Aerial Photography at the Agricultural Adjustment Administration: Acreage Controls, Conservation Benefits, and Overhead Surveillance in the 1930s

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Abstract

Aerial photography played an important but largely unsung role in New Deal efforts to improve farm income. Established in 1933, the Agricultural Adjustment Administration (AAA) promoted agriculture secretary Henry Wallace's "ever-normal granary" with production controls (1934–1935) and conservation programs (1936–1937) before Congress adopted a combined strategy in 1938. To administer these programs and ensure performance, the AAA set up an innovative hierarchy of state, county, and local committees. Experiments in 1935 and 1936 demonstrated that aerial photography provided cost-effective, adequately precise measurements and led to a concerted effort to extend photographic coverage. In 1937, 36 photographic crews flew 375,000 square miles (970,000 square km), and by late 1941 AAA officials had acquired coverage of more than 90 percent of the country's agricultural land. From its initial goal of promoting compliance, the Agriculture Department's aerial photography program became a tool for conservation and land planning as well as an instrument of fair and accurate measurement. Local administration and a widely perceived need to increase farm income fostered public acceptance of a potentially intrusive program of overhead surveillance.

Introduction

The Great Depression of the 1930s hit farmers harder than it did most other Americans. Falling prices for produce and livestock encouraged increased production, which led in turn to even lower prices. Between 1929 and 1932, for instance, the realized net income of the average farm operator fell 69 percent, from $6,264 to $1,928 (U.S. Bureau of the Census, 1965, p. 280). The typical operator had borrowed heavily to buy the tractors used to increase production, and declining receipts forced many farmers to sell out, move on, or seek work in cities plagued by rising unemployment. Without higher and stable prices, those who remained faced a bleak future. And because most farmers did remain, the prospects for lower production and higher prices were not promising.

New Deal Strategies for Agricultural Stabilization

This dismal dilemma of agricultural economics might seem an unlikely stimulus for cartographic innovation. But a mapping connection became inevitable when President Franklin Roosevelt, elected in late 1932, sought to raise farm income and stabilize prices by reducing supply. Because government could not order farmers to plant less, New Deal planners devised a voluntary acreage-reduction program with attractive incentives, local control, and surveillance procedures for promoting fairness and inhibiting cheating. A crucial means of New Deal agricultural surveillance was aerial photography, which provided suitably precise measurements of field size, afforded rapid coverage, and left a cartographic legacy for soils mapping, land-use classification, regional planning, and geographic research.

Like many New Deal programs, agricultural stabilization required incremental fine-tuning (Blaisdell, 1940, pp. 39–75). In May 1933, two months after Roosevelt took office, Congress established the Agricultural Adjustment Administration (AAA) to carry out agriculture secretary Henry Wallace's vision of an "ever-normal granary." Over the next two and a half years, the agency focused on controlling production through voluntary contracts with growers, who agreed to reduce acreage in exchange for benefit payments to offset lost income. Benefits were funded through a tax on processors. In January 1936, the Supreme Court ended production controls by declaring the tax unconstitutional.

Congress quickly adopted a conservation program, which paid farmers to switch from soil-depleting to soil-conserving crops. A schedule of grants for soil-conserving and soil-building practices replaced acreage-reduction contracts, and farmers applied for whatever payments they were eligible. In 1936, which witnessed one of the worst droughts in the country's history, the program diverted 31 million acres to soil-conserving crops. The drought was apparently a stronger incentive than conservation because, when normal rainfall returned the following year, participation in the program dropped, and bumper crops pushed prices downward.

In 1938, Congress adopted a dual strategy, which combined conservation with production and marketing controls. To reduce surpluses of key commodities, the 1938 Farm Act also called for voluntary acreage allotments for corn, cotton, rice, tobacco, and wheat. In addition, the law offered loans to farmers and sought stable prices for livestock, poultry, and dairy products.

With a need to move quickly and secure farmers' cooperation, the AAA set up an innovative hierarchy of state, county,

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and local committees to administer its programs and ensure performance (USDA, 1936, pp. 14–15; USDA, 1963, pp. 143–78). Starting in 1934, the agency established in each state an agricultural conservation committee consisting of three to five members, each representing a key agricultural region or sector. These state committees had both advisory and supervisory roles, including oversight of the county committees, which disbursed funds and checked the performance of individual farmers. At a more local level, township committees consisting entirely of farmers assisted their neighbors in filling out forms and helped the county committee in checking performance and certifying claims.

When conservation became the focal point in 1936, county committees also estimated the acreage of each farm's "soil-depleting base" and verified shifts from soil-depleting to soil-conserving crops (USDA, 1936, p. 15; Blaisdell, 1940, pp. 50–51). A farmer who thought his estimate was inaccurate could appeal to the state committee. In addition to reviewing the work of county committees, the state committees coordinated training and program planning with one of the AAA's five regional divisions, established in 1936 to address the unique problems and practices of farmers in the northeastern, east-central, southern, western, and north-central parts of the country (USDA, 1963, p. 495).

Monitoring Compliance with Aerial Photography

Whether focused on conservation or production controls, New Deal farm policy depended on accurate measurements of field size at the farm level. As Agricultural Adjustment Administrator H. R. Tolley (1937) noted in a 1937 radio interview, "Before we can make any payment, we have to find out what each man applying has done to earn it" (Tolley, 1937). Measurement was especially important under the 1938 Farm Act, which required the Agriculture Department to calculate acreage allotments for each basic crop according to formulas based on the likely size of the year's harvest, and to reallocate the national production quota back to states, counties, and individual farms.

According to Tolley, the agency had "tried out" aerial photography in Oregon and Washington "as early as" 1934, but "didn't do much of it until [1936]" (Tolley, 1937). What "tried out" means is described in a short report titled "Converting Aerial Photographs to Farm Acreage," by L. O. Howard (1936), chief engineer for the Whitman County Wheat Production Control Association, in eastern Washington. According to the 1935 Census of Agriculture, Whitman County had more than 2,700 farms and over a half million acres (200,000 ha) of harvested cropland, making it one of the state's largest agricultural counties, and wheat was the dominant crop (U.S. Bureau of the Census, 1936, Vol. 1, p. 915). As chief engineer, Howard supervised a staff of 13, which included six planimeter operators, who measured area directly from the air photos; five assistants, who assembled and mounted photographs, recorded results, and checked calculations; and a two-man field crew, which took ground measurements used in estimating scale. In addition, a general supervisor and four field foremen directed the work of 20 field crews of two men each. A large field force was needed to meet with farmers and inspect fields directly. As Administrator Tolley told his radio audience, even though "the farmer-committeemen can identify fields and landmarks on the pictures . . . they always go out to the field and identify the crops before they put it down in the record. The purpose of the pictures is not to identify crops but to provide accurate measurements" (Tolley, 1937).

According to Howard (1936), "the Government insisted on an accuracy within 1% of the true acreage." Although well aware of scale variations resulting from Whitman County's rolling topography, he never mentioned "tilt" or the use of optical or trigonometric correction in his report, which describes the use of known ground distances to correct the "assumed scales furnished by the flyers." He reported that "repeated checks have been made where surveys were available and the results have in many cases been astounding." A list of acreages based on aerial and ground surveys for six representative farms indicated deviations of no more than half a percent.

Engineers in the AAA's northeast region were wary if not equally naïve about tilt, which is not mentioned once, by name, in an eight-page 1938 instruction bulletin for county committees within the region. Titled *Procedure for Determination and Report of Performance—Use of Aerial Photographs in Determining Performance*, the manual contained concise instructions for using and caring for photographs, identifying farms, and determining acreage with a planimeter (USDA, 1938a). It reported that photos were often divided into "two or more zones each of which will have an individual scale or correction factor." To determine a field's area in acres, the planimeter operator merely multiplied the measured area in square inches by a scale factor, determined beforehand by the state office and drawn, together with blue zone lines, on the face of each print. An updated version issued the following year attributed scale variation to "tilt and topographic relief" but was equally silent about procedures for delineating zone boundaries or estimating scale factors (USDA, 1939).

By contrast, a 47-page mimeographed *Manual of Practice*, distributed to state offices in the Southern Division, outlined procedures for annotating photographic prints used by county committees (USDA, 1938b). In addition to "establishing an adequate and uniform standard" for inspecting photography received from other government agencies and private contractors, the manual provided guidelines for the field measurement of ground-control lines by odometer, steel tape, plane table, or transit; the use of scale-check lines and scale points in calculating scale factors and adjusting for relief; the estimation of tilt and the identification of a photograph's nadir point and isocenter; and the zoning of areas of equal scale on tilted photographs or for terrain with "excessive relief." In essence, zone boundaries were delineated on enlarged prints so that field sizes calculated from the scale-adjustment factor and a precise planimeter measurement would not differ by more than one percent from their true value.

Photogrammetrists working with the AAA were skeptical about the agency's shortcuts as well as the quality of its imagery. In a 1937 article in *Photogrammetric Engineering*, C. S. Coblentz (1937), an engineer with the state committee in Indiana, reported that "the average tilt [of photography used in one relatively flat county was] approximately two degrees, and it was not uncommon to find photographs with five and six degrees tilt." Although uncorrected area measurements might have errors as large as five percent, adjustment for tilt and scale deviations could reduce error to one percent or less. In a longer article two years later, Coblentz (1939) criticized the practice of using a single ground measurement to estimate scale for every fifth or sixth frame along a flight line and then using linear interpolation to estimate the scale of intervening frames. He reported average errors of three percent (compared to ground surveys based on transit and steel tape) and recommended the use of enlarged prints rectified with a tilt easel if the agency was at all serious about its one percent accuracy standard.

Despite this uncertainty, aerial measurement could be more efficient, less expensive, and possibly more accurate than ground-traverse surveys. In a short report to the American Society of Photogrammetry, W. N. Brown (1936) described a 1935 experiment involving six counties spread across five states. Despite the claim that "accurate cost was kept on each step of the operation based on weekly reports from each county," he presented only one number to support the conclusion that aerial survey was more efficient than ground traversing, namely, a saving of "at least 33%" if the original negatives could be used for five years—a reasonable assumption insofar as farmers seldom altered field boundaries.[1] A year later, a more convincing report by C. S. Coblentz (1937) identified 75,000 acres (30,000 ha) of cropland as the county threshold beyond which aerial photography was appreciably more efficient than ground traversing.

Harry Tubis (1937), a photogrammetrist with the Tennessee Valley Authority on temporary assignment to the East Central Division of the AAA, summarized progress in acquiring photography in a short paper in *Photogrammetric Engineering* in April 1937. Tubis and Marshall Wright, of the Soil Conservation Service, had served as technical advisors to the Agriculture Department's Land Policy Committee, which interviewed representatives of each region before drawing up agency-wide specifications for acquiring new or existing aerial imagery. Informed by standards developed by the newly formed American Society of Photogrammetry, the AAA's specifications included average forward overlap of 65 percent and average sidelap of 30 percent, flight lines with either a north-south or east-west orientation, maximum crabbing of 10 percent, a maximum average tilt for the "entire project" of one percent, and a scale of 1:20,000 (accurate to within 5 percent) for negatives and contact prints. To promote accuracy, planimeter operators typically worked with "ratioed" prints individually enlarged (to 1:7,920 scale) so that one inch represented 660 feet (1/8th mile).[2]

According to Tubis (1937), the agency's photogrammetric efforts from 1934 through 1936 were largely experimental, and included the planning phase preceding an ambitious 1937 program, two new photographic laboratories (at Washington, D.C., and Salt Lake City), the acquisition of roughly 385,000 square miles (1,000,000 sq km) of photography from other government agencies as well as several private companies, and the commissioning of 375,000 square miles (970,000 sq km) of new photography. This new imagery—"itself a mile-stone in the development of aerial mapping"—was good news, no doubt, for the emerging profession of photogrammetry as well as for out-of-work civil engineers. In late 1933 the journal *Science* reported the hiring of many unemployed engineers for a "crash mapping program" in ten southern states (Science, 1933).

[1]Brown's (1936) treatment of "accuracy of measurement" is equally dubious. One of his two tables compared average measurements, by state, for 173 fields surveyed using both aerial photography and ground traverses. If field size is the key measurement, of what value are state totals when a substantial overestimate for one field could largely compensate for a considerable underestimate elsewhere? More outrageous is the table's summary row, which reported only a 0.3 percent difference between methods for the combined area of all 173 fields. His second table, which compared measurements for six fields on two farms in North Carolina, is only slightly more informative. Although the deviations for these six arbitrarily selected individual fields ranged from 0.8 to 7.1 percent, nowhere did Brown address the range and distribution of individual errors.

[2]Guidelines prepared in the AAA's North Central Region (USDA, 1937) provide insights on the use of ground control and ordering of enlarged prints in one division's state offices. In addition to recommending distance measurement along section-line roads with a steel tape or chain in relatively level counties and with chain or stadia rod elsewhere, the guidelines called for depositing copies of county-level photo-index maps with the divisional office, the state office, and the county office. Because the bulletin refers to a separate inspection of photography but makes no mention of tilt, I infer that the North Central division did not delineate zones with separate scale factors, as did the Southern division, where relief was generally greater. In the North Central division, photography showing excessive tilt was apparently rejected and reflown.

Expanded Aerial Coverage

Tubis's (1937) article included a map (Figure 1) showing where aerial mapping of farms had been scheduled for 1937. Project areas included California's Central Valley, the southern Piedmont, the upper Mississippi Valley, and the potato lands of Aroostook County, Maine. A concentration of mapping in the eastern parts of the Dakotas, Nebraska, Kansas, Minnesota, Iowa, and Missouri suggest the apportionment of compliance surveillance among key farming states, within which aerial mapping was focused on each state's more productive agricultural counties. An accompanying table listed separately the areas (in square miles) of new and existing photography for each of the AAA's five regions. The South led the other four regions in both categories, perhaps because of concern over excess production of cotton and tobacco. Although project areas scheduled for 1937 covered only a fraction of the nation's farmland, agency administrator H. R. Tolley (1937) "hope[d] to finish the job by the end of 1940."

If the AAA didn't meet its target, it must have come close. In a 1949 article in *Photogrammetric Engineering*, Ralph Moyer (1949), chief of the agency's Aerial Photographic and Engineering Service, observed that "aerial photographic coverage had been secured for practically all of the agricultural land in the country prior to the start of World War II." Indeed, a 1941 report by the Land Committee of the Natural Resources Planning Board (NRPB, 1941, p. 37) credited the AAA with having "expanded coverage enormously" but also noted that the agency used its photos "exclusively" for measuring field size.

Operations changed radically after the United States entered the war in late 1941. The government refocused its aerial photographic efforts on military intelligence, and the USDA contributed its photogrammetric expertise and laboratories to the war effort. With the nation at war, the agricultural surplus became less a curse than a blessing, but the need for production controls returned in the late 1940s (Moyer, 1949). Broad areas needed to be reflown because field boundaries had changed and some of the earlier imagery was substandard. A 1946 internal memorandum of the Production and Marketing Administration (as the AAA was by then known) reported that "many of the photographs now in use in county offices [had] become badly worn through long use during the war years" (USDA, 1946). Even so, a 1947 U.S. Geological Survey aerial photography status map (Figure 2) showed the USDA as holding the most generally usable coverage for about half the nation—more than the Department of the Interior, the War Department, the Tennessee Valley Authority, and all other federal and state agencies and commercial firms combined.

Adoption of aerial photography by the AAA had substantial and lasting effects on agriculture and mapping. Among the more obvious benefits are cost-effective compliance monitoring, experienced photogrammetric personnel for the war effort, and imagery support for soils mapping and regional planning. At the national level, the photos helped Census Bureau personnel organize and conduct the 1945 Census of Agriculture (Science, 1944). At the more local level, air photos fostered communication between farmers and conservation extension agents, who distributed aerial prints of individual farms with fields carefully marked as an aid for working out a multi-year crop rotation and conservation plan (Moyer, 1950).

Conclusion

The photogrammetric leitmotif at the AAA changed in less than a decade from optimistic, somewhat lax expediency to cautious pragmatism bolstered by a more systematic treatment of error. Equally remarkable from the present perspective is the apparent absence of any popular resistance to the government's use of overhead imagery, which could—at least in retrospect—be perceived as an intrusive form of surveillance. Although the

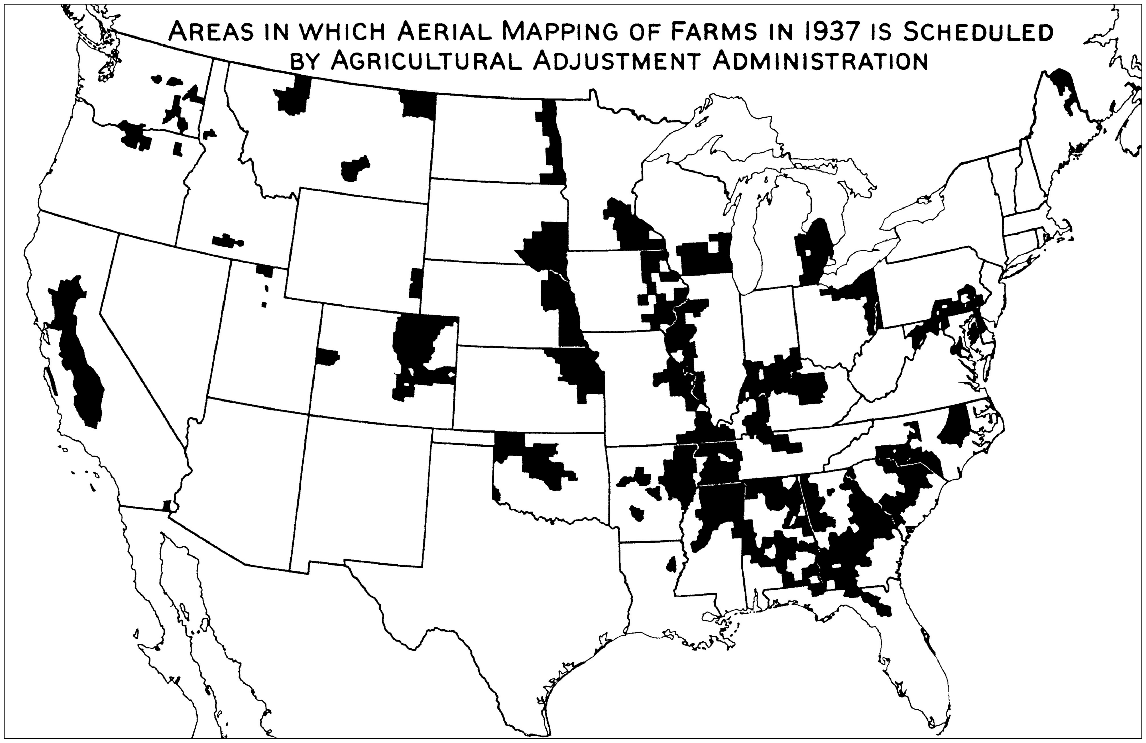
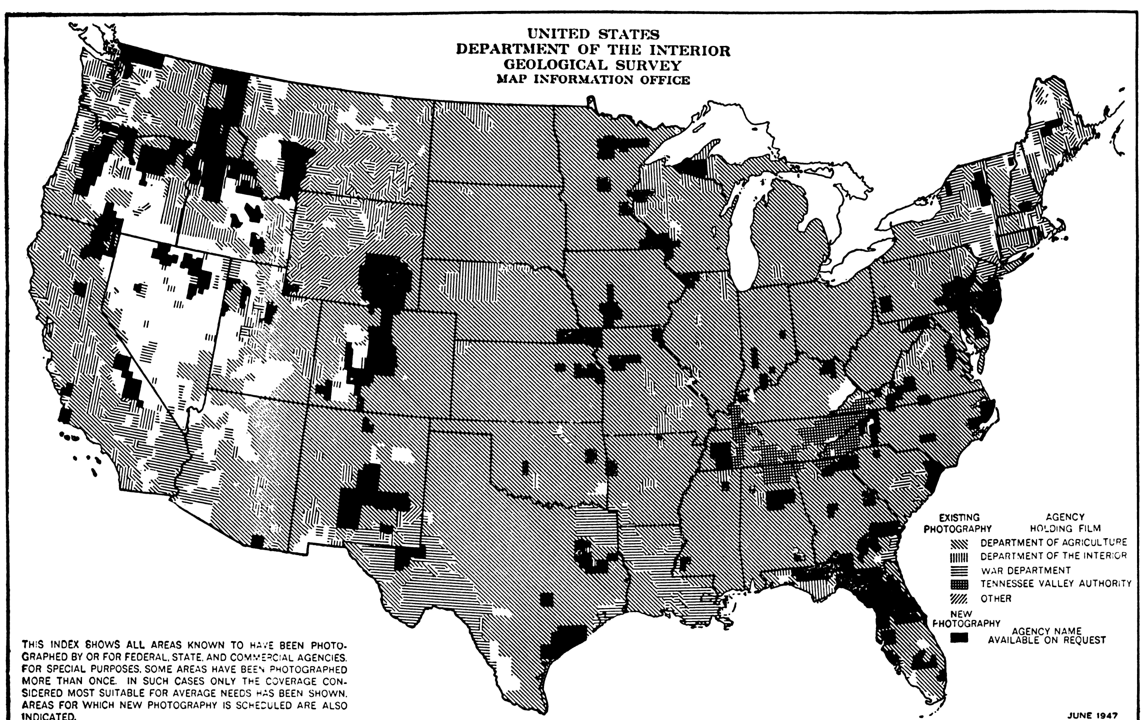


Figure 1. Areas selected for aerial compliance mapping by the Agricultural Adjustment Administration during 1937. Source: Tubis (1937, p. 22).



U. S. Geological Survey

Figure 2. Status map of aerial photography in the United States, June 1947. U.S. Geological Survey map reproduced in Spurr (1948, p. 66).

photography later proved useful for other types of mapping, the AAA's single-minded emphasis on area measurement hardly seemed threatening. Even so, this pursuit of precision no doubt contributed to the rarity of cheating, as did the broadly inclusive use of township and county committees with state and divisional oversight. In a sense, the AAA might be said to have pioneered the concept of public participation GIS.

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