THE ECONOMIC IMPACT OF WATER RESOURCE DEVELOPMENT PROJECTS

by

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INTRODUCTION

Senate Document No. 97, 87th Congress, 2d session, dated 29 May 1962 reaffirmed the comprehensive, objective approach to plan formulation and evaluation outlined in Proposed Practices for Economic Analysis of River Basin Projects, May 1958 (the Green Book). The portion of this document pertinent to the economic impact of water resource development projects is as follows:

> "V.B.1. Reports on proposed plans shall include an analysis of present and projected future economic conditions in the project area and the contribution that comprehensive or project development may be expected to make toward the alleviation of problems and the promotion of economic growth and well being within the zone of influence. Economic projections will be made to provide a basis for appraisal of conditions to be expected with and without the plans under consideration, and an estimate of the contribution that comprehensive development may make to increased national income and welfare and regional growth and stability."

Normally an "economic base study" is the estimate of the future development of an area that is projected to occur in the absence of additional Federal investment in water and related land resource development. In addition, according to the guidance contained in Senate Document No.97, each report on proposed plans should include an estimate of the future economy of the pertinent area with the proposed water resource development plan in operation. My remarks here today will relate to the latter part of these instructions.

The purpose of this presentation is to suggest a rational and workable procedure for use in estimating the basin and national economic impact of water resource development plans. By impact I mean the economic effects - changes - in economic activity in an area economy that are attributable to the construction and operation of water resource development projects.

The impact on total economic activity that originates from water resource development projects stems from the investment expenditures made during the construction and operation phase of the project and from the expenditures of the users and beneficiaries of the project facilities and services. The general origin of these impacts is briefly described below.

During the construction phase of a project, the expenditure of construction funds normally provides a short-term stimulus to the area economy near the construction site. In addition, the production and distribution of construction materials, supplies, and equipment away from the construction site generates additional expenditures. However, the impacts of expenditures remote from the project site are difficult to quantify.

During the operation phase of a project stimuli to the economy originate in various ways and in various places. For our purposes these stimuli are categorized as having basin and national impacts.

Basin impact is defined as normally occurring in the river basin where an implemented project(s) is located. Included are the net increases in employment and income opportunities resulting from the operating and maintenance of the project and the net increases in income and employment attributable to expansion by the various businesses whose principal clientele are related to the project functions, such as recreational and agricultural service businesses. Where employment opportunities in local areas are not transfers from outside the area and the economic impact has national as well as basin significance.

National impact is considered as normally occurring in the area which is outside of the river basin where the projects are located. It is the net additions of employment and income to the national economy that are attributable to particular water resource development projects. They are the net increases in employment and income opportunities that would not exist in the absence of the project. In addition, the expenditures at the local level which are re-spent to procure goods and services outside of the local area could in part represent net additions to the national economy and therefore have a national impact.

POTENTIAL MEASUREMENT PROCEDURES

There is no logical basis for deciding, with certainty, that level of detailed analysis which will provide the most accurate estimates. In theory, a greater depth of analysis should provide better insight to the forces that influence the factors to be estimated; and, therefore, it should provide a "better" estimate. But, in practice, greater detail in the analysis stage does not guarantee a more accurate estimate.

The measurement procedures discussed herein take this into consideration, but they are by no means all-inclusive. This discussion attempts to present what is thought to be the more appropriate procedures for use in estimating the economic impact of water resource development projects. The method that is to be used in a specific study will largely be dictated by the size of the study area, the amount of time and funds available for that portion of the overall planning process, the training and experience of the personnel who are to make the study, and the ready availability of the required basic data. The following paragraphs present a summary of pertinent information concerning some potential methods of analysis.

The step-down ratio procedure can vary considerably in the amount of detail involved and at the same time be a relatively simple and inexpensive technique of analysis when compared to other procedures.

Basically, this procedure rests upon the premise that the components of employment or income, etc., in a small area are "functionally related" to the level of that activity occurring within the larger area of which it is a part. Therefore, by analyzing historical data relating to the economic factors to be projected, ratios are developed to express the functional relationship between the smaller and its larger economic unit.

Numerous variations in the step-down ratio technique are possible. These can bring more or less detail into the overall analysis, as desired. The degree of detail possible is limited by the historical data available and the availability of a projection or other information with at least the same amount of detail as in the basic data.

The economic base multiplier technique is a more complicated method of analysis.

The first step after obtaining the data,analyzing, and classifying them by base (export) or non-base (non-export) sectors is to establish a ratio of nonbasic-to-basic employment. This ratio is called the "normal" ratio. Since it is supposed to represent the relationship that normally exists between the two sectors, all other things being equal, it should be based on a comparative analysis of employment data covering more than just one point in time. It is imperative, with this method, as with any other method that uses "ratios" in its application, that the analyst determine the ratio that historically has prevailed in the study area. But, even more important, he must also project any changes that may occur in that ratio.

After the normal ratio has been determined, any changes in basic employment activities will alter it. Since this method assumes that basic sector activities constitute the prime-mover in the study area, changes in the basic sector will cause changes of a similar nature in nonbasic activities. These changes will eventually bring the now altered normal ratio back to "normal."

A variation of the "employment multiplier" procedure described above is the "income multiplier." Using the latter as the measure, emphasis is placed upon the flow of incomes between the basic and nonbasic sectors of the local economy. One can immediately see the connection between the various measures that can be used, because if employment increases (or decreases), so will income.

The inherent weakness of the economic base multiplier method needs repeating at this point. Even if one had complete knowledge and could thereby precisely categorize all economic activity in the study area as either export-oriented or locally-oriented, future estimates of employment (or any other parameter used) would still depend upon the relative stability of the nonbasic/basic ratio. However, this ratio may not be stable in the long run. Indeed, an argument can be made that this ratio is inherently unstable as a direct result of the very growth it attempts to predict.

One of the most detailed procedures of analysis that can be (and has been) used in analyzing economic activity is the input-output analysis approach. Input-output analysis is a systematic method of analyzing in detail the inter-relationships between the sellers and purchasers in an area economy. As such it records the destinations of outputs and the source of inputs. Only the general framework of analysis of this method will be presented herein.

The greatest value in using the input-output method is realized in analyzing the more highly complex, interrelated, and independent economies of study areas. Considering its limitations, this method would be out of place, for example, in analyzing a "one-industry" study area. The interdependent nature of a complex economy tends to justify the use of this analytical tool.

In effect, the input-output method "stops the flow process" to determine, at that point in time, answers to the questions: (1) From whom did the industries buy their inputs? (2) To whom did they sell their outputs? and (3) How much did they buy and sell in each instance? An input-output table allows one to trace the input purchases and output sales of any industry from and to all other industries and to final market users.

Given the input-output relationships and the outputs of each industry, a determination of how many employees are required to produce the output of each industry can be made. Therefore, additional data on labor productivity, hours of work, etc., are required on an industry-by-industry basis. This information, on employees required per unit of industry output, is used, in turn, to determine total industry employment required to produce the respective total industry output. An employment total for the economy is obtained by summing the employment totals of all industries.

With a knowledge of how much labor inputs are required to produce the known outputs, an input-output model can then be used to project the level of employment that would be required to supply a different output total for the economy on an industry-by-industry basis. A major problem is, therefore, to accurately project demands for final goods and services for the final markets at the target year. Then, working back through the various interindustry flows of semi-finished outputs, the labor and other inputs that would be required to produce the new output totals can be determined.

Some shortcomings to the input-output method are apparent. It was noted above that this method analyzes the economy at one point in time. The new industry-by-industry inputs of labor, etc., that are required to produce the projected output totals are usually determined on the basis of factors (ratios) prevailing at the time the input-output relationships are established. The new inputs required to produce the new outputs are based on the level of prices, the state of technology (or production methods), input costs (labor and material), labor productivity, etc., prevailing at the time the industries are first analyzed. It may be realistic to believe

that the above factors, and the linkages established between final markets and the industries supplying those outputs, do not change substantially in the short run. Input-output relationships, per se, are likewise valid for some short period of years and some ranges of outputs. However, it is still true that the water resource planning process requires long-range projections. Certainly, in a dynamic economy, all of the above factors are subject to change-over time. However, in an effort to keep the above factors "current" over this time span, an analyst may attempt to project changes in them and then adjust labor and other input requirements accordingly. This is not a simple task.

As can be determined from the explanation of input-output studies, their production is very costly. They require the services of highly-trained and experienced economists over a long period of time, large and precise data inputs, and normally the facilities of large capacity high-speed computers.

While I would like to do a good input-output study as a part of a water resource study, the money, time, and people necessary to make the study are not readily available, nor can their availability be foreseen. In addition, it is questionable that the value received from such a study would be commensurate with its cost.

SELECTION AND DEVELOPMENT OF PROCEDURE

The brief discusstion of the various procedures has been as simple and straightforward as possible. However, in "real world" situations the analytical methods discussed above can become quite sophisticated and comprehensive in their application. The recognition of problems that may be encountered in carrying out some of the more sophisticated methods of analysis causes different procedures to be used for different studies. Because of the time and money usually available, practically any method to be utilized must be tempered with a considerable amount of judgment, especially in predominantly rural un- or undeveloped areas.

For the determination of the impact of construction expenditures a variation of the economic base multiplier-step down procedure is suggested. This procedure utilizes data contained in "Labor and Material Requirements for Civil Works Construction by the Corps of Engineers," Bulletin No. 1390, Bureau of Labor Statistics (BLS), U. S. Department of Labor, 1964; and an article in the February 1965 Monthly Labor Review, entitled "Employment Effects of Construction Expenditures." This BLS study is based on data for 45 Corps of Engineers Civil Works projects. Seventeen of these projects were for various types of dredging and were treated separately in the BLS report. The other 28 projects were dams and levees. For preauthorization planning, information contained in the BLS study is thought to be the most reasonable and expeditious procedure to be used in estimating economic impact of construction expenditures.

Information included in the BLS study indicates that the distribution of contract cost was as follows.

TABLE 1

PERCENT ALLOCATION OF TOTAL CONTRACT COST

Cost element	Civil works	
	Land operations(1)	Dredging
Materials	35.0	17.3
Equipment	19.3	24.9
On-site wages	26.0	32.3
Other	19.7	25.5
Total	100%	100%

(1) Includes levees, dams, pile dikes, bank stabilization, local flood control, and other similar projects.

With respect to the percent distribution of on-site total labor the BLS study shows the following.

TABLE 2

PERCENT ALLOCATION OF TOTAL ON-SITE LABOR COST

	Land operations	Dredging
Skilled	40%	43%
Semiskilled and unskilled	50%	52%
Administrative and supervisory	10%	5%

It is realized that for individual projects some of these percentages will vary because of varying costs of purchased materials, labor costs, wage distribution, and the skill composition of the labor force. However, for our purposes these estimates should be adequate.

An approximation of the basin impact of the construction expenditure for land operation projects can be computed by applying the 26.0 percent (percent of total contract cost paid for on-site wages) to the estimated contract cost of the project. The resulting amount represents the additional expenditures in the basin area stemming from the contractors' on-site wage expenditures. For ease of computation and simplicity, it is assumed that the expenditures induced into the basin economy by these expenditures are equal to the amount of these expenditures that are sent out of the basin for initial expenditure. The income created during the construction period would be a net addition to the basin and national economies for the duration of construction. As to the non-basin income, it is suggested that they would be "overhead" oriented in that the construction of individual projects would not materially affect the level of income remote from the construction site. For instance, the construction of one dam or levee in Arkansas would not materially affect the income in the remaining 49 States. In addition to estimating the basin income resulting from construction expenditures, the percentages cited above plus locally derived information on unemployment and underemployment could be used in estimating redevelopment benefits in areas designated under the Public Works and Economic Development Act of 1965 (P. L. 89-136, Titles I and IV).

Table 3 shows a hypothetical example computation of Construction Period Economic Development Income. This income can be converted to average annual benefits by the use of a selected development period and the current interest rate used in project evaluation.

TABLE 3

COMPUTATION OF CONSTRUCTION PERIOD ECONOMIC DEVELOPMENT INCOME FOR LAND OPERATIONS

Wage cost:

Estimated contract cost	$10,000,000
On-site wages percent (from Table 1)	26%
Estimated on-site wages	2,600,000

Allocation of wage cost to type of labor:

Type of labor	Percent allocation (Table 2)	Amount of wages
Skilled labor	40% X 2,600,000	$1,040,000
Semiskilled and unskilled labor	50% X 2,600,000	1,300,000
Administrative and supervisory	10% X 2,600,000	260,000
Total	100%	2,600,000

Allocation of wage cost to un- or underemployed labor:

Type of labor	Amount of wages	Percent of labor hired locally (1)	Wages paid to local hire un- or underemployed labor
Skilled	$1,040,000	10	$104,000
Semiskilled and unskilled	1,300,000	50	650,000
Administrative and supervisory	260,000	10	26,000
Total	2,600,000		788,000

(1) These percents should be determined for individual projects and should be based on existing conditions in the "labor shed" on a project. The percents used in this example are hypothetical.

The estimation of employment and income attributable to the operation and maintenance of projects is a particularly vexing problem. For convenience of discussion it will be divided into three parts, employment and income derived from (a) personnel who operate the project, (b) recreational fish and wildlife utilization of the project, and (c) the operation of the project for other purposes. Conspicuous by its absence is the estimation of the impact of a project on governmental income and expenditures.

For example, with the construction of a reservoir and the resulting increase in land values and employment and income in an area, local and State governments generally have experienced increased tax collections. At the same time there have been increased needs for governmental services such as roads, health and sanitation facilities, and law enforcement. In addition, potential welfare payments in an area could be reduced due to reductions in unemployment. While these are legitimate items for inclusion in an impact study, I have not considered them because of their diverse nature and the additional time needed to derive a reasonable rational method to approximate their magnitude.

The estimates of the annual cost of project operation and maintenance can be obtained from data developed in connection with the determination of the economic feasibility of projects. These data may have to be adjusted to take into consideration the increasing levels of income projected in the "economic base study." These jobs and the income stemming therefrom are new jobs and income which would not have existed if the project had not been constructed. They are, therefore, net additions to employment and income at the local as well as the national level. In addition, in areas designated under Title I and Title IV of P. L. 89-136, these jobs and income created would aid in alleviating the unemployment and underemployment problem. They could be creditable as redevelopment benefits.

The estimation of the employment and income stemming from the recreation fish and wildlife utilization of a project is one of the most difficult estimates to make. It involves estimating the jobs and income created at the project site and the additional jobs and income created away from the site. Jobs and income derived from serving the recreationist during his trip to and from the project and at his home prior to the trip are in the latter category. In addition, it is pointed out that some expenditures by recreationists are simply reallocation of usual expenditures. As such they do not tend to create new income flows but are only changes from one income stream to another with no change in the total.

Studies showing the breakdown of tourist expenditures have been made by many States. "Travel Trends in Western States," Western Council for Travel Research, P. O. Box 8066, Foothill Station, Sale Lake City, Utah, contains a compilation of such studies which include studies by the Universities of Arkansas and Missouri. These particular studies indicate that the average expenditure per visitor day in 1960 in Arkansas and Missouri was $5.37 and $7.50, respectively. These expenditures were broken down as follows.

TABLE 4

DISTRIBUTION OF AVERAGE EXPENDITURE PER RECREATION DAY

	Missouri	Arkansas
Food	25%	33.2%
Lodging	19%	19.5%
Transportation	28%	23.5%
Entertainment	3%	9.5%
Other	25%	14.3%

The basin impact can be determined by multiplying the selected average total daily expenditure by the estimated visitation. An estimate of the number of employment opportunities created can be obtained by dividing total expenditures by a sales per employee estimate derived from data in the Census of Business. Table 5 shows a hypothetical example of the computation of the basin impact of expenditures of recreationists.

TABLE 5

BASIN IMPACT OF INCOME AND EMPLOYMENT ATTRIBUTABLE TO PROJECT VISITATION

Income:

Estimated average daily visitor expenditure		$6.00
Estimated percent spent in basin		75%
Estimated adjusted average daily visitor expenditure (AADVE)		4.50
Estimated average annual total expenditure (AADVE X 1,000,000 average annual recreation days) =	4,500,000	
Estimated percent of expenditure that is paid to basin labor - 50% (The remaining 50% is paid to other factors of production.)		
Estimated basin average annual income directly attributable to project visitation (50% X $4,500,000) =	2,250,000	

Employment:

From data collected by the 1963 Census of Business it is estimated that retail establishments made sales of approximately $30,000 per employee in Arkansas.	
To determine the jobs created by the expenditure of $4,500,000 - Divide it by $30,000 which gives . . .	150 jobs

As pointed out previously, some of the expenditures by recreationists are reallocation of expenditures from one location to another. In view of this a portion of the local expenditure does not result in new national employment and income opportunities; therefore, it does not have a national impact. I believe that the lodging and transportation expenditures represent new spending and consequently create new employment and income opportunities. The total estimated lodging and transportation expenditure is multiplied by the estimated visitation to obtain the national expenditure effect. I have assumed that this would be the increase in national income creditable to the project. These amounts can be converted to employment opportunities as was done in

estimating local impact. Table 6 shows a hypothetical computation of the national impact attributable to project visitation.

TABLE 6

NATIONAL IMPACT OF INCOME AND EMPLOYMENT
ATTRIBUTABLE TO PROJECT VISITATION

Income:

Estimated daily visitor expenditure	$6.00
Estimated percent that represents "new" expenditures (lodging and transportation)	43%
Estimated average daily "new" visitor expenditure	2.50
Estimated average annual total expenditure: Daily expenditure, $2.50, times average annual visitation 1,000,000 =	$2,500,000
Estimated percent of expenditure that is paid to labor 50% (Remaining 50% goes to other factors of production.)	
Estimated national average annual income attributable to project visitation 50% X $2,500,000 =	$1,250,000

Employment:

To determine the national employment divide the income $2,500,000 by the national sales per employee estimate $29,000 derived from the 1963 Census of Business, 2,500,000 ÷ 29,000 =	86

Although there are several items which could be covered under this heading, my discussion will be centered around the impacts stemming from the flood control features of the project. Estimates of flood damages prevented can, by the use of variations of the step-down ratio procedure, be adjusted to approximate the total employment and income opportunities resulting from operating a project for flood control. By relating value of present agriculture production of an area, number of hired farm workers income and farm wages and salaries paid, ratios can be developed. These ratios can then be applied to the estimates of flood damages prevented to obtain estimates of the additional local income and employment opportunities attributable to the project. Table 7 shows a hypothetical example of a computation utilizing this approach. For our purposes I believe that these income and employment opportunities are net additions at the national level and therefore have national impacts of the same amount.

TABLE 7

BASIN IMPACT OF FLOOD DAMAGES PREVENTED

Average annual damages prevented	$4,000,000
Income:	
Preliminary data from the 1964 Census of Agriculture for a sample area indicates that 6.75 percent of every $1.00 value of agriculture products sold is for farm wage and salaries. Therefore, $4,000,000 X 6.75% =	270,000
This is the increase in average annual personal income of farm workers attributable to the reduction of flooding.	
Employment:	
Preliminary data from the 1964 Census of Agriculture indicates that the current average annual wage per agricultural worker approximates $2,500. By dividing this amount into $270,000 (the increase in farm wages and salaries paid) gives an estimated increase in hired employment of 108.	108
This is the estimated net increase in hired farm employment attributable to a $4,000,000 reduction of average annual flood damages.	

In summary, I have briefly discussed and illustrated suggestions as to how the determination of the economic impact of water resource development projects can be made. I hope these suggestions will stimulate further consideration on how our practices in this area might be improved.