Use of the Comparison Method in Agricultural Airphoto Interpretation

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ABSTRACT: *Obtaining data on changes in the use of agricultural land is an expensive and time-consuming process when field methods are used. The availability of successive airphoto coverage for many agricultural areas, made in the last few years, provides a means of comparing recent conditions with those prevailing before World War II. Two methods developed to provide data by airphoto comparison analysis are described. They overcome the difficulties posed by field survey methods.*

INTRODUCTION

A STARTLING change has characterized agriculture in the United States during the last 30 years. In this period, the major uses of farmland have changed in many of the areas that remain in production. Some previously in production have shifted to urban, industrial, recreational, and other nonfarm uses. In many places, new farmland has been developed by clearing and draining forest land.[1]

Obtaining detailed information about these changes in order to use it in economic analysis and for other purposes presents many difficulties. Time, funds, and personnel have not been available for making adequate field studies to get information on specific location, acreage, trends, and other data on changes in land-use. In many areas where field studies had been made, later changes necessitated further study to bring information up-to-date. Some quick, economical method was needed to solve this problem.

The requirements for data in this situation suggested airphoto interpretation using two or more sets of photographs taken at intervals, following the standard procedure used to obtain information by photo intelligence agencies in World War II.

For the most part, use of this very effective method for agricultural studies in the United States has not been possible until recently. Although airphoto coverage was available for most agricultural areas in the United States before World War II, a second coverage was not made for most areas until about 1950. Since then most of the areas covered before World War II have been photographed again by private concerns under contract to the U. S. Department of Agriculture. As of June 1957, the Department had photographs covering 7,216,131 square miles, which include two or three coverages for many counties.[2]

In 1955, the use of airphoto comparison analysis was begun in the Farm Economics Research Division, Agricultural Research Service, U. S. Department of Agriculture, to obtain data for economic analysis of several types of land use changes. At about this time, also, airphoto comparison analysis using successive Department of Agriculture coverages was being used by Gibbs and Husch[3] in a study of forest land in New Hampshire.

In a similar situation in Canada, L. E. Philpotts was making an airphoto comparison study of an agricultural area for which postwar coverage duplicated photographs made in 1938.[4]

[1] Wooten, H. H., and Anderson, J. R. "Major Uses of Land in the United States, Summary for 1954." *U. S. Dept. Agr., Agr. Inform. Bul. 168*, January 1957.

[2] Compiled by Coordinator of Photography, U. S. Department of Agriculture.

[3] Gibbs, C., and Husch, B. "Forest and Land Use Trends from Aerial Photographs, 1943–1953, Town of Madbury, New Hampshire," New Hampshire Agr. Expt. Sta. Dept. Forestry, Forestry Mimeogr. 3. March 1956.

[4] Philpotts, L. E. "The Use of the Aerial Photo in the Change of Land Use in Southwestern Saskatchewan," Canada Dept. Agr., Marketing Serv. Econ. Div., Ottawa, Aug. 1957.

Two methods were developed to meet the needs for data in the Farm Economics Research Division. Both methods make use of the successive airphoto coverage made for the Department of Agriculture. The first is based on using 1:20,000 contact photographs; the other uses the photo index sheets, usually about 1:63,360. In the sections that follow the procedures are discussed for each method.

Contact Print Comparison Method

The first use of airphoto comparison study of contact prints to obtain data was in connection with cropland development by clearing and draining forest land. Sample townships where land clearing had been reported were selected for study. The detailed procedure used was described in an earlier publication.[5] The process is essentially a comparison of "before and after" conditions, with two sets of photographs used to identify and locate changes.

Contact airphotos to provide stereo coverage for an earlier and a later period were obtained for the selected township. Match lines were placed on a sufficient number of the more recent photographs to cover the township area. The township boundary was drawn on the matched photographs by transfer from available maps. By stereo study of both sets of photographs, areas of land-use change were identified and were outlined on the later set of airphotos. Figure 1 illustrates typical changes associated with development of farmland.

After areas of change had been identified and annotated, they were measured by using a transparent dot grid. Acreage for each type of change was computed by using the airphoto scale, or by taking a dot count for the entire area (township) and applying the count to the known area.

Typical data obtained by interpreting

[5] Dill, H. W., Jr., "Land Clearing and Drainage Data from Airphoto Interpretation," *U. S. Dept. Agricultural Economics Research*, Vol. IX, No. 3, July 1957.

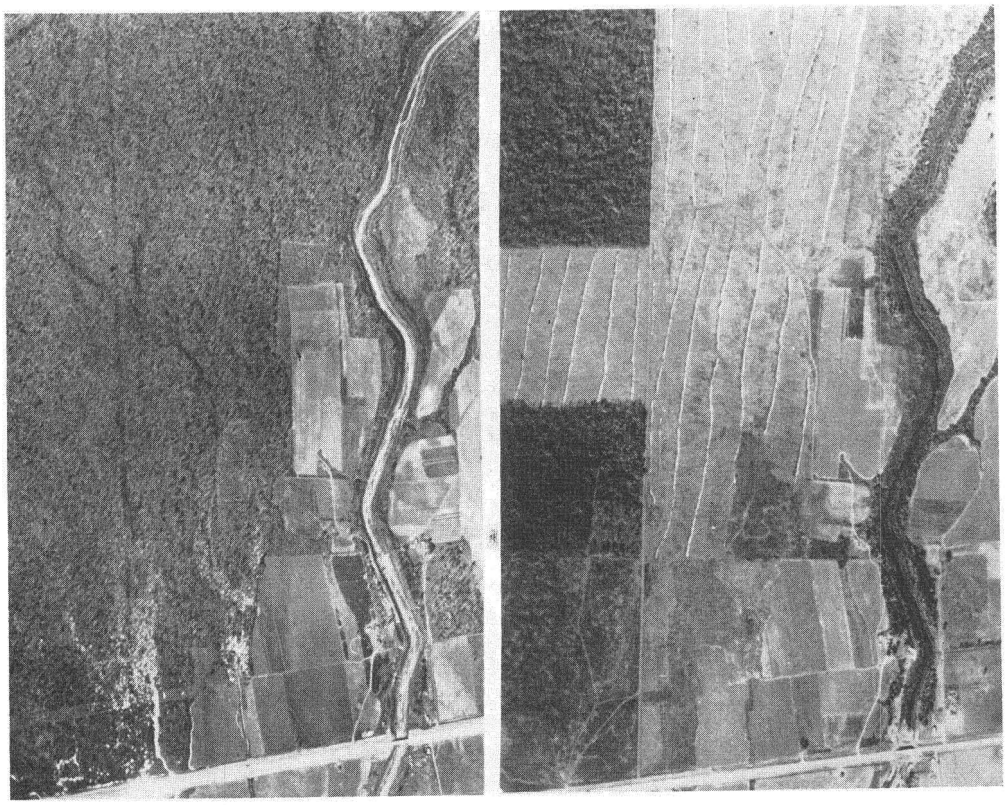

Fig. 1. These contact airphotos of the same area in Chicot County, Ark., illustrate development of new farmland by clearing and draining forest land. The airphoto on the left was taken in 1944 and the one on the right in 1955. 1:20,000. (Commodity Stabilization Service, USDA.)

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*	*Per cent*	*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

TABLE 2

LAND USE, LONG ACRE TOWNSHIP, BEAUFORT COUNTY, NORTH CAROLINA, 1954

Land use	*Dot count*	*Percentage of total dot count*	*Area*[1]
Cropland:	*Number*	*Per cent*	*Acres*
Rotation cropland (1938)	7,110	11.8	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	[1] 99,648

[1] 155.7 square miles—Areas of the United States, Bureau of the Census, 1940.

contact prints are illustrated by Tables 1 and 2. The types of change and the detailed information that can be obtained, depend upon the scale, quality and time of year of the photography, and on the skill of the interpreter. In the study for which the data are shown, three types of land clearing were identified, as each would have a different cost per acre. (See Table 1.)

This procedure demonstrated that detailed data on changes in land-use, suitable for utilization in economic analysis, could be obtained from airphoto interpretation in a short time, with minimum expenditure of funds and with a small technical staff. The method was satisfactory for small areas, but projection of data to a larger universe presented the usual problems associated with sampling. It was apparent that some other method was needed to provide information for larger areas. The photo index sheet described in the following section was developed to meet this need.

Airphoto Index Sheet Comparison Method

Use of photo index sheets was prompted by the need to obtain data quickly for larger areas, such as counties, watersheds, and major river flood plains. Use of contact prints is a quick, economical method as compared with field study for a small area, but, in studying a county, for example, use of this method requires a considerable expenditure of money and time. Although it may be argued that the uncontrolled mosaic was not intended for use in area measurement, the possibility of error from this source is small compared with that from projecting sample data to a larger area. As use of airphotos permits study of the whole area (or universe), this method has a distinct statistical advantage over a sampling method.

Where land-use changes have a characteristic pattern that can be identified, efficient use can be made of airphoto index sheets in isolating problem situations within a large area before using comparison analysis. For example, land clearing in process can often be identified by the characteristic pattern shown in the enlargement in Figure 2 and on the 1955 airphoto index sheet in Figure 3. Presence of this pattern suggests that the adjacent areas may have been cleared, and that comparison should be made with earlier coverage. This association can be verified by reference to Figure 3, in which 1955 and 1944 conditions can be compared.

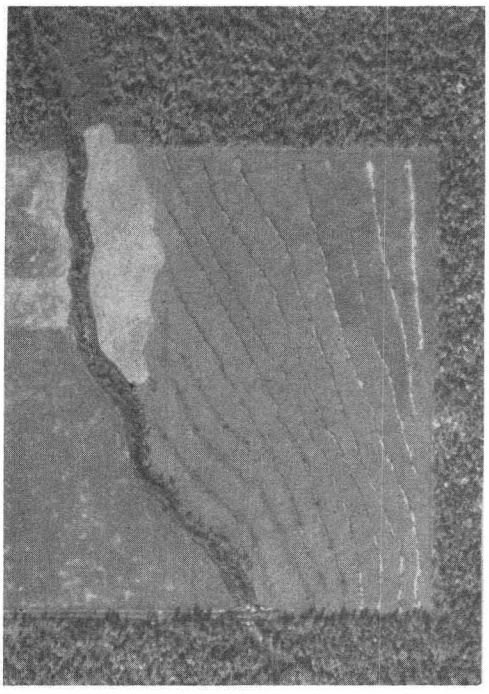

Fig. 2. This enlargement from a contact print shows the characteristic pattern of land clearing in process. The dark lines are windrows of felled trees, pushed into piles by use of a bulldozer. The white lines are windrows that dried and were burned. (CSS-USDA.)

The procedure in using index sheets for comparison studies is essentially a detailed check in which changes are recorded on the latest coverage. It has been found that several items make the work easier. In the first place, the airphoto index sheets are studied under magnification. The Dazor magnifier with attached fluorescent lights and mounted on a floating arm is useful for this purpose. The magnifying lens of this instrument can be placed at the proper height over the photographs, leaving the hands free for annotating, recording data, and shifting photographs. Experience has shown that folding the older index sheet into sections about 4 inches wide makes the comparison easier.

After changes in land-use have been identified and outlined on the index sheets, the next step is determined by job requirements. Areas of land-use change can be measured with a dot grid, and acreage can be computed by the methods described above for contact prints. The estimated acreage data can be used for many purposes.

A second possibility would be to buy or borrow stereo contact coverage of areas

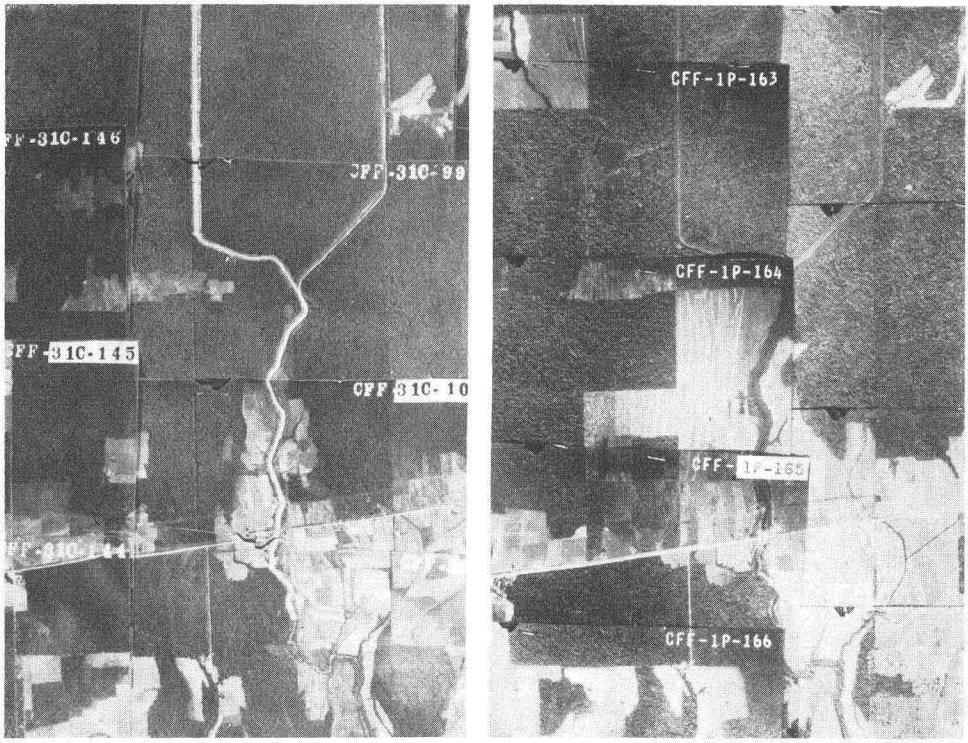

FIG. 3. Land clearing as it appears on airphoto index sheets for a portion of Chicot County, Ark. The photographs on the left were taken in 1944 and those on the right in 1955. Scale approximately 1 inch-mile. (Index sheets from CSS-USDA.)

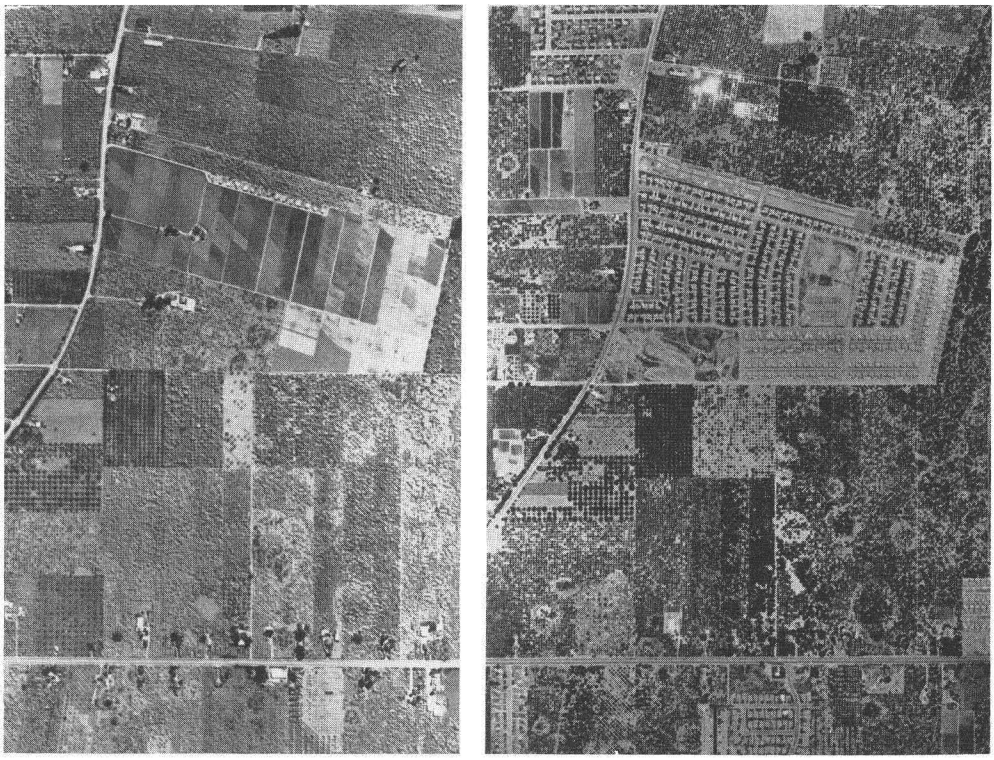

FIG. 4. These airphotos of the same area in Santa Clara County, Calif. illustrate the shift from farm to urban land use. The photograph on the left was taken in January 1950, the one on the right in June 1956. During this period, part of the area was shifted from cropland and orchards to residential use. 1:20,000 contact prints. (CSS-USDA.)

that show changes, to obtain greater detail or to check "possible" situations.

A third step, following stereo study of areas of change, would include field study of these sites, either by a complete check or by checking a sample number. For all of these purposes, the annotated index sheet serves as a location map for use in the office or in the field.

Use of this method has been made in fields other than farmland development. In areas where agricultural land is reverting to forest, airphoto comparison analysis has provided data on the acreage and the type of land that is reverting. Figure 4 illustrates the situation in an area where agricultural use is shifting rapidly to urban use. The comparison study procedure used in this field is similar to that used in land development for using both contact prints and photo index sheets.

SUMMARY

Use of airphoto comparison methodology provides a means of obtaining data on agricultural land uses for economic analysis, with a minimum expenditure of funds, and a small number of professional personnel, in a relatively short time. The two methods allow for a choice of approach, depending on the job requirements. Or, used in combination, they are a good substitute for field mapping, particularly for large areas.

*Determination of the Angle of Dip of Seemingly Vertical Strata on Vertical Aerial Photographs**

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INTRODUCTION

Most photogeologists are familiar with the phenomenon of perspectively overturned beds in stratified rock. The impression one receives from the photographs is that the strata seem to dip in the opposite direction from the actual one. Sometimes they also appear to be considerably steeper than they actually are, without reaching an overturned position.—Also, the contrary is more or less familiar: that strata appear on the photographs to be less steep than they are in reality. However, the author has never found any written description as to how, from seemingly vertical strata, the true dip can be determined. Such a determination is simple and rapid, and does not require the use of a stereoscope. The method is described in this paper, after first determining under what conditions the strata are perspectively overturned, steepened or moderated.[1]

THE THREE ZONES OF PERSPECTIVELY OVERTURNED, STEEPENED AND MODERATED DIPSLOPES

In the cross section of Figure 1, O is the photographic lens; the line WW is the terrain or surface of the photographic print (film or plate); and OC is the altitude of the airplane or the focal-length f of the camera, respectively. The strata are supposed to dip with the same angle ω all over, from W to W. The beds in 1 and 4 are at the extreme margins of the vertical aerial photograph.

The widths of the projections of the dipslopes upon the print are drawn along the line XX. The projection of the slope is broadest in 1, less broad toward the left, as for instance in 2. In 3, many points of the

[1] What applies to the inclined strata is of course also valid for similar features, such as hill slopes, etc.

* Subsequent to preparing this paper the author was transferred to Nicaragua and is now associated with the Nicaraguan Oil & Mineral Development Company, S. A.