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**Regionalization in the Context
of Multiobjective Planning
and Evaluation**

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NOTE TO THE READER

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These reports are in the nature of working papers. Their purpose is to encourage innovative thought and intellectual response. The views presented are strictly those of the authors and are not necessarily those of the Center for Economic Studies or other elements of the Corps of Engineers.



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INTRODUCTION

Regional and River Basin evaluation practices currently utilized by Federal planning agencies have been reviewed by a special Task Force of the Water Resources Council (WRC) and the review has resulted in the formulation of a recommended set of "Procedures for Evaluation of Water and Related Land Resource Projects. */ Fundamental in these recommended changes is the concept of planning within the context of four broad objectives. These broad objectives (or multiobjectives) are: (1) national economic development, (2) environmental quality, (3) social well-being and (4) regional development. Preparation of "Procedures" was achieved by means of an initial report, followed by wide discussion in public hearings and field testing, resulting in critical reviews by Federal, State and local agencies, private and academic interests.

Acceptance of multiple planning objectives represents both a desire to broaden evaluation procedures to make more explicit the social preference function and to develop more efficient procedures to communicate the range of impacts, both desirable and undesirable, to those who make decisions regarding funding of public investment in water and related land resource development. The WRC recommended Procedures for evaluation of water resources development portray a system sensitive to multiple objectives and formulate the basic argument that aggregate national income measures of benefits and costs provide insufficient

*/ Dated 31 July 1970 and presented to the Council of Representatives Water Resources Council on 12 August 1970.

information to those who make decisions about water resources development. The aggregate national values omit reference to income class and ignore environmental and social values which are becoming more important in the preference function describing social welfare.

Extensive field testing of the recommended procedures and subsequent critical reviews have revealed the significant influence of regional delineation on the absolute level of benefit and cost estimates and on the information set in these estimates. For example, consider the possible construction of a major reservoir on the mainstem of the Susquehanna River above Pittston, Pennsylvania. Such a reservoir would inundate substantial areas of Tunkhannok and Towanda, Pennsylvania and threaten the economic life of these communities which are now urban nodes in an otherwise rural and lightly populated area. From the environmental point of view, inundation would reduce the scenic and esthetic quality of this section of the Susquehanna River, which now possesses some unique characteristics vis-a-vis the remainder of the Basin. On the other hand, a major reservoir could encourage managed development along this section of the river (for recreation and vacation home use) and provide substantial improvement in water supplies to water short areas downstream (York-Lancaster-Baltimore area) and improved water quality in the Chesapeake Bay. Delineation of regions appropriate for displaying impacts and benefits of this potential project and alternatives illustrates the issues. If one region and the nation are selected as the relevant regions, and if the region is closed on a 4-county area upstream of the dam, the regional impact would be substantially negative to that region. If another region

is selected downstream of the dam, the impacts will be highly positive. But these two regions alone will not contain all relevant income impacts. Much of the recreational use of such a project, or for alternatives, would come from the population of the metropolitan New York and Philadelphia areas. Potential power output would be marketed in and benefit a much wider area. Thus an almost infinite range of regional impacts can be identified in various regional boundaries, and maximum impact information would be displayed by utilizing a set of regions closing on the nation.

Clearly, evaluation procedures for multiobjective planning require careful conceptual and analytical definition of relevant regions. It has been forcefully argued that impacts which represent a net of zero (an algebraic summation of positive and negative impacts) from the national standpoint are not irrelevant to the evaluation process. Regional delineation of such effects offers important information to the understanding of potential investment impact upon various interest groups, whether they are interested solely in national income, regional distribution of income, environmental issues or of any mix of these impacts.

In addition, adoption of a procedure for estimating the net national benefits of any objective or set of objectives as the algebraic summation of benefits (and disbenefits) over all regions of the nation offers substantial planning and accounting advantages over those procedures which tend to submerge offsetting impacts as irrelevant, since additional discipline is placed upon the benefit-cost analyst to estimate positive, negative or zero impacts for each region.

While the emphasis of this paper is upon regionalization over space, similar emphasis can be placed in the procedure upon distribution of benefits and disbenefits across income classes or various social groups within the social well-being objective.

Fundamental to the evaluation system accommodating multiobjectives is a system for displaying the effects of a proposal on the objective function. The WRC recommended Procedures propose an accounting system with 4 accounts to be evaluated from the national standpoint. The display and analysis of changes in impacts between considered alternatives would provide a basis for assessing the relative tradeoffs among alternatives and determining a recommended plan. An early draft of the WRC Procedures (referred to as the "Blue Book") was utilized in testing several Federal project proposals by a number of test teams prior to the revision of the document. Testing results reflect both the various test teams' perception of the recommended Procedures and the analysis of various projects under the procedures as perceived by the teams.

One conclusion of the test team effort is abundantly clear; that boundary parameters of each objective determines the magnitude and type of identified impacts. The national income objective has few problems in this sense because the system is closed upon the national boundaries. However, regional income gains or losses and the expression of goals with respect to this objective are extremely sensitive to the way in which boundaries are defined.

Thus the WRC recommended Procedures imply that water development impacts across regions and between income classes represent a basic strategy in estimation of benefits to various national objectives. One

of the problems that the new procedures bring is the absence of an operational and acceptable procedure for formulating projects and programs and identifying benefits to an objective function containing multiple dimensions. Some sort of weighting between objectives will be required either implicitly or explicitly if optimization of the multiple dimensioned objective function is to be attempted. However, this issue can be set aside for further consideration without compromising the requirements for methods for identifying and quantifying those second and subsequent rounds of impacts to water resource investment alternatives over space and time (and by income class). Such a procedure is essential in implementing the regional development objective which may be relevant to the nation and which is generally of primary concern to localities involved in water resources development proposals. The same requirements for information to display impacts over space and time can be anticipated and met by procedures advocated for national income.

Accounting Framework

A convenient way to display impacts by region is as follows, although there is leeway in the selection of the appropriate number of regions.

The appropriate delineation of relevant regions to display sufficient information is a function of "generation" and "displacement" areas, described more fully below. The principle governing selection of the appropriate regions is that offsetting impacts are not concealed. Thus regions in which beneficial and adverse impacts are minimal can be aggregated into one region; however, regions in which impacts approach

IMPACT OF _____ PLAN

Item	Region _i	Region _n	$\sum_{i=1}^n$ Region _i = National
Income Flood Control Water Supply . . . Employment				
Environment Miles Trout Stream Areas Slackwater Fisheries . . .				
Social Well-Being Income to Families < \$3,000 Income \$3,000 < X < \$10,000 > \$10,000				

zero because of offsetting effects should be divided in such a way as to display the nature of positive and negative impacts.

The following discussion centers upon the issues of regionalization involved in estimating impacts on national economic and regional development. First there is a discussion of the relation between national income and those benefits heretofore described as net national secondary (income) benefits and some discussion of an appropriate division of effort which would facilitate their estimation. The second section discusses conceptual principles in defining relevant regions needed in the evaluation procedure.

"Secondary Benefits" and the WRC Evaluation Procedures

National secondary benefits are those additions to national income in excess of the value placed by direct users of project output, where value is equal to the area below the demand schedule relating quantity demanded at various prices.

Long and careful arguments have been advanced regarding the relationship of these effects on the estimation of national income effects of a water program or project. Most of the participants agree, however, on the conditions under which positive net national secondary income benefits can be expected; (1) Presence of unemployed or underemployed resources which can be productively employed directly in the project construction and operation, or in activities of those firms which either locate or increase output and employment as a result of the provision of water services and other production related attributes of a given locale; and/or (2) the presence of scale economies which can be captured by increased

output permitted by water investment and other production attributes in a given locale.

Emphasis on multiobjectives does not reduce the importance of user benefits but does add the space and time dimensions to those benefits, since any credible sequence of events would start with users. Therefore, careful estimates of user benefits over space and time will be required.

A basic requirement is a procedure for calculating national secondary benefits. One procedure is under preparation by the Office of Business Economics, Department of Commerce (OBE), which has a program underway to provide estimates of impacts across a number of regions closing on the nation. */ The OBE system anticipates a division of responsibility between agencies, their field offices, and OBE which would encourage and maximize feasible participation at each level and provide an analytical system which would identify impacts outside of those areas serviced by agency field offices.

In this context, OBE has developed the system around the following division of labor. Agency field offices would provide estimates of primary generation impacts. OBE would estimate primary displacement **/ secondary generation and displacement impacts. In the context of the OBE system, "Generation" refers to positive impacts whereas displacement refers

*/ Also see paralleling work by Charles Leven et al, published as IWR Report 69-1 and distributed to all Corps of Engineers Field Offices; available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151 at a cost of \$3.00 per volume

**/ Except for agricultural impacts which appear to be suitable for evaluation by Department of Agriculture (ERS) national model.

impacts immediate to the project, whereas secondary refers to the second and subsequent rounds through the economy.

The above division of labor may be modified to some extent by the provision of aid to agency field offices in identification of primary displacement impacts, either by OBE or agency level (say Office of the Chief of Engineers). However, principal responsibility for identifying primary generation impacts will be at the field level, since those offices possess much more intimate knowledge of local economic conditions and opportunities.

Within the context of the OBE system, the following section addresses in greater detail the theoretical and conceptual issues in defining boundaries of relevant regions.

It has been frequently and accurately stated that the definition of a region (for any purpose) should be made on the basis of the specific criteria which suits the purpose at hand. Unfortunately, attempting to use several conflicting criteria, e.g., economic vs. political, and to define a single region for a number of purposes renders this simple dictum operationally impractical. These divergent criteria point up the differences, real or supposed, between regions appropriate for considering differing projects. On a general level the differences in defining planning regions for natural resource programs and for urban oriented (population resource) programs have stood out strongly and have been much discussed since the turn of the century. */

*/ For a review of this discussion see "The Concept of a Planning Region - The Evolution of an Idea in the United States," in John Friedman and William Alonso (ed) Regional Development and Planning (Cambridge: The M.I.T. Press, 1965). Also see R. Struyk, Regional Economic Development Models - A Critical Appraisal Based on the International Trade Experience, Institute for Water Resources, Center Paper 70-1.

A number of theoretically satisfactory economic criteria have been set out for the purpose of defining regions, the Office of Business Economics (OBE) has worked to convert these theoretical criteria into operational procedures. Because the OBE regions are based largely on economic criteria and because much of the basic planning data which they provide is available on the basis of its national system of regions and because these regions offer one basis for allocating benefits and costs spatially to the nation, it seems worthwhile to examine in some detail the criteria employed by OBE. The following paragraphs (closing on page 13) were furnished by OBE to describe the procedure followed in constructing its regional system for the United States.

OBE Economic Areas

The purpose of the delineation of the country into economic areas was to define areas in which structural economic relationships could be best identified, measured and projected. Central place theory provided the conceptual basis for the delineation of the desired regions. The application of this theory resulted in city regions, each with its hinterland in which the establishments, both business and households, are functionally related. These regions constitute modal-functional economic areas.

One of the main characteristics of these regions is that each combine the place of work and place of residence of its labor force. Therefore, there is a minimum of commuting across the economic area boundaries.

Each economic area has a group of basic or export industries which produce goods and services to export to other areas of the country and thus earn the exchange with which to purchase the specialized goods and services of the other regions.

The economic areas remain open for the most part to the movement of transportable commodities and to the movement of people to non-transportable special services such as education at large national universities and recreation at places like Miami and Las Vegas. The production location of these types of goods and services is determined not so much by transportation costs as it is by the costs associated with special resources. Different commodities are associated with production processes requiring different input relationships and the comparative advantage of an area for the production of a commodity is determined by the area's relative endowment of the factors of production. Of course, regional specialization has implications for regional economies of scale in the production of commodities thus further reinforcing regional comparative advantage and specialization.

In addition to the basic or export industries each area has another another group of industries which produce most of the services and some of the goods required by the household sector and by local enterprise as intermediate products. Each of the areas approach self-sufficiency in regard to these residentiary industries which include general and convenience retail and wholesale trade activities and those other services which are difficult or impossible to transport and are most efficiently consumed in the vicinity of their production.

Thus, the economic areas correspond to the closed trade areas of central place theory in which the number and type of residentiary establishments and their size and trade areas are bounded by the relative transportation costs from hinterland to competing centers.

Delineation procedures. The first step in the economic area delineation was the identification of the economic centers. Standard metropolitan statistical areas (SMSA's) which generally are trade and labor market centers were chosen where possible. However, not all SMSA's were considered to be the center of an economic area because some are integral parts of larger metropolitan complexes. For example, the Jersey City, Newark, Patterson-Clifton-Passaic, Stamford, Norwalk, and Bridgeport SMSA's are all part of the New York City complex. In rural parts of the country where there are no SMSA's, cities of 25,000 to 50,000 population are the economic centers.

After identifying the economic centers the next task was that of determining to which center each of the remaining counties was economically focused. Primarily the data used in this determination were the journey-to-work data from the 1960 Census of Population. Those data were summarized and posted on maps so as to show the gross commuting from each individual county to each adjacent county and to as many as 13 counties altogether if such commuting occurred. Counties were then associated with the economic centers in accordance with the commuting pattern.

In places where the commuting pattern of adjacent economic centers overlapped, counties were included in the economic area containing the

center with which there was the greatest commuting connection. In the case of cities where the commuting pattern overlapped to a great degree, no attempt was made to separate the two cities; instead, both were included in the same economic area. Many counties were associated with an economic area not because of their commuting tie to the central city, but because of their association with other counties which were tied to the economic areas. Thus, for the first ring of counties around the central county the criterion was commuting to the latter while for the next ring the criterion was commuting to the central county or to the first ring.

In the more rural parts of the country, the journey-to-work information was insufficient to establish boundaries of the economic areas. For these areas the road network and certain geographic features which would affect the time of travel to the economic centers, and the linkage of counties by the other socio-economic ties such as communications, cultural, recreational and trade activities were the major determinants.

Because of the necessity of using counties as the building blocks a number of compromises had to be made in assigning counties when it was obvious that one portion of a county commuted in one direction while another portion commuted in a different direction. Such compromises do not damage delineation significantly, however, as separate areas were not delineated where the overlapping of commuting patterns was too great.

System of Regions

Possibly the potentially most important economic effect of a water resource investment is that it either alters the economic focus of the

region spatially and/or quantitatively; or causes an altogether new economic focus to emerge. An example of the first case is the provision of flood protection to a formerly unprotected area, producing a shift in the location of industrial activity. The second case is exemplified by a large multipurpose project at the periphery of two existing economic regions; the completion of the project with accompanying increases in industrial activity and service and trade activity in response to recreationists demands could well be sufficient to produce a new economic center with its own labor shed, trade area, and movement toward self-sufficiency.

It is clear, then, that the definition of the project region (the region displaying maximum primary generation impacts and probably maximum secondary generation impacts), that is the economy which serves as the focus of activity in the geographic area, depends crucially on the dimensions (size and purposes) of the investment project. Stated more simply the project region is the area within which increased water related economic activity and/or the direct consequences of such activity occurs. The task of converting this conceptual definition into an operational one is a complex task involving project purposes, and before addressing it directly the several types of regions with which the planner may have to concern himself are outlined in order to provide an enlarged context for the discussion of the operational definition.

To begin, consider the following definitions of regions:

- (1) Project region: ' the area within which increased water-related activity and/or the direct consequences of such activity occurs.

- (2) OBE region: the area within which the economic activity of the project region without the project is focused. For convenience, more than one region defined by OBE may be aggregated.
- (3) Displacement region: the area from which the project is anticipated to draw labor force, jobs, or visitors to the project area. This is likewise the area in which substitutions of consumption or production will occur as the project regions draw income and people to the project region.
- (4) System of regions: a system of regions closing on the entire area of the continental U.S. including the region defined in (2); this set of regions is the same for all project evaluations, save for the project region itself.

From the foregoing it is evident that depending on the scale and purposes of a project it is possible for the regions defined by (1), (2), and (3) to be identical. Consider, for example, a small single-purpose recreation project which basically serves the population in the OBE or nodal region. Based on this statement (1) and (2) are the same as no new economic focus will emerge; the displacement region is also the nodal region as the substitutions between the recreation goods consumed at the project site and elsewhere all occur within this region. Note that the visitations and accompanying substitutions associated with those outside of the OBE region are not omitted from the evaluation: they fall under the "systems of regions," and are therein accounted for.

Consider now a slightly more complicated situation of a multipurpose project providing recreation facilities, flood protection in the immediate

area of the project, and regulation of stream flow which has only water supply effects. The project itself is located at the periphery of two OBE areas. The effects of the project in the project area to be considered are (a) the attraction of manufacturing jobs to the newly protected river-side sites in response to the high quality and consistently available water supply, i.e., developmental effects, and (b) the use of the recreational facilities by persons living in the two OBE regions already mentioned and those in a third OBE region. Examination of the number of industrial jobs and service-trade jobs created indicate that a major new economic focus will result in the area as a result of the project. The project region can then be defined (in county size blocks) in terms of the anticipated location of those activities and the ultimate location of the residence of those employed in the area as well as the actual area occupied by the project. The OBE regions are now redefined as the original OBE regions adjusted for the presence of this new economic focus; this permits a continuing tie-in to the national system of regions. Turning now to the displacement regions two facts are in evidence: (a) the displacement region for the two project purposes will not be the same; (b) the displacement region for any purpose is in a very real sense an operational planning region, one that is used as an intermediate step in the evaluation procedure used to define the relevant spatial areas in which substitutions will occur, as such it need not be reported as a separate entity since in every case it will be subsumed in the national system of regions. Returning to the case at hand, the displacement region for manufacturing activity is the

general geographical area which will be placed in real competition for particular water using industries by the increase of activity in the project region, assuming for the moment the project region to be competitive in other factors. Ultimately, this area will have to be large enough to include a realistically large fraction of the industry being considered but within a reasonable distance of the project region since initially only relatively marginal locational shifts would be anticipated. The displacement region for the recreation purpose, would be the region in which recreational services previously used by prospective users of the proposed project are located.

The definitions and the two hypothetical examples of their application seems to underscore several critical points. The definitions of all these planning regions are in essence extremely flexible but each must be supported by economic logic and empirical observation. The definition of the project region cannot be made in isolation from the larger economic context in which the project-induced activity occurs and the extent to which this activity produces a new economic focus in the area. Finally, the formal defining of displacement regions is an essential step in evaluating the spatial economic consequences of water resource investments even though the recommended evaluation procedures do not specify this determination.