Chapter 2: NAR Planning: An Overview

This chapter provides an overview of the planning methods used in the NAR study. First, the principal methods used in planning the NAR are outlined: multiobjectives; mathematical models; and institutional arrangements. Then, three other elements of the planning process are described: the analysis of needs, sources and devices; the planning regions; and the forecast years. A final section contains perspectives on the methods. The chapter provides a framework for detailed treatments of the principal planning methods in the chapters to follow.

2.1 MULTIOBJECTIVES

The use of multiobjectives (Chapters 3 and 4) is one of the distinguishing features of the NAR study, along with the use of mathematical models and the institutional methods for planning that were utilized. The NAR was one of the first explicitly multiobjective Federal studies; its use of these techniques followed closely upon the publication of the landmark work on them, Maass et al. (1962). Multiobjective analysis is a generalization of traditional cost-benefit analysis. Traditional analysis focuses on the national income (or "economic") objective of water planning. Multiobjective analysis, by contrast, emphasizes the design of water projects and programs in terms of all relevant objectives, environmental, regional, social, and others, including the national income objective. In practice, as in the NAR, multiobjective analysis is concerned with the choice of objectives, the development of alternative feasible plans responsive to objectives, and the final choice of a plan. Works that describe the theoretical structure of multiobjective planning include Maass et al. (1962); Marglin (1967); UNIDO (1972); Major (1977); and Major and Lenton (1979); see also Figure 3-1.

NAR planning took place in terms of three objectives: national income (the traditional objective of benefit-cost analysis); regional development; and environmental quality. These objectives, chosen for reasons described in Chapter 3, were formally adopted for NAR planning by the Coordinating Committee in September, 1967 (A-10).

The level of detail at which each multiobjective effect was examined in NAR planning varied depending on the importance of the effect for decision-making; the available staff, time and other resources; and the methods available. Relatively detailed work was done for economic cost accounting and for visual and cultural effects; on the other hand, economic benefits were discussed in terms of general magnitude, and regional effects were discussed rather broadly. The multiobjective

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approach was thus used in the NAR study as a conceptual framework to guide the organization and evaluation of information, rather than as a consistently detailed guide to the evaluation of individual projects. (For guidelines for the latter use see UNIDO, 1972.)

The approach to plan formulation for multiobjectives that was employed in the study included the development of three alternative plans, each with a somewhat exaggerated emphasis on a single objective. These would be examined by the Coordinating Committee, which would use them to decide on a final recommended mixed objective plan for the NAR. This approach to multiobjective plan formulation shaped both the models and the institutional methods used in the study.

2.2 MATHEMATICAL MODELS

Three models were important components of the NAR planning process: a demand (or requirements) model, based on input-output methods; a mathematical programming supply model; and a storage-yield model used to generate hydrologic inputs to the supply model. These models were utilized together to forecast requirements and to estimate costs of supply. The models were developed within the NAR planning context: a framework study; a commitment to multiobjective methods; large quantities of data from different agencies; and many standard methods of economics, engineering, and water planning. The three models are treated in detail in Chapters 5, 6, and 7 respectively. Two overviews of the use of models in water resources planning are provided in Friedman et al. (1984), and Rogers and Fiering (1986).

The demand model is a group of subroutines based on forecasting relationships designed to yield estimates of demands for water based on specific assumptions. The mathematical components of the model are an input-output table for the NAR region, a regression estimator for publicly supplied municipal and industrial water, and a group of arithmetic operations associated with these components. (References on input-output analysis, an economic simulation and forecasting method, are provided in Chapter 5.) The principal inputs to the model are projections of regional economic product, population, personal income, and water withdrawal coefficients, together with projections of the geographic distribution within the region of these variables. The model acts on the inputs to produce estimates by benchmark years of water flow demands by economic sector, by type of water quality, and by subbasin, basin, state or area. These flow demands are inputs to the supply model. Many different runs, responsive to alternative assumptions about forecasts and objectives, were made with this model; these are summarized and evaluated on T-271 to T-292.

The supply model is a mathematical programming (optimizing) model (see Chapter 6 for references to this technique). It is designed to permit evaluation of the sources and the costs of supplies of water required