changes in the past, it should be possible to predict more accurately what they will do under similar conditions. Also, when a satifactory rapport has been developed between the University and individual cooperators, many types of supplementary reports from the cooperators are feasible.

The study reported has answered some questions regarding the possibilities of establishing representative sample of farmers reporting financial information on a monthly basis. The experience gained has been valuable and is expected to lead to other investigations of a related nature.

Evaluation of Agricultural Flood Damage by Airphoto Analysis of Flood-Plain Samples

By Kenneth C. Nobe and Henry W. Dill, Jr.

The United States Department of Agriculture is cooperating in an interagency study to plan for the future development and control of the water resources of the Potomac River Basin.[1] One assignment undertaken by the Farm Economics Research Division, Agricultural Research Service, is that of appraising both the agricultural damages from floods, and the benefits from alternative combinations of control structures on the main stem and the major tributaries of the Potomac River. Techniques were developed for using sample cross-sectional data and airphoto interpretation, rather than the conventional detailed field surveys, to help us measure agricultural damage from floods. This paper discusses the development of these techniques and indicates how they may be applied to flood-damage studies in other areas.

ECONOMIC EVALUATION of agricultural damage from floods is an integral part of studies designed to plan for future development and control of land and water resources. It is of particular importance in the design and justification of flood-control and multiple-purpose projects in rural areas. To compute benefit-cost ratios accurate flood-damage data are required, and these in turn are necessary for economic evaluation of individual water-control structures and for comparison of alternative projects. A benefit-cost ratio as used in this type of analysis is defined as "the arithmetic proportion of estimated average annual benefits to average annual costs, insofar as these factors can be expressed in monetary terms".[2]

Background Data

Four main types of data are required for the economic evaluation of agricultural damage from floods: (1) Flood frequencies; (2) areas inundated, by stage of flooding; (3) physical data on land use, yields, management practices, and inputs of land, labor and capital; and (4) economic data on value of inputs and returns to land in the flood plain, including economic losses from past floods. Necessary also are projections of future conditions, with and without a flood-control project. Combining these data into an economic evaluation is at best a complex process; it is limited further by lack of data on flood stage-land area inundated relationships in map form.

[1] The Corps of Engineers, U.S. Army, is authorized to prepare a comprehensive plan for the development and conservation of water and related resources in the Potomac River Basin. Participating in this study are the U.S. Departments of Agriculture, Commerce, Interior, Health, Education, and Welfare, the Federal Power Commission, Atomic Energy Commission, Interstate Commission on the Potomac River Basin, National Capital Regional Planning Council, and Advisory Group for the Potomac River Basin, as well as other State and Federal agencies interested in the development of the Potomac Basin.

[2] Schwartz, H. E. DETERMINATION OF FLOOD FREQUENCIES IN A MAJOR DRAINAGE BASIN. Extrait des Compes Rendus et Rapports, Assemblee Generale de Toronto, 1957.

Maps showing stage-area relationships would be the ideal base for study of the effect of flooding on present land use and cropping systems. They would serve also as a base for locating areas in which land use had changed in the past and in which land enhancement would be expected as a result of varying degrees of flood control from potential structures. The lack of stage-area maps for the Potomac River led to a test of an alternative method of determining stage-area relationships that would allow for correlation of land use to stage of flooding.

The use of airphoto interpretation as a tool for flood-damage appraisal was suggested by a report on a study carried out by the New England-New York Inter-Agency Committee.[3] The Potomac Survey differs from the New England-New York study, in that for the latter, stage-area maps were available for part of the study area. For the Potomac Survey, it was necessary to find a substitute for stage-area maps. Limitations of time and funds precluded detailed cross-sectional mapping and the transfer of such field information to airphotos by using photogrammetric plotting equipment. A test project was carried out, therefore, to learn whether the use of airphoto interpretation, combined with a field survey of a sample of representative river valley cross sections, could provide us with a reasonably accurate estimate of overall stage-area relationships.

How Data Were Obtained

Potomac River mile 203, which is approximately 5 miles southwest of Williamsport, Md., was chosen as the test area and was later studied in the field (figs. 1 and 2). This section of the river is characterized by a relatively broad flood plain in agricultural use on the inside bend of the river, and a narrow wooded flood plain on the outside bend.

The inundation line of the 1936 flood (flood of record) was superimposed on an airphoto of the test area. This was later broken into four strata, each a half mile in length. Strata 1 and 3 occur on the West Virginia side and strata 2 and 4 on the Maryland side. In each stratum, the point was chosen at random and a straight line was drawn through it in such a way that it intersected the river at a right angle to the tangent of the river.

Cross-sectional data were obtained along these lines. They were used to represent the stratum in which they occurred, and measurements were weighted equally to represent total flood-plain land in the study area. The upper edge of the river bank (point of zero flooding) was set at 18 feet, and the 1936 floodline at 43 feet.[4] This allowed for the delineation of 5 flood-stage lines spaced at 5-foot intervals in elevation.

The elevation points were plotted on an airphoto and measured with a 0.0001-foot scale ruler—0.0001 foot is equal to 20 feet lineal distance—and recorded by stage (table 1). Stage totals were expressed as percentages and applied to the calculated total acreage of the flood plain (based on a dot grid count of delineated flood-plain area), to obtain acreage by stage.

Total of the stage 1 measurement figures, for example, is 0.0019; for all stages, it is 0.0176. Stage 1, therefore, includes 10.8 percent of the total flood-plain area (0.0019/0.0176). The calculated total acreage of the flood-plain area is 202 acres; therefore, the flood-plain acreage in stage 1 is 21.8 acres (10.8x202).

Airphoto analysis was used to ascertain land use by stage. Four major types of land use were measured—cropland, woodland, pasture, and other (industrial, residential, transportation routes). These calculations are shown in table 2. The distance measured in stratum 1, stage 1, for example, is 0.0006; it falls in the woodland category. For stage 2 in stratum 1, the total measured distance is 0.0035; of this total 0.0015 is cropland and 0.0020 is woodland. The recorded measurements of the four strata were weighted equally, and the totals were converted to percentages. The percentages in turn were applied to the total flood-plain acreage to indicate land use by stage (table 2).

[3] Dill, H. W. Jr. PHOTO INTERPRETATION IN FLOOD CONTROL APPRAISAL. Photogrammetric Engineering, March 1955.

[4] Calculations based on the Shepherdstown flood gage suggest that these assumed elevations approximate closely the actual situation in the study areas.

TABLE 1.—*Estimated total acreage of flood plain by stage, Potomac River mile 203, reach P–3* [1]

Airphoto measurements	Flood-plain stages					Total
	Stage 5 (1,936 to −5)	Stage 4 (−5 to −10)	Stage 3 (−10 to −15)	Stage 2 (−15 to −20)	Stage 1 (−20 to river)	
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Stratum 1	0. 0004	0. 0006	0. 0012	0. 0035	0. 0006	0. 0063
Stratum 2	. 0003	. 0004	. 0009	. 0007	. 0002	. 0025
Stratum 3	. 0005	. 0006	. 0009	. 0053	. 0006	. 0079
Stratum 4	(2)	(2)	(2)	. 0004	. 0005	. 0009
Total	0. 0012	0. 0016	0. 0030	0. 0099	0. 0019	0. 0176
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Percentage [3]	6. 8	9. 1	17. 0	56. 3	10. 8	100. 0
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Acreage	13. 7	18. 4	34. 4	113. 7	21. 8	202. 0

[1] The estimated total acreage is given at 202 acres, a figure arrived at by airphoto analysis. Measurements were made on airphotos by a scale of 0.0001 feet=20 feet lineal distance. The percentage of total acreage in each stage is based on 4 hypothetical cross-sections of the flood-plain area. The individual cross-sections were limited to one side of the river in each case.

[2] Insignificant amounts.

[3] The percentages of total lineal distance across the entire flood plain (as measured on airphotos) that lie within individual stages are synonymous with the percentages of the 202 acres in river mile 203 that lie within these stages.

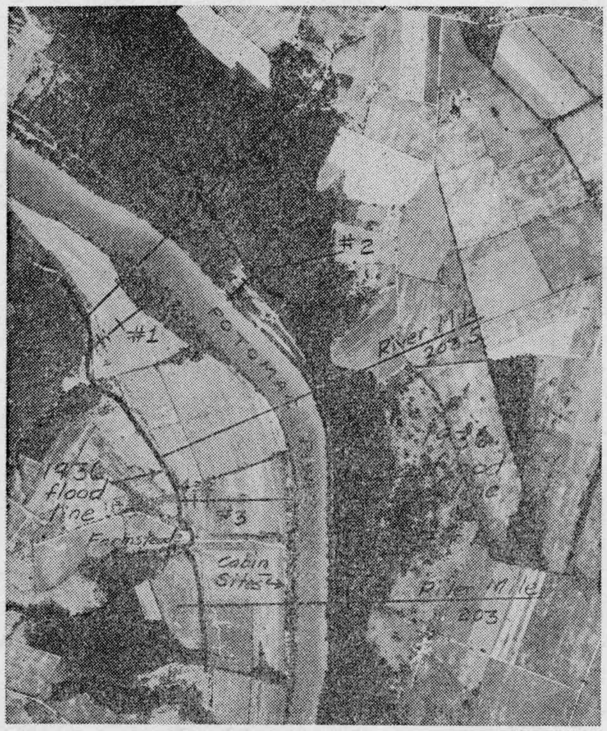

FIGURE 1.—Flood plain land along mile 203 of the Potomac River. Study cross-sections are shown by number. The dark areas are woodland, the light gray areas cropland. There are cabins in the narrow band of woodland on the left bank of the river. Airphoto from Commodity Stabilization Service, U.S. Department of Agriculture. Scale 1 : 20,000.

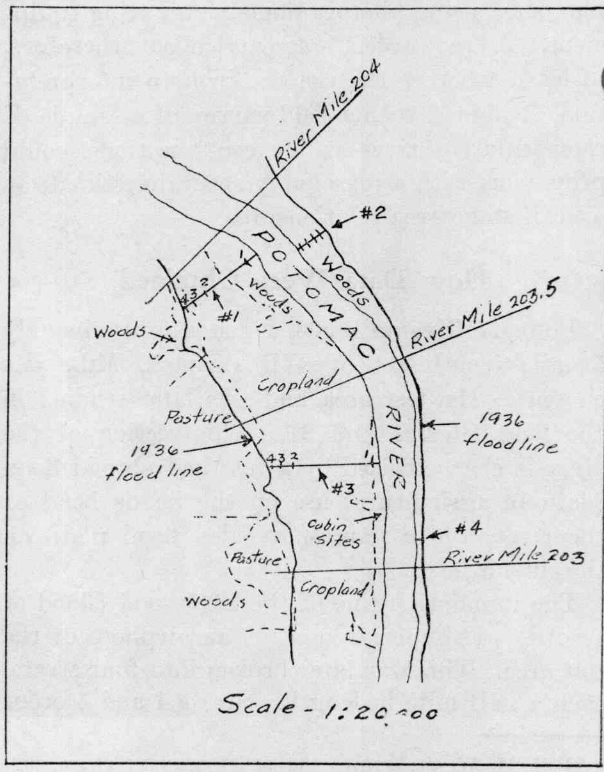

FIGURE 2.—Sketch of major land uses shown in airphoto reproduced in figure 1.

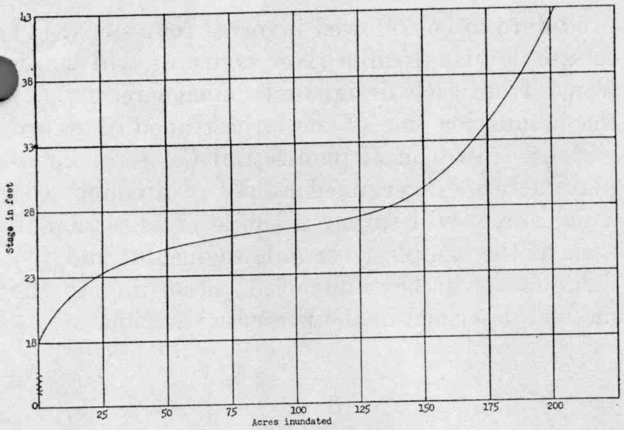

FIGURE 3.—Flood stage-land area inundated relationship for mile 203 of the Potomac River.

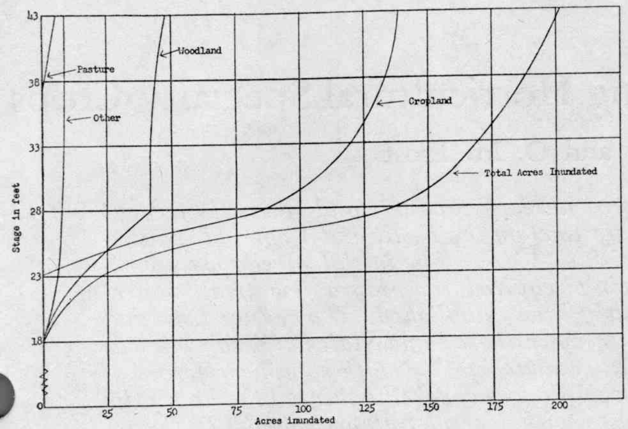

FIGURE 4.—Flood stage-land use-area relationships for mile 203 of the Potomac River.

The data included in tables 1 and 2 were used to construct stage-area curves for the test area (figs. 3 and 4). Figure 3 shows total area (in acres) in relation to flood stage in feet. Figure 4 shows both a total area curve as well as individual curves for each land use. A visual comparison of these curves with figures 1 and 2 begins to bear out some of the relationships shown in these curves. The combined area in stages 2 and 3, for example, can be verified as a high proportion of the total flood-plain area. Figure 1 also indicates that most of the pasture acreage occurs in stage 5 and that a high proportion of the woodland is in stage 1.

Application of Findings

The results of this test case indicate that reasonably accurate stage-area relationships can be ascertained from data obtained from a sample of river-valley cross sections. Damage estimates by

TABLE 2.—*Estimate of land use of flood plain by stage, Potomac River mile 203, reach P–3* [1]

Airphoto measurements	Crops	Woods	Pasture	Other
FLOOD PLAIN STAGE 5				
Stratum 1 .... foot	---	---	0. 0004	---
Stratum 2 .... do	---	0. 0003	---	---
Stratum 3 .... do	0. 0005	---	---	---
Stratum 4 .... do	[2]	[2]	[2]	[2]
Total .... do	. 0005	. 0003	. 0004	---
Percentage of area acres	41. 7	25. 0	33. 3	---
Acreage .... do	5. 7	3. 4	4. 6	---
FLOOD PLAIN STAGE 4				
Stratum 1 .... foot	. 0005	---	. 0001	---
Stratum 2 .... do	---	. 0002	---	0. 0002
Stratum 3 .... do	. 0006	---	---	---
Stratum 4 .... do	[2]	[2]	[2]	[2]
Total .... do	. 0011	. 0002	. 0001	. 0002
Percentage of area acres	68. 8	12. 5	6. 2	12. 5
Acreage .... do	12. 7	2. 3	1. 1	2. 3
FLOOD PLAIN STAGE 3				
Stratum 1 .... foot	. 0012	---	---	---
Stratum 2 .... do	. 0009	---	---	---
Stratum 3 .... do	. 0009	---	---	---
Stratum 4 .... do	[2]	[2]	[2]	[2]
Total .... do	. 0030	---	---	---
Percentage of area acres	100. 0	---	---	---
Acreage .... do	34. 4	---	---	---
FLOOD PLAIN STAGE 2				
Stratum 1 .... foot	. 0015	. 0020	---	---
Stratum 2 .... do	. 0007	---	---	---
Stratum 3 .... do	. 0053	---	---	---
Stratum 4 .... do	---	. 0004	---	---
Total .... do	. 0075	. 0024	---	---
Percentage of area acres	75. 8	24. 2	---	---
Acreage .... do	86. 2	27. 5	---	---
FLOOD PLAIN STAGE 1				
Stratum 1 .... foot	---	. 0006	---	---
Stratum 2 .... do	---	. 0002	---	---
Stratum 3 .... do	---	---	---	. 0006
Stratum 4 .... do	---	. 0005	---	---
Total .... do	---	. 0013	---	. 0006
Percentage of area acres	---	68. 4	---	31. 6
Acreage .... do	---	14. 9	---	6. 9

[1] The estimated total acreage is given at 202 acres, a figure arrived at by airphoto analysis. Measurements were made on airphotos by a scale of 0.0001 feet=20 feet lineal distance. The percentage of total acreage in each stage is based on 4 hypothetical cross-sections of the flood-plain area. The individual cross-sections were limited to one side of the river in each case.

[2] Insignificant amounts.

stage are possible when these data are combined with flood-loss data. It indicates further that airphoto-interpretation techniques and sample cross-section data are useful tools in situations in which stage-area maps and other necessary hydrological data are lacking.

The general approach used in the test case has been accepted for use in the evaluation of agricultural flood damages on the main stem and major tributaries of the Potomac River. The procedure to be followed involves four steps: (1) A sample of half-mile river segments will be selected from each designated damage reach; (2) the inundation line of the largest flood of record will be drawn on airphotos and the total flood-plain acreage determined by dot grid count; (3) a field crew will survey a single cross-section in each of the sample river-mile segments; and (4) field data will be summarized according to the method described in the preceding section.

Comparative Methods of Surveying Horticultural Specialty Crops

By R. A. McGregor and O. M. Frost

A program of estimates covering eight classes of nursery products and four selected cut flowers grown in 5 States was undertaken in late 1956 by the Fruit and Vegetable Statistics Branch of the Agricultural Estimates Division, AMS. The initial survey was an almost complete enumeration with estimates being required for only a few small nonrespondents whose size of operation had previously been established. To reduce time and costs, random sampling was tested in a 1957 survey in these same States. A sample was drawn to measure 1957 sales in relation to those made in 1956 with sampling errors of about 2 percent by States for each item. The sample was checked against (1) the results obtained from a general mailing to all producers with several followups and (2) the results obtained from similar mailings and followups of large nonrespondents by personal interview. Final results show that more accurate estimates are obtained from general mailings to all known producers with selective followups of the larger nonrespondents.

IN DECEMBER, 1956, the Fruit and Vegetable Branch of the Agricultural Estimates Division, Agricultural Marketing Service, began a new program of crop reports on the horticultural specialties industry. Five States were selected for a pilot study on the basis of their geographic distribution and importance in the industry.

Considerable time was spent in assembling a list of nearly 8,700 potential producers in California, Colorado, Florida, Illinois, and Iowa. Each was mailed a questionnaire which sought information on size and type of production. Approximately 90 percent answered the inquiry after five mailings were made. Nonrespondents were classified by personal contacts or from information obtained from secondary sources.

About 2,800 qualified as commercial growers of the products to be estimated in future surveys. A commercial producer is defined as one who grows and sells in a calendar year cut flowers, flowering plants, or nursery products with a total value of $1,000 or more.

The first production survey, made during the winter of 1956–57, covered four selected cut flowers and eight classes of nursery products. The mailed inquiry yielded an 80-percent return. Four general mailings, followed by special delivery airmail letters to larger nonrespondents, were used to obtain this return. Followup work through personal contact was concentrated on larger growers.

The data were summarized by seven size strata established after the initial enumeration. They covered 97 percent of the estimated sales of four selected cut flowers and 94 percent of the estimated sales of eight classes of nursery products.