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Review of the Economic Benefits and Costs Resulting from Dewey Reservoir

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REVIEW OF THE ECONOMIC BENEFITS AND COSTS RESULTING FROM DEWEY RESERVOIR

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INTRODUCTION

"Review of the Economic Benefits and Costs Resulting from Dewey Reservoir" is based on research performed as part of a project entitled "The Economic Impact of Flood Control Reservoirs" (OWRR Project No. A-006-KY) sponsored by the University of Kentucky Water Resources Institute and supported in part by funds provided by the United States Department of Interior as authorized under the Water Resources Research Act of 1964, Public Law 88-379. The Division and District offices of the U.S. Army Corps of Engineers have assisted by making available the necessary data.

The overall project is examining the economic consequences which resulted from the construction of four existing reservoirs in the hope of being able to suggest improved economic evaluation techniques. This is the fourth in a series of reports on the project and deals primarily with the evaluation of income redistribution benefits from construction of a flood control and recreation reservoir in Appalachia by examining the income distributions of those paying for and those benefitting from the project.

Any comments the reader might have on the research problem, the approach described in this report, or the findings described are encouraged and should be directed to L. Douglas James, Project Director.

ABSTRACT

The purpose of this investigation was to study the economic effects of the construction of Dewey Reservoir in Floyd County, Kentucky. Primary emphasis was placed on determining the degree the project had shifted income to this economically underdeveloped area by determining the incomes of those receiving project benefits and those paying project costs. The income redistribution effects of all benefits and costs associated with Dewey Reservoir were evaluated by assuming that the Federal income tax structure indicates the marginal value of income to individuals in the various income brackets.

Major benefits from the Dewey Project have been: flood control, $722,166 annually and recreation, $814,720 annually. Comparing these benefits with the average annual cost of the project yields a direct benefit cost ratio of 1.58.

It was found that the flood damage reduction benefits have negative redistribution effects (-$77,670), because those receiving the benefits have incomes higher than that of the average taxpayer.

The positive income redistribution benefits in decreasing order resulted from: repayment incidence ($~~293,670~~ 197,860), recreation benefits ($133,720), project expenditures ($26,618), and Mississippi River benefits ($294.). Total average income redistribution benefits from Dewey have been $~~376,632~~ 280,822. Adding this to the direct benefit gives a benefit-cost ratio of ~~1.96~~ 1.87.

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Chapter I

APPROACH TO INCOME REDISTRIBUTION BENEFITS

DEVELOPMENT OF BENEFIT-COST ANALYSIS

HISTORY OF FEDERAL INVOLVEMENT

Throughout the nineteenth and twentieth centuries the Federal Government has shown an increasing interest by its increased participation in the development of the water resources of the United States. The origin of the U.S. Army Corps of Engineers in 1802 was the starting point of Federal involvement in the nation's water resources program. In 1824 the Congress appropriated $75,000 for the removal of snags and other impediment to navigation from the Ohio and Mississippi Rivers, two very important cargo and passenger transporting routes before the advent of the railroad (1, p. 7). Throughout the remainder of the nineteenth and the early years of the twentieth centuries, Federal interest rested mainly in the improvement of the nation's navigable rivers.

Prior to 1879, the control of floods was viewed by Congress as a local problem and the responsibility of local government. After the severe flooding of the Mississippi River Valley in 1874, the Congress began to realize that local groups could not cope with large flood disasters; and in this year a small appropriation was made for the control of flooding in the alluvial valley of the Mississippi River (1, p. 136). From 1879 to 1936, the lower Mississippi and Sacramento

Rivers were the only rivers in the country where Federal funds were spent for flood control. With the passage of the Flood Control Act of 1936, the Federal Government through the Corp of Engineers assumed responsibility for flood damage abatement throughout the entire country. Since 1936, other water resources development purposes, such as recreation, water quality control and hydroelectric power, have been added; and the nation's water resources program has received an ever increasing amount of funds and attention.

Since the Federal budget for water resources development is limited and the pressure for new projects is increasing yearly, a method must be available by which the Congress can choose the projects which will be most beneficial to the country as a whole and allocate funds accordingly. For comparison purposes, proposed projects must be, as far as possible, reduced to a "common denominator." The theory of welfare economics has produced the method of benefit-cost analysis for ordering projects according to their contributions to national welfare net of the sacrifices of the nation's resources required to build them.

The Flood Control Act of 1936 gives the basis for project justification in stating that a project is justified if "benefits to whomsoever they may accrue are in excess of the estimated cost, and if lives and social security of people are otherwise adversely affected" (2, p. 2964). This act launched the Corps of Engineers on its modern flood control program and this basic criterion has since been extended to all water resources programs in which the Federal Government is involved. The criterion of project benefits exceeding estimated project costs raises the question of how to define and estimate project benefits and costs.

BENEFITS DEFINED

Eckstein defines the benefit of a project to an individual as "that amount of money which he would be willing to pay if he were given the market choice of purchase" (3, p. 48). In the evaluation of a large Federal water resources program the planner is faced with the problem that the services which the project offer are usually not commensurable with products or services offered in the competitive market. At this point the planner is obliged to devise a method by which services, such as flood control, water quality control, and recreation, can be expressed in market units. In the case of flood control, the benefit is measured as the cost required to replace or repair all the goods that the project prevented from being destroyed or damaged and the services that the project prevented from being interrupted. Other methods have been developed for measuring benefits from the provision of other non marketable goods and services, and these methods will be discussed later in this report.

COSTS DEFINED

Project costs are taken as the sum of design, construction, operation and maintenance, and right-of-way costs. Although some disagreement exist among the several Federal agencies involved in the development of the nation's water resources on some specific points of cost estimation, the basic procedures are well established.

THE GOAL OF PROJECT DEVELOPMENT

The generally accepted goal of water resources projects is the maximization of "national welfare." Immediately one is faced with the problem of constructing a social welfare function which expresses the contribution of a project to the national welfare. This function could be used to rank proposed projects, and the decision process would consist simply of choosing those projects which contribute most to national welfare. Let us then examine the requirements for an ideal social welfare function.

SOCIAL WELFARE FUNCTION

James defines the ideal social welfare function as "a scalar mathematical expression which combines all human goals in such a manner that everyone can agree that the greater the value of the expression the more happy and contented society will be" (4, p. 1). It is quickly seen that such a social welfare function, called first order efficiency, can never be obtained. For instance, some might propose that maximization of national income will maximize national welfare; but are all rich people happier than all poor people? Society desires that the national income be distributed among all the people; but in what proportions? Society wants everyone to be healthy; but how much of the nations resources should be sacrificed in the interest of public health? These and other considerations, such as national defense, cultural preservation, etc., make it very clear that no ideal social function can be constructed.

In lieu of the impracticality of achieving an ideal social welfare function, first order efficiency, planning agencies faced with the necessity of choosing among alternatives have turned to maximization of national income, second order efficiency. This practice does not reflect a deliberate decision to preclude such considerations as public health or income redistribution. These factors are usually considered as intangibles and weighed qualitatively in the decision making. The practice rather reflects the lack of an adequate methodology for using any more general goal than second order efficiency.

There are two ways of considering the problem of maximizing national welfare. The first school of thought assumes that the individual consumer is fully competent to decide what is best for him, and consequently the consumers collectively can decide what is best for society. The market will adjust itself according to the collective consumption decisions so that the goal of maximum national welfare will be met. The market must be free to adjust, that is, price fixing or monopoly must be absent from the economy.

The second school of thought presupposes that man is not rational or informed enough to select the things in the market that will be most enriching to his life. Given a free choice in the market, an individual might choose the alternative which contributes least to national welfare. For example, society might spend $1,000,000 for firearms for sporting when money is direly needed for hospital construction. The advocates of this school of thought propose political is efficient if those who benefit would be willing to pay those who would benefit from the alternative investment most likely to be substituted in its place an amount large enough to pursuade the second group to forego the investment. The theory of compensating payments is discussed fully in Marglin (5, pp. 20-27). To consider the division of the economic pie, one must recognize that the ability to make compensating payments is affected by income. Economic efficiency criteria produce socially acceptable results only as the existing income distribution is accepted as ideal.

INCOME REDISTRIBUTION

With the social welfare function in common use defined to rank proposed designs according to their contribution to national income, second order efficiency, we now examine the problem of how the procedure could be modified to consider the effect of the project on the distribution of income and the method of distribution.

Concerning the division of the economic pie, Congress might wish to redistribute income to a certain group of citizens, Group X. If supplying Group X with the desired amount of income were the sole consideration it might be most economical to give Group X a direct subsidy. Direct subsidies infer administrative and accounting costs, and many members of our society have expressed the strong opinion that a direct subsidy undermines the "moral fiber" of the nation. With these objections, among others, to direct subsidies as a means of redistributing income, one might then consider the construction of water resources projects as an acceptable means. How then does one decide the best way to redistribute income by water resources projects, and how does one measure the amount of income redistributed?

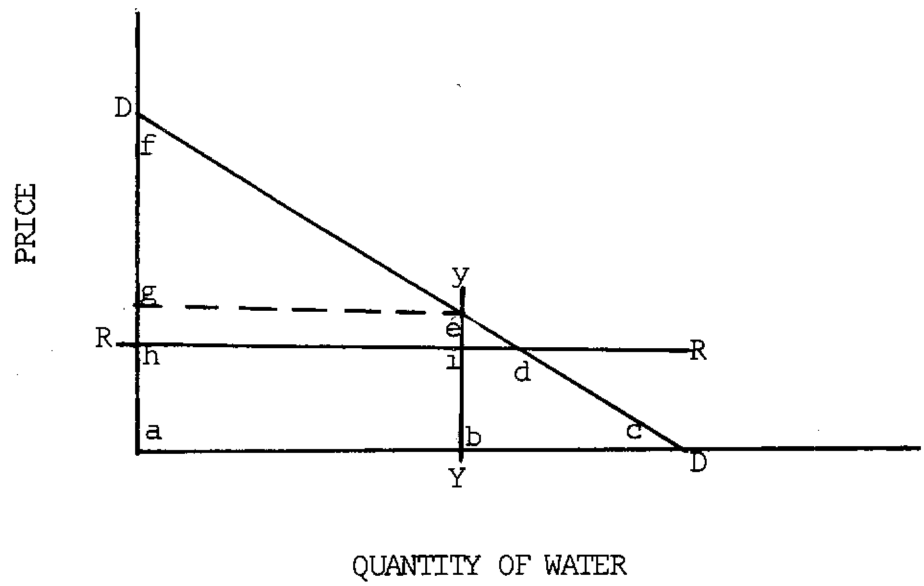
EVALUATING INCOME REDISTRIBUTION EFFECTS

MARGLIN APPROACH

Two approaches to income redistribution in the analysis of alternative water resources projects were found in the literature. First, Marglin suggests that the desired income distribution can theoretically be attained by the selective pre-pricing and rationing of project outputs to those to whom a preselected amount of income is to be distributed (5, p. 62). The rationing of outputs from water resources projects prevents the market from performing its service of allocating resources in the most efficient manner from a national income standpoint. Although, as we have seen before, maximization of national income isn't the sole objective in maximizing national welfare and one must sacrifice a certain amount of efficiency in order to distribute income.

Marglin gives the example based on a desire to redistribute a fixed amount of income to a group of Indians by the construction of an irrigation project in their vicinity (5, p. 64). First one decides the price to be charged for the irrigation water, then he decides the level of output at the preassigned price necessary to provide the Indians with the desired amount of extra income. Figure 1 shows by the line DD a hypothetical aggregate demand schedule for

Fig. 1. Demand Schedule for Irrigation by Indians



irrigation water by the Indians. Line RR is the preassigned price level to be charged for the irrigation water. Since the total willingness of the Indians to pay for water is area acf and the cost to the Indians of quantity YY of water is area abih, one is able to adjust YY until area hief is equal to the amount of income to be distributed to the Indians. Although some of the same arguments are given against price discrimination as are given against a direct subsidy, most people feel that charging even a token price is preferable over giving the output to the consumer.

HAVEMAN APPROACH

A second approach to analyzing income redistribution effects of water resources development is given by Haveman where he considers that the relative value placed on income to different income classes by the nation is indicated by the income tax structure (6, p. 132). A dollar of income to a rich individual is relatively less important to the individual than a dollar of income to an individual of lesser means. Haveman proposes that a marginal utility of income function can be constructed for any year by calculating marginal tax rates for each income bracket. For example, if the marginal tax rate of the average adjusted gross income were found to be 0.1, then the marginal utility of income to an income group with marginal tax rate of 0.2 would be one-half that to the group with average income. By assigning the marginal tax rate of the average adjusted gross income as unity one can calculate welfare equivalent weights for each income class for a given year.

A water resources project redistributes income by obtaining funds from the taxpayers and paying them out to those providing labor and material to construct a project which when completed benefits those using its output. In order to apply the weighting factors calculated from marginal tax rates, it is necessary to estimate the distributions of the funds collected, the funds paid, and the benefits received by tax bracket. The first distribution considers the relative economic position of those from whom the funds are obtained as any beneficial income redistribution effects from project construction depend on a generally lower income level among beneficiaries than among taxpayers. The second distribution considers the ability of project construction to stimulate the local economy by providing employment opportunity and increased business activity. The third distribution considers the ability of the project to stimulate the local economy by providing output useful to low income groups.

Haveman, in analyzing the effect of the Corps of Engineers program on the southeastern states, assumes the benefits of a project to accrue to the residents as a whole of the state in which the project is located and uses the state income distribution as a basis for his calculations. In this report, the benefits are seen to accrue to a much smaller group of people, and the specific area of benefit is used to analyze the redistributional effects of one specific Corps of Engineers project in rural eastern Kentucky. With methods available for analyzing redistributional effects of water resources programs, one might wish to examine the nation's water resources programs and see if income redistribution is considered in Federal appropriations, and if so, to what extent it affects the decision making process.

Haveman examines the post World War II appropriations for Corps of Engineers projects in the ten southeastern states, with 18.6 percent of the total United States population, and finds they have received 27.1 percent of the appropriations allocated to the Corps' General Construction Fund. Even more conclusive evidence that this area has been favored in water resources appropriations is given by the fact that two of the southern states, Arkansas and Kentucky, with 3 percent of the nation's population received 8 percent of the total General Construction appropriations. Table 1 gives the percent of the total General Construction appropriations allocated to the south during specific time periods (6, p. 77). It is seen that the Congress has attempted to use water resources programs to

TABLE 1

PERCENT OF CORPS OF ENGINEERS APPROPRIATIONS ALLOCATED TO THE SOUTH[1]

Time Period	Percent of Total Corps Appropriations Allocated to the South
1946-1948	31.8
1948-1951	28.4
1951-1954	28.0
1954-1957	24.5
1957-1960	25.0
1960-1962	27.7
1946-1962	27.1

[1]Source: Reference - 6, p. 77.

stimulate the economic growth of the south.

SCOPE OF THIS STUDY

The approach of this study is to evaluate the effectiveness of water resources development in redistributing income by a case study of an existing project. This topic has been of particular interest in Appalachia and other economically depressed areas where many have visualized water resources development as a method of economic stimulation. For the case study, one of the oldest Corps of Engineers' reservoirs in Appalachia, Dewey Reservoir in

Floyd County, Kentucky, was chosen. The approach was to evaluate from the standpoint of economic efficiency the benefits and costs which have resulted from project construction, estimate the incidence of project effects by tax bracket, and use Haveman's approach to quantify the total resulting income redistribution benefit. The results should indicate the relative magnitude of the income redistribution benefit in the heart of one of the most economically depressed areas in the country.

Chapter II

THE DEWEY RESERVOIR AREA

RESERVOIR DESCRIPTION

Dewey Reservoir was constructed in 1946-1949 to help alleviate flooding on the Big Sandy, Ohio, and Mississippi Rivers. The reservoir provides for storage of 93,300 acre-feet of which 81,000 acre-feet is reserved for flood control during the winter and spring flood season. During the summer, 17,200 acre-feet of storage is used for recreation and low flow augmentation. Dewey Reservoir controls 207 square miles of the drainage area of Johns Creek, a tributary of the Big Sandy River, in Floyd and Pike Counties of eastern Kentucky. The dam site is located approximately five miles northeast of Prestonsburg, Kentucky and seven miles southeast of Paintsville, Kentucky, the county seats of Floyd and Johnson counties respectively, Figure 2. The area is located on the western side of the Appalachian Mountain range.

Dewey Reservoir was constructed under provisions of the Flood Control Act of 1936. The portion of the act authorizing such projects reads, in part, as follows:

> The general comprehensive plan for flood control and other purposes in the Ohio River Basin, as set forth in Flood Control Committee Document Numbered 1, Seventy-fifth Congress, first session, with such modifications thereof as in the discretion of the Secretary of War

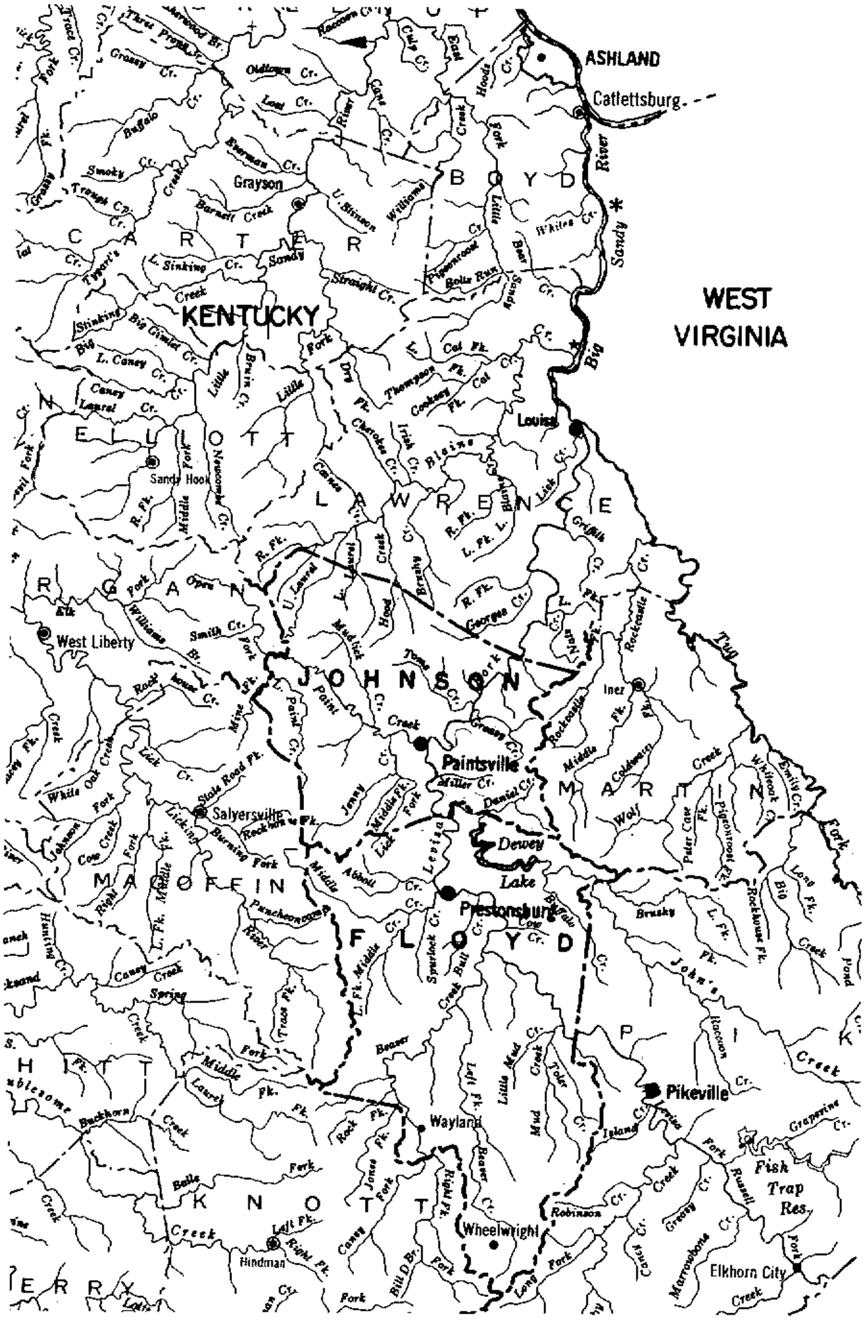


Figure 2. General Location Map for Dewey Reservoir

> and the Chief of Engineers may be advisable, is approved and for the initiation and partial accomplishment of said plan there is hereby authorized $75,000,000 for reservoirs and $50,300,000 for local flood protection works; the reservoirs and local protection projects to be selected and approved by the Chief of Engineers (7, p. 1).

OCCUPATIONS AND LABOR SUPPLY

INDUSTRIAL EMPLOYMENT

The Dewey Reservoir labor supply area is defined by the Kentucky Department of Commerce as Floyd County and the adjacent counties of Johnson, Knott, Magoffin, Martin, and Pike (8, p. 4). The area is economically dominated by the bituminous coal mining industry. In 1962, 8,154 persons or 65.8 percent of those employed in all types of industry were employed in coal mining (8, p. 3). Table 2 shows the distribution of all industrial employment in 1962 for the Dewey Reservoir area (8, p. 7).

BITUMINOUS COAL MINING

Recent years have seen a general decline in coal mining employment; and as a result of its dependence on coal for industrial employment, the economic growth of eastern Kentucky has been severely curtailed. Improvements in mining equipment, advances in mining technology, a rapidly increasing labor cost, and a lack of proportional increase in demand for coal have had detrimental effects on the economy of the area.

Until 1950, the coal industry in eastern Kentucky showed a definite growth trend in both employment and output. In 1949, John L. Lewis, president of the United Mine Workers Union, succeeded in

TABLE 2

PRESTONSBURG AREA COVERED EMPLOYMENT ALL INDUSTRIES, SEPTEMBER, 1962[1]

Industry	Area Total	Floyd	Johnson	Knott	Magoffin	Martin	Pike
Mining & Quarrying	8,154	3,068	279	355	179	165	4,108
Contract Construction	608	369	92	8	16	0	123
Manufacturing	665	124	91	37	37	28	348
Transportation, Communications, & Utilities	747	205	173	30	27	20	292
Wholesale & Retail Trade	2,310	493	577	19	85	29	1,107
Finance, Ins. & Real Estate	394	108	74	41	8	9	154
Services	1,441	290	256	0	7	4	884
Other	13	3	0	0	0	0	10
Total	14,332	4,660	1,542	490	359	255	7,026

[1] Includes only workers covered by unemployment insurance.

Source: Reference 8, p. 7.

obtaining a three-day work week in mines east of the Mississippi River. The advent of the three day work week and union strikes decreased output in the larger mines and allowed smaller non-union mines to claim a larger portion of the sales market. The large mines of eastern Kentucky where the seams of coal are buried deep, unlike the shallow seams of western Kentucky, were not suited for strip mining operations where large amounts of coal can be mined with little labor. As a result, the strip mining operations of western Kentucky increased output while production dropped in the larger mines of eastern Kentucky. The down trend started in 1950, is still evidenced today, and is causing the eastern Kentucky bituminous coal mining industry to suffer greatly.

AGRICULTURE

There are approximately 1200 farms in Floyd County and 1000 in Johnson County. These are normally small subsistance farms averaging about seventy acres each (8, p. 23). Most of the farms are owner-operated and furnish the livelihood of the farmer and his family with very little surplus. Burley tobacco, corn, and hay are the major crops grown. Table 3 gives agricultural statistics for Floyd and Johnson Counties (8, p. 23).

The farm land lies mainly in the small fraction of the total land in valleys adjacent to the rivers and streams. The hills are too steep to permit any agricultural use other than limited grazing. The hills are covered with timber, but most of it is second or third growth and of poor quality.

TABLE 3

AGRICULTURAL STATISTICS FOR FLOYD AND JOHNSON COUNTIES, 1962[1]

Crops	Total Production	
	Floyd County	Johnson County
Alfalfa Hay (tons)	350	250
Clover Hay (tons)	900	1,140
Lespedeza Hay (tons)	380	480
Corn (bu.)	219,000	111,000
Burley Tobacco (lbs.)	19,000	848,000

[1]Source: Reference 8, p. 23.

ECONOMIC CONDITIONS

INCOME AND EMPLOYMENT

At the time of project completion in 1950, the median family incomes for Floyd and Johnson Counties were $1904 and $1340 respectively. This is compared with a median family income of $1774 for Kentucky and $2619 for the United States (9, p. 17-42). It must be noted that the economy of the Dewey Reservoir area was on the brink of a sharp decline. The bituminous coal mining industry was destined for a sharp decline in the following decade.

In 1950, there were 13,691 persons in the labor force of Floyd County and 6,294 in the labor force of Johnson County. There were 695 and 255 unemployed persons in Floyd and Johnson Counties respectively (9, p. 17-98). This amounts to approximately 5% unemployment, but as noted before the area was beginning an economic decline which is still evidenced today.

EDUCATION AND AGE

The median school years completed of persons over twenty-five years of age in 1950 was 7.2 for Floyd County and 7.5 for Johnson County. This is about equal to the Kentucky state average, 7.5, and somewhat below the United States figure, 9.3 (9, p. 17-90).

In 1950, there were 11,710 persons living in Floyd and Johnson Counties (9, p. 17-76). Table 4 gives the age distributions for the two counties. It is seen that over half of the persons were under nineteen years of age. This meant that a large labor force was to become available in the next decade, 1950-1960.

TRANSPORTATION FACILITIES

RAILROADS

The Dewey Reservoir area is served by the Ashland Division of the Chesapeake and Ohio Railway operating between Ashland, Kentucky, and Elkhorn City, Kentucky. There are two through freights daily and outbound carloads average 1,210 per month with the major part carrying scrap metal. Inbound carloads average seventy-five per month and consist mainly of gas and oilfield supplies and government commodities (8, p. 8).

HIGHWAYS

U.S. Highways 23 and 460 and State Routes 404, 1107, 1427,

TABLE 4

AGE DISTRIBUTIONS FOR FLOYD AND JOHNSON COUNTIES, 1950[1]

Age	Floyd County	Johnson County
Under 5 years	8,584	3,126
5-9	7,150	2,754
10-14	6,520	2,757
15-19	5,274	2,280
20-24	4,346	1,906
25-29	3,962	1,709
30-34	3,379	1,477
35-39	3,364	1,482
40-44	2,603	1,292
45-49	2,143	1,053
50-54	1,627	993
55-59	1,399	841
60-69	1,985	1,308
70-84	1,015	803
85 and over	105	65
Total	25,087	12,555

[1] Source: Reference 9, p. 17-76

and 80 serve the Dewey area. In addition, the Mountain Parkway, a four-lane toll road that runs from Winchester, Kentucky to Campton, Kentucky, is extended to Prestonsburg. Almost all the State and U.S. Routes are winding, narrow highways, and many are in poor repair. The Mountain Parkway, however, is an excellent highway with gentle curvature and slight grades and is expected to be a boon to commercial and tourist travel as the area becomes more developed. The area is served by Point Express, Inc., of Charleston, West Virginia, a large commercial trucking concern.

COMMUTED TRANSPORTATION

In addition, the Greyhound Bus Lines and Allen Brothers Bus Lines provide daily bus service. Twenty-four hour taxi service is available throughout the area. The nearest commercial airport is in Huntington, West Virginia, but the Prestonsburg-Paintsville Airport is located five miles north of Prestonsburg and has a 2,900 foot black topped runway to accommodate small private airplanes.

PURPOSES OF DEWEY RESERVOIR

FLOOD CONTROL

The Dewey Reservoir project was conceived in 1936 as an aid in reducing flooding on the Mississippi River; however, it was concluded that the project would be ineffective and unduly expensive for this purpose at that time. In a review of the flood control needs of the Ohio River Basin entitled, "Comprehensive Flood Control Plan for the Ohio River Basin," dated November 12, 1937, the Dewey project was found to be economically justified as an integral part of the comprehensive Ohio River flood control program.

Prior to the construction of Dewey Reservoir, extensive flood damages regularly occurred to the lands lying directly downstream from the dam site and especially to Paintsville, Kentucky where as much as 80 percent of the area of the town had been flooded (7, p. 4). Since construction, Dewey Reservoir has been a great aid in reducing flooding along Johns Creek and the Levisa Fork of the Big Sandy River. The group of flood control reservoirs in the Ohio River Basin, of which Dewey is a part, has significantly reduced flood damage along the Ohio River.

RECREATION AND WATER QUALITY

Although Dewey was conceived as a flood control reservoir, other project purposes have also been achieved. Jenny Wiley State Park has been built and operated on the shore of Dewey Reservoir by the Kentucky Department of Parks and has become a favorite vacation and recreation retreat for the people of Kentucky and adjoining states. In the event that a severe drought should occur, water from Dewey could be released to help alleviate water supply shortages or achieve better water quality control at downstream towns. Detailed figures on the amounts of benefits from the different facets of the Dewey development program will be given later in this report.

Chapter III

ANALYSIS OF EFFICIENCY BENEFITS AND COSTS

TYPES OF EFFECTS

COSTS

The construction and maintenance of Dewey Reservoir requires many kinds of cost. Many governmental agencies have incurred financial cost. The Corps of Engineers' General Construction appropriations financed the construction of the reservoir, and much of the maintenance funds are furnished by the Corps. The Kentucky Department of Parks and Kentucky Department of Fish and Wildlife have spent and are currently spending large sums for the development of recreation facilities. Additional amounts have been spent on the development of roads and by private interests in developing facilities directly or indirectly related to recreation.

Other kinds of economic cost have also resulted. Higgins found the economic cost of land acquisition at Dewey Reservoir to exceed the financial cost because of various values not incorporated into a price negociated between a willing buyer and a willing seller (10, pp. 115-118). The closing of county roads had various adverse consequences to those whose customary travel routes were interrupted. Various secondary or indirect costs resulted from loss of property tax base to the local community, loss of local farm production from the flooded bottom lands, and various related effects.

BENEFITS

The benefits from the project, likewise, result from many diverse economic effects and accrue to individuals in many geographic areas. Flood control benefits accrue to those downstream from the reservoir: on Johns Creek just below the reservoir, on Levisa Fork and the Big Sandy Rivers downstream to Ashland, Kentucky, on the Ohio River from Ashland, Kentucky, to the Mississippi River, and on the Mississippi River from the Ohio River to the Gulf of Mexico. The flood control benefits resulting from Dewey Reservoir become an increasingly small portion of the total benefits resulting from all reservoirs as the distance from the reservoir increases, but the storage utilized at Dewey Reservoir during floods does lessen the flood peaks in all these reaches.

Visitors from all over the United States come to Dewey Reservoir and receive recreational enjoyment and thus recreational benefits. Lesser amounts of benefit have resulted from low flow augmentation and improvements to the roads near the reservoir. This chapter attempts to quantify these benefits and costs based on the goal of economic efficiency.

EQUIVALENT DOLLARS

TIME EQUIVALENCE

Before proceeding with the numerical evaluation of benefits and costs, it is necessary to account for the fact that all benefits and costs did not accrue in the same year. A dollar spent in project construction in 1948 is not equivalent to a dollar realized in flood control benefits in 1963 for two reasons. One reason is the time value of money. Cash flows occurring in different years must be discounted to an equivalent base before they are compared. This analysis will use the 3.125 per cent rate used by the federal agencies in 1967 for discounting.

The second reason is inflation. A dollar in 1963 has a different value than a dollar in 1948. The customary procedure for handling inflation is to use a cost index which indicates the changing value of a dollar spent for a specific purpose year by year.

PRICE INDEX

The price index used in this report is the Bureau of Reclamation, Building Cost Index. The author considers this index to be the most indicative of the various indices available of the true time pattern of the worth of dollars related to expenditures or benefits from water resources projects. This index incorporates the change in the productivity of equipment and technology which occurs throughout the years because it is based on contract bid prices. The contract bid items used are those common to water resources projects. Many other indices only consider the cost which must be paid for a base unit of labor and materials and thus ignore the time change in productivity of these inputs. Table 5 lists annual values of the price index for the years 1948-1965. 1961 was chosen as a base year for all calculations in this report.

TABLE 5

BUREAU OF RECLAMATION, BUILDING COST INDEX

Year	USBR Index	1961 Base	Year	USBR Index	1961 Base
1948	93	66	1957	131	94
1949	94	67	1958	132	94
1950	97	69	1959	137	98
1951	114	81	1960	140	100
1952	115	82	1961	140	100
1953	115	82	1962	143	102
1954	116	83	1963	146	104
1955	120	86	1964	150	107
1956	128	91	1965	155	111

Source: Reference: 19, p. 90

ANALYSIS OF COSTS

ORIGINAL ESTIMATE

In 1939, the Corps of Engineers' allotted $300,000 for initiation of construction on the Dewey Reservoir project (7, p. 2). At this time it was estimated that the total cost of land acquisition, acquisition of flowage rights, and dam construction would be $2,645,000 (7, p. 11). The original estimate of annual cost was for $118,000 for capitalization of the installation cost and $13,000 for maintenance and operation. The annual construction cost was obtained by using an interest rate of three percent and a project life of fifty years. Table 6 gives the breakdown of the 1939 estimated costs.

POST WORLD WAR II ESTIMATE

World War II began before a contract could be awarded and

TABLE 6

ESTIMATED COST OF DEWEY RESERVOIR PROJECT, 1939

Item	Cost
Structures, Dam and Appropriations	$1,535,000
Lands	480,000
Buildings	140,000
Clearing	30,000
Roads and Bridges	260,000
Gas Developments and Mineral Rights	130,000
Cost of Acquisition of Flowage Rights	70,000
Total Cost of Flowage and Construction	$2,645,000

work begun on the reservoir. No federal water resources projects were constructed during the war unless they contributed directly to the national defense.

With the end of World War II, the Federal government could once again return to the task of developing the water resources of the nation. In 1945, a revised project statement was issued which listed a revised cost estimate of $3,940,000 for the Dewey project (11, p. 13). War-time inflation was the main reason for the sharp increase in the estimated cost of the Dewey project.

ESTIMATES DURING CONSTRUCTION

After the initiation of construction, new estimates of the total installation cost of the Dewey project were made and periodically revised according to departure between the preconstruction estimates and the actual costs incurred. As a result of the large area over which the flood control benefit accrued and the policy at the time, virtually all installation and operation and maintenance costs were assumed by the Federal government. Table 7 gives running estimates and actual costs incurred in association with the project by year. Throughout construction, (1947-1950), total cost estimates were increased in all years but the last. At first inspection, one might suspect a gross underestimation of cost, but much of the variance was caused by unforeseen labor and material procurement problems and by difficulties with the prime contractor.

CONSTRUCTION PROBLEMS

The original contract amount of the prime contract for construction of the dam and appurtenances was $1,994,215.60 (12, p. 16). During construction twenty-three contract modifications were granted to the contractor at an additional federal cost of $119,415.43 bringing the total to $2,113,629.03 (12, p. 16). Among the contract modifications were extensions of contract time for delays caused by strikes and work stoppages and changing of certain construction materials. The Dewey area had very little skilled labor, and living conditions in the area were such as to make it difficult to entice skilled and semi-skilled labor to accept employment on the project. The area was well supplied with unskilled labor but the rate of turnover was so high that it was necessary to train workers

TABLE 7

DEWEY RESERVOIR COST SUMMARY

Year	Estimated Federal Cost	New Work Cost	1961 Dollars	O & M Cost	1961 Dollars
1946	$5,216,000	$ 340,200	$ 521,391	$ 0	$ 0
1947	5,216,000	636,693	968,874	0	0
1948	6,246,800	1,023,352	1,540,523	0	0
1949	7,456,500	2,529,527	3,767,376	0	0
1950	6,716,000	1,292,572	1,865,556	19,336	27,907
1951	6,716,000	315,062	386,918	38,293	47,026
1952	6,639,800	78,969	96,136	39,166	47,680
1953	6,414,700	90,225	109,839	35,531	43,255
1954	6,415,000	36,716	44,312	37,536	45,301
1955	6,347,000	14,453	16,861	36,565	42,658
1956	6,348,182	7,609	8,322	42,033	45,973
1957	6,348,182	0	0	39,160	41,850
1958	6,348,182	0	0	36,834	39,066
1959	6,348,182	0	0	37,795	38,622
1960	6,348,182	0	0	45,337	45,337
1961	6,504,000	642	642	40,080	40,080
1962	6,501,415	152,592	149,390	46,579	45,601
1963	6,501,415	0	0	46,256	44,354
1964	6,501,415	0	0	49,697	46,383
Average Annual			$385,671[1]		$ 43,799[2]

[1]Discounted over 50 years at 3.125 percent

[2]Average annual value 1950-1964

continually. Accessability of the construction site, bad weather, and sharp increases in labor wage rates all contributed to construction problems causing increased costs. After project completion, the Corps estimated that the principal contractor had lost $590,600 as a result of the job cost exceeding his bid (12, p. 25). In 1962, the contractor obtained $152,600 additional payment on a claim.

Table 8 gives the cost breakdown for design and construction of the dam, purchase of real estate, clearing of the reservoir area, and relocation of highways and utilities. Although the final cost of construction was much higher than originally expected, during the construction the nation's economy was undergoing a very rapid growth period. Labor and material costs were rising rapidly. The original cost estimates were based on cost indices which did not foretell such an economic boom; therefore, costs were underestimated substantially.

HIGHWAY COSTS

The Commonwealth of Kentucky and Federal Government have spent in excess of $4,000,000 for the construction and improvement of highways in the immediate reservoir area. Table 9 lists the costs incurred for highways which as well as could be determined were built or improved primarily to service traffic attracted by Dewey Reservoir. Only costs occurring in the immediate vicinity of the reservoir are included. The map on Figure 3 indicates the approximate location of the highways included.

TABLE 8

CORPS OF ENGINEERS COST SUMMARY FOR DEWEY RESERVOIR

Definite Project Report	$ 20,000
Preliminary Engineering and Design	376,333
Real Estate	2,082,319
Highway Relocation	239,500
Utility Relocation	407,077
Cemetery Relocation	56,485
Clearing	148,560
Dam	2,750,182
Miscellaneous Construction	243,348
Contractor's Claim	152,592
Late Construction	59,420
Total Construction Cost	$ 6,501,415

OTHER COST

Many other agencies have expended money as a result of the presence of Dewey Reservoir. Recreation facilities and improved highways have induced expenditures by others for various types of facilities. For example, the Boy Scouts of America and Girl Scouts of America have summer camps at the park which entailed construction costs of approximately $110,000.

RECREATION COSTS

The Kentucky Department of Parks and Kentucky Department of

TABLE 9

KENTUCKY DEPARTMENT OF HIGHWAYS, HIGHWAY COST

Year	Capital Cost	1961 Dollars	O & M Cost	1961 Dollars
1956	$ 517,150	$ 565,630	$ 0	$ 0
1958	300,450	318,660	0	0
1959	1,475,670	1,507,970	0	0
1960	165,840	165,840	0	0
1961	317,120	317,120	220	220
1962	323,780	316,990	0	0
1963	10,800	10,360	11,200	10,740
1964	998,420	931,850	24,770	23,120
Total	$4,109,230	$4,134,420	$36,190	$34,080
Average	$273,949	$281,140	$ 2,412	$23,120[1]

Source: Kentucky Department of Highways

[1]Average value for highways existing in 1964

Fish and Wildlife Resources and other public agencies have developed extensive recreation facilities at Dewey Reservoir. Costs for Jenny Wiley State Park were obtained from the Kentucky Department of Parks and annual numbers of fish stocked in Dewey were obtained from the Division of Fish and Wildlife Resources. In the absence of specific data on the cost of stocking fish in a reservoir, this report assumes a unit cost of $0.01 per fish stocked. Approximately 2,800,000 fish have been stocked in Dewey Reservoir. Table 10 gives the cost of parks and fishery operations at Dewey. Park revenues from the Jenny Wiley State Park facilities existing as of the end of 1964 average $345,515 annually expressed in 1961 dollars.

COST SUMMARY

Because of the extensive development of Dewey Reservoir

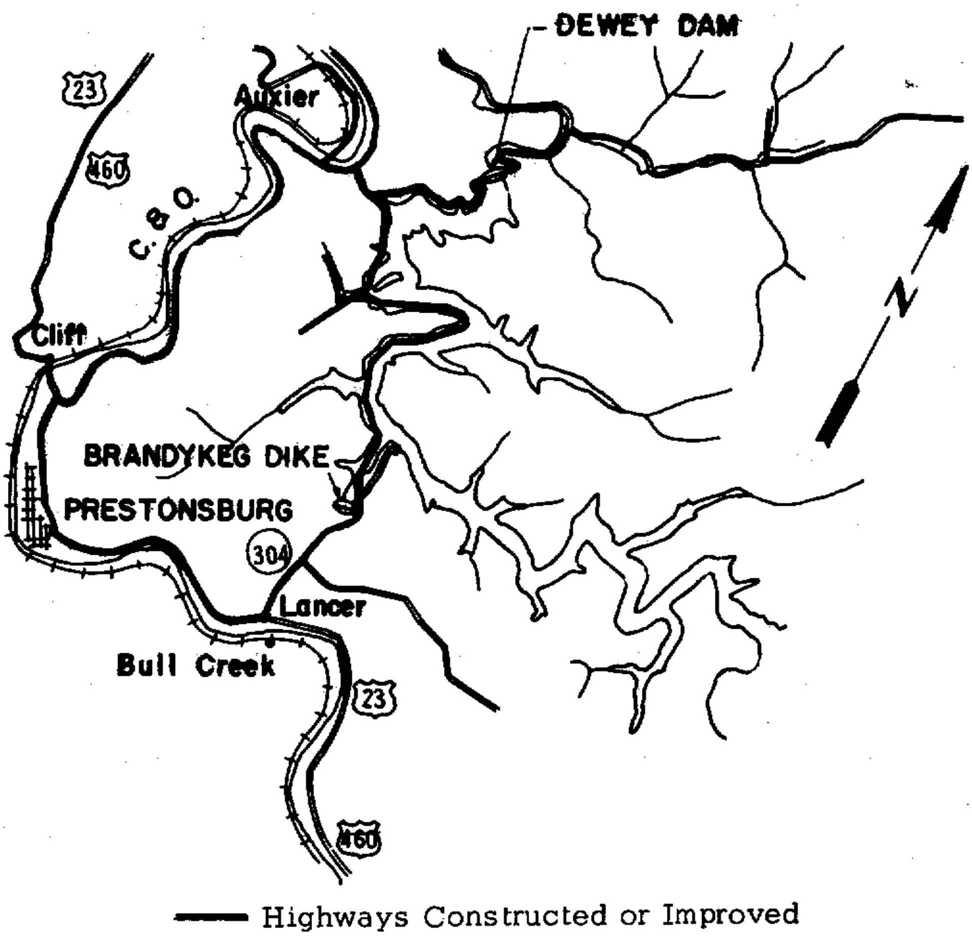


Figure 3. Highways Improved or Constructed Since Construction of Dewey Reservoir

TABLE 10

DEWEY RESERVOIR, PARKS AND FISHERIES COST

Year	Capital Cost	1961 Dollars	O & M Cost	1961 Dollars
1953	$ 0	$ 0	$ 16,698	$ 20,327
1954	27,910	34,578	40,300	48,637
1955	21,093	24,608	58,653	68,428
1956	110	120	44,751	48,946
1957	12,307	13,152	46,921	50,144
1958	54,653	57,964	57,245	60,714
1959	3,114	3,182	95,440	97,529
1960	42,041	42,041	74,645	74,645
1961	197,964	197,964	94,211	94,211
1962	1,411,621	1,382,005	378,326	370,388
1963	291,714	279,724	429,895	411,226
1964	2,395	2,235	443,552	413,980
Total	$2,064,922	$2,037,573	$1,780,637	$1,759,200
Average		$ 118,647		$ 412,603[1]

Source: Kentucky Department of Parks and Kentucky Division of Fish and Wildlife Resources.

[1] Average value for facilities existing in 1963 and 1964.

for recreation and the construction of highways around the reservoir and in the immediate vicinity, large costs have been incurred in addition to the construction cost. Table 11 gives a cost summary of cost incurred because of the construction of Dewey Reservoir and were thus necessary to realize the resulting benefits. Values listed in Table 11 are in 1961 dollars.

ANALYSIS OF BENEFITS

ORIGINAL ESTIMATE

In 1937, when the project was proposed for construction, the Corps of Engineers estimated the annual benefits would total

TABLE 11

TOTAL COST OF FACILITIES AT DEWEY RESERVOIR[1]

Type of Cost	Amount	Life	CRF	Annual Amount
Dam and Appurtances	$5,490,000	50	.03981	$218,556
Land and Relocations	3,920,000	00	.03125	122,500
O and M, Dam and Reservoir	-	-	-	43,799
Highway Construction	4,134,420	20	.06800	281,140
O and M, Highways	-	-	-	23,120
Recreation Facilities	2,037,573	25	.05824	118,668
O and M, Recreation Facilities	-	-	-	412,603
Park Revenues	-	-	-	-345,515
Scout Camps	110,000	25	.05824	6,406
Contractor's Loss	756,734	50	.03981	30,126
Additional Economic Cost of Right-of-Way[2]	2,040,000	00	.03125	63,750
		Total Annual Cost		$975,153

[1]Values are in 1961 dollars
[2]Reference - 10, p. 116.

$260,000. Table 12 gives the individual breakdown on this sum.

FLOOD CONTROL BENEFITS

The Corps of Engineers makes regular flood damage surveys to evaluate benefits resulting from existing reservoirs. Data collected in damage surveys after major floods are used to construct stage-damage curves. During each flood the actual stage is recorded; and, by routing the flood, the stage which would have occurred without the reservoir is found. Using the actual and modified stages and the stage-damage curve, the reduction in flood damage due to the reservoir can be calculated. The Corps of Engineers lists the reduction in flood damage effected by each reservoir for every year.

TABLE 12

ESTIMATED ANNUAL BENEFITS FROM DEWEY RESERVOIR, 1937[1]

Flood Damage Prevention-Tributary	$107,000
Flood Damage Prevention-Ohio River	74,000
Mississippi River Benefits	27,000
Conservation and Recreation	40,000
Water Supply and Sanitation	11,000
Navigation	1,000
Total Annual Benefits	$260,000

[1] Source: U. S. Army Corps of Engineers

For the years in which flood damages were prevented, the values listed for Dewey Reservoir (excluding Mississippi River Benefits) are found on Table 13.

Stage-damage curves are compiled for specific reaches along a river. Figure 4 shows the reaches from Dewey Dam to Louisa, Kentucky, used for referencing the Corps of Engineers stage-damage curves. For these reaches the Corps records actual stages and estimates stage reductions effected by Dewey. These data enable one to utilize the stage-damage curves and calculate the flood control benefit effected along each reach. Table 14 lists these benefits.

From Louisa, Kentucky, on the Big Sandy River downstream to the Ohio River and along the Ohio, many reservoirs effect

TABLE 13

FLOOD DAMAGES PREVENTED BY DEWEY RESERVOIR

Year	Damages Prevented (Current Dollars)	Damages Prevented (1961 Dollars)
1950	727,000.	1,048,000.
1952	7,000.	8,500.
1955	765,000.	887,000.
1957	2,499,460.	2,659,000.
1958	758,000.	804,000.
1959	48,000.	49,000.
1960	47,000.	47,000.
1962	3,891,000.	3,820,000.
1963	1,519,000.	1,460,000.
1964	53,000.	50,000.
Average Annual		722,166.

Source: U.S. Army Corps of Engineers.

flood damage reduction. The Corps of Engineers, instead of calculating the stage reduction attributable to each specific reservoir, combines a group of reservoirs in the analysis. For example, a group of reservoirs might reduce the peak flood stage at Louisville, Kentucky, by one foot. The stage-damage curves would be used to determine reduction in flood damage that resulted from this reduction in peak stage and the value obtained would be reported as benefit attributable to the group. The regional Corps office then allocates the benefit to specific reservoirs, usually on the basis of storage.

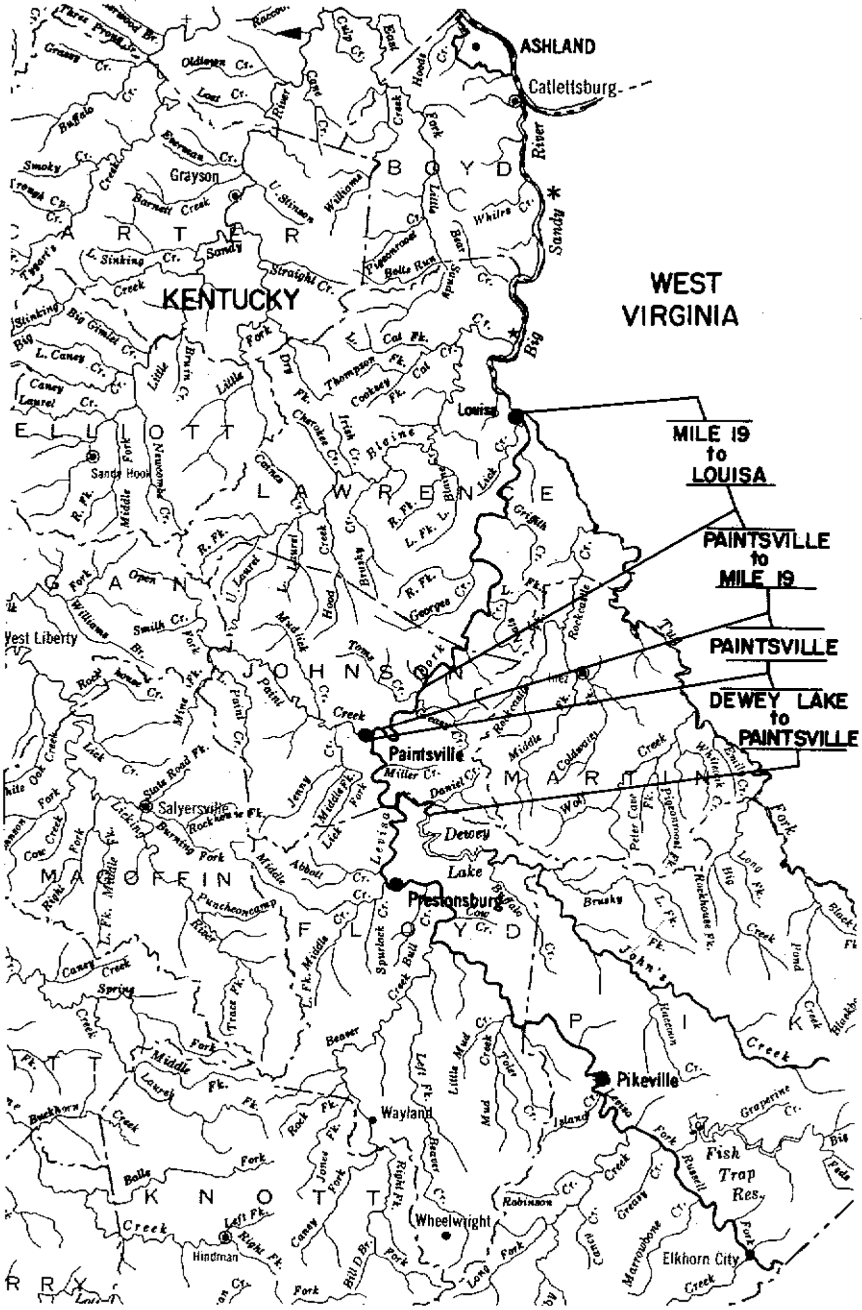


Figure 4. Levisa Fork Flood Control Reaches

TABLE 14

FLOOD BENEFITS ATTRIBUTABLE TO DEWEY BY YEAR, LEVISA FORK[1]

Year	Levisa Fork Reach			
	Johns Creek to Paintsville (Reach 1)	Paintsville (Reach 2)	Paintsville to Mile 19 (Reach 3)	Mile 19 to Louisa (Reach 4)
1950	$ 1,000.	$ 5,000.	$ 1,000.	$ 2,000.
1951	1,000.	10,000.	2,000.	1,000.
1952	0.	8,000.	1,000.	21,000.
1953	0.	0.	0.	0.
1954	0.	0.	0.	0.
1955	20,000.	390,000.	20,000.	27,000.
1956	2,000.	10,000.	1,000.	3,000.
1957	60,000.	2,500,000.	80,000.	19,000.
1958	11,000.	154,000.	9,000.	19,000.
1959	0.	0.	0.	3,000.
1960	0.	0.	0.	0.
1961	0.	0.	0.	0.
1962	7,000.	72,000.	6,000.	45,000.
1963	45,000.	700,000.	52,000.	45,000.
1964	0.	0.	0.	0.
Total	$147,000.	$3,849,000.	$172,000.	$185,000.

1 Values listed are in 1961 dollars.

MISSISSIPPI RIVER BENEFITS

The original proposal for the construction of Dewey contained an estimate of flood control and low flow augmentation benefits realized on the Mississippi River of $27,000. The author considers this estimate to be quite high when one considers that Dewey has very little storage and controls a small drainage area, relatively speaking, and is far removed from the Mississippi River.

The Corps of Engineers estimates that the reservoirs in the Ohio River Basin, of which Dewey is one, effect $4,593,700, expressed in 1961 dollars, in low flow augmentation and flood control benefits annually (14, p. 26). Two methods might be used to determine the portion of the total attributable to Dewey.

The existing reservoirs in the Ohio River Basin have a total flood control storage of 24,900,000 acre-feet, of which 81,000 acre-feet is at Dewey. By assuming each acre-foot to be equally effective, one would estimate the Mississippi River benefits effected by Dewey to be $14,940 annually.

However, in calculating benefits to a reservoir that is a part of a large group, one must consider the marginal benefit that the reservoir adds to the whole system. The Corps of Engineers has proposed that additional reservoirs be built with a total storage capacity of 10,300,000 acre-feet which will yield $186,000 annually in additional benefits. An alternate approach to allocating benefits to Dewey is to consider that the marginal benefits resulting from 81,000 acre-feet of storage at Dewey will be the same per acre foot as that resulting from adding 10,300,000 acre-feet to the existing total Ohio River storage. This method estimates Dewey benefits to the Mississippi River at $1,470. In this report it is assumed that Dewey effects $1,470 annually in Mississippi River flood control and low flow augmentation benefits.

RECREATIONAL BENEFITS

Dewey Reservoir attracts pleasure seekers from all of Kentucky as well as from the adjoining states. Excellent facilities for recreation are available. Space is provided for most water-related recreational activities at the reservoir. Table 15 shows the annual recreation visitation to Dewey since 1952.

Recreation benefits are analyzed using an equation developed by Tussey (15, p. 14). The method estimates benefits from the incremental change in visitation which would be caused by a change in the distance traveled to the recreation site and the unit cost of distance traveled.

The general form of the equation developed for estimating visitation is:

$$V = KP/d^n \qquad (1)$$

where V is the estimated visitation in visitor-days, P is the population of the area from which the visitor started, d is the distance from the reservoir to the origin area, n is an exponent relating distance and visitation, and K is a constant which describes the willingness of individuals to visit the reservoir. By use of multiple regression analysis on recreation visitation data to another Kentucky Reservoir, Tussey evaluated K to equal 2577 and

TABLE 15

DEWEY RESERVOIR ATTENDANCE SINCE 1952[1]

Year	Attendance[2]	Year	Attendance[2]
1952	551,911	1960	369,600
1953	432,986	1961	365,300
1954	533,000	1962	425,300
1955	664,735	1963	764,700
1956	500,312	1964	592,900
1957	396,090	1965	779,100
1958	180,552	1966	960,300
1959	226,485		
		Average	518,400

[1]Source - reference 15, p. 48.

[2]Based on vehicle counts and an average of 3.2 persons per vehicle.

n to equal 2.445 (15, p. 85).

The value of cost per mile of travel was calculated by:

$$C = 2.42 \left[(1 + a)m + \frac{t}{v}\right] / bp \qquad (2)$$

where C is the cost per mile per visitor day, b is the average number of days a visitor stays at the site, p is the average number of visitors per vehicle, m is the marginal vehicle operating cost in dollars per mile, t is the marginal value in dollars of an hour of time to the vehicle occupants, v is the mean speed in miles per hour, and a is the incidental expense for food, lodging, etc. above that which the visitor would have spent had he stayed at home expressed as a fraction of vehicle operating cost (15, p. 129).

Values used for cost calculations were[1]:

$$
\begin{aligned}
b &= 2.27 \text{ days} \\
p &= 3.67 \text{ visitors per vehicle} \\
m &= 0.053 \text{ dollars per mile} \\
t &= 1.50 \text{ dollars per hour} \\
v &= 40 \\
a &= 0.50
\end{aligned}
$$

Using equation 1, the visitation can be calculated; and if, holding all other variables constant, travel distance is increased by increments (Δd), visitation will decrease. The demand curve can be constructed by plotting the visitation for each increment of distance as a function of the cost for that increment (the product of C and Δd), Figure 5. The area under the demand curve is the recreation benefit (15, pp. 117-123).

For the study, the United States was subdivided into 168 population centers, 120 Kentucky counties, the 47 other contiguous states, and the District of Columbia. Benefit calculations were made for the average annual Dewey Reservoir visitation of 518,400 and benefits obtained are listed on Table 16 (15, p. 13). The values tabulated correspond to those tabulated by Tussey on his Table 27 under the heading of "Eq. 11" except that they are reduced by the ratio of 518,400 to his predicted visitation of 970,846 and rounded to the nearest $10.

WATER SUPPLY AND NAVIGATION BENEFITS

The original proposal for construction of Dewey Reservoir

[1]for detailed information on these values see: reference 15, p. 129.

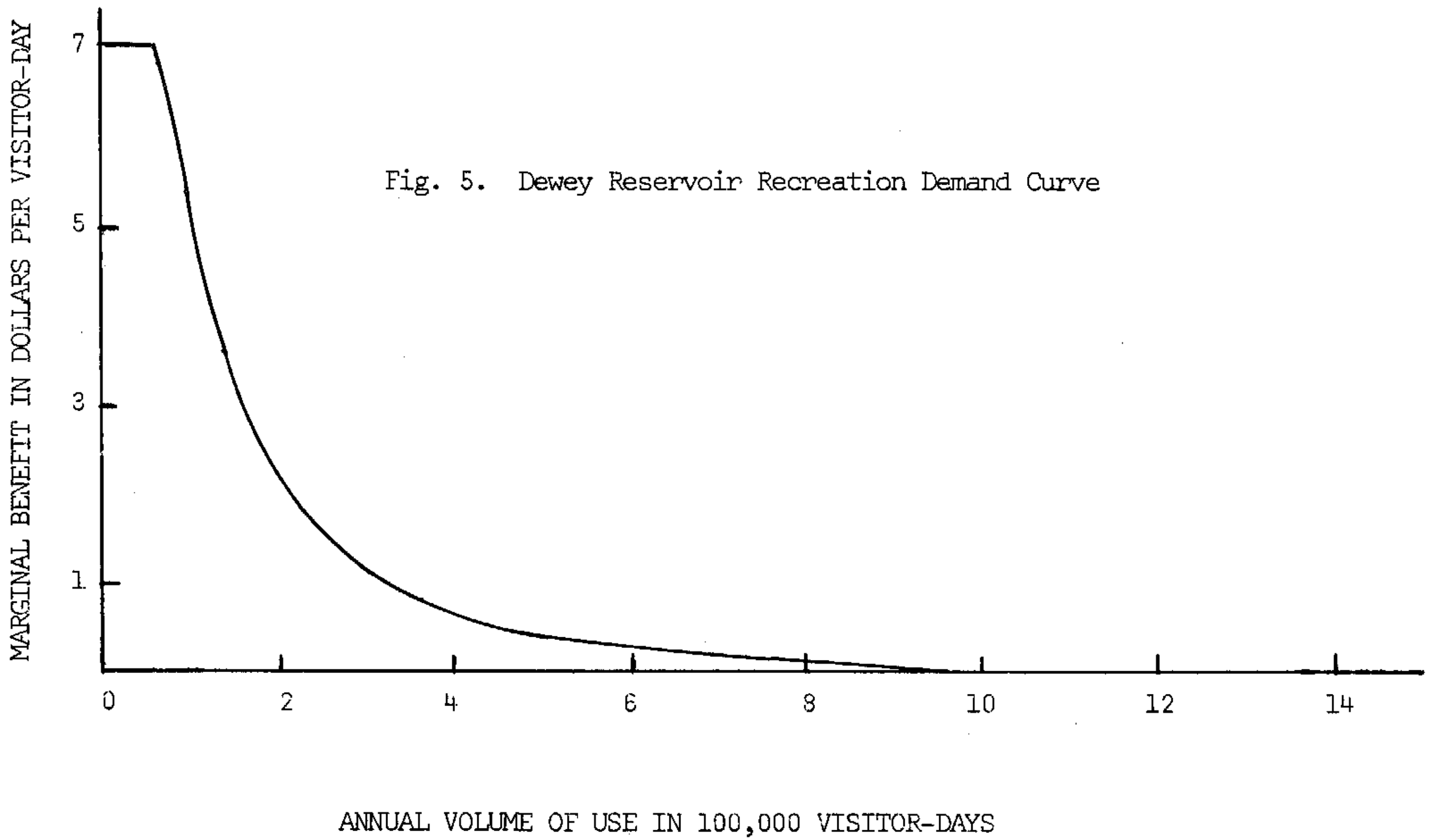


Fig. 5. Dewey Reservoir Recreation Demand Curve

TABLE 16

RECREATION BENEFITS ATTRIBUTABLE TO DEWEY RESERVOIR

Population Center	Recreation Benefit	Population Center	Recreation Benefit
Adair	$ 290.	Graves	$ 120.
Allen	140.	Grayson	190.
Anderson	290.	Green	200.
Ballard	30.	Greenup	2,680.
Barren	390.	Hancock	50.
Bath	820.	Hardin	1,060.
Bell	1,830.	Harlan	3,740.
Boone	470.	Harrison	590.
Bourbon	900.	Hart	200.
Boyd	8,070.	Henderson	210.
Boyle	640.	Henry	260.
Bracken	310.	Hickman	20.
Breathitt	3,740.	Hopkins	250.
Breckenridge	160.	Jackson	800.
Bullitt	260.	Jefferson	9,560
Butler	90.	Jessamine	530.
Caldwell	70.	Johnson	38,900.
Calloway	90.	Kenton	3,120.
Campbell	2,370.	Knott	5,380.
Carlisle	20.	Knox	1,280.
Carroll	160.	Larue	170.
Carter	3,600.	Laurel	1,340.
Casey	390.	Lawrence	4,740.
Christian	350.	Lee	880.
Clark	1,210.	Leslie	1,300.
Clay	1,520.	Letcher	4,500.
Clinton	170.	Lewis	960.
Crittenden	40.	Lincoln	600.
Cumberland	140.	Livingston	30.
Daviess	560.	Logan	170.
Edmonson	100.	Lyon	70.
Elliott	1,600.	McCracken	230.
Estill	1,060.	McCreary	380.
Fayette	5,460.	McLean	70.
Fleming	800.	Madison	1,810.
Floyd	59,190.	Magoffin	7,270.
Franklin	850.	Marion	390.
Fulton	40.	Marshal	80.
Gallatin	80.	Martin	9,850.
Garrard	380.	Mason	960.
Grant	260.	Meade	250.

TABLE 16 - Continued

Population Center	Recreation Benefit	Population Center	Recreation Benefit
Menifee	$ 560.	Delaware	$ 1,160.
Mercer	460.	Washington, D.C.	3,530.
Metcalfe	130.	Florida	4,880.
Monroe	170.	Georgia	16,060.
Montgomery	990.	Idaho	90.
Morgan	3,250.	Illinois	20,870.
Muhlenberg	210.	Indiana	44,760.
Nelson	440.	Iowa	2,790.
Nicholas	390.	Kansas	1,350.
Ohio	150.	Louisiana	2,790.
Oldham	260.	Maine	480.
Owen	220.	Maryland	12,250.
Owsley	580.	Massachusetts	4,980.
Pendleton	340.	Michigan	19,850.
Perry	6,530.	Minnesota	1,500.
Pike	32,540.	Mississippi	2,860.
Powell	540.	Missouri	5,680.
Pulaski	1,160.	Montana	80.
Robertson	100.	Nebraska	770.
Rockcastle	650.	Nevada	20.
Rowan	2,710.	New Hampshire	770.
Russell	260.	New Jersey	12,390.
Scott	590.	New Mexico	190.
Shelby	400.	New York	24,030.
Simpson	110.	North Carolina	52,210.
Spencer	140.	North Dakota	190.
Taylor	340.	Ohio	170,390.
Todd	80.	Oklahoma	1,310.
Trigg	50.	Oregon	130.
Trimble	100.	Pennsylvania	37,500.
Union	80.	Rhode Island	790.
Warren	460.	South Carolina	15,080.
Washington	260.	South Dakota	250.
Wayne	360.	Tennessee	18,230.
Webster	90.	Texas	2,940.
Whitley	950.	Utah	120.
Wolfe	1,270.	Vermont	330.
Woodford	400.	Virginia	20,980.
Alabama	9,960.	Washington	210.
Arizona	160.	West Virginia	26,120.
Arkansas	2,490.	Wisconsin	4,320.
California	1,110.	Wyoming	70.
Colorado	440.		
Connecticut	2,850.	Total	$814,720.

estimated a total of $12,000 annually for water supply and navigation benefits. Dewey is operated to maintain a minimum flow of 10 cubic feet per second. The only towns which would significantly benefit from water supply from Dewey are Paintsville and Louisa, Kentucky. The water supply agencies in both towns were consulted, and both stated that, since their town lies on the Levisa Fork of the Big Sandy River, Dewey has very little affect on their supply of water. However, both indicated that in the event of a very severe drought, Dewey might help alleviate water supply problems. Low flow augmentation benefits on the Ohio River are even more difficult to evaluate. In light of the foregoing, no attempt will be made to assign a water supply benefit to the reservoir.

Navigation on the Big Sandy River is becoming less and less important. The only possible area where Dewey could influence navigation is the reach from Louisa to Ashland, Kentucky. Dewey controls about 6% of the drainage area of this reach; therefore any navigation benefit which Dewey might affect would be very small and will be ignored in this report.

BENEFIT SUMMARY

Although Dewey Reservoir was conceived as primarily a flood control reservoir, average annual recreation benefits have somewhat exceeded the average annual flood control benefits. Flood control benefits were found to be $722,166 annually, recreation benefits $814,720 annually, and flood control and low flow augmentation on the Mississippi River $1,470 annually. An efficiency benefit summary for Dewey Reservoir is given on Table 17.

TABLE 17

TOTAL EFFICIENCY BENEFITS FROM FACILITIES
AT DEWEY RESERVOIR

Type of Efficiency Benefit	Annual Amount
Flood Control	$722,166
Mississippi River	1,470
Recreation	814,720
Total Annual Efficiency Benefit	$1,538,356

COMPARISON OF BENEFITS AND COSTS

At the time of project construction, it was estimated that Dewey Reservoir would have a benefit-cost ratio of 2.0. The values calculated in this chapter for actual efficiency benefits and costs were $1,538,356 and $975,153 respectively. These values yield a benefit cost ratio of 1.58. Although the actual value is somewhat below the estimated value, the Dewey Reservoir Project has produced benefits well in excess of the costs. The total benefits are even larger if uncertainty benefits as described in Chapter IV and income redistribution benefits as described in Chapter V are added.

Chapter IV

ANALYSIS OF UNCERTAINTY BENEFITS

UNCERTAINTY

Because of the nature of occurrence of flood disasters; neither the time that a flood will occur nor the magnitude of the flood can be foretold. Flood damages may amount to several thousand dollars in destroyed or damaged property to one individual in a given year and then remain at very low levels for many years until the next major flood. The uncertainty of not knowing in advance when major flood losses will occur and the threat to financial solvency may cause many of those harmed to be willing to pay a premium to avoid the loss pattern above the expected average annual value of the loss. One might illustrate this concept by the payment of fire insurance premiums exceeding the expected loss by an amount equal to the profit and overhead cost of the insurance company as a safeguard against a major financial disaster. When a flood control reservoir is constructed, it reduces both the average annual damages downstream and the probability of major flood disasters. This second kind of benefit is the uncertainty benefit as estimated here.

UNCERTAINTY BENEFITS

The flood damage reducing capacity of Dewey Reservoir has yielded benefits by reducing the risk of major floods in the downstream reaches. This benefit will be called the uncertainty benefit and will be calculated by the method advanced by Thomas (5, p. 150). Thomas proposes evaluation based on the concept of a theoretical fund where the victims of flood damage pay a certain fixed amount per year into a fund with the fund being used to reimburse the people for any flood damage they might suffer.

The theory is that people would rather pay a small fixed amount each year than to pay a large amount at larger intervals of time. For example, an individual might prefer to pay $100 each year and have this money used to pay for any flood damages he suffers than to pay $3,000 once every 50 years to repair and replace property damaged by flooding.

Use of the Thomas uncertainty fund requires a decision as to the level of security it is to provide, that is, what probability will be tolerated of the fund being insufficient to repay the damages suffered during a sequence of major flood disasters. For instance, it might be decided that a probability of the fund being exhausted of 5.0 percent or of 0.5 percent can be tolerated. The formula for the uncertainty benefit is:

$$\frac{V\alpha \quad CRF \quad (\sigma_1 - \sigma_2)}{2r} \qquad (3)$$

where $V\alpha$ is the normal deviate with probability α of being exceeded, α is the specified probability that the fund will be exceeded, CRF is a capital recovery factor, σ_1, and σ_2 are the standard deviations of the flood damages without and with the reservoir respectively, and r is the rate of interest earned by the fund.

The standard deviation of the flood damages with and without Dewey Reservoir were calculated for each reach. An interest rate of 3.125% and an infinite project life were used. Average annual uncertainty benefits were calculated for each reach and the results are given on Table 18. The average annual uncertainty benefits for a probability of exceedance of 5% and 0.5% are $216,154 and $338,356 respectively. It is seen that the majority of the uncertainty benefits accrue to Paintsville, Kentucky. This would seem right as Dewey Reservoir is the most effective in reducing major floods in the reaches immediately downstream.

TABLE 18

AVERAGE ANNUAL UNCERTAINTY BENEFITS FROM FLOOD CONTROL

Reach	5% Prob. of Exceed. $V\alpha$ = 1.645	.5% Prob. of Exceed. $V\alpha$ = 2.575
Johns Creek - Paintsville	$ 3,552.[1]	5,560.[1]
Paintsville	133,656.	209,219.
Paintsville - Mile 19	4,613.	7,220.
Mile 19 - Louisa	2,818.	4,413.
Ohio River		
Reach 1	2,424.	3,795.
Reach 2	6,169.	9,656.
Reach 3	2,468.	3,862.
Reach 4	13,982.	21,888.
Reach 5	3,290.	5,150.
Reach 6	7,402.	11,588.
Reach 7	18,301.	28,647.
Reach 8	3,701.	5,794.
Reach 9	617.	965.
Reach 10	1,028.	1,609.
Reach 11	5,758.	9,012.
Reach 12	3,290.	5,150.
Reach 13	3,084.	4,828.
Total	$ 216,154.	$ 338,356.

[1] All values in 1961 dollars

Chapter V

ANALYSIS OF INCOME REDISTRIBUTION BENEFITS

INTRODUCTION

Dewey Reservoir lies in an area where unemployment is high and income low. In 1960 the per capita incomes for Floyd and Johnson Counties were $1,207 and $776 respectively. These figures are below that of Kentucky ($1,543) and well below that of the United States ($2,225). In light of this, one might suspect that any substantial investment in public works, such as the construction of Dewey Reservoir, might achieve substantial income redistribution to the surrounding low income area. This section of the report will attempt to define a method for estimating the redistributional effects of Dewey and present the results in terms of an income redistribution benefit.

APPROACH

The very term income redistribution implies that income is shifted from one group to another. A water resources project would shift income from those paying for the project to those employed during project construction and those benefitting from project produced output. The magnitude of the shift can be analyzed from the amount of funds involved and the income distribution of those in each of the three groups. However, the desirability of the shift can only be evaluated through a value judgement on how the total national income should ideally be distributed.

The consensus seems to be that if all other factors are equal projects benefitting those poorer than the average taxpayer are to be preferred over those benefitting those richer than the average taxpayer. Projects employing the otherwise unemployed are to be preferred over those diverting highly paid skilled labor from other employment. The problem is how are benefits accruing to the rich to be weighted relative to those accruing to the poor. In this report, the answer to this problem is based on the value judgement made in establishing the Federal income tax rate schedule. The fact that the rich are required to pay a higher percentage of a marginal dollar of income in income tax than are the poor represents a collective value judgement on the marginal utility of income. The application of this value judgement which will be used is that originally devised by Haveman.

CALCULATION OF INCOME WEIGHTING FACTORS

Haveman proposed construction of a curve relating the marginal utility of income to income level by calculating the marginal utility of income to individuals in the different income classes from the amount of Federal income tax paid. The marginal tax rates are calculated by dividing the change in income tax paid per return between consecutive brackets by the change in adjusted gross income per return between the same two brackets. Data necessary for the calculation of these marginal tax rates was obtained from references 17 and 18. Figures 6 and 7 illustrate the marginal tax rates for the years 1950, 1958, 1962, and 1964 by income class (6, p. 135).

The average adjusted gross income per return for 1950, 1958, 1962, and 1964 were $3,420, $4,810, $5,542, and $6,067 respectively. By taking the marginal tax rate of the average adjusted gross income as unity, and dividing the marginal tax rates of each income class by that of the average income, welfare equivalent weights can be calculated for each year. Table 19 gives welfare equivalent weights for 1950, 1958, 1962, and 1964. Therefore, the benefit an individual in a certain income class receives can be multiplied by the excess of the appropriate welfare equivalent weight above unity to yield the income redistribution benefit. The benefit would be negative for individuals with above average incomes.

INCOME REDISTRIBUTION TO BENEFICIARIES

FLOOD CONTROL BENEFICIARIES

In Haveman's analysis of the income redistribution effects of water resources investment in the ten southeastern states, he assumes the benefits effected in a certain state are distributed among a group of people having the same income distribution as do the people in the state as a whole (6, p. 138). With this assumption, he can use the state income distribution in calculating income redistribution effects. Using one statewide income distribution is a rather broad assumption. The majority of the flood benefits might be concentrated in an unusually low income area, thus causing an

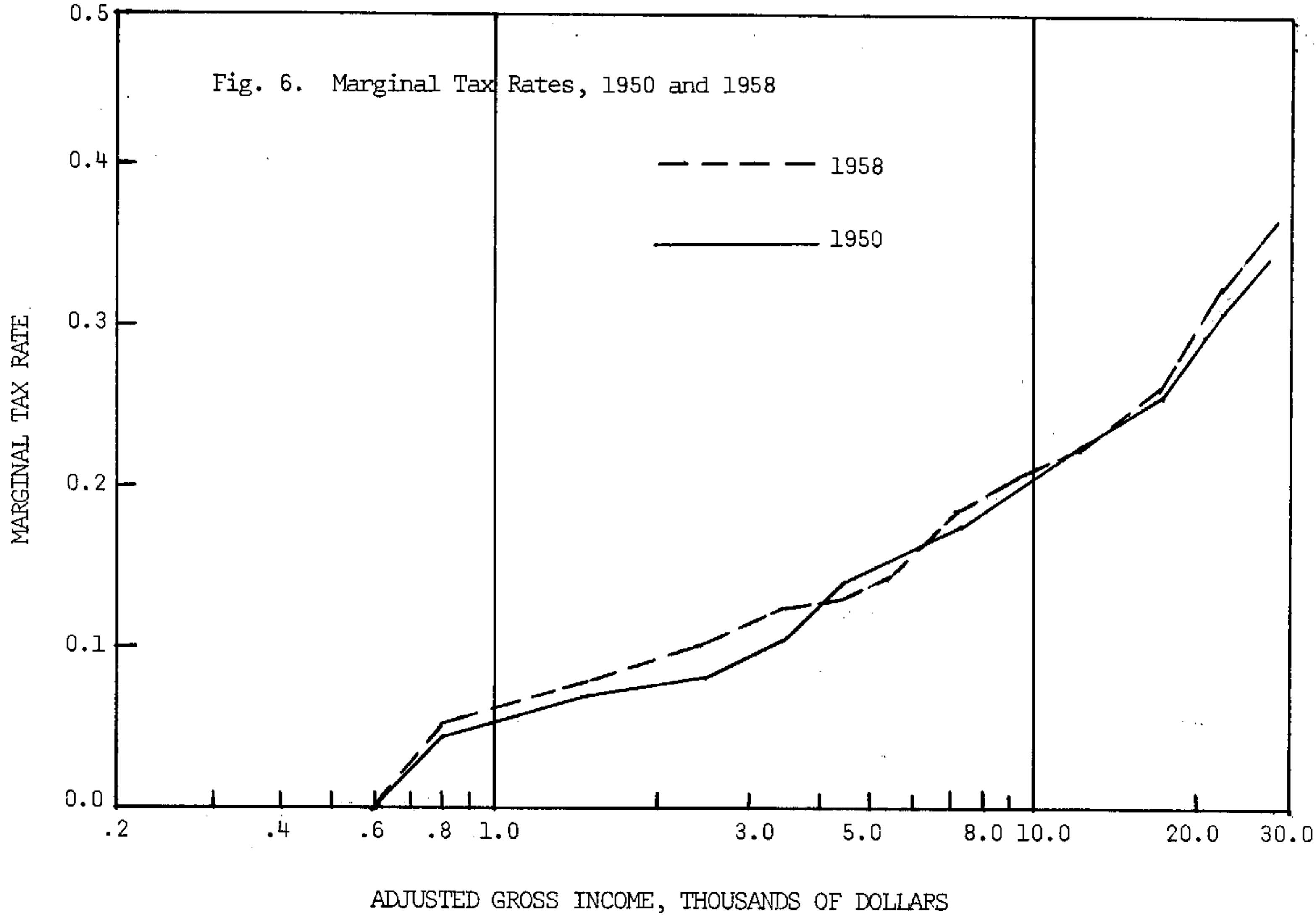


Fig. 6. Marginal Tax Rates, 1950 and 1958

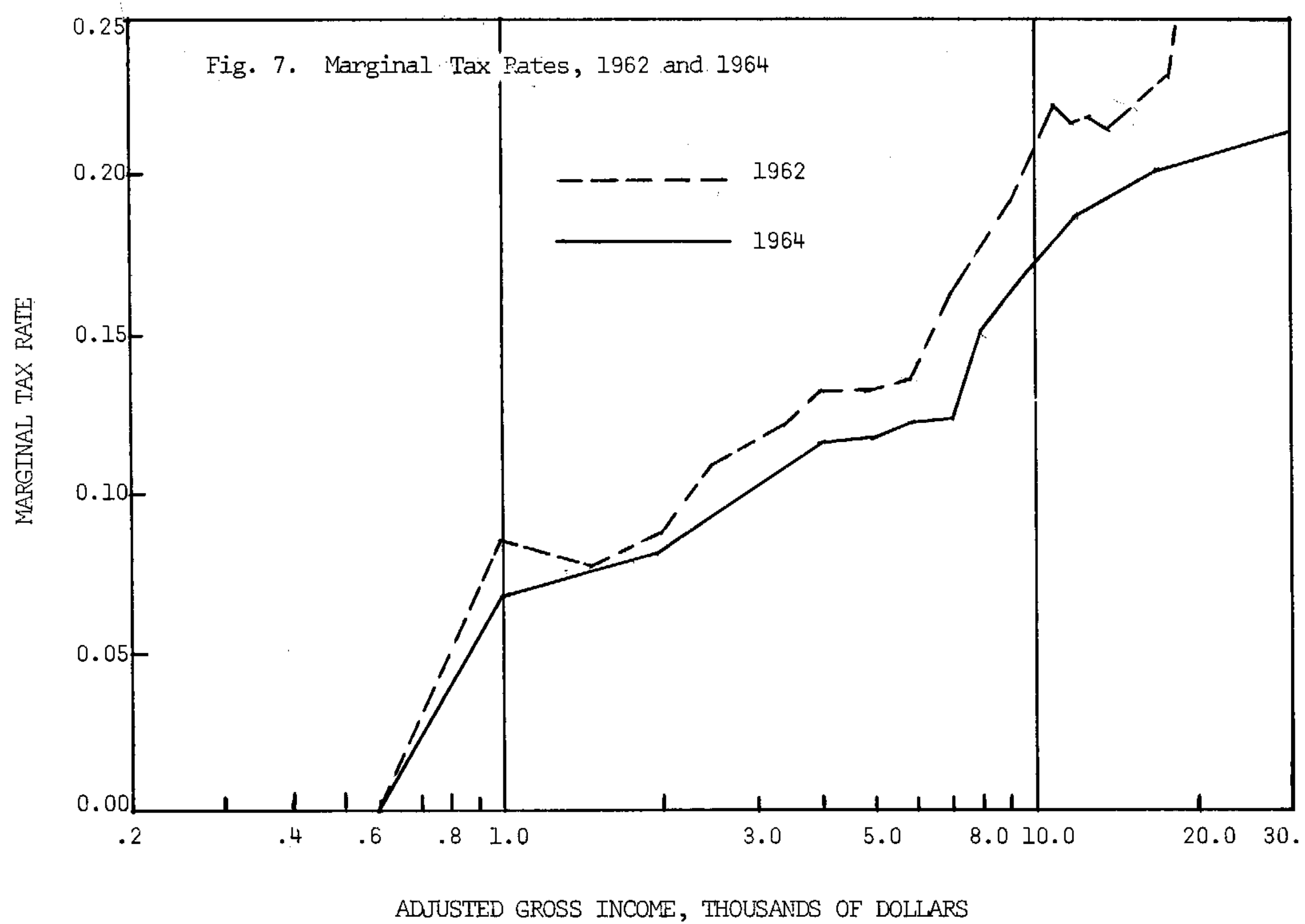


Fig. 7. Marginal Tax Rates, 1962 and 1964
1962
1964
MARGINAL TAX RATE
0.25
0.20
0.15
0.10
0.05
0.00
.2
.4
.6
.8
1.0
3.0
5.0
8.0
10.0
20.0
30.0
ADJUSTED GROSS INCOME, THOUSANDS OF DOLLARS

TABLE 19

WELFARE EQUIVALENT WEIGHTS BY INCOME CLASS

Gross Income, Thousands of Dollars	Welfare Equivalent Weights			
	1950	1958	1962	1964
Under 1	2.28	2.65	2.68	3.05
1-2	1.50	1.71	1.79	1.63
2-3	1.30	1.34	1.24	1.36
3-4	.99	1.07	1.12	1.13
4-5	.75	1.03	1.02	1.05
5-6	.59	.94	1.00	1.01
6-7	.59	.80	.91	.99
7-8	.59	.73	.80	.89
8-9	.59	.69	.73	.78
9-10	.59	.65	.72	.73
10-15	.46	.61	.62	.66
15-20	.41	.52	.58	.61
20-25	.34	.33	.48	.59

underestimation of the redistributional effects. Conversely, the benefits might be concentrated in a high income area, thus overestimating the redistributional consequences. In this report the attempt was made to calculate benefits to specific regions, one to ten counties in area, and apply income redistribution factors calculated from the income distribution of the specific counties. By considering the specific area in which the benefits were realized, the redistributional effects to the area can be examined without influence from regions that do not receive benefits from the project under study.

DIVIDING FLOOD CONTROL BENEFITS BY LOCATION

In order to proceed, it was necessary to locate the flood control benefits by the river reach along which they occurred. The reaches used by the Corps of Engineers for referencing stage-damage curves were used for flood benefit division, Figure 8. Data on changes in flood stages resulting from Dewey Reservoir was directly available for the river reaches upstream of Louisa, Kentucky; but as mentioned before, the Corps of Engineers does not record the flood benefits effected in each reach of the Ohio River which are attributable to Dewey Reservoir alone. Only the total benefit resulting from all upstream reservoirs combined is recorded. Each year a total flood benefit figure from all reaches combined for Dewey Reservoir is also reported. The problem encountered was how to assign the flood benefits from Dewey to the different reaches of the Ohio River from the data furnished by the Corps of Engineers.

OHIO RIVER REACH

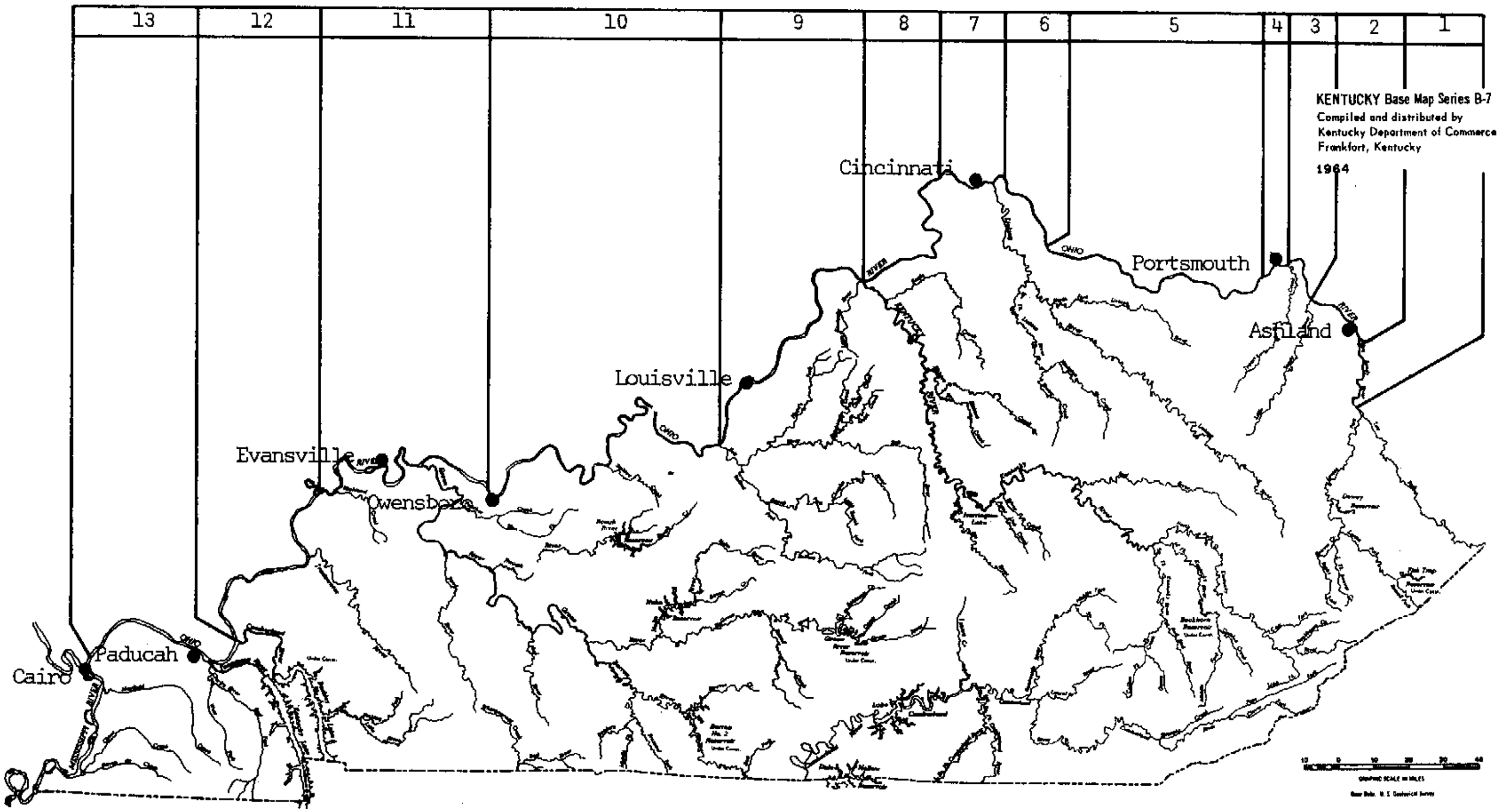


Figure 8. Ohio River Flood Control Reaches

OHIO RIVER BENEFITS

The flood benefits effected by Dewey on Johns Creek and the Levisa Fork of the Big Sandy River were first calculated by utilizing the stages with and without Dewey Reservoir and stage-damage curves furnished by the Corps of Engineers. The total benefit in these reaches was subtracted from the total Dewey Reservoir flood control benefit to yield the flood benefits effected on the Ohio River. Several methods of dividing this total benefit among the various Ohio River reaches were tried, but the most satisfactory results were obtained by allocating benefits in proportion to the product of the flood damages which actually occurred in a specific reach and the percent of the drainage area of the reach controlled by Dewey Reservoir.

In order to calculate the damages which actually occurred, stage-damage curves and actual stages during each annual flood for the different reaches were obtained from the Corps of Engineers and the drainage areas were obtained from reference 16. Percentage of flood control benefits effected by Dewey on the Ohio River which pertain to the reach were calculated for all reaches for the years 1950 through 1964. Table 20 lists the values obtained. The total Ohio River flood control benefit from Dewey in a specific year is multiplied by the corresponding factor from Table 20 to give the benefit effected in the specific reach in that year. Table 21 lists the values calculated.

INCOME DISTRIBUTION OF BENEFICIARIES BY REACH

Once the total flood control benefit had been distributed

TABLE 20

FACTORS FOR DISTRIBUTING FLOOD CONTROL BENEFITS TO OHIO RIVER[1]

Year	Flood Control Reach												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1950	3.3	7.3	2.5	12.0	7.8	9.3	18.0	7.3	4.9	3.9	11.9	7.2	4.6
1951	3.6	11.1	3.7	6.0	8.8	10.8	20.8	12.9	0.1	1.8	15.8	3.4	1.2
1952	2.8	8.7	3.1	4.9	9.8	9.8	19.0	14.1	5.3	4.6	13.2	3.7	1.0
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.3	0.0	0.0	47.4	6.0	3.3
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
1955	2.9	7.1	2.0	34.5	9.0	8.0	18.4	5.4	3.0	2.4	5.3	1.3	0.7
1956	0.0	9.4	4.6	5.6	0.5	4.7	11.4	14.8	7.3	7.2	26.2	6.3	2.0
1957	0.0	7.4	9.2	13.0	0.0	3.9	12.1	13.1	5.6	2.6	26.4	3.6	3.1
1958	4.6	10.6	3.0	4.9	7.4	11.8	26.6	8.5	5.1	4.0	10.9	2.4	0.2
1959	1.2	8.1	2.4	3.5	3.2	11.1	20.5	13.2	6.2	5.6	20.2	4.3	0.5
1960	0.0	16.5	8.2	8.4	0.0	3.8	5.2	7.3	0.0	1.0	40.0	6.8	2.8
1961	0.-	6.0	1.6	0.9	0.0	2.5	17.6	17.9	12.4	6.9	25.8	5.5	2.9
1962	2.9	5.9	2.3	14.6	4.4	11.7	27.2	9.2	5.7	4.1	8.3	2.6	1.1
1963	2.7	5.7	2.6	17.3	5.2	12.8	21.5	9.0	4.2	3.6	9.5	3.9	2.0
1964	0.7	1.9	0.7	1.0	4.3	13.5	28.2	12.8	18.7	8.6	6.6	2.5	0.5

[1] Percentage of total benefit which accrued to that reach.

TABLE 21

FLOOD BENEFITS ATTRIBUTABLE TO DEWEY BY YEAR, OHIO RIVER[1]

Year	Flood Control Reach												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1950	34.0	76.0	26.0	125.0	81.0	96.5	187.0	76.0	51.0	40.5	123.5	75.0	47.5
1951	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955	12.5	30.5	9.0	148.0	38.5	34.5	79.0	23.0	13.0	10.5	23.0	5.5	3.0
1956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	28.0	64.5	18.5	30.0	44.5	72.0	164.5	52.0	31.0	24.0	66.5	14.5	1.0
1959	0.5	3.7	1.1	1.6	1.5	5.1	9.5	6.1	2.8	2.6	9.3	2.0	0.3
1960	0.0	7.8	3.8	4.0	0.0	1.8	2.4	3.4	0.0	0.5	18.8	3.2	1.3
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	37.0	218.0	85.0	540.0	163.0	432.0	1000.0	341.0	210.0	151.0	307.0	96.0	110.0
1963	16.5	35.0	16.0	107.0	32.0	79.0	133.5	56.0	26.0	22.0	59.0	24.0	12.0
1964	0.4	1.0	0.4	0.5	2.2	6.7	14.1	6.4	9.3	4.2	3.3	1.2	0.3
Sums	128.9	436.5	159.8	956.1	362.7	727.6	1589.9	563.9	343.6	255.8	610.4	221.4	175.4

[1]Values in thousands of dollars

geographically, some assumption had to be made as to the income distribution of project beneficiaries within each area. This was done by determining the income distribution of the people in the counties along the reach as a whole, the relationship between county wide incomes and incomes in the flood plain, and making an assumption as to how the total benefit was distributed among those of varying income levels.

Income distributions for the counties, lying adjacent to the river, along a specific reach were obtained and added to find the composite income distribution of the reach (9, p. 19-65). Having the income distribution within the counties along the reach as a whole, the next step was to obtain data on the relative income levels of persons living in the flood plain as opposed to those living in the same reach but outside the flood plain. In order to examine this problem, the assumption was made that the income level of an individual is indicated by the amount of property he owns. Three areas were chosen which were indicative of three types of areas in which flood damage might occur, and property assessment values in the flood plain were compared with those outside the flood plain.

RELATIVE INCOME LEVELS

Johnson County: The first area studied was Johnson County, Kentucky. This county is representative of Eastern Kentucky, where the majority of the flood benefits from Dewey Reservoir accrue. Property assessment values for property both in and out of the flood plain were obtained from the County Tax Commissioner of Johnson

County. A random sample of all property in the county was taken by recording the first and last value on each page in the property assessment records. A sample of property in the flood plain was obtained by local inquiry as to the name of property owners who had been flooded. The median assessments in and out of the flood plain were found to be $4,715 and $4,610 respectively.

Having found the median assessments approximately equal, it is now left to determine if any significant difference exists in the distribution of assessment values around the median. A dimensionless plot was made of percent of median assessment versus percent of properties assessed at less than the indicated percent of median assessment, Figure 9. From the plot, Table 22 was obtained and value of χ^2 was calculated to determine if there was a significant difference between the property assessment distributions inside and outside the flood plain (22, p. 278). The value of χ^2 calculated was 4.02 which indicates that no significant difference exists. As a result both the median and the distribution of incomes around the median as represented by the standard deviation were found for Johnson County to be the same for those living in the flood plain as for persons living outside the flood plain.

Hardin County: The second area studied was Western Kentucky. In this area farming and urban development requiring flat land are not restricted to the land along the rivers as they are in Eastern Kentucky. West Point, a small town of approximately 2,000 population lying adjacent to the Ohio River in Hardin County, Kentucky, was chosen to represent the area in the flood plain. Radcliff, a town

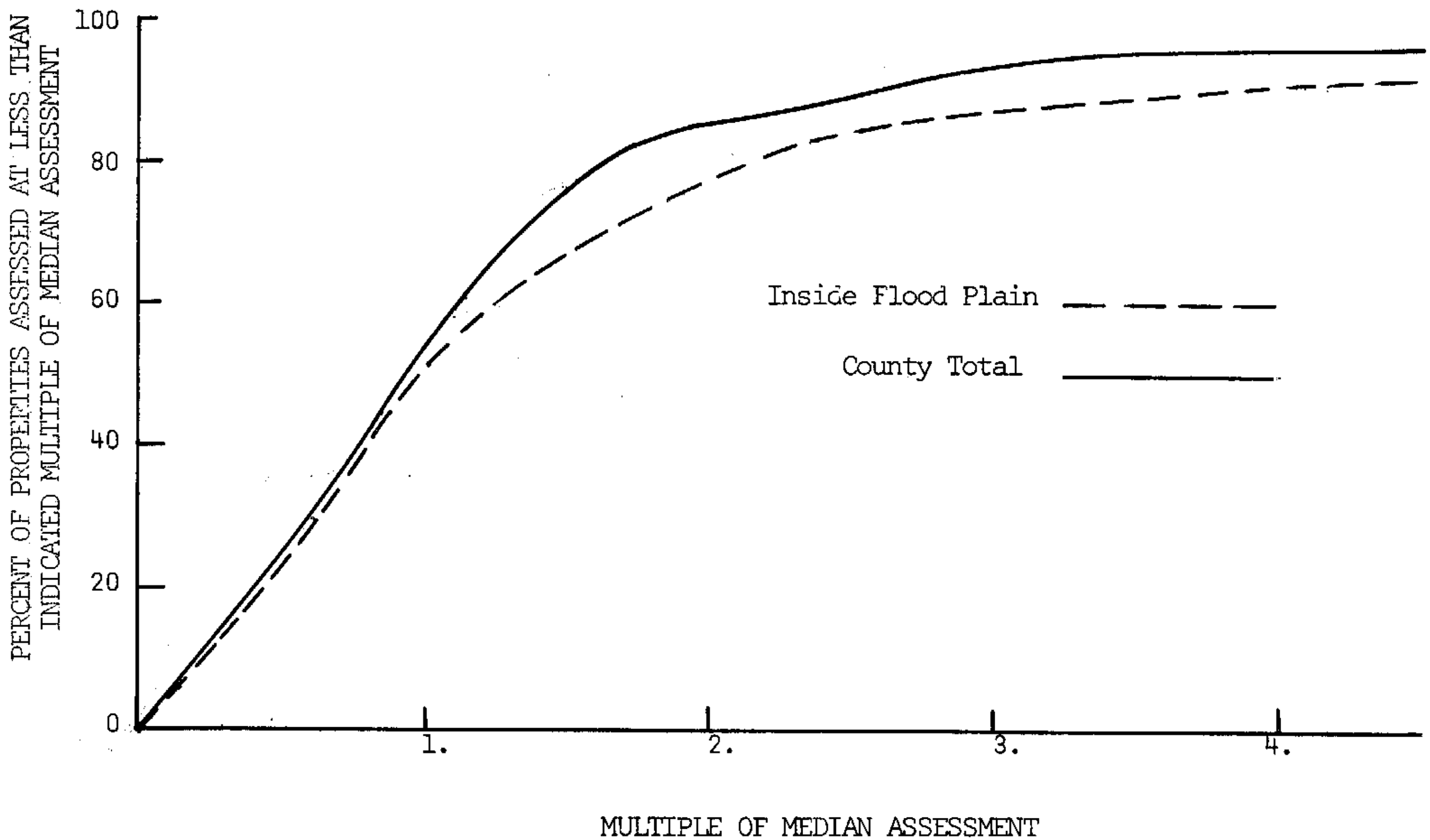


Fig. 9. Property Assessment Distribution, Johnson County, Kentucky

TABLE 22

PROPERTY ASSESSMENT DISTRIBUTIONS FOR
JOHNSON COUNTY, KENTUCKY

Multiple of Median Assessment	Fraction of Properties in Assessment Group Interval	
	Flood Plain	Johnson Co.
0.0-0.5	0.230	0.250
0.5-1.0	0.280	0.290
1.0-1.5	0.150	0.220
1.5-2.0	0.110	0.090
2.0-2.5	0.080	0.040
2.5-3.0	0.020	0.040
3.0-3.5	0.020	0.020
3.5-4.0	0.020	0.010
4.0-4.5	0.010	0.005
4.5-5.0	0.005	0.003

$$X^2 = 4.02$$

approximately the same size as West Point and also in Hardin County, Kentucky but not subject to flooding from the Ohio River, was chosen as a representative area outside the flood plain. The median assessments for West Point and Radcliff were found to be $4,300 and $8,700 respectively, indicating a great difference in the economic status of the two towns. The analysis performed on Johnson County was repeated and Figure 10 obtained, for the towns now under study yielding a value of χ^2 of 3.23. The low value of χ^2 indicates that no significant difference exists between the distributions of assessment values around the median, but the large discrepancy in the median assessments indicates that, on the whole, the people living in the flood plain are poorer materially than those living outside the flood plain.

Jefferson County: The third area studied was a large city, Louisville, Kentucky, partly lying inside and partly outside the flood plain. Property assessment values were obtained, and the median assessment values inside and outside the flood plain were found to be $10,430 and $17,370 respectively. The assessment values were plotted to yield Figure 11. A χ^2 of 5.986 was calculated for the distribution around the median indicating no significant difference in the distributions.

Application: Having found that no significant difference exists between the distributions of property assessment values about the median for areas inside and outside the flood plain, the assumption is made that the income distribution of those in the flood

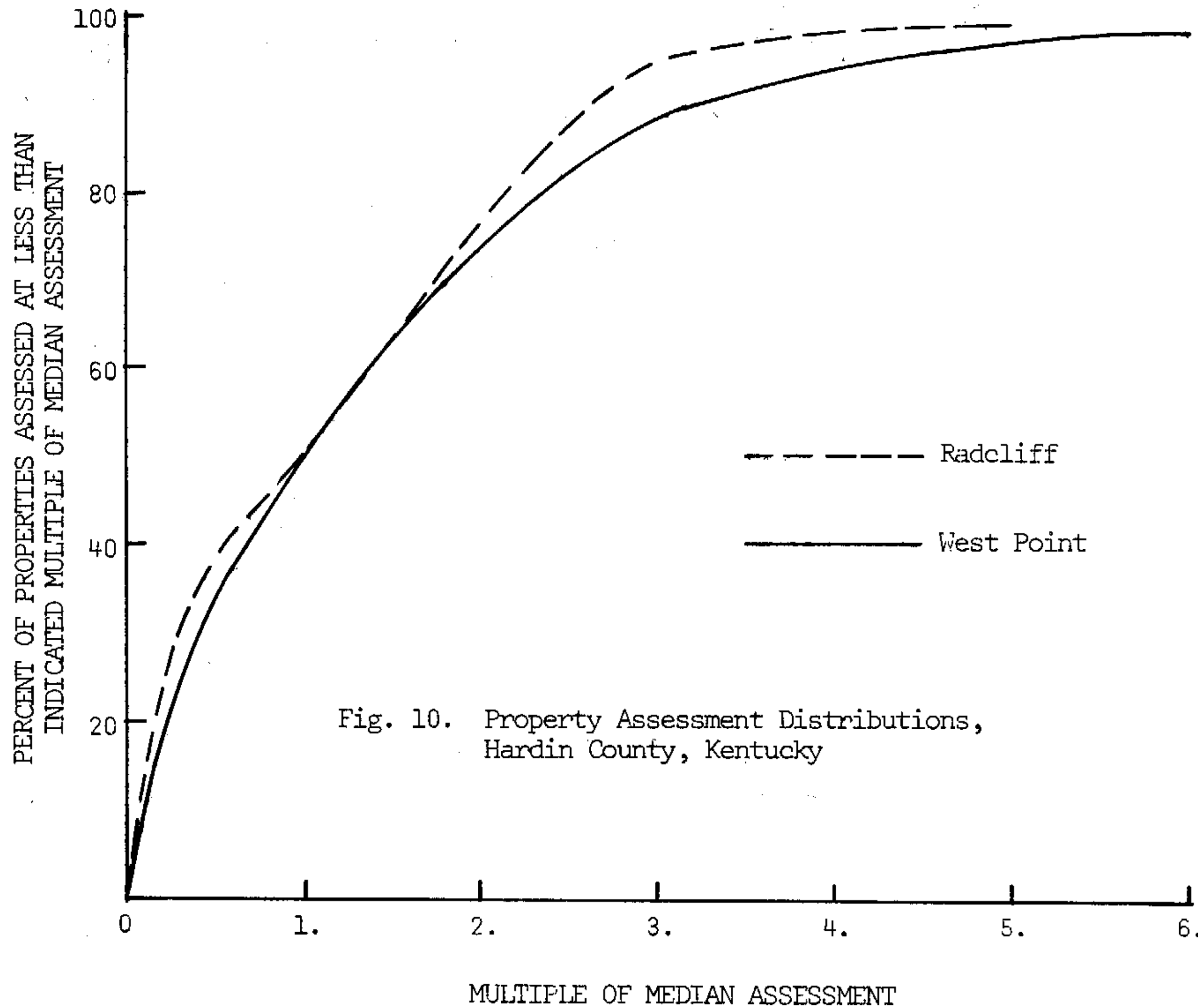


Fig. 10. Property Assessment Distributions, Hardin County, Kentucky

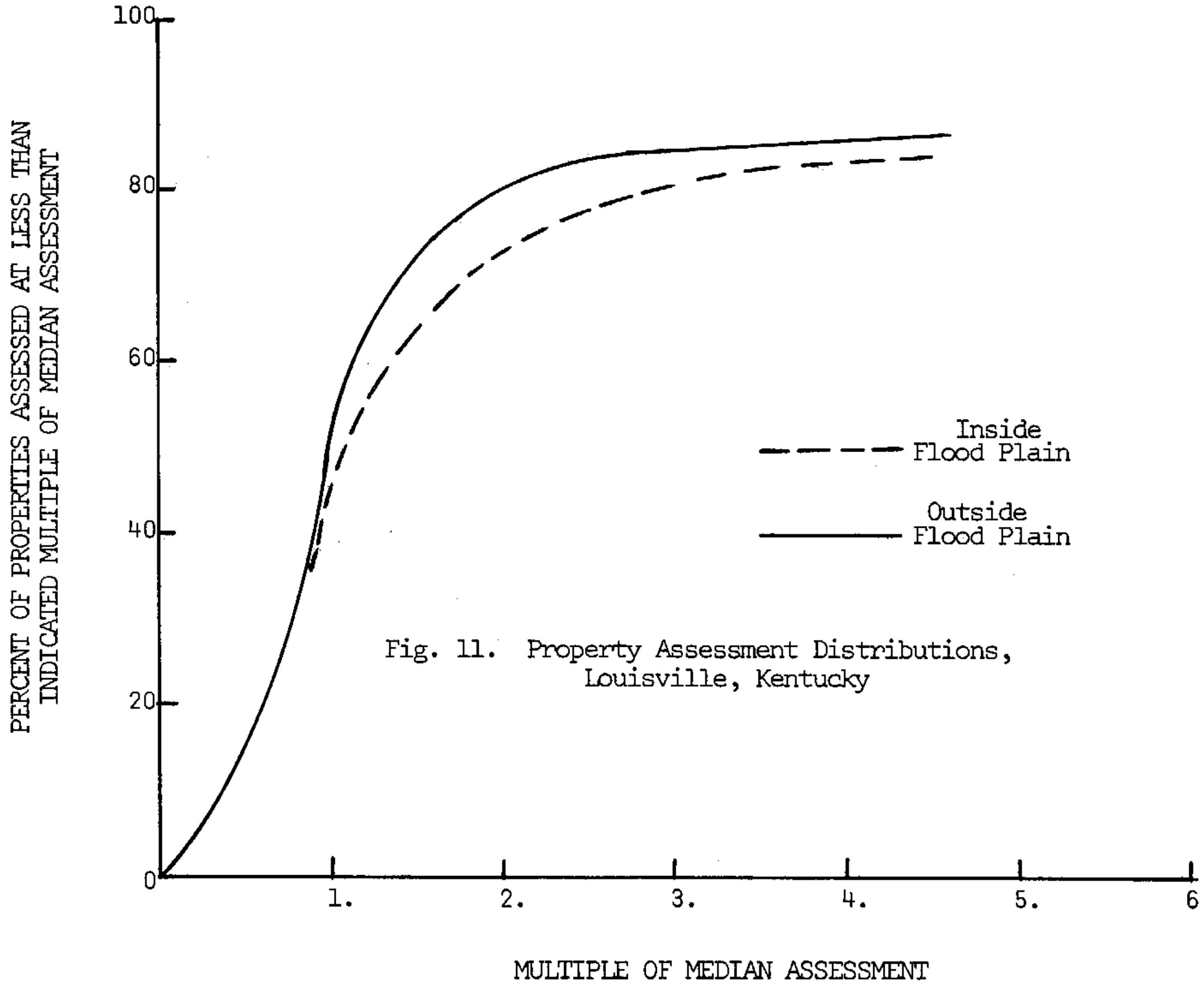


Fig. 11. Property Assessment Distributions, Louisville, Kentucky

plain relative to their median income is the same as it is for the inhabitants of the counties along the reach as a whole. It now remains to translate the difference in the median property assessments inside and outside the flood plain into a difference in median income.

Johnson County data was used to establish a relationship between assessments and income because of the extensive assessment data collected. First it was found that approximately 20 percent of the people living in Kentucky owned no real property (21, p. 19-8). From the dimensionless plot of income distribution for Johnson County (analagous to Figure 13) it was found that 20 percent of the people have incomes less than $1,300. Therefore, an assumption that it is those with lowest income who own no real property would lead to the conclusion that all land is owned by individuals whose annual incomes are more than $1,300. A plot was made of property assessment as a function of income. For example, the assessment value for which 40 percent of all assessments in Johnson County were smaller was plotted versus the income for which 40 percent of all incomes in Johnson County above $1,300, were smaller. The percent figure was varied to give the different points on Figure 12.

Figure 12 is applied by taking the median assessment value for the flood plain, $10,430 for Louisville, Kentucky, and reading the corresponding income, $7,770 for Louisville, Kentucky. The income value for the median assessment outside the flood plain of $17,370 is found by the same process to be $10,200 for Louisville. The ratio of $7,770 to $10,200 multiplied by the

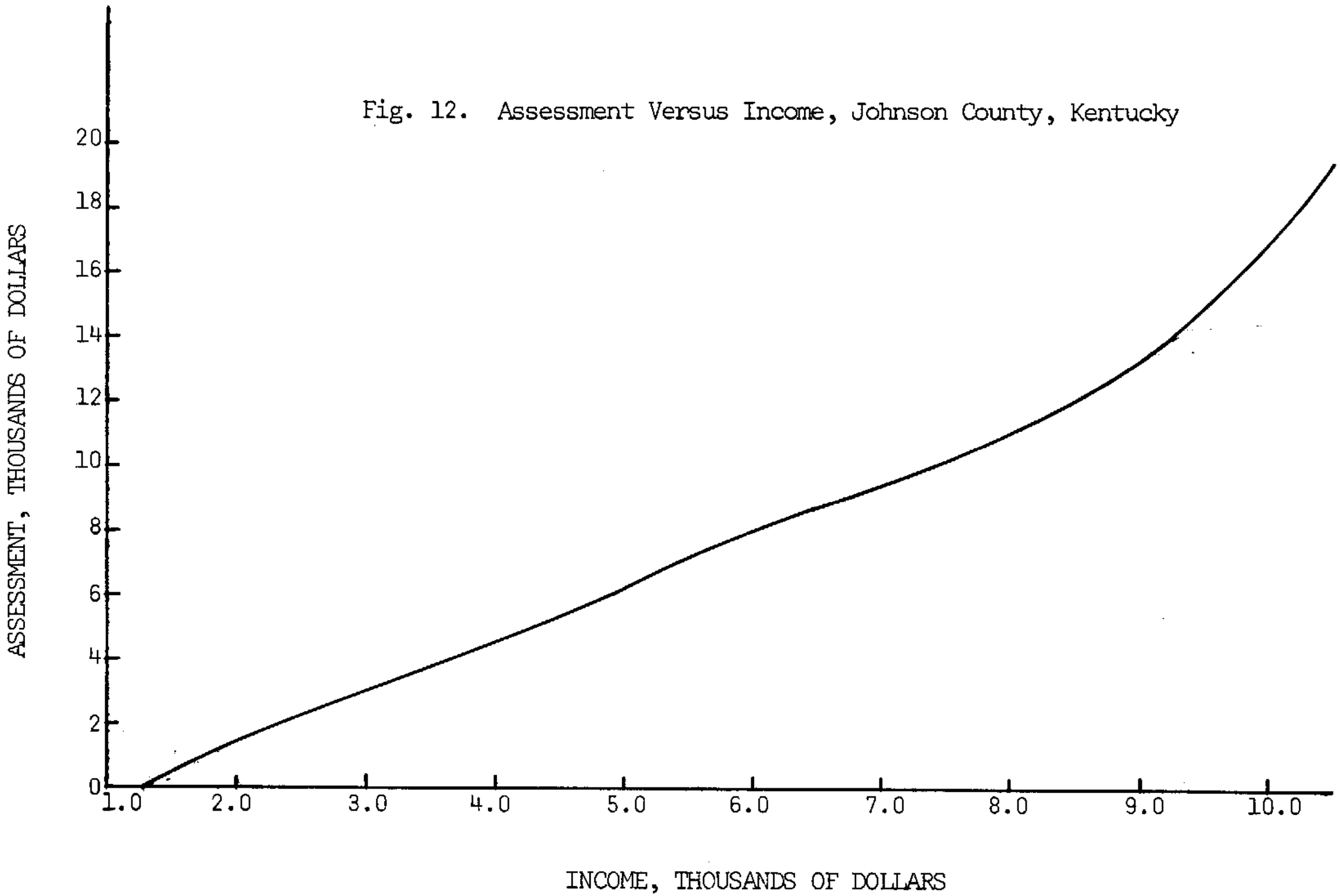


Fig. 12. Assessment Versus Income, Johnson County, Kentucky

median income for Jefferson County gives an estimate of the median income of those living in the flood plain.

BENEFIT DISTRIBUTIONS

With the total benefit accruing to those along the reach and the income distribution of those in the flood plain available, it was next necessary to divide the total benefit among those of varying income levels. Two possible assumptions were considered. The first was that each individual in the flood plain benefitted equally. The second was that each individual received a benefit proportional to the value of the property he owned. The second assumption seemed to be by far the more logical. Flood damage occurs primarily to real property, and one would generally expect the susceptibility of property to damage to be roughly proportional to its value.

An income redistribution factor was calculated for each reach for every year from 1950 through 1964. Reach 8 will be used as an example to illustrate the procedure used in the calculation of the factors.

CALCULATION OF INCOME REDISTRIBUTION FACTORS

Reach 8 is comprised of the Kentucky Counties of Breckinridge, Hancock, Daviess, and Meade and the Indiana Counties of Harrison, Crawford, Perry and Spencer. The family income distributions for 1949 and 1959 were obtained from the United States Census records and the distributions were added to give a composite, reach 8, income distribution, Table 23. The income distributions were plotted in

TABLE 23

REACH 8 INCOME DISTRIBUTIONS

Adjusted Gross Income (thousands of dollars)	Number of Families
1959	
0.0-1.0	3858
1.0-2.0	4944
2.0-3.0	5031
3.0-4.0	6161
4.0-5.0	5595
5.0-6.0	4844
6.0-7.0	3787
7.0-8.0	2790
8.0-9.0	1830
9.0-10.0	1247
10.0-15.0	2047
15.0-25.0	589
over 25.0	294
Median Income = $4271	
1949	
0.0-0.5	5085
0.5-1.0	4515
1.0-1.5	4530
1.5-2.0	4020
2.0-2.5	4550
2.5-3.0	3820
3.0-3.5	2930
3.5-4.0	1815
4.0-4.5	1515
4.5-5.0	1045
5.0-6.0	1350
6.0-7.0	700
7.0-10.0	650
over 10.0	475
Median Income = $2038	

dimensionless form as is shown in Figure 13. The plots for 1949 and 1959 agreed very closely showing a near constant distribution about the median income.

The income increments, shown on Table 23 and used for referencing the welfare equivalent weights, were then expressed as multiples of the median income for the years 1950, 1958, 1962, and 1964. The fraction of the families in each income class was calculated and the median income of the class recorded. In order to account for the fact that the individuals with higher incomes own more property, the values of median property assessment for the various median incomes were read from Figure 12 and multiplied by the fraction of families in the different income brackets. These products were added and the fraction of the total in each adjusted gross income range was calculated and is listed under product-fraction on Table 24. The product-fraction was multiplied by the appropriate welfare equivalent weight from Table 19 and the values added to give the income redistribution factor. A sample calculation of the income redistribution factor for Ohio River reach 8 for the year 1958 is given on Table 24.

Income redistribution factors were also calculated in the same manner for the years 1949, 1962, and 1964 and the results were plotted, Figure 14. For any year from 1950 through 1964, the income redistribution factor for reach 8 can be read. Calculations were made in like manner for all Ohio River reaches and the results obtained are listed on Table 25. When it is determined that X dollars of benefits occur to a specific reach in a certain year,

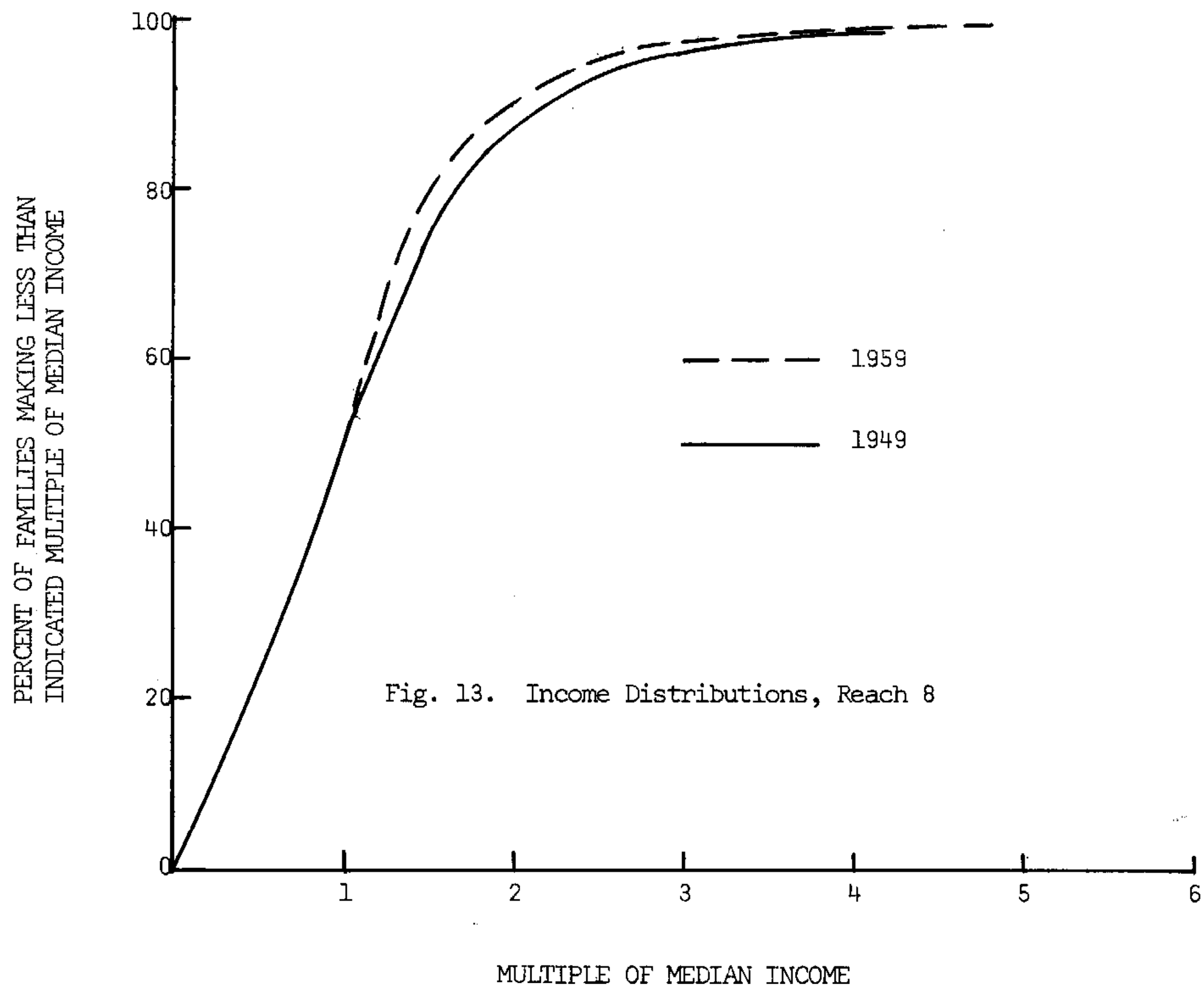


Fig. 13. Income Distributions, Reach 8

TABLE 24

SAMPLE CALCULATION OF INCOME REDISTRIBUTION FACTOR FOR REACH 8, 1958

(1)	(2)	(3)	(4)	(5)			
Adjusted Gross Income		Median Assessment Figure 11	Fraction of Families	Product (3) (4)	Product-Fraction	Welfare Equivalent Weight	
$1,000 Range	Median	$1,000					
0-1	0.5	0.0	0.12	0.000	0.000	2.65	0.000
1-2	1.5	0.5	0.14	0.070	0.015	1.71	0.027
2-3	2.5	2.3	0.15	0.345	0.076	1.34	0.102
3-4	3.5	3.8	0.17	0.646	0.143	1.07	0.153
4-5	4.5	5.3	0.20	1.113	0.246	1.03	0.253
5-6	5.5	7.2	0.08	0.576	0.127	0.94	0.119
6-7	6.5	8.8	0.04	0.352	0.078	0.80	0.062
7-8	7.5	10.2	0.04	0.408	0.090	0.73	0.066
8-9	8.5	12.1	0.02	0.242	0.054	0.69	0.037
9-10	9.5	15.0	0.01	0.150	0.033	0.65	0.021
10-15	12.5	31.0	0.02	0.620	0.137	0.61	0.084
Total				4.522	1.000		0.924
				Income Redistribution Factor =			0.924

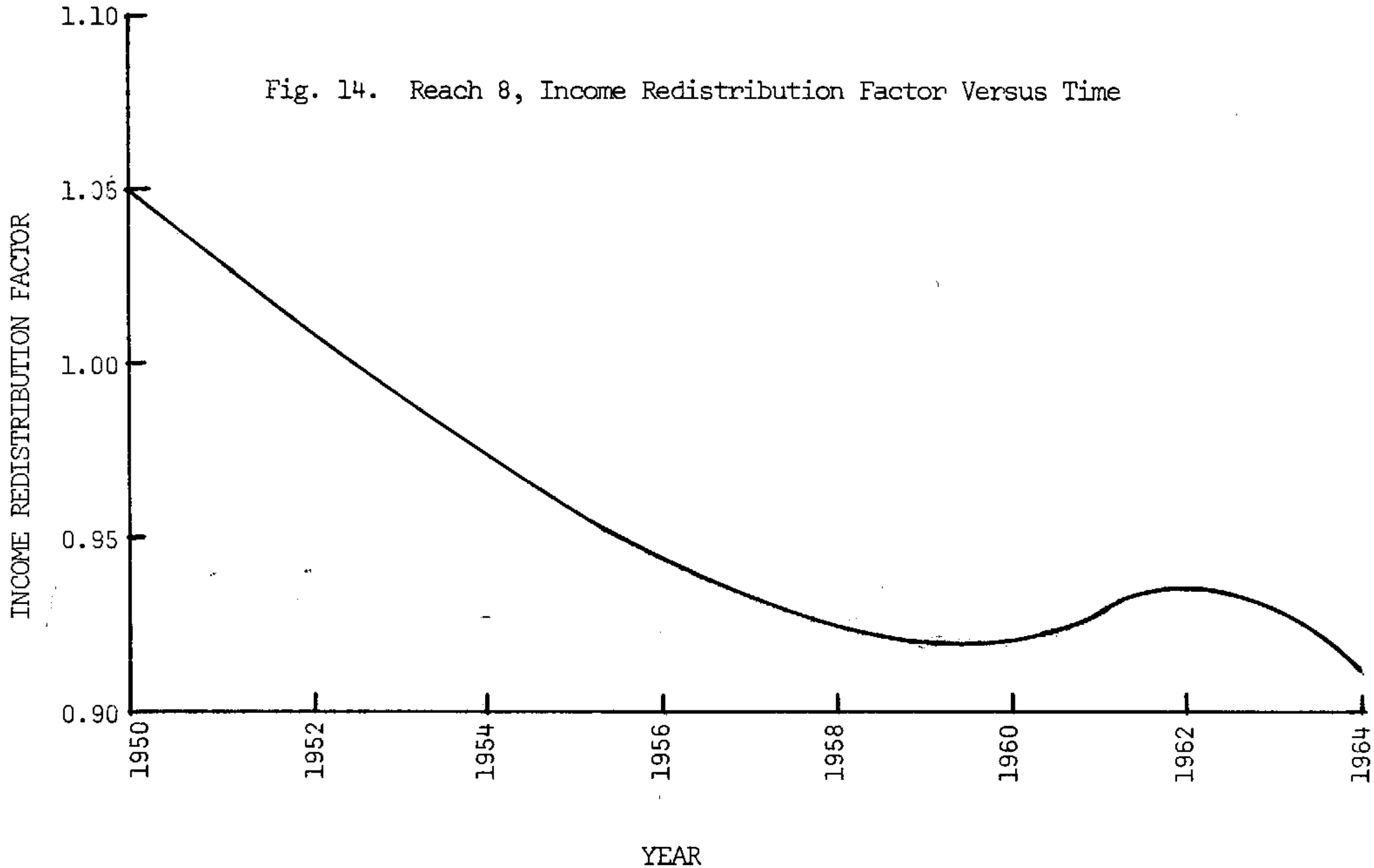


Fig. 14. Reach 8, Income Redistribution Factor Versus Time

TABLE 25

INCOME REDISTRIBUTION FACTORS FOR FLOOD CONTROL BENEFITS

Year	Johnson County	Paints-ville	Lawrence County	Ohio River Reach										
				2	3&4	5	6	7	8	9	10	11	12	13
1950	0.92	0.84	0.93	1.06	1.14	0.93	1.06	1.04	1.05	0.99	1.13	1.34	0.90	1.10
1951	0.93	0.84	0.92	1.05	1.12	0.92	1.04	1.01	1.03	0.97	1.11	1.28	0.92	1.08
1952	0.94	0.83	0.92	1.04	1.10	0.90	1.01	0.98	1.01	0.95	1.08	1.23	0.94	1.06
1953	0.94	0.83	0.91	1.02	1.07	0.89	0.98	0.96	0.99	0.94	1.06	1.18	0.96	1.04
1954	0.95	0.83	0.91	1.01	1.05	0.87	0.96	0.94	0.97	0.92	1.03	1.13	0.98	1.02
1955	0.95	0.83	0.90	0.99	1.03	0.86	0.94	0.92	0.96	0.90	1.01	1.08	1.00	1.01
1956	0.96	0.82	0.90	0.98	1.01	0.85	0.92	0.90	0.94	0.89	0.99	1.03	1.02	0.99
1957	0.96	0.82	0.90	0.97	0.99	0.84	0.91	0.88	0.93	0.88	0.97	0.99	1.04	0.98
1958	0.96	0.82	0.90	0.96	0.98	0.83	0.90	0.86	0.92	0.88	0.96	0.95	1.05	0.96
1959	0.96	0.82	0.91	0.96	0.96	0.83	0.90	0.85	0.92	0.87	0.94	0.92	1.06	0.95
1960	0.95	0.81	0.93	0.95	0.96	0.83	0.90	0.84	0.92	0.87	0.94	0.89	1.07	0.94
1961	0.94	0.81	0.95	0.95	0.96	0.83	0.91	0.84	0.93	0.88	0.94	0.87	1.07	0.94
1962	0.93	0.80	0.97	0.96	0.96	0.84	0.91	0.83	0.94	0.88	0.95	0.85	1.07	0.94
1963	0.92	0.80	0.96	0.97	0.96	0.84	0.91	0.84	0.93	0.90	0.95	0.83	1.08	0.94
1964	0.92	0.80	0.94	0.98	0.96	0.84	0.90	0.84	0.91	0.90	0.95	0.80	1.09	0.94

this amount can be multiplied by the appropriate income redistribution factor and the original amount, X, subtracted from the product to yield the income redistribution benefit. Income redistribution benefits for all reaches are shown on Tables 26 and 27. The average annual income redistribution benefit resulting from flood control effects of Dewey Reservoir has been -$77,670 over the years 1950 through 1964. The basic cause of the overall negative value is that the property owners who suffer flood damage have higher incomes than the population as a whole.

RECREATION BENEFICIARIES

In order to figure the income redistribution effects of the direct recreation benefits found on Table 16, it was also necessary to assume an income distribution for the recreation visitors. As no data was available on the income distribution of recreation visitors from a given county to a given reservoir relative to the income distribution of the residents of the county as a whole, it was assumed that the two distributions were identical. This assumption is strengthened by the low correlation found between median county income and county income distribution and the propensity of those in a county to visit Dewey Reservoir for recreation (15, p. 82). Knetsch and Davis, on the other hand, found a positive correlation between income and recreation benefit received (23, p. 131). Nevertheless, the assumption made in this report should not lead to significant error in estimating income redistribution benefits.

Income redistribution benefits were calculated for the

TABLE 26

INCOME REDISTRIBUTION BENEFITS FROM FLOOD CONTROL, JOHNS CREEK AND LEVISA FORK[1]

	Reach			
Year	Johns Creek to Paintsville	Paintsville	Paintsville to Mile 19	Mile 19 to Louisa
1950	-80.	-820.	-70.	-140.
1951	-70.	-1,600.	-150.	-80.
1952	0.	-1,340.	-80.	-1,720.
1953	0.	0.	0.	0.
1954	0.	0.	0.	0.
1955	-1,000.	-67,860.	-1,900.	-2,560.
1956	-90.	-1,770.	-100.	-300.
1957	-2,580.	-450,000.	-8,080.	-1,920.
1958	-460.	-28,180.	-920.	-1,940.
1959	0.	0.	0.	-260.
1960	0.	0.	0.	0.
1961	0.	0.	0.	0.
1962	-480.	-14,400.	-180.	-1,350.
1963	-3,380.	-139,300.	-2,080.	-1,800.
1964	0.	0.	0.	0.
Total	-$8,140	-$765,270	-$13,560.	-$12,070

1 Values listed in 1961 dollars.

TABLE 27

INCOME REDISTRIBUTION BENEFITS FROM FLOOD CONTROL, OHIO RIVER[1]

Year	Flood Control Reach												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1950	-2.4	4.9	3.8	18.1	- 5.3	6.1	6.9	3.5	- 0.6	5.4	41.9	-7.3	5.0
1951	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955	-1.2	-0.2	0.3	4.4	- 5.4	- 2.2	- 6.5	1.0	- 1.2	0.1	1.8	-0.1	0.0
1956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	-2.8	-2.4	-0.5	- 0.8	- 7.4	- 7.3	- 22.5	- 3.9	- 3.9	-1.1	- 3.2	0.7	0.0
1959	0.0	-0.2	0.0	- 0.1	- 0.3	- 0.5	- 1.4	- 0.5	- 0.4	-0.1	- 0.7	0.1	0.0
1960	0.0	-0.4	-0.2	- 0.2	0.0	- 0.2	- 0.4	- 0.3	0.0	0.0	- 2.0	0.2	-0.1
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	-1.1	-9.4	-3.6	-23.2	-26.6	-38.9	-167.0	-22.2	-23.2	-7.8	-47.0	6.8	-6.4
1963	-0.7	-1.1	-0.6	- 4.4	- 5.1	- 7.2	- 22.0	- 3.9	- 2.7	-1.1	-10.3	1.8	-0.7
1964	0.0	0.0	0.0	0.0	- 0.3	- 0.6	- 2.2	- 0.6	- 0.9	-0.2	- 0.7	0.1	0.0
Total	-8.2	-8.8	-0.7	-6.2	-50.4	-50.8	-215.1	-26.9	-32.9	-4.8	-21.2	+2.3	-2.2

[1] Values in thousands of dollars, 1961

Average = -77.67 thousands annually

recreation benefits listed on Table 16. The 168 population centers were arranged in order of median family income from smallest to largest. The total was then broken down into eight groups of 21 population centers each. The middle population center in each group was used to calculate an income redistribution factor for the entire group. It was assumed that recreation benefits accrue to all individuals, equally, that is, a person who makes $1,000 per year would receive the same recreational benefit as would the individual whose income is $100,000 per year. Income redistribution factors were calculated in the same way as for flood control benefits except that no median assessment value was used, column 3 on Table 24, to account for benefits being a function of amount of property owned.

Table 28 lists the population centers chosen and the income redistribution factors which were calculated. The appropriate income redistribution factor was used for calculating an income redistribution benefit for each population center and the results are listed on Table 29. It is seen that Dewey Reservoir effects $133,720 annually in income redistribution benefits from the provision for recreation.

MISSISSIPPI RIVER BENEFICIARIES

For the $1,470 average annual benefits from Dewey Reservoir to the Mississippi River, an income redistribution factor was calculated by assuming that the income distribution of Louisiana could be used to approximate the distribution of individuals living

TABLE 28

INCOME REDISTRIBUTION FACTORS FOR RECREATIONAL BENEFITS

Population Center	Income Redistribution Center
Casey Co.	1.68
Trigg Co.	1.52
Pike Co.	1.46
Lyon Co.	1.30
Pendleton Co.	1.25
Greenup Co.	1.21
N. Mexico	1.08
Delaware	.94

along the Lower Mississippi River. A factor of 1.20 was calculated and when applied to the $1,470 average annual Mississippi River benefits yields an average annual income redistribution benefit of $294.

SUMMARY OF INCOME REDISTRIBUTION BENEFITS TO BENEFICIARIES

The direct benefits attributable to Dewey Reservoir accrue to people of such income that they yield the income redistribution benefits annually found on Table 30. It is seen that the average annual income redistribution benefit is $56,344.

INCOME REDISTRIBUTION FROM PROJECT EXPENDITURES

DIVISION OF PROJECT EXPENDITURES

In addition to increasing the income of those benefitting

TABLE 29

INCOME REDISTRIBUTION BENEFITS FROM RECREATION BENEFITS

Population Center	Redistribution Benefit	Population Center	Redistribution Benefit
Adair (22)[1]	150.	Graves (88)	30.
Allen (29)	70.	Grayson (30)	100.
Anderson (97)	70.	Green (56)	90.
Ballard (65)	10.	Greenup (116)	560.
Barren (49)	180.	Hancock (62)	20.
Bath (34)	430.	Hardin (102)	260.
Bell (37)	950.	Harlan (66)	1,120.
Boone (147)	30.	Harrison (100)	150.
Bourbon (96)	220.	Hart (36)	100.
Boyd (132)	650.	Henderson (111)	40.
Boyle (99)	160.	Henry (79)	80.
Bracken (81)	90.	Hickman (57)	10.
Breathitt (2)	2,540.	Hopkins (109)	50.
Breckenridge (46)	70.	Jackson (5)	540.
Bullitt (122)	50.	Jefferson (148)	-570.
Butler (26)	50.	Jessamine (45)	240.
Caldwell (73)	20.	Johnson (38)	20,230.
Calloway (82)	30.	Kenton (150)	-190.
Campbell (155)	-140.	Knott (17)	3,660.
Carlisle (69)	10.	Knox (8)	870.
Carroll (84)	50.	Larue (68)	50.
Carter (63)	1,660.	Laurel (33)	700.
Casey (11)	270.	Lawrence (28)	2,460.
Christian (94)	90.	Lee (15)	600.
Clark (110)	250.	Leslie (14)	880.
Clay (12)	1,030.	Letcher (44)	2,070.
Clinton (7)	120.	Lewis (54)	440.
Crittenden (50)	20.	Lincoln (40)	310.
Cumberland (18)	100.	Livingston (61)	10.
Daviess (124)	120.	Logan (59)	80.
Edmonson (24)	50.	Lyon (74)	10.
Elliott (25)	830.	McCracken (130)	20.
Estill (39)	550.	McCreary (13)	260.
Fayette (138)	440.	McLean (72)	20.
Fleming (47)	370.	Madison (85)	450.
Floyd (52)	27,230.	Magoffin (4)	4,940.
Franklin (140)	70.	Marion (76)	120.
Fulton (80)	10.	Marshall (112)	20.
Gallatin (86)	20.	Martin (27)	5,120.
Garrard (67)	110.	Mason (101)	240.
Grant (93)	60.	Meade (120)	50.

[1]Median income rank from lowest to highest in parenthesis.

TABLE 29 - Continued

Population Center	Redistribution Benefit	Population Center	Redistribution Benefit
Menifee (10)	380.	Delaware (158)	-70.
Mercer (87)	110.	Washington D.C. (156)	-210.
Metcalfe (20)	90.	Florida (123)	1,020.
Monroe (16)	120.	Georgia (113)	3,370.
Montgomery (70)	300.	Idaho (135)	10.
Morgan (23)	1,690.	Illinois (164)	-1,250.
Muhlenburg (83)	60.	Indiana (149)	-2,690.
Nelson (108)	90.	Iowa (133)	220.
Nicholas (51)	180.	Kansas (136)	110.
Ohio County (41)	80.	Louisiana (115)	590.
Oldham (125)	50.	Maine (127)	40.
Owen (77)	70.	Maryland (162)	-740.
Owsley (1)	390.	Massachusetts (161)	-300.
Pendleton (95)	80.	Michigan (160)	-1,170.
Perry (48)	3,000.	Minnesota (142)	120.
Pike (53)	14,970.	Mississippi (58)	1,320.
Powell (43)	250.	Missouri (134)	450.
Pulaski (35)	600.	Montana (139)	10.
Robertson (21)	70.	Nebraska (126)	160.
Rockcastle (19)	440.	Nevada (166)	-0.
Rowan (60)	1,250.	New Hampshire (144)	60.
Russell (6)	180.	New Jersey (167)	-740.
Scott (103)	150.	New Mexico (137)	20.
Shelby (107)	80.	New York (163)	-1,440.
Simpson (55)	50.	North Carolina (106)	10,960.
Spencer (75)	40.	North Dakota (118)	40.
Taylor (92)	80.	Ohio (157)	-10,220.
Todd (42)	40.	Oklahoma (121)	270.
Trigg (32)	30.	Oregon (152)	-10.
Trimble (89)	20.	Pennsylvania (145)	3,000.
Union (91)	20.	Rhode Island (143)	60.
Warren (90)	110.	South Carolina (98)	3,770.
Washington (64)	80.	South Dakota (114)	50.
Wayne (9)	240.	Tennessee (105)	4,560.
Webster (78)	30.	Texas (128)	230.
Whitley (31)	490.	Utah (153)	-10.
Wolfe (3)	860.	Vermont (129)	30.
Woodford (117)	80.	Virginia (131)	1,680.
Alabama (104)	2,490.	Washington (159)	-10.
Arizona (141)	10.	West Virginia (119)	5,490.
Arkansas (71)	750.	Wisconsin (154)	-260.
California (165)	-70.	Wyoming (151)	-10.
Colorado (146)	40.		
Connecticut (168)	-170.	Average Annual	$133,720.

TABLE 30

SUMMARY OF INCOME REDISTRIBUTION BENEFITS TO BENEFICIARIES

Item	Average Annual Amount
Flood Control	-$77,670
Mississippi River	$ 294
Recreation	$133,720
Total	$ 56,344

from project output, a water resources project may also affect income distribution by increasing the incomes of those who receive funds spent during project installation for goods or services rendered. In a situation of full employment, the workers and suppliers would merely transfer their services from one job to another without any significant change in income. In a situation of significant unemployment, new jobs may be created providing the otherwise unemployed have the proper skills to contribute to project construction. The project may reduce unemployment either by direct hiring of the otherwise unemployed or by hiring away from other jobs those who are subsequently replaced by the unemployed. At the time of the construction of Dewey Reservoir in the late 1940's, about five percent of the work force in the Floyd County area was unemployed.

Some insight into the effects of the expenditure for reservoir construction on the local economy can be obtained by subdividing the construction costs into categories. Project expenditure will be broken into parts, and documentation of reasoning used in making the breakdown estimates will be given. Expenditures will be divided into seven parts:

1. Wages paid to residents of the local area.
2. Wages paid to people brought into the local area from outside to work on the project.
3. Wages paid to people away from the project site.
4. Cost of materials purchased from local suppliers.
5. Cost of materials brought in from outside.
6. Direct payments to local people.
7. Direct payments to people away from the project site.

DEFINITE PROJECT REPORT AND PRELIMINARY ENGINEERING:

The sum of $396,333 was expended for project planning and design and paid primarily to those who worked at sites away from the project location.

REAL ESTATE:

The sum of $1,655,944 was paid to land owners for right-of-way and more was spent to acquire it. From an examination of tract registers it was found that a total of $196,685 was paid to absentee land and mineral rights owners. The balance of $1,459,259 was paid to people living in the local area. Of the total remaining government cost of $426,375 the major part was for hired personnel involved in land acquisition. From the project cost summary sheets, the amount of $215,270 was for hired labor prior to 1949. Very few of these people would come from the local area, most were attorneys and appraisers which were either hired from outside or were Corps' personnel. Of this $215,269, $20,000 was allocated for local labor. This would seem to be a liberal estimate. The sum of $50,000 was allocated for Corps' personnel who worked away from the project site such as personnel who contacted absentee land owners and administrative personnel in the Huntington office.

Government costs since 1949 have been $211,106. This also would mainly be for Corps of Engineers and specialized legal personnel. Of this figure $20,000 was allocated to the local economy for any qualified civil service secretaries, notary publics, etc.

HIGHWAYS AND UTILITIES:

The sum of $225,000 was paid to Floyd County to relocate and construct county roads. Costs are divided as follows: Clearing costs was assumed to go for local labor. Two thirds of excavation is allocated to local labor and one-third to materials purchased locally. All costs for culverts and pipe were allocated to materials purchased outside the local economy. Crushed limestone surface is allocated to materials purchased locally, and engineering and overhead is assumed to be for those brought in from outside the local area to work on the project. Government costs are allocated to those such as inspectors and consultants for the county during construction brought in from outside the local area. The sum of $2,500 for right-of-way was a direct payment to local people.

Utilities relocation costs were divided in the same proportions as highway relocations. In the absence of detailed information on utility relocations, this seemed to be a reasonable assumption.

CEMETERIES:

Of the $54,485 expended for cemetery removal, the major part would be for local labor. Most of the work would be done by unskilled laborers of which the local area is abundantly supplied. The work was done under contract and from Corps' reports apparently was done in an orderly manner. Of the contract amount the assumption is made that approximately fifteen percent was for contractor profit. Since most of the work was done by local labor, $40,000 was allocated as local wages. The sum of $1,000 was allocated to materials purchased locally to account for any hard tools purchased from local suppliers.

CLEARING:

From wages paid, the assumption was made that tractor operators and foremen were brought in from outside the local area. All other labor costs were allocated to residents of the local area. The assumption of $5,000 for materials purchased locally will account for the purchase of axes, saws, chains, etc. from local suppliers. Other materials were assumed to have been purchased from outside suppliers.

DAM:

An estimate of the portion of hired labor from the local area was obtained from Mr. Herbert Witty, resident engineer for the Corps of Engineers during construction. Mr. Witty estimated that of the total of $992,074 paid for labor by the prime contractor, approximately 85% was for labor hired from the local area. This would make the sum of approximately $845,000 expended for local labor. In addition the wages paid by local contractors were $9,693 making a total amount paid to local labor of $854,693. The balance of the labor cost were assumed to be to those brought in from outside to work on the project; or a total of $187,887. Mr. Witty also estimated that ten percent of the materials necessary to construct the dam was purchased from local suppliers. Therefore, of the $1,707,602 expended for materials, $170,760 was spent through local suppliers. This leaves $1,536,842 to be bought from outside suppliers. Since the contractor operated at a loss, nothing was allocated for contractor profit.

LATE AND MISCELLANEOUS CONSTRUCTION:

These two items were divided in the same proportions as dam construction as they were for similar work.

CONTRACTOR CLAIM:

The contractor claim of $152,592 was a direct payment to the contractor. The prime contractor was Ryan Construction Company of Evansville, Indiana.

HIGHWAYS CONSTRUCTED OR IMPROVED

Of the total of $4,134,420 spent by the Federal Government and Commonwealth of Kentucky for construction and improvement of highways since project construction, it was assumed that 40%, or $1,240,326, was for wages paid to residents of the local area since most of the work was done by local contractors and local highway department maintenance crews. No allocation was made for wages to people brought in from outside. Ten percent, or $413,420, was assumed to be for design engineers that worked away from the project, and since most highway construction materials are available in the local area, 35%, or $1,447,047, was allocated to materials purchased locally. The remaining 15%, or $620,163, was assumed to be contractor profit and a direct payment to a local person.

RECREATION FACILITIES

Construction of recreation facilities were assumed to be divided in the same proportions as highway construction except for 15% being assumed to go for materials, such as tables, benches, and building construction materials, purchased from outside suppliers, leaving 20% of the materials being purchased locally.

INCOME REDISTRIBUTION BENEFIT

The construction cost as subdivided into the seven categories is listed on Table 31. To make the figures comply with published Corps of Engineers figures the preceding values were given in dollars of the year in which they were spent. The totals as shown have been converted to 1961 dollars and will be used in

TABLE 31

DEWEY RESERVOIR COST BREAKDOWN

	Labor			Materials		Other	
Item[1]	1	2	3	4	5	6	7
Def. Project Report	$	$	$ 20,000	$	$	$	$
Preliminary Engineering and Design			376,333			4,800	197,000
Real Estate	40,000	336,375	50,000			1,459,259	196,685
Highways	83,168	58,425		63,817	31,590	2,500	
Utilities	141,360	99,310		108,460	53,690	4,257	
Cemeteries	40,000	5,000		1,000	1,485		9,000
Clearing	68,493	15,604		5,000	59,463		
Dam	854,693	187,887		170,760	1,536,842		
Misc. Constr.	70,280	15,450		14,043	126,370		
Contr. Claim							152,592
Late Constr.	18,460	4,060		3,700	33,200		
Kentucky Highways	1,240,326		413,420	1,447,047		620,163	
Kentucky Parks	815,029		203,752	407,515	305,635	305,635	
Total 1961 dollars[2]	3,861,674	1,040,415	1,261,359	2,382,291	2,950,397	3,041,684	449,455

[1]The seven items are defined on p. 89.

[2]The individual items are in current dollars. The columns cannot be added without applying a conversion factor.

the calculations.

Although the expenditures for materials purchased locally did have secondary effects and aided the local economy, only the direct payments to local people and wages paid to residents of the local area, columns one and six of Table 31, will be considered as producing income redistribution effects.

The construction workers were poorly-trained and had very little, if any, previous experience in working on large construction projects. Because of the extra cost resulting from the contractor being forced to train workers, the overall net benefit from using low income workers would be decreased somewhat. Although this training cost was clearly present, no method for analyzing its magnitude is available.

WAGES PAID TO RESIDENTS OF LOCAL AREA

Column one, wages paid to residents of the local area, will be analyzed by assuming that the individuals receiving the wages have incomes equal to the median income for Paintsville, Kentucky. It was also assumed that because of the substantial unemployment and low income conditions prevailing in the area at the time, that these funds added by the full amount to the net cash income of the area.

Federal Funds: It was assumed that all wages paid by the Federal government were paid in the year 1950. Adding all the values in column one of Table 31, except funds spent for highway and parks constructed by the Commonwealth of Kentucky, and expressing this sum in constant 1961 dollars gives $1,787,859. The median income for Paintsville, Kentucky in 1950 was $2,018, and the welfare equivalent weight for this income from Table 19 is 1.30. Applying this factor to the $1,787,859 yields an income redistribution benefit from federal wages paid to local people of $536,358 or, using a project life of 50 years and a 3.125-percent discount rate, $21,341 average annual benefit.

State Funds: It is assumed that all wage paid for construction of highways and parks were paid in 1960. In 1960 the median income for Paintsville, Kentucky was $5,000 giving a welfare equivalent weight of 1.03. Applying this factor to the wages paid to residents of the local area during construction of highways, parks and late construction, $2,073,815, gives an income redistribution benefit of $62,214. This benefit expressed as an average annual amount using a 20-year project life and a 3.125-percent discount rate is $4,230.

DIRECT PAYMENTS TO LOCAL PEOPLE

For analyzing the direct payments to local people, it was assumed that the value paid by the Corps of Engineers equalled the assessed value of the property. One can then divide the total amount paid for property by the number of properties bought and find the average price paid per property. Having this, one goes to Figure 12 and reads the median income associated with the assessment figure found.

Federal Funds: The total federal funds paid for real estate was $1,651,800 in 1950, for 440 tracts giving a value of $3,750 per tract. From Figure 12 one obtains a median income for this assessment of $3,500. The 1950 welfare equivalent weight for this income is .99. The federal cost for land in 1961 dollars is $2,115,886 and applying the factor yields an income redistribution benefit of -$21,158, or -$841 dollars average annual benefits.

State Funds: It was assumed that the median assessment value found for 1950, $3,750, could be extended to 1960 by the price index giving $5,412. Entering Figure 12 with this assessment value gives a median income of $4,500. The welfare equivalent weight for this income is 1.03. Applying this factor to the direct payments to local people from parks and highway construction, $925,798, gives an income redistribution benefit of $27,773. Again using a 20-year project life and 3.125-percent discount yields an average annual value of $1,888.

SUMMARY

The total income redistribution benefits from project expenditures was found to be $26,618 as shown on Table 32.

INCOME REDISTRIBUTION THROUGH PROJECT REPAYMENT

SIGNIFICANCE OF EFFECT

A net positive income redistribution benefit requires those benefitting from project construction to be poorer than those from whom the funds used to pay for the project were obtained. The income redistribution benefits calculated in the preceding sections

TABLE 32

SUMMARY OF INCOME REDISTRIBUTION BENEFITS
FROM PROJECT EXPENDITURES

Item	Average Annual Amount
Wages Paid to Residents of Local Area	
Federal Funds	$21,341
State Funds	4,230
Direct Payments to Local People	
Federal Funds	-841
State Funds	1,888
Total	$26,618

are based on the assumption that the funds are obtained from those of average income. A more complete analysis requires investigation of the incidence of these funds by income group. If the funds were obtained from those of higher than average income, the benefit would be increased. Funds obtained from those of below average income would have the opposite effect. The purpose of this section is to look into the sources of funds used to pay for Dewey Reservoir and adjust the total estimated income distribution benefits accordingly. The approach is to apply the weighting factors derived from analyzing marginal tax rates to the funds obtained from each income group except that the results will be of opposite sign because the cash flow is in the opposite direction.

SOURCE OF FUNDS

Federal Funds: Because the funds required for the construction and operation of Dewey Reservoir came from both the United States and the Kentucky governments, the two sources must be analyzed separately to evaluate their effects on income redistribution. Two assumptions as to the source of the Federal funds for payment of the Dewey Reservoir Project might be made. First, one might assume that the funds were furnished by increasing the national debt. Since the time of repayment of the national debt is uncertain, possibly the debt will never be repaid, there can be no reasonable estimate of the state of the economy at the repayment time. However, in all probability, the economic welfare of the taxpayers as a whole will improve with time. Requiring more affluent future generations to pay for improving the welfare of a presently poorer group is desirable from the point of view of income redistribution. On the other hand, a larger national debt may aggrevate inflation to the economic detriment of many poorer people on fixed income. The results would be an undesirable income redistribution effect. It was not within the scope of this study to further explore the income redistribution effects of this assumption, but it is a matter to which others might wish to give further attention.

The assumption that all project costs were paid in the year of project completion from tax revenues affords one with the necessary information for computing a redistribution effect. Actually Federal revenues come from many sources, but, as another simplifying assumption, only the individual income tax will be used. If the costs are paid at the time of project construction and benefits are realized at some later date when the economy is more developed, two effects are noted. The incidence effect considers the incidence of the income tax among the taxpayers and the relative economic well being of the taxpayers in comparison with the population as a whole. The time effect considers the economic well being of the population at the time the funds were expended relative to that at the time the benefits were realized. Because the majority of the tax revenues come from people with higher than average incomes but benefits are realized in the years after costs are expended when average incomes are higher, the two effects act in opposite directions.

State Funds: State funds may be assumed to come from state tax revenues as state debt and resulting inflationary effects are relatively less important. State, as do Federal funds, come from many revenue sources, but the state income tax was the primary one in Kentucky at the time of project expenditure. Both the incidence and the time effects still need to be considered.

INCIDENCE EFFECT

Federal Factor: The incidence effect accounts for the fact that individuals in the higher income brackets bear a larger portion of the tax burden than do individuals with lesser incomes. The incidence effect of expenditures will be estimated from published Federal income tax statistics.

All federal expenditures for the initial installation of the Dewey Reservoir project are assumed to occur in 1950. By using the welfare equivalent weights calculated for this year in the preceding pages of this chapter, the factor for determining the utility worth of funds spent for the Dewey Project can be calculated.

The fraction of Federal taxes paid by income bracket is first noted (17, p. 151). This fraction is then multiplied by the appropriate welfare equivalent weight and the products summed to yield the incidence factor for 1950. The tabulation of this procedure is given on Table 33, and the incidence factor, for federal funds spent on initial construction, is found to be 0.6134.

Operation and maintenance of the project will continue indefinitely into the future. There is no way for determining the state of the economy in future years. Consequently, there is no way of analyzing the full incidence effects of operation and maintenance costs. However, in order to obtain some idea as to the relative trend in the incidence factor with time, the factor for 1960 was computed by the same method shown on Table 33, and a value of 0.6852 found. The assumption will be made that the 1960 factor can be used to analyze all federal operation and maintenance costs associated with Dewey Reservoir.

<u>State Factor</u>: To examine the incidence effects of state funds spent for highways and parks, a Kentucky state incidence factor was calculated. The expenditures by state agencies seems to be centered around the year 1960, and this year is used for calculating the factor. No data was available as to the fraction of state taxes paid by income bracket; therefore, the following procedure was used to

TABLE 33

CALCULATION OF FEDERAL INCIDENCE FACTOR, 1950

Income Bracket (thousands of dollars)	1950 Welfare Equivalent Weight	Fraction of Taxes	Product
Under 1	2.28	0.0022	0.0050
1-2	1.50	0.0332	0.0498
2-3	1.30	0.0837	0.1088
3-4	.99	0.1185	0.1173
4-5	.75	0.1112	0.0834
5-10	.59	0.2168	0.1279
10-15	.46	0.0631	0.0290
15-20	.41	0.0413	0.0169
20-25	.34	0.0335	0.0114
25-30	.31	0.0275	0.0085
30-40	.26	0.0431	0.0112
40-50	.23	0.0321	0.0074
50-60	.21	0.0243	0.0051
60-70	.20	0.0194	0.0039
70-80	.20	0.0153	0.0031
80-90	.19	0.0128	0.0024
90-100	.19	0.0106	0.0021
100-150	.19	0.0334	0.0063
150-200	.18	0.0179	0.0032
200-250	.17	0.0114	0.0019
250 & over	.18	0.0487	0.0088
Total		1.0000	0.6134

Factor = 0.6134

estimate approximate values.

First, the Federal income tax collected in Kentucky was listed by tax bracket (18, p. 81). The federal and state base tax rates were obtained, and the Federal tax collected in Kentucky multiplied by the ratio of the Kentucky base rate to the Federal rate was assumed to give the Kentucky State tax by income bracket. Calculations proceeded as on Table 34, and the 1960 Kentucky State incidence factor was found to be 0.7227. This factor will be applied to all state expenditures associated with the Dewey project.

TIME EFFECTS

A time factor will now be calculated to account for the fact that the economy will be in a more developed state at the time of benefit realization than at the time of project repayment. First, the median incomes for the years 1958, 1962, and 1964 were expressed in 1950 dollars. A plot of median income versus time was made; and for each year, the median income was noted and the appropriate 1950 welfare equivalent weight was obtained and plotted against time. Table 35 gives the 1950 welfare equivalent weights for the years 1950 through 1964. The 1950 welfare equivalent weights for the various years from Table 35 are used as time factors to account for changes in the economy over the years. It now remains to determine the time gap between the time of project costs and the time of benefit realization.

The time of average benefit realization after the Federal expenditures was found by assuming a project life of 50 years. Based on the assumptions of a uniform annual change in the time factor and

TABLE 34

CALCULATION OF KENTUCKY INCIDENCE FACTOR, 1960

Income Bracket	Kentucky Federal Tax	U. S. Tax Rate Percent	Kentucky Tax Rate Percent[1]	Kentucky State Tax	Fraction of State Taxes	Welfare Equivalent Weight	Product
Under 1	480	20.0	0.0	0	0.000	2.65	0.0000
1-2	7,304	19.9	2.0	734	0.009	1.71	0.0154
2-3	16,062	19.8	2.0	1,622	0.019	1.34	0.0255
3-4	28,759	20.0	3.0	4,314	0.052	1.07	0.0556
4-5	34,474	20.2	4.0	6,826	0.082	1.03	0.0875
5-6	34,540	20.2	5.0	8,549	0.103	.94	0.0968
6-7	37,416	20.3	5.0	9,215	0.111	.80	0.0888
7-8	32,431	20.4	5.0	7,944	0.095	.73	0.0694
8-9	27,922	20.6	6.0	8,132	0.098	.69	0.0676
9-10	17,046	20.8	6.0	4,917	0.059	.65	0.0384
10-15	46,617	21.4	6.0	13,070	0.157	.61	0.0958
15-20	17,109	23.4	6.0	4,387	0.053	.52	0.0276
20-25	12,099	25.5	6.0	2,846	0.034	.42	0.0143
25-50	36,149	30.8	6.0	7,042	0.084	.33	0.0277
50-100	20,309	42.0	6.0	2,901	0.036	.28	0.0101
100-150	3,021	50.5	6.0	359	0.004	.27	0.0011
150-200	1,295	54.2	6.0	143	0.001	.27	0.0003
200-500	2,258	57.5	6.0	236	0.003	.27	0.0008
500 or more	237	60.0	6.0	24	0.000	.27	0.0000
Total				83,261	1.000		0.7227

Factor = 0.7227

[1] reference - 24, p. 635.

TABLE 35

1950 WELFARE EQUIVALENT WEIGHTS BY YEAR

Year	1950 Welfare Equivalent Weights
1950	1.000
1951	1.000
1952	0.998
1953	0.995
1954	0.994
1955	0.993
1956	0.991
1957	0.989
1958	0.985
1959	0.981
1960	0.975
1961	0.969
1962	0.960
1963	0.950
1964	0.875

a uniform annual benefit, the average time from cost to benefit may be estimated by multiplying the uniform gradient present worth factor at 3.125 percent for 50 years by the capital recovery factor at 3.125 percent for 50 years. This calculation was made and it was found that the time from project construction to the time of average benefit realization is 19 years. Thus, it is assumed that funds spent on the project in 1950 will reach average benefit realization in the year 1969.

The project life of the highways and recreation facilities constructed by the Commonwealth of Kentucky was assumed to be 20 years. An analysis using a 3.125-percent discount rate and a 20-year project life was made, and it was found that the time to average benefit realization is nine years. By assuming that state funds were spent in 1960 the same year as for federal funds, 1969, is obtained.

Since no time factor for 1969 can be calculated directly, the 1964 factor was extended to 1969 by assuming that the factor will continue to decrease each year by the average amount of decrease over the 15 year period studied, 0.008. The factor calculated for 1969 is 0.835.

SUMMARY OF REPAYMENT INCIDENCE EFFECTS

FEDERAL FUNDS

The average annual Federal expenditure for the initial construction of the Dewey Reservoir Project is the sum of the dam cost and lands and relocations cost. These items from Table 11 total $341,056. The incidence factor, 0.6134, which accounts for richer individuals bearing a larger share of the tax burden is divided by the time factor, 0.835, which accounts for changes in the economy and this quotient, .7346, is multiplied by the Federal cost to yield the utility worth of the funds used for construction. The utility cost is subtracted from the total federal cost to give the income redistribution benefit. The average annual redistribution benefit calculated is $90,513. In addition, the Federal government has furnished approximately 50 percent of the funds spent by the Kentucky Department of Highways for construction and improvement of highways in the Dewey area. The average annual Federal expenditure for highways is $140,570. Since 1960 was assumed to be the date of construction the time factor must be referenced to 1960. By taking the 1960 time factor as unity a 1969 factor is calculated for funds spent in 1960. The factor calculated is 0.856. By performing the same calculation as for 1950 expenditures, using an incidence factor of 0.6852, an income redistribution benefit from federal participation in highway construction in the Dewey area was found to be $28,084.

Since operation and maintenance costs occur in every year, no time factor need be applied. The average annual operation and maintenance cost borne by the Corps of Engineers for the Dewey Project is $43,799. Applying the incidence factor of 0.6852 there results an average annual income redistribution benefit from operation and maintenance costs of $13,878.

STATE FUNDS

For all state capital expenditures, an incidence factor of 0.7227 and a time factor of 0.856 will be used. State expenditures for recreation facilities and for 50 percent of the highway costs total $259,238. Applying the incidence and time factors yields an average annual income redistribution benefit of $40,370.

Average annual maintenance and operation costs born by the Commonwealth of Kentucky for highways and recreation facilities net of revenue at Dewey are $90,208. Applying an incidence factor of 0.7227 yields an average annual redistribution benefit of $25,015. Table 36 gives a summary of income redistribution benefits effected through repayment incidence for the Dewey Reservoir Project.

TOTAL INCOME REDISTRIBUTION BENEFIT

The analysis of income redistribution benefit found $56,344 1961 dollars annually in income redistribution benefits to beneficiaries, $26,618 in income redistribution benefits from project expenditures, and $197,860 in income redistribution benefits through project repayment. The total value was $280,822. This amounts to 18.3 percent of the total direct benefits of $1,538,356.

TABLE 36

INCOME REDISTRIBUTION BENEFITS THROUGH REPAYMENT INCIDENCE

Item	Average Annual Cost[1]	Incidence Factor	Time Factor	Average Annual Redistribution Benefit
1950 Federal Construction	$341,056	0.6134	0.835	$ 90,513
1960 Federal Construction	140,750	0.6852	0.856	28,084
Federal O&M	43,799	0.6852	-	13,878
State Construction	259,238	0.7227	0.856	40,370
State O&M	90,208	0.7227	-	25,015
Total				$ 197,860

[1]Values in 1961 dollars.

CHAPTER VI

SUMMARY

DESCRIPTION OF STUDY

The purpose of this study was to examine in retrospect the economic consequences of constructing, in 1949, a large Federal water resources project, Dewey Reservoir in Floyd County, Kentucky, an economically underdeveloped area in the Appalachian area of rural Eastern Kentucky. The prime objective was whether analysis of those benefits actually resulting in the 15 years since construction of an old project can provide guidance to better benefit prediction for proposed projects. Particular emphasis was placed on determining whether the construction of Dewey Reservoir had caused a favorable redistribution of income. Favorable income redistribution was taken as to mean that income is shifted from individuals with high incomes to those with low incomes.

Project construction costs were analyzed, and an estimate of the total amount of money injected into the local economy was made. Uncertainty benefits resulting from the reduced threat of a major flood disaster were also estimated. Income redistribution benefits were evaluated by analysis of the relative incomes of project beneficiaries. Recreation benefits, flood damage reduction benefits, uncertainty flood benefits, and income redistribution benefits were found to be the major benefits, in descending order, resulting from Dewey Reservoir.

APPROACH USED

DIRECT BENEFITS AND COSTS

Initial project cost, operation and maintenance costs, and flood control benefits were estimated from data obtained from the Corps of Engineers' offices at Huntington, West Virginia and Louisville, Kentucky. Recreation benefits were quantified using the methodology developed by Tussey (15). Costs for recreation facilities and highway construction were obtained from the highways and parks agencies of the Commonwealth of Kentucky.

UNCERTAINTY BENEFITS

Uncertainty benefits were estimated by using the Thomas uncertainty fund with a probability of the fund being exhausted of 0.5%. This corresponds roughly to the frequency of the Corps of Engineers' design floods for the urban areas downstream from Dewey Reservoir.

INCOME REDISTRIBUTION BENEFITS

Income redistribution was analyzed by the method advanced by Haveman (5) which assumes that the marginal value of income to an individual is indicated by the Federal income tax structure. Direct benefits from flood control and recreation were first divided according to the geographical location of beneficiary residence. Flood control benefits were assumed to accrue in proportion to the value of real property owned in the flood plain, and data was collected to indicate the incomes of those owning property in the flood plain relative to those owning property elsewhere. The income distribution of recreation beneficiaries was assumed to be the same as the income distribution of those living in the population center from which they came.

The redistribution effect of funds spent in the Floyd County area during project construction was examined by calculating an income redistribution factor based on the estimated incomes of local workers and materials suppliers engaged in project construction. The fact that the share of the tax burden borne varies with income was also considered to estimate the income redistribution from project repayment.

SIGNIFICANCE OF FINDINGS

The findings of this report show Dewey Reservoir to have been economically justified from a direct benefit, direct cost standpoint. From the results summarized on Table 37, the ratio of direct benefits to direct costs is found to be 1.58. Both benefits and costs were found to be substantially in excess of totals estimated prior to construction of the reservoir, but this is largely caused by inclusion of categories of benefits and costs which were not considered at that time. Dewey has aided greatly in reducing flooding in the downstream reaches, thus causing increased farm production and increasing the propensity of business to locate in the areas previously more vulnerable to flooding.

Average annual recreation benefits were found to be $814,720.

TABLE 37

BENEFIT-COST SUMMARY FOR DEWEY RESERVOIR

Item	Average Annual Amount[1]
Direct Cost	$975,153
Direct Flood Control Benefits	722,166
Direct Mississippi River Benefits	1,470
Direct Recreation Benefits	814,720
Uncertainty Flood Benefits (0.5%)	338,356
Redistribution- Project Expenditures	26,618
Redistribution- Repayment Incidence	197,860
Redistribution- Flood Control Benefits	-77,670
Redistribution- Mississippi River Benefits	294
Redistribution- Recreation Benefits	133,720

[1]Values in 1961 Dollars

Average annual expenditure by the Departments of Parks and Highways for providing recreational facilities and access amounts to $835,531 but $345,515 is received by park revenues to leave a net cost of $490,016. If none of the reservoir cost is allocated to recreation, the benefit-cost ratio for recreation facilities would be 1.66. Average annual flood control benefits (including those on the Mississippi River) were found to equal $723,636. The annual cost of the dam and reservoir was found to be $478,731. The benefit-cost ratio of the dam and reservoir on the basis of flood control only would be 1.51.

Income redistribution benefits, as computed by the Haveman Method, were also found to be substantial in the case of Dewey Reservoir and are tabulated by category on Table 37.

Adding the income redistribution benefits from Table 37 gives a total benefit-cost ratio of 1.87, further proving the justification of the Dewey Project. Income redistribution benefits were found to amount to about 24 percent of direct benefits. This could be an important factor in the economic justification of marginal projects. However, the percentage would be much smaller for a project whose primary purpose was flood control because of the finding that beneficiaries from flood control have larger than average incomes.

Adding uncertainty benefits from Table 37 to direct and redistribution benefits gives a benefit-cost ratio of 2.21.

SUGGESTED ADDITIONAL RESEARCH

Much additional research is needed on the effects of reservoirs on income redistribution. Additional information is needed concerning the income levels of those who benefit from water resource projects. Factors might be developed which relate topography, industrialization, occupations and other community characteristics to relative income levels. Additional data is needed to verify the relative income levels of those living in the flood plain as opposed to those living outside the flood plain, found in comparing Radcliff versus West Point, Kentucky. Without the large income differential found in this case, the income redistribution benefit from flood control would have been even more negative. Likewise, income levels of recreation visitors should be investigated. It is very probable that a very poor person living in Tucson, Arizona would be less likely to visit Dewey than would a rich person. However, the fragmentary data which have been collected would indicate that middle income groups may be more likely to visit recreation reservoirs than either. Finally, additional research is needed on the incomes of those supplying labor and materials to reservoir construction.

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