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resident or family over the 14-year period covered in the accompanying tables may differ greatly from those suggested by global figures. As shown in table 2, disposable income per capita of the farm population increased from \$345 in 1941 to \$840 in 1954, a rise of 143 percent. During the same period, the increase for the entire population was about 125 percent—from \$697 to \$1,569. But present indications suggest a continued rise during 1955 in the per capita disposable income of the population at large, whereas a drop is anticipated for the farm population. The effect of these changes will probably be to bring disposable income per capita of the farm population to a figure approximately half of the national average.

In table 3, the USDA index of prices paid for farm family living is used to deflate both the aggregate and the per capita amounts of disposable income into dollars of 1947-49 purchasing power. Expressed in these terms, income of the farm population has declined steadily since 1951, and has been below the 1941 level in each year since 1952. The estimate for 1954 shows constant-dollar disposable income of farm people to be about 5 percent below that of 1953 and 17 percent below 1941. On a per capita basis, disposable income in 1954 had a purchasing power well above that of 1941 and slightly greater than 1949, but lower than that of any other year in the period covered.

Economics of Small Watershed Development*

By Harry A. Steele

Passage of the Watershed Protection and Flood Prevention Act has focused attention on the small watershed development program.¹ The strategic problems involved are those that center around management of land and water and the resulting effects on water runoff, soil erosion, and sedimentation. Significant among these problems are those of water-management, which require action by groups of landowners, communities, and local government. Not all small watersheds have significant interfarm problems. Some have problems that can be solved by individual farmers through land-treatment measures and practices. Floodwater retarding structures, levees, floodways, irrigation structures, drainage installations, gully stabilization, streambank control, highway stabilization, and revegetation of critical runoff and sediment-source areas will be needed for watershed development. In planning and installing these types of measures, assistance is available under the Watershed Protection and Flood Prevention Act. This discussion is concerned with the legislative development of the program, its dependence on economic appraisal, and the economic research needed to make it fully effective.

ALTHOUGH there was considerable discussion of upstream measures for control of floods before 1900, one of the earliest acts specifically aimed at this purpose was the Weeks Forest Purchase Act, passed in 1911. This act, later amplified by the Clark-McNary Act of 1924, provided for the acquisition of forest lands at the

headwaters of streams with a view to controlling runoff. The administration of national forests also implied responsibility for flood control and water conservation.² In 1928, the Mississippi Flood Control Act authorized the Secretary of Agriculture to study ways in which forestry might aid control of Mississippi River floods.³

*This paper was given in part at a meeting of the Committee on Water Resources Development, Western Agricultural Economics Research Council, Pullman, Wash., June 27-29, 1955.

¹ Public Law 566, 83d Congress, 68 Stat. 666.

² GRAY, L. C. REPORT ON FLOOD CONTROL SURVEYS, May 1939. Bur. Agr. Econ. (Unpublished.)

³ U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF LAND USE COORDINATION, THE LAND IN FLOOD CONTROL, U. S. Dept. Agr. Misc. Pub. 331, 38 pp., illus.

The McSweeney-McNary Act of that year authorized investigations to find ways to prevent erosion and control water runoff. In 1929 the Congress provided for the establishment of field research stations to develop measures for preventing erosion and retarding runoff. Legislation passed in 1933 for relief of unemployment authorized work to prevent forest fires and soil erosion.

In 1935 the Congress took a major step in establishing the Soil Conservation Service, declaring it to be the policy to provide permanently for control and prevention of soil erosion and thereby to preserve natural resources and control floods. In that year also, the Fulmer Act authorized the Secretary of Agriculture to enter into cooperative agreements with the States in a national program for better management of forest lands. The Soil Conservation and Domestic Allotment Act, which became law in 1936, included flood control among its major objectives.

The year 1936 is even better known because it was the year in which the first comprehensive national flood-control act was passed. The 1936 Flood Control Act provided that the U. S. Army Corps of Engineers should make Federal investigations and improvements of rivers and other waterways for flood control, and that the United States Department of Agriculture should make Federal investigations of watersheds and install measures for retardation of runoff and waterflow and for prevention of soil erosion on watersheds. This act designated a list of watersheds that would be surveyed, the Secretary of War to make the flood-control surveys and the Secretary of Agriculture the surveys for the runoff and water retardation. In 1937, the Water Facilities Act authorized the Department of Agriculture to assist individual farmers and groups of farmers to make better use of water in the 17 Western States. Again in 1938, the Secretary of Agriculture was authorized and directed to make surveys and preliminary examinations for flood control in designated watersheds.

Under these authorizations, the Department of Agriculture became a partner with the Corps of Engineers in developing Federal programs for watersheds for the purpose of flood control. From 1937 through 1943, the Department of Agriculture completed (1) preliminary examinations to determine whether detailed surveys were justified for 154 watersheds, covering 1¼ million square miles;

(2) detailed surveys including plans for programs for 18 watersheds covering 100,000 square miles and, (3) appraisals of flood damage for 40 additional areas in cooperation with the Corps of Engineers. In addition to completed investigations, approximately 50 examinations and 32 surveys were initiated but were later deferred because of World War II.⁴ In 1944, Congress authorized the Department of Agriculture to install works of improvement on 11 watersheds.

After World War II ended, surveys were resumed by the Department of Agriculture. A number begun before the war were completed and new ones were started. From 1945 to 1954, policies relating to watershed management were somewhat unsettled. There were differing viewpoints within the Department, the Bureau of the Budget, and the Congress. One view was that plans should be made for flood control on small or intermediate sized watersheds following the pattern of the 1936 act. Another group wanted to plan on a comprehensive basis for entire river basins, with segments of the work determined by administrative action.

Because of resulting uncertainties, changing policy, and modification of procedures, few surveys were completed and still fewer were sent to Congress during this period. The Committee on Agriculture of the House of Representative pointed out that in 17 years more than \$17 million had been spent on preliminary examinations and sized watersheds following the pattern of the 1936 Flood Control Act. More than 1,000 surveys had been authorized; 58 were completed, and only 11 projects had been authorized by the Congress. No single upstream river-basin project had been completed.⁵

The House Agriculture Committee held a public hearing in August 1950 on the proposed agricultural program for the Missouri Basin, which for the first time outlined the size of the watershed-protection job for a major river basin. Field hearings were held by the House Agricultural Committee in the fall of 1951. These hearings indicated that public support for a watershed program was widespread. The Committee concluded

⁴ WOOTEN, H. H. THE AGRICULTURAL FLOOD CONTROL PROGRAM, *JOUR. Land and Public Utility Econ.*, February 1946, pp. 35-47.

⁵ SOIL CONSERVATION AND WATERSHED PROGRAMS, HR Report No. 1140, 83d Congress, 2d s.

that a serious gap exists between the soil and water conservation program on farms and the large water-control structures in major river developments; that the work in small watersheds could proceed without waiting on major river structures; and that the watershed projects should be cooperative among the Federal Government and States, local governments, and local people. So far as possible, each should bear an equitable portion of the cost.⁵

Watershed Protection and Flood Prevention Act

Several watershed bills were introduced in 1952 and 1953 but no action was taken. In 1953, an amendment to the Appropriation Bill was passed which provided funds for starting pilot projects in 62 watersheds. These projects were designed to demonstrate the watershed program and provision was made for evaluating the results.

In 1954, the Congress passed the Watershed Protection and Flood Prevention Act. The main change from earlier bills is the greater emphasis on State and local responsibility. Federal activities are limited to aiding local organizations in undertaking the work. Although the 1936 Flood Control Act carried a requirement that local interests would furnish rights-of-way, and pay for operation and maintenance, the initiative for undertaking each project and the responsibility for its completion was with the Federal Government.

Thus, we have moved from Federal initiative and responsibility in selection of projects, planning, construction, and maintenance, as set out in the 1936 act, to a situation under the 1954 act in which the major initiative and responsibility for these functions rests with local organizations.⁶

The Watershed Protection and Flood Prevention Act pertains to water-management measures that are beyond the capabilities of individual farmers but that are needed to complement and make more effective the soil- and water-conservation measures on farms and to serve or protect the watershed community. Watershed-protection measures lie between the programs for soil- and water-conservation on farms, and large water-control structures in major river developments. The act places the responsibility for initiating

⁶ YOUNG, GLADWIN E. LOCAL RESPONSIBILITIES FOR WATERSHED PROTECTION PROGRAMS. *State Government* 27 (12): 255-257, December 1954.

watershed programs on local organizations.⁷ Local people must apply for assistance on watershed projects. They must participate in the planning, financing, and construction of the projects, and must arrange for maintaining works of improvement installed under the act. Watershed projects are to be locally sponsored with Federal participation rather than Federal projects with local participation.

Decisions Involved in Developing a Project

A series of decisions is involved in developing a watershed program. In each step in the process those in positions of responsibility must use judgment to arrive at rational decisions. Many factors are taken into account, but throughout the process there is a weighing of the probable costs and returns of the program.

We are concerned here with economic analysis, as it may improve the decision-making process. Following is a partial list of decisions that must be made in developing a watershed project.

The local organization must decide whether the watershed problems are serious enough to warrant preparing an application for a project. They must decide whether a program is likely to be worth while and worth working for. Although precise economic analysis is not practicable at this stage, there must be a weighing of benefits and costs in the minds of those involved. Even at this early stage, the probable incidence of benefits in relation to costs is a factor.

When an application has been prepared by a local organization, the State must study it and decide whether the problem is serious enough to warrant further study and whether a worth while project is possible. The State must also weigh the merits of several applications, if more than one is submitted, and must recommend priorities as to which watershed project should be undertaken first. These decisions at the State level involve the weighing of benefits and costs, along with other factors, to see whether an individual project is worthwhile. It involves also a comparison of the benefits and costs of several projects.

Next in the process of developing a watershed project is a decision by the United States Depart-

⁷ SANDALS, KIRK, AND STEELE, HARRY A., A LAW THAT PUTS RESPONSIBILITY AT HOME, U. S. Dept. Agr. (*Water Yearbook of Agriculture*, 1955: 165-170.

ment of Agriculture as to whether to authorize investigation and assistance in planning. At this point, the Department must decide whether it is likely that a worth while project can be developed, whether planning money should be spent on it, and whether local people are likely to meet their responsibilities. Here again, not only benefit cost analysis but the incidence of benefits and costs affect the decision. At this point, precise economic analyses are not available and reliance must be placed on a reconnaissance field examination for this decision.

In preparing a work plan, a group of decisions is involved in formulating the watershed project and in testing the economic justification of its component parts. These decisions rest on economic appraisal. It is this part of the process that is usually thought of as involving benefit cost analysis and it is in this phase that the detailed data necessary for an accurate appraisal are developed. Also at this stage all prior estimates can be checked. The difference between the decisions in this stage of watershed development and other decisions is one of detail rather than of kind.

In the planning process, the major problem is to test the scope and size of the various separable parts of the program, in order to expand each separable part to a point at which its marginal benefits equal its marginal costs.⁸ This goal of program formulation is seldom achieved. Failure to achieve it may be explained partly by the administrative, financial, and physical limitations on the number of alternatives that may be tested. The necessary physical surveys that would permit detailed analysis of various alternatives are usually so costly as to be prohibitive.

Here is a problem for economists. Simple, streamlined, and relatively inexpensive methods must be developed for testing alternatives and eliminating all except the most promising. If this were done, detailed analysis of the remaining choices would be possible.

When the plan has been developed and agreement has been reached as to the content, size, and

scope of the program and the recommended sharing of costs, the Secretary of Agriculture must decide whether to participate further in the project. At this stage, cost-sharing has probably as much bearing on the decision as has the relationship between benefits and costs.

As pressure develops for funds, watersheds will compete for Federal assistance, and the watershed that makes the largest contribution in relation to its abilities will have a high priority. The Department must base its decision not only on the sharing of the costs of installation but also on the arrangements for maintenance and operation that have been made by the local organization. Careful attention must be given to these arrangements. The Department may no longer be an active participant in the project when the maintenance stage is reached, and these responsibilities will rest solely on the local organization.

Local organizations must decide whether to accept the responsibility of the project. They make the final decision as to whether to sign contracts and agree to undertake the financial responsibility involved. At this point, cost-sharing will become firm. If the cost-sharing is not to their liking, many local organizations may change their minds about undertaking the program. They will measure the costs against their own evaluation of local benefits. Local organizations, at this point, will need a plan for spreading costs among property owners within the organizations. Individual property owners must balance costs against prospective benefits.

The project will be reviewed by other agencies and it must be before the Congress, in session, for 45 days before the Secretary can authorize its undertaking. The Congress will have the opportunity to veto the program if it is found not to be justified or for other reasons.

The Bureau of the Budget and the Congress will review annually the request for appropriations for Federal participation in the program. No doubt they will examine the individual projects as to benefits and costs in deciding the extent to which the Federal Government should participate.

Benefit-Cost Analysis

If benefit-cost analysis is to serve all these purposes, it will be put to a real test. The Department's policy includes this statement: "Works of

⁸ FEDERAL INTER-AGENCY RIVER BASIN COMMITTEE, SUB-COMMITTEE ON BENEFITS AND COSTS. PROPOSED PRACTICES FOR ECONOMIC ANALYSIS OF RIVER BASIN PROJECTS. 85 pp. May 1950. See also, TIMMONS, JOHN F. ECONOMIC FRAMEWORK FOR WATERSHED DEVELOPMENT. *JOUR. FARM Econ.* 36: 1170-1183, December 1954.

improvement should be based on sound economic analysis. Costs should be less than assured identifiable benefits. Benefits are to be assessed with care and are to be clearly creditable to the improvement. Intangible benefits not subject to evaluation should not be used for economic justification. They may appropriately be used as argument but not as a part of economic analysis."⁹

The Department's handbook¹⁰ for planning watershed programs indicates that benefit-cost analysis is intended to serve several interrelated objectives. These objectives provide a guide for the formulation and selection of sound projects. Application of the provisions of the handbook for benefit cost analysis should show whether benefits are in excess of costs, guide project formulation to maximize net benefits, and aid in selecting the least costly alternative means of meeting project needs. In addition, it should serve as one of the bases for establishing priorities among projects and provide information for determining an equitable sharing of costs.

Evaluation is to be made of all structural measures for which Federal assistance in the cost of installation is provided.

Studies are to be made, as necessary, for formulating projects that are justified on the basis of incremental benefits and costs for each separable segment.

The handbook indicates that land-treatment measures are the basic element of any watershed project and that they shall be considered the initial increment for project formulation. Economic justification of structural measures for inclusion in the project shall be on the basis that the land-treatment measures scheduled for completion in the watershed work plan are installed and effective.

Because Federal assistance to be provided under the act for land-treatment measures is limited to technical assistance required to complete planning and application of such measures during the installation period—and for other reasons—benefit cost analysis is not to be made of land-treatment measures.

⁹ Policy of the Secretary of Agriculture for the administration of the Watershed Protection and Flood Prevention Act, March 1955.

¹⁰ U. S. SOIL CONSERVATION SERVICE. INTERIM WATERSHED PROTECTION HANDBOOK, v. p. 1955. (Processed.)

Measures that require monetary evaluation include: (1) Measures primarily for land stabilization; (2) waterflow-control measures, such as floodwater-retarding structures, channel improvements, levees and dikes, desilting basins, and mechanical field measures installed primarily for flood prevention; and (3) water-management measures, including irrigation, drainage, and water supply.

Benefits that may be included in the benefit-cost analysis are:

1. Reduction in direct and indirect damages from floodwater and sediment.
2. Increases in net income (gross less all associated costs) from changed use of property made possible as a result of reduction in flood hazard.
3. On-site increases in net income from additional production or reduced costs of production, on lands on which measures are installed.
4. Increased net income from additional production, or reduced cost of production, of farm products as a result of drainage and irrigation.
5. Savings in the cost of water treatment resulting from reduction of sediment in industrial, municipal, and domestic water supplies.
6. Other benefits that can be evaluated in monetary terms.

In computing benefits and costs, the time period to be used is 50 years after benefits are available or the useful economic life of the project, whichever is less.

For projects to be installed within 5 years, current prices are to be used for installation costs and projected prices for operation and maintenance costs and benefits.

Interest rates for discounting and computing average annual equivalent values will be 2½ percent for Federal costs and the borrowing rate for local organizations and property owners.

Cost-Sharing

In his policy statement on the act, the Secretary of Agriculture states: "It is the policy that local organizations will be expected to assume that part of the cost of installing works of improvement, exclusive of Federal costs of technical services such as planning, design, supervision, and economic analysis, which is equal to the ratio of local benefits to total benefits and all construction costs for water distribution and other facilities for purposes other than flood prevention and features related thereto. In addition to such costs as accrue to

the Federal Government under the above provisions, the Federal Government may share a portion of the costs otherwise accruing to the local organization when justified in the work plan and the reasons for so doing are set out in detail.”

Under the act and policy decisions, local organizations are required to bear the cost of:

1. Land easements and rights-of-way.
2. Capacity in structures for purposes other than flood prevention and features relating thereto.
3. Necessary water rights.
4. Operation and maintenance of works of improvement.
5. Administration of contracts let by local organizations.
6. Installation of land-treatment measures on non-Federal land.
7. That part of construction or installation of structural works of improvement, exclusive of installation services, which is equal to the ratio of local benefits to total benefits.
8. All construction costs for water distribution and other facilities for purposes other than flood prevention and features related thereto.

The cost-sharing arrangements for each watershed will be negotiated within these policies but the general goal will be for the aggregate non-Federal share of the cost of watershed projects throughout the Nation to be at least 50 percent.

Cost-sharing is to be determined on the basis of an allocation of benefits by classes. Class 1 benefits are those that stem from the prevention or reduction of losses. They include floodwater and sediment reduction, prevention of the destruction or impairment of productivity of land and water resources, and the recharging of ground water. Class 2 benefits are those that stem from increased productivity of land and water resources and include increased productivity from irrigation, drainage, agricultural water facilities, and more intensive use of land protected from floods.

Classes 1 and 2 benefits are further subdivided into A and B categories. Benefits in the A category are direct primary benefits which accrue to immediate local beneficiaries. Benefits in the B category are those that accrue to other beneficiaries and the Federal Government. Under current policy, costs allocated to class 1B benefits would be borne by the Federal Government and costs allocated to class 1A and classes 2A and 2B would be borne by local interests.

Provision has been made in the Secretary's policy statement and in the handbook for considering adjustments in costs when this formula results in an inequitable burden on the local organi-

zations. Such adjustment would involve the assumption by the Federal Government of a share of construction costs of structural measures allocable to classes 1A, 2A, and 2B. The local organization might argue that it had already installed part of the program; that costs of land treatment were very large; that the land use adjustments required were prohibitive, or that for many other reasons the Federal Government should bear a larger share of the costs.

It is on the basis of such negotiations that final cost-sharing arrangements will be reached. At this point the Federal Government must decide whether the required Federal investment is justified and the local organization must decide whether the local investment is justified. The local organization has the additional decision as to how it will spread local cost among landowners within its boundaries. Thus, in the end the watershed project must meet the test of economic analysis from both Federal and local viewpoints.

Unsolved Problems of Benefit-Cost Analysis in the Small Watershed Program

The uses of the benefit-cost data enumerated place a heavy burden on appraisal procedures and on those who develop and use them. The major difficulty stems from the need for considering both the national and the local viewpoints. Appraisal procedures for water-resource projects have been developed primarily with a national viewpoint in mind, whereas the arrangements provided in the Watershed Protection Act require both national and local perspectives. The justification of a Federal project requires a welfare-oriented national public viewpoint. The economic justification of a purely local project, on the other hand, is more closely related to what we might call “financial feasibility.” The appraisal framework for “partnership projects” should probably reflect a joint application of these differing points of view.

The major questions that benefit-cost appraisals are expected to answer relate to social or public justification. A proposed project with a 1:1 ratio or better is usually regarded as economically desirable. A ratio of less than 1:1 is regarded as undesirable from an economic viewpoint. Available evidence suggests that such appraisals have only limited use for the formulation and design of projects; and even less for the assessment of

charges. Greater emphasis should be placed on the use of appraisal data for project formulation, rather than to indicate overall justification for projects. Under the Watershed Act, there will also be greater need for evaluation data for cost-sharing purposes.

The full impact of these requirements on appraisal techniques is not clear at present, but apparently two generalizations are warranted: (1) New appraisal techniques must shift from present emphasis on total project values to schedules of value which relate both costs and benefits to varying degrees of project scale; and (2) new procedures must be devised for the appraisal of benefits wherein it is possible to identify beneficiaries with a much higher degree of accuracy than is now possible.

With respect to the conflict in viewpoints between the Federal Government and the local organization, three examples may be helpful. From a public viewpoint, the inclusion of secondary benefits in the project analysis usually is not regarded as appropriate. The theory is that the use of capital resources for project purposes would preclude the creation of comparable values in investments foregone. It is apparent that this reasoning does not apply to a community decision, particularly if the invested funds would otherwise have been invested outside the community.

An additional illustration of the difference in viewpoint is the production of a product, the price of which is held above the equilibrium price by Government program or other restrictions. For a public evaluation, equilibrium prices may be approximated at a lower level than is actually expected, thereby reflecting the marginal cost of producing the commodity. To do this in an appraisal that is locally oriented would result in lower returns than realistically might be expected.

With emphasis on local cost-sharing and the prospect that the local organization with the best financial resources will be given high priority, it may be that areas most in need of the programs will not be able to get them.

These examples illustrate the problems involved in the economic appraisal required by this program. The physical and economic analysts involved in the program face a challenging task. They will need assistance from a program of research in improving appraisal techniques and in obtaining more adequate data.

Problems for Further Economic Research

The suggestions for research that follow indicate ways in which the colleges and the Agricultural Research Service might provide such assistance.

Economic planning and program formulation.—The watersheds to be considered under the act cannot be larger than 250,000 acres. The first 62 watersheds approved for planning averaged about 77,000 acres. If costs are to be kept within reason, planning must be efficient. Research is needed on the most efficient methods of measuring benefits and costs, including simple and inexpensive methods that can be used to test various alternatives in program formulation. Economists should work with hydrologists and agronomists in experimental watershed research. Establishment of a North Central Advisory Committee to develop an integrated program of watershed research illustrates the desirable approach.

Watershed input-output data.—More adequate data are needed to guide estimates of the effects of watershed programs. For example, more information is needed on the effects of floodwater and sediment on crops at the different seasons. Data could be obtained by physical scientists and economists working together on integrated experiments.

Responsibilities of local organizations.—The Watershed Act places great responsibility on local organizations. Thorough studies of these responsibilities and of the powers that will be necessary to meet them are needed. Most States do not have enabling legislation for establishing adequate local organizations. Local organizations have had little experience in meeting the management problems that will arise in planning, installing, and maintaining watershed projects. Research should explore the experience of comparable irrigation and drainage districts. With local organizations bearing a large share of the costs, there may be more interest in various kinds of land use regulations to protect works of improvement.

Finally, consideration should be given to the part that the State should play in watershed development. State agencies might play a vital role in directing and assisting local organizations in watershed development.