount, and type of drainage installation was determined. As the study continued, it became apparent that information on the distribution of major land use types would be useful. Comparison of the area cleared with the acreage of cropland would show the trend in land development more clearly than providing only the acreage of land cleared or expressing this figure as a percentage of the township area. The procedure used in obtaining the data on land clearing, drainage, and use is discussed in detail in the section that follows.

### Photo Interpretation Procedure

Aerial photographs were available for all three townships for 1938-40 and 1954 from the Commodity Stabilization Service, U. S. Department of Agriculture. The 1:20,000 scale contact prints were used. Because of their higher resolution contact prints were selected in preference to photographs with a larger scale, particularly as the higher resolution affected tone and texture in the identification of grassland and brush. To aid further in interpretation and annotation, positype paper prints were used. Stereoscopic photo coverage was obtained for all three townships for both periods.

Before beginning the interpretation study, it was necessary to establish the township boundary lines on the photographs as carefully as possible in order to obtain the actual acreages in the various categories of clearing and land use. The boundary was transferred from U. S. Geological Survey topographic sheets or highway planning maps of the U. S. Bureau of Public Roads. The next step was to put match lines on the latest set of photographs to avoid duplication or omission of any area and to locate the photographs within the township. When these two steps were completed, actual interpretation began. This is described for each of the three parts of the study, with Long

Acre Township, Beaufort County, N. C., used as an example of the procedure and results.

### Land Clearing

The land-clearing study was essentially a field-by-field comparison of the early and later photo coverage with stereoscopic study of the comparable areas for each set of photographs. To assure complete coverage of the township, a clear acetate line grid was placed over each of the latest photographs and the entire photograph was checked with the early coverage by block. When areas of clearing and reversion were identified, they were outlined to scale on the recent photographs and marked with appropriate symbols. It was decided that the following classes of land clearing and reversion would be most appropriate for conditions in the area and also suitable for use in the economic studies to be carried out at a later date.

Land clearing :	Symbol
From brush and grass-----	b
From scattered trees and brush-----	t
From forest (over 50% crown cover)-----	T
Reversion to forest :	
From cropland-----	c
From grass-----	g

After interpretation and annotation of the data, the area of the township on each photograph and the acreages of each type of land clearing and reversion were measured by using a dot grid. A transparent small circle-type grid with 40 dots per square inch was used. The accuracy of the dot grid compares favorably with that of the planimeter and the time saved is appreciable. Studies conducted in the measurement of forest and non-forest uses have indicated that the dot grid gives accurate results even with grids having only 16 to 25 dots per square inch.<sup>3</sup> The data for each photograph were recorded separately for later possible use in other studies. After the dot count was completed for the entire township, the percentage of each type of land clearing or reversion was computed, based on the total dot count. Acreage figures for each type of activity were obtained by applying the percentage figures to the total acreage for the township, as given by the Bureau of the Census in the report, "Land Area of the U. S.—1940."

<sup>3</sup> Tryon, T. C., Hale, G. A., and Young, H. A., "Dot Gridding Air Photos and Maps," Photogrammetric Engineering, Vol. XXIV, No. 5, December 1955.

## Drainage Ditch Installation

As mentioned previously, during the clearing study it was decided to estimate the amount of new drainage ditch installation from a photo comparison study. Areas of new installations of main and secondary ditches were identified and annotated on the recent photographs and were measured by using a magnifier scale. The area affected by these new installations could not be estimated accurately, but it was believed that the linear data might aid in economic studies of land drainage.

## Land Use Classification

Land use for the entire township was determined by photo interpretation and the area of each use was computed. The following land use types were established and identified:

- Rotation cropland (1938)
- Cropland cleared (1938-54)
- Cropland clearing in process
- Idle cropland
- Permanent pasture
- Forest
- Forest from reversion (1938-54)
- Residences and farmsteads
- Urban areas (Washington Park and Pinetown)
- Roads and railroads
- Drainage ditches
- Tidal marsh
- Water

*Rotation cropland* includes land plowed and in row crops, small grains, and grass. In the study reported here, it was not possible to identify specific crops because of the date of the photography.

*Idle cropland* presented a problem, as there was a possibility of confusing it with hayland or pasture. In general, however, the idle cropland had a lighter tone and rougher texture than the hayland and ordinarily no trees were present, as was the case with most of the areas classified as pasture. Only a small acreage was in this category.

*Permanent pasture.*—This class of land use was distinguished from idle cropland by the darker tone, rough texture, and presence of large trees in most units. In some instances permanent pasture was adjacent to and apparently merged into woodland that was pastured. Many of the units were small fenced areas adjacent to the farm buildings. Paths and tracks were not too apparent, perhaps because of the season of the year. As in the case of idle cropland, only a relatively small acreage was observed.



PLATE I.—Air photo of a part of Long Acre Township, Beaufort County, N. C., taken in April 1938. Areas outlined with white dashed lines and marked "x" have been cleared. Compare with 1954 conditions on the same area shown in plate 2. (Photograph from Commodity Stabilization Service, USDA.)

*Forest.*—Forest was classified into two categories: Forest present on the early photo coverage, and those areas that reverted from cropland and grassland.

*Area measurement of land use.*—After interpretation and annotation of the photographs was completed, the area of each type of land use was measured by using a transparent grid as described above. It should be noted that this procedure involved a very detailed type of interpretation for several items, particularly residences, farmsteads, roads, drainage ditches, and streams. In using the dot grid, as opposed to the planimeter, a certain portion of the dots fall squarely on roads, ditches, houses, and so on. It is believed that this system gives due weight to the area occupied by each of these items. For example, ditches are a rather prominent feature in this area, and careful count using the dot grid indicated that they occupied as much area as roads and railroads. In



PLATE II.—Airphoto of the area shown in plat 1 taken in December 1954. Arrows point out new drainage ditches. (Photograph from Commodity Stabilization Service, USDA.)

the same way, it appears that small areas of clearing, farmsteads, and so on are given due consideration in area measurement by this procedure.

## Results of the Study

### Land Clearing

Data on acreage of land clearing are shown in table 1, with Long Acre Township used as an example of the detailed data obtained. It should be noted that one assumption is involved concerning clearing in process for cropland. It was assumed that this clearing was for rotation cropland or intensive cultivation. This was based on the fact that clearing would involve considerable expense and in many instances, land drainage was being installed. Based on these facts, it was believed that these areas would be used for intensive cultivation.

Granting the above assumption, the total amount of clearing is 3.2 percent of the township,

TABLE 1.—*Land clearing, by type, Long Acre Township, Beaufort County, North Carolina, 1938-54*

Type of clearing	Dot count	Percentage of total dot count	Area
Clearing for cropland:			
Completed:	Number	Percent	Acres
Light brush.....	179	0.3	297
Brush and scattered trees.....	335	.6	594
Forest.....	1,025	1.7	1,699
Total.....	1,539	2.6	2,590
In process:			
Brush and scattered trees.....	108	.2	199
Forest.....	233	.4	399
Total.....	341	.6	598
Grand total.....	1,880	3.2	3,188
Clearing for urban use:			
Completed:			
Brush and scattered trees.....	13	.03	30
Forest.....	33	.07	69
Total.....	46	.10	99

or 3,188 acres (table 2). Expressed as a percentage of the township area, it is relatively small. However, land cleared in the previous 16 years amounted to 21 percent of the 1954 cropland.

Another point concerning land clearing is the kind of clearing that is being done. In general, two kinds were noted: Clearing of land in blocks for establishing new fields, and clearing that was associated with extending existing fields, cleaning out corners, wet spots, and so on. (See plates I and II.) No precise study of the kinds of clearing was made, although a percentage estimate of the two kinds mentioned was made for each photograph. The average of these estimates for the township showed that 78 percent of the clearing was in complete blocks, mostly from forest, while the remaining 22 percent was in connection with adjustment of fields. As a matter of interest, the acreage of land clearing, cropland reversion, and cropland are shown in table 3 for the three townships studied.

*Drainage ditch installation.*—The amount and type of drainage ditch installed from 1938 to 1954 is shown in table 4. The classification of drainage ditches into main and secondary ditches was for

TABLE 2.—*Land use, Long Acre Township, Beaufort County, North Carolina, 1954*

Land use	Dot count	Percentage of total dot count	Area <sup>1</sup>
Cropland:			
Rotation cropland (1938)-----	Number 7, 110	Percent 11. 8	Acres 11, 758
Cropland cleared (1938-54)-----	1, 539	2. 6	2, 590
Cropland clearing in process-----	341	. 6	598
Idle cropland-----	121	. 2	199
Total-----	9, 111	15. 2	15, 147
Permanent pasture-----	146	. 2	199
Woodland:			
Forest-----	45, 274	75. 5	75, 234
Forest from reversion (1938-54)-----	141	. 2	199
Total-----	45, 415	75. 9	75, 434
Residences and farmsteads	931	1. 6	1, 595
Urban concentration (Washington Park and Pinetown)-----	150	. 2	199
Cleared for urban use (recreation)-----	46	. 1	99
Roads and railroads-----	590	1. 0	996
Drainage ditches-----	627	1. 0	996
Tidal marsh-----	135	. 2	199
Water-----	2, 860	4. 8	4, 784
Grand total-----	60, 012	100. 0	<sup>1</sup> 99, 648

<sup>1</sup> 155.7 square miles—Areas of the United States, Bureau of the Census, 1940.

convenience only; it was not related to capacity. The scale of photography was too small to attempt this type of measurement. The main ditches included those that extended over more than one or a small group of farms. In turn, the farm ditches included all those on farms, although differences in width were noted.

*Land use.*—The land use classes summarized in table 2 were described previously; however, a few items should be mentioned in summary. Included in the urban concentration (towns of Washington Park and Pinetown) is a small industrial area adjacent to Washington Park. Also, the item of residences and farmsteads includes several concentrated residential areas, particularly those along Pamlico Sound east of Washington Park.

### Conclusion

Use of the photo interpretation method pro-

TABLE 3.—*Summary of land clearing, cropland reversion, and cropland for sample township, North Carolina*

Item	Area		
	Beaufort County, Long Acre Township 1938-54	Pitt County, Belvoir Township, 1940-54	Robeson County, Alfordville Township, 1938-54
Cropland-base year-----	Acres 11, 758	Acres 8, 738	Acres 14, 815
Cropland clearing <sup>1</sup> -----	<sup>2</sup> 3, 188	<sup>3</sup> 709	<sup>4</sup> 2, 934
Idle cropland-----	199	71	184
Total cropland 1954-----	15, 147	9, 518	17, 933
Cropland reversion-----	199	71	45

<sup>1</sup> Includes clearing in process 1954.

<sup>2</sup> 21 percent of 1954 cropland.

<sup>3</sup> 7 percent of 1954 cropland.

<sup>4</sup> 27 percent of 1954 cropland.

TABLE 4.—*Drainage ditch installation, Long Acre Township, Beaufort County, North Carolina, 1938-54*

Type of installation	Amount	
Main ditch:	Linear feet	Miles
Installed-----	40, 335	7. 1
Under construction-----	5, 640	1. 1
Total-----	45, 975	8. 7
Farm ditch:		
Installed-----	179, 141	33. 1
Under construction-----	16, 110	3. 1
Total-----	195, 251	36. 2

vided suitable estimates for economic analysis of the various classes of data described above. The extent of these classes has been shown on aerial photographs which are available for use in field schedule work. The work was accomplished in a relatively short time with a minimum number of personnel. The method allows for most efficient use of trained and experienced people. The savings in time and expense in efficient use of personnel are the main advantages of the photo interpretation method described, as photographs would be needed both for this procedure and for detailed field studies by direct mapping used in combination with the questioning of farmers.

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