Utah State University

DigitalCommons@USU

January 1979

Levels of Analysis in Comprehensive River Basin Planning

Dean T. Larson

L. Douglas James

Kirk R. Kimball

Jim Mulder

A. Berry Crawford

Charles Johson

See next page for additional authors

Utah State University
MERRILL-CAZIER LIBRARY

Authors

Dean T. Larson, L. Douglas James, Kirk R. Kimball, Jim Mulder, A. Berry Crawford, Charles Johson, Lance Rovig, and Ken Sizemore

LEVELS OF ANALYSIS IN COMPREHENSIVE RIVER BASIN PLANNING

by
Dean T. Larson, L. Douglas James, and Kirk R. Kimball
with
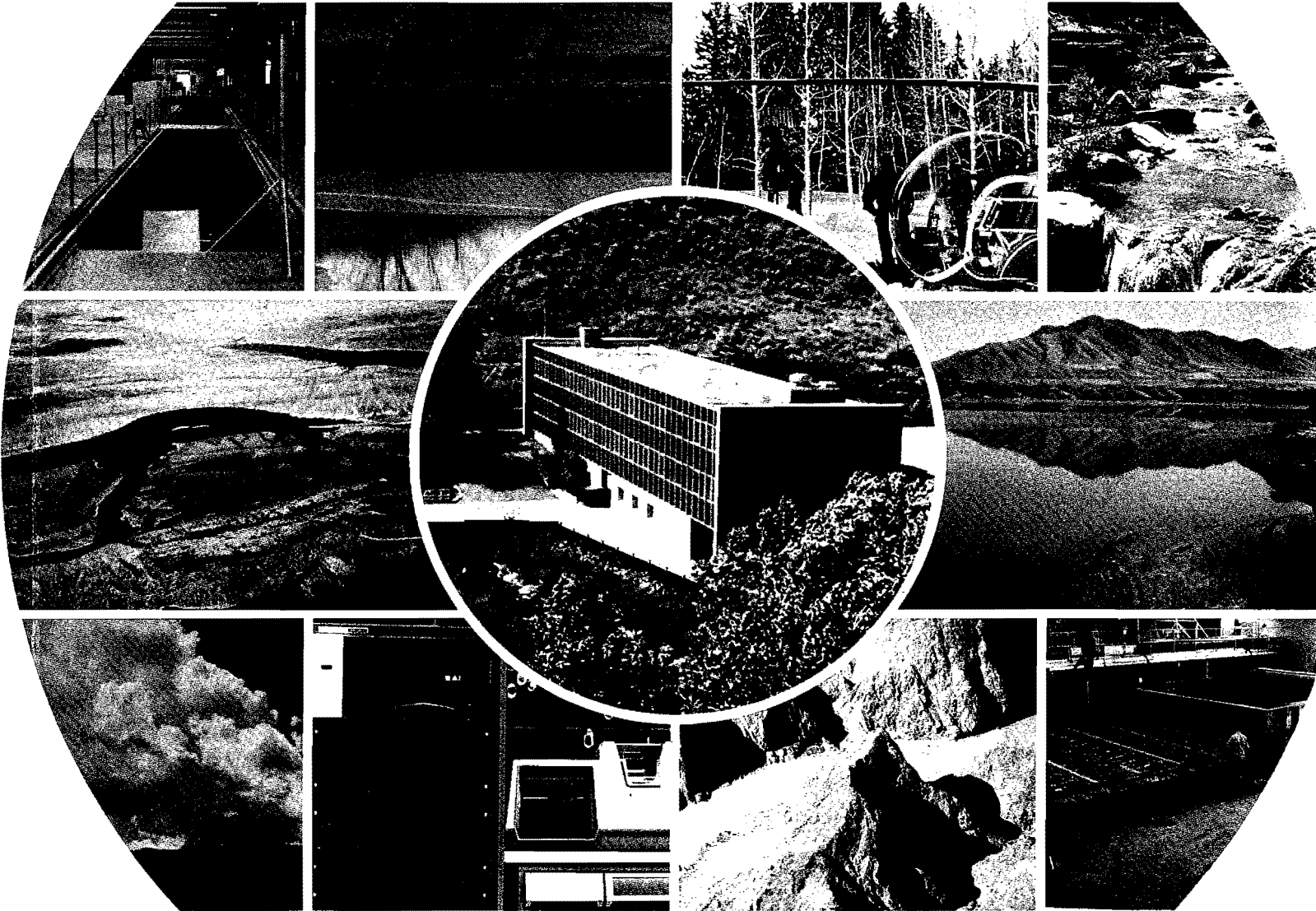Jim Mulder, A. Berry Crawford, Charles Johnson, Lance Rovig, and Ken Sizemore

LEVELS OF ANALYSIS IN COMPREHENSIVE RIVER BASIN PLANNING

by

Dean T. Larson, L. Douglas James, Kirk R. Kimball

with

Jim Mulder, A. Berry Crawford, Charles Johnson
Lance Rovig, and Ken Sizemore

Utah Water Research Laboratory
College of Engineering
Utah State University
Logan, Utah 84322

May 1979

ABSTRACT

Since nearly every water resources management choice has two
or more sides, differences must be resolved in decision making.
Equitable resolution requires an understanding of the reasons for the
differences. These reasons originate in that implemented plans have
physical-environmental, economic, social, cultural, and political
impacts at levels ranging from local to national or international in
scope. Decisions are made by individuals and groups impacted in all
of these dimensions and at all of these levels; the decisions generate
additional impacts; and the entire interactive process changes water
management practice in ways outside the control of any one decision
point or even decision dimension. The objective of this study is to
conceptualize this process in a way that will help in establishing
institutional mechanisms for reconciling differences among levels of
analysis.

The conceptualization used viewed differences in choices being
made at the various levels of analysis as associated with perspective
differences having value, jurisdication, action, and temporal ele-
ments. The possible combinations of differences within and between
these elements were used to identify ten categories of institutional
obstacles to efficient water planning (differences in values, con-
flicts between value and jurisdiction, etc.). The history of water
resources planning in the Colorado River basin was then examined to
identify 17 specific institutional obstacles, and a computerized
policy simulation was applied to levels of analysis in the Uintah
basin of Utah to identify three more. These 20 obstacles were
shown to be broadly distributed over the ten categories, and the
nature of the obstacles defined provides valuable insight into the
common characteristics of the major institutional obstacles to water
management.

The principles of logic as applicable to rationality in decision
making were then used to identify two root causes of levels' con-
flicts. If alternatives are evaluated from a single perspective, the
ostensible causal relationships commonly used lead to estimates of the
sum of the consequences from the parts of a water management program
being far more than the total consequences of the entire program.
Looked at another way, since available water resources planning tools
do not properly allocate consequences from interactive processes to
individual causal sources, decisions made to achieve a desired impact
are not based on reliable information. In fact, different decisions
made over time from a single perspective have conflicting impacts.
When multiple perspectives are considered, one finds that individual
values do not aggregate linearly in forming social values, many
actions are not efficient in achieving preferred values, and decision
makers are not able to implement their plans as desired. Real world
situations combine interacting perspectives and partial contribu-
tions. Nine recommendations are made on what to do next in improving
water resources planning in an interactive, nonlinear world.

ACKNOWLEDGMENTS

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

ix

CHAPTER I

LEVELS OF WATER RESOURCES PLANNING

Introduction

As economic growth and technological advances have added to the complexity of interactions of water availability and use with the economy, environment, and society, systems analysis techniques have become increasingly important in water resources planning. The systems approach has led to considerable improvement in understanding these interactions so that quantitative models could be developed to represent the interactions in design optimization. Analysis leading to a reasonable decision in the presence of interactive relationships amounts to solving a relational problem. Problems caused by economic, environmental, and social impacts are all relational.

While much more research is needed to understand and solve the relational problems in project and other water management optimization, the topic of this report is much narrower. The subject here is the subset of relational problems that must be solved in optimizing the planning process. The issues of this subset are called the problems of levels of analysis. Why do planners for different jurisdictions come to different conclusions on a given management issue? Why do water resources groups pursue different courses of action than do land management groups? Why do planners so often encounter major resistance from the public when they try to proceed to implementation? What can be done to bring diverse viewpoints together, improve the efficiency of the planning process, and thereby improve resource management? These are some of the issues in solving problems in levels of analysis.

Problem Setting in the Colorado River Basin

Individuals make countless water use decisions daily. These individual decisions aggregate into the use society makes of its water and related land resources.

Water resources planners review current and potential water use for opportunities to make more beneficial use of water and for problems that can be ameliorated. They define action alternatives, collect information on their consequences, and present their resulting evaluations for discussion and decision making.

When water is abundant, each user can pursue his own interest with little effect on others. As the demand for water becomes almost as large as the average annual runoff, conflicts among users and opportunities for cooperation for mutual benefit multiply. The planning must be more thorough to lay the foundation for objective development and management decisions.

Three principal factors make the need for careful planning increase with demand. First, the increasing marginal cost, in both economic and environmental terms, of developing additional water justifies greater planning effort to get the most for more money spent and to avoid unnecessary environmental and social costs from the greater impact of larger projects. Second, when nearly all the available water is being used, the system loses its resilience in coping with external events that reduce supply or increase demand. This loss necessitates greater and more effective interaction between land and water planning. Third, the greater marginal benefit from the last units of water used justifies greater management effort to prevent the waste of a more valuable commodity.

New demands that develop after all the water nature supplies has been put to use can only be supplied by taking water previously used by others. In discussions of such shifts, former users and those with the new demands, including people who identify with both groups, are likely to have quite different views of the exchange, and the negotiation is complicated because changes that occur often have significant effects on still other groups. Water exchanges among individuals in water short areas consequently become quite sensitive in the community and are closely regulated by water rights officials. Proposals to change government water management policy become very sensitive in the political arena.

Such a situation exists in the Southwestern United States, where the Colorado River and its tributaries supply 15 million people in seven states. The water from the Colorado supports 8.0 percent of the nation's population with less than 1.5 percent of the annual runoff in a region where high temperatures and long growing seasons add greatly to water requirements. Perennial water shortages result in continual conflicts and discussion of trade offs in

1

water allocations among users. These dialogues make the Colorado River Basin an ideal area to study the economic, political, and cultural linkages that connect people's lives in their efforts to obtain water and use it beneficially.

The Set of Relational Problems

The set of relationships important to water resources planning can be divided between impact relationships and decision relationships. Impact relationships cause impacts from decisions made, and decision relationships influence decisions contemplated. The impact relational problems include forecasting impacts that will occur and avoiding undesirable impacts. The decision relational problems include bringing the best information into the decision making and compromising conflicting decisions being made at various levels.

Impact Relationships

As diagramed on Figure 1, a decision on a new water project or policy as depicted by a black dot in the center of the figure scatters impacts in many directions shown as economic, governmental, social, cultural, and physical-natural dimensions. Impacts in each dimension vary from very local to very broad concerns. For example, impacts in the social dimension range from those on individuals to those on society as a whole.

The linkages causing these impacts generally radiate outward from the center. A decision may affect an individual and then affect others indirectly as they perceive what happens. A decision affects individuals, directly and indirectly, and because it does so, it also affects families. When these more localized effects are more numerous they aggregate to affect groups. Effects
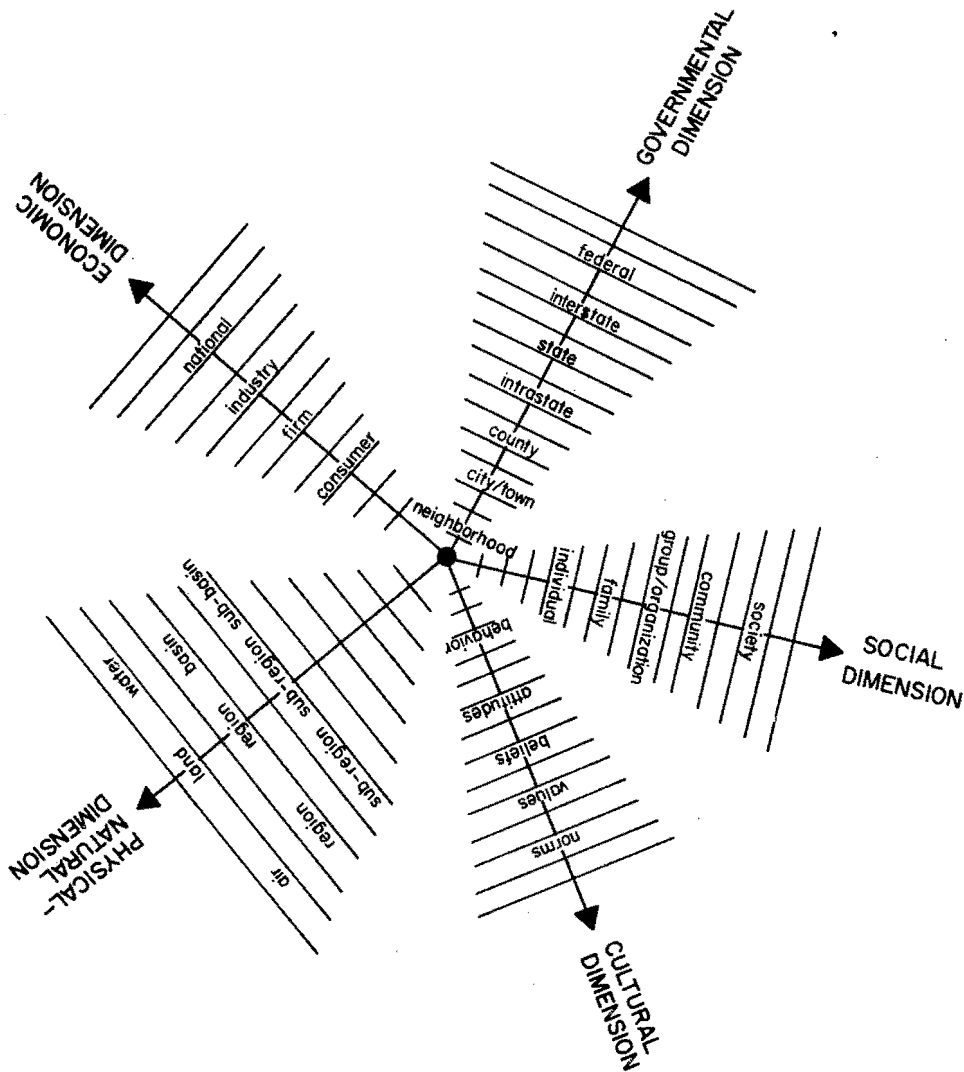
Figure 1. Partial representation of interconnected dimensions and elements in a planning system.

2

on many groups change communities, and effects on communities aggregate to change society. As the effects radiate outward, they also cross from one dimension to another. As examples, economic effects on consumers can affect families as well as can social effects on individuals. Experimental effects on water quality or on industrial employment can alter cultural values.

Each point along a dimension may be defined as a level of impact. Each level of impact includes many elements, specifically many consumers, neighborhoods, individuals, behaviors, or small drainage basins. The elements at a level vary from many small units near the center to fewer but much larger units further out. For example, there may be millions of consumers, thousands of firms, scores of industries, and one or two national economies affected by a given decision.

The impacts radiating outward from a new project or policy tend to be damped at the higher impact levels. An effect that completely changes a neighborhood may not even be noticed at the national level, or major alterations in behavior may occur within fixed cultural norms.

Decision Relationships

Each element at each level is also a locus of decision making. An impacted consumer may respond in a variety of ways. One consumer is likely to respond quite differently than another.

The top level decision makers in the national economy may also respond, but two important trends can be observed as one goes to higher decision making levels. First, the decision making process involves more participants and occurs through more complex interactive processes. Second, the decisions made become more powerful in the impact they exert. Decisions to alter the course of the national economy have a much greater impact than do those of an individual consumer changing his buying habits.

The decision making within a given element responds to some combination of the original stimulus and perceived effects on or responses by other elements, either on the same or on other dimensions. Decisions by elements will often be different from one another and may be either complementary or competitive in nature.

From the viewpoint of the general welfare of society, information on impacts along all five dimensions is relevant to making water use decisions as well as many other decisions that indirectly affect water availability or use, for example, by changing the runoff characteristics of the land surface, the need for water by municipal or industrial users, etc. No one decision

maker considers, wants to consider, or even is capable of considering all the information on all impacts along all five dimensions. Instead, each reviews data on what, from his perspective, appear to be key variables or indicators of harm or merit.[1] Perspective thus serves as a filter that reduces the total set of relevant information to a lesser set that its user can assimilate, but the reduction process is very biased. Methods for reducing this bias are the key to solving the "level of analysis" problem.

Decision making in water resources management is a collective process. Each actor decides according to his perception of his best interest. Each acts on the basis of perceived information and reacts to perceived actions or statements of others. It is these relational interactions among decision makers that are the primary focus of this study. Specifically, what methods and procedures exist or can be developed to define interest and coordinate actions for the mutual benefit of the diverse individuals, groups, organizations, and levels of decision making in the total water planning process? The importance of this question has been recognized for sometime, but no one has made much progress in organizing a theory that can be used to achieve effective methods and testing it against empirical information.

Received View as a Theoretical Basis

Conceptually, the linkages within and among the various levels of analysis are not well understood, although certain ones have received much attention in various social sciences. Examples include the problem of exernalities in economics and political science; the problem of sub-optimization in business; that of conflict resolution in political science; and that of interest aggregation in economics, political science, and sociology. The results of these various studies can best be applied by finding a common thread of applicable theory. One common ground exists in the philosophical, logical, and semantic issues that these efforts employed in defining "perspective," "point of view," and "level of analysis." Common issues include:

How can a planning perspective be identified and/or defined?

What is involved in the definition of a planning system?

---

[1]In the TechCom study hundreds of indicators and variables were identified for nine primary goals related to water resources planning (Technical Committee of the Water Resources Centers of the Thirteen Western States, 1974).

What are the conceptual categories that best describe interactions among planning perspectives and levels?

Whether purposefully or incidentally, assumptions used in answering the above questions underlie any attempt to coordinate and/or integrate planning for a complex system. A proper understanding of the conceptual issues related to levels of analysis must be coupled with a technical understanding of such varied areas as hydrology, economic analysis, environmental impact, institutional setting, and social well-being. It is within the contexts of both the conceptual prerequisites and planning actualities that the aims and objectives of this study should be understood.

Because of the diversity of interrelated actors, an operational theory needs to begin with a shared language or understanding of such key terms as "relational problems," "levels of analysis," "perspectives," and "points of view." The kind of shared language needed is one like that characterized as "received view" among philosophers on the nature of scientific theory. These philosophers have been able to develop a profound understanding of how to structure scientific theory because a "received view" was consensually understood to identify a specified set of conditions for a theory to be accepted as a theory (Suppe, 1977). Planners need consensual understanding of conditions for a plan to be accepted as a plan. In order to lay a foundation for the needed consensus, the present study will begin with a review of the observed relational problems, issues, and parameters that characterize the study region and sub-regions (Colorado River Basin, State of Utah, and Uintah Basin), and that have been discussed in the context of national water resources planning.

Decision Points in Land and Water Use

In focusing on levels of analysis problems, it is useful to examine the alternatives for land and water use and the decision points choosing among them. The use alternatives can be characterized in several ways. Patterns of land use, for instance, are often categorized in terms of woods, pasture, farms, homes, factories, etc., and can be displayed as a spatial configuration at a given point in time. This pattern changes as parcels shift from one use to another. Patterns of water use may be defined in terms of power generation, waste dilution, fish habitat, etc., or water diverted from the stream for agricultural, industrial, or municipal supply. The decision points occur at the individual, community, state, regional, and national levels in the governmental dimension, and over a corresponding range of levels along the other dimensions shown on Figure 1.

The patterns of land and water use at a given point in time are the product of many decisions made by individual "property managers." They include persons who own land, lease from a landlord, or work for a corporation; they include farmers with water rights and home owners who water their lawns. Each person bases his decision on some kind of analysis (informed, uninformed, or misinformed; superficial or profound) from which he concludes that certain land or water use is beneficial from his point of view. Each decision is to various degrees influenced by the characteristics and availability of the resources and by the way others use or do not use adjacent lands or waters.

As a property manager's benefit from land or water use is affected by the activities of his neighbors, he is motivated to influence them to adopt certain uses and avoid others. He may exercise personal and social pressures to advance his private interest. If individual efforts to control these external effects fail in matters which many people think important, the notion of general or public interest creates a role for government in guiding individual land and water use decision making toward some acceptable public standards. Laws, regulations, financial incentives, and other means are employed to confine individual choices within the bounds of acceptability as defined by some higher level of analysis. These instruments can be used at public interest levels varying from the local community to the nation as a whole. Communities monitor the actions of individuals, states monitor the actions of communities, etc.

The public interest as seen at a given level is defined by actors in the political and governmental arena which impacts and is impacted by the decisions that emerge. For example, actors work through local government leaders to establish a community viewpoint (more accurately a dynamically changing viewpoint responding to a wide variety of influences). The governmental actors then use instruments available to them to build projects or to confine individual, private choices within the bounds of community acceptability. Ideally, all community decisions should originate from some kind of analysis that has concluded that a given action would promote the public interest and that a certain action plan is the most suited to achieve the desired results.

As the quantity and quality of available water is affected by upstream land and water use and in turn affects the quantity and quality of water available for those downstream, communities need to be motivated toward land and water use policy in conformance with state or regional public interest. Some level of government high enough to internalize both beneficial and adverse external effects may well find it necessary to influence community policy to in turn influence individual property manager decisions (the flood plain management program for example) or to implement direct construction

of necessary facilities (a water supply reservoir for example). Implementable incentives are needed to achieve a combined pattern of land and water use to achieve the general good.

In an hierarchial system of jurisdictional governments, a number of arenas are available for establishing consensus and implementing programs. Decision systems are found at the property manager, town, county, regional council of governments, state, interstate compact, and national levels. Each level possesses its own viewpoint with respect to all five impact dimensions (Figure 1), and each has its own limitations on what it can and cannot do. Each jurisdiction has its own access to information (correct or incorrect), its own capability for evaluation of alternatives, its own resources to implement the selected courses of action, and its own legal and institutional restrictions on its activities. The total decision making and "planning" system for land and water use combines all these levels deciding, interacting, adjusting, and continually changing in both perception and viewpoint.

At each level, the decision process is affected by what participants observe or know of the problems and selected solutions at higher or at lower levels, or at the same level in other jurisdictions. The water and related land use management practices within the Colorado River Basin thus result from a decision making system functioning at many levels and at many locations at each lower level. The success or failure of any effort to influence these practices cannot be adequately evaluated at any one level alone because the interactions among the levels of analysis must be taken into account.

Illustrative Relational Problems
in the Colorado River Basin

In order to illustrate the wide scope of relational issues faced by water resources planners, it is helpful to describe some of the linkages in decision making in the Colorado River Basin. The current linkages among the various levels of analysis are in turn strongly influenced by historical linkages that produced the existing context of the legal agreements, court decisions, and water rights that govern water allocation. For example, Colorado River water is allocated among seven states through the Colorado River Compact of 1922, a U.S. Supreme Court decree in Arizona vs. California (376 U.S. 340, 1964) and the Colorado River Basin Project Act--PL 90-537 (USDI, Bureau of Reclamation, 1975).[2] In addi-

___

[2]The water rights of many Indian tribes in the region have not been finally settled, so that some significant uncertainties about water allocations remain at the state levels.

tion, the basin states are responsible to insure that 1.5 million acre-feet water of specified quality is delivered to Mexico annually.

One could begin a discussion of the myriad interconnections among decision levels in the region with just about any issue or geographical area. One interesting account (Lichtenstein, 1977) follows the course of the Colorado River, beginning at its headwaters. Alternatively one might start with the Denver metropolitan area which lies outside the drainage area but draws more than 70 percent of its water from the Colorado (Hundley, 1970). For our purpose, it is useful to develop the relational questions and issues by beginning with the Imperial Valley in California, near the downstream end of the river.

The Imperial Valley was a desert before irrigation began with Colorado water. Now the valley produces an estimated one-half billion dollars worth of agricultural commodities annually and supplies vegetable markets in all parts of the country. The Imperial Irrigation District, the largest single user of Colorado water, imports close to 3 million acre feet of water from the Lower Colorado River, or about two-thirds of California's allocated 4.4 million acre feet. The remainder of California's share as well as additional Colorado water, bringing California's total annual use to about 5.1 million acre feet, is transported to the Southern California coastal plain where it provides about 50 percent of the water for the San Diego and Los Angeles areas.

A number of water use issues within California emerge from this situation. California is presently using about 0.7 million acre feet of water officially allocated to Arizona and Nevada. When these other Lower Basin states claim their water, which California users will have to give up what they now have? Will they be able to obtain replacement water from Northern California or from saline water conversion? Who should pay the cost for the imported water or for ocean water conversion? What is the optimum allocation of water within the State of California and what values should be used or are affected by such an optimum? What priorities should govern water allocation among the different areas in Southern California and the state as a whole, and how should various interests be weighted? For instance, should municipal use drive out agricultural use? How should the water rights of California Indian tribes affect the allocation of water? What planning process should California implement to insure that the distribution of water among different users will be equitable and efficient?

These kinds of questions can be repeated for every state in the basin, for the region as a whole, and for the entire country. They can be answered in some sort of objective sense by specialists evaluating the

trade offs scientifically, but actual choices are more often made through the collective decision making of many actors at diverse levels. Furthermore, many of these choices do not make a great deal of sense from a purely objective viewpoint.

The difficulties in rationally planning an optimum water allocation at the state level are compounded at the basin level where the constraints of political feasibility are greater. The significance of politics can be demonstrated by speculating how planning might proceed if only economic efficiency were considered. One possible outcome could be that water diversions to most of Arizona and Southern California would not be justified on the basis of opportunity cost calculations. Water used in the Imperial Valley might be more efficiently used in other parts of the basin. Long-run economic efficiency might favor resettlement of populations from Arizona, Nevada and California to other areas in the basin or the country. Another possible outcome would be that such considerations as milder climate and greater availability of other factors of production in the Lower Basin would make it economically efficient to reallocate water from the Upper to the Lower Basin.

As one more possibility, it may be economically feasible for both Upper and Lower Basins to import water from the Columbia River, although just the study of this possibility has already created conflicts with the Northwest states (Idaho Water Resources Research Institute, 1976). The point is that none of these reallocations is possible because political factors far out-weigh economic efficiency when one is dealing with complex, large-scale planning systems.

In addition to these water quantity problems, salinity has become a major problem in the Lower Basin. Further increases in salinity may cripple agriculture in some areas. While damage estimation presents difficult technical problems (Utah Water Research Laboratory, 1975: p. 232-244), a Bureau of Reclamation (1974) approximation estimates a possible reduction of $16 per acre in net farm income for the Imperial Valley if salinity increases by 320 mg/l by the year 2000. Costs to other Lower Basin areas are similar or higher. Since the salts that reach the valley originate in all areas of the basin, an effective program to reduce salinity needs to involve almost everyone upstream. Furthermore, the entire country is affected as the federal government bears the cost of the desalting plant at the California-Mexico border to ensure that water of appropriate quality enters Mexico.

It is complicated to determine what salinity control measures are most efficient, equitable, and effective, and how such measures can be best implemented. One writer describes the basic difficulty as follows:

The problem of salinity control cannot be narrowly construed. Decisions concerning salinity control have implications for water resource development in the basin. Water resource development decisions have environmental and social implications of the most far-reaching kind. Decisions affecting the basin as a whole need to be examined systematically and comprehensively, but no existing institution has a basin-wide interest and perspective as its primary focus (Utah Water Research Laboratory, 1975).

Thus salinity control measures cause numerous conflict situations. One major conflict is illustrated by the insistence of the states in the Upper Basin that they will not tolerate interference with their development to reduce salinity for farmers, municipal, and other users in the Lower Basin (Utah Water Research Laboratory, 1975: p. 99).

The water quantity and quality interrelationships described in this section are only suggestive of the many relational problems that pertain to water supply and quality issues. Other relational issues related to energy, economic development, recreation, environmental quality, and social welfare are just as important.

With respect to problems in levels of analysis, all the important interactions among decision makers acting at various levels along the various dimensions of Figure 1 influence water policy. All need to be considered in an effective formal planning framework. How can this be done? Can it be done at all? Progress in this direction can only be made by integrating the conceptual, procedural, and institutional components of the planning system in an organizing framework that guides the planning process.

Research Objectives

General Objectives

The two previous sections have tried to convey the complex context faced by water resources planners because of the many and varied impact relationships affecting elements over a range of levels along several dimensions. The complexity increases as the impacts generate feedback linkages to multiple decision points. The planner rightly seeks optimality as he weighs tradeoffs among alternatives but he must also recognize the constraints the options being selected at other decision points create for the decisions that he would like to implement. The processes of impact, choice at other decision points, and formal planning decisions interact dynamically in response to multiple external stimuli as resource availability, technological capability, environmental health, and many other conditions change. The general

6

objective of this study is to help planners who must work in this context by 1) developing a conceptual representation of their levels of analysis problems and 2) suggesting institutional mechanisms to help integrate different planning perspectives in achieving common goals.

General Procedure

The general approach to accomplish these planning objectives will begin by identifying important levels of analysis problems as seen in 1) the history of planning decisions within a portion of the Colorado River Basin (Chapter II) and 2) the current state of the water resources planning art (Chapter III). A simulation model (PROPDEMM) for expressing preferences from three levels of analysis (basin, state, and local) will then be used in trying to understand these problems in greater depth (Chapter IV). Out of these efforts, specific problems will be defined and used as a basis for the conceptual development and suggestion of institutional mechanisms in the second part of this report.

Research Framework, Activities, and Methods

The research procedure combined 1) conceptualization and theory, 2) application, and 3) analysis. The methods included a mail survey and personal interviews, content analysis of newspapers, and the application of a computer simulation (PROPDEMM II, a programmed policy decision making model). The results of the conceptual/theoretical analysis and the following simulation were synthesized in recommendations for dealing with institutional issues and concerns.

From the start of the project, levels of analysis problems were found to be very important in numerous contexts, but previous in-depth analyses with practical relevance were lacking. It was therefore decided to begin with development of a conceptual framework that could provide a foundation for dealing with levels of analysis problems in water resource planning practice. To this end, a large scale literature review was undertaken to identify the theoretical as well as applied work that has been accomplished with respect to levels of analysis. Considerable theoretical work relating to social choice, levels, and relational problems has been done in economics, systems theory and cybernetics, philosophy, sociology, and political science.

The application was based on the three "planning systems" defined by the Colorado River Basin, the State of Utah, and the Uintah Basin in Northwestern Utah. These three levels provide an excellent example of the complexities that characterize the interactions, conflicts, and planning activities in a large river basin. The region has been studied extensively, so that large amounts of data are available, facilitating the identification and investigation of levels of analysis problems. In addition, each area has major water planning challenges due to water scarcity and quality control problems. Some of the problems were outlined earlier in this chapter for the Colorado Basin. Additionally, in Utah and the Uintah Basin, special problems are posed by energy development and by emerging population pressures.

The conceptual foundation was complemented by simulation of decision making at the various levels. The model needed to portray several levels of analysis in isolation and also interrelate them. PROPDEMM II was chosen because it could do this as it evaluates large amounts of planning information in concise formats.

PROPDEMM II simulates planning decisions from three cross-impact matrices that represent the socio-political, socio-economic-environmental, and course-of-action components. The model links the three matrices through the concept of "value impact" postulated to be the fundamental element of any policy or planning situation. In addition, PROPDEMM II is among the politically most realistic simulations in that it gives explicit expression to political factors such as the power of interest groups, their commitment to certain values, the rigidity of their positions, their interactions historically, and their concern with costs of public programs.

Simulation of the major planning-related interactions within each of the three systems provided comparisons that could be used to identify levels issues and problems that need to be addressed. Because the three systems are hierarchically ordered (the Uintah Basin is part of the State of Utah, which is turn depends for most of its water on the Colorado River), the interrelationships among them can be more easily traced and examined. The results could be used to analyze how interrelationships among interest groups, socio-economic-environmental factors, and courses-of-action for different levels of planning affect or are affected by each other.

Summary

The interdependence of decision making at various levels along the five dimensions shown in Figure 1 with water use and management effort necessitates comprehensive, integrative planning practices. Unfortunately, relatively little practical knowledge and understanding exists about the nature and functioning of complex, interrelated impact and decision systems. What is worse, a large number of decision makers and planners are only vaguely aware that limitations to their understanding of how impacts interact with

decisions may well be resulting in very poor decisions. Planners need a conceptual understanding that is descriptive of the complexity of activities that impact upon one another, rooted in experience, and able to improve practice.

One way to begin is to identify and examine the kinds of water and land use decisions. It is apparent that patterns of water and land use are the combined result of decisions made by a number of individuals with different degrees of influence. The various social, economic, and political interests lead to specific viewpoints and perspectives that affect the planning system as a whole. They must somehow be taken into account in the overall planning process.

The Colorado River Basin provides numerous examples of the kinds of analytical and synthetic problems that need to be resolved in regional planning. These problems, as a class, may be termed relational problems. While relational problems encompass all types of interactions, levels of analysis problems refer to interrelationships in decision making, particularly characterized by some hierarchical ordering, as exemplified, for instance, by various layers of government. Levels of analysis problems present perhaps the most difficult conceptual and practical obstacles to improved comprehensive river basin planning. To develop the necessary understanding for dealing with relational and levels of analysis problems, this study will examine both the context of planning inquiry and that of planning practice, respectively through philosophical and simulation analyses.

CHAPTER II

THE "LEVELS OF ANALYSIS" PROBLEM IN CURRENT
WATER RESOURCES PLANNING

Introduction

Water resources planning may be broadly
defined to encompass the design, implementa-
tion, and operation of schemes to reduce
flood damage, supply water, protect water
quality, generate hydroelectric power,
provide navigable waterways, provide opportu-
nity for water-oriented recreation, or
otherwise increase the benefits people derive
from water resources. The purposes of plan-
ning are to select worthy schemes, to
develop functional designs, and to provide
cost-effective implementation. The work that
planners do, however, is often under used or
ignored in actual selection, design, and
implementation processes. To return to the
decision framework presented with Figure
1, decisions are made on these points at many
levels using many degrees of analysis. Some
use the results of the planning, and others
do not. Thus, whether the plan is ever
implemented as planned or not, the planning
does have a beneficial impact to those who
can use the information disseminated.
Nevertheless, many plans are never imple-
mented because of obstacles of the "levels of
analysis" sort. The purpose here is to
identify some of these principal obstacles
and explore ways to reduce them.

The strategy will begin from an examina-
tion of the purposes of water resources
planning and the conventional procedure
for achieving those purposes. It will
review how the increased complexity of modern
society has expanded the scope of planning
considerations and changed planning pro-
cesses. A comparison between needs for
change that have been met and those that have
not will provide insight into institutional
obstacles. Four components of each level of
analysis will then be used to classify
institutional relationships in planning,
identify conflict situations, and select
examples for use in developing a better
understanding of institutional obstacles or
levels of analysis problems.

Purposes of Water Resources Planning

The threefold purpose of water resources
planning is 1) to select water development
or management schemes that are worthy invest-
ments for limited capital resources con-
sidering the consequent economic, environ-
mental, and social effects, 2) to develop
a design (whether for a multipurpose reser-
voir or a flood-plain zoning regulation) that
will indeed perform satisfactorily in its
intended function, and 3) to work out such
details of project implementation as de-
veloping working institutional arrangements
for project management, raising the necessary
finances, securing needed political approval,
and getting user groups to make proper use of
project output.

The Planning Process

The process for water resources planning
widely accepted as an ideal was outlined by
Fox (1963), as:

1. To plan on the basis of objectives
and criteria specified by legislative action
or achieved through group consensus prior to
beginning the planning. The principles
and standards adopted by the Water Resources
Council (1973) have since become the official
federal criteria, and more recently a number
of changes to them are being seriously
considered.

2. To expand these broad criteria
into quantifiable indices of project per-
formance that can be compared to determine
the relative merits of the design alterna-
tives.

3. To collect the data relevant to
water resources management or project de-
sign in the area under study and then to
use that data to evaluate alternative courses
of action by comparing them in terms of the
selected indices.

4. To select through such an analysis
by professionals the single best plan or
most promising group of plans. A group
of plans would be selected if nonquantifiable
factors or conflicts among objectives make
it impossible for professional analysis to
decide what is best.

5. To expose the selected plan or group
of plans to public discussion for final
selection or for revision as necessary.

6. To finalize the design and then implement the selected plan.

In execution, the definition of a worthy project varies with the viewpoint of the evaluator, and project selection is highly dependent on prevailing public opinion. Detailed design is largely performed by technicians and ends up being highly dependent on standards that have come to be generally accepted by the profession. The implementation arrangements have largely been worked out through political compromise rather than thoughtful analysis of alternatives.

Expanding Scope of Planning Considerations

A water resources planner might, for example, be charged with selecting, designing, and facilitating implementation of a scheme for flood damage reduction for a given community. In a typical situation, he would determine an acceptable level of protection (usually against at least the 100-year flood for an urban area), collect the needed data, perform alternative designs, and select as optimal the design maximizing benefits net of cost. The plan, which might be a protective levee, would be discussed at a public meeting and implemented once beneficiaries obtained the necessary funding through the political process. In another example, an irrigation planner might recommend a small dam diverting water into a canal to the service area.

As the need for larger projects to solve larger problems and the need to minimize unnecessary magnification of downstream flood peaks and provide a dependable water supply during extended droughts turned both flood control and irrigation technologies to reservoirs, one large reservoir was found to be more economical than two smaller ones, and the multiple-purpose (combining in this case flood control with irrigation) project began (Linsley and Franzini, 1964, p. 619-626). As a number of reservoirs came to be built along a river (the Columbia, Missouri, or Tennessee), benefits could be increased by coordinated operation, and multi-project systems (combining reservoirs in a river basin) began (Krutilla and Eckstein, 1958, p. 61-68). As it became obvious that project construction had important environmental and social as well as economic effects, multiple objective planning was recommended (Hufschmidt, 1969).

As water and land resources become more fully utilized, the need to account for a wide variety of interactions between them is becoming increasingly important (Whipple et al., 1976). For example, the need for an expanded water supply as well as the quantity and quality of the flow in the stream depend on land use within the basin. Indeed, the movement to increase emphasis on non-structural measures was an attempt to achieve the benefits of water planning by changing land use (moving highly damageable development out of the flood plain for example) rather than by constructing more facilities. The title of the principles and standards specified for planning by the Water Resources Council (1973) notes that they are to be applied to both water and related land resources. Interactions between land and water use that need to be considered (James and Lee, 1971, p. 501-503) include 1) the extent to which land use determines the demand for flood control, irrigation, recreation facilities, etc.; 2) deterioration in water quality as pollution from city streets or agricultural chemicals are washed into streams; 3) changes in the runoff process as the loss of forest land reduces soil moisture and snow pack and as urbanization speeds storm runoff and reduces low flows; 4) the extra erosion and sedimentation induced by logging, improper soil conservation practices on agricultural land, or construction activities; and 5) increases in precipitation associated with forestation or urbanization.

The importance of land-water-use relationships is maximum at locations where major land use change is occurring. Urbanization has an important effect in growing cities. Coal and oil shale development are likely to have a major impact in the Colorado River Basin. Transportation facilities are important in determining land use and hence the need and spatial pattern for water resources development. Policy on providing or not providing water and sewer facilities can be important in shaping urban development.

Expansions to the Planning Process

As outlined in the previous section, the planning process has been faced with expanding 1) from single to multiple purpose projects, 2) from single to multiple project systems, 3) from single to multiple planning objectives, and 4) from water to more comprehensive planning incorporating interactions of water with land and other related resources. The first expansion required engineering expertise existing within a single agency to cooperate in a common design and has been executed so successfully that the overwhelming majority of the reservoirs built in recent years have been multiple purpose. The second expansion required application of the expertise of a single discipline, systems analysis or operations research, to solve a well-structured optimization problem and has been generally successful. The third expansion required the cooperative effort of multiple disciplines in developing new methodology for reconciling differences among multiple viewpoints, and multiple objective planning efforts have not yet succeeded in doing much more than slowing the planning process to the point where very few plans are being implemented and the critical water management decisions are being made outside the formal framework.

The fourth expansion requires working inter-action between professional groups educated from widely differing perspectives in developing methodology to deal with processes so complex that even researchers operating at the frontier of knowledge do not really understand them.

In summary, the planning process has successfully expanded from single to multiple purpose projects and from single to multiple project systems. It has not been able to expand from single to multiple objectives nor to integrate water with land and regional planning. The explanation for this difference logically lies in the differences in the obstacles to success.

Planning to Serve the Public

Every experienced water resources planner knows that there is too much uncertainty in available information, methods, and understanding of the problems to ever be sure that one has really arrived at the best plan. A planner can always profit from additional information and points of view. In the following discussion on how to identify, define, and overcome the obstacles to comprehensive planning, the goal is by no means to show how to sell a plan produced by experts to a doubtful or a hostile public. It is rather to contribute guidelines that can help planners listen better to various publics and thereby do a better job of achieving consensus solutions.

Technical Obstacles to Comprehensive Planning

The technical obstacles to comprehensive planning include limited information on the relevant physical, economic, social, and ecological systems and how their components interact with one another, limited ability to reason from the information that is available in a manner that leads conclusively to a best plan, and limited availability of the manpower and finances required to gather and analyze information (McKean, 1958). With respect to system description, the physical sciences are still far from able to describe all the interactions between important variables controlling the temporal and spatial distributions of the rates of infiltration, evapotranspiration, movement of water through the soil, etc. (Fleming, 1975). Economists (James and Lee, 1971) are an order of magnitude further and sociologists (Finsterbusch and Wolf, 1977) and ecologists (Corwin et al., 1975) are even another order of magnitude further from being able to describe how planning alternatives differ in impacts of the sorts within their respective areas of expertise.

With respect to evaluative techniques, no algorithms are available to optimize with respect to the complex objective function that would be needed to portray the

national economic development goal of water resources management as bounded by all the complex constraints limiting practical planning choices for real systems. Working techniques for collective optimization with respect to several relevant goals (economic, environmental, and social) as an operational form of multiple objective planning are an order of magnitude further from reality.

With respect to financing and staffing, there is not a team of planners that does not claim that it could do a better job with more resources, nor is there a team that could not organize more efficiently to do a better job with the resources at hand. All of these technical obstacles are important. Each deserves further research, but all are outside the scope of the issues in levels of analysis.

Institutional Obstacles to Comprehensive Planning

The symptoms of institutional obstacles to comprehensive water resources planning are seen in legal and jurisdictional conflicts, slow response to changing conditions, and politically imposed constraints on alternatives to be considered. The causes behind these symptoms, however, go much deeper and are rooted in the conflicts in the desired sorts of land and water use among people in a free society. Even the development plans or management programs that do most to promote the public welfare adversely effect some individuals, interest groups, and communities. As each group takes political action in its own defense, it generates forces that make planning decisions more dependent on political power, legal barriers, and the chance timing of decision opportunities than on an objective assessment of public welfare. Over the years, groups with common interests combine in varying alliances on varying issues at varying times, and the outcomes of the resulting political trading are probably the most important single influence on decision making. Many water resources planners have wondered whether careful evaluation of the alternatives is really worthwhile after seeing their best efforts rejected by politicians who have incomplete understanding of the implications. The essence of the situation, however, is that the systems institutionalized for the orderly resolution of disputes among conflicting interests, for protecting individual rights, and for maintaining stable land and water use policy have simultaneously created major obstacles to action to meet pressing social needs.

Some see a remedy to this situation in establishing cybernetic systems that will make all parties better informed and thereby more appreciative of one another's positions (Beer, 1975). While better information flow systems can do a great deal of good and a great deal of effort should be spent in their development, the fact that different

people, all fully informed, would still make different choices must also be faced. In cases where one individual can choose without affecting others, the public interest is best served by permitting each individual freedom to make his own choice (Pigou, 1938). In other cases where a choice made by one individual severely affects the lives of others, the public interest requires limitations on the freedom of individual choice. It is in setting and enforcing those limitations that conflicts develop and are institutionalized into obstacles restricting further action. In summary, the obstacles to comprehensive water resources planning and management in the United States originate in the conflicts resulting because different conclusions on how land and water should be used are being reached by different groups taking different actions to achieve different objectives from different jurisdictional viewpoints.

Framework for Institutional Problem Identification

In order to probe these institutional obstacles more deeply, a framework is needed for systematic inspection of water planning institutions so that obstacles can be identified, classified, and analyzed. The descriptive framework used here has four components illustrated in Figure 2 and described in a little more detail below. Each component acts within each element at each level of analysis along each dimension of Figure 1.

1. <u>Values</u>. The goals or objectives being pursued include economic development (increasing real incomes), the preservation or enhancement of environmental quality, the improvement of social well-being, and regional development (increasing real income at the local or river basin as opposed to the national level).

2. <u>Jurisdiction</u>. The level of the decision making ranges from private decision making at the individual or family level, corporate decision making, general or special-district local government decision making, decision making at the state level, and decision making at the national level.

3. <u>Action</u>. The physical need and the action being contemplated for dealing with it encompass water resources planning flood control, drainage, irrigation, municipal water supply, navigation, hydroelectric power, water quality control, recreation, and the protection of fish and wildlife. For integrating land with water planning, one must add soil and land conservation, desirable urban growth patterns, quality build-

	Temporal	Values	Jurisdiction	Actions
Temporal	Different horizons Overlapping durations Model increments	Short run vs. long run Value change Salience and satiation cycles	Changing boundaries Different horizons Creation and termination of agencies	Sequence Duration Processes Technological advance
Values		Polarities and affinities Different orderings Aggregation	Aggregative and distributive effects Assignment of appropriate functions Local interest variations	Criteria of achievement and instrumental actions "Accidental" conflicts
Jurisdiction			Aggregation Integration Externalities Duplication and overlap Creation and termination of agencies Area vs. function	Coordination Duplication Capacity and utilization Thresholds
Actions				Exclusivity Specialization Unintended consequences

Figure 2. Matrix of levels problems within and between planning dimensions.

ings, transportation, neighborhood recreation, industrial growth, mineral development and a number of other needs and actions related to land use.

4. _Temporal_. Goals, levels, and actions are constantly changing. As these changes occur faster than the institutionalized system can adjust, parties may continue to advocate policies that are no longer in their best interest because of delays in obtaining information on changing conditions or because of the difficulties in changing a position once adamantly advocated. These temporal problems become particularly important in the water planning arena because periods from project conception to implementation of 10 to 20 years are ordinary.

Problem Classification Within the Framework

Within each component, one finds conflicts in values, conflicts in jurisdictional viewpoints, conflicts in needs emphasized and actions taken, and conflicts in time perspective. Among components, values, viewpoints, perceived needs, and selected actions change with time; pursuit of a particular viewpoint or once-favored action may be found to conflict with basic values; or actions may prove not to be really wise. Problems may exist in two or more components simultaneously. Finally, key action alternatives are omitted from consideration because they do not fall in the advocacy role of any single value, jurisdictional viewpoint, nor problem area. Each of these problem categories will be discussed below as illustrated by situations regularly faced in water resources planning and plan implementation.

Conflicts Within a Component

1. _Conflicts in values_. The study of the sources and expressions of human values has received considerable attention and may ultimately provide the real keys to reducing the institutional obstacles to planning for the common good. For water resources planning purposes, values are expressed in terms of the twin objectives of economic development and environmental quality (Water Resources Council, 1973) while every individual has some concern for both, some people are more concerned with employment and incomes while others feel that they can scarcely exaggerate the destructiveness of unfettered economic growth to basic human environmental support. The first group is going to favor structural water resources development for an expanding economy, while the second group is going to favor nonstructural water resources management for environmental protection. Each side is going to create every institutional obstacle within its power to prevent plans that it opposes from being implemented. The diversity in values reduces as one goes from smaller to larger jurisdictional viewpoints (individuals

vary much more in values than do communities or states), and the intensity of the conflict increases as groups with common values become better organized.

One indication of the difficulty in resolving conflicts in values is the fact that such differences do not occur in expanding from single to multiple purpose projects nor from single to multiple project systems and that these planning expansions have been successful. In contrast value conflicts are inherent in expanding from single to multiple objectives and in integrating water with land planning, and neither of these planning expansions have been successfully implemented.

Apparent value conflicts may originate in different understandings of the facts or in true value differences. In the prevailing situation of incomplete information, each side tries to overwhelm its opposition with alleged "facts" presented in a way to make any who take a differing viewpoint seem quite foolish. Continued research can hopefully separate facts from fantasy so that issues can be discussed on a value basis, but our current understanding of the environmental and social consequences of human activity is still a long way from making this possible. To some extent, value conflicts may be resolved by permitting individuals or jurisdictions with differing values to go their own way (for exampe by employing different standards for water quality control or flood plain management), but the administrative and legal problems in varying management policies are very difficult to overcome. James et al. (1976) discussed these problems with respect to land use controls in flood prone areas.

2. _Conflicts in jurisdictional viewpoints_. Those planning from individual, corporate, local, state, or national viewpoints may overlook other viewpoints through ignorance or purposefully to achieve advantage. The adverse consequences of failing to consider other viewpoints depend on how the actions of those of one viewpoint affect the others, the consequences economists have long labeled as external effects. Effects of the actions of one individual on other individuals or of one community on other communities are true external effects and become more severe as population densities and economic development increase. Effects of the actions of a higher level in an hierarchy (federal for example) on component lower level units (states for example) are internal to both systems but may be considered pseudo-external effects because the higher level unit may be less concerned over the harm caused because those affected are a small portion of its total citizenry or because the citizens of other component lower units may have compensating opinions or be affected in compensating ways. Effects of the actions of those at a lower level of the hierarchy (individual citizens for example) on a higher level (their government) are a

special pseudo-external effect problem in water resources planning. Lower levels try hard to get the higher level to pay for projects that they would not be willing to pay for themselves because the benefit they receive is far more than their portion of a cost spread over the larger group. Many in such smaller units seem to believe that they are actually getting a "free lunch."

In comparing these jurisdictional viewpoints, it is important to remember that while the higher level jurisdictions are able to afford larger and more spectacular projects, the lower level jurisdictions are in aggregate spending more money and having a larger impact on water resources management. For example, less than one third of the irrigated acreage in the United States is served by federal irrigation projects. In addition, the higher level jurisdiction is more remote from the action and consequently less able to implement its plans.

Several approaches have been tried to resolve conflicts in jurisdictional viewpoints. The traditional one at the higher levels has been to form river basin commissions at which representatives of the various levels can interact toward achieving a consensus. The number of elements that must participate causes such group meetings to break down at lower levels. For many years management schemes were formulated by assuming that individuals, corporations, and communities would act rationally with respect to the objective function the planners were using, but experience showed this not to be the case, probably because these other groups were not planning from the same criteria. Many federal water projects have not produced anticipated benefits because the individuals who stood to gain did not respond as anticipated. The recent emphasis on nonstructural measures may in part be viewed as an effort to force individuals to comply with government plans for flood plain use, water conservation, etc. Implementation requires laws forcing the lower levels to conform to the higher level viewpoint or providing economic or other incentives to encourage them to do so. The former method is less in keeping with the democratic tradition, but the latter method generally gives planners a less secure feeling about the outcome.

3. Conflicts in emphasized need. Those who perceive a particular physical need as extremely important and are consequently doing all they can to meet that need (for example, a community recently devastated by a major flood and seeking flood control) may come in conflict with others who are trying to meet some other need (such as irrigation water). If both groups are planning from the same viewpoint (different agencies in the government of the same state), the need is to improve coordination among units within the administrative structure, a phenomenon of growing importance as the complexity of government increases. The need for inter-

federal agency coordination resulted in creation of the Water Resources Council at the national level, inter-agency river basin commissions at the state and regional level, and other appropriate coordinating units. The need to coordinate water with land planning, however, has not been resolved. Those planning for flood control communicate much better with those planning for irrigation that with those planning for parks or mineral development. The second pair of administrative units may be so far apart in a governmental hierarchy that new coordinating mechanisms have to be established and, what is often worse, the disciplines predominating in the two units may vary so greatly in professional values that a new common language has to be established for exchanging viewpoints.

4. Conflicts in time perspective. The various participants in the planning process operate from various time perspectives. Professional water resources planners characteristically think of project justification in terms of 50 or 100 years, whereas the politicians making the choices often emphasize accomplishments to be achieved by the next election. Professional water resources planners characteristically design from an assumption that the public using project output (protected flood plain land or irrigation water) will respond to that output as seems wise from the public planning perspective, when in reality those in business in the private sector expect a higher rate of return on their investment and payback over a shorter planning horizon (Grant and Ireson, 1970, p. 456-493). The various discount rates used by different planning jurisdictions (normally ranging from high values in the private sector to low values in government) are a manifestation of this variation in time perspective that causes a great deal of difficulty as the various planning jurisdictions attempt to implement conflicting plans. Local government is often required by law to pay back borrowed money within a period much shorter than 50 years. Hydroelectric power developments, which are frequently planned by the private sector, are characteristically formulated from a different time perspective than are other types of water projects. Land use planners also tend to plan for a shorter time period than do water resources planners.

Very little has in fact been done in response to the problems caused by these conflicts in time perspective. Adjustments are made to the private or market value of land to estimate an equivalent public value for planning purposes (James and Lee, 1971), and other similar adjustments are also made by planners in the public sector. These, however, do not get at the more fundamental problem of a difference in time perspective causing projects to be undertaken in the public sector even though they would be rejected as unprofitable by the private sector (Hirschleifer et al., 1960). A more general solution would require economic

incentives that actually bring private sector planning more in line with general welfare criteria.

Conflicts Among Dimensions

1. Time-value conflicts. Values change with time. The irrigation program of the Bureau of Reclamation was in part established to move people out of the congested, industrialized east to settle uninhabited areas. Today, the first and fourth states in population are in that then under-populated area. In the 1950s, structural water resources development was very popular, and many were strongly pushing a low social discount rate so that more water development projects would be built for the benefit of future generations. A generation later, the shift in values from an economic to an environmental emphasis has created a situation where many would be happier with fewer dams. The use of present values for long-term planning is in effect assuming that people from now to the planning horizon will continue to hold the same values that they hold today. Recent experience shows that values are not stable, and the danger of distorting the desires of those who come after us increases as planners shift from economic criteria to other and more volatile values in multiple objective planning.

2. Time-viewpoint conflicts. The goals of those operating from a particular jurisdictional viewpoint change with time. Individuals tend to pursue more basic human needs in poverty situations and personal fulfillment needs when they become more affluent (Maslow, 1954). Special short-run situations may cause deviation from long run goals. Governments change goals as elections replace decision-makers. While all these groups are free to change their opinions, water projects require a financial commitment and an operating schedule for dividing project outputs (conservation versus flood control storage within reservoirs for example) that cannot easily be changed with time. Major projects must be reauthorized at the congressional level before changes in the allocation of stored water among beneficiaries can be made. One of the major planning issues of coming years is likely to be how to maintain the flexibility of project operation required to maximize achievement of planning objectives and yet to achieve the stability required to honor financial commitments and contractual obligations to the original project beneficiaries.

3. Time-need conflicts. Water planning in the United States has passed through periods emphasizing inland navigation, irrigation, hydroelectric power, flood control, and now water quality control (James and Rogers, 1976). These changes in needs have occurred in response to advances in transportation technology, the harnessing of electrical energy, climatic cycles bringing concentrated periods of floods or droughts,

alterations in net food supply, and the need for the public to protect itself against the external effects of polluters who do not consider others in their waste disposal decisions. Each need has lead to an institutionalized system for installing the reservoirs, treatment plants, zoning legislation, etc., required to satisfy it. These systems have grown into large organizations that are often slow to change with shifts in public need, particularly when such shifts would reduce the role of the organization. The removal of outdated institutional structures is exceedingly difficult to implement in the public sector.

4. Value-viewpoint conflicts. Individuals, corporations, localities, states, and the federal government have different value perspectives. The federal government is now officially committed to planning from the twin objectives of economic development and environmental quality. The other viewpoint levels and elements at a given level have not formally defined their planning values and vary greatly among themselves in preferred objectives. In fact, one of the basic strengths of the American system of government is that it provides a structure for different elements in society to pursue different objectives and to reconcile conflicts among their courses of action. The federal government, the state, and the community can each study a water resources planning or management situation, come to their own conclusion on what action is best, and then arbitrate their differences. In practice, however, the system has been greatly handicapped by the much greater expertise and financial resources available to the federal government, making it impossible for the other viewpoints to negotiate on an equal basis. The recent trend away from federal structural measures and toward state and local actions (structural as well as nonstructural) to fill the vacuum is working in the opposite direction.

5. Need-viewpoint conflicts. Those operating from different jurisdictional viewpoints tend to meet needs through the types of action with which they are most familiar or best able to implement. For example, individuals develop parcels of land and decide on their use of water project outputs. Corporations make similar decisions at a larger scale; communities adopt land use and utility service plans; states regulate water rights and water quality standards; and the federal government constructs large water development projects. Furthermore, our constitutional form of government limits what each level can do. The federal government cannot engage in land use zoning, and private parties cannot build large projects. Furthermore, those planning to meet a given kind of need are predisposed toward the set of alternatives commonly used for achieving that purpose and are unlikely to think of working with those meeting other needs in a multi-purpose solution. Consequently, plans tend to take on characteristics popular with those

planning in the jurisdiction with primary responsibility even where some other type of plan may be more efficient. As examples, the Corps of Engineers has built large flood control structures where flood plain zoning may have produced greater net benefits, and may individuals continue ventures that they find profitable even though another less familiar venture might be even more profitable.

6. Value-need conflicts. Those working to satisfy particular needs tend to emphasize values that they perceive as most likely to develop support for their cause. Economists have complained that their skills are used to sell rather than to select projects (Smith, 1974); and in recent years, economic arguments have been used by environmentalists to strengthen opposition to projects they oppose. The basic problem is that the public and its politically-chosen decision makers are generally unwilling to select how the total water resources budget should be divided among needs nor how the budget for a particular need (municipal water supply for example) should be divided among projects based on the results of an impartial multiple objective analysis of the alternatives. The decision making is in reality based on other criteria or values. Formal value statements (such as the principles and standards released by the Water Resources Council) in this setting become tools for selling what has already been decided as needed. For example, water quality control measures are not planned on the basis of these principles and standards and are justified to the public on the grounds of the fundamental importance of environmental protection. Water quantity supply measures are now relatively much less salable in terms of intrinsic merit and consequently are justified, but less often successfully so, on the basis of the principles and standards. If a detailed analysis shows that continuing to pollute a stream is better than to treat the wastes, environmentalists are much more likely to start looking for flaws in the methodology than to be convinced.

7. Higher-order combinations. The relational framework of values, viewpoints, needs, and time components is used above to classify institutional obstacles to water resources planning within a given component or between pairs of components. One can also visualize obstacles created by higher-order conflict situations generated by simultaneous differences in three or even all four components. Qualitatively, these conflicts represent combinations of factors outlined above. Quantitatively, however, the more complexity that exists in a conflict situation, the more powerful the obstacles to rational resolution become. More areas of disagreement provide those taking extreme positions more lines of argument to prevent compromise and provide more points requiring compromise.

In such multi-component conflict situations, greater external pressure is required to force a compromise resolution of the issues, and the nature of the compromise reached is less likely to depend on merit. Each component has elements that tend to dominate, but those dominating change over time. The federal government usually dominates the viewpoint component, at least in cases where the key federal agencies believe it their mission to do so. Water quality control has been moving to the front as the dominant water planning purpose, but the juxtaposition between water and land planning is not yet clear. One senses a growing attitude, however, that water planning has had its chance and failed and that land planning is the upcoming favored cureall to national ills. Economic development was long the dominant planning goal and probably still is even at the federal level where environmental quality is nominally but not operationally equal.

Conflicts in Gaps Between Components

The existing institutions for water and related land resource planning have evolved in response to the needs for action that people have seen and worked together to implement. Technological advance, resource depletion or degradation, population shifts, changes in world economic or political conditions, and a number of other factors are, however, continually generating new requirements for water resources management that do not fall directly within the values, jurisdictional viewpoints, and needs emphasis of the prior institutional framework. Water quality control and groundwater management in humid areas where supplemental irrigation is expanding illustrate needs that water planning institutions have recently had to expand to accommodate. Where water problems crossed previous jurisdictional boundaries, river basin commissions, interstate compacts, and regional commissions of local governments have had to be established. The recent environmental movement was able to add a new environmental quality perspective to an institutionalized system that previously placed little emphasis on these factors.

These efforts have been able to achieve the political clout to change the system but only after a period of time. One wonders what planning inefficiencies occur during the period required to effect the change and what inefficiencies continue to occur because worthy needs are unable to change the system. Some of the gap areas that are probably more significant include tributary land use management to minimize downstream flood and water quality problems in urban areas, water and power conservation programs, water quality control strategies relying on methods other than treatment, and provision for variation in water quality or flood plain land use standards according to the needs of the local community.

16

Institutional Response to
Identified Problems

The above framework and discussion suggests the principal institutional obstacles to effective and coordinated water and land resource planning as 1) limitations in available factual information that make it possible for special interest groups to sway public choice through biased presentation of the alternatives, 2) viewpoint and time perspective differences among planning sectors (public v. private or national v. local) that cause conflicting land and water use policies, 3) the inability of the top decision-making levels to deal effectively simultaneously with more than one problem at a time (other problems are being relegated to the background now that water quality control is the central focus), 4) insufficient recognition of the magnitudes of the changes in values, viewpoints, and needs that occur over the long planning horizons (50 or 100 years) typically used for water and land resources (one can consider the difficulty a planner in 1880 would have in formulating projects to meet the needs of today), 5) the formal commitments during plan implementation that make subsequent beneficial change very difficult, 6) the concentration of planning funds and expertise in groups of biased viewpoints or constrained perspective, 7) gaps between planning and implementation agencies that favor plan selection to be based on familiarity or legal authority rather than merit, 8) use of planning capabiity to prepare cases for selling plans already selected rather than to gather facts that can be used to compare the merits of possible alternatives, and 9) problem areas that are not properly handled because they either fall in the gaps between responsibilities in the institutionalized system or become a source of conflict because more than one element perceives responsibility.

One observation of the total land and water management process would be that the nine institutional obstacles are more effective in preventing plan implementation than plan formulation. A skeptic of the planning process could make a good case for a claim that most comprehensive planning never leads to implementation, that the forces creating the nine obstacles never appear as strong during planning as they are when implementation seems imminent (people do not respond to hypothetical alternatives in the same way that they will later to real conditions), and that therefore one needs rather to work on improving management practice by beginning from (more limited) plans that are being implemented. "Comprehensive planning" would be better advised to drop its search for an idealistic optimal management scheme and concentrate on devising implementable actions that could improve what is occurring. Planning should concentrate on implementable, incremental improvements. The logical conclusion to this reasoning is that the "levels-of-analysis" obstacles to comprehensive river basin planning are unneces-

sarily aggravated by an inappropriate planning strategy. The ideal or ultimate plan should be only a goal for use in judging proposals or observed activity within the basin. The emphasis within the planning process should be to identify a limited number of priority actions to be promptly implemented.

On the whole, land and water planning institutions have been responsive to problems that they could solve within a single administrative structure (multipurpose projects for example) but have not been effective in solving problems requiring conflict resolution or cooperation between decision elements. Conflicts severe enough to gain public attention rise to and are eventually resolved in the political arena (for example the allocation of Colorado River water among the basin states or the one-time failure of federal flood control agencies to make sufficient use of flood plain management), but many lesser issues are never resolved. Often, no part of the institutional structure really feels responsible for consequent delays or inaction.

The existing system is not good at resolving conflicts among separated agencies. Technological advances (for example upgrading from the rational method to watershed modeling for estimating flood peaks) are only slowly adopted by professionals or agencies established in previous methodologies. When problem solving requiring changes to existing institutions, implementation is an order of magnitude more difficult. Carefully organized research to identify the basic causes of resistance to technical innovation and institutional change within the water and related land resources planning arenas is sorely needed. The problems outlined above provide a good list of needed changes that are not bringing needed responses and thus a good starting point for needed research.

Recommendations For Dealing With
Institutional Problems

One reason that the above institutional obstacles are more effective in preventing plan implementation than in preventing plan formulation is that planners become so attached to their recommendations that they do not recognize legitimate opposition and fail to give proper consideration to other viewpoints. Special effort needs to be made to understand the opposition to plan implementation. PROPDEMM provides a powerful tool that can be used for this purpose by bringing out specific issues of controversy that need to be resolved in solving the levels-of-analysis problem.

One of the pervasive difficulties with comprehensive river basin planning as currently practiced in the United States is that it is interpreted as requiring a general comprehensiveness that cannot be delivered. Consequently, few practical results appear,

the public becomes disillusioned by planners, and the funds required for planning are threatened politically.

Once problem elements are identified, one needs to consider the alternatives for dealing with each one. Here again Figure 2 is helpful. If the planner uses it to distinguish differences in who is acting to achieve what physical changes in pursuit of what basic goals, he can then analyze the situation to identify alternatives that dissatisfied actors might find equal or even prefer. The situation may be resolved by providing such information to the key parties. Failing identification of equivalent or preferred alternatives, the planner could at least fall back to the alternative involving minimum net sacrifice from the previous position.

One of the root causes of difficulty in water resources planning practice is that the political decision making system often has good reason for not waiting for a comprehensive and objective analysis before selecting a course of action. In a situation of partial information, those operating from more powerful levels of analysis have been able to fill in the unknowns with assertions favoring their judgment or have developed decision making institutions that 1) produce decisions that they regard favorably or 2) keep things working smoothly enough to avoid unpleasant confrontations. They then perceive institutional change as a threat to this desirable state of affairs and resist change efforts.

A second root cause lies in the limitations of human capability to absorb complex information and use it in rational decision making. This also leads to biased selection of information and the same sorts of differences in conclusion depending on the level of analysis.

The logical response to this situation is to develop more factual information relevant to water and related land resources decision making and to present that information in a way that those at the various levels of analysis can understand. Specific research thrusts might address 1) more comprehensive development of factual information with particular emphasis needed in the environmental and social areas, 2) incentives to minimize rather than aggravate viewpoint differences, 3) methods for institutions to deal with many problems simultaneously, 4) methods for coping with time changes in viewpoints and needs, 5) ways to introduce

new flexibility into the commitments required at project implementation, 6) more equal distribution of planning resources among the various viewpoints, 7) more equal capability for implementing the various possible measures, 8) greater commitment to search out facts for evaluation by merit rather than sell previously made decisions, and 9) more complete coverage of the spectrum of planning needs.

As progress is made on doing a better job of getting the facts together, levels of analysis differences will be reduced toward those based on differences in values. The next research need will then be in the area of developing a better system for resolving value differences either through compromise in decision making or through providing for greater diversity among the various segments of society without undue adverse external effects on one another. Another key component to better value-difference resolution is deriving ways to accelerate the decision-making process toward more timely responses to decision needs.

Summary

This chapter began exploring the levels of analysis problem in water resources planning by defining planning as a threefold process combining selection, design, and implementation of a worthy alternative and by outlining the planning process. A description of how this process has worked and how it has responded to the need for change with time showed how the changes required to make the process work better that can be made without causing confrontations among existing planning groups have largely succeeded but that changes whose implementation would lead to intergroup conflict have seldom come to pass. Such stalemate situations are resulting where different groups are taking different actions to achieve different objectives from different jurisdictional viewpoints and addressing different time frames. Nine principal institutional obstacles to effective and coordinated water and related land resources planning were enumerated from these conflicts and analyzed. The result was recommendations for research and findings application to 1) develop the factual information that will help planners overcome these obstacles and 2) quickly resolve the value conflicts remaining once the facts are known. This generalized analysis together with the specific problems identified in the Colorado River Basin provide a basis for more detailed investigation into levels of analysis problems.

CHAPTER III

ISSUES AND INSTITUTIONS FOR WATER RESOURCES PLANNING IN
THE COLORADO RIVER BASIN, UTAH, AND THE UINTAH BASIN

Introduction

The first step in developing a working
understanding of real world experience with
levels of analysis problems was to identify
such issues in the history of water planning
for the Colorado River Basin. The water of
the Colorado River is the lifeblood of the
arid Southwestern United States where it sup-
plies major needs in seven states (Colorado,
Wyoming, Utah, New Mexico, Arizona, Nevada,
and California).[1] The primary source areas
for runoff in this desert climate are the
high mountain areas near the crest of the
Rockies and in scattered other intermountain
ranges. These areas constitute such a small
fraction of the total basin that the Colorado
produces less water per unit area than does
any other major river basin in the country.
The runoff is collected from these mountain
ranges and carried 1440 miles from the head-
waters to the Gulf of California along a
route where water, because of its scarcity
in the desert, is extremely valuable for
agriculture and municipalities.

Despite this competition for water with-
in the basin, the concentration of water in
the Colorado River has proved very attractive
to cities outside the basin. The river
serves 2.5 million people who reside in the
basin and 12.5 million people through water
exports to the metropolitan centers of
Denver, Salt Lake City, Los Angeles, and San
Diego. It supports wildlife and recreation in
areas of unparalleled aesthetic value, and at
the same time supplies water for cities,
irrigated agriculture, energy production,
industry, and mining.

Table 1 generalizes current land use-
water use relationships within the Colorado
River Basin. The two principal water de-
pletions are seen to be the large water
exports and irrigated agriculture Although
irrigated lands occupy only 1.8

---

[1]Since many recent and generally
available reports contain detailed physical
descriptions of the Colorado River system
(Bureau of Reclamation, 1971, 1974, 1975;
Bishop et al., 1975; Bishop, Chambers, Mace,
and Mills, 1975; Water Resources Council,
1974; Lichtenstein, 1977), only a brief
overview is presented here.

percent of the basin, they account for 40
percent of the consumptive use. This estab-
lished agricultural use, which has histori-
cally been in competition only with limited
municipal use within the basin is now
experiencing pressure from a new and develop-
ing water demand for energy resource extrac-
tion and processing.

As the principal source of water in
seven arid states, it is not surprising that
issues of Colorado River water management
have generated much political heat, and that
many actors and institutions have been
involved at national, multi-state, state, and
substate levels. This complex institutional
history, can be reviewed for implications for
solving problems in levels of analysis from
three different levels or perspectives: the
Colorado River Basin as a whole, the State of
Utah, and the Uintah Basin in the north-
eastern corner of Utah.

The discussion is organized under two
main headings: Issues and Institutions.
Under the heading of "Issues," attention will
be given to water allocation, Indian and
federal water rights, water development
projects, energy development, 160-acre
limitation, water quality, and the 1976-77
drought. Under the heading "Institutions,"
attention will be given to the institu-
tional actors and institutional settings in
which these issues have been debated and
resolved.

Issues

Water Allocation

Until just the last 10 or 15 years, the
"Law of the River"--an amalgamation of
statutes, compacts, treaties, court deci-
sions, contracts, regulations, and adminis-
trative rulings--has dealt almost entirely
with allocation and development of the waters
of the Colorado River Basin. The allocation
system for the Colorado River and its tribu-
taries operates at four levels: inter-
national, interregional, interstate, and
intrastate.

At the international level, a formal
division of water between the United States
and Mexico was accomplished by the Mexican

Table 1. Summary of land and water use in the Colorado River Basin.

	Land Use[1]		Water Depletions[2]	
	Acres x 10^6	% of Basin	AF (1000's)	% of Total
Rangeland	95.1	58.3	a	-
Forest	57.4	35.2	a	-
Agriculture				
Irrigated	2.9	1.8	3,636	40
Dry	1.0	0.5	a	
Urban (M&I)	0.9	0.5	255	3
Other	3.2	1.9		
Water Surface	1.4	0.8	(evaporation)	
(water export)	-	-	5,189b	57
(fish & wildlife)			39	-
	163.0	100.0	9,119	100

Source: [1]Water Resources Council (1971).
         [2]Salinity Control Forum (June, 1975).

aOn-site use of precipitation.
bOf this, 4,538 maf are exported to Southern California, of which about 1 maf are diverted by the Metropolitan Water District of Southern California primarily for M&I use, and the balance by the Imperial Irrigation District and the Coachella County Valley Water District predominantly for irrigation use.

Water Treaty of 1944. Mexico was guaranteed an annual amount of 1.5 maf, except in times of extreme shortage.

At the interregional level, the 1922 Colorado River Compact divided the basin states according to whether the drainage entered the river above or below Lee Ferry, Arizona, into the Upper Basin (composed of the "upper division" states of Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin (composed of the "lower division" states of Arizona, California, and Nevada). Some of the area in Arizona is in the Upper Basin while small parts of Utah and New Mexico are in the Lower Basin. The Compact assured the Lower Basin that depletions by the Upper Basin states would not prevent at least 75 maf of aggregate flow per ten-year period from reaching the Lower Basin at Lee Ferry. The Lower Basin received a guaranteed ten-year (not annual) minimum flow; the Upper Basin became the guarantors. At the time of the compact, the available record of measured streamflow was very sparse and average annual virgin flow was estimated to be in the range of 15 maf. One of the major problems has been that this estimate has proved too high. Average annual flows have been about 13 maf.

Allocation of Colorado River water at the interstate level was achieved by the Upper Colorado River Basin Compact of 1948 (for the Upper Basin states) and the Arizona v. California Supreme Court case of 1963 (for the Lower Basin states). The 1948 Compact allots to Arizona 50,000 acre feet per annum

and apportions the balance of the annual consumptive use available to the Upper Basin to Colorado, 51.75 percent; to New Mexico, 11.25 percent; to Utah, 23 percent: and to Wyoming, 14 percent. The Arizona v. California decision divided the total of 7.5 maf available in an average year to the Lower Basin by giving California an annual entitlement of 4.4 maf; Arizona, 2.8 maf; and Nevada, 0.3 maf. Utah and New Mexico can use water originating in their small portions of the Lower Basin area. This decision affirmed the allocation among the three states made by the Boulder Canyon Project Act of 1928.

At the intrastate level, the beneficial consumptive use of water has been allocated through the creation and recognition of state water rights. Although the water rights systems of the Colorado River Basin states differ in certain respects, all of them are based on the "appropriation doctrine," which was described by the National Water Commission in its Water Policies for the Future (1973) as follows:

The basic tenets of that system are that (1) a water right can be acquired only by the acquiring party diverting the water from a water course and applying it to a beneficial use and (2) in accordance with the date of acquisition, an earlier acquired water right shall have priority over other later acquired water rights.

Water in excess of that needed to satisfy existing rights is viewed as unappropriated water available for appropriation by diversion and application of the water to a beneficial use. The process of appropriation can continue until all of the water in a stream is subject to rights of use through withdrawals from the stream. (p. 271.)

Assuming 15 maf/year as the average flow, Utah's share of Colorado River water is about 1.4 maf/yr (0.23 (15.0 - 7.5 - 1.5)). The Utah Division of Water Resources estimates that current depletions from the Colorado River Basin in Utah are about 700,000 acre feet. This leaves about 700,000 acre feet not currently being used; however, the State Engineer has estimated that the exercise of additional approved filings, including those which have been approved for the Central Utah Project, would deplete Utah's entitlement by another 600,000 acre feet. In addition, a substantial number of filings are awaiting action by the State Engineer. Although no definitive tabulation of these unapproved filings has been made, they are believed large enough that if they were approved and exercised the total water use would exceed Utah's compact entitlement. For all intents and purposes, therefore, Utah's share of Colorado River water has already been appropriated.

Three major tributaries (the Green, the Yampa, and the White Rivers) join the Colorado River in the Uintah Basin. Although Colorado has agreed that Utah is entitled to 500,000 af/yr from the Yampa, no quantitative agreement has been reached concerning Utah's entitlement from the White. Utah's share from the Green (flowing from Wyoming) is also an unsettled issue.

Indian and Federal Reserved Water Rights

By a statute enacted in 1866, the United States is recognized as the original owner of the vast public domain in the West. Over the course of time, the federal government has set aside large tracts of land for national parks and forests, wildlife refuges, and other uses. When a tract of land is reserved from the public domain for some such purpose, the government also reserves sufficient water from sources pertinent to the reserved land to accomplish that purpose; the water thus reserved is the federal reserved water right. Unlike the appropriative right that other water users obtain from state government, the federal right remains valid even if the water is not actually used (the "use it or lose it" principle does not apply).

The heart of the federal reserved water rights problem is that many water users, whose right is junior to the 1866 federal statute, fear that the water that they have

been able to use for years because the federal government has not been exercising its right will be lost as the U.S. chooses to utilize the full quantity of its right. The unresolved issue has created an atmosphere of uncertainty and controversy in which the Carter Administration expects to move expeditiously to identify areas where federal use is of highest importance and to quantify reserved rights consistent with the priorities set out.

Indian water rights reserve water for Indian reservation land. Like federal reserved rights, Indian water rights cannot be lost through nonuse. Also like federal reserved rights, most Indian water rights have not been quantified.

There is a strong pressure from all parties-at-interest to resolve the uncertainty in this situation. Administration policy favors quantification through negotiation and the use of federal (not state) courts to litigate Indian claims when negotiations are not successful. The preference for solving the issue of Indian water rights claims through administrative means appears to be widespread. The Senate Select Committee on Indian Affairs introduced (in 1978) a bill to remove certain legal obstacles to tribes and states interested in entering into compacts or intergovernmental agreements. A National Conference of State Legislatures (NCSL) task force, composed of state legislators and tribal representatives, proposed the establishment of a commission to explore and test on a pilot basis forms of intergovernmental cooperation (coordination, mediation, conciliation) at the state-tribal level. In addition, the National Association of Counties (NACO) is collaborating with the Civil Service Commission and the National Tribal Chairmen's Association to initiate an effort which would experiment with such intergovernmental form of cooperation at the tribal-county level. These initiatives reflect a dissatisfaction with judicial or single, blanket legislative approaches to solving the complex and highly diversified jurisdictional problems involving the Indian tribes.

The issues of Indian and federal reserved water rights are of great importance for the Uintah Basin. Exercise of the federal reserved water rights for the Flaming Gorge National Recreation Area, the extensive Forest Service land in the Uintah National Forest, and BLM land holdings could, when quantified, add up to a substantial claim. The Indian water rights claim by the Ute Tribe on the Uintah and Ouray Reservation is also substantial. The Utes claim 129,201 acres of irrigable land on the reservation, for a minimum entitlement of 387,000 acre feet based on 3 acre feet of water per irrigable acre.

The tribe signed an agreement in 1965 to defer some of its water rights until 2005 so the Central Utah Project (CUP) could proceed.

But several tribal members objected and sued the CUP in order to insure that Indian water needs will be met before CUP water is exported to the Salt Lake City metropolitan area.

Water Development Projects

The Colorado is one of the most highly regulated rivers in the world. Its many dams and reservoirs, water diversion and conveyance systems, and aqueducts for out-of-basin exports are the product of a long history of interaction between water planners, decision makers in the political arena, and the public.

From the passage of the Reclamation Act of 1902 to the present time, major water development projects in the basin have, for the most part, been undertaken through the Bureau of Reclamation. Local institutions have worked through their representatives in Congress and state water agencies in getting the federal government involved. Federal subsidies have been an important factor in making projects financially feasible. Irrigation development has had strong public support in the basin states and has been supported nationally as part of an equitable apportionment of funds for regional development. State agencies have played important political roles in the process, as have multi-state coalitions such as the Upper Colorado River Basin Compact Commission, working to resolve conflicts, build coalitions, and get facilitating legislation through state legislatures.

The variability of annual flows has been an important stimulus for construction in the Upper Basin. Since a growing population and economy cannot be maintained with an undependable water supply, legislation was enacted to provide for the construction of storage facilities to minimize the impact of yearly flow variations (Boulder Canyon Project Act of 1928, Colorado River Storage Project Act of 1956, and the Colorado River Basin Project Act of 1968).

Prior to passage of the Colorado River Storage Project Act of 1956, most water development projects served the Lower Basin. Determined to develop and beneficially use its apportioned share of Colorado River water (California has consistently used far more than its 4.4 maf entitlement) and fearful that nonuse might result in the loss of its entitlement, especially in view of the increasing severity of the problem of salinity, the Upper Basin has since pushed hard for completion of the numerous projects authorized under the Storage Project Act (including the Central Utah Project in Utah which involves several units of special significance to the Uintah Basin). The Bureau has invested over $380 million in the State of Utah, much of it allocated to construction of Flaming Gorge Dam and the Vernal Unit of the Central Utah Project.

The political controversy associated with water project in the Colorado River Basin became more heated the Carter Administration announced its "hit list" in the spring of 1977. Dismayed by the large backlog of projects,[2] the very substantial federal outlays that would be required to implement these projects, and the belief that many of them were uneconomic or environmentally unsound, President Carter ordered a review of 342 projects. After an initial screening, 32 were selected for extensive study (with public hearings). Of these, nine were recommended for continued funding, five for modification, and 18 for deletion. While the Bonneville Unit of the Central Utah Project was one of the nine "reinstated projects," three Colorado projects (Fruitland Mesa, Savery-Pothook, and Narrows) were among the 18 recommended for deletion. The House Appropriations Committee approved only six deletions (including the three Colorado projects), but put the other 12 back in the bill which the President reluctantly signed in October 1977.

The water projects issue flared up again when the President transmitted his recommendations for new project starts to Congress in June 1978. While the President's recommendations for new construction starts included 17 Corps of Engineers projects and nine Bureau of Reclamation projects, noticeably absent were Fruitland Mesa, Savery-Pothook, and Narrows (in Colorado) and the Uintah and Upalco Units of the Central Utah Project.

The House Public Works Committee produced a bill that far exceeded the Administration's recommendations. It provided for 53 new construction starts (27 more than those recommended by the President) at a cost of $1.8 billion. Included were the (above) three Colorado projects and the Uintah and Upalco Units of the Central Utah Project.

Dismayed by the reappearance of the six projects that had been deleted the previous year, the absence of funding for the Water Resources Council (which he wished to play a key role in implementation of his water policy), a provision that would mandate the hiring of more than 2,300 new Corps and Bureau employees, and the high price tag, the President vetoed the bill in October 1978. Failing to override the veto, a substitute bill consistent with the President's desires was hurriedly passed and signed into law.

Since the President's recommended new construction starts sought to follow the project evaluation criteria articulated

---

[2]Thirty Bureau and 233 Corps projects with construction underway; 17 Bureau and 254 Corps projects authorized but not funded; and numerous other projects in various stages of planning.

in his June 1978 Water Policy Message to Congress, the successful veto perhaps signals greater use of objective analysis and less of "porkbarrel" water politics in funding decisions. Since the Uintah and Upalco Units of the Central Utah Project--authorized two decades ago in the Colorado River Storage Project Act--have not been approved for funding, it appears likely that these projects will have to meet the standards discussed in the next section.

Water Policy

In his June 1977 Environmental Message to Congress, President Carter announced that he was directing the Water Resources Council, the Office of Management and Budget, and the Council on Environmental Quality to undertake a comprehensive review of water resources policy, The review would cover criteria for project planning, cost-sharing arrangements, conservation strategies, and other matters continuing a long series of previous efforts to establish a uniform national water policy. Early investigations in the Carter review revealed that 25 separate federal agencies collectively spend more than $10 billion per year on water resources projects and related programs. Furthermore, states are primarily responsible for water policy within their boundaries and yet are not integrally involved in setting priorities and sharing in federal project planning and funding.

In order to improve planning practice and achieve more efficient management of federal water resources programs, the President announced in a message to Congress in June 1978 that he would direct the Water Resources Council to 1) add water conservation as a specific component of both the economic and environmental objectives of the Principles and Standards; and 2) require explicit formulation and consideration of a primarily nonstructural plan as an alternative to each structural water project planned.

Additional announced criteria were that projects 1) be actively supported by state and local officials; 2) require a state financial contribution above existing cost sharing; and 3) provide for recovery of federal and state costs (when vendible outputs are involved).

160-Acre Limitation

The 1902 Reclamation Act limits the delivery of federal reclamation water to farms of 160 acres or less and requires that the owner of the farming operation actually live on the land. Both the 160-acre limitation and residency requirement have been unpopular and generally not enforced.

In compliance with a directive from the U.S. District Court in the District of Columbia, Interior Secretary Andrus proposed rules and regulations (in August 1977) for their enforcement.

Witnesses participating in the hearings held throughout the West on the proposed rules and regulations were generally opposed, even though approximately 90 percent of the acreage in the 17 Reclamation states meets the 160-acre limitation. The widespread opposition led to a new Administration policy presented by Secretary Andrus to Congress in April 1978. This policy would increase the individual acreage from 160 to 320 acres; require that an individual must live within 50 miles and be involved in the farming operation to be eligible; disallow minor children as eligible for acreage allotments; allow an individual with less productive land within a project area to receive additional land to achieve "equivalency"; allow an individual to lease up to one-half of his allotment or to acquire up to 480 acres through an ownership/lease combination; set the maximum amount of acreage in single operations eligible for reclamation project water at 960 acres; allow partnerships if they meet the size, residency, and farming involvement requirements; and allow the sale of excess land to family, neighbors, and long-term tenants and employees and otherwise require the sale of land by lottery.

Energy Development

The Colorado River Basin contains large energy resources. There is more oil in the shale deposits of northwest Colorado, northeast Utah, and southwest Wyoming than in all the Middle East. The Colorado plateau of Colorado, Utah, and the Navajo Reservation has 95 percent of all the uranium in the country. The total amount of sub-bituminous and lignite coal in the region is estimated to be 1.3 trillion tons--enough to provide the U.S. with fuel, at its present rate of consumption, for more than three centuries (Bureau of Reclamation, 1975).

The Uintah Basin itself contains vast reserves of oil shale, tar sands, coal, oil and gas, and some uranium. The "oil boom" began in the area in the mid-1960s and is still going strong. Two large tracts of land in the basin were selected by the Department of the Interior as prototypes for oil shale development. The leases on these tracts are held by the White River Shale Oil Project (Sun, Sohio, and Phillips). Much of the basin's energy resources are on the Uintah and Ouray Reservations.

Estimated production from the oil shale deposits is 300,000 bbl per day by the early 1980s, increasing to 2.8 million bbl per day by the mid 1990s (Bureau of Reclamation, 1975). Bishop et al. (1975) has estimated that, under current technology, a 100,000-bbl/day operation would require about 17,000 acre feet of water per year. Keith,

Andersen, and Gardner (1975) estimated the consumptive use of water required for energy development to total between 700,000 acre feet and 2,300,000 acre feet.

Approximately 90 percent of water use in the Colorado River Basin now occurs in the agricultural sector. When energy companies can afford to pay $400 or more for an acre foot of water that benefits farmers by amounts in the $7-16 range, significant shifts in water use from agriculture to energy can be expected, provided that the institutional environment (state water use priorities, prohibitions on intersectoral transfers, level of federal subsidy to agriculture, cost sharing arrangements for new projects, etc.) does not impose prohibitive limitations.

A shift in water use from agricultural to energy development will have significant economic, environmental, and social impacts. With respect to environmental concerns, energy use may improve or degrade the water quality depending on the extraction and processing technologies selected for the energy resource. Transfers to energy uses which have a high return flow would increase water quality since the energy use would not pollute the water and the leaching of salts from irrigated cropland would be reduced; however, transfers to consumptive energy uses would provide less water for dilution and thus reduce water quality. Many other economic, environmental, and social impacts could be cited which are just as important.

Water Quality

In the first half of the century, siltation was regarded as the most serious water quality problem in the basin. While soil conservation practices and the sediment trapped in reservoirs have reduced siltation problems, increased leaching of soil salts, reservoir evaporation, and diversion of fresh water from the basin have caused the problem of salinity to grow steadily more serious. Natural systems contribute half to 70 percent of the salt load. Of the man-caused sources, most salt is contributed by irrigated agriculture. Again estimates vary, but a 1972 EPA publication estimated that 33 percent of the total salt load comes from agriculture, with only 2 percent coming from municipal and industrial sources. The Bureau's Water Quality Improvement Program contains efforts to upgrade on-farm management as a means of solving the problem, but implementation is constrained by factors from other perspectives working against farmer acceptance.

By the 1940s, salinity had become a major issue in U.S.-Mexican relations. Although the 1944 Mexican Water Treaty does not specifically refer to the issue of salinity, Mexico has repeatedly voiced the belief that the United States had obligated itself to deliver to Mexico water of the same quality as that delivered at Imperial Dam. The issue reached a head when Wellton-Mohawk drainage water and reduced flows associated with upstream development caused salinity levels in the waters reaching Mexico to increase to 1500 ppm in 1962. The Mexican government reopened negotiations that resulted in Minute 218 (1965) and an agreed reduction of salinity levels in Mexico's received waters (1240 ppm in 1971).

Still dissatisfied, however, Mexico's President Echeverria stated in 1972 that Mexico would not accept drainage water from the Wellton-Mohawk project. He further stated that the only valid interpretation of the 1944 Treaty is that Mexican farmers must receive water of the same quality as that at Imperial Dam. The following round of negotiations led to Minute 242 (1973), which called for the reduction of the salinity of water delivered to Mexico to a level no more than 115 ppm (+ 30) in excess of the salinity at Imperial Dam. This goal was to be achieved by the construction of a large desalinization plant to treat the Wellton-Mohawk drainage and led eventually to the 1974 Colorado River Basin Salinity Control Act which implemented Minute 242 and authorized a number of other salinity control projects (mostly in the Upper Basin).

Increases in salinity reduce agricultural productivity, damage equipment and plumbing, and limit the use of water in industry and municipalities. Bishop et al. (1975) estimated that salinity damages amount to about $230,000 per mg/l at Imperial Dam, and the Bureau of Reclamation (1974) shows a possible reduction of $16 per acre in net farm income for the Imperial Valley if salinity increases by 320 mg/l by the year 2000.

A new philosophy of salinity control within the United States was adopted with the passage of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). Section 402 of the Act makes the discharge of pollutants into receiving waters illegal unless the discharger has complied with the effluent limitations specified in a permit. The states are encouraged to assume responsibility for the permit program. Four of the Colorado River Basin states presently have an approved permit program. Utah is one of the three states that does not.

Section 301 of P.L. 92-500--the effluent limitation program--required that point source effluents from agriculture and industry be limited to levels achievable through application of the best practicable technology (BPT) by 1977 and the best available technology (BAT) by 1983. The goals are to make water safe for aquatic life and wildlife by 1983, and to achieve zero pollution discharge (ZPD) by 1985.

It was strongly argued by water and agricultural interests in the Colorado River Basin that P.L. 92-500 is basically muni-

cipally and industrially oriented and should not be indiscriminately applied to irrigated agriculture. Early and vigorous efforts on the part of EPA to apply the permit and effluent limitation programs to agriculture met strong resistance. There were no technically feasible salinity control measures that farmers could afford.

In 1973, EPA clarified application of the permit program to irrigated agriculture by specifying that permits would only be required when there is a point source of discharge and when the return flow is from more than 3,000 contiguous acres which use the same drainage system. The regulation was temporarily struck down in 1975 through a suit brought by the Natural Resources Defense Council, which wanted continuation of the permit requirements for small farmers, but that ruling was later overturned.

In 1974, EPA issued a regulation requiring the states to adopt numeric standards for salinity, consistent with the policy of maintaining average annual salinity levels in the lower main stem at or below 1972 levels (nondegradation) and to submit a plan of implementation not later than October 18, 1975. The Salinity Control Forum, formed by the Colorado River Basin states in 1972 to deal with EPA in implementing the Act, developed numeric standards based on the nondegradation policy and succeeded in gaining EPA concurrence in setting these standards at locations below Hoover, Parker, and Imperial Dams (as opposed to state boundaries as earlier advocated by EPA). The approved implementation plan is based on the Bureau of Reclamation's Water Quality Improvement Program, which incorporated the salinity control projects authorized by the 1974 Salinity Control Act and other salinity control measures.

The 1976-77 Drought

The winter months of 1976-77 saw spreading and deepening conditions of drought throughout the Colorado River Basin--indeed, by the spring of 1977, moderate to severe drought covered large portions of the country. Measurements of Colorado River flow at Lee Ferry in April and May showed the lowest flows in over 70 years of record.

As conditions worsened, private and public concern rose sharply and led to remarkable state and federal responses. Over 60 drought-related bills were introduced in Congress, including those making up the President's $844 million "drought package," and many existing federal programs were mobilized to deal with the problem. The result was one of the most expensive (an estimated $4 billion total) and one of the most rapidly mounted relief efforts in the nation's history. Action at the state level was no less impressive, with emergency powers being granted to governors, scores of drought-related bills being introduced in

state legislatures, and local, state, and multistate task forces being formed to develop plans and programs for dealing with the expected problem.

Despite the widespread drought conditions, the 1977 crop year was one of the best in U.S. history. A number of factors were responsible for this anomalous outcome. The soil conservation measures and added reservoir storage implemented after droughts of the 1930s and 1950s helped mitigate potential damages. Extensive groundwater pumping saved many crops. In many areas, production was up despite drought-related lower yields simply because more acres were planted. Farmers in some areas were simply lucky--infrequent rains came at the right time. Nevertheless, many farmers and livestock producers were hard hit with the greatest losses occurring in livestock and dryland farming operations.

Institutions

Survey of Interstate Institutions

The issues characterized above have a long and continuing history that has generated many contesting interests. In the process of becoming one of the most regulated rivers in the world, the Colorado has also become one of the most institutionally complex. This section describes the principal institutions and how they have interacted to determine how the waters of the Colorado are used.

Owing to the large amount of public lands in the basin and the national policy of irrigating desert areas, the federal government has exerted a strong influence on Colorado River Basin development. The Bureau of Reclamation has played a preeminent role in water project development. The Supreme Court resolved interstate allocation issues in the Lower Basin. Federal courts have been involved in the resolution of Indian water rights issues and--despite the movement to seek nonjudicial solutions in this difficult and sensitive area will no doubt continue to be involved in future decisions concerning the nature and extent of Indian water rights. The Environmental Protection Agency has played a central role in the field of pollution control and, along with the Bureau of Reclamation, has been a key actor in controversial efforts to reduce salinity levels in the Colorado and its tributaries.

While federal actions have been a dominant force in the development and use of Colorado River water, institutions within the basin have been effective in "shaping" the federal involvement. A significant portion of the basin's institutional development has occurred as a result of state initiatives and multi-state agreements. The basin's numerous water-related interests and the dynamics of "distributive water politics" have created a

large variety of multi-state organizations of which the 12 shown in Table 2 provide a representative sample.

The role that regional and state organizations have played in influencing federal policy is aptly described by Mann (1975). Adopting Lowi's (1972) concept of "distributive politics," Mann has shown how different organizations with divergent missions have banded together in loose coalitions for the purpose of realizing common objectives. Coalitions have appeared when organizations within the basin have perceived a common threat or a common benefit, and when collective action has been perceived as an effective strategy for avoiding the threat, obtaining the benefit, and ensuring that associated costs and benefits are worked out in an "equitable" manner among competing basin interests. Example coalitions and agreements have been forged to influence Congressional water project authorizations and appropriations, to minimize federal dictation in interstate allocation decisions, to ensure that federal concessions to Mexico do not compromise basin interests unduly, to ward off "unreasonable" EPA pollution standards and enforcement actions (especially in regard to salinity), and to prevent a federal preemption of the prerogatives and rights of states to manage water within their boundaries.

Example Performance of the Western
States Water Council during the
Drought Emergency

By the winter of 1976-1977 several western states had already experienced drought conditions for a year or more and initiated drought mitigation programs. As conditions worsened, the states began to turn to collective action and federal assistance. Growing concern was evident at a January 20 meeting of the Western Governors' Task Force on Regional Policy Management in which possible multi-state actions were discussed, and at a January 28 meeting of the Western States Water Council. It was decided at the latter meeting that the Council should publish a weekly bulletin, Western Drought Conditions, 1977.

These two meetings led to a third meeting on February 20, attended by the governors of 14 western states and Interior Secretary, Cecil Andrus. Three notable agreements were reached at the meeting; 1) the Secretary of the Interior would seek appointment of a federal drought coordinator in the Executive Office (Jack Watson was appointed February 22), 2) each governor would appoint a state drought coordinator and, 3) the governors would meet one week later at the National Governors Conference to consider further steps (Western States Water

Council, 1978). That meeting resulted in the formation of the Western Regional Drought Action Task Force (WRDATF), staffed by the Western States Water Council and the Institute for Policy Research.

The WRDATF was organized to serve as an information clearinghouse on drought relief programs, represent the states' interests before Congress and the Administration, and organize special studies. The prinicpal achievements of WRDATF were:

1. Weekly publication of Western Drought Conditions: 1977.

2. Coordination of state efforts with four federal agency (the Federal Disaster Assistance Administration, the Bureau of Reclamation, the Department of Agriculture, and the Corps of Engineers) programs.

3. Review from the state viewpoint of the proposed $844 million White House "drought package" and exchange of information on problems and actions of the individual states.

4. Assignment of a representative to the Office of the White House Drought Coordinator to monitor and report on Administration and Congressional drought initiatives and to prepare, publish, and distribute a "directory of federal drought assistance."

5. Formation of working groups to deal with issues and problems in the areas of crops and irrigation; livestock and rangeland; fish, wildlife, and recreation; energy, business, and industry; and Task Force Management.

6. Assignment of a member of the Utah Department of Agriculture to USDA on a temporary duty assignment to coordinate federal and state agriculture programs.

7. Initiation and organization of efforts leading to the passage and signing of a bill which gave the Secretary of the Interior authority to reallocate funds from his "water bank" program to other programs (e.g., state grants) (Western Governors' Policy Office, 1978, p. 26-27).

The significant role achieved by the states in shaping the federal drought mitigation program was made possible by establishing a temporary, special purpose multi-state organization (WRDATF) which was able to mobilize the existing resources of established organizations (Western States Water Council and Western Governors' Policy Office). As precipitation levels increased in the winter of 1977-78, the common need for the Task Force diminished; and the organization was dissolved in the spring (Western Governors' Policy Office, 1978).

Example Performance of the Western States Water Council in Influencing Carter Administration Water Policy

When the President announced a six-month study of water policy on May 23, 1977, the Western States Water Council (WSWC) obtained and disseminated information that became available prior to formal publication of the options on July 15 in the Federal Register. A draft briefing paper informed the western governors of the issues emerging, but the Council decided that it could not make a formal statement at the July 28-29 or August 1-2 hearings because of the short time period between publication of the options and the hearings (Western States Water Council, 1978).

The Western Governors' Conference convened in September in Anchorage, Alaska, with Secretary of the Interior Andrus and other federal officials in attendance. A special committee of the Council had used the additional time to prepare a briefing document to assist the governors in their dicussions with the federal officials. Many western governors perceived a threat of encroachment on state water perogatives, and saw a need for formalizing a policy to assert state interests.

Articulation of these concerns led to a meeting in Reno of the western governors with Vice President Mondale and Secretary of the Interior and a following meeting with the President in Denver. Both meetings sought administration assurance that there would not be encroachment on state and local perogatives, but the western governors remained skeptical.

The 13 executive orders of July 1978 documented the water policy decisions made by the President to that point and lead to creation of 19 task forces responsible for making recommendations on particular water policy issues. The Western States Water Council has been monitoring the progress of these task forces and has repeatedly taken the position that the implementation recommendations be brought back to a high level policy position for review (Barnett, 1979).

Because of the difficulty of obtaining informed gubernatorial response to so many water policy proposals, the National Governors' Association (with Utah Governor Scott Matheson chairing the water subcommittee) adopted 13 principles for water policy to provide the states a common reference against which future Administration policy initiatives could be measured. The WSWC worked closely with the National Governors' Association while these principles were developed.

Up to that point, the Council had refrained from expressing an official position to avoid diversive regional responses. Once a Western States' position was established, the Council became convinced that a statement was in order. One was approved in October 1978. Highlights include:

1. An appeal for maximum flexibility in the manner and methods by which states are permitted to contribute their share of water project costs.

2. An objection to the preclusion of state court adjudication of federal reserve and Indian water rights.

3. A request that the Secretary of the Interior direct federal officials to observe state water rights laws in the operation of federal reclamation projects, and to recognize the primacy of the state role in water resources allocations.

4. A call for application of conservation measures to meet site-specific needs.

5. A call for consistency in federal funding level for state planning efforts.

6. A reassertion of state primacy in the protection of groundwater supply and instream flows (Western States Water Council, 1978).

These positions provide excellent examples of state-federal differences in western water policy.

State Water Organizations

At present, water planning in Utah is performed in three distinct executive agencies: Office of the State Engineer, which is responsible for the administration of the state's water rights law; Division of Water Resources, which administers water conservation and development projects and represents Utah in negotiations involving the state's interstate waters; and Water Quality Section of the Bureau of Environmental Health, which administers the State's Water Quality Act and represents Utah's water quality interests in the Colorado River Basin Salinity Forum (Crawford and Weatherford, 1975).

The Division of Water Reosurces was assigned the task of formulating a state-wide water resources plan. The agency is active in planning small-scale water projects, assessing alternative uses for Utah's remaining unappropriated water, and looking into options on how the state can meet its future water needs.

The Water Quality Section of the Bureau of Environmental Health is responsible for state water quality planning. Several levels are involved. Under Section 106 of the Federal Water Pollution Control Act Amendments, Utah is required to submit to EPA each year a state program plan which outlines the state's principal water quality problems, reviews accomplishments during the previous year, and shows how the state will allocate resources during the ensuing year among the water quality program areas, including planning, the permit system, monitoring

Table 2. Water-related regional organizations in the Colorado River Basin.

Name of Organization	Type of Organization	Mission	Issue Identification[a]	Budget	Source of Funding
Upper Colorado River Commission	Compact Commission	Apportionment of Colorado River water uses; determine upper basin states' delivery obligations at Lee's Ferry; resolve controversies; secure upper basin agricultural and industrial development and promote related water storage projects; encourage flood control	1-7	$160,000 (FY76)	From states in same proportion as upper basin consumptive use allocation
La Plata River Compact Commission	Compact Commission	Administer La Plata River Compact; moniter and maintain stream gaging stations	1	None	Activities carried out by state engineers of member states (Colo. & N.M.)
Pacific Southwest Interagency Committee	Joint Federal-State Regional Organization	Provide means of coordination of interests, policies, programs and activities of states and federal agencies in water and related land resources investigations, planning, construction, operation, and maintenance; provide means of conflict resolution	1-7	None	Staff support and other costs provided by members
Four Corners Regional Commission	Joint Federal-State Regional Organization	Distribute and administer federal funds for infrastructure development under the Public Works and Economic Development Act of 1965	1,3,5,7	$733,295 (FY76) (Admin. Exp.)	Federal
Old West Regional Commission	Joint Federal-State Regional Organization	Distribute and administer federal funds for infrastructure development under the Public Works and Economic Development Act of 1965	1,3,5,7	$825,328 (FY77) (Admin. Exp.)	Federal
Colorado River Basin Salinity Control Forum	State Executive Branch Organization	Promote interstate cooperation on salinity and other interstate water problems	3	None	Staff support and other costs provided by members
Western States Water Council	State Executive Branch Organization	Promote cooperation among western states in planning for programs leading to integrated development by state, federal, and other agencies of western water resources	1-7	$174,000 (FY78)	Mostly from state assessments
Committee of Fourteen	State Executive Branch Organization	Advise the State Department on Colorado River salinity problems in negotiations with Mexico	1,3	None	Staff support and other costs provided by members
North American Interstate Weather Modification Council	State Executive Branch Organization	Coordinate international, interstate, and intrastate weather modification activities to attain legislative uniformity and effective information exchange while maintaining state and local control	1	$10,700 (FY76)	Membership dues
Interstate Conference on Water Problems	State Executive Branch Organization	Provide a forum for expression of states' viewpoints on water problems of common concern	1-7	$18,712 (FY75)	State assessments and federal grants

Table 2. Continued.

Western Snow Conference	Professional Association	Coordination of water supply forecasts and techniques of snow surveying watershed management, conservation and use	1	$6,000 (FY75)	Membership dues and fees for services
Association of Western State Engineers	Professional Association	Forum to discuss state water rights administration; preserve states' rights in use and control of state waters	1,3,5,7	$1,000 (FY75)	State dues, registrations, carryovers

[a]1 Water development
2 Carter Administration water policy
3 Water quality
4 1976-77 drought
5 Indian and federal water rights
6 160-acre limitation
7 Energy development

and enforcement, facilities construction, training and certification of operators, development of stream standards, public participation, and administration.

At another level, Utah has been working on basin plans for its rivers. These plans provide classifications of each segment of the streams according to waste assimilation capacities in relation to the water quality standards established by the state. They analyze future population growth and economic development and outline systematic management and regulation approaches for maximizing public benefit with minimum public expenditures.

The basin plans provide a framework for two other levels of planning, namely area-wide and facilities planning. Area-wide (or so-called "208") plans will be developed for all areas of the state having serious pollution problems. The Uintah Basin is one such area. Among other things, these plans call for the control of nonpoint sources of pollution, the protection of groundwater, and the regulation of the location and construction of any facilities which may result in pollution. In effect, Section 208 of the Federal Water Pollution Control Act Amendments calls for the integration of land use and water management planning. Facilities planning involves engineering and economic feasibility studies for the construction of wastewater treatment facilities, with the objective of integrating such facilities into basinwide waste management systems.

A closely related institutional issue is the perceived need for the integration of water and land use planning. In it final report, Water Policies for the Future the National Water Commission (1973) concluded: "Water planning is not adequately integrated with planning for the land uses that water developments are expected to serve." The Commission recommended that if Congress enacted land use planning legislation, it should provide for coordination of water planning and land use planning at all levels of government. As noted above, Section 208 of the Federal Water Pollution Control Act Amendments of 1972 also calls for an integrated planning approach.

An effort, known as the "Utah Process" was initiated several years ago in the Office of the State Planning Coordinator, to coordinate all levels of planning the state. In a 1972 report, that office summarized its accomplishments:

1. It proposes and to some degree has systematized, applied, and tested, a structure to implement and maintain a coordinated planning procedure.
2. It has designed this structure to bring into the planning process the administrators of the various governmental

agencies, agency planning specialists, and other decision makers.
3. It has made use of a planning concept (Alternative Futures) which provides for the continuing consideration of possible future events, singly and in various combinations, which can significantly alter future requirements for governmental services and the order of their priority.
4. It has evolved a means (Economic and Demographic Impact Model) by which known statistical data, in combination with anticipated but uncertain events, can be projected to obtain a more dependable picture of what the relationship of public needs and available resources will be five or ten years in the future.
5. It has evolved a planning process which at every step is oriented toward establishing an effective relationship between planning and budgeting (Office of the State Planning Coordinator, 1972).

Uintah Basin Water Organizations

Planning within the Uintah Basin combines regional efforts instigated by state government with the activities of the various counties and communities.

There are three counties in the Uintah Basin: Daggett, Duchesne, and Uintah. Each is governed by a Board of County Commissioners elected at large. by voters in the county. A measure of continuity is provided for the board by the biennial election of two of the commissioners to a four-year overlapping term. The third commissioner is elected for a two-year term.

There are four third class cities (Vernal, Roosevelt, Duchesne, and Myton) and three towns (Manila, Tabioni, and Altamont) in the Uintah Basin area. The four third class cities operate under the mayor-council form of government. In each odd-numbered year a municipal election is held in which either the mayor and two councilmen or three councilmen are elected to office.

The Ute Indians, who occupy 15 percent of the land in the area, have a tribal council form of government. The Indian lands are held in thrust by the Bureau of Indian Affairs which occupies office space in Fort Duchesne (Horne, 1973).

The three counties of the Uintah Basin compose one of seven intercounty planning districts in the state through the Uintah Basin Association of Governments (UBAG) created in 1970 to assist municipalities and counties in planning and promoting basin-wide development. UBAG also sponsors and administers federal grants and programs for

counties and municipalities in the basin and aids local officials in the preparation and revision of plans and guidelines for resource development.

The Governor in 1974 established the Planning and Development Advisory Council and a supporting Technical Committee under the direction of the Executive Director of the Uintah Basin Association of Governments (UBAG). The Council was created primarily to provide information and planning assistance for local jurisidictions, in anticipation of growth induced by energy development.

The Planning and Development Advisory Council has 13 members and consists of elected officials from cities and counties of the basin. The Technical Committee was formed as a means of providing specific data, documents, and studies to the Advisory Council. The committee provides expertise in socio-economic, environment, transportation, education, finance, water, and community service.

Observed Levels Problems

The above description of Colorado River Basin water issues brings out a number of problems in levels of analysis. In the order of the issues and institutions presented, some of them are:

1. The Colorado River water allocation has been set politically without reference to desirability in terms of the basic national water planning objectives of economic development and environmetal quality. Furthermore the negotiation process that produced this allocation was so protracted and strenuous that the parties are not interested in reopening the issues by studying the equity of the results.

2. The allocation set by water interests has major implications for the development of one of the largest sources of fossil fuels in the world. Specifically, the existing allocation may constrain energy development in ways highly detrimental to the national interest in an era of energy shortage.

3. Overestimation of average annual runoff from the basin at the time the waters of the river were legally allocated has probably worked to increase development dependent on the water and intensify conflicts among user groups. The situation provides an excellent example of the need for better coordination among dimensions in decision making (Figure 1).

4. The institutionalization of Indian and Federal Reserved Water Rights has created situations in which certain water uses are favored over others for reasons having little to do with current benefits from use and over which state and local interests have little voice.

5. People are beneficially using water which by right should go for federally reserved pruposes or use by Indians. Severe differences in opion can be anticipated should these rights be quantified (a process likely to begin soon) or exercised.

6. Indian water rights appear to be in at least partial conflict with water export to metropolitan Salt Lake City. The values to be used in resolving the issue have not been defined.

7. The institutions for water development in the Colorado River Basin have been strongly oriented toward irrigation, and much uncertainty exists as to how they will respond to growing pressure to use more of the water for municpal and energy-related uses.

8. Historical water allocation and use decisions are not in harmony with a national water policy trend toward decision making by objective criteria. Continued clashes can be expected between those promoting a common evaluative framework for all water planning and those who believe that they can better promote their interest through the political process.

9. The push by the executive branch of the federal government toward water conservation (defined as reduction in use as part of a nonstructural water management effort) runs strongly counter to the water use values of the people in the Colorado River Basin and in many respects to the physical facts of return-flow hydrology in an arid basin. The national emphasis can thus be expected to generate significant conflicts in the West.

10. The recently proposed compromise revision to the 160-acre limitation is of a sort that never makes all sides happy and is probably going to be a subject for continuing discussion. If farmers react to acreage limitations by making greater use of privately financed groundwater development, important implications would result for both water resources managment and energy conservation.

11. Since the western irrigation projects were justified in part as promoting family farming, any major shift of water use from agriculture to the large corporations engaged in developing fossil fuel resources raises important issues related to water pricing and the equity of federal subsidy.

12. The probable shift of water use from agriculture to energy is being considered in the context of fragmentary information on consequent economic, environmental, and social impacts. When people experience unanticipated impacts as these shifts are made, their policy preferences are likely to change drastically. One can expect a rather unstable water planning environment.

13. Adopted salinity standards represent another case in which management goals were established through the political process without reference to the objective analysis advocated by national water policy. The situation reinforces a state perception of a national government that does not use its own rules when planning salinity control measures in national favor but then forces states to comply with very stringent planning requirements before funding their projects.

14. The difference in goals and values between the national government and irrigators is seen in farmer resistance to federally promoted on-farm salinity control practices. The differences will have to be reconciled for decision making at the individual level to promote national goals.

15. Drought-period decision making is much less thorough than that done more leisurely at other times. When water management policy is not determined before drought conditions develop, the quickly determined water policy may prove less than adequate and yet continue for a long time afterwards. When policy is determined beforehand, drought conditions create strains among water users that put it to a severe test. Fortunately, the 1977 drought in the Colorado Basin did not reach a severity that created such a test, largely because of the extensive carryover storage available in large reservoirs from previous years.

16. Institutionally expressed state-federal water policy differences stress desires on the part of each side to increase their management responsibility and do not explicity address the problems of resolving important differences in policy preferences. The existing interstate and state-federal framework is focusing on procedural but not well on substantive issues.

17. Organizations institutionalized for planning at the national level are oriented toward achieving national objectives and have competent technical staff for promoting them. At lower levels of analysis, organizations tend to be swayed more by national priorities and programs than by local needs or desires. Local people can, however, express their desires and are likely to be able to be more effective in doing so when dealing with Congress than by interacting through administrative channels.

Conclusion

The above description of issues and institutions in the Uintah Basin of the Colorado River drainage area were used to list 17 issues related to differences in levels of analysis. The list is suggestive rather than exhaustive, but it provides a reasonable idea as to the issues existing among planning levels in an arid climate.

CHAPTER IV

PROPDEMM: AN APPLICATION OF A POLICY SIMULATION
COMPUTER MODEL TO A MULTILEVEL,
MULTIGOAL PLANNING SYSTEM

In a third approach to a better under-standing of levels of analysis problems, a simulation was attempted of the local region, state, and national viewpoints on water management in the Uintah Basin. The hope was that the more explicit representation forced by having to quantify relationships for a model would provide additional insights that would contribute to conceptual representation of levels of analysis problems.

Computer Simulation of Partially Hierarchial Systems

Recent advances in our understanding of the relationships among physical, economic, environmental, and social factors in land and water planning have been made possible, in part, by use of sophisticated computer technology for data processing and analysis. The increased capacity to process information has increased our ability to analyze larger and more complex systems in greater detail. This, in turn, has increased the potential benefits from computer modeling (Riley, 1976, p. 18-19). A wide range of managment alter-natives can be evaluated as systematic information storage and retrieval permit focusing attention on component parts without losing sight of the larger system. Clarity in system definition is increased, and information deficiencies and needs are identified.

A computer model is a set of equations representing some real system. The model defines functional relationships within a system, defines constraining parameters at system boundaries, and transforms raw in-formation into a useful format for the interpretation of large system activities.

The variety and complexity of models have increased with advances in computer technology. Basically, however, there are two approaches to model development: mathe-matical programming (optimization) and simulation. Mathematical programming seeks to identify management decisions that do the best job of achieving some defined goals. Simulation models attempt to represent system behavior in response to defined sequences of external stimulation. Both types can con-tribute valuable information on impacts on planning objectives of a range of feasible alternatives.

For realistic representation of real world conditions, water resources planning models needs to recognize the value, juris-diction, action, and temporal components of decision making as shown on Figure 2 in the framework of multiple levels deciding at multiple levels as shown on Figure 1. The practical problem preventing this sort of representation is that a sufficient conceptu-al basis is yet to be established. This point is made in recognition that the theory of multilevel, multigoal hierarchical systems has been advanced by Mesarovic, Macko, and Takahara (1970) and applied by Haimes (1976) to planning for the Maumee River Basin. The point shown in Figure 1 is that real world decision systems are not entirely hierarchial and further work is needed to plan in this context. Economic analysis has developed rules for dealing with situations where conditions depart from the assumptions of perfect competition. Planning theory needs rules for dealing with varying degrees of departure from hierarchial decision systems.

General Structure of PROPDEMM

This chapter uses the PROPDEMM simula-tion to identify levels of analysis problems. The PROPDEMM (Programmed Policy Decision Making Model) simulation was developed by Mulder in 1974 under a grant from the Utah State University Environment and Man Program sponsored by the Rockefeller Foundation (Hoggan et al., 1974). The simulation is an application to water resources planning of concepts adapted from PRINCE, a simulation of international relations developed by Coplin and O'Leary at Syracuse University. In previous applications, Hoggan et al. (1974) utilized the simulation to determine the effect of group interactions on alternative plans for the Willamette River Basin, and Keith et al. (1977) used it to determine and evaluate social, political, and environmental trade offs in a multiobjective planning for the Virgin River Basin. During the course of this project, PROPDEMM was modified to eliminate erroneous formulae and increase the program efficiency. The altered version is referred to as PROPDEMM II.

PROPDEMM was developed to "simulate decision processes which involve political and social-ecological interactions" from

information on the considerations shown in Figure 3. According to Mulder (1974), general policy decision making involves four factors: interest groups, group values, policy objectives, and courses of action. The PROPDEMM simulation is built on the following assumptions about the relationships between these four factors: 1) interest groups represent the general populace in articulating policy demands, 2) the interest groups possess value preferences for some present, or future, state, 3) the decision maker is responsible for converting these values into policy objectives, and 4) the policy objectives will be used to formulate plans, or courses of action, which will achieve the objectives, and hence the more abstract values of the relevant interest groups. For example, an interest group may desire to maintain, or even increase, its level of attainment of some value. When this desire is communicated to the decision maker, he will devise a course of action by which the value attainment will be preserved or increased in the future.

A second feature of PROPDEMM is its characterization of interest groups and their interactions (Mulder, 1974; Hoggan et al., 1974; Keith et al., 1977). For this study, five interest groups were used. Each is characterized by 1) environmental value preferences, 2) environmental value salience, 3) power to affect a course of action, 4) potential for punishment or reward as determined by the decision maker, 5) degree of dogmatism, 6) cost consciousness, 7) potential to affect and, in turn, be affected by the other interest groups, and 8) openness to change. Figure 4 illustrates the relationship of interest group attributes to the general policy decision model.

The following data inputs are required and generally must be estimated subjectively for the modeling.

1. Group dogmatism vector. One dogmatism value for each group is entered by an ordinal integer value between 1 and 7. A high dogmatism is indicated by a ranking of 7.
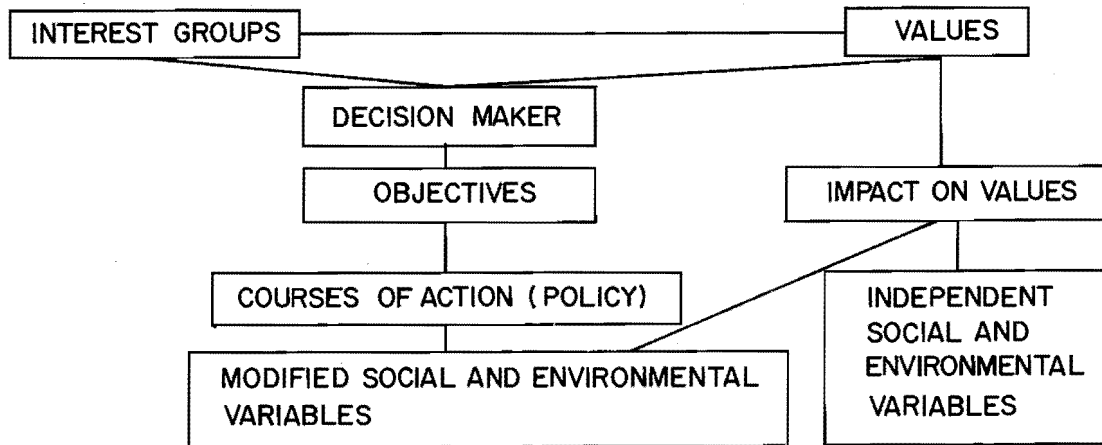
Figure 3. General policy decision model.
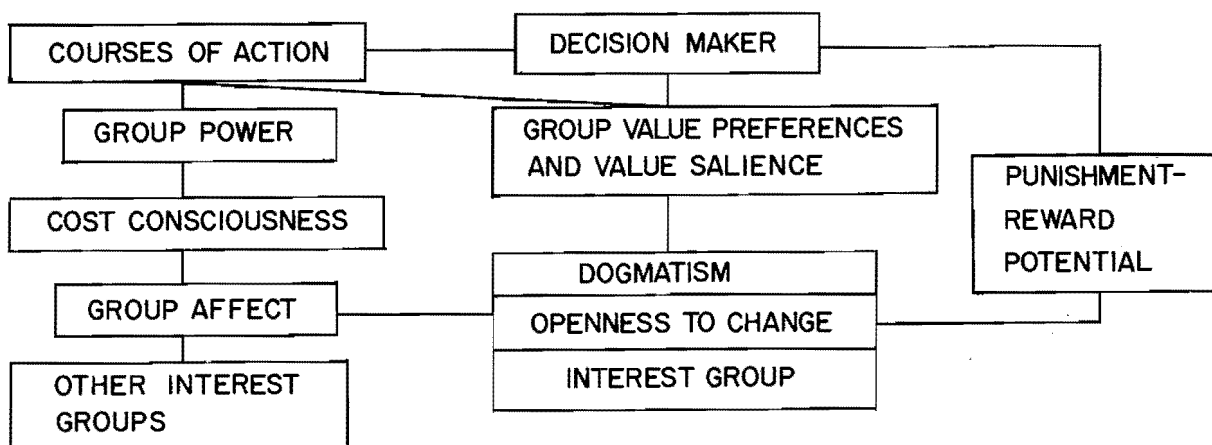
Figure 4. Relationship of interest groups to the general decision model.

34

2. _Punishment-reward potential vector_.
One punishment-reward potential value for
each group is entered by an ordinal integer
value between -3 and 3. A -3 indicates a
high potential for punishment by the decision
maker.

3. _Cost consciousness/cost level_
vectors. The cost consciousness vector is
entered by an ordinal integer value between 1
and 7. A ranking of 7 represents a high level
of cost consciousness among a group. The
cost level vectors are also inputted by
ordinal integers between 1 and 7. There is
one cost level for each course of action.

4. _Group affect vector_. For each
group, a set of affect vectors is entered to
represent the affect of that one group on all
other groups. The affect vectors are
supplied as ordinal integers between -3 and
3. A -3 represents a high negative affect;
no affect is represented by 0; and, a high
positive affect is represented by 3.

5. _Group values vector_. Ten environ-
mental values are entered for each group.
The group values are entered using -3 to 3 on
an ordinal scale representing the degree
of preference.

6. _Group salience vectors_. Ten sa-
lience vectors are entered for each group.
The salience vectors represent a degree of
commitment to each of the ten environmental
values. An ordinal scale of 1 to 7 is
used.

7. _Group power vectors_. Fifteen
values for each group represent the power
that that group has to impact each course of
action. A 1 to 7 ordinal scale is used to
rank the group power.

8. _Environmental impact value vectors_.
A -3 to 3 ordinal scale is used to enter the
impact of a given environmental factor on
the environmental values. A scale of 1 to
5 is used to rank each environmental factor
with respect to impact intensity on the
environmental values. A 1 represents the
most intense.

9. _Outcome value vectors_. There are
five possible outcomes for each course of
action. These outcomes, with associated
probabilities, are entered using an ordinal
scale ranging between -3 and 3. The -3
represents a high negative outcome or
impact.

10. _Indicated salience level_. The
indicated salience level is that level of
salience which is regarded as significant to
the decision process. This level is entered
using an ordinal ranking of 0 to 7.

From input information on the above
factors, PROPDEMM simulates outputs to aid
the decision maker. The first output
is the Environmental Value Modification
vector indices. These indices indicate the
match between existing environmental condi-
tions and group environmental values. The
decision maker is able to view these indices
and propose courses of action to improve the
fit.

Following formulation of applicable
courses of action, an output is provided in
the form of a preliminary Nonsystemic
Political Feasibility Index (NSPFI). This
output gives the decision maker his first
information on how each interest group
stands with regard to the formulated courses
of action. The output is preliminary
because it treats each interest group as if
it were affected only by the environmental
conditions and the courses of action. From
this output, the decision maker is able to
determine those aspects of a course of action
that are liked or disliked by the interest
group. This knowledge may permit the
decision maker to modify some undesirable
features or develop alternatives more likely
to be acceptable.

The final output of the PROPDEMM simula-
tion is the Sytemic Political Feasibility
Index (SPFI). This index utilizes the NSPFI
index and incorporates the impact that
other interest groups may have on a given
group's support for particular courses of
action. The model thus provides for the fact
that the selection of a political strategy by
an interest group requires an estimate of
support and opposition from other groups.
The SPFI, when compared to the NSPFI, gives
the decision maker information on the im-
portance of group interactions and on pos-
sible coalitions among interest groups.
Refinements can be made in order to design
alternatives capable of generating greater
support.

Uintah Application

The model was applied to three levels
of decision making--the Uintah Basin, the
State of Utah, and the Colorado River Basin--
chosen according to a combination of hydro-
logic and political jurisdiction criteria.
The three levels correspond to the planning
perspectives emphasized in recent national
legislation. For example, basin-wide plan-
ning and state planning are encouraged in
Title II of the Water Resources Planning Act
of 1965 (PL 89-90). The Principles and
Standards require multiobjective project
evaluation. Subbasin planning and area-wide
planning are encouraged in the 1965 Act, and
in Sections 201, 208, 209, and 303 of the
Federal Water Pollution Control Act of 1972
(PL 92-500) (Mulder et al., 1978).

It is of interest to note, however, how
the degree to which the units fail to overlap
geographically produces problems in the
part-whole relation in the level structure.
The Uintah Basin is a hydrologic subdivison
of the Colorado River Basin, and covers
portions of southwest Wyoming, northwest
Colorado, and northeast Utah. The Uintah

Basin Association of Governments is a political subdivision of the State of Utah and thus covers only a portion of the hydrologic region. At the state level, Utah is a member of the Colorado River Basin Compact, but hydrologically it is divided approximately in half between the Colorado Basin and the Great Basin where most of the people live. Finally, at the basin level, the member states of the Compact cover the entire drainage area of the river, except a small portion in Mexican territory, but the states also cover a great deal of additional territory--not one is exclusively within the Colorado River Basin.

Other levels of analysis in the governmental dimension of Figure 1 could have been chosen. The lowest political subdivisions--counties, cities, and special purpose water-related districts were not included. Neither was the federal government. Also excluded were levels along the physical-natural dimension, such as the smaller hydrologic areas (six in the Uintah Basin) and the upper and lower basins and levels in the economic social and cultural dimensions. Since PROPDEMM was applied to only three of the many possible levels of analysis and in only one of the five dimensions, the results could not be expected to provide planning answers, but they hopefully would identify planning problems.

In opting for three general purpose governmental units, this application glossed divisions that might be better for a special purpose perspective. If water quality is the priority interest, the river concourse would be the prominent object of attention. If electricity generation were the primary consideration, water quantity would be the important water consideration, and transmission lines would determine the units. Different results would be obtained by focusing on the other major historic water development goals, such as irrigation and flood control. All of these possibilities could not be incorporated in one PROPDEMM simulation.

Having identified the decision making levels, the next step was to determine the values being pursued by prominent interests within each jurisdiction and a set of alternative courses of action for water development at the respective decision levels. This information was derived from a general values survey of residents of the Uintah Basin area, a content analysis of the major daily newspapers in the Colorado River Basin, interviews with government officials at the three levels, and a review of the reports of government agencies concerned with Colorado River water. Since the collected information could not be objectively transformed into model inputs, the modeling effort must be considered as heuristic (although probably a fair representation of the interest of actors in the planning system). Because the purpose of this PROPDEMM application was to develop insights into levels of analysis problems

rather than to resolve particular water resources planning issues in the Uintah Basin, the groups and the information describing them used in the model will not be spelled out in this report. Greater specificity in that regard would be expected to add controversy away from the desired thrust of this study.

The first use of the simulation model was to select courses of action for the planning systems. To accomplish this task, the relevant interest groups, group data, and environmental data (Appendix B) were entered into the PROPDEMM II model (Appendix A) to generate an environmental state for the 1990 planning horizon. The generated environmental state represents the most desired environmental factors, the least desired environmental factors, and the most probable environmental factors.

Following the generation of the environmental states, the Environmental Value Modification Vector Indices were computed. These indices (Table 3) measure the match between the environmental states and the values of the interest groups. From these indices it is possible to derive suitable courses of action (Table 4) designed to improve the match between group values and environmental factors, increase the potential to achieve more desired environmental conditions, and mitigate, or minimize, occurrence of the less desired environmental conditions.

By achieving these objectives, the course of action becomes a tool to increase interest group value satisfaction, or goal attainment. In order to permit multilevel impact assessment, PROPDEMM II has been structured so that each planning level can not only identify its own course of action preferences but also its peferences for courses of action at the other two levels.

For each planning level, five alternative courses of action were devised. These courses of action are a composite of present, or past, water resource project plans. Each course of action is assigned five possible outcomes with probabilities of occurrence approximating a normal distribution. In Table 5, the values seen by the State of Utah planning system for the possible courses of action at all three simulated levels of decision making are tabulated.

The most probable outcome of each course of action is rated at a 40 percent probability of occurrence. The next two outcomes tabulated, rated at 20 percent probability of occurrence, represent somewhat more optimistic and pessimistic impacts respectively. The final two outcomes, rated at 10 percent probability of occurrence, represent the maximum positive and negative impacts. Each outcome set thus spans a potential impact range.

For exploring the problems of multiple decision levels, cross impacts of courses of

Table 3. Environmental value modification vector indices.

THE SMALLER THE INDEX VALUE, THE CLOSER THE FIT BETWEEN
EXISTING CONDITIONS AND A SET OF GROUP VALUES
FORMULAE ARE: XEMV = ABS(EIVV-GRPVAL)/GRPSAL
PXEMV = XEMV/PROBABILITY OF CONDITION

State of Utah
Environmental State 1 Most Probable

Environmental Cond	Prob	Group 1 XEMV	(PXEMV)	Group 2 XEMV	(PXEMV)	Group 3 XEMV	(PXEMV)	Group 4 XEMV	(PXEMV)	Group 5 XEMV	(PXEMV)	Group 6 XEMV	(PXEMV)	Selected Vector XEMV	(PXEMV)
1443500 People	44	4.0	(9.1)	4.5	(10.2)	4.1	(9.4)	6.9	(15.7)	4.5	(10.2)	5.0	(11.3)	3.2	(7.3)
8.5 MAF Annual	33	5.6	(17.0)	3.0	(9.0)	2.9	(8.7)	6.3	(19.2)	4.5	(13.7)	3.2	(9.5)	1.8	(5.5)
15166 AF M-I WTR	38	4.9	(12.8)	3.8	(10.0)	3.6	(9.4)	6.6	(17.3)	3.7	(9.7)	4.8	(12.5)	3.1	(8.2)
Social Service 3	40	6.4	(15.9)	3.0	(7.4)	4.4	(11.0)	6.0	(15.1)	3.3	(8.2)	3.7	(9.4)	2.3	(5.7)
$856M PUB Invest	43	6.0	(14.0)	3.1	(7.2)	3.8	(8.8)	7.0	(16.3)	3.9	(9.1)	3.5	(8.2)	2.0	(4.7)
5702 MW Energy	40	3.4	(8.4)	3.7	(9.3)	4.3	(10.6)	8.7	(21.9)	5.0	(12.4)	3.4	(8.4)	1.8	(4.6)
500 MG/L TDS	33	8.2	(24.7)	3.8	(11.4)	5.6	(17.0)	7.6	(23.0)	2.8	(8.5)	6.3	(19.0)	4.2	(12.7)
6.0-8.0% UNEMP	40	5.9	(14.6)	3.9	(9.7)	4.1	(10.2)	6.3	(15.8)	3.1	(7.7)	4.7	(11.7)	3.1	(7.8)
29M Tourist Days	38	5.7	(14.9)	3.5	(9.1)	3.6	(9.4)	5.9	(15.4)	3.6	(9.4)	3.7	(9.7)	2.2	(5.9)
137 Quad BTU's	40	4.8	(12.0)	4.2	(10.5)	3.9	(9.8)	9.3	(23.3)	4.8	(12.1)	3.4	(8.5)	1.8	(4.5)

Environmental State 2 Most Desired

Environmental Cond	Prob	Group 1 XEMV	(PXEMV)	Group 2 XEMV	(PXEMV)	Group 3 XEMV	(PXEMV)	Group 4 XEMV	(PXEMV)	Group 5 XEMV	(PXEMV)	Group 6 XEMV	(PXEMV)	Selected Vector XEMV	(PXEMV)
1443500 People	44	4.0	(9.1)	4.5	(10.2)	4.1	(9.4)	6.9	(15.7)	4.5	(10.2)	5.0	(11.3)	3.2	(7.3)
10.2 MAF Annual	9	7.7	(85.7)	3.3	(36.5)	3.5	(39.1)	7.5	(82.9)	5.5	(61.5)	2.2	(23.9)	1.5	(17.0)
13166 AF M-I WTR	18	4.9	(27.4)	3.3	(18.1)	3.3	(18.6)	5.1	(28.2)	3.3	(18.1)	4.3	(23.7)	2.8	(15.7)
Social Service 5	9	6.0	(66.9)	3.3	(36.5)	4.1	(45.7)	6.4	(71.5)	3.3	(36.2)	4.1	(45.7)	2.6	(28.9)
$856M PUB Invest	43	6.0	(14.0)	3.1	(7.2)	3.8	(8.8)	7.0	(16.3)	3.9	(9.1)	3.5	(8.2)	2.0	(4.7)
5702 MW Energy	40	3.4	(8.4)	3.7	(9.3)	4.3	(10.6)	8.7	(21.9)	5.0	(12.4)	3.4	(8.4)	1.8	(4.6)
400 MG/L TDS	12	9.8	(81.5)	4.7	(39.0)	7.5	(62.2)	7.7	(64.2)	2.2	(18.1)	7.2	(60.3)	5.0	(41.4)
3.0-4.5% UNEMP	12	5.0	(41.8)	3.0	(24.6)	3.4	(28.4)	5.8	(48.6)	3.9	(32.7)	3.8	(31.8)	2.3	(18.9)
32M Tourist Days	27	5.7	(21.1)	3.2	(12.0)	4.9	(18.2)	5.2	(19.2)	4.7	(17.5)	3.8	(14.0)	2.3	(8.4)
137 Quad BTU's	40	4.8	(12.0)	4.2	(10.5)	3.9	(9.8)	9.3	(23.3)	4.8	(12.1)	3.4	(8.5)	1.8	(4.5)

Environmental State 3 Least Desired

Environmental Cond	Prob	Group 1 XEMV	(PXEMV)	Group 2 XEMV	(PXEMV)	Group 3 XEMV	(PXEMV)	Group 4 XEMV	(PXEMV)	Group 5 XEMV	(PXEMV)	Group 6 XEMV	(PXEMV)	Selected Vector XEMV	(PXEMV)
1353000 People	20	4.5	(22.4)	4.4	(22.2)	4.0	(19.9)	6.8	(34.1)	4.1	(20.4)	4.9	(24.4)	3.2	(.15.8)
6.8 MAF Annual	12	4.9	(41.0)	8.8	(73.1)	8.7	(72.4)	9.5	(79.4)	3.3	(27.3)	8.8	(72.9)	6.5	(54.4)
17166 AF M-I WTR	20	5.6	(27.8)	5.3	(26.5)	4.1	(20.7)	9.6	(47.9)	5.0	(24.9)	5.3	(26.3)	3.4	(17.2)
Social Service 1	12	5.8	(48.5)	3.0	(24.6)	5.2	(43.7)	5.6	(46.8)	4.7	(38.8)	4.0	(32.9)	2.6	(21.7)
$770M PUB Invest	20	5.9	(29.2)	3.1	(15.6)	3.9	(19.6)	6.2	(30.9)	3.4	(17.1)	3.9	(19.7)	2.4	(12.2)
6272 MW Energy	20	3.8	(18.9)	4.8	(24.2)	5.0	(25.1)	9.6	(48.0)	6.8	(34.0)	4.2	(21.1)	2.8	(13.8)
600 MG/L TDS	15	6.8	(45.3)	3.1	(20.8)	4.0	(26.9)	6.9	(45.9)	3.2	(21.3)	5.0	(33.6)	3.2	(21.3)
10.0+ % UNEMP	5	6.2	(123.7)	5.1	(101.3)	5.3	(105.2)	6.5	(129.4)	2.7	(53.6)	5.8	(115.7)	4.2	(84.7)
26M Tourist Days	20	6.0	(30.1)	3.3	(16.4)	4.1	(20.6)	6.4	(32.2)	3.3	(16.3)	4.1	(20.6)	2.6	(13.0)
151 Quad BTU's	23	3.9	(17.0)	5.9	(25.7)	4.8	(21.0)	11.2	(48.9)	6.9	(24.8)	4.2	(18.2)	3.2	(13.8)

action for other planning systems are entered into the simulation. These cross impacts are represented, for the Utah level, in level 1 and level 3 of the course of action outcome value vectors. Level 1 outcome value vectors are the course of action outcome impacts on the State of Utah planning system of the five courses of action designed for the Uintah Basin planning system. This recognizes that planning activities in the Uintah Basin will have some effect on the values and interest groups at the statewide decision making level.

Level 3 outcome value vectors represent the impacts on the State of Utah planning system of courses of action designed for the Colorado River Basin planning system. The outcome value vector impacts of courses of action designed for the State of Utah as they affect the Uintah Basin and the Colorado River Basin planning systems are entered into

Table 4. Courses of action.

Uintah Basin 1:	Completion of Jensen Unit of Central Utah Project as planned in final EIS
Uintah Basin 2:	Completion of irrigation phase of Jensen Unit of Central Utah Project as planned in final EIS
Uintah Basin 3:	Completion of municipal–industrial phase only of Jensen Unit of Central Utah Project as planned in final EIS
Uintah Basin 4:	Completion of Trout Creek alternative for Jensen Unit of Central Utah Project as planned in final EIS
Uintah Basin 5:	Completion of Brush Creek Tunnel alternative for Jensen Unit of Central Utah Project as planned in final EIS
State of Utah 1:	Completion of all phases of Central Utah Project. Completion of all phases of Virgin River Project
State of Utah 2:	Completion of Central Utah Project with no export to the Sevier River Basin
State of Utah 3:	Completion of Jensen, Uintah, and Upalco units of Central Utah Project with water allocated to energy development. Completion of small scale Virgin River Project for limited energy production
State of Utah 4:	Completion of Jensen, Uintah, and Upalco units of Central Utah Project with water allocation to agriculture only. Completion of lVirgin River Water Project for agricultural use only
State of Utah 5:	Completion of Bonneville Unit of Central Utah Project only. Completion of all phases of Virgin River Project
Colorado River Basin 1:	Completion of Central Utah Project. Completion of Central Arizona Project
Colorado River Basin 2:	Implement USBR Colorado River Water Quality Improvement Program. Completion of Central Utah Project. Completion of Central Arizona Project. Develop groundwater supplies in Upper Basin
Colorado River Basin 3:	Completion of Central Arizona Project. Completion of Dolores Project
Colorado River Basin 4:	Completion of Navajo Indian Irrigation Project, Dolores Project. Implementation of USBR Colorado River Water Quality Improvement Program
Colorado River Basin 5:	Completion of Uintah, Upalco units of Central Utah Project for energy development. Develop groundwater in Upper Basin. Implement USBR Colorado River Water Quality Improvement Program

the two other PROPDEMM iterations which simulate the policy interactions of Uintah Basin groups, values, and environmental data, and Colorado River Basin groups, values, and environmental data, respectively.

By providing course of action cross impact analysis, PROPDEMM allows a policy maker the option of assessing the desirability of the programs of others in terms of their effects on his planning system. This enhances the potential for coordinated policy formulation to mitigate, or minimize adverse impacts and to support favorable ones.

In addition to the data concerning the desirability and likelihood of outcomes of alternative courses of action, PROPDEMM also uses course-of-action cost estimates. The cost level factor can represent the total cost of the project, the amortized annual cost of the project, or the cost of the project per unit of benefit. The last representation is to be generally preferred, but it was not available for most of the alternatives for this simulation.

The first two types of cost representations present a problem when fitted to the data requirements of the PROPDEMM simulation. In earlier applications of PROPDEMM, a seven point scale was adequate. The cost levels of the courses of action, although numerically different, were of the same order of magnitude. For example, all course-of-action cost levels were in one case between $100 million and $125 million. The seven point scale is set to cover the extremes.

In the present PROPDEMM simulation, the costs of the available courses of action are quite different among the three levels. This presents problems of scale comparison and sensitivity. For the Uintah Basin, the costs of the available courses of action range between $10 million and $33 million. For the State of Utah, the estimated course-of-action costs range between $100 million and $620 million. For the Colorado River Basin courses of action, the estimated costs begin at $300 million and go to well over $1.3 billion. If the scales which represent these cost levels were applied only to their respective planning systems, no problem

38

Table 5. Course of action outcome value vectors for State of Utah planning system.

OUTCOME VALUE VECTORS

LEVEL I

UB 1

	ECON	ENER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	2	1	1	2	1	1	-2	3	2	0	p=.40
Outcome 2	1	1	1	2	2	2	-1	3	2	0	p=.20
Outcome 3	0	0	0	0	0	0	-2	0	-1	0	p=.20
Outcome 4	2	2	1	2	2	2	0	3	2	0	p=.10
Outcome 5	1	-1	0	1	0	0	-2	0	-1	0	p=.10

UB 2

	ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
Outcome 1	1	0	0	1	0	0	-1	1	0	0	p=.40
Outcome 2	1	0	0	2	0	1	0	1	1	0	p=.20
Outcome 3	0	-1	0	0	0	0	-1	0	-1	0	p=.10
Outcome 4	1	0	0	2	0	1	0	2	2	0	p=.10
Outcome 5	0	-1	0	0	0	0	-2	0	-1	0	p=.10

UB 3

	ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
Outcome 1	1	1	1	0	1	1	-1	1	1	0	p=.40
Outcome 2	1	2	1	0	2	2	0	1	1	0	p=.20
Outcome 3	0	0	0	0	0	0	-2	0	-1	0	p=.20
Outcome 4	1	2	1	0	3	2	0	2	1	0	p=.10
Outcome 5	0	0	0	0	0	0	-2	-1	-1	0	p=.10

UB 4

	ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	2	0	0	2	0	2	-2	1	1	0	p=.40
Outcome 2	1	1	1	2	1	2	-1	1	2	0	p=.20
Outcome 3	0	0	0	0	0	0	-2	0	-2	0	p=.20
Outcome 4	2	1	1	2	1	2	0	1	3	0	p=.10
Outcome 5	1	0	0	1	0	-1	-1	0	-2	0	p=.10

UB 5

	ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	-1	0	-1	0	-1	-1	0	-1	0	0	p=.40
Outcome 2	0	0	0	0	0	1	0	0	0	1	p=.20
Outcome 3	-2	-1	-2	-1	-1	-1	0	-2	-1	-1	p=.20
Outcome 4	0	0	0	1	0	1	0	0	0	2	p=.10
Outcome 5	-2	-1	-3	-2	-1	-1	-1	-2	-1	-2	p=.10

LEVEL 2

UT 1

	ECON	ENER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	2	1	3	2	3	1	-1	2	1	0	p=.40
Outcome 2	3	2	3	3	3	1	0	2	1	1	p=.20
Outcome 3	1	0	1	1	1	-1	-2	-2	-1	-1	p=.20
Outcome 4	3	3	3	3	3	2	0	2	2	1	p=.10
Outcome 5	1	0	1	0	1	-1	-2	-3	-1	-1	p=.10

UT 2

	ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
Outcome 1	2	1	3	1	3	1	-1	1	1	0	p=.40
Outcome 2	2	2	3	2	3	1	0	1	2	1	p=.20
Outcome 3	1	0	1	0	1	-1	-1	-1	-1	-1	p=.10
Outcome 4	3	2	3	2	3	2	0	1	2	1	p=.10
Outcome 5	1	0	1	1	1	-1	-2	-1	-1	-1	p=.10

UT 3

	ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
Outcome 1	2	2	0	-1	0	0	-1	1	-1	-1	p=.40
Outcome 2	2	2	0	0	1	1	-1	1	-1	0	p=.20
Outcome 3	1	1	0	-2	0	-1	-2	0	-2	-1	p=.20
Outcome 4	3	2	0	0	2	1	-1	2	-1	0	p=.10
Outcome 5	1	1	0	-2	-1	-1	-3	-1	-2	-1	p=.10

UT 4

	ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	1	0	0	2	0	1	-1	-1	1	1	p=.40
Outcome 2	2	1	0	3	1	1	-1	0	1	1	p=.20
Outcome 3	-1	-1	0	1	0	0	-2	-2	-1	1	p=.20
Outcome 4	2	2	0	3	1	1	0	0	2	1	p=.10
Outcome 5	-1	-2	0	1	0	0	-2	-3	-1	0	p=.10

UT 5

	ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
Outcome 1	1	0	2	1	2	2	-1	-1	1	0	p=.40
Outcome 2	1	1	2	2	3	2	0	0	1	1	p=.20
Outcome 3	0	-1	1	-1	1	0	-2	-1	-1	-1	p=.20
Outcome 4	1	0	2	2	2	2	0	0	1	0	p=.10
Outcome 5	0	-2	1	-2	1	-1	-2	-1	-1	-1	p=.10

Table 5. Continued.

OUTCOME VALUE VECTORS

		ECON	ENER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
						LEVEL 3						
	Outcome 3	1	0	1	1	1	-1	-1	-2	-1	-1	p=.20
	Outcome 4	3	3	3	3	3	1	0	2	2	1	p=.10
	Outcome 5	1	0	1	0	1	-1	-2	-3	-1	-1	p=.10
CRB 2		ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
	Outcome 1	2	1	3	1	3	1	0	2	1	1	p=.40
	Outcome 2	3	2	3	1	3	2	0	2	2	1	p=.20
	Outcome 3	1	0	2	-1	2	-1	-1	-2	0	-1	p=.10
	Outcome 4	3	3	3	1	3	2	0	2	2	1	p=.10
	Outcome 5	1	0	2	-1	2	-1	-2	-3	-1	-1	p=.10
CRB 3		ECON	EMER	MUNI	AG W	IND	REC	ENW	LAND	FISH	PVT	
	Outcome 1	0	0	0	0	0	0	0	0	0	0	p=.40
	Outcome 2	0	0	0	0	0	0	0	1	0	0	p=.20
	Outcome 3	0	-1	0	-1	0	0	0	0	0	0	p=.20
	Outcome 4	0	0	0	0	0	0	0	0	0	0	p=.10
	Outcome 5	0	-1	0	-1	-1	0	0	-1	0	0	p=.10
CRB 4		ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
	Outcome 1	0	0	0	0	0	0	1	0	1	0	p=.40
	Outcome 2	0	0	0	0	0	0	1	-1	1	0	p=.20
	Outcome 3	0	-1	0	-1	0	0	1	0	1	0	p=.20
	Outcome 4	0	0	0	0	0	0	1	0	1	0	p=.10
	Outcome 5	0	-1	0	-1	-1	0	1	-1	1	0	p=.10
CRB 5		ECON	EMER	MUNI	AG W	IND	REC	ENV	LAND	FISH	PVT	
	Outcome 1	1	2	1	1	2	1	-1	1	1	1	p=.40
	Outcome 2	2	2	1	1	2	1	-1	1	1	1	p=.20
	Outcome 3	0	1	0	0	1	0	-1	-1	1	-1	p=.20
	Outcome 4	2	3	2	1	2	1	-1	1	1	1	p=.10
	Outcome 5	0	0	0	0	0	-1	-2	-1	1	-1	p=.10

would occur. But, cross impact analysis among planning systems requires that all three cost factor scales be attached to a single scale of reference.

In this application of PROPDEMM, the cost factor problem was resolved by making all cost level factors equal using the State of Utah planning system as the center of analysis. The simulation will be analyzed as if a policy maker for the State of Utah were going to use the results to formulate a state water resources plan and negotiate for coordination with plans of the other two levels. In centering the analysis on the State of Utah, potential scale problems are minimized. No planning system is more than one step removed from the system under examination.

The final input variable affected by the levels problem is the group power vector. This vector represents the potential of a group to influence a course of action. Table 6 shows the power of the Utah interest groups to affect not only courses of action designed for the State of Utah planning system, but also those for the Uintah Basin and Colorado River Basin planning systems.

As might be expected, interest groups have the most power to affect courses of action designed for their own system. The Utah interest groups have more power to affect Uintah Basin activities than Colorado River Basin activities because of the political-institutional structure of the planning systems. The county-state relationships are legally defined in the statutes of the State of Utah which establish a hierarchical relationship with the state serving as a locus of power. The Colorado River Basin-State of Utah relationship, on the other hand, is less well defined. The planning system for the Colorado River Basin of seven member states plus management agencies of the federal government is really a loose confederation of political sovereignties. It has no hierarchical arrangement that would permit a central authority to impose its will on the states. The participating federal agencies can veto any plan proposed by the member states, but each state can veto projects within its own boundaries.

Results of the PROPDEMM Simulation

The first phase of the simulation analysis provides an assessment of the political feasibility of the courses of action considered. This assessment is presented for the State of Utah in the Systemic Political Feasibility Indices, shown in Table 7. Level 1 represents the desir-

Table 6. Group power vectors.

	UB 1	UB 2	UB 3	UB 4	UB 5	*	UT 1	UT 2	UT 3	UT 4	UT 5	*	CRB1	CRB2	CRB3	CRB4	CRB5
IND-ENERGY DEV	3	2	4	3	5	*	3	4	6	3	6	*	3	3	1	1	4
COMMERCE-TOURISM	3	2	2	2	2	*	3	3	3	4	4	*	2	2	1	1	2
AGRICULTURE	3	4	2	4	3	*	4	3	3	6	4	*	4	5	1	1	1
RECREATION	2	3	2	3	4	*	3	3	2	4	3	*	3	4	1	1	1
ENVIRONMENTAL	5	4	4	7	6	*	6	6	6	5	4	*	7	7	3	4	5
DECISION MAKER	5	5	5	5	5	*	5	5	5	5	5	*	5	4	1	1	3

GROUP POWER VECTORS

ability of the five courses of action designed for the Uintah Basin from the viewpoint of the State of Utah, level 2 represents the desirability of the five courses of action designed for the State of Utah, and level 3 represents the desirability of the five courses of action designed for the Colorado River Basin in the State of Utah.

According to the total Systemic Political Feasibility Indices for the State of Utah, the most desirable, or politically feasible, course of action is CA #4 (UT 4), followed by CA #5 (UT 5) and CA #3 (UT 3). The SPFI of UT 4 is the sum of the course-of-action values for the five State of Utah interest groups.

The value structure of the interest groups reflects a high preference for economic growth, agricultural water supply, recreational opportunity, and private property control. UT 4, which calls for the completion of the Jensen, Uintah, and Upalco units of the Central Utah Project for agricultural water supply with limited emphasis on energy water supply and also the completion of the Virgin River water project for agricultural water supply, provides a moderate to high contribution to the attainment of these values. It is the most preferred alternative for four of the five interest groups and the course of action the policy makers for the Utah planning system would try to implement.

For the desired multilevel, multigoal planning scenario, PROPDEMM was modified to recognize the inter-level impacts of different policy alternatives. The next step, therefore, was to review the effect of courses of action designed at other levels on the State of Utah planning system. This can also be accomplished from the Systemic Political Feasibility Indices (SPFI) in Table 7.

Level 1 of the SPFI table represents the Uintah Basin courses of action. Of these five courses of action, CA #4 (UB 4) and CA #5 (UB 5) make the greatest contribution to the goal attainment of the Utah planning system interest groups. UB 4 appeals most to the commerce-tourism, agriculture, and recreation interest groups, while UB 5 appeals most to the industry-energy development and environmental interest groups. A policy maker for the State of Utah, acting to minimize levels of analysis conflicts, would encourage the adoption of one of these two courses of action to enhance his own policies contained in UT 4.

Level 3 of the SPFI table represents the five courses of action designed for the Colorado River Basin planning system and their contribution to the goal attainment of the Utah interest groups. Courses of action CA #2 and CA #1 (CRB 2 and CRB 1) make the greatest contribution by appealing to the values of commerce-tourism, agriculture, and recreation interest groups. The environmental group prefers CA #4 (CRB 4) while the Industry-Energy Development group prefers CA #5 (CRB 5) by a large margin. Again, the Utah policy maker would encourage the adoption of CRB 2, or CRB 1, to complement his own policies designed for the State of Utah planning system.

At this point, the State of Utah policy maker knows which courses of action, at all levels, will make the maximum contribution to the goal attainment of the Utah interest groups. He can formulate a policy of coordinated plans which will be optimal from his planning perspective. Unfortunately, the optimal policies for the State of Utah might be nonoptimal for the interest groups of other planning systems. For this reason, it becomes necessary to examine the SPFI outcomes from the perspective of the other planning systems as they appear in the remaining two PROPDEMM iterations. The computer printout is in Appendix B.

Analysis of the course-of-action preferences from the three PROPDEMM iterations indicates the policy conflict shown in Table 8.

The Uintah Basin planning system sees its course of action UB 4 as optimal. Both Utah and the Colorado River Basin planning systems also see UB 4 as the Uintah Basin course of action which makes the greatest contribution to their own goal attainment. Thus, no policy conflict potential exists in

41

SYSTEMIC POLITICAL FEASIBILITY INDICES
THE LARGER THE INDEX VALUES, THE MORE FAVORABLE THE COURSE OF ACTION
FORMULAE AREA SIP = OO * NSIP
SPFI = STP * PWR * SSN

Level 1

Group	SSN	CA #1 SIP PWR (SPFI)	CA #2 SIP PWR (SPFI)	CA #3 SIP PWR (SPFI)	CA #4 SIP PWR (SPFI)	CA #5 SIP PWR (SPFI)
Ind-Energy Dev	4.2	0.52 3 (6.6)	-0.13 2 (-1.1)	1.13 4 (19.1)	-0.11 3 (-1.3)	0.47 5 (9.9)
Commerce-Tourism	4.8	3.40 3 (48.5)	3.81 2 (36.2)	3.75 2 (35.6)	4.17 2 (39.6)	2.36 2 (22.4)
Agriculture	4.4	2.55 3 (34.1)	2.35 4 (41.4)	1.86 2 (16.4)	2.38 4 (41.9)	1.35 3 (17.9)
Recreation	3.9	4.19 2 (32.6)	3.15 3 (36.8)	2.35 2 (18.3)	3.03 3 (35.4)	2.00 4 (31.2)
Environmental	5.6	0.23 5 (6.4)	0.75 4 (16.9)	0.60 4 (13.4)	0.69 7 (27.3)	1.80 6 (60.8)
Total SPFI		(128.3)	(130.2)	(102.8)	(142.9)	(142.3)

Level 2

Group	SSN	CA #1 SIP PWR (SPFI)	CA #2 SIP PWR (SPFI)	CA #3 SIP PWR (SPFI)	CA #4 SIP PWR (SPFI)	CA #5 SIP PWR (SPFI)
Ind-Energy Dev	4.2	0.72 3 (9.1)	1.03 4 (17.4)	1.97 6 (49.8)	-0.25 3 (-3.2)	0.45 6 (11.4)
Commerce-Tourism	4.8	2.53 3 (36.0)	2.64 3 (37.7)	2.47 3 (35.2)	2.92 4 (55.5)	2.49 4 (47.3)
Agriculture	4.4	2.21 4 (38.9)	2.03 3 (26.9)	1.43 3 (18.9)	2.38 6 (62.9)	1.75 4 (30.8)
Recreation	3.9	2.75 3 (32.1)	2.26 3 (26.4)	3.25 2 (25.3)	2.75 4 (42.9)	2.47 3 (28.9)
Environmental	5.6	-0.31 6 (-10.3)	-0.00 6 (-0.1)	-0.10 6 (-3.4)	0.82 5 (23.1)	0.38 4 (8.4)
Total SPFI		(105.8)	(108.3)	(125.8)	(181.2)	(126.8)

Level 3

Group	SSN	CA #1 SIP PWR (SPFI)	CA #2 SIP PWR (SPFI)	CA #3 SIP PWR (SPFI)	CA #4 SIP PWR (SPFI)	CA #5 SIP PWR (SPFI)
Ind-Energy Dev	4.2	0.72 3 (9.0)	0.37 3 (4.7)	-0.28 1 (-1.2)	-0.54 1 (-2.3)	1.14 4 (19.2)
Commerce-Tourism	4.8	2.93 2 (27.8)	3.02 2 (28.7)	2.42 1 (11.5)	2.48 1 (11.8)	2.60 2 (24.7)
Agriculture	4.4	2.18 4 (38.3)	1.75 5 (38.4)	1.43 1 (6.3)	1.42 1 (6.2)	2.0Z2 1 (8.9)
Recreation	3.9	2.20 3 (25.7)	1.67 4 (26.1)	2.33 1 (9.1)	2.48 1 (9.6)	1.61 1 (6.3)
Environmental	5.6	-0.16 7 (-6.2)	0.03 7 (1.3)	1.58 3 (26.7)	2.19 4 (49.3)	0.38 5 (10.7)
Total SPFI		(94.6)	(99.2)	(52.4)	(74.7)	(69.7)

the adoption of this course of action. The State of Utah planning system sees course of action UT 4 as its optimal policy, the Uintah Basin and Colorado River Basin planning systems concur, and thus again there is no policy conflict.

At the level of the Colorado River Basin, the PROPDEMM simulation does indicate a policy conflict. The optimal course of action for the Colorado River Basin is CRB 5 with CRB 4 as a second preference. This is not a good policy for the State of Utah planning system but could satisfy the Uintah Basin second preference, CRB 5. If, however, CRB 5 is adopted, there will be greater disagreement between the State of Utah and the Uintah Basin than if CRB 1 were adopted. The PROPDEMM simulation can then be used by the policy maker to identify the source of

Table 8. Conflicting COA optimals.

| Planning Perspective | Preferred Course of Action For | | | |
| | Uintah | Utah | Colorado Basin | |
			First Performance	Second Performance
UINTAH BASIN	UB 4	UT 4	CRB 1	CRB 5
STATE OF UTAH	UB 4	UT 4	CRB 2	CRB 1
COLORADO RIVER BASIN	UB 4	UT 4	CRB 5	CRB 4

this conflict, and by so doing, take steps to achieve a satisfying solution. That specific application to levels of analysis problem solving is beyond the scope of this report.

Evaluation of PROPDEMM

Since it has been shown that the PROPDEMM simulation indicates policy preference conflicts among levels of analysis, the remaining question is whether, in light of the PROPDEMM formula analysis performed by Kimball (1978), the indicated conflicts are valid. The PROPDEMM simulation may be divided into 1) formulae which help the decision maker create courses of action, 2) formulae which determine the political feasibility of courses of action for given interest group factors and 3) indices which provide additional information for iterative purposes but are not tied to the other parts of the program.

The analysis of the first set of formulae indicated some conceptual problems in that use of the group salience factor in division operations diminishes the importance of increasing salience. This problem does not invalidate the course-of-action design for two reasons. First, although the marginal impact of the group salience index diminishes as group salience increases, the intent of this input factor is not reversed. Figures 5a and 5b illustrate the problem. Figure 5a represents the ideal relation between GRPSAL and its impact designing courses of action, while Figure 5b represents the representation in the PROPDEMM simulation. The direction is correct, but the relationship is biased so as to undervalue salient interests. This will usually result in courses of action being altered towards a closer fit between environmental conditions and group values but will not achieve the match desired by the interest groups. The selected courses of action are meeting some interest group expectations but are not as effectively designed as they could be.

A second desirable feature is that each course of action in the PROPDEMM simulation is assoicated with five possible outcomes with specified probabilities of occurrence.
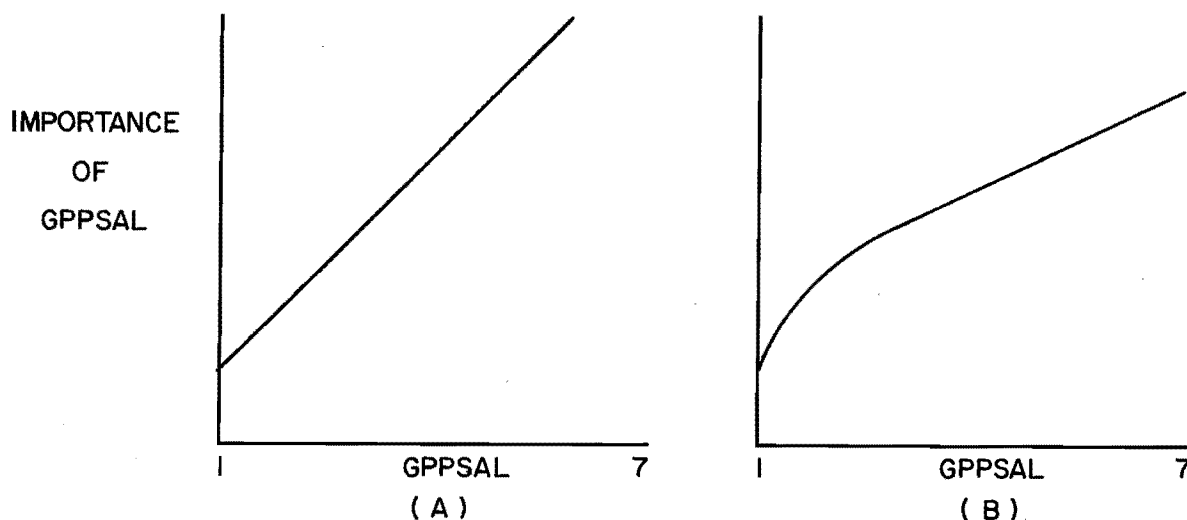
Figure 5. GRPSAL relationships.

This minimizes the impact of any single course-of-action outcome vector and broadens the potential outcome impact.

The analysis of the formulae which comprise the main part of the PROPDEMM simulation indicated two problems which might affect the validity of the PROPDEMM political feasibility assessment. The first problem is a sensitivity problem identified in the Selected Salience Number (SSN) computations. In Table 7, the Uintah Basin courses of action were ranked in terms of their contribution to the State of Utah planning system goals. The SPFI indices would place course of action UB 4 above UB 5 as a preferred course of action. The net difference in the two indices is 0.6. Given the precision of the SSN index, a factor used in computation of the SPFI index, one cannot really distinguish between the two courses of action in desirability.

The second problem encountered in the main part of PROPDEMM is peculiar to the levels of analysis applications. This problem centers around the use of a seven point scale of measurement and was most evident in the cost factor computations. In the present application, this problem was minimized through use of the State of Utah planning system as the level of analysis. However, the problem was not removed. In the two sets of iterations which were completed for each planning perspective, the change from seven point cost factor rankings to cost level equalization accounted for five changes in SPFI ranking at the State of Utah level, eleven changes in SPFI ranking at the Uintah Basin level, and eleven changes in ranking at the Colorado River Basin level. This illustrates both the importance of the cost factor in the PROPDEMM simulation and the validity problems which arise when this factor is removed through equalization.

The seven point scales are controversial in another aspect, as well. In PROPDEMM, the numbers are treated as if they possessed interval or ratio properties, although they are clearly ordinal. Recent developments in psychological measurement suggest that in many cases such manipulations of ordinal numbers do not lead to inconsistent results (Long and Wilken, 1974). Although no tests were conducted on PROPDEMM to determine whether the necessary assumptions on the uniqueness of orderings are warranted, the analysis of program formulae that was done would lead one to suspect problems in the reliability of "close" rankings.

Finally, it should be observed that the full theoretical model has not been operationalized. The vector representing punishment-reward potential, for example, is being used but must be modified in order to overcome the conceptual problem of a single input vector. Also, to complete the modeling of the political process, an information segment of the model must be developed to allow input of vectors representing positive and negative information connected with the perceived impacts of courses of action and the salience of the positive and negative information vectors. The development of these additional input factors will enhance the model and simulate a more realistic version of the actual political decision making process.

Summary

The PROPDEMM simulation was instrumental in identifying and clarifying three levels problems:

1. Identifying decision levels. The PROPDEMM simulation requires specification of the decision making domain--or domains--in a multilevel setting. Sometimes the real boundaries are difficult to discover and compare among levels In the present case, the political and hydrologic boundaries for each level cover different territory. In general, when multilevel decision systems do not exhibit subset relations from the highest to the lowest levels, it is more difficult to represent the levels and their interrelationships in a model.

2. Identifying a set of alternatives comparable across levels. Part of the problem of identifying comparable alternatives is a carryover from the problem of identifying the decision making levels, from whose perspectives the alternatives are defined. One would expect ill-defined levels to create a corresponding problem of ill-defined alternatives. The PROPDEMM simulation assumes some exclusivity in the courses of action. Even though some courses of action overlap with other courses of action designed for different levels, the final physical action associated with a course of action takes place at a local site(s). This makes it difficult to distinguish between courses of action which are local and regional. The difficulty of locating a course of action at one level or the other is increased by the fact that water resource projects and programs tend to be multipurpose and multisponsored.

3. Integrating evaluations of alternatives. In water resources development, basin plans typically consist of combinations of local projects. Benefits that accrue to people outside the project locality, and especially costs borne by nonlocal interests, are less likely to enter into project evaluations from a local perspective than from the basin perspective. This is one reason for different rankings of planning alternatives.

CHAPTER V

PROBLEMS TO ADDRESS IN CONCEPTUALIZING A PLANNING THEORY

Introduction

At the beginning of this report, the relational problems in water resources planning defined to be of particular interest were those in the area of levels of analysis broadly defined as the problems needing to be solved to optimize the planning process. It was subsequently noted that progress in solving levels of analysis problems requires a conceptual basis for putting it all together; but that before one can begin to build that basis, he needs to understand the problems that the planning theory needs to deal with. These problems were searched out in Chapters II, III, and IV. Chapter II found a number of levels of analysis issues through qualitative review of planning as practiced in the Colorado River Basin. Chapter III found issues in nationwide planning practice, and Chapter IV found some in a simulation of planning as practiced in the Uintah Basin. The identified problems are listed at the end of each chapter, and the purpose here is to sort them into an integrated set for the subsequent theoretical development.

Problems of a Unitary Planning Agency

One of the classical justifications used for governmental planning is that individuals, when left on their own or only limited by market forces, do not adequately consider external effects on others in their decision making. A favorite approach to the problem is to internalize the externalities within a common management. After doing so, one would, of course, still have the problems of aggregating common values for the constituency of the planning unit, working from incomplete information, coping with a variety of uncertainties, and preserving flexibility to deal with circumstances that come along.

The dimensions used in Figure 1, however, demonstrate the flaw in this approach. One would have, to make this method effective, not only to internalize by enlarging the physical and governmental units to include all those affected (the whole world would have to be included to be complete). He would also have to enlarge to include the economic, social, and cultural dimensions, and this expansion would get the planners into some areas where few people want them. Finally available planning tools are not capable of optimizing a system large enough to internalize the relevant world.

Classification of Identified Levels Problems

The 17 levels problems identified in Chapter III from the analysis of planning issues in the Colorado River Basin and the three levels problems identified from the PROPDEMM application to the Uintah Basin described in Chapter IV are classified by the scheme shown in Figure 2 and described in Table 9. All 20 problems were classified within a single combination or a combination pair rather than as "higher order combinations" or "gaps between components" even though many of the problems certainly display higher-order or gap aspects. Each problem is referenced in the table back to its chapter of origin and problem number there.

The 20 levels problems included at least one in nine of the ten classifications with five classified as conflicts in jurisdiction and four as value-need conflicts. Four other classifications had two problems, and three had one problem. Altogether nine problems had jurisdictional aspects, nine had value aspects, nine had need aspects, and four had time aspects.

Summary

The identification of levels problems showed them to be widely distributed among a diversity of classifications and not concentrated in a few. Since the identification did not attempt to be exhaustive and no effort was made to weight the problems identified by severity, one cannot at this point state a preference for any particular emphasis in the needed conceptual advance.

Table 9. Classification of levels of analysis problems identified from Colorado River
          Basin Review or by PROPDEMM.

1. Conflicts in Values
    a. Conflict between water users and government on 160-acre limitation (3-10).
    b. Conflict between water users and government on salinity control practices (3-14).

2. Conflicts in Jurisdiction
    a. Competition between Indians and Wasatch Front for water (3-6).
    b. Federal planners have much more extensive staff support than do those at other
        levels (3-17).
    c. Jurisdictions in decision systems do not exhibit subset relations (4-1).
    d. Courses of action among jurisdictions are difficult to distinguish when the bound-
        aries among jurisdictions are poorly defined (4-2).
    e. Jurisdictions conflict in position as they experience different impacts from one
        another (4-3).

3. Conflicts in Emphasized Need
    a. Planning to supply the need for water is not coordinated with planning to supply
        the need for energy (3-2).
    b. Competition in municipal and energy uses taking water from agriculture (3-7).

4. Conflicts in Time Perspective
    None

5. Time-Value Conflicts
    a. Individual water allocation and use decisions out of harmony with water planning
        value framework (3-8).

6. Time-Jurisdiction Conflicts
    a. Individuals have begun to use water which will later have to be taken from them
        to satisfy Indian and Federal Reserved Water Rights (3-5).

7. Time-Need Conflicts
    a. Political allocation of Colorado River water before firm flow information was
        available (3-3).
    b. Emergency water allocation during drought emergencies that sets precedences for
        future (3-15).

8. Value-Jurisdiction Conflicts

    a. Indian and Federal Reserve water rights are defined through state-federal juris-
        dictional compromise outside water planning value framework (3-4).
    b. Federal emphasis on water conservation defined as a reduction in use is not
        accepted by Utah jurisdictions (3-9).

9. Need-Jurisidiction Conflicts
    a. Institutionally expressed state-federal water policy differences emphasize juris-
        dictional rights to protect need differences (3-16).

10. Value-Need Conflicts
    a. Political allocation of Colorado River water outside official water planning
        value framework (3-1).
    b. Shift in water use from agriculture to energy conflicts with values used previously
        in water development (3-11).
    c. Shift in water use from agriculture to energy conflicts with current water planning
        value framework (3-12).
    d. Political establishment of salinity standards outside official water planning
        value framework (3-13).

PLANNING PERSPECTIVES AND LEVELS

Introduction

Conceptualization of comprehensive planning has introduced the concepts of multiple objectives and public participation into water resources management. Plans must now be considered from multiple perspectives. As planners have moved away from evaluating alternatives solely in terms of their contribution to economic development as seen from the perspective of the nation as a whole, they have found that the decision making principles and tools which were developed over the years for single perspective planning to be inconclusive in multiple perspective situations. Because available tools are not leading to timely decision making within the framework of officially adopted planning principles, the institutionalized water resources planning and management process is continually falling further behind.

The line of investigation used here to address this situation is to seek a conceptual framework that can be used to achieve acceptance of a common plan fulfilling a variety of needs as seen from a variety of jurisdictional and value viewpoints. Consensus acceptance of a common conclusion requires that the perspectives formed as analyses are made at many levels and from many viewpoints be reconciled to some acceptable degree of common satisfaction. The development and management of water resources involves decisions by individuals and private firms, by local, state, and national levels of the political system, and by actors influential in the economic, social, cultural, governmental, and technical dimensions of society. The decisions made by actors in each element at each level are based on analyses (informed, uninformed, or misinformed; superficial or profound) using concepts that provide a degree of generality suitable to the objectives of the analyst. The different objectives of different decision makers imply that analyses will proceed at different levels of generality and use different concepts. Progress in reconciling divergent conclusions that result from these differences must be based on a sound understanding of how levels of analysis are related. The strategy here is to develop a working concept in this chapter of how levels of analysis are related and then deal with specific problems in applying that concept in Chapters VII and VIII.

The Concept of a Planning Perspective

The most serious difficulties in formulating and implementing water resources management plans generally originate in conflicts among the choices of interested parties. The conflicting choices frequently arise from differences in perspective. In art, the term "perspective" is used when talking of the distances, positions, and proportions of the objects represented, relative to the position assumed by the artist. If the artist changes position, he acquires a different perspective. Analogously, as Baier (1965, p.91) observes, when we speak of perspectives on issues requiring decisions, "we have in mind the demands, goals, or aims of persons holding certain special positions or jobs or functions in a society," and each position can be expected to lead to somewhat different resolutions to common issues, based on different reasons or justifications.

A decision maker adopts a perspective, either explicitly or implicitly, as he forms a position on an issue. The perspective provides "characteristic modes of explanation"--answers to: what is the nature of the problem, what are the important factors, what will happen if X is done--and the justifying reasons for action--answers to: what are my (our) responsibilities and obligations, what are my (our) goals, how efficient and effective are the various possible courses of action in fulfilling these goals and responsibilities? (Moline, 1968; Weiler, 1976.) Consequences of taking a perspective thus include: 1) limiting one's set of aims and interests; 2) relying primarily on evaluative criteria related to achievement of those aims; 3) regarding other interests as less relevant; 4) biasing one's interpretation of the "facts"; and 5) agreeing with others (in matters related to the first four tendencies) who share (or to the degree that they share) the same perspective (Moline, 1968, p. 195). A perspective, then, can be thought of as a perceptual filter for selecting some considerations as relevant and rejecting others. A perspective once adopted in the process of deciding an issue will set a precedent that will be more likely to be followed than reversed in the future.

An explicit, general principle of relevance is found in Moline's succinct statement:

A consideration C is relevant from a point of view P to the extent that ignoring C avoidably prevents, interferes with, or fails to take advantage of an opportunity to facilitate the accomplishment of the aims which are characteristic of P. (1968, p. 197.)

The principle, however, may be difficult to apply. Uncertainty as to the aims characteristic of P causes the set of relevant considerations to be ill-defined. Moreover, determination of what "prevents, interferes with, or fails to take advantage of an opportunity" cannot generally be done a priori, but requires experience. The judgement of which obstacles are avoidable depends on the agent's capabilities and his beliefs in his capabilities--not to mention all of the further conditions that need to be accounted for in causal judgments. Such beliefs must have some grounding in the actual experience of the agent. These points suggest four dimensions to perspective: 1) a

set of characteristic aims or values, 2) a scope of control or jurisdiction in which these values are pursued, 3) possible actions with consequences relevant to the achievement of the values, and 4) the time frame in which the issue at hand must be decided. The four dimensions are illustrated graphically in Figure 6.

The values dimension. Everyone can probably agree with the idea of value as a general standard for plan formulation, selection, and justification. Albert (1956) observes that values 1) are normative elements in the definition of a situation, 2) may be implicit or explicit, 3) are relatively persistent through time, and 4) are interrelated in culturally or individually distinctive patterns. Economic efficiency has provided the first explicit and long-time standard of federal project evaluation (James and Rogers, 1976), although analysis of actual historical choice patterns show that it has not been the sole criterion (Haveman, 1965).
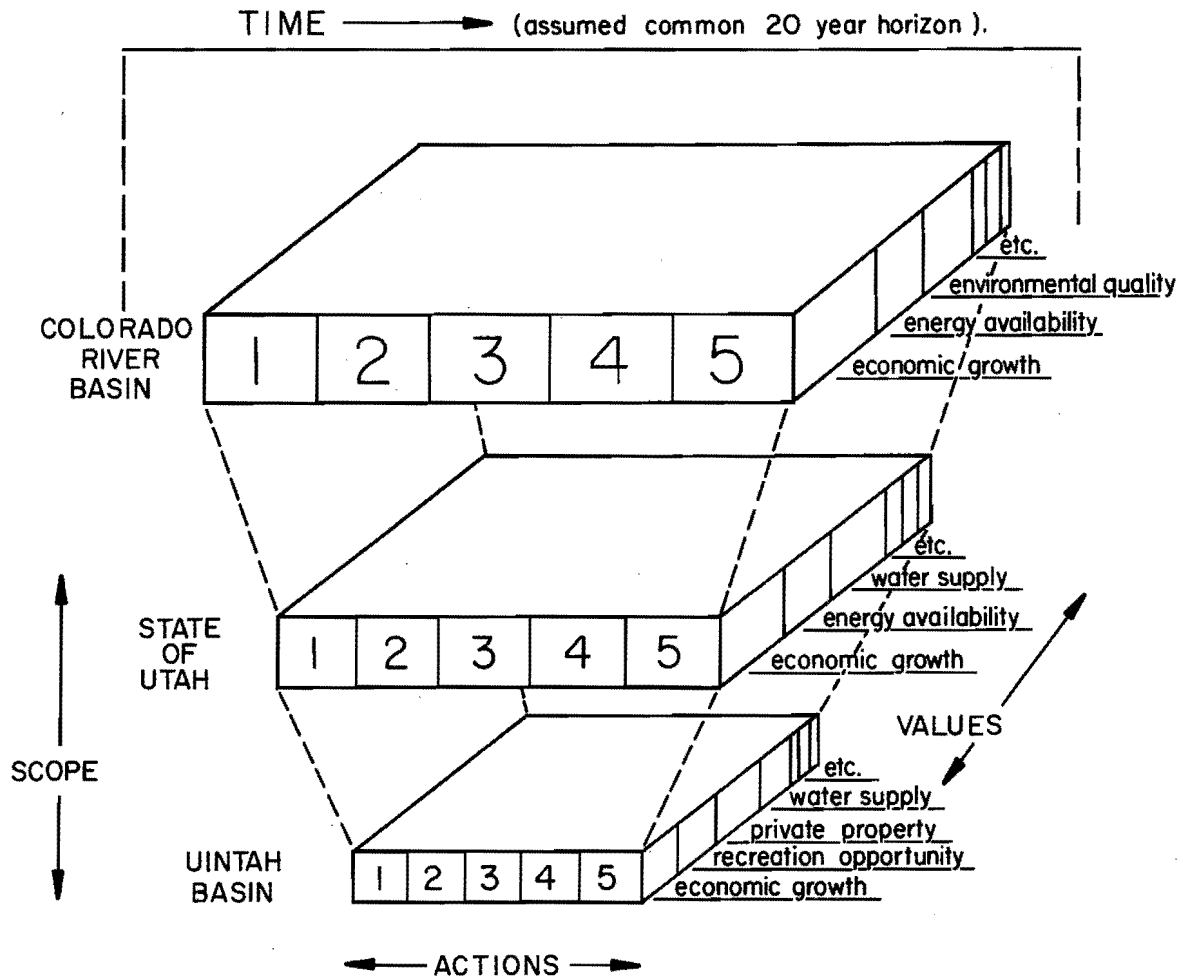
Figure 6. Four dimensions of the Colorado River Basin planning system.

The scope of control dimension.   Planning activities are limited by geographically identifiable boundaries and by functional assignments.   A metropolitan water agency plans for water supply in the area under metropolitan control, but does not plan for health care, nor for water services outside of the metropolitan area.   The configuration of political and functional boundaries has a significant effect on planning coordination and on the alternatives considered.   Integrated water and related land resources planning, for example, is hindered by the fragmented authority in land use controls.

The action dimension.   The authority and capability of the planning agent is also specified in the action dimension. The problem here is that conception of alternatives is far more flexible than ability to implement them.   Even large organizations have difficulty in implementing alternatives with which they have not had previous experience.

The temporal dimension.   Timing issues penetrate each of the other dimensions. Planners generally think in terms of sequences of events extending to some time horizon.   The events, then, constitute the basic temporal units for analysis, and the time horizon serves as the boundary beyond which identification of possible events is either unnecessary or else so uncertain that the effort is not worthwhile.   Before the horizon is reached, the values pursued by a decision maker, and the boundaries of his scope of control, may change, requiring periodic updating of plans.   In addition, implementation of a plan requires the accommodation of temporal relations among activities and of the delayed consequences of actions taken.

The desirability of water resource development and management schemes cannot be defined until the planning system boundaries and elements have been identified.   But needs and alternatives for meeting them can be viewed from many perspectives, each leading to a different identification of "the planning system" and its components (Wimsatt, 1974).

One may encounter differences in points of common reference, differences in division into subunits, and differences in level structures. For example, the boundaries of units defined by political consideration (nations, states, counties, etc.) do not correspond to the watershed units identified by hydrologic considerations, and economic trade regions provide yet a different set of units.   As one influential philosopher has argued, one cannot speak about objects absolutely, but only from a perspective (Quine, 1969).   Only by adopting uncritically a background ontology can one interpret what another is referring to by the use of certain expressions, and there is not just one "correct" background ontology to adopt.

A logical determination of what to include in a planning system must be based upon an understanding of how or why in fact certain distinctions are important.   A guide is found in Moline's principle of relevance defining the important distinctions as those believed to be necessary to the effective pursuit of goals.   The word "belief" in this definition is not used to say that one perceives only what one wants.   The high degree of agreement in identification of physical objects suggests that many things are perceived independently of the purposes of those perceiving them.

Campbell (1958) has suggested that the criteria used to identify physical objects can be of assistance in sharpening identification of systems with less tangible boundaries.   These tests for determining whether an object is a member of some system include: 1) a common fate, defined as covariation of some attribute over time; 2) similarity, where members have, and non-members do not have, some relevant property or set of properties; 3) proximity; 4) resistance to intrusion; 5) uniformity of diffusion.   Application of these tests may improve the clarity of system definition, but they cannot guarantee that different individuals' definitions agree.   Since the number of elements that might be considered in defining a complex system is likely to exceed the information processing capabilities of the analyst, the criteria for inclusion become relative as one defines as large a system as he can handle by adding elements in order of decreasing importance. The real problem, as Van Gigch (1974, p. 17) observes, resides in compromising between those who attempt to take into account too little and distort reality and those who attempt to take into account too much and are incapable of reaching a solution.   Different results will be obtained by different analysts using the same basic methods, due to differences in analytical capability and interest in the analysis.

The planning purposes of the analyst provide an additional pragmatic grounds for defining the system to consider. Accumulated planning experience has evolved to a point giving the planner a fairly good idea of what to look for when the analysis begins. Practice has achieved general agreement on the planning purposes and what should be included in comprehensive analyses.   In Chapter II these purposes were defined as 1) the selection of water development or management schemes that are worthy investments for limited capital resources considering the consequent economic, environmental, and social effects, 2) development of a detailed design that will indeed perform satisfactorily in its intended function, and 3) specification of such details of project implementation as working institutional arrangements for project management, raising the necessary finances, securing needed political approval, and getting user groups to make proper use of project output.

The purposes of management scheme selection, design, and implementation can be accommodated in a planning system defined according to the four dimensions of planning perspective. In comprehensive river basin planning, planning activities that affect the use of water resources in the basin are obvious choices for inclusion. Once the river basin planner defines his system, his decisions begin to be made from the viewpoint of that system as a whole. The river basin planner, therefore, develops his own perspective but must also recognize and relate his perspective to other decision makers, without introducing more complexity than he can handle.

In practice, the river basin planning perspective is typically conceived as derivative of the common interests of jurisdictions in the basin. Although the analyst is likely to give too little attention to the perspectives adopted by others, the acceptability and implementation of the resulting plans will suffer when he does.

Perspective Adoption and Adjustment

It was suggested earlier that a perspective is characteristically formed during the process of human decision making. This claim assumes people to be purposive creatures, who in pursuit of various purposes differentiate between perceptions of features associated with successful achievement and of features that thwart practical pursuits. For the pragmatist, the obstacles have epistemological primacy. Consensus is more easily achieved as planning factors to avoid than as goals to pursue. This inherent human purposiveness, then, is at the core of adopting a planning perspective, but clearly a learning process is required to develop a repertoire of actions that will further the chosen purpose to recognize the limits of one's control. The learning process can be described in terms of a feedback process involving a perceived deficiency, an action intended to remove the deficiency, and an evaluation of success.

It is important to remember that an essential part of this learning process is social. There are many possible purposes or values, in many combinations, that can be pursued; there are many possible actions by which values can be pursued; there are many individual decision centers and thus many potential combinations of choices to be made. The social environment of an individual decision center prevents some possibilities, and more importantly, the socializing institutions provide instruction that an individual would otherwise have to learn by trial and error, if at all.

Organizations can be viewed analogously as acquiring a perspective by continuous articulation of organizational goals and developing a set of operating procedures found to be effective in achieving them.

Organizations are different from persons in being composed of many autonomous decision units. If cooperation in pursuing organizational goals through selected tasks is to be attained, individual members will have to take the probable actions of other members of the organization into account. In other words, individuals assume the perspectives, or at least some of them, of others in the organization. Indeed, acquiring the ability to take the perspective of another is an essential part of the socialization process.

People, organizations, and governments are often interested in trying to induce a particular change in another's perspective by rational means. One attempts to persuade another that his perspective is deficient in some respect, and that there are good reasons to make some alteration. Individuals' perspectives and organizational perspectives may be criticized for being too narrow, and less often, for being too broad (Moline, 1969, p. 193).

Criticisms of scope of perspective require the assumption of at least one dimension as fixed, usually some part of the values dimension. In one sense, this requirement amounts to no more than the recognition that the critic, too, must have a perspective. More importantly, it would not be rational to change a perspective in response to criticism unless the reason warranting the change is already included in the perspective. Thus, rational improvements in the planning perspectives involved in the planning system require that individuals be able to adopt several perspectives, and that there is ample opportunity for dialogue (Habermas, 1975; Friedmann, 1973).

The Concept of Level

Water resources management decisions are made at both individual and collective levels. Individuals decide on such things as land use, water conservation, and flood proofing. Governments decide on structural measures such as dam or channel construction, and on nonstructural measures such as zoning ordinances or water utility price regulation.

The schematic of Figure 6 indicates decisions being made in governmental, technical, economic, social, and cultural dimensions. Decisions in the governmental dimension directly relate to water resources management while the decisions made in the other dimensions are unlikely to be purposefully related to water resources considerations. Governments decide on water projects, but the processes forming cultural norms are generally not strongly dependent on water policy and can more appropriately be considered as part of the water planning context than as part of the explicit water planning system.

For this reason, the four decision making levels commonly taken as within the

system within which water resources planning operates are private individuals, local governments, state governments, and the national government. Each of these levels is related to the others (as well as to decision making levels in the other dimensions that influence but are not defined as within the water planning system) in various ways. If the general forms of these relationships could be identified, the planning effort could be substantially improved.

The general problem presented by multiple decision making levels is that project proposals are generated and evaluated from the different perspectives of each decision maker. The analyses of each decision maker are based on the concepts and degree of detail that he deems appropriate to the purposes at hand. The result is that different proposals are chosen as preferable from different viewpoints for different reasons. The problem of constructing a unified water resources management plan in a setting of multiple decision levels therefore emerges from the difficulties of reconciling the conclusions of analyses carried out at different levels of analysis.

Progress in resolving these difficulties requires a better understanding of what a level is. One philosopher who has given a good deal of attention to the meaning of "level" has identified nine senses of the term relevant to science or philosophy (Bunge, 1963, Ch. V). Four of them are of interest to the present study. One of the most common uses of the term identifies levels with degrees or amounts on a static scale. In the context of a river-basin study, the concern with water surface level is an obvious example. More generally, this sense of "level" is found in the phrase "a high (low) level of X," where "X" is any abstract quality that a thing could have more or less of. This use is not usually a source of difficulty, except when threshold effects are associated with different levels. Water level in a river can be measured on a continuous scale that reaches the flood stage at some point. For some purposes it is necessary only to know that the flood stage has been reached; for other purposes it may be important to know what the flood stage is. In this case, both interests can be satisfactorily accommodated. But when different perspectives focus on different ranges of a continuous scale, as occurred in the cost comparisons between the Uintah and Colorado Basins in PROPDEMM, a single satisfactory resolution is less likely.

A second sense of "level" is degree of complexity. One system is at a higher level than another if the former has more constituent parts and interrelations than the latter (LaPorte, 1975, p. 12-13; Metlay, 1975, p. 26). The planning and management structure for water in a river basin is at a higher level, in this sense, than planning and management for water in an irrigation canal because there are more elements

and interrelationships in a river basin that must be considered. Care must be taken here, however, to recognize the role of conceptual frameworks and practical purposes in characterizing complexity (LaPorte, 1975, p. 7; Wimsatt, 1974, p. 69-74; Wittgenstein, 1953, Sections 46-48).

The third sense of level involves the relation between parts and wholes; its most familiar occurrence is found in various forms of anti-reductionism: "the whole is more than the sum of its parts." The import of these statements is often unclear because of the multiple senses of "whole," "part," and "sum" (Nagel, 1952). Generally the terms "whole" and "part" are used correlatively, so what is needed is an account of the kinds of whole there are to better understand how wholes may be composed of parts (Nagel, 1952; Grossman, 1973). For example, it is fairly unproblemmatic to say that a river basin is composed of all those subbasins, the drainages of which merge at some point. Adopting this hydrological perspective, it is seen that the area of the basin is the sum of the areas of the subbasins. But this sort of additive composition relationship does not hold for other properties of interest: it is not clear how to interpret "sum" in the statement "water quality of a river basin is the sum of water quality of the subbasins of which it is composed."

In many cases, the statement that the whole is greater than the sum of the parts is invoked as a claim for the existence of emergent properties at the level of the whole. That is, we think of levels when the whole exhibits properties not exhibited by the parts and especially when there is no apparent explanation for the property in terms of the parts. In the first case, we have at least descriptive levels (Wimsatt, 1974), and in the second case, the stronger claim of irreducibility. Generally, macro-economics is said to be reducible too, or derived from, micro-economics; nevertheless, it is more convenient to use macro-level terms to describe macro-level phenomena (Brodbeck, 1968). It is much less clear that all social aggregate terms are reducible to descriptions of the individuals composing the aggregates (Lukes, 1973, p. 110-122; Gellner, 1968).

A fourth sense of "level" of interest to this study is hierarchy--an asymmetric ordering of strata. The formally pyramidal structure of authority in military organizations is generally thought to be the best example. Weber's ideal-typical rational bureaucratic form of organization (which he thought would become the dominant modern form because of its efficiency) has hierarchical arrangement as one of its central characteristics (Weber 1946, p. 197). The definition of a hierarchial system has been carefully set out in Mesarovic, Macko, and Takahara (1970), and hierarchical aspects of water planning and management systems have been modeled by Haimes (1973), among others.

In our culture, the term "hierarchy" has a somewhat negative connotation, perhaps because it appears to be antithetical to the ideal of democratic equality. Actually, it would be unusual to find an example of a social institution that did not exhibit some elements of hierarchy and equally unusual to find an institution that was perfectly hierarchical.

The concern with identifying levels and their interactions is rooted in the potential benefit from doing so. There are at least two reasons (not independent of each other) for this benefit. First, natural systems appear to be organized into levels, and levels concepts can thus be used to improve understanding of how they operate. Second, Simon (1969) has suggested that organization into levels is a natural way of coping with complexity. This coping refers both to the advantages in performance that complex systems can achieve and to the problems of control that accompany increased complexity. The advantage of complexity is in that specialization becomes possible when relatively simpler entities are joined together, and specialization increases ability to pursue opportunities and resist hazards. The control problems arise from the need to coordinate specialized activities by channeling the information each unit needs if it is to make timely contributions to collective goals.

The observation that complex systems are composed of relatively less complex subsystems suggests that understanding of complex systems could be improved by analyzing them in terms of their component parts. This is the basic idea in reductive explanations; one of the more successful modes of explanation is science. A reductive explanation consists of showing how the macro-phenomenon to be explained is the result of, or composed of, micro-phenomena. One might, for example, explain the decision of an agency to undertake a given project as the result of actions by certain individuals in the agency. The distinction between micro and macro is relative; the micro level contains smaller units that stand in some composition relation to the macro units (Everson and Paine, 1973). Thus, individuals are micro relative to counties, and counties are micro relative to states (though the macro-micro relations are not of the same type).

One practical effect of complexity is to inhibit action. The use of levels in conceptualizing problems can therefore be seen as a way of reducing complexity to facilitate action. Large problems, that seem overwhelming when taken as a whole, may be solved satisfactorily once defined into a set of smaller problems. Similarly, if the knowledge required to perform certain tasks can be organized into levels of concepts (going from general to specific), the process of transmitting this knowledge can be improved.

In selecting the level of analysis to use in a water resources planning study, an investigator should focus on the level which best accounts for the phenomena to be explained (Winsatt, 1974) because they are of interest to those who will use the results of the planning. A reductive approach to explanation requires use of the lowest or "bottom" level because a reductive explanation is not complete unless the reduction is carried that far. Such is the position of the methodological individualists in the social sciences, who claim that persons are the fundamental social units and thus that no explanation of social phenomena is complete unless all relevant predicates describing social aggregates have been reduced to predicates describing individual behavior (Brodbeck, 1968; Watkins, 1968).

Opposed to the methodological individualists are the emergentists or holists, who claim the existence of irreducible social facts. Proponents of this approach argue that predicates describing social groups or institutions may appear in complete explanations of social phenomena (Durkheim, 1964; Gellner, 1968; Agassi, 1975).

Advocates of this approach thus suggest that reduction to the lowest possible level is not necessarily desirable. It requires extra work and makes explanation of irreducible social facts impossible. According to this position, the levels of analysis employed in any particular inquiry, should depend on the explanatory needs of the investigator. Simon (1969) suggests that planners seldom achieve explanatory benefits worth the efforts of employing more than three levels: the focal level to be explained, the level above, of which it is part (the context or environment), and the level below containing the parts into which focal units are to be analyzed.

Sometimes the selection is dictated by methodological concerns, as when data are available only in highly aggregated form (Dogan and Rokkan, 1969). In many cases, investigators adopt different level foci for different purposes (Singer, 1961). This can create problems in utilization of the results because relevance to policy actions in a given functional area varies from one policy maker to another--compare the needs of a county board responsible for flood plain zoning with those of the director of the National Flood Insurance Program. Planning studies should therefore be carefully designed so that the level of analysis employed by the planner corresponds to that of the user. At the same time, of course, the user must recognize the possibility that data or methodological problems may make it impossible to achieve results at the level desired.

An excellent example of employing different focal levels to explain the same

phenomenon is found in Allison's study (1971) of the Cuban missile crisis. He applied three analytic approaches to political science and provided three different, but plausible, explanations of what took place in October 1962. The three models are summarized in Table 10. Model I is the national actor model frequently used in international relations. An equivalent in water planning would be to treat an entire basin as a single decision unit and determine the best basin-wide allocation of water in terms of national principles and standards. Government action is interpreted within the framework of the value-maximizing behavior adopted for decision analyses. Model II focuses on the set of organizations involved in the formulation and execution of government policy. According to the model, complex organizations can only act through an established routine which must order the actions of a large number of individuals. This implies that effective organizational response to any new situation must be in terms of established routines. In other words, the price of being able to perform complex tasks is the limitation of flexibility. Finally, Model III is the bureaucratic politics paradigm which interprets government actions as the result of a sequential bargaining game.

> The bureaucratic politics model sees no unitary actor but rather many actors as players, who focus not on a single strategic issue but on many diverse intra-national problems as well, in terms of no consistent set of strategic objectives but rather in terms of various conceptions of national, organizational, and personal goals, making government decisions not by rational choice but by the pulling and hauling that is politics (Allison, 1969, p. 407).

All three of these models can be profitably employed to analyze processes in a planning system. Model I provides a perspective for choosing among the development alternatives for a basin-wide plan; but implementation of a plan determined in this manner must be tempered by recognition that implementation will be constrained by the established repertoires of existing organizations as in Model II and by the rather unpredictable outcome of bargaining as in Model III. In short, comprehensive planning requires all three levels of analysis and must be sensitive, therefore, to the problems of consistency that arise in shifting focus from one level to another.

The foregoing remarks suggest that in many cases a multiple level focus is appropriate for comprehensive planning. Ideally, one would hope that as the analysis shifts focus from one level to the next, the understanding gained will be complementary and cumulative. This is seldom the case. Propositions and recommendations at one level may be of little consequence from the perspective of another level, or worse, they may actually conflict. In the latter case, the investigator may simply have to choose the level that will dominate. In these cases, one would expect decisions to favor the level paying for the study (Brewer, 1973), creating imbalances when resources for analysis are unevenly distributed among decision levels.

During a study with a multiple level focus, the investigator typically has information about units at one level, and is interested in what, if anything, can be inferred from this information about units at another level. The process requires that collected data be either aggregated or disaggregated. Either operation requires assumption of a rule governing the procedure.

In the social sciences, recognition of the existence of inherent problems in aggregating or disaggregating data dates back at least to Robinson (1950) (and somewhat earlier in economics). Alker (1969) gen-

Table 10. Outline of three levels of analysis. (Adapted from Allison, 1970, p. 256).

	MODEL I	MODEL II	MODEL III
Paradigm	Government action as rational choice	Government action largely determined by institutional standard operating procedures and goals	Government action as the result of bargaining among concerned individuals in positions of power
Basic unit of analysis	National actor	Organizational actors	Players in positions
Organizing concepts	The usual canons of rational choice	Factual problems & fractionated power Parochial priorities & perceptions Standard operating procedures Uncertainty avoidance Central coordination accounts Decisions of government leaders	Players in positions Parochial priorities & perceptions Goals & interests Stakes & stands Deadlines & faces of issues Power Action-channels Rules of the game

eralized Robinson's conclusion and identified seven fallacies of ecological inference, summarized in Figure 7. It is usually possible to resolve the objects of analysis into three levels: individuals, groups of individuals, or an overall level, like the social system. In analyses where different levels are recognized, it is not <u>logically</u> true that: 1) what is true overall is true within a particular group (universal fallacy); 2) what is true overall is true between groups (individualistic fallacy); 3) what is true of a particular group is true overall (selective fallacy); 4) what is true in a particular group is true in another group (contextual fallacy); 5) what is true in a particular group is true between groups (cross-sectional fallacy); 6) what is true between groups is true within a group (historical fallacy); 7) what is true between groups is true overall (ecological fallacy).

The possibility of ecological fallacy in planning is quite high not only because it is of interest to express the relationships between phenomena of different levels, but also because the only available data are often collected at a level different from the planning focus. As Hannan (1971, p. 475) points out, "problems of aggregation and disaggregation arise largely as a consequence of <u>missing data</u>." Since ecological inferences are not necessarily true (nor necessarily false) but often unavoidable, it becomes necessary to offer an auxiliary premise to warrant the inference. This suggests that positions on ecological inference may be located along a continuum, defined by degree of willingness to assume similarity of properties across levels. On this continuum, the homology approach at one end supports unrestricted use of propositions across levels, and the inconsistency approach at the other end rejects such use of propositions (Hannan, 1970; 1971).

Each planning effort, by choice or by default, locates somewhere along this continuum according to the approach taken how to express the micro-macro composition rela-

tions. The aggregation procedure can take the form of "natural" intermediate forms (Ando, Fisher, and Simon, 1963) obtained from the application of a specified algorithm. Alternatively, it may search out the most likely relation between specified macro and micro variables. For decision making, the most useful aggregation problem is interpreted as the most efficient simplication, in terms of best allocation of resources available for the analysis, given the kind of decision to be made and the available implementation means (Nataf, 1968; Theil, 1972).

All sorts of studies from scientific inquiry to fact gathering for political decision making can and usually need to be analyzed at various levels. For each decision, Boulding (1956) tells us that "Somewhere, however, between the specific that has no meaning and the general that has no content there must be, for each purpose, and at each level of abstraction, an optimum degree of generality." The problem is determining the degree of generality at which an analysis will provide the best results in terms of the goals of each portion of the planning.

One of the most common problems in public works planning is that any proposal, be it a dam and reservoir or a curb and gutter, is simultaneously considered from perspectives using various levels of analysis ranging from the top levels of government to people in the immediate vicinity. Different designs are likely to be preferred from the different viewpoints, and each level uses different concepts in reaching its decision and consequently in discussing the reasons for its decision with others. A planner may not have freedom of choice on a level of analysis and may have to work toward reaching a conclusion acceptable at all levels without creating conceptual confusion. When the total study requires analysis at more than one level, great care must be taken not to apply concepts discovered at one level indiscriminately to other levels.
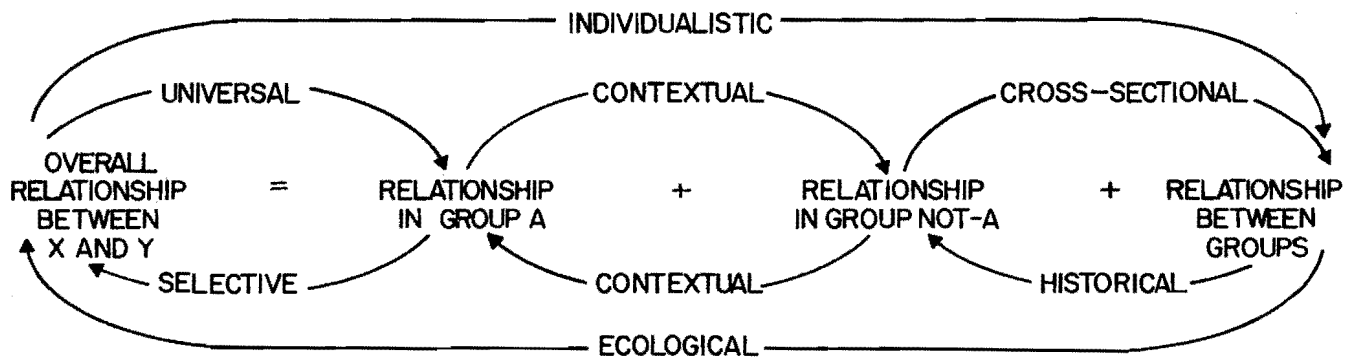
Figure 7. Types of ecological fallacies (adapted from Alker, 1969).

Recapitulation

The discussion in this chapter has described how the concept of perspective can be used in defining a total planning system and how the appropriate level for analyzing that system varies with perspective and needs to be explicitly chosen in harmony with the purposes of the planning effort. Perspectives are inherent in human decision making where they take on values, scope of control, capability of action, and temporal dimensions that collectively define the relevant planning system. Different actors with voices in the decision making process developed different perspectives based on experience and capability with respect to these dimensions, and the total relevant system would encompass all aspects relevant from any perspective. A more practical definition of the relevant system, however, recognizes that the planning process cannot afford to devote extensive effort in areas of the total system that are of interest to relatively few actors and that socialization processes among the actors work to reduce the scope of accepted concerns.

The selected planning system can then be analyzed from the perspectives of the various parties who have active interest in the sorts of decisions at hand, in this case water management and use decisions. In practice this means concerned individuals and the levels of government from local to national having jurisdiction in the matter. The primary levels concepts useful in this analysis are the relationships among parts and wholes and the concept of hierarchy. The reductionist approach would reduce the whole system to its smallest component units, but the theory of the existence of irreducible social facts and the practical limitations in data availability and data processing make inquiry at a higher level, chosen to satisfy the explanatory needs of the investigator, more satisfacory. Where multiple perspectives are involved, explanatory needs vary with perspective, and inquiry is necessary at a level to meet each need. This means two or three levels in practice. In concentrating on two or three selected levels, however, one should recognize the ever-present possibility of biasing the results because of ecological fallacy in that relationships found among groups at the levels chosen do not represent relationships among groups at other levels or the overall situation.

The discussion in this chapter has shown that the problems of levels of analysis are among the most fundamental in conceptualizing a comprehensive river basin plan. A conceptual framework based on the idea of a planning perspective, was defined and will be used in the next chapter to consider how relational problems may be overcome when planning from a single perspective, and in the following chapter the concept will be expanded to multiple objective planning.

RELATIONAL PROBLEMS IN SINGLE PERSPECTIVE ANALYSES

Introduction

Relational problems seem less serious when a single planning perspective is involved. Although decision making on total planning systems nearly always involves multiple levels, an analyst can take a single perspective by specification of selected interrelationships. The results of these selections may lead to implausible or erroneous conclusions, but the levels phenomenon does not usually obstruct plan formulation. To put the situation differently, when planning studies use multiple levels analysis, decisions must be made on which levels to use and how to relate them. An indecisive analyst is thus in a position similar to that of two analysts who disagree on what the best focus for study is. But the individual analyst is likely to have an easier time resolving (ignoring?) his difficulties.

The relational problems to be explored in this chapter may be generally characterized as emerging from the planner's need to structure the dimensions of his perspective to make good use of available information in finding answers to questions that arise in the planning study. A reasonable way to order the discussion of these problems is to arrange the four dimensions of planning perspective in the matrix form used in Chapter II (Figure 2) and discuss each cell.

Problems Within the Temporal Dimension

The Temporal Dimension

Planners generally think in terms of scenarios consisting of sequences of events extending to some future time horizon. The events, then, constitute the basic temporal units in analysis, and the temporal horizon serves as the boundary beyond which the identification of later possible events is either unnecessary or else so uncertain that the effort is not worthwhile. Internally, the planning period may be thought of as a temporal whole composed of events--the temporal parts.

The philosophical issues in the individuation of events are too complex for full discussion here,[1] and it will be sufficient for our purposes to follow a generally pragmatic line and show how what counts as an event is heavily dependent on

the purposes of the people concerned. This functional orientation is evident in the discussion by James and Lee (1971, p. 9-10) of four planning horizons in engineering economy studies:[2]

> The economic life ends when the incremental benefits from continued use no longer exceed the incremental cost of continued operation. The physical life ends when a facility can no longer physically perform its intended function. The period of analysis is the length of time over which project consequences occurring are included in a particular study. The construction horizon is reached when the constructed facilities are no longer expected to satisfy future demands.

If projects are compared on the basis of expected net benefit, the fate of a project may depend on how far into the future the analyst is willing to go in estimating the flow of benefits and is particularly likely to do so if a low discount rate is used (Herfindahl and Kneese, 1974, p. 189-222; National Water Commission, 1973; Krutilla and Fisher, 1975; Howe, 1971).

In principle, there seems to be no limit to the number of time subdivisions that can be made, so that one can characterize processes of very short duration and very long duration on the same scale. The fact that this can be done in principle, however, does not overcome the practical difficulty of assigning value to the smallest units and to the largest units on the same scale. People concerned with activities or events that occur within the smaller temporal

---

[1] A good discussion of the problems here is found in Beardsley (1975); also Davidson in Rescher et al., eds., (1969).

[2] A related statement is found in the Water Resources Council's statement of Principles and Standards (1973:24784). The period of analysis will be the lesser of 1) the period of time over which the plan can reasonably be expected to serve a useful purpose considering probably technological trends affecting various alternatives; on 2) the period of time when further discounting of beneficial and adverse effects will have no appreciable effects on design.

intervals have difficulty grasping the practical import of events that are not signifcant except over longer intervals. Conversely, when one is concerned with longer intervals, events of shorter duration tend to fade to insignificance. This difference perhaps in part accounts for the differences in planning perspective between those thinking of short-term economic gain and those thinking of long-term ecologic loss. It is a basic fact, as Hayek has argued, "that it is impossible for any man to survey more than a limited field, to be aware of the urgency of more than a limited number of needs" (1944, p. 59).

It is also useful to distinguish among four patterns of distribution within the interval (Rescher and Urquhart, 1971, p. 159-161): 1) Holistic activites occur over the interval as a whole but cannot be said to occur in any subinterval. 2) Homogeneous activities can be said to take place over any or all subintervals in the same sense that they can be said to take place in the interval as a whole. Constructing an irrigation canal is a holostic activity for one dealing in annual time units while irrigating fields is a homogeneous activity. 3) Majoritative activities go on during most, but not necessarily all, parts of the time interval. Reading this report is likely to be a majoritative activity for a day or two. 4) Finally, occasional activities go on at some times in the interval but not necessarily most of the time. Gaging water quality or stream flow are examples. The classification for a given activity, however, depends on the length of the time interval. Keeping these different temporal patterns in mind can be helpful in constructing efficient management systems.

The Values Dimension

For at least the past century, one of the dominant philosophies of value in the United States has been utilitarianism. This dominance is apparent in the use of benefit-cost analysis as a method of social policy evaluation. One of the fundamental claims of utilitarianism (and to the non-utilitarian, one of its fundamental deficiencies) is that ultimately there is only one values (or, at least one highest value), although there is some disagreement among utilitarians on what to call it.[3] Among the candidates are "pleasure," "utility," "happiness," and "the general welfare." Other value terms--say, "liberty," "justice," "beauty," are to be valued because (and only because) of their contribution to the general welfare. The one ultimate value is the only criterion of choice needed. Alternative courses of action can, theoretically,

_____

[3]On this and other current issues in utilitarianism, see the excellent review by Brock (1973).

be measured by this single dimension, and the one ranked highest (assuming there are no ties) is the one which ought to be chosen. Economic efficiency has provided the first explicit and long-time ostensible standard of federal project evaluation (James and Rogers, 1976). Because economic efficiency as traditionally applied can conflict with other values, like equality (Okun, 1975) or environmental quality (Commoner, 1971), important considerations are left out when efficiency is the sole evaluative criterion.

It is useful to distinguish among the ways values can conflict (Rescher, 1969b). Probably the most common case of conflicting values (labeled "accidental" in Figure 2) is where mutually exclusive courses of action contribute to the fulfillment of two or more values to differing degrees. These conflicts are called accidental because they arise in the context of competing states of affairs rather than in the content of the values themselves; a different, as yet unidentified, alternative might satisfactorily achieve the values at issue without conflict.

In contrast, other values necessarily conflict. Some values in fact seem to occur in polar pairs. Familiar examples include liberty and authority, individualism and collectivism, participation and expertise. In every case where one is relevant the other member of the pair is also. An improvement in one requires diminution in the other.

Finally, there are conflicts among criteria of value achievement. For example, people may agree on the need for clean water but disagree over how clean is "clean." Apparent conflicts of this sort are often actually based on one of the other types of conflicts mentioned. However, two agents sometimes more or less independently adopt standards for the same value and later find they need to come to some sort of agreement on criteria of achievement. The adoption of the Principles and Standards for federal water planning is an example. The need for common standards becomes greater as the number of agents involved increases.

The objection that economic efficiency does not capture important considerations in water resources managment has led to the explicit recognition of environmental quality as an added value. Lesser attention has been given to regional development and social well-being (Water Resources Council, 1973). All these values cannot be reduced to a single value without a straightforward reduction method. Because the concept of decision implies convergence on a single alternative, the admission of multiple values requires aggregation across values.

Systematic attention to aggregating values for multiobjective decision making is fairly recent, but a growing number of techniques and applications are being reported. Useful recent surveys of this work include MacCrimmon (1973) and, with emphasis on

water resources applications, Cohon and Marks (1975). MacCrimmon groups 19 aggregating techniques into four major categories with three subdivisions in each.[4] His four major categories indicate the variety of approaches possible for aggregating multiple values, and therefore, the difficulty of identifying the "best" for given cases.

The first category is the weighting method. It requires that a scale be constructed for each value of interest, so that each alternative may be quantified with respect to each value. A numerical weight is assigned to each value score, reflecting the relative importance of the value, and products of values and weights are summed to give each alternative a single score. The alternative with the highest total score is then chosen.[5]

MacCrimmon's second major category is the sequential elimination method. It also begins with a set of attributes expressing the values in terms of which alternatives are to be characterized. The attributes are scaled in such a way that they form a set of constraints. Any alternative that does not comply with the set of constraints is then eliminated. Generally, the set of constraints can be specified so that at least one acceptable alternative is found.

The third category of multiobjective techniques is mathematical programming. The attributes of interest are the variables, and the alternatives are implicitly identified by the set of constraints imposed upon the values of the variables. These constraints may be both technological and--as in the case of goal programming--preference. An algorithm generates a set of preferred points from the set of feasible solutions (i.e., the set of solutions satisfying the constraints) and systematically evaluates them in terms of a specified objective function in order to converge on an optimum.

The final group of techniques is the spatial proximity method. Some applications of this method are simply instances of the previous methods where emphasis is placed on geometric representations. Each value is represented by a dimension in multidimen-

---

[4]Cohon and Marks use three major categories to divide 12 approaches. But their interests are slightly different from those here, i.e., they wish to evaluate techniques with mathematical representations in terms of computational efficiency and comprehensibility of the display of alternatives.

[5]The PROPDEMM technique described in Chapter IV falls roughly into this category, with the complication that multiple values are distributed over several decision makers. Thus, the weighting procedure not only weights values (via "Group Salience"), but groups as well (via "Group Power").

sional space, the decision maker is asked to identify the ideal point in that space, and alternatives that are ranked according to their distance from the ideal.

The Scope/Jurisdiction Dimension

Generally, a policy is considered less relevant if it does not affect the welfare of individuals in the decision making unit. Political units in fact behave somewhat like egoists. If efficiency is the primary value, one would want to adjust the boundaries of the decision unit to the boundaries of policy effects.

> If the boundaries of the political body are not roughly congruent with the boundaries over which the external benefits or costs prevail, decisions will be biased and inefficient. If the affected area is too small, important benefits or costs will be ignored. If the area is too large, excessive centralization and the associated inefficiencies will result. (Schultze, 1968, p. 127-128.)

Unlike individual egoists, political units cannot operate on the basis of simple welfare maximization; the distribution of costs and benefits is crucial.

One of the long-standing controversies in political theory is the determination of the best size of the policy for the performance of its responsibilities. These responsibilities fall under the general goal of promoting the general welfare.

Of course such an abstract value as the general welfare does not provide much guidance in deciding what the boundaries of the political unit ought to be and if taken to encompass all welfare effects would lead to a political boundary that would include the whole world. Appropriate smaller units are difficult to identify without defining the particular activities that are appropriate for governments to undertake.

The Action Dimension

The primary source of conflict in the actions dimension is associated with difficulties in ascertaining the technical feasibility of action alternatives and consequent different perceptions of probable effectiveness. When performance cannot be predicted to the general satisfaction of the various decision makers, each is likely to prefer the action with which he is most familiar. Often this choice is grounded in part on faith that the familiar can be made to work more than on evidence from past performance. Dam builders and the enforcers of zoning laws both believe they can succeed working in the framework they know best. The way out of this sort of conflict is found in

developing better causal relationships for prediction, and that topic is examined in the balance of this chapter. The implication is that problems associated with imperfect causal relationships predominate in single perspective analyses and problems associated with clashes in the other three dimensions predominate in multiple perspective analyses.

Causal Relations

Causal relationships become a problem when deterministic efforts to represent them do not portray what the decision makers presented with the plan have found to happen in similar situations in their experience. The problem becomes particularly severe should subsequent experience after action is taken on the planning information conform more closely to the expectations of the doubtful decision maker than of the planner.

The faulty planning projections can result from inadequacies in a deterministic model used by the planners or in the fact that random events in real world systems mean that projections can only be made on a stochastic basis. Departure in a given situation may then simply be because a rare random event (a major flood for example) happened to occur within a planning horizon in which it would not normally be expected. Such events become particularly difficult to deal with in planning for multiple level decision making because the various actors usually have quite different risk aversions and perceptions of possible outcomes.

Further probing of the problem requires exploration of causal relationships in greater depth. Causal judgments have several uses in planning:

> (1) We make causal judgments to explain the occurrence of particular events; (2) we seek causal knowledge because of its predictive usefulness; (3) knowledge of causal connections often gives us power to control events; (4) causal attributions involving agents are important in the attribution of moral responsibility, legal liability, and so on; (5) causal concepts are often used in special technical senses in physical theory (Kim, 1973, p. 572).

The first practical problem is how to determine that a causal relation exists between two objects.[6] Current approaches often take Hume's famous statement as a point of departure:

> We may define a cause to be an object followed by another, and

---

[6]Useful recent collections of articles on causation, with introductory surveys are Brand (1976) and Sosa (1975).

where all the objects, similar to the first, are followed by objects similar to the second. Or in other words, where, if the first object had not been, the second never had existed. (Hume, 1902:VII, 72, emphasis omitted.)

The standard modern version of causation is that one event C is the cause of another event E if E occurred after C, and C and E are instances of (the antecedent and consequent of) a general law. In other words, given the natural law and the initial condition C, event E follows deductively (Nagel, 1961, p. 73-75; Hempel, 1966, p. 49-58). This explanation is generally thought to be adequate for at least some range of phenomena. Disagreement centers on how broad this range is, and what sort of analysis may be provided for causal relations beyond it.

Causal relationships are sought and used in two ways in planning. One is the determination that something is the cause of some effect, and the other is the determination of the causal contribution of something to subsequent states of affairs, that is the consequences of some event. Few claims that one thing caused another thing are ever made unconditionally, but rather on the assumption that a number of other "background" conditions--the ever present ceteris paribus cause--also pertained. The question that then arises is why the one thing should be singled out as the cause when the truth of the assertion evidently depends on the presence of other conditions. Various attempts have been made to reformulate the notion of causation to address this question. One recent suggestion, by Mackie (1975), is that we identify causal attributions with an INUS condition, which he defines as "an insufficient but necessary part of a condition which is itself unnecessary but sufficient for the result." Having thus explicitly included relevant background conditions; one must return to the question of how any one part of the sufficient conditions can be favored as the cause, and answering the question poses the additional problem of delimiting the boundary of the sufficient condition. It does not, after all, seem reasonable to include the entire state of the universe just prior to the result in the sufficient condition.

In cases where we have a well-established scientific theory--such that the cause and effect in question can be construed as instances of a causal law--the situation is not so difficult. The central concern is that the cause and effect in question are of the appropriate kind, as indicated in the covering law. In other words, the laws on which we are able to rely provide guidance in singling out the cause. Secondly, one should look for other relevant conditions known to be required if the causal relation is to hold but likely to be present in the context in which the law is being applied. In other

words, background conditions become salient to the degree that they are known to be variable.

The problem planners encounter in trying to predict the consequences of their actions is notable lack of scientific laws for projecting impacts other than those in the technical dimensions of Figure 1. Consequently, a very large number of auxiliary conditions seem to be required in order to make explanations and predictions fit the covering law model. Alternatively, it has been observed that the logical form is satisfied easily enough, but at the expense of plausibility (Mandelbaum, 1960). It has been suggested by some (Mandelbaum, 1960; Winch, 1958; Louch, 1966) that events in practical affairs are identified according to different standards--i.e., the interests of actors in particular situations--than are events in scientific contexts, so that traditional causal interpretations are inappropriate, or at least cannot be applied until the events in question have been analyzed into components. The implication is that causal explanations proposed for actual situations are heavily dependent on the interests of actors doing the explaining; moreover, the actions of actors depend on their interests.[7] The supporting assumptions for causal explanations in practical affairs, then, are often closely tied to salient values and objectives. Since these may be different for different groups, and can change over time, the same generality and stability of causal laws in hard sciences does not appear to be attainable in policy sciences (Reynolds, 1976).

Another way to put this problems is that when planners bring human actions into a discussion of causes and effects, they must take into account the possiblility that actions have some of the consequences they do because of their intrinsically social nature.[8] If someone diverts an amount of water in the Colorado Basin, two likely consequences that fit our ordinary causal model are a decrease in downstream flow and an increase in downstream salinity. Another consequence might be a law suit filed by downstream water users wishing to collect for damages. The first two consequences may be

expected to follow regularly from a water diversion, but the third consequence is contingent upon the institutional setting in which water allocations are made. Thus, the criteria for identifying causes in practical affairs must include the institutions which make certain actions possible and partially determine the conditions under which an agent may be held to be the cause of certain effects (Hart and Honore, 1959).

The second problem of causation that arises in planning activities is the notion of the consequence of an action. Our ordinary conception of performing an action is that of making something happen or bringing something about. We think of actions generating consequences in the future. Some of the consequences are beneficial, some are harmful, and others are neither beneficial nor harmful. Judgments as to whether a consequence is beneficial or harmful and the degree of benefit or harm vary with perspective and level of analysis. In addition, we are often interested in determining whether certain consequences are intentional or unintentional.

If the utilitarian's teleological evaluation of proposed actions is adopted-- that is, if the alternative is chosen that is expected to have the highest net benefits-- then there must be some way of estimating the relevant consequences of the alternatives before they occur. If we want to improve future predictions by monitoring the consequences of past actions, we need a way of identifying the consequences of the actions as they happen.[9] Our initial inclination, then, is to claim that ideally we should compare the total consequences of each alternative. But Bergstrom (1966) has argued persuasively that the consequences of an action, or any plausible interpretation of "consequences," are indeterminate. Prior (1968, p. 54) goes further and claims that "the notion of the total consequences of an action seems thus to suffer from an incurable incoherence which renders it useless for ethical theory or for any other sort of theory."

The reason for Prior's objections is the difficulty of separating what happens after the performance of an action into the consequences of that action and consequences of other happenings. Since the occurrence of an effect requires the presence of other conditions, one may think of the consequences of these conditions as what would have happened if the action in question had not been performed, but everything else had been the same (Lewis, 1973). But this is almost certain to place too much

---

[7]Although he does not have the final word in all cases, the agent's view of his actions is the favored interpretation. Presumably the agent views what he is doing according to the practical purposes to which he is attending.

[8]Actions that are "internal" to a practice--that is, actions that cannot be performed except within a definite institutional setting--are paradigm cases of this social dependence. The rules governing the practice are then said to be constitutive of the action see Searle (1969, p. 33-42).

---

[9]Equivalently, we must be prepared to identify actions in terms of their consequences. What is meant by performing that action is the bringing about of those consequences (Lyons, 1965).

weight on the action in question, for consequences will be attributed to it that occur only because it and certain other conditions are present--for example, the chemical effluent that is not harmful alone, but interacts with another harmless effluent to form a toxic chemical.

The consequences of actions are further rendered indeterminate by subsequent decisions. Present actions have consequences extending into the future, forming the conditions in which future decisions are taken. But since each future decision also generates consequences, each decision point represents, as it were, a dilution of the consequences of previous decisions. In other words, we cannot determine the total consequences of present actions because some of them depend on future decisions.

This indeterminacy of the consequences of an action creates problems in forecasting for making planning choices. The commonly expressed desire of decision makers for certain prediction is not attainable because the planner can never be sure. But we are reasonably sure of what we are doing in some cases, and this indicates that we employ other standards of prediction. These other standards may be summarized as explicit or implicit rules indicating possible consequences that may be ignored and possible consequences that, for various reasons, should be included in our deliberations. This corresponds to D'Arcy's (1963) concept of focal act descriptions: features of acts that, if they apply in a given instance, cannot be omitted from the description of that act without deception. The application of these rules and norms make planning possible, but creates problems at the same time.

By narrowing the range of considered consequences, it becomes possible to identify and compare actions in terms of a manageable set of characteristics required for successful performance. In fact, we may observe that different actions are identified with varying degrees of certainty as to their consequences. One common way to identify actions, but maintain a choice dependent on consequences, is to conceive of the action as bringing about some (especially desired) state of affairs; in other words, identification by goal. An action of this sort is called by whatever phrase is the appropriate replacement for "X" in "bringing about X." Notice, however, that it is necessary to distinguish between the action and the goal, so that we shall be able to describe the action "bringing about X" as "bringing about X by Y-ing" (Austin, 1956-57; Anscombe, 1976; Meiland, 1970, p. 36-42). The distinction is necessary for the same reason, basically, that "total consequences" proved to be unworkable. There are cases where we fail to bring about what we intended to, but nevertheless we can say what it was that we were doing. When intention and performance do not match one does not then decide that he

must have deceived himself about what his intentions really were.

At the other end of action identification are those actions that are identified fairly independently of consequences, or not conceptually tied to particular goals. The descriptions of such actions are, in other words, fairly neutral with respect to different practical purposes.

One way to view a plan is as a specified set of actions leading to a goal. Therefore, the identification of actions according to their contribution to goals is an essential part of planning. On the other hand, if actions cannot be identified independently of particular goals, it will be more difficult to coordinate the activities of different agents, particularly different agents pursuing different goals and having different training.

A tension is thus created between the advantages of more certain goal achievement from specialization and the increased difficulty of coordinating individuals with different specialized training. A further tension is created between the increased effectiveness of specialization, under a certain range of circumstances, and the possibility of reduced effectiveness when special procedures are applied in circumstances outside of this range (Alexander, 1964). Finally, the need to restrict the range of consequences in order to identify actions at all implies that virtually every action will have unintended consequences.

Unintended consequences become a serious planning problem under conditions of rapid social change, for such circumstances are likely to change the conditions necessary for an action to have even its expected effects. Since society is unlikely to excuse (negative) unintended consequences a second time, it is often necessary either to take a meliorative actions or refrain from actions, even though their consequences are not certain.

Recapitulation

The discussion in this chapter describes key problems in the temporal, values, scope-jurisdictional, and action dimensions of perspective for planning by a single analyst. The temporal problems center on how to divide planning time into subunits and fit processes into those units. The value problems are that the values perceived from different perspectives can conflict and so can the criteria used to determine whether desired values have been achieved. The principal scope-jurisdictional problem is that institutionalized boundaries of responsibility vary from those encompassing a desirable planning system. The action problems relate to the inadequacies of available tools for forecasting the impacts

of actions under consideration. A more detailed probing of these inadequacies then showed certain fundamental inadequacies in the way planners handle necessary and sufficient conditions in applying causal relationships to be as if not more important than inadequacies in the relationships available to planners in projecting the consequences of contemplated actions for decision makers. The common consequence is that the sum of the benefits achieved from a group of implemented plans is often far less than the sum of the benefits causally attributed to each of them individually because of the interactions among them. Planning models need to be refined to deal with this problem more explicitly.

CHAPTER VIII

RELATIONAL PROBLEMS IN MULTIPLE PERSPECTIVE ANALYSES

Introduction

Chapter VII was used to explore the relational problems in single perspective planning. The effort identified the problems in aggregating available data units to obtain relevant information and in disaggregating the total planning system to an appropriate level for predicting the consequences of action alternatives as major planning issues. Deeper exploration, however, showed that the ideal of putting descriptive data together in a way that would permit the use of physical laws to predict the consequences of action alternatives is not in harmony with the realities of how causes lead to effects. The consequences of a contemplated course of future action or of a monitored historical choice cannot in actuality be separated from what would have happened without that action. Consequences for which an action provides both necessary and sufficient conditions do not continue over a long time frame but rather are in fact soon altered in nature by consequences stemming from other actions or decisions. Dynamically interacting real world conditions make it impossible to attribute long consequence time streams to a single initial course of action.

What then is the planner to do? Is he to recommend against all long-term actions for social betterment because theoretical limitations in the effects one can attribute to a cause make it impossible to prove action justified? Such a policy can be followed only at tremendous loss to social welfare because none of the interacting actions would be taken. The solution to the dilemma must rather be found in defining a test for project justification short of requiring proven causal benefits to exceed costs. Benefits associated with some lesser degree of partial causality must be accepted.

The notion of acceptance leads to the problems in multiple perspective planning since acceptance is achieved through reconciling conclusions reached by diverse decision makers on the basis of the perspectives that they have developed in coping with their particular situations. The relational issues in reaching these conclusions combine those already discussed as pertaining to reaching the component single perspective conclusions, the likelihood that contrary to reductionist philosophy the process of social decision making contains elements that cannot be broken down into individual decision making units, and the problems of duplicating realistic social decision making

processes for reconciling individual differences in a planning framework. The planner must reconcile differences in plan formulation in a way that the public served is willing to accept as conforming to a reasonable collective preference. This chapter addresses these issues by dealing with the relational problems encountered in the multiple perspective context.

Values Used in Multiple Perspective Planning

Individuals form their values without too much concern as to whether the procedure used was proper or whether the results are really in their own best interest. Collective values thus include two kinds of criteria in addition to values obtained for society by reconciling differences in individual preference.

Consequently, the values relevant to multiperspective planning can be classified into three groups. The first is composed of substantive criteria, like efficiency and environmental quality, that are applied to probable decision outcomes themselves. Second, procedural criteria guide the process by which decisions are reached. For example, procedural criteria are specified for use by water resources agencies in estimating costs and benefits. The third group is the source of legitimacy or origin of the evaluative criteria in use. For agencies, the usual sources of legitimacy are legislation and executive orders, and thus failure to cite, or, worse yet, to abide by the relevant legislative or executive authorizations can be sufficient to bring action to a halt. Legislation and orders are also justified by recognized purposes, so failure to achieve goals can bring changes. Finally, agencies are sensitive to public support and opposition, so that agency perceptions of the public mood affects the commitment with which an agency implements its programs.

The evaluative base for government involvement in water resources has gradually expanded (James and Rogers, 1976). Consequently, social values that previously did not enter into the analyses of benefits may now be used to justify government sponsored water resources activities. In general this broadened evaluative base has stimulated water resources development, but recent experience with environmental quality standards has shown that the inclusion of additional objectives can also dampen project

activities. It has been fairly easy to design multiple purpose projects partly because the usual means for pursuing these purposes are similar--for example, water impoundments for water supply, hydroelectricity, agriculture, flood control, and recreation. More importantly, serious problems have not arisen in evaluating these projects because each purpose is interpreted with reference to the overall objective of economic efficiency. In contrast, addition of a second objective of environmental quality has caused major design problems.[1]

The lack of a common frame of reference for comparing the objectives of economic efficiency and environmental quality makes the adoption of one or another of the many possible frames of reference a political issue, characterized by dispute and revision of earlier decisions (Connolly, 1974; Braybrooke and Lindblom, 1963). Where there is divergence in opinions concerning which values to pursue, the criteria used to determine what to do are procedural. Two vague standards have general support: policymaking should be rational and democratic. The meaning and implications of these standards have received wide attention in political science.

The ordering of values for social decision making is very difficult to achieve because incomparable values are distributed in a variety of ways over diverse individuals. The impossibility of making interpersonal comparisons of utility, assumed by economists, leads to quite pessimistic conclusions. Arrow's famous theorem (1963), for example, proved that any locus of control composed of more than two individuals and facing more than three alternatives will not be able to construct a rule for aggregating individual preferences into well-ordered values and that is general and nondictatorial.

One aspect of the problem, outside the scope of Arrow's discussion, is the aggregative tendencies of certain values as opposed to the disaggregative tendencies of their pursuit. Some interests are more effectively pursued by smaller and other interests require larger units. The reason for this difference is related to the concept of economies and diseconomies of scale. Given a technology, one may expect a U-shaped curve relating average cost to total production, where the downward-sloping portion reflects increasing economies of scale and the upward-sloping portion indicates increasing diseconomies of scale (Leftwich, 1973). The

low point on the curve determines the optimal size of unit for pursuing that purpose given the existing technology.

In planning, particular values are generally pursued by characteristic means (i.e., technology). Thus the values, given the available stock of knowledge and resources, are associated with optimal scopes of decision and control; and given a scope of decision and control, there is an associated optimal level of pursuit for particular values.[2] For example, water is generally less costly to pump from a single well in municipalities and from wells serving individual owners in rural areas. These differences affect pursuit of health values.

<div style="text-align:center">

Temporal Issues in Multiple Perspective Planning

</div>

Since the identification of events depends on planning perspective, different planning groups attacking the "same" planning problem from different perspectives will use different events to describe the same time period. In order to achieve commensurability for comprehensive analysis, one may need, for example, to reconcile the diverse temporal perspectives of irrigators (who think in terms of planting, harvest, and possibly future subdivision), administrators (who think in terms of budget and work schedules), and legislators (who think in terms of elections and legislative dockets). When a project reaches its construction phase, it requires definition of the temporal relations among events. With the adoption of a standard temporal reference, it becomes easier to conceive of kinds of actions rather than of particular actions. That is, we can think of the temporal requirement of an action independent of any particular performance of it.

The interaction among agents with different time horizons (e.g. the politician seeking payoff before the next election v. the environmentalist concerned with long run ecological stability) in the planning system thus presents two kinds of problems (U.N. Economic Commission for Europe, 1970, p. 15-17). First, differences in values being pursued must be reconciled. Second, there must be sufficient communication to avoid inadvertent disruptive actions. The latter is made more difficult by the fact that future actions are based on uncertain assumptions that can be verified only with the passage of time. In an interdependent system, a source of uncertainty for one agent is the actions of other agents.

Over time, values change and technological advances are made, old alternatives need to be reevaluated as do those that have

---

[1]The costs of environmental quality can be measured by conventional means but the benefits are more difficult to measure. Some efforts have been made to bring some aspects of environmental quality into the domain of economics by the concept of amenity rights (Mishan, 1969, p. 36-42).

---

[2]The use of "optimal" here refers only to least average cost of production.

newly become possible (Baier and Rescher, 1969). The history of federal involvement in water projects can be seen as a process of broadening the values to be enhanced by water resources management (James and Rogers, 1976). This trend corresponds with the notion that values tend to be pursued hierarchically, so that as one value is attained the next value becomes salient (Maslow, 1972; Rokeach, 1973).[3]

Value changes can occur rapidly. A dam failure rapidly increases the importance of safety in the eyes of people in the immediate vacinity. The increase in concern for environmental quality has been somewhat more gradual. The decline in relative importance of irrigated agriculture to the western economy has been much more gradual.

Value changes with time often bring concomitant changes in the structure of loci of control. The emergence of well-organized articulation of Indian interests in heretofore unused water rights, for example, adds a new twist to water allocation decisions (National Water Commission, 1973, Ch. 14). The heightened prominance of environmental interests is expressed in the growth in membership and power of environmental interest groups, and in the creation of special government agencies at the state and national levels (Council of State Governments, 1975).

In general, the inclusion of new groups in the decision process increases the time required to make decisions, particularly when these groups have special institutionalized methods for the promotion and protection of their interests. Bardach and Pugliaresi (1977, p. 23) for example, claim that "there can be little doubt that a major effect of the EIS (environmental impact statement) requirement has been to give environmental groups a legal and political instrument to cancel, delay, or modify development projects that they oppose." This impact of new interest groups in water policy decisions has also been noted by Ingram (1972).

It should also be kept in mind that values vary with locality. Environmental quality is a national interest, but this does not mean that the salience of environmental interests are uniform either within or among localities. Furthermore, the values and their salience for all groups change with time.

Problems of incommensurability would be more serious if events were the only temporal measure. Planners minimize this problem by using time units that are independent of events and with which all groups are familiar.

---

[3]This is not to imply that government agencies follow the same pattern of development that Maslow described for individuals.

If the identification of events is partly a function of practical purposes, those pursuing different purposes will generate different temporal frames, creating problems of commensurability for comprehensive analysis. Project approvals, for example, must fit into the institutional temporal perspectives of legislative sessions, budget cycles, election years, and court dockets. Construction requires a complicated sequencing of the various construction activities, subject to both man-made (e.g. strikes) and natural (e.g. severe weather) interruptions.

Jurisdictional Issues in Multiple Perspective Planning

Jurisdictional assignments are made for management purposes and bounded by territory or function. The jurisdictional authority thus assigned is continually faced with problems caused by interactions with activities and decisions going on outside that boundary and by limitations in its capability to manage within the defined jurisdictional boundary. Furthermore, some duplication and overlap, or redundancy (Landau, 1969), is required to facilitate interaction. Any locus, then, will be faced with coordination to avoid accidental conflicts of action. In some cases, agents independently pursuing different objectives may accidently create for themselves unnecessary problems which could be avoided by the adoption of some common rule. The convention of driving on the right side of the street is an example.

In cases where multiple agents are independently pursuing their goals, the coordinative rules generally direct that agents refrain from certain actions. In other cases, an agent incapable of independently achieving some goal must cooperate with others. Cooperation to achieve specific goals requires closer coordination than is necessary to prevent interference among independent activities. The guiding rules are likely to restrict activities not related to the common goal. Since different agents have different incentives to cooperate (and different priorities on the other activities they will have to restrict), it is often difficult to attain effective cooperation through voluntary means (Olson, 1965).

The difficulty in securing cooperation is compounded by virtue of numbers alone. Even in conditions that seem most conducive--a cooperative attitude and basic agreement on goals--success is difficult to attain (Devons, 1971; Pressman and Wildavsky, 1973). Multiple loci of decision and control imply differences in values and, therefore, incentives to cooperate.

Scope of Control Issues in Multiple Perspective Planning

If scope of control for a value were determined by maximizing efficiency in

pursuit of that value (in a homogeneous environment), the planning system would be structured as a collection of special-purpose agencies whose jurisdiction (i.e., scope of control) changed only with changes in technology. Some values (those for which optimal production units are of small size) would be pursued by many agencies of fairly small scope, some values would require only a few agencies, and some values might be best pursued by a single agency. On the other hand, if a given structure of scopes of control were to determine what values were pursued, probably no single value would be efficiently produced.

Actual situations are controlled partly by values and partly by scope of control. Values tend to be pursued at one or another existing level of government. In cases where all existing levels are seen to be inappropriate, incentive is created to form a new level, of a scope more adequate to deal with the problem (Ostrom, 1973; Bish, 1971). The frequency of such cases is evidenced by the proliferation of interstate commissions, interagency committees, councils of government, and special purpose districts. Nevertheless, these new levels are not created from "scratch," but are composed of units already present, and thus may not really have ideal scope. The Colorado River Compact, for example, is composed of seven states covering an area much larger than the basin. One can imagine a much different pattern of use for basin water if drainage divides had been used to determine state boundaries. Denver and Los Angeles, for example, would probably not receive the major part of their water supply from the Colorado River, as they do now.

Relational Problems in Coordination

One approach to the difficulty of securing cooperation to achieve mutually advantageous objectives among multiple jurisdictions is to ask what would be done by an omniscient, benevolent dictator. Real world water management policy falls short of what such a dictator could accomplish because 1) real world policy makers are not omniscient in that they often operate from incorrect or insufficient information and 2) real world policy makers are not able to dictate but rather are constrained by such relational problems as having to work with only a portion of the relevant system, the limited perspective of key individuals, and limited coordination among the loci of decision making. Relational efficiency can be defined as the net increase in the value the p   receives from water resources that is actually being achieved by planning divided by the net increase that would be achieved by the dictator. Total relational efficiency can be divided into two components associated with the two factors listed above: 1) information efficiency and 2) coordination efficiency. The second factor is of primary interest here.

Without planning, water resource policy is established by interactions among individuals and groups acting from limited information in the market place and the political arena. Economists have long recognized that market transactions have external effects that cause some third parties to profit and others to be harmed by exchanges between buyers and sellers. The same sorts of externalities result from political transactions. These beneficial and adverse external effects can be identified, quantified, and described. Hopefully, planners should be able to use this information to identify priorities for their efforts to improve relational efficiency.

The externalities occur as decision making entities at all levels act in the market place or in political bargaining in ways that affect others who do not participate in the action. The effect may be technological in that it generates physical changes that helps or harms others or it may be pecuniary in that it changes prices and thus causes buyers to lose money to the profit of sellers who gain money.

The presence and importance of these externalities has been treated at length by economists in the literature and has been used repeatedly as a principal argument for government water planning. The fact is, however, that externalities have not been systematically evaluated when government does the planning (some kinds have instead been systematically ignored) and used to produce better plans. Since most externalities appear desirable from some perspectives and undesirable from others, many of the most important relational problems affecting coordination efficiency are in fact rooted in a failure of many water resources planners to give adequate attention to the problem. The need in multiple level analysis is thus to determine what planners can do to 1) be more systematic in the measurement of external costs and benefits and in the identification of who loses and who gains and 2) use this information in the total planning process to improve relational efficiency.

The activities most likely to require government action are those dealing with public goods and externalities. In the case of water resources planning, "the provision of most water services involves special problems of a systemic character which are not amenable to simple solution by provision in a competitive market economy" (Ostrom, 1968, p. 125).

Optimal levels of provision of public goods (or avoidance of public bads) are determined by the net benefits. The logical political boundary for planning provision of a given public good would be the service area of the most promising facility to produce the good. The most rational unit for most water resources planning appears to be the watershed, but this is not necessarily the best unit for the provision of other

government services. The fact that relevant political boundaries differ for different public goods has suggested to some that multiple jurisdiction in a political system could be more efficient in the provision of public services (Ostrom, 1973; Bish, 1971). One justification for federalism can be made on these grounds, but interactive and co-ordinating working relations among these multiple jurisdictions is difficult to achieve.

It has been observed that the increasing complexity and interrelatedness of modern society has made it difficult for local governments to fulfill their responsibilities. Many social problems do not seem amenable to local treatment but require the centralization of authority at a higher level. On the other hand, local governments are thought to be more responsive to the needs of the people than regional governments and can more easily promote citizen participation in the political process. The need to accommodate local variations thus provides arguments for decentralization.

The pragmatic problem with respect to planning units is how to do the best job with the political units we have. The study of interorganizational relations has as a primary task the identification of the conditions that inhibit, and are conducive to, cooperation among various organizations.

Finally, wherever production can be increased at lower unit costs, economies can be realized. Obviously, this consideration cannot be separated from the objectives that are to be met by the outputs, and thus unclear objectives make the determination of economies of scale more difficult. In the case of multiple objectives, an increase in scale may be economical for some and not for others. Inefficiencies also arise when benefits or burdens of the activities undertaken by one jurisdiction spill over into other jurisdictions. Such cases mean that all the costs or benefits of production are not being considered by the producing unit. The ideal solution is to adjust boundaries until all those who benefit or bear a cost are within the producing unit; but with multiple objectives, there may be no ideal boundary adjustment.

Economists have for years debated the possiblity and practicality of defining a social welfare function in order to determine the social benefits and costs of alternative courses of action. They have considered ways in which winners could compensate losers (financially) and elaborate mathematical systems for estimating a reasonable compensation.

Some of the issues and proposals for resolving them that have been raised are:

1. Construct a social welfare function from information on individual values and preferences recognizing both additive components and new elements introduced by socialization within the decision process. Such an effort would require development of practical composition rules. The state of the art is such that "a new composition rule may be introduced when at some level (of analysis), or for some range of problems, the assumption of independence is inadequate." Some axioms may have to be added, some deleted, and collective criteria may have to replace individual criteria at some aggregate level of analysis (Staaf, 1973, p. 21).

2. Develop a theory of value on the basis of a system of ethics that places other than monetary values on human lives and natural resources (Staaf, 1973, p. 12-13)

3. Form interest groups to represent the quiet majority, the disadvantaged and inarticulate unorganized groups, to overcome the unequal distribution of influence and power. Overt behavior of organized groups and their declared preferences must not be used as the only relevant indicators of what is desirable (Staaf, 1973, p. 14).

4. Develop a theoretical framework for defining social rationality. Social benefits need to be defined with reference to human needs and well-being, objectively determined and politically accepted, instead of being taken as given (Staaf, 1973, p. 16).

5. Generate a social welfare function that explicitly expresses the values of the community (Bergson, 1964). Empirical studies of values are needed so that the intangibles of life can be incorporated into welfare theory (Mishan, 1970).

6. Develop an operational framework for implementation. For example, Marris (1974) has recommended "a committee of wise men to impose a social welfare function (i.e., draw up an extensive ordering of society's objectives, preferences and priorities) and then to promulgate this in a system of prices" once the committee agrees on units of measurement of public gains and losses. The public gains would be produced by "social benefit corporations" with emphasis on responsibility to society at large (Marris, 1974, p. 397-398). The problems of interpersonal comparisons would be overcome by binding decisions made by committees. Such a social benefit corporation might be patterned after the Yugoslavian system wherein the workers and public control the decision making hierarch (Marris, 1974, p. 397-398). However, Bacharadi (In U.N. Economic Commission for Europe, 1970, p. 5) favors indicative planning over an imposed welfare function.

One can see form the nature of these issues raised that the approach one favors varies with highest level decisions in all planning dimensions (Figure 1). The appro-

priate approach for reconciling water planning issues varies with choices between capitalistic and socialistic elements in government and with social choices between individual freedom and authoritarianism.

Apart from these broader issues on the philosophy of ordering individual and social choice, resolution of choice conflicts has been handicapped by the failure of welfare economics and related disciplines to develop a theory that can provide an ideal against which suggested methods of interpersonal comparison can be judged (Baumol, 1966).

Compensation of losers by gainers does not hold up to theoretical criticism because it assumes that the marginal utility of money is the same for all. Externality reflects interdependencies as one's utility is affected by what someone else does.

Cost-benefit analysis by government planners has problems because "government is, typically, at least partially ignorant of the dimensions of the benefits, and very likely also of the costs. In many cases, decision-makers are not even able to specify the nature of the benefits and costs involved in a given program" (Crocker, 1971, p. 18). Furthermore, "because the gainers and losers from any government action in general will not be identical, the government must determine the magnitude of net gains and losses among various groups and individuals, and then somehow balance the desirability of the distribution effects against the pure economic efficiency affects revealed through straight forward benefit-cost analysis" (Crocker, 1971, p. 19). Even where government is informed and can estimate magnitudes, it may not be feasible or realistic for planners to estimate dollar values (prices) for benefits and costs.

More generally "there is no universal technology relating individual adaptations to collective results, neither a beneficient teleology nor a pernicious one" (Marris, 1974, p. 55). Conflicts between levels (agencies) could also be resolved by reciprocal explanation, persuasion, and constructive and understanding search for consensus or use of incentives (U.N. Economic Commission for Europe, 1970, p. 5).

Illustrated Planning Response to External Economies and Diseconomies

Externalities occur when social costs or benefits differ from private costs or benefits. A commonly used example is in water polluu ᵗⁱᵒⁿ where a factory manager responds to his cost of production (raw material, labor, overhead, advertising, etc.) more readily than he does to the costs others must bear in cleaning up the water. If this cost is born by society, the social cost of production by the factory exceeds private cost. If the water is not cleaned up, then social cost

exceeds private cost due to the loss of recreation, harm to the natural environment, etc. The price society pays for the products the factory produces thus equals either the purchase price plus the tax dollars for pollution control or the purchase price plus the loss in utility to recreationists and to the environment. In addition to these market responses, firms or governments of greater size and power possess greater bargaining power and can shift part of their costs to society as a whole or onto firms or governments of less power.

Since the destructive and constructive side-effects of production and consumption are not reckoned into the choices made by decision makers interacting in the market place, they must be measured (Staaf, 1973, p. 12-13) for evaluation in planning. This requires criteria of measurement and needs to be done in recognition that economic rationality does not imply social rationality and that the individual maximization of profit and satisfaction does not imply the maximization of social benefit. A large gross national product does not guarantee a healthy, satisfied nation (Staaf, 1973, p. 13; Samuelson, 1973, p. 195).

Because, in large part, the difficulties multiple level planning systems have in dealing explicitly with such issues, the strategy of the government to handle the externalities problem of water quality control over the past two decades has relied on detailed central regulation and construction subsidies for such waste treatment plants, proved excessively costly, and not worked well (Kneese, 1975, p. 1, 7-8). In practice, "Regulatory agencies often become the captives of the industries they are charged with overseeing" (Kneese, 1975, p. 7). Kneese concludes that new incentives and institutions are needed to spur individual decision makers, in their own self-interest, toward socially desirable actions. He also finds that subsidies for the construction of capital facilities are inefficient in dealing with social problems; as well as costly and political (Kneese, 1975, p. 8). Greater efficiency could be achieved by region-wide agencies that place stiff taxes that offer polluters incentives to clean up the environment (Kneese, 1975, p. 2). "The market works efficiently when costs can be imputed to and levied on those who create them" (Walker, 1969, p. 73).

Illustrated Planning Response to Internal Diseconomies and Economies

Internal economies are represented by increasing returns to scale where the increase in output more than exceeds the increase in input. For example, if the size of a warehouse room is enlarged from 5' x 5' to 10' x 10', the volume increases eight times. Most power plants, water treatment measures, and reservoirs for water supply follow this principle until the facility

increases to a size where diminishing marginal returns to scale began to predominate. Specialization of labor and overcoming indivisibilities can also result in increasing returns to scale.

The important relational problems with respect to returns to scale is that the technology of the production process governs the return to scale of the plant. In contrast, organizational laws govern the size of the firm (the management unit). Decreasing returns to scale can result when management is no longer efficient in responding to hierarchical or bureaucratic information and suffers communication breakdowns. As the firm grows too large, too many lines of communication develop, breakdowns occur, and the firm can no longer integrate its own activities in its own interest. Since water resources planning involves many complexities not found in industrial management and the same laws limiting organizational effectiveness apply, water planners must select some limited number of control factors. One of the major relational problems is that planners operating from different perspectives choose different ones. Differences result which cannot be resolved without getting into a situation too complicated for a comprehensive planning organization to resolve.

Composition of Social Criteria

Composition laws govern extension of relationships derived from micro units to macro level applications. Laws that apply to the individual firm are extended to apply to the industry and the economy as a whole. Total flood damages are estimated as the sum of the damages suffered by affected individuals. Composition laws, however, may cease to apply at certain levels of aggregation. Flood losses become more than additive when the cost of repair increases or getting qualified help becomes impossible because suppliers of repair services cannot satisfy the demand (Yancey et al., 1976). Inputs that possess qualitative differences which give rise to increasing or decreasing returns to scale cannot be made homogeneous by placing a homogeneous monetary value measurement on them. Only if the variables are cardinally homogeneous can one get constant returns to scale.

The major problem in applying available composition laws to derive social criteria is that the theorems and axioms have been based on an assumed independence of the individual units. As one of the best known examples, the pure competition model used to define economic efficiency from market expression of individual consumer preferences and hence the foundation for benefit-cost analysis assumes that the consumer preferences are independent of one another. Furthermore, no laws nor relationships have been defined for the case of interdependence where individual peferences are not linearly additive.

The problem that interdependency poses for logical derivation of social criteria by making the values of individuals not linearly additive is analogous to the problem found in the last chapter of logical prediction of effects where causal relationships are not linearly additive. In both cases, the way for planning methodology to improve is to develop 1) better understanding of the dynamic, interactive relationships and 2) rules for dealing with partial value fulfillment and partial causality in decision making.

The principal measure of value in economic markets is price. Price, however, is only one among many political, psychological, and other variables that affect resource flows. Chamberlain (1965, p. 362) even claims that bargaining relationships are more important and furthermore that "There is no ground for predicting the behavior of any economic unit, any more than physics can predict the behavior of any atom. It is only probability based on large numbers, that permits us to generalize as to actions and reactions under given conditions" (Chamberlain 1965, p. 356). Even then, the generalized micro relationships must be understood within the context of given macro relationships (Chamberlain, 1965, p. 364).

In important areas of resource conservation, prices signal false information. The waste-assimilating capacities of air and water, as common property resources, do not command a price in the marketplace. Thus their overuse is encouraged. Collectively held common property goods will be too soon exhausted unless they are given a value and treated, not as free goods, but rather as scarce goods to be economized and conserved. Incentives imposed by government such as effluent charges or tax breaks are one way to get total price to reflect the true cost of externalities and to get individual decision makers to act in socially optimal ways.

Effluent charges are essentially rents charged for the lease of rights to dispose of wastes in publicly owned environmental resources. They are a nonmarket solution to externalities in that government must externally, to market processes, determine the effluent charges and coordinate them into an overall system effective in combating interrelated environmental problems (Crocker, 1971, p. 87-88). Several problems complicate government efforts to deal with externalities. To begin with the technical issues, the external effects of air pollution are very difficult to measure. Water pollution measurement is easier but still leaves the question of assigning responsibility "all the men who have put straw on the camel, or just the last man before its back is broken?" (Goldman, 1972, p. 16).

Assignment of administrative responsibility does not automatically solve these technical problems. Government intervention is no panacea for the failures of the private

71

market system. Central regulation cannot handle the complexity of externalities, and the basic failures of the price system must be corrected not buried under concrete and steel (construction subsidies) (Kneese, 1975, p. 4-9). Part of the problem is that it is very difficult to define public interest (Crocker, 1971, p. 113) and determine whether externalities (Friedmann calls them "neighborhood effects") warrant government intervention.

> Neighborhood effects impede voluntary exchange because it is difficult to identify the effects on third parties and to measure their magnitude; but this difficulty is present in government activity as well.. Consequently, when government engages in activities to overcome neighborhood effects, it will in part introduce an additional set of neighborhood effects by failing to charge or to compensate individuals properly. Whether the original or the new neighborhood effects are the more serious can only be judged by the facts of the individual case, and even then, only very approximately (Friedmann, 1962, p. 124).

Basic microeconomic and value theory have been based on individual tastes and preferences and their aggregation based on an assumption of independence. A new theory for aggregating social choice is needed if social wants and needs are to be achieved. Perhaps such a theory could use Arrow's Value Theory to go from individual tastes to social preferences. Perhaps, it would more effectively be based on sociopolitical and psychological considerations and factors (Staaf, 1973, p. 13). Perhaps, the answer lies in providing each participant the resources and incentives to use interpersonal and interagency comparisons of utility in resolving conflicts by reciprocal explanation, persuasion, and a constructive understanding search for consensus (U.N. Economic Commission for Europe, 1970, p. 5). The main difficulty to be overcome is the indeterminancy encountered wherever one attempts to aggregate independent parts into interdependent wholes or disaggregate interdependent wholes into independent parts.

If society is to achieve its goals in a world of externalities, planners must provide decision makers information on the extent of these effects and on how to equitably adjust for imbalances. However, democratic ideals require rejection of imperative or imposed planning (a benign dictator or group of dictators). Between the extremes of firm control to prevent externalities from happening and letting them freely occur lies some acceptable middle ground.

Temporal Issues in Social Choice

One cause of perplexing relational problems is the persistence of political

systems and the results of their actions beyond the lifetimes of their citizens. For long range planning in a democratic society, where citizen participation and consent are so important, the difficulty of justifying obligations imposed on future generations is greater than optimizing for present members of society. One writer (Bock, 1970) suggests that long-range governmental planning can restrict not only the options for the present generation, with possible deleterious effects on individuals motivated by a possible "brighter future," but can also restrict the opportunity for the exercise of choice by future generations. Resolution of the issue involves determination of the responsibility of the present generation for the future, given that present actions can affect the self-determination of future generations and that present values and technology may be quite different than those of the future.

In a somewhat different form, the issue concerns the production of temporal externalities, which suggest that the adoption of a given temporal horizon has implications in terms of both efficiency and equity (Page, 1977). One advantage of the extended lifespan of government organizations is that projects which require long periods in which to realize benefits can be more readily undertaken than would be the case without such organizations. If organizations are more likely than individuals to undertake long-range programs, then at least some of these programs will reflect a difference in temporal preference between organizations and individuals.

The preferences of both groups and individuals change over time. This fact makes ad hoc agreements involving many agents very expensive and vulnerable to dissolution in the case of unexpected implementation delay. A case study by Pressman and Wildavsky (1973) documents the slow disintegration of cooperation in one federal program, in spite of broad agreement and generous funding at the outset. They recommend that, in view of this fragility of voluntary agreements, programs be kept as simple and direct as possible.

In high conflict situations such as that existing in allocating Colorado River water, the cost of decisions through voluntary agreement may be very large. The effort required to achieve agreement is such that participants are seldom willing to reopen discussion, partly because of the unpleasantness of the process and the amount it detracts from other activities and partly because of a fear that they will fare less well next time. No one is willing to reopen negotiations each time new facts or changing conditions suggest the standing compromise as nonoptimal. As the departure from optimality increases over time, however, stronger regulations and the threat of greater sanctions are required to keep practice in line with policy. Over time one might expect the jurisdictions that entered into the voluntary

agreement to perceive continued enforcement against the best interest of their constituents to be more undesirable than reopening negotiations.

The institutionalization of cycles contributes also in other ways to the temporal dimensions of perspectives at all levels of decision making. For example, obvious short-term cycles are found in the legislative process and the judicial process. The judicial process tends to emphasize the sequence in reaching a determination. The legislative process is more influenced by duration. The basic contrast resulting from this difference in emphasis is the tendency for the judicial process to become drawn out in an effort to reach a definitive solution to an issue, as opposed to the tendency of the legislative process to periodically redecide the issue, with more or less continual policy adjustment.

The combination of changing preferences and the duration of institutional processes are important considerations in choice of political tactics. Legislative proposals put to a vote near the end of a session are usually thought to have a better change of passage than those introduced early, because there is less time for examination and debate. At the other end, litigation has proven to be an effective environmentalist tactic for opposing development projects because, even if the court battle is lost, the project can be delayed long enough that

popular support diminishes and rising costs lower the benefit cost ratio.

Just as legislative railroading can produce inferior legislation, the use of the judicial system to defeat projects can lead to results that are not in the public interest. Most legislatures have undertaken measures to improve the quality of legislation. It may be similarly beneficial to consider reforms in the judicial process whereby judgments of project acceptibility may be made more rapidly.

Recapitulation

The additional problems discussed in this chapter as associated with expanding from a single to a multiple perspective in aggregate expand on the principal conclusion of the last chapter, namely that the set of available planning tools are based on an assumption of additivity of basic units whereas a dynamically interactive real world is not that way. It is not realistic to plan from concepts of individual values aggregating linearly into social values, of actions efficiently achieving values, of decision makers being fully in control of situations and able to implement their plans, or of jurisdictional authority matching management needs. In every such situation, what one instead finds is situations of interacting perspectives and partial contribution. The major thrust needed for more effective planning is development of acceptable methodology for a real nonlinear world.

CHAPTER IX

CONCLUSIONS AND RECOMMENDATIONS

The general inference that can be made from the research reported herein is that water resources planners generally have a poor understanding of the relational and levels of analysis problems in policy making. This lack of insight into the basic nature of these problems is imposing a high cost on society, particularly because many conflicts that occur might otherwise be circumvented or prevented. The literature that deals with relational and levels problems is largely unknown to practicing water resources planners, and the literature has not developed to a point where established principles about improved methods for dealing with these problems can be practically implemented in large scale planning. Critical knowledge gaps need to be filled. This means that further exploratory or basic research must be conducted before practical successes can be expected.[1] The specific conclusions presented in this chapter refer to basic problems that should be resolved before practical solutions are possible.

Conclusion 1: Not much research that has had practical significance has been done, either analytically or institutionally, to resolve relational and levels of analysis problems in large-scale planning. If the question were asked: "What kinds of hard knowledge are appropriate and available to understand and evaluate how the socio-cultural, economic, and political activities of farmers in the Uintah Basin relate to the same kinds of activities of businessmen in Southern California?" only very little such knowledge can be identified. But that is probably the kind of knowledge that is necessary in basin-wide planning. Similarly, if it is asked what institutions and institutional procedures are appropriate to relate the activities of the two groups, good answers would be difficult to find and substantiate.

Recommendation 1: Basic and applied research is needed to develop specific knowledge about analytical/conceptual and institutional procedures appropriate for dealing with relational and levels of analysis problems in river basin planning.

------

[1]One might even say that, somewhat inadvertently, an entire research area of basic as well as applied problems in policy making and planning lies virtually untouched.

Conclusion 2: The orientations and perspectives of planners, or agencies involved in planning, have a major impact on the manner in which relational and levels of analysis problems are resolved. The importance of the role of concepts and perceptions in planning behavior is not generally recognized (to the extent that it can be observed). The range of activities involving definition of the problem, goal formulation and classification, specification of objectives, and identification of alternative courses of action, depend on the conceptions and perceptions of those who do the planning. Uncritical acceptance of basic biases and assumptions is the rule rather than the exception in many planning efforts.

Recommendation 2: Planning procedures need to be instituted to insure that the role of basic conceptions and perceptions is explicitly recognized with respect to their impacts on dealing with relational and levels of analysis problems.

Conclusion 3: The synergistic effects that emerge as the result of the systemic interactions among different subsystems of a river basin have major impacts that need to be taken into account in basin-wide planning. As a planning analysis moves from subbasin to basin, it is clear that patterns of interaction emerge with results that cannot be explained simply by combining the analyses of the subbasins. A new analysis is necessary from the viewpoint of the basin as a whole. For planning purposes, it is critical that the differences between analyzing the system as a whole versus combining the separate analyses of the subsystems are made clear. These differences represent the synergistic effects that emerge from integrating a larger system. Methods are needed to determine what these differences are, how they emerge, and what their effects are.

Recommendation 3: Specific research support should be provided to investigate how synergistic effects create relational and levels of analysis problems in river basin planning. The effort should focus on the way synergistic effects emerge, their impacts, and their implications with respect to planning procedures.

Conclusion 4: Much of the information and data that are collected for different parts of a river basin are not compatible, thereby creating obstacles that hamper

75

efforts to cope with relational and levels of analysis problems. Relational and levels of analysis problems present special difficulties that require a high degree of coordination and integration of planning activities. Such coordination and integration is hampered by the fact that different planners and agencies rely on data that varies according to location or may be inconsistent in other ways. Although some efforts have been made to standardize data collection procedures, much more remains to be accomplished. For example, different levels of government need to put greater effort into exchanging information and standardizing collected data.

Recommendation 4: An intergovernmental task force should examine how data management procedures can be improved so that inconsistencies among planning agencies in a region or river basin are minimized.

Conclusion 5: The methods, techniques, and models in river basin planning are not generally suitable for analysis of multilevel problems because they do not represent the dynamic interactive elements in a real world setting.

Recommendation 5: Multilevel problems in comprehensive river basin planning involve not only hydrologic phenomena, but also social, economic, and political variables. Although multilevel problems are rare in hydrologic applications and modeling of physical phenomena is becoming increasingly sophisticated, such is not the case with social, economic, and political variables and the related modeling efforts. Therefore, existing modeling methods, techniques, and concepts should be evaluated to determine their limitations in handling relational and level of analysis type problems and how interactive elements can be added to do a better job.

Conclusion 6: The planning activities and functions that have developed are frequently inappropriate or ineffective in comprehensive river basin planning. The dynamics of the planning system, as discussed in this report, are such that no ingle agency or governmental level is best suited for all planning activities. In a completely centralized setting, important considerations will inevitably be left out of the planning perspective. On the other hand, while special districts may provide the scope that is best adapted to a function, proliferation of such districts increases the difficulty of achieving coordinated planning.

Recommendation 6: Studies should be undertaken to determine how planning functions should be distributed, and what planning activities are appropriate for different organizations and agencies in regional and river basin planning, particularly as these concern relational and levels problems.

Conclusion 7: Planning difficulties are compounded by the poor communication

processes that usually characterize interactions among organizations responsible for various planning functions and activities. mOne useful application of the idea of a planning perspective developed here is that it shows numerous possibilities for perceptual differences that, if unrecognized, can lead to communication distortions. Many of the problems created by poor communication could be avoided if planners 1) were more careful in considering the potential impacts of their activities at different levels and on the performance of other functions and 2) less optimistic of being completely understood.

Recommendation 7: Communication processes should be developed and designed to improve the quality of planning interactions among organizations and agencies so they can be more effective in integrating and coordinating the activities required in comprehensive river basin planning.

Conclusion 8: Rules and regulations that are established to deal with one situation are often inappropriately applied to other, different situations, or are inconsistent with one another when multilevel problems are involved. One of the most frequent complaints made by state and local officials concerns the difficulty in complying with the numerous, highly detailed federal regulations. The suitability of a uniform national regulation in a region depends on how well that region matches the national norm used to establish the regulation. To the degree western water quality problems differ from those in the east, national water quality regulations cause administrative problems.

Recommendation 8: In developing rules and regulations, special attention should be given to levels issues, so that significant local variations in conditions will not be ignored and cause inconsistencies in the way various parties are affected.

Conclusion 9: Calculation of costs and benefits is often done for only one planning level, thereby ignoring costs and benefits that would be recognized at other levels, creating inefficiency and inequitable distribution.

Recommendation 9: Traditional benefit-cost calculation has taken place only at that level at which the project impacts were estimated. For example, small projects provided a benefit-cost figure based only on local impacts. Large regional projects provided a benefit-cost figure based only on the aggregate regional impacts and ignoring the subsystem economics. Therefore, techniques and procedures should be developed for better benefit-cost estimation by area of impact or by perspective dimension. Such tools would provide more accurate information on the distribution of costs and benefits which accrue as a result of river basin projects that generate multilevel impacts.

76

REFERENCES

Achinstein, P. 1965. Theoretical models. British Journal of the Philosophy of Science, 16:102-120.

Achinstein, Peter. 1964. Models, analogies, and theories. Philosophy of Science, 31:328-350.

Achinstein, Peter. 1965. The problem of theoretical terms. American Philosophical Quarterly 2.

Ackoff, Russell L. 1974. Planning in the systems age. In: Systems and Management Science. Petrocelli, New York.

Advisory Commission on Intergovernmental Relations. 1974. Substate regionalism and the federal system, Vol. IV. Governmental Functions and Processes: Local and Areawide. Government Printing Office, Washington, D.C.

Agassi, Joseph. 1975. Institutional individualism. British Journal of Sociology, 26:144-55.

Albert, Ethel M. 1956. The classification of values. American Anthropologist, 58:221-248.

Alexander, Christopher. 1964. Notes on the synthesis of form. Mass.: Harvard University Press, Cambridge, Mass.

Alker, Hayward R., Jr. 1969. A typology of ecological fallacies. In: Quantitative Ecological Analysis in the Social Sciences, Matei Dogan and Stein Rokkan, eds. MIT Press, Cambridge, Mass.

Allison, Graham T. 1971. Essence of decision: Explaining the Cuban missile crisis. Little, Brown and Company, Boston, Mass.

Ando, A., F. Fisher, and H. A. Simon. 1963. Essays on the structure of social science models. MIT Press, Cambridge, Mass.

Angyal, A. 1969. A logic of systems. In: Systems Thinking, F. E. Emergy, ed. Penguin Books, Baltimore, Maryland.

Anscombe, G. E. M. 1976. Intention. (2nd ed.) Cornell University Press, Ithaca, New York.

Armstrong, E. L., ed. 1976. "History of public works in the United States: 1776-1976." American Public Works Association. Chicago.

Arrow, Kenneth. 1963. Social choice and individual values (2nd ed.). John Wiley, New York.

Arrow, Kenneth J. 1956. Mathematical models in the social sciences. In: General Systems, Yearbook of the Society for General Systems Research 1956. Society for General Systems Research, Ann Arbor, Michigan.

Austin, J. L. 1956-57. A plea for excuses. Proceedings of the Aristotelian Society, 57:1-30.

Axelrod, Robert. 1970. Conflict of interest. Markham, Chicago.

Ayer, A. J. 1946. Language, truth and logic. (2nd ed.) Victor Gollancz, London.

Bacharach, Michael. 1970. Economic decision systems with several levels: Concepts and current problems. In: Multi-Level Planning and Decision Making. United Nations, New York.

Bahm, Archie J. 1974. Metaphysics. Barnes and Noble, New York.

Baier, Kurt. 1965. The moral point of view. Random House, New York.

Baier, Kurt and Nicholas Rescher, eds. 1969. Values and the future. Free Press, New York.

Bain, J. S. 1973. Environmental decay--environmental causes. Little, Brown and Co. Boston, Mass.

Bardach, Eugene, and Lucian Pugliaresi. 1977. The environmental impact statement vs. the real world. The Public Interest, No. 49:22-38.

Barnett, Jack. 1979. Personal Communication, February 8.

Barton, Allen H. 1961. Organizational measurement. College Entrance Examination Board, New York.

Baumol, William J. 1966. Economic theory and operations analysis, 2nd ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Beardsley, Monroe C. 1975. Actions and events: the problem of individuation. American Philosophical Quarterly, 12:263-276.

Beer, Stafford. 1975. On heaping our sciences together. In: Systems and Management Annual, Russell Ackoff, ed. Petrocelli, New York.

Benditt, Theodore M. 1973. The public interest. Philosophy and Public Affairs, 2:291-311.

Benveniste, Guy. 1972. The politics of expertise. Glendessary Press, Berkeley.

Bergson, A. 1964. The economics of Soviet planning. Yale University Press, New Haven, Connecticut.

Bergstorn, Lars. 1966. The alternatives and consequences of actions. Almquist and Wiksell, Stockholm.

Bertalanffy, Ludwig von. 1956. General system theory. In: General Systems Research, part 1. Ann Arbor, Michigan.

Beuchner, Helmut K. 1971. The ecosystem level of organization. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Bish, Robert L. 1971. The public economy of metropolitan areas. Markham, Chicago.

Bishop, A. Bruce, et al. 1975. Colorado River regional assessment study. Part one: Executive summary, basin profile, and report digest. Utah Water Research Laboratory, Utah State University. Logan, Utah.

Bishop, A. Bruce, Melvin D. Chambers, William O. Mace, and David W. Mills. 1975. Water as a factor in energy resources development. Utah Water Research Laboratory, Utah State University. Logan, Utah.

Biswas, A. K., ed. 1976. Systems approach to water management. McGraw Hill, New York.

Black, Max. 1968. Models and metaphors. Cornell University Press, Ithaca.

Black, R. D. 1958. The theory of committees and elections. Cambridge University Press, New York.

Bock, Edwin. 1970. Governmental problems arising from the use and abuse of the future - the last colonialism? In: Temporal Dimensions of Developemnt Administration, Dwight Waldo, ed. Duke University Press, Durham, N. C.

Bolan, Richard S. 1967. Emerging views of planning. Journal of the American Institute of Planners, 33:233-245.

Boulding, Kenneth. 1956. General systems theory: The skeleton of science. In: General Systems, Yearbook of the Society for General Systems Research, part 1. Ann Arbor, Michigan.

Boulding, Kenneth. 1964. General systems as a point of view. In: Views on General Systems Theory, Mihajlo D. Mesarovic, ed. John Wiley and Sons, New York.

Boulding, Kenneth. 1971. The economics of pollution. New York University Press, New York.

Braham, Mark. 1973. A general theory of organization. In: General Systems, 1973 Yearbook. Society for General Systems Research, Washington, D.C.

Braithwaite, R. B. 1953. Scientific explanation. p. 88-114. Harper & Row, New York.

Braithwaite, R. B. 1962. Models in the empirical sciences. In: Logic, Methodology and Philosophy of Science, E. Nagel, P. Suppes, and A. Tarski, eds. Stanford University Press.

Brand, Myles, ed. 1976. The nature of causation. University of Illinois Press, Urbana, Ill.

Brandt, Richard B. 1967. Personal values and the justification of institutions. In: Human Values and Economic Policy, Sidney Hook, ed. New York University Press, New York.

Braybrooke, David, and Charles E. Lindblom. 1963. A strategy of decision. Free Press, New York.

Brewer, Gary D. 1973. Politicians, bureaucrats and the consultant: A critique of urban problems-solving. Basic Books, New York.

Brock, Dan W. 1973. Recent work in utilitarianism. American Philosophical Quarterly, 10:241-275.

Brodbeck, May. 1959. Models, meanings and theories. In: Symposium on Socio-

logical Theory, L. Gross, ed. Evanston.

Brodbeck, May. 1968. Methodological individualisms: Definition and reduction. In: Readings in the Philosophy of the Social Sciences, May Brodbeck, ed. Macmillan, New York.

Brody, Baruch A. 1973. Logic: theoretical and applied. Prentice Hall, Englewood Cliffs, New Jersey.

Brown, G. Spencer. 1973. Laws of form. Bantam Books, New York.

Brutian, G. H. 1975/76. Language and levels of abstraction as criteria for determining the status of systems of logic. Soviet Studies in Philosophy, 14:3-23.

Bunge, Mario. 1963. The myth of simplicity. Prentice-Hall, New York.

Bunge, Mario. 1969. The metaphysics, epistemology and methodology of levels. In: Hierarchical Structures, Whyte, Wilson and Wilson, eds. American Elsevier Publishing Co., Inc., New York.

Burke, Roy, III, and James P. Heaney. 1975. Collective decision making in water resource planning. D. C. Heath, Lexington, Mass.

Byerly, H. 1969. Model structures and model objects. British Journal of the Philosophy of Science, 20:135-144.

Campbell, Donald T. 1958. Common fate, similarity, and other indices of the status of aggregates of persons as social entities. Behavioral Science, 3:14-25.

Carroll, Lewis. 1976. Sylvie and Bruno. Vintage Press, New York.

Chamberlain, Neil W. 1965. Collective bargaining. 2nd ed. McGraw-Hill, New York.

Chickering, A. Lawrence. 1975. Land use controls and low income groups: Why are there no poor people in the Sierra Club? In: No Land Is An Island. Institute for Contemporary Studies, San Francisco.

Churchman, Charles W. 1961. Prediction and optimal decision; philosophical issues in a science of values. Prentice-Hall, Englewood Cliffs, New Jersey.

Ciriacy-Wantrup, S. V. 1964. Benefit-cost analysis and public resource development. In: Economics and Public Policy in Water Resource Development, Stephen C. Smith and Emery N. Castle, eds.

Iowa State University Press, Ames, Iowa.

Cohon, Jared L., and David H. Marks. 1975. A review and evaluation of multiobjective programming techniques. Water Resources Research, 11:208-220.

Coleman, James. 1972. Collective decisions and collective action. In: Philosophy, Politics, and Society, 4th Series, Peter Laslett, W. G. Runciman, and Quentin Skinner, eds. Basic Blackwell, Oxford.

Coleman, James S. 1971. Social systems. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Commoner, Barry. 1971. The closing circle. Alfred A. Knopf, New York.

Connolly, William E. 1974. The terms of political discourse. D. C. Heath & Co., Lexington, Mass.

Coplin, William D., and Michael D. O'Leary. 1972. Everyman's prince; a guide to understanding your political problems. Duxbury Press, North Scituate, Mass.

Copi, Irving M. 1967. Symbolic logic. Macmillan, New York.

Corwin, Ruthann, et al. 1975. Environmental impact assessment. Freeman, Cooper, and Co., San Francisco.

Council of State Governments. 1975. Integration and coordination of state environmental programs. Council of State Governments, Lexington, Kentucky.

Crawford A. B., and G. D. Weatherford. 1975. Some possible impacts of energy development on Utah's water institution. In: Impacts of Energy Development on Utah Water Resources. p. 199-218. Proceedings of 3rd Annual Conference of Utah Section of AWRA.

Crocker, T. D. 1971. Environmental economics. Dryden Press, Hinsdale, Illinois.

Cross, J. G. 1969. The economics of bargaining. Basic Books, New York.

Culyer, A. J. 1973. The economics of social policy. Dunellen Publishing, New York.

Cupps, Steven. 1977. Emerging problems of citizen participation. Public Administration Review, 37:478-87.

Curry, R. L., and L. L. Wade. 1968. A theory of political exchange. Prentice-Hall, Englewood Cliffs, N. J.

Dahl, Robert. 1956. A preface to democratic theory. University of Chicago Press, Chicago.

Dahl, Robert, and Edward Tufte. 1973. Size and democracy. Stanford University Press, Stanford, California.

Dahrendorf, Ralf. 1959. Class and class conflict in industrial society. Stanford University Press, Stanford, California.

Dallmayr, Fred K. 1974. Empirical political theory and the image of man. In: Social Structure and Political Theory, William E. Connolly and Glen Gordon, eds. D. C. Heath, Lexington, Mass..

Daneke, Gregory A. 1977. Those pork barrel blues: The new politics of water resource planning and management. Midwest Review of Public Administration, 11:91-104.

D'Arcy, Eric. 1963. Human acts: An essay in their moral evaluation. Clarendon Press, Oxford.

Davidson, Donald. 1967. Truth and meaning. Synthese, 17:304-323.

Davidson, Donald. 1969. The individuation of events. In: Essays in honor on Carl G. Hempel, Nicholas Rescher, ed. D. Reidel, Dordrecht, Holland.

Derthick, Martha. 1975. Between state and nation. The Brookings Institution, Washington, D.C.

Deutsch, Karl W. 1966. The nerves of government. Free Press, New York.

Devons, Ely. 1971. The problem of coordination in aircraft production. In: Papers on Planning and Economic Management. Manchester University Press, Manchester, England.

Diesing, Paul. 1962. Reason in society. University of Illinois Press, Urbana, Illinois.

Dogan, Matei, and Stein Rokkan, eds. 1969. Quantitative ecological analysis in the social sciences. MIT Press, Cambridge, Mass.

Dorfman, R. 1972. Economics of the environment. Norton, New York.

Dror, Yehezekel. 1963. The planning process: A facet design. International Review of Administrative Sciences, 29(1):44-58.

Durkheim, Emile. 1964. The rules of sociological method. The Free Press, New York.

Dye, Thomas R. 1972. Understanding public policy. Prentice-Hall, Englewood Cliffs, N. J.

Easton, David. 1965. A systems analysis of political life. Wiley, New York.

Edel, Abraham. 1959. The concept of levels in social theory. In: Symposium on Sociological Theory, Llewelyn Gross, ed. Row, Peterson & Co., Evanston, Illinois.

Emerson, F. C. 1973. The economics of environmental problems. School of Business Administration: Division of Research. University of Michigan. Ann Arbor, Michigan.

Emery, F. E., and E. L. Trist. 1965. The causal texture of organizational environments. Human Relations, 18:21-32.

Eulau, Heinz. 1969. Micro-macro political analysis: Accents of inquiry. Aldine Publishing Co., Chicago, Illinois.

Evan, William. 1965. Toward a theory of inter-organizational relations. Management Science, 11:B217-30.

Everson, David H., and Joann Poparad Paine. 1973. An introduction to systematic political science. The Dorsey Press, Homewood, Ill.

Farre, G. L. 1967. Remarks on Swanson's theory of models. British Journal of the Philosophy of Science, 18:140-147.

Fesler, James. 1949. Area and administration. University of Alabama Press, University, Ala.

Fesler, James. 1965. Approaches to the understanding of decentralization. Journal of Politics, 27:536-66.

Feyerabend, Paul K. 1963. How to be a good empiricist - a plea for tolerance in matters epistemological. From Philosophy of Science: The Delaware seminar, II. Reprinted in P. H. Nidditch, ed. The Philosophy of Science. Oxford University Press, Oxford. 1968.

Finsterbusch, Kurt, and C. P. Wolf. 1977. Methodology of social impact assessment. Dowden, Hutchinson, and Ross, Stroudsburg, Pa.

Fleming, George. 1975. Computer simulation techniques in hydrology. Elsevier, New York.

Forrester, Jay W. 1971. Behavior of social systems. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Fox, Irving. 1963. Basin planning: Past experience and current problems. Paper presented at a joint meeting of the Columbia Basin and Missouri Basin Inter-Agency Committees, Jackson Hole, Wyo., June 19.

Fox, Irving. 1964. Review and interpretation of experiences in water resource planning. In: Organization and Methodology for River Basin Planning. C. E. Kindsvater, ed. Water Resources Center. Georgia Institute of Technology, Atlanta, Georgia.

Fox, Karl A. 1974. Social indicators and social theory: Elements of an operational system. Wiley, New York.

Frey, Fredrick W. 1970. Cross-cultural research in political science. In: The Methodology of Comparative Research, Robert T. Holt and John E. Turner, eds. Free Press, New York.

Friedman, Milton. 1962. Capitalism and freedom. University of Chicago Press, Chicago, Illinois.

Friedmann, John. 1973. Retracking America: A theory of transactive planning. Doubleday Anchor, Garden City, New York.

Fullerton, Herbert H., W. Chris Lewis, Jay C. Andersen, John E. Keith, and Reed Willis. 1975. Regional development: An econometric study of the role of water development in effectuating population and income changes. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Furniss, Norman. The practical significance of decentralization. The Journal of Politics, 37:958-82.

Garfinkel, Harold. 1962. The rational properties of scientific and common sense activities. In: Decisions, Values, and Groups, Vol. II, Norman F. Washburn, ed. Pergamon Press, New York.

Gellner, Ernest. 1968. Explanations in history. In: Readings in the Philosophy of the Social Sciences, May Brodbeck, ed. Macmillan, New York.

Gerard, R. W. 1956. A biologist's view of society. In: General Systems, Yearbook of the Society for General Systems Research, part 1, Ann Arbor, Michigan.

Girill, T. R. 1971. Formal models and Achinstein's "analogies." Philosophy of Science, 38:96-104.

Girill, T. R. 1972. Analogies and models revisited. Philosophy of Science, 39(2):241-244.

Glikson, A. 1971. The ecological basis of planning. Martinus Nijhoff, The Hague, Netherlands.

Goldman, M. 1972. Ecology and economics. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Grafton, Carl. 1975. The creation of federal agencies. Administration and Society, 7:328-365.

Grant, E. L., and W. G. Ireson. 1970. Principles of engineering economy. Ronald Press, New York.

Grice, H. P., and P. F. Strawson. 1956. In defense of a dogma. The Philosophical Review, 65:141-158.

Grossman, Bernhardt. 1973. Ontological reduction. Indiana University Press, Bloomington, Ind.

Habermas, Jurgen. 1975. Legitimation crisis. Beacon Press, Boston.

Haimes, Y. Y. 1973. Multilevel approach for regional water resource planning and management. Case Institute of Technology, Case Western Reserve University, Cleveland, Ohio.

Haimes, Y. Y., et al. 1977. Multiobjective analysis in the Maumff River Basin: A case study on level-B planning. Case Western Reserve University, Cleveland.

Haimes, Y. Y., and W. A. Hall. 1974. Multiobjectives in water resources systems analysis: The surrogate worth tradeoff method, Water Resources Research, 10:615-624, August.

Haimes, Yacov Y. 1976. Multiple objectives in water and related land resource planning. In: Colorado River Basin Modeling Studies: Proceedings of a seminar, Calvin G. Clyde, Donna H. Falkenborg, and J. Paul Riley, eds. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hall, A. D., and R. E. Fagen. 1956. Definition of system. In: General Systems, Yearbook of the Society for General Systems Research, part 1, Ann Arbor, Michigan.

Hall, Warren A. 1970. Some problems in the application of systems analyses in water resource systems. In: Systems Analysis of Hydrologic Problems. Proceedings of the Second International Seminar for Hydrology Professors. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hannan, Michael J. 1970. Aggregation and disaggregation in sociology. Lexington Books, Lexington, Mass.

Hannan, Michael J. 1971. Problems of aggregation. In: Causal Models in the Social Sciences, Hubert M. Blalock, ed. Aldine, Chicago.

Harrison, Ross. 1970. No paradox in democracy. Political Studies.

Hart, H. L. A., and A. M. Honore. 1959. Causation in the law. Oxford University Press, Oxford.

Haveman, Robert H. 1965. Water resources investment and the public interest. Vanderbilt University Press, Nashville, Tennessee.

Hayek, Friedrich A. 1944. The road to serfdom. University of Chicago Press, Chicago.

Held, Virginia. 1970. The public interest and individual interest. Basic Books, New York.

Helfrich, H. W. 1970. The environmental crisis. Yale University Press, New Haven, Connecticut.

Heller, W. 1976. The economy: Old myths and new realities. Norton, New York.

Hempel, Carl. 1950. Problems and changes in the empiricist criterion of meaning. Revue Internationale de Philosophie 4:41-63. Reprinted in Readings in the Philosophy of Language, Jay F. Rosenberg and Charles Travis, ed. Prentice-Hall, Englewood Cliffs, N. J., 1971.

Hempel, Carl. 1965. Aspects of scientific explanation. The Free Press, New York.

Hempel, Carl. 1966. The philosophy of natural science. Prentice-Hall, Englewood Cliffs, N. J..

Hempel, Carl G. 1966. The philosophy of science. Prentice-Hall, Englewood Cliffs, New Jersey.

Hempel, Carl G. 1969. Reduction: Ontological and linguistic facets. In: Philosophy, Science and Method: Essays in Honor of Ernest Nagel. Sidney Morgenbesser, Patrick Suppes, and Morton White, eds. St. Martin's Press, New York.

Herbst, P. G. 1976. Alternatives to hierarchies. Martinus Nijhoff, Leiden, The Netherlands.

Herfindahl, Orris C., and Allen V. Kneese. 1974. Economic theory of natural resources. Charles E. Merrill, Columbus, Ohio.

Hesse, M. B. 1963a. Analogy and confirmation theory. Philosophy of Science, 30:207-221.

Hesse, M. B. 1963b. Models and analogies in science. Sheed and Ward, New York.

Hirschiman, Albert O. 1967. Development projects observed. The Brookings Institution, Washington, D.C.

Hirshleifer, Jack, et al. 1960. Water supply: Economics, technology, and policy, University of Chicago Press, Chicago.

Hoggan, Daniel H. 1969. State organizational patterns for comprehensive planning of water resources development. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hoggan, Daniel H., Jim Mulder, Sarah Jane Taylor, Dennis E. Oaks, Brent Somers, and Raymond L. Richardson. 1974. A study of the effectiveness of water resources planning groups. Utah Water Research Laboratory, Logan, Utah.

Holden, Barry. 1974. The nature of democracy. Harper and Row, New York.

Hollingshead, Anne Huston. 1973. A systems model for minimizing urban sprawl. In: General Systems, Society for General Systems Research, 1973 Yearbook, Washington, D.C.

Homa, Donald, and Richard Vosburgh. 1976. Category breadth and the abstraction of prototypical information. Journal of Experimental Psychology, 2:322-330.

Horne, Mark H. 1973. Uintah Basin study. Utah Department of Natural Resources, Salt Lake City, Utah.

Howe, Charles W. 1971. Benefit-cost analysis for water system planning. American Geophysical Union, Washington, D.C.

Hufschmidt, M. M. 1969. Perspectives and goals for water resources planning. Journal Water Pollution Control Federation, 41:1353-1357, July.

Hume, David. 1888. A treatise of human nature. Oxford University Press, London.

Hume, David. 1902. Enquiries concerning the human understanding and concerning the principles of morals. ed. L. A. Selby-Bigge. Oxford University Press, Oxford.

Hundley, Norris, Jr. 1975. Water and the West. University of California Press, Los Angeles, California.

Hutten, E. 1956. The language of modern physics. Macmillan, New York.

Idaho Water Resources Research Institute. 1976. An appraisal of conflicting

institutional attitutes on the West-wide Study Report. Proceedings Paper No. 308. Idaho Water Resources Research Institute, University of Idaho, Moscow, Idaho.

Ingram, Helen. 1972. The changing decision rules in the politics of water development. Water Resources Bulletin, 8:1177-1188.

Ingram, Helen, and J. R. McCain. 1977. Federal water resources managment: The administrative setting. Public Administration Review, 37:448-455.

James, L. D., J. A. McCrary, and D. E. Jones, Jr. 1976. Dealing with variable flood hazard. Proceedings of ASCE, 102:(WR2):193-208, November.

James, L. Douglas, and Robert R. Lee. 1971. Economics of water resources planning. McGraw-Hill, New York.

James, L. Douglas, and Jerry R. Rogers. 1976. Economics and water resourcs planning in America: 1776-1976. Paper presented to the annual convention of the American Society of Civil Engineers, ASCE reprint 2754, Philadelphia, Pa., September 27-October 1.

Johnson, C. W. 1977a. The role of logic in modeling planning systems. Unpublished manuscript, Utah Water Research Laboratory, Logan, Utah.

Johnson, C. W. 1977b. The role of logic and philosophy of resolving levels of analysis problems. Unpublished manuscript, Utah Water Research Laboratory, Logan, Utah.

Kahane, Howard. 1973. Philosophy and logic. Wadsworth, Belmont, California.

Kauffman, Stuart A. 1971. Articulation of parts explanations in biology. In: Boston Studies in the Philosophy of Science, Vol. 8, R. C. Buck and R. S. Cohen, eds. D. Reidel, Dordrecht, Holland.

Keith, John E., Jay C. Andersen, and B. D. Gardner. 1975. Some economic implications of projected water-energy patterns in the Colorado River Basin. In: Impacts of Energy Development on Utah Water Resources. Proceedings of the Third Annual Conference of the Utah Section of the American Water Resources Association. Utah Water Research Laboratory, Utah State University. Logan, Utah.

Keith, John, et al. 1977. The Virgin River Basin study: A regional approach to multiobjective planning for water and related resources. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Kim, Jaegwon. 1973. Causes and counterfactuals. Journal of Philosophy, 70:570-572; reprinted in Sosa, ed., 1975.

Kimball, Kirk R. 1978. An application of the PROPDEMM simulation to the levels of analysis problem in comprehensive river basin problem. Masters thesis. Utah State University, Logan, Utah.

Klassen, Leo H., and Jean H. P. Paelinck. 1974. Integration of socio-economic and physical planning. Report to the United Nations Centre for Housing, Building, and Planning. Rotterdam University Press, Rotterdam, The Netherlands.

Kleene, S. C. 1962. Introduction to meta-mathematics. D. Van Nostrand, Princeton, New Jersey.

Kluckhohn, Clyde. 1951. Values and value orientations. In: Toward a general theory of action. Talcott Parsons and Edward Shils, eds. Harvard University Press, Cambridge, Mass.

Kneale, W., and M. Kneale. 1968. The development of logic. Oxford University Press, London.

Kneese, Allen V. 1970. Economics and the environment. Resources for the Future. Johns Hopkins University Press, Baltimore, Md.

Kneese, Allen V. 1975. Pollution, prices, and public policy. Resources for the Future and the Brookings Institution. Brookings Institution, Washington, D.C.

Kochen, Manfred and Karl W. Deutsch. 1973. Decentralization by function and location. Management Science, 19:841-56.

Krimerman, Leonard I., ed. 1969. The nature and scope of social science: a critical anthology. Appleton-Century-Crofts, New York.

Kripke, Saul. 1972. Naming and necessity. In: Sematics of Natural Language, Donald Davidson and Gilbert Harman, eds. D. Reidel, Dordrecht, Holland.

Krutilla, J. V. 1975. The economics of natural environments. Resources for the Future. Johns Hopkins University Press, Baltimore, Md.

Krutilla, J. V., and O. Eckstein. 1958. Multiple purpose river development. Johns Hopkins Press, Baltimore.

Krutilla, John V., and Anthony C. Fisher. 1975. The economics of natural environments. Resources for the Future, Washington, D.C.

Kuhn, Thomas S. 1962. The structure of scientific revolutions. University of Chicago Press, Chicago.

Landau, Martin. 1969. Redundancy, rationality, and the problems of duplication and overlap. Public Administration Review, 29:346-358.

LaPorte, Todd R. 1975. Organized social complexity: Explication of a concept. In: Organized Social Complexity, LaPorte, ed. Princeton University Press, Princeton, N. J.

Larkey, Patrick D. 1977. Process models of governmental resource allocation and program evaluation. Policy Sciences, 8:269-301.

Lazarsfeld, Paul F., and Herbert Menzel. 1962. On the relation between individual and collective properties. In: Complex Organizations, Amitai Etzioni, ed. Holt, Rinehart, and Winston, New York.

Lee, Colin. 1974. Models in planning. Pergamon Press, New York.

Leftwich, Richard H. 1973. The price system and resource allocation 5th ed., Dryden Press, Hinsdale, Ill.

LeShan, Lawrence. 1975. How to meditate: A guide to self-discovery. Bantam Books, New York.

Levine, Sol, and Paul White. 1962. Exchange as a conceptual framework for the study of interorganizational relationships. Administrative Science Quarterly, 5:583-601.

Lewis, David. 1973. Causation. Journal of Philosophy, 70:556-67; Reprinted in E. Sosa, ed., Causation and Conditionals.

Lichtenstein, Grace. 1977. The battle over the mighty Colorado. In: The New York Times Magazine. New York. July 31.

Lindblom, Charles. 1965. The intelligence of democracy. Prentice-Hall, Englewood Cliffs, N. J.

Lindblom, Charles. 1973. Incrementalism and environmentalism. In: Managing the Environment. Environmental Protection Agency, Washington, D.C.

Linsley, R. K., and J. B. Franzini. 1964. Water resources engineering. McGraw-Hill, New York.

Litwak, Eugene, and Lydia F. Hylton. 1962. Interorganizational analysis: A hypothesis on co-ordinating agencies. Administrative Science Quarterly, 6:395-420.

Long, John Frederick, and Paul H. Wilken. 1974. A fully nonmetric unfolding technique: Interval values from ordinal data. In: Sociological Methodology, 1973-1974, Herbert L. Costner, ed. Jossey-Bass, San Francisco, Calif.

Lorenz, Konrad. 1971. Knowledge, beliefs, and freedom. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Louch, A. R. 1966. Explanation and human action. University of California Press, Berkeley and Los Angeles, Calif.

Lowi, Theodore J. 1964. American business, public policy, case studies, and political theory. World Politics, 16:677-715.

Lowi, Theodore J. 1972. Four systems of policy, politics, and choice. Public Administration Review, 32:298-310.

Luce, R. D., and H. Raiffa. 1957. Games and decisions. Wiley, New York.

Lukes, Steven. 1968. Methodological individualism reconsidered. In: The Philosophy of Social Explanation, Alan Ryan, ed. 1973. Oxford University Press, London.

Lukes, Steven. 1973. Individualism. Harper and Row, New York.

Lyons, David. 1965. The forms and limits of utilitarianism. Oxford University Press, London.

Maass, Arthur. 1966. Benefit-cost analysis: Its relevance to public investment decision. Reprinted in Water Research, Allen V. Kneese and Steven C. Smith, eds. Resources for the Future, Washington, D.C.

MacCrimmon, Kenneth R. 1973. An overview of multiple objective decision making. In: Multiple criteria decision making, James L. Cochrane and Milan Zeleny, eds. University of South Carolina Press, Columbia, S.C.

Mackett, R. L. 1976. Hierarchical policy relationships, consistency and indicators in the planning process. Socio-Economic Planning Sciences, 10:149-53.

Mackie, J. L. 1965. Causes and conditions. American Philosophical Quarterly. 2:245-255 and 261-264. Reprinted in Causation and Conditionals. E. Sosa, ed. Oxford University Press, Oxford. 1975.

Maitra, Amit K. 1973. Towards a science of regional systems. In: General Systems,

Society for General Systems Research, Washington, D.C.

Makridakis, S., and Claude Faucheux. 1973. Stability properties of general systems. In: General Systems, Yearbook of the Society for General Systems Research, Washington, D.C.

Mandlebaum, Maurice. 1955. Societal facts. In: The Philosophy of Social Explanation. Alan Ryan, ed. Oxford University Press, London. 1973.

Mandelbaum, Maurice. 1960. Historical explanation: The problem of "covering laws." History and Theory, 1: Reprinted in Ideas of History, V. II, Ronald D. Nash, ed. E. P. Dutton, New York. 1969.

Mann, Dean E. 1975. Political incentives in U.S. water policy: Relationships between distributive and regulatory politics. In: What Government Does, Matthew Holden, Jr., and Dennis L. Dresang, eds. Sage Publications, Beverly Hills, Calif.

Mansfield, E. 1975. Microeconomics. 2nd ed. Norton, New York.

Margolis, J., and W. Trzeciakowski. 1970. Multi-level planning and decision-making: A background paper. In: Multi-Level Planning and Decision-Making. United Nations, Economic Commission for Europe, New York.

Marris, Robin, Ed. 1974. The corporate society. Wiley, New York.

Maruyama, Magovoh. 1973. Human futuristics and urban planning. Journal of the American Institute of Planners, 39: 346-358.

Maslow, A. H. 1954. Motivation and personality. Harper, New York.

Maslow, Abraham H. 1972. The farther reaches of human nature. Viking Press, New York.

Massey, Gerald. 1970. Understanding symbolic logic. Harper & Row, New York.

Matthew, E. 1973. Economics and the environment. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

McCloskey, Herbert J. 1957. An examination of restricted utilitarianism. Philosophical Review, 66:466-485.

McDonald, Roderick P., and H. Swaminathan. 1973. A simple matrix calculus with applications to multivariate analysis. In: General Systems 1973, Society for General Systems Research, 1973 Yearbook, Washington, D.C.

McKean, R. N. 1958. Efficiency in government through systems analysis. John Wiley & Sons, New York.

McNeill, David. 1971. Sentences as biological systems. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Mead, George Herbert. 1934. Mind, self, and society. University of Chicago Press, Chicago.

Meiland, Jack. 1970. The nature of intention. Methuen, London.

Mendelson, E. 1964. Mathematical logic. Van Nostrand, Princeton.

Mesarovic, M. D. 1966. A conceptual framework for the studies of multilevel multigoal systems. Systems Research Center Report SRC 101-A-66-43. Case Western Reserve University, Cleveland, Ohio.

Mesarovic, M. D., and D. Macko. 1969. Foundations for a scientific theory of hierarchical systems. In: Hierarchical Structures, Whyte, Wilson and Wilson, eds. American Elsevier Publishing Co., Inc., New York.

Mesarovic, M. D., D. Macko, and Y. Takahara. 1970. Theory of hierarchical, multilevel systems. Academic Press, New York.

Metlay, Daniel. 1975. A quasi-operational definition of complexity. In: Organized Social Complexity, Todd R. La Porte, ed. Princeton University Press, Princeton, N. J.

Mishan, E. J. 1969. Technology and growth: The price we pay. Praeger, New York.

Mishan, Edward J. 1970. 21 popular economic fallacies. Praeger Press, New York.

Moline, Jon. 1968. On points of view. American Philosophical Quarterly, 5:191-198.

Moore, G. E. 1965. External and internal relations. In: Philosophical Studies. Littlefield, Adams and Co., Totowa, N. J.

Mulder, Jim. 1972. PROPDEMM: A computer simulation of political decision making and environmental policy. Report to Environment and Man Program. Utah State University, Logan, Utah.

Mulder, Jim. 1974. The development and application of PROPDEMM: A computer simulation of the policy process in water resources planning. Ph.D. dissertation. Syracuse University, Syracuse, New York.

Mulder, Jim, et al. 1978. The study of interactions among different levels of analysis in comprehensive river basin planning. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Mulder, Jim, L. Douglas James, Kirk Kimball, Lance Rovig, Kenneth Sizemore, and Daniel Hoggan. Forthcoming, 1979. Integrating water resources and land use planning. Utah Water Research Laboratory, Logan, Utah.

Nagel, Ernest. 1952. Wholes, sums, and organic unities. Philosophical Studies, 3:17-26.

Nagel, Ernest. 1961. The structure of science. Harcourt, Brace, and World, New York.

Nataf, Andre. 1968. Aggregation. In: International Encyclopedia of the Social Sciences. D. Sills, ed. Macmillan and the Free Press, New York.

National Water Commission. 1973. Water policies for the future. Water Information Center, Inc., Port Washington, N.Y.

Niemi, R. G., and H. F. Weisberg. 1968. A mathematical solution for the probability of the paradox of voting. Behavioral Science, 13:317-323.

Nowak, Stefan. 1976. Understanding and prediction. D. Reidel, Dordrecht, Holland.

Nozick, Robert. 1974. Anarchy, state, and utopia. Basic Books, New York.

Office of the State Planning Coordinator. 1972. Report on the development of the Utah process: Coodination through evaluating alternative state futures. Salt Lake City, Utah.

Okun, Arthur M. 1975. Equality and efficiency: The big tradeoff. The Brookings Institution, Washington, D.C.

Olson, Mancur, Jr. 1965. The logic of collective action. (rev. ed.) Schocken Books, New York.

Ostrom, Vincent. 1968. Water resouces development: Some problems in economic and political analysis of public policy. In: Political Science and Public Policy, Austin Ranney, ed. Markham, Chicago.

Ostrom, Vincent. 1971. The political theory of a compound republic. Virginia Polytechnic Institute, Center for the Study of Public Choice, Blacksburg, Virginia.

Ostrom, Vincent. 1973. The intellectual crisis in modern public administration.

University of Alabama Press, University, Ala.

Ozbekhan, Hasan. 1971. Planning and human action. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Ozbekhan, Hasan. 1974. Thoughts on the emerging methodology of planning. In: Systems and Management Science, Russell L. Ackoff, ed. Petrocelli, New York.

Page, Talbot. 1977. Discounting and intergenerational equity. Futures, XX: 377-382.

Parkinson, G. H. R., ed. 1968. The theory of meaning. Oxford University Press, Oxford.

Pateman, Carole. 1970. Participation and democratic theory. Cambridge University Press, London.

Pattee, Howard. 1969. Physical conditions for primitive functional hierarchies. In: Hierarchical Structures, Whyte, Wilson and Wilson, eds. American Elsevier Publishing co., Inc., New York.

Peterson, Dean F. 1976. The TECHOM methodology. In: Colorado River Basin modeling studies: Proceedings of a seminar. Calvin G. Clyde, Donna H. Falkenborg, and J. Paul Riley, eds. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Pigou, A. C. 1938. The economics of welfare. McMillan and Co, London.

Platt, John. 1969. Theorems on boundaries in hierarchical systems. In: Hierarchical Structures, Whyte, Wilson and Wilson, eds. American Elsevier Publishing Co., Inc., New York.

Plott, Charles R. 1976. Axiomatic social choice theory: An overview and interpretation. American Journal of Political Science, 20:511-596.

Porter, David O., and Eugene A. Olsen. 1976. Some critical issues in government centralization and decentralization. Public Administration Review, 36:72-84.

Pressman, Jeffrey, and Aaron Wildavsky. 1973. Implementation. University of California Press, Berkeley and Los Angeles.

Prior, Arthur N. 1968. The consequences of actions. In: Papers on Time and Tense. Oxford University Press, London.

Przeworski, Adam, and Henry Teune. 1970. The logic of comparative social inquiry. John Wiley & Sons, New York.

Putnam, Hilary. 1966. The analytic and synthetic. In: Minnesota Studies in the Philosophy of Science, Vol. III, Herbert Feigl and Grover Maxwell, eds. University of Minnesota Press, Minneapolis.

Putnam, Hilary. 1975. The meaning of "meaning." In: Language, Mind, and Knowledge, Keith Gunderson, ed. University of Minnesota Press, Minneapolis.

Quine, W. V. O. 1959. Methods of logic. Holt, Rinehart, and Winston, New York.

Quine, W. V. O. 1961. Two dogmas of empiricism. In: Form a Logical Point of View. 2nd ed. Harvard University Press, Cambridge, Mass.

Quine, W. V. O. 1969. Ontological relativity and other essays. Columbia University Press, New York.

Rapoport, Anatol. 1966. Two-person game theory. University of Michigan Press, Ann Arbor, Michigan.

Rapoport, Anatol. 1970. N-person game theory. University of Michigan Press, Ann Arbor, Michigan.

Rawls, John. 1955. Two concepts of rules. Philosophical Review, 64:3-32.

Rawls, John. 1971. A theory of justice. Harvard University Press, Cambridge, Mass.

Reagan, Michael D. 1972. The new federalism. Oxford University Press, New York.

Rescher, Nicholas. 1969a. Introduction to value theory. Prentice-Hall, Englewood Cliffs, N.J..

Rescher, Nicholas. 1969b. Delphi and values. P-4182. Rand Corporation, Santa Monica, Calif.

Rescher, Nicholas. 1975. A theory of possibility. Basil Blackwell, Oxford.

Rescher, Nicholas, and Alasdair Urquhart. 1971. Temporal logic. Springer Verlag, Wien, Austria.

Reynolds, James F. 1976. Policy science: A conceptual and methodological analysis. Policy Sciences, 6:1-27.

Riker, William H. 1961. The theory of political coalitions. Yale University Press, New Haven, Connecticut.

Riley, J. Paul. 1976. Modeling purposes and strategy. In: Colorado River Basin Modeling Studies: Proceedings of a Seminar. Calvin G. Clyde, Donna H. Falkenborg, and J. Paul Riley, eds. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Rittel, Horst W. J., and Melvin M. Webber. 1974. Dilemmas in a general theory of planning. In: Systems and Management Science, Russell L. Ackoff, ed. Petrocelli, New York.

Robinson, W. S. 1950. Ecological correlations and the behavior of individuals. American Sociological Review, 15:351-357.

Rokeach, Milton. 1973. The nature of human values. Free Press, New York.

Rorty, Richard M. 1967. Relations, internal and external. In: The Encyclopedia of Philosophy, v. 7, ed. Paul Edwards, Macmillan and Free Press, New York.

Rose, J. 1975. The economics of natural resource depletion. John Wiley and Sons, New York.

Rowley, Charles K., and Alan T. Peacock. No date. Welfare economics: A liberal restatement. John Wiley and Sons, New York.

Rovig, Lance R. 1976. On the measurement of the extent of preference, interpersonal comparisons, and rates of substitution. In: Intermountain Economic Review. Salt Lake City, Utah. Spring.

Ruggie, John Gerard. 1975. Complexity, planning, and public order. In: Organized Social Complexity, Todd R. LaPorte, ed. Princeton University Press, Princeton, New Jersey.

Russell, Bertrand. 1968. Logic and knowledge. Macmillan, New York.

Samuelson, Paul. 1967. Arrow's mathematical politics. In: Human Values and Economic Policy, Sidney Hook, ed. New York University Press, New York.

Samuelson, Paul. 1973. Economics. 9th ed. McGraw-Hall, New York.

Scheffler, Israel. 1967. Anatomy of inquiry. Alfred A Knopf, New York.

Schermerhorn, John R., Jr. 1975. Determinants of interorganizational cooperation. Academy of Management Journal, 18:846-56.

Schmandt, Henry. 1972. Municipal decentralization: An overview. Public Administration Review, 32:571-88.

Schon, Donald A. 1970. The blindness system. The Public Interest, 18:25-38.

Schultze, Charles L. 1968. The politics and economics of public spending. The Brookings Institution, Washington, D.C.

Schwartz, Steven P., ed. 1977. Naming, necessity, and natural kinds. Cornell University Press, Ithaca, N.Y.

Searle, John R. 1969. Speech acts. Cambridge University Press, London.

Sen, Amartya K. 1970. Collective choice and social welfare. Holden-Day, San Francisco.

Simon, Herbert A. 1962. The architecture of complexity. In: American Philosophical Society Proceedings, 106:467-492.

Simon, Herbert A. 1969. The sciences of the artificial. MIT Press, Cambridge, Mass.

Simon, Herbert. 1972. Theories of bounded rationality. In: Decision and Organization, C. B. McGuire and Roy Radner, eds. North Holland Publishing Co, Amsterdam.

Singer, J. David. 1961. The levels-of-analysis problem in international relations. In: The International System, Klaus Knorr and Sidney Berba, eds. Princeton University Press, Princeton, New Jersey.

Singer, J. David. 1969. The level of analysis problem in international relations. In: International Politics and Foreign Policy, Rev. Ed., James N. Rosenau, ed.. The Free Press, New York.

Skyrms, Brian. 1975. Choice and chance. 2nd ed. Dickenson, Encino.

Smelser, Neil. 1962. Theory of collective behavior. Free Press, New York.

Smith, Stephen. 1974. Economics and economists in water resources planning. In: Man and Water. L. D. James, ed. University of Kentucky Press, Lexington.

Society for the Advancement of General Systems Theory. 1956. General systems. Yearbook of the Society for General Systems Research, part 1. Ann Arbor, Michigan.

Society for the Advancement of General Systems Theory. 1973. General systems. Society for General Systems Research, 1973 Yearbook, Washington, D.C.

Sosa, Ernest, ed. 1975. Causation and conditionals. Oxford University Press, Oxford.

Spencer-Brown, G. 1972. Laws of form. Julian Press. New York.

Staaf, Robert J. 1973. Externalities: Theoretical dimensions of political economy. Dunellen, New York.

Stark, Werner. 1958. The sociology of knowledge. The Free Press, Glencoe, Illinois.

Strasnick, Steven. 1976. The problem of social choice: Arrow to Rawls. Philosophy and Public Affairs, 5:241-273.

Study Committee on Policy Management Assistance. 1975. Strengthening public management in the intergovernmental system, Vol. II, Executive summary. In: Public Administration Review, 35:700-705.

Sunick, L. 1973. Environmental management and politics. Center for Governmental Studies. Northern Illinois University, Rockford, Illinois.

Suppe, Fredrick. 1977. The structure of scientific theories. Second Edition. University of Illinois Press, Urbana, Illinois.

Suppes, P. 1957. Introduction to logic. Chapter 12. Van Nostrand, Princeton.

Suppes, Patrick. 1960. A comparison of the meaning and uses of models in mathematics and the empirical sciences. Synthese, 12:287-301.

Sutherland, John W. 1975. SYSTEMS: Analysis, administration, and architecture. Van Nostrand Reinhold Company, New York.

Swanson, J. W. 1966. On models. British Journal of the Philosophy of Science, 17:296-311.

Taylor, Ronald N. 1975. Phychological determinants of bounded rationality: Implications for dicisionmaking strategies. Decision Sciences, 6:409-429.

Technical Committee of the Water Resources Research Centers of the Thirteen Wester States. 1974. Water resources planning, social goals, and indicators: Methodological development and empirical test. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Theil, Henri. 1972. Statistical decomposition analysis. North Holland Publishing Co., Amsterdam.

Thompson, D. N. 1973. The economics of environmental protection. Winthrop Publishing, Cambridge, Mass.

Tullock, Gordon. 1970. Private wants, public means. Basic Books, New York.

United Nations Economic Commission for Europe. 1970. Multi-level planning and decision-making. United Nations (E/ECE/7500), New York.

U.S. Bureau of Reclamation. 1971. Upper Colorado River Basin: Comprehensive framework study. Government Printing Office, Washington, D.C.

U.S. Bureau of Reclamation. 1974. Colorado River water quality improvement program: Status report. United States Department of the Interior. Government Printing Office, Washington, D.C.

U.S. Bureau of Reclamation. 1975. Westwide study report on critical water problems facing the eleven western states. Untied States Department of the Interior. Government Printing Office, Washington, D.C.

U.S. Department of the Interior. 1974. Report on Water for energy in the Upper Colorado River Basin. Government Printing Office, Washington, D.C.

U.S. Federal Water Pollution Control Administration. 1970. The economics of clean water. Government Printing Office, Washington, D.C.

U.S. Water Resources Council. 1973. Water and related land resources, establishment of principles and standards for planning. Federal Register, 38:24778-24869.

Utah Division of Water Resources. 1976. The State of Utah water - 1975. State of Utah, Salt Lake City, Utah.

Utah Section of the American Water Resources Association. 1975. Impacts of energy development on Utah water resources. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Utah Water Research Laboratory. 1975. Colorado River regional assessment study. PART ONE: Executive summary, basin profile, and report digest. Prepared for National Commission on Water Quality. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Utah Water Research Laboratory. 1975. Colorado River regional assessment study. PART TWO: Detailed analyses, narrative description, data, methodology, and documentation. Prepared for National Commission on Water Quality. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Utah Water Research Laboratory. 1975. Colorado River regional assessment study. PART THREE: Area specific water quality analysis and environment assessment. Prepared for National Commission on Water Quality. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Utah Water Research Laboratory. 1975. Colorado River regional assessment study. PART FOUR: Bibliography and appendices. Prepared for National Commission on Water Quality. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Van Dyne, G. M. 1969. The ecosystem concept. Academic Press, New York.

Van Gigch, John P. 1974. Applied general systems theory. Harper and Row, New York.

Von Newmann, J., and Oscar Morgenstern. 1947. Theory of games and economic behavior. 2nd ed. Princeton University Press, Princeton, N. J.

Walker, William R. 1969. Economics of air and water pollution. Virginia Polytechnic Institute, Blacksburg, Virginia.

Wamsley, Gary L., and Mayer N. Zald. 1973. The political economy of public organizations. Public Administration Review, 33:62-73.

Warren, Roland L. 1967. The interorganization field as a focus for investigation. Administrative Science Quarterly, 12:396-419.

Water Resources Council. 1974. Water for energy self-sufficiency. Government Printing Office, Washington, D.C.

Watkins, J. W. N. 1968. Methodological individualism and social tendencies. In: Readings in the Philosophy of the Social Sciences, May Brodbeck, ed. Macmillan, New York.

Watt, K. E. 1968. Ecology and resource managment. McGraw-Hill, New York.

Weber, Max. 1946. From Max Weber: Essays in sociology. Trans. and Ed. H. H. Gerth and C. Wright Mills. Oxford University Press, New York.

Weiler, Gershon. 1976. Points of view. In: Language in Focus, Asa Kasher, ed. D. Reidel, Dordrecht, Holland.

Weiss, Donald. 1973. Wollheim's paradox: Survey and solution. Political Theory, 1:154-170.

Weiss, Paul A. 1971a. The basic concept of hierarchic systems. In: Hierarchically Organized Systems in Theory and Practice. Hafner Publishing Co., Inc., New York.

Weiss, Paul A. 1971b. Hierarchically organized systems in theory and practice. Hafner Publishing Co., Inc., New York.

Wendell and Schwan. 1972. Intergovernmental relations in water resources activities. Springfield, Va.: NTIS (PB-210-358).

Western Environmental Associates, Inc. 1975. Baseline description of socio-economic conditions in the Uintah Basin. Western Environmental Associates, Inc., Providence, Utah.

Western Governors' Policy Office. 1978. Managing resource scarcity: Lessons from the mid-seventies drought. Institute for Policy Research, Western Governors' Policy Office, Denver, Colorado.

Western States Water Council. 1978. 1977 annual report. Salt Lake City, Utah.

Western States Water Council. 1978. Position on the administrations water policy reforms by Western State's Water Council. Salt Lake City. October 25.

Wheare, K. C. 1963. Federalism. 3rd ed. Oxford University Press, New York.

Whipple, W., Jr., et al. 1976. Reorientation of urban water resources research. Rutgers Water Resources Research Institute, New Jersey, February.

Whyte, Lancelot Law. 1969. Structural hierarchies: A challenging class of physical and biological problems. In: Hierarchical Structures. Whyte, Wilson and Wilson, eds. American Elsevier Publishing Co., Inc., New York.

Whyte, Wilson and Wilson, eds.. 1969. Hierarchical structures. American Elsevier Publishing Co., Inc., New York.

Wildafsky, Aaron. 1974. The politics of the budgetary process. 2nd ed. Little, Brown, Boston.

Wilson, John. 1956. Language and the pursuit of truth. Cambridge University Press, London.

Wimsatt, William C. 1974. Complexity and organization. In: PSA. 1972, Kenneth F. Schaffner and Robert S. Cohen, eds. D. Reidel, Dordrecht, Holland.

Wimsatt, William C. 1976. Reductionism, levels of organization, and the mind body problem. In: Consciousness and the Brain, Globus, Maxwell, and Savoduick, eds. Plenum Press, New York.

Winch, Peter. 1958. The idea of a social science. Routledge and Kegan Paul, London.

Wittgenstein, Ludwig. 1953. Philosophical investigations. Macmillan, New York.

Wittgenstein, Ludwig. 1961. Tractatus logico-philosophicus. Routledge & Kegan Paul, London.

Woods, B. 1972. Eco-solutions: A casebook for the envirnomental crisis. The Learning Press, Morristown, New Jersey.

Wyzga, R. E. 1972. Environmental damage costs. OECD, Washington, D.C.

Wyzga, R. E. 1974. Environmental damage costs. OECD, Washington, D.C.

Yancey, Thomas L., L. Douglas James, D. Earl James, Jr., and Jeanne Goeddert. 1976. Disaster-caused increases in unit repair costs. Proceedings of the ASCE, 102(WR2):265-282, November.

Zeleny, M., ed. 1975. Kyoto 1975. Springer-Verlag, New York.

PROPDEMM II COMPUTER PROGRAM
DOCUMENTATION

Program PROPDEMM II is a revision of PROPDEMM written in FORTRAN IV and is compatible with either an IBM system 360 configuration or Burroughs 6700. The documented listing is set up to be used on a Burroughs 6700.

Compilation time is approximately 28 seconds. Approximate storage required is 7650 words (48 bit words).

Execution time is approximately 7 seconds.

Since the Burroughs 6700 is a virtual memory computer storage requirements are hard to estimate. However, array storage is approximately 4862 words, total program code of 2502 words, 11 program segments, and 155 disc segments.

Printed lines of execution output is 1877 lines for the current execution of the programs the numbers of lines printed for the program listing and compilation is (500).

The number of cards in the program deck is 500.

The number of cards in the data deck is 77.

The program deck is punched in EBCDIC code using an IBM 029 keypunch. A utility program available at the Utah State University Computer Center will convert EBCDIC or 029 keypunch code to BCD or 026 keypunch code, thus permitting compilation and execution on a UNIVAC 1180 computer.

The following deck setup is for a Burroughs B6700 computer. All words written in capital letters must be punched literally as they appear. To compile the PROPDEMM II program card deck, the following control cards must be used:

Beginning in card column 1[1]:

2 USER necessary accounting information (this will vary from computer center to computer center. The user will need to contact the

---

[1]A "2" represents an invalid character or a 1 and 2 overpunched.

computer center in question for correct accounting information).

2 PASSWORD "password" (this card may also vary depending on the computer center) where password may be any character combination known only to the user.

2 COMPILE PROPDEMM FORTRAN LIBRARY

where LIBRARY is an optional item. If the user desires to store the compiles PROPDEMM program deck permanently on a system program library disk, he need only punch the word LIBRARY in the card as shown. The advantage of such an action permits the user to execute the program as many times as desired without needing to recompile the program deck each time. If LIBRARY is not used, SYNTAX may be punched in its place. This indicates that the program will be compiled only and not executed. In either case, the program will be compiled only.

2 DATA
PROPDEMM program deck is placed here.

2 END
This completes the compilation procedure.

To compile and execute PROPDEMM in one operation, arrange control cards as follows:

2 USER accounting information
2 PASSWORD "password"
2 COMPILE PROPDEMM FORTRAN GO where GO may or may not be punched, indicating execution. If GO is left out, execution is automatically assumed.
2 DATA
Program deck.
2 DATA CARD/DECK
PROPDEMM data cards.
2 END

The user should be aware that the decision maker and objective vectors are treated in the same manner as the other five groups in all computations. At the present development of PROPDEMM these vectors

do affect the other groups and are affected by the other groups.

No program-generated error messages will appear in PROPDEMM.

PROPDEMM II DATA PREPARATION

All data input to PROPDEMM II must be prepared in order as follows. Format specifications included are written in FORTRAN IV for use on a Burroughs 6700 computer.

1. SWITCH CARDS: Format (20I1). Four values are entered on this card to represent the variables SWSEL, SWESG, SWOVVG, and SWID. All values are '1' or '0'. A '0' in any column will suppress program execution of that item.

   column
   1 SWSEL switch prints selected vectors only when SWESG and/or SWOVVG are turned on.

   2 SWESG switch prints environmental state vectors modified by groups.

   3 SWOVVG switch prints outcome value vectors modified by groups.

   4 SWID switch prints issue differences.

2. INDICATED SALIENCE LEVEL: Format (5I2). A single number is placed on this card as follows:

   column
   2 any integer value between 0 and 7. The remainder of the card is not used.

3. GROUP DOGMATISM VECTOR: Format (7F1.0). Input as shown:

   column
   1-7 Seven dogmatism values, one for each group, single spaced. The group information must be in the same order as the groups will be analyzed. The seventh group is the selected vector group which may be used as a hypothetical group. A positive integer must occupy each column.

4. PUNISHMENT-REWARD POTENTIAL VECTOR: Format (5I2). Five values are entered as shown:

   column
   1-10 Any integer value between -3 and+3. If a negative value is entered then a (-) sign and the integer value occupy the two place field. If a positive integer is entered, then the integer alone will occupy the second place in the two

place field. No (+) sign is necessary for positive integers.

5. COST CONSCIOUSNESS/COST LEVEL VECTORS: Format (7I1, 15I2). Values are punched on the card as follows:

   column
   1-7 Seven single digit integer values each associated with the cost consciousness of a group including both the decision maker's value and an objective value which may represent a hypothetical group. Range of possible values: 1-7.

   9-37 The cost levels of all 15 courses of action are punched as single digit numbers within a range of -3 to+3. When the value is positive, right justify the digit in the given field as no (+) sign is necessary.

6. GROUP AFFECT VECTOR: Format (28F2.0/ 21F2.0). The affect values require two data cards and are input thusly:

   column
   1-14 Group 1 values
   15-28 Group 2 values
   29-42 Group 3 values
   43-56 Group 4 values
   (next card)
   1-14 Group 5 values
   15-28 Group 6 or decision maker
   29-42 Selected vector
   The values are entered in two digit fields using values from -3 to+3. Where using '0' as a positive integer right justify entry. The (-) sign will occupy the first digit position in negative entires.

7. GROUP VALUES VECTORS: Format (3(5A4, 10I2, 5A4, 10I2/) 5A4, 10I2, 5A4, 10I2). The group value vectors require four data cards and are prepared as follows:

   column
   1-20 Group name
   21-40 Group values (10)
   41-61 Group name
   62-80 Group values (10)

This format allows the use of seven groups. The first three data cards will input two groups per card and the fourth card will input the remaining group. The group values are entered in two digit fields using a -3 to+3 scale. Entries must be right justified with the (-) sign occupying the first digit position for negative entires.

92

8. GROUP VALUE NAMES: Format (2(4(5A4)/), 4(5A4)). The value names require three data cards as shown below:

column
1-4 Abbreviation of value #1 name
5-20 Value #1 name
21-24 Abbreviation of value #2 name
25-40 Value #2 name
41-44 Abbreviation of value #3 name
54-60 Value #3 name
61-64 Abbreviation of value #4 name
65-80 Value #4 name

This pattern is followed on the second data card for values 5, 6, 7, and 8. The third card follows the same format for the input of values 9 and 10.

9. COURSE OF ACTION NAMES: Format (3 (20Af/), 20A4). Four data cards are prepared thusly:

column
1-20 Course of action name
21-40 Course of action name
41-60 Course of action name
61-80 Course of action name

Each of the first three cards will input the names of four courses of action. The fourth card will input the names of three courses of action. It is not necessary to fill all of the spaces within a field.

10. GROUP SALIENCE VECTORS: Format (70 I 1). Salience vectors for all seven groups are entered on one data card.

column
1-10 Group 1 salience vector
11-20 Group 2 salience vector
21-30 Group 3 salience vector
31-40 Group 4 salience vector
41-50 Group 5 salience vector
51-60 Decision maker salience vector
61-70 Objective vector salience vector

Salience is ranked on a 1-7 scale and input through single digit fields.

11. GROUP POWER VECTORS: Format (75I 1/30 I1). Two data cards are required to input the group power vectors.

column
1-15 Group 1 power for courses of action #1 through #15
16-30 Group 2 power for courses of action #1 through #15
31-45 Group 3 power for courses of action #1 through #15
46-60 Group 4 power for courses of action #1 through #15

46-60 Group 4 power for courses of action #1 through #15
61-75 Group 5 power for courses of action #1 through #15
(next card)
1-15 Decision maker power for courses of action #1 through #15
16-30 Objective vector power for courses of action #1 through #15

Each group power vector is contained in a 15 digit field representing the 15 courses of action. Groups must be entered in the order listed. A 1-7 scale is used to rank group power.

12. SALIENCE OF POSITIVE INFORMATION VECTOR: Format (60I1). One data card is needed to input this vector.

column
1-10 Group 1 positive information salience
11-20 Group 2 positive information salience
21-30 Group 3 positive information salience
31-40 Group 4 positive information salience
41-50 Group 5 positive information salience
51-60 Decision maker positive information salience

Each groups positive information salience is entered in a 10 digit field corresponding to the 10 environmental values. Salience rankings are performed on a 1-7 scale and the 7th group—the objective vector is omitted from input. At the current time this data is not used in the PROPDEMM II program but must be input to fulfill format requirements.

13. SALIENCE OF NEGATIVE INFORMATION VECTOR: Format (60I1). All input requirements are the same as presented in SALIENCE OF POSITIVE INFORMATION vector above. vector above.

14. POSITIVE INFORMATION VECTOR: Format (75 I 1/15 I 1). Two data cards are needed for this vector.

column
1-15 Group 1 access to positive information
16-30 Group 2 access to positive information
31-45 Group 3 access to positive information
46-60 Group 4 access to positive information
61-75 Group 5 access to positive information
(next card)
1-15 Decision maker access to positive information

Each group is ranked for access to positive information for each source of action. This ranking is performed on a 1-7 scale with 1 representing perfect information. The decision

93

maker vector will always be equal to a series of "1's" in a fifteen digit field. At the current time this data is not used in the PROPDEMM II program but must be input to fulfill format requirements.

15. NEGATIVE INFORMATION VECTOR: Format (75 I 1/15 I 1). All input requirements are the same as presented in POSITIVE INFORMATION VECTOR above.

16. ENVIRONMENTAL IMPACT VALUE VECTORS: Format (24(2(4A4, 1I2, I1)/), 2(4A4, 1I2, I1)). Twenty-five data cards are used to input the EIVV. They are prepared as follows: follows:

column
1-16 Name of environmental factor (up to 16 characters)
17-36 Ten integer impact values—right justified in a set of ten two-digit fields. A -3 to +3 scale is used.
37-38 Probability value
39 Intensity of impact ranking between the five levels of each environmental factor. A scale of 1 to 5 is used with "1" representing the most intense.
40-55 Name of environmental factor
56-75 Impact values
76-77 Probability
78 Impact ranking

Repeat as above on the next 24 cards. Column 79-80 may be used for any useful data identifying information.

17. OUTCOME VALUE VECTORS: Format (24 (33I2/), 33I2). Twenty-five cards are required to input these vectors. So there are 5 possible outcomes per course of action, they should all be grouped in proper sequence.

column
1-20 Ten integer values ranging from -3 to +3 right justified in a set of ten two-digit fields. Positive values do not require an indicating sign, but negative values must be preceeded by a minus (-) sign always.
21-22 Probability value
23-42 Ten impact values
43-44 Probability value
45-64 Ten impact values
65-66 Probability values

Repeat as above on next 24 cards. Columns 67-80 on each card may be punched with any information.

A summary of required data to be punched follows:

1st card: Program switches

2nd card: Indicated salience level

3rd card: Dogmatism vector

4th card: Punishment-reward potential vector

5th card: Cost factor vectors

6th-7th cards: Group affect vectors

8th-11th cards: Group values vectors

12th-14th cards: Group values names

15th-18th cards: Course of Action names

19th card: Group salience vectors

20th-21st cards: Group power vectors

22nd card: Salience of positive information vector

23rd card: Salience of negative information vector

24th-25th cards: Positive information vectors

26th-27th cards: Negative information vectors

28th-52nd cards: Environmental impact value vectors

53rd-77th cards: Outcome value vectors

PROPDEMM ERRATA LEGEND

Subscripts:

i = impact values
j = conditions
k = groups
s = environmental states
l = courses of action
m = outcomes
r = reference group
z = the No. of GRPSAL's > SL

Variables:

$EMV_{j,k,s}$ = environmental value modification vector

$ESVV_{i,j,s}$ = impact values resulting from specific environmental conditions.

$GRPVAL_{i,k}$ = the values on likes and dislikes of a specific group.

$GRPSAL_{i,k}$ = the degree of significance of a value to a group

$XEMV_{j,k,s}$ = environmental value modification vector index

94

$OMV_{m,k,l,s}$ = outcome value modification vector

$OVV_{i,l,m,s}$ = the impact values resulting from specific course of action outcomes

$XOMV_{m,k,l,s}$ = outcome value modification vector index

$GP_{i,k,l,m,s}$ = the group position

$POVV_{m,k,l,s}$ = the position outcome value vector

$PIP_{l,k,s}$ = the partial issue position

$NSIP_{l,k,s}$ = the nonsystematic issue position

$XCL_{l,s}$ = $\sum\limits_{k=1}^{7} (CL_{l,x} \times CC_k)$

$CL_{l,s}$ = the cost level of a course of action.

CC_k = the cost consciousness of a group k as regards a course of action.

SSN_k = the selected salience number for group k.

SL = the salience level number representing the level of salience considered significant by group k.

$NSPFI_{l,k,s}$ = the nonsystematic political feasibility index.

$PWR_{k,l,s}$ = the power group k possessess to block a course of action.

$OC_{r,l,s}$ = the openness to change index.

$AFF_{r,k}$ = the degree of friendship or hostility between group r and k.

DOG_r = the dogmatism of group r—its political rigidity.

$ID_{r,k}$ = $(NSIP_r - NSIP_k)$, the issue difference between the groups.

$SIP_{k,l,s}$ = the systematic issue position.

$SPFI_{k,l,s}$ = the systematic political feasibility index.

$PCI_{r,l,s}$ = the potential for change index.

$XGVD_r$ = the group value difference index.

PROPDEMM

1. $EMV_{j,k,s} = \sum\limits_{i=1}^{10} \dfrac{|ESVV_{i,j,s} - GRPVAL_{i,k}|}{GRPSAL_{i,k}}$

$EMV_{j,k,s}$ = environmental value modification vector. There is a EMV for each of the 10 conditions per environmental state for each of the 7 groups and 3 environmental states given the 10 values per condition. There will be 210 EMV's; 3 ES x 10 ESVV's x 7 groups.

The SVV (selected value vector) and SSV (selected salience vector) are included as objective vectors as groups 7. Group 6 is the decision maker.

j = condition, there are 10 conditions per environmental state (ES).

i = impact value, there are 10 impact values per condition.

k = groups, there are 7 groups.

s = environmental states, there are 3 ES's ESI = most probable, ESII = most desirable, ESIII = least desirable.

$ESVV_{i,j,s}$ = The impact values resulting from specific (j) environmental conditions j = 1...10 for each environmental state(s). The ESVV's are given on a -3 to 3 scale.

$GRPVAL_{i,k}$ = the values or likes and dislikes of a specific group (k), k = 1...7, regarding each of the 10 values; e.g., water quality, economic growth, etc. The GRPVAL's are given on a -3 to 3 scale.

$GRPSAL_{i,k}$ = the degree of significance of a value to a group—a measure of intensity of feelings regarding each of the 10 values. GRP-SAL's are given on a 1 to 7 scale.

Thus as GRPSAL and ESVV → GRPVAL the EMV
        expected   desired

and the more desirable the environmental condition.

2. $XEMV_{j,k,s} = \dfrac{|ESVV(S,J,K)BRPVAL(I,K)|}{GRPSAL(,I)}$

$XEMV_{j,k,s}$ = environmental value modification vector index. There is an XEMV for each EMV.

The smaller the index the more desired the environmental condition; i.e., the closer the fit between expected and desired values.

3. $OMV_{m,k,l,s} = \displaystyle\sum_{i=1}^{10} |OVV_{i,m,l,s} - GPRVAL_{i,k}|$

$OMV_{m,k,l,s}$ = outcome value modification vector. There is a OMV for each of the 5 outcomes per each of the 5 courses of action for each of the 7 groups and 3 environmental states. There will be 525 OMV's; 5 OVV's x 5 CA's x 3 ES's x 7 groups.

The SVV and SSV are included as group 7 and the decision maker as group 6.

$OVV_{i,l,m,s}$ = the impact values resulting from specific (m) course of action outcomes m = 1...5 for each course of action. The OVV's are given on a -3 to+3 scale.

Thus as GRPSAL ⬆ and expected ➝ desired
$$OVV \longrightarrow GRPVAL$$
the OMV ⬇ and the more desirable the course of action outcome.

4. $XOMV_{m,k,l,s} = \dfrac{|(OVV(S,L,M,K) - GRPVAL(K,I)|}{GRPSAL(K,I)}$

$XOMVm,k,l,s$=Outcome value modification index. There is an XOMV for each OMV.

5. $PXOMV_{m,k,l,s} \dfrac{OMV_{m,k,l,s}}{PROB_{OVV_m}}$

$PXOMV_{m,k,l,s}$=probability outcome value modification vector index. There is a PXOMV for each OMV.

The smaller the index the more desired the course of action outcome.

6. $POVV_{m,k,l,s} \displaystyle\sum_{i=1}^{10}$

$$\dfrac{(3-|(OVV(S,L,M,I)-(GRPVAL(K,I)| \times GRPSAL(K,I)}{10}$$

$POVV_{m,k,l,s}$ = the position outcome value vector. There is a POVV for each group for each course of action for each outcome for each environmental state. 5 OVV's x 5 CA's x 3 ES x 7 groups = 525 POVV's. POVV⬆ if GP⬆ or GRPSAL⬆. The larger the POVV the more favorable the outcome.

7. $PIP_{l,k,s} = \dfrac{\displaystyle\sum_{m=1}^{5} (POVV_{m,k,l,s} \times OVV_{s,l,m})}{5}$

$PIP_{l,k,s}$ = the POVV weighted with the probability of the outcomes for each course of action. PIP⬆ as POVV⬆ or PROB⬆. The larger the PIP the more favorable the course of action. There is PIP for each course of action for each ES for each group. 5 CA's x 3 ES's x 7 groups = 105 PIPS.

The PIP is the partial issue position.

8. $NSIP_{l,k,s} = \dfrac{PIP_{l,k,s}}{XCL_{l,s}}$ in which $XCL_{l,s} = \displaystyle\sum_{k=1}^{7} (CL_{l,s} \times CC_k)$

$NSIP_{l,k,s}$ = the nonsystematic issue position. It is nonsystematic since political interactions with other groups is not considered at this point in the calculations. There is a NSIP for each group for each course of action for each ES; 5 CA's x 7 groups x 3 ES = 105 NSIP's. As CC⬆ and CL⬆ NSIP⬇.

CC_k = the cost consciousness of group k and is measured on a scale of 1 to 7. A low CC of say 1 or 2 means the group does not consider the CL of a CA relevant or significant.

$CL_{l,s}$ = the cost level of a CA and is measured on a scale of 1 to 7.

*Note: this is a change—the scale used to be -3 to 3 but for reasons of difficulties dividing by zero or trying to get NSIP's that were not negative numbers, the scale had to changed to 1 to 7.

A low CL means the group feels that the cost of a CA is not high.

96

Thus NSIP ↓ as CC ↑ or CL ↑ the higher the CL and degree of CC the less support a group will give to a CA.

9. $SSN_k = \dfrac{\dfrac{\sum\limits_{i=1}^{Z}(GRPSAL_{i,k})}{10\sum\limits_{i=1}^{Z}GRPSAL_{i,k} - \sum\limits_{i=1}^{Z}(GRPSAL_{i,k} - ISL_k)}}{} + \dfrac{\sum\limits_{i=1}^{10}GRPSAL_{i,k}}{10}$

SSN_k = the selected salience number for group k. This number is the aggregate or "average" salience value for the GRPSAL vector. Instead of GRPSAL vector of saliences we now have one salience number the selected salience number. The SSN is computed using GRP-SAL's and the SL. There are 7 SSN's—one for each group.

ISL_k = the indicated salience level. The SL is that salience number representing the degree of salience considered significant. Saliences $<$ ISL are not used in the "averaging" computation of the SSN. There is only one ISL.

Z = the number of GRPSAL's $>$ ISL

10. $NSPFI_{l,k,s} = (SSN_k \times PWR_{k,l,s} \times NSIP_{l,k,s})$

$NSPFI_{l,k,s}$ = the nonsystematic political feasibility index. It is nonsystematic since external political interactions are not considered. It measures the support a group will give to a CA without external political interaction effects. NSPFI ↑ if NSIP ↑ PWR ↑ , and SSN ↑ . The political feasibility of a CA ↓ as NSPFI ↑. There is an NSPFI for each group for each CA for each ES. 7 groups x 3 E ss x 5 CA's = 105 NSPFI's.

$PWR_{k,l,s}$ = the power a group possesses to block a course of action. It is given on a scale of 1 to 7. A PWR of 7 means the group can block a CA.

11. $OC_{r,l,s} = \sum\limits_{k=1}^{7} \dfrac{\left(\dfrac{AFF_{r,k}}{|1 + ID_{r,k}|}\right) \times \left(\dfrac{SSN_r \times PWR_{r,l,s}}{SSN_k \times PWR_{k,l,s}}\right)}{Dog_k}$

$OC_{r,l,s}$ = the openness to change index. It represents the measure of influence of each group k on a reference group r to determine the OC of the reference group r. As the Dog_r ↓ , PWR_r ↑ , SSN_r ↑ , ID ↑ , AFF ↑ , SSN_r ↓ PWR_k ↓ , the OC_r ↓ . There is an OC for each grop for each CA for each ES. 7 groups x 5 CA's x 3 ES's = 105 OC's.

r = the reference group.

$AFF_{r,k}$ = the degree of friendship or hostility between r and any group k.

*Note, for math reasons the scale has been changed from -3 to 3 to 1 to 7. 1 = strong negative affect or much hostility, 7 = strong friendship. The more friendly the groups the more OC the reference group.

$ID_{r,k}$ = the issue difference between the r group and k group. $ID_{r,k}$ to prevent division by zero, and the r group and k group. $ID_{r,k}$ = 1(NSIP$_r$ - NSIP$_k$)1; since ID can be zero on negative we divide $AFF_{r,k}$ by $(1 + ID_{r,k})$ to prevent division by zero, and we need the absolute value to prevent OC from being a negative number. The less the ID the greater OC.

DOG_r = the dogmatism of r. This is given on a 1 to 7 scale. 7 = very rigid politically or very dogmatic. The more dogmatic r is the less OC_r is.

12. $SIP_{k,l,s} = (OC_{k,l,s} \times NSIP_{k,l,s})$

$SIP_{k,l,s}$ = the systematic issue position. It is systematic because it takes into consideration the political interactions of one group on another (the $OC_{r,k}$).

There is a SIP for each group for each course of action for each environmental state. 7 groups x 5 CA's x 3 ES = 105 SIP's.

SIP $\uparrow$ as OC $\uparrow$ and NSIP $\uparrow$, it measures the support a group will give a course of action given that they are interacting politically.

13. $\quad SPFI_{k,l,s} = (SIP_{k,l,s} \times PWR_{k,l,s} \times SSN_k)$

$SPFI_{k,l,s}$ = the systematic political feasibility index. It is systematic because external political interactions are considered (SIP). It measures the support a group will give a CA given that they interact. There is a SPFI for each group for each CA for each ES; 7 groups x 5 CA's x 3 ES's = 105 SPFI's.

14. $\quad PCI_{k,l,s} = \sum_{k=1}^{7} \left[\dfrac{SSN_r \times PWR_{r,l,s}}{SIP_{k,l,s} + SSN_k + DOG_k} \right]$

$PCI_{r,l,s}$ = the potential for change index.

The PCI represents the extent to which a group can be influenced to change in the direction wanted by the decision maker. $PCI_r \uparrow$ if $DOG_k \downarrow$ $SIP_k \uparrow$ $SSN_k \downarrow$ and the $PWR_r \uparrow$, $SSN_r \downarrow$. Remember that group 6 is our decision maker. There is a PCI for each group for each CA for each ES. 7 groups x 5 CA's x 3 ES's = 105 PCI's.

15. $\quad XGVD_k$

$$= \sum_{k=1}^{7} \left[\frac{\sum\limits_{i=1}^{10} GRPSAL_{i,r} \times (3 - |GRPVAL_{i,k} - GRPVAL_{i,k,r}|)}{10} \right]$$

$XGVD_k$ = the group value difference index. It measures the differences in value positions of the various group. The larger the index the more similar the values of the reference group r and any other group. As $GRPVAL_r \rightarrow GRPVAL_k$, the $XGVD \downarrow$. There is an XGVD for each group.

```
┌─────────┐
│  Start  │
└─────────┘
     │
     ▼
╲─────────────╱
 ╲ Read all  ╱
  ╲raw input ╱
   ╲ data   ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write group╱
  ╲values and╱
   ╲  SVV   ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write group╱
  ╲salience  ╱
   ╲and SVV  ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write group╱
  ╲ power    ╱
   ╲vectors  ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write cost ╱
  ╲ factor   ╱
   ╲values   ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write group╱
  ╲ affect   ╱
   ╲values   ╱
    ╲──────╱
        │
        ▼
╲─────────────╱
 ╲Write group╱
  ╲dogmatism ╱
   ╲and      ╱
    ╲PRPOT  ╱
        │
        ▼
╲─────────────╱
 ╲Write info ╱
  ╲modificati╱
   ╲for group╱
    ╲salience╱
        │
        ▼
╲─────────────╱
 ╲Write info ╱
  ╲modificati╱
   ╲vectors  ╱
    ╲issue position╱
     ╲values╱
```

Start

Read all raw input data

Write group values and SVV

Write group salience and SVV

Write group power vectors

Write cost factor values

Write group affect values

Write group dogmatism and PRPOT

Write info modification for group salience

Write info modification vectors for issue position values

2

Write environmental impact value vectors

Compute environmental conditions for each environmental state

Write environmental state value vectors

Is SWESG switch on? → No → 10

Yes

Is SWSEL switch on? → Write heading for ES modification by each group

Yes

Write headings for ES modification by selected vectors

Compute ES modified by selected vectors

Write ES modified by selected vector

Compute ES modified by group values

Write ES value vectors modified by group values

11

3

```
        ┌───┐                                    ┌───┐
        │ 3 │                                    │ 4 │
        └─┬─┘                                    └─┬─┘
          ▼                                        ▼
   ┌──────────────┐                         ╱───────────────╲
   │   Compute    │                         │  Compute OVV   │
   │ environmental│                         │  modified by   │
(10)──▶│value modif.  │                     │     group      │
   │   indicies   │                         │     values     │
   └──────┬───────┘                         └───────┬────────┘
          ▼                                         ▼
    ╱──────────╲                            ┌───────────────┐
   ╱Write headings╲                         │   Write OVV   │
  ╱ for EV modi-  ╲                   (20)──▶│  modified by  │
  ╲  fication     ╱                         │  group values │
   ╲  indicies   ╱                          └───────┬───────┘
    ╲──────────╱                                    ▼
          ▼                                   ╱──────────╲
    ╱──────────╲                             ╱ Write OVV  ╲
   ╱  Write  EV ╲                           ╱ modified by  ╲
  ╱ modification ╲                          ╲    group     ╱
  ╲   indicies   ╱                           ╲   values   ╱
   ╲──────────╱                               ╲──────────╱
          ▼                                         ▼
    ╱──────────╲                             ╱──────────╲
   ╱Write headings╲                         ╱Write headings╲
  ╱  for outcome  ╲                        ╱   for OVV     ╲
  ╲     value     ╱                        ╲  modification ╱
   ╲   vectors   ╱                          ╲   indicies  ╱
    ╲──────────╱                             ╲──────────╱
          ▼                                         ▼
   ┌──────────────┐                          ╱──────────╲
   │ Compute OVV  │                         ╱Write indicies╲
   │ closeness to │                   (19)──▶ for OVV      ╲
   │ fit indicies │                         ╲ modification ╱
   └──────┬───────┘                          ╲  vectors   ╱
          ▼                                   ╲──────────╱
      ╱───────╲                                     ▼
     ╱   Is    ╲                             ╱──────────╲
    ╱ SWOVVG    ╲                           ╱Write headings╲
(19)◀── switch  ╱                          ╱   for POVV    ╲
    ╲   on?    ╱                           ╲     and       ╱
     ╲───────╱                              ╲    PIP      ╱
          ▼                                  ╲──────────╱
      ╱───────╲                                     ▼
     ╱   Is    ╲                            ┌───────────────┐
 ┌────────╲ SWESL   ╲                       │  Compute POVV │
 │Write   ◀── switch ╱                      │      and      │
 │headings ╲  on?   ╱                       │      PIP      │
 │for OVV   ╲──────╱                        └───────┬───────┘
 │modified by   ▼                                   ▼
 │group     ╱──────────╲                    ╱──────────╲
 │values   ╱Write heading╲                 ╱ Write POVV ╲
 └───┬──╱ for OVV modi-  ╲                 ╱    and      ╲
     ▼  ╲ fied by        ╱                 ╲    PIP      ╱
   (20) ╲ selected       ╱                  ╲──────────╱
         ╲ vectors      ╱                         ▼
          ╲──────────╱                     ┌───────────────┐
                ▼                          │    Compute    │
         ┌──────────────┐                  │selected salience│
         │ Compute OVV  │                  │    numbers    │
         │ modified by  │                  └───────┬───────┘
         │selected vectors│                        ▼
         └──────┬───────┘                       ┌───┐
                ▼                                │ 5 │
             ┌───┐                               └───┘
             │ 4 │
             └───┘
```

100

```
         ┌─────┐                                    ┌─────┐
         │  5  │                                    │  6  │
         └──┬──┘                                    └──┬──┘
            │                                          │
            ▼                                          ▼
   ╱─────────────────╲                         ╱───────────────╲
  ╱  Write headings    ╲                       ╱       Is        ╲      No
 ╱      for cost         ╲          ◄──────────┤   SWID switch    ├──────────┐
 ╲       indicies        ╱                      ╲      on?       ╱            │
  ╲     and NSIP        ╱                        ╲───────────────╱           │
   ╲─────────────────╱                                  │                    │
            │                                           │                    │
            ▼                                           ▼                    │
   ┌─────────────────┐                         ╱─────────────────╲          │
   │    Compute       │                       ╱   Write headings   ╲        │
   │     cost         │                      ╱      for group        ╲      │
   │    indicies      │                      ╲        issue          ╱      │
   └─────────────────┘                        ╲     differences    ╱        │
            │                                   ╲─────────────────╱         │
            ▼                                           │                    │
   ┌─────────────────┐                                  ▼                    │
   │    Compute       │                        ╱─────────────────╲          │
   │     NSIP         │                       ╱       Write         ╲        │
   │                  │                       ╲      GRPVAL         ╱        │
   └─────────────────┘                         ╲─────────────────╱          │
            │                                           │                    │
            ▼                                           ▼                    │
  ╱─────────────────╲                          ╱─────────────────╲          │
 ╱  Write cost         ╲                       ╱      Write          ╲       │
 ╲    indicies         ╱                       ╲     GRPAFF          ╱       │
  ╲   and NSIP        ╱                         ╲─────────────────╱         │
   ╲───────────────╱                                    │                    │
            │                                           ▼                    │
            ▼                                  ╱─────────────────╲          ▼
  ╱─────────────────╲                         ╱      Write          ╲     ┌────┐
 ╱ Write headings     ╲                       ╱    group issue        ╲    │ 35 │
 ╱  for NSPFI,          ╲                      ╲    differences       ╱     └──┬─┘
 ╲  SSN, NSIP,         ╱                        ╲─────────────────╱          │
  ╲  GRPPWR          ╱                                   │                    │
   ╲───────────────╱                                     ▼                    ▼
            │                                   ╱─────────────────╲
            ▼                                  ╱  Write headings     ╲◄──────┘
   ┌─────────────────┐                         ╱  for openness         ╲
   │   Compute        │                        ╲   to change          ╱
   │   NSPFI,         │                          ╲  indicies         ╱
   │   TPFI           │                           ╲───────────────╱
   └─────────────────┘                                    │
            │                                             ▼
            ▼                                    ┌─────────────────┐
  ╱─────────────────╲                            │    Compute       │
 ╱ Write NSPFI,       ╲                          │   openness to    │
 ╱  SSN, NSIP,         ╲                          │    change       │
 ╲  GRPPWR            ╱                          │    indicies      │
  ╲─────────────────╱                            └─────────────────┘
            │                                             │
            ▼                                             ▼
  ╱─────────────────╲                          ╱─────────────────╲
 ╱     Write           ╲                       ╱  Write openness    ╲
 ╲      TPFI          ╱                        ╱   to change          ╲
  ╲─────────────────╱                          ╲    indicies         ╱
            │                                    ╲─────────────────╱
            ▼                                             │
   ┌─────────────────┐                                    ▼
   │  Compute group   │                         ╱─────────────────╲
   │     issue        │                        ╱  Write headings    ╲
   │   differences    │                        ╱    for SIP           ╲
   └─────────────────┘                         ╲      and            ╱
            │                                    ╲     SPFI         ╱
            ▼                                     ╲───────────────╱
         ┌─────┐                                          │
         │  6  │                                          ▼
         └─────┘                                       ┌─────┐
                                                       │  7  │
                          101                          └─────┘
```

```
                    ┌───────┐
                    │   7   │
                    └───┬───┘
                        │
                        ▼
            ┌───────────────────────┐
            │       Compute         │
            │       SIP and         │
            │        SPFI           │
            └───────────┬───────────┘
                        │
                        ▼
            ╱───────────────────────╲
            │      Write SSN,        │
            │     SIP,GRPPWR,        │
            │        SPFI,           │
            │        TSPFI           │
            ╲───────────┬───────────╱
                        │
                        ▼
            ╱───────────────────────╲
            │    Write headings      │
            │        for             │
            │        PCI             │
            ╲───────────┬───────────╱
                        │
                        ▼
            ┌───────────────────────┐
            │       Compute          │
            │        PCI             │
            │                        │
            └───────────┬───────────┘
                        │
                        ▼
            ╱───────────────────────╲
            │       Write            │
            │        PCI             │
            ╲───────────┬───────────╱
                        │
                        ▼
            ╱───────────────────────╲
            │    Write headings      │
            │        for             │
            │        XGVD            │
            ╲───────────┬───────────╱
                        │
                        ▼
            ┌───────────────────────┐
            │       Compute          │
            │        XGVD            │
            │                        │
            └───────────┬───────────┘
                        │
                        ▼
            ╱───────────────────────╲
            │       Write            │
            │        XGVD            │
            ╲───────────┬───────────╱
                        │
                        ▼
                  ╭───────────╮
                  │    Stop    │
                  ╰───────────╯
```

APPENDIX B

PROPDEMM APPLICATION

Uintah Basin

A complete listing is available in Kimball (1979)

Environmental Factors	ECON	RURA	WATR	REC	PVT	INDU	MUNI	COMM	AG W	ENV		
100K BBL/day	2	-2	2	0	0	2	1	-2	-1	-1	P=.33	Rank=4
50K BBL/day	2	-2	2	0	0	2	0	-2	-1	-1	P=.10	Rank=5
Indian Water Claim												
580K Af/Y Indian	-2	2	-3	-2	0	-3	-3	2	-3	2	P=.20	Rank=5
387K Af/Y Indian	-2	2	-3	-2	0	-3	-3	2	-2	2	P=.45	Rank=3
256K Af/Y Indian	-2	2	-2	-1	0	-2	-2	1	-2	2	P=.30	Rank=2
193K Af/Y Indian	-3	3	-1	1	0	-2	1	1	-2	1	P=.15	Rank=1
No Indian Water	-3	3	3	2	0	3	3	1	3	-1	P=. 1	Rank=4
Per Capita Income												
$4000 Per Cap	-2	2	-2	-2	0	0	-2	-1	-2	0	P=. 5	Rank=5
$4500 Per Cap	-1	1	-1	-1	0	0	-1	1	-1	0	P=.10	Rank=4
$5000 Per Cap	1	0	1	1	0	0	1	1	1	0	P=.40	Rank=3
$5500 Per Cap	2	-1	1	2	1	1	2	1	1	-1	P=.35	Rank=2
$6000 Per Cap	3	-2	2	3	2	1	2	-1	1	-2	P=.37	Rank=1
Export Water												
197K Af Export	-2	0	0	0	0	-1	-1	-2	-3	-3	P=.41	Rank=5
149K Af Export	-1	0	0	0	0	-1	-1	-2	-2	-3	P=.30	Rank=4
102K Af Export	0	0	0	1	0	0	0	-1	-2	-2	P=.43	Rank=3
50K Af Export	0	0	1	1	0	0	0	-1	-1	-1	P=.25	Rank=2
No Exports	3	-1	2	2	0	1	2	0	3	2	P=.15	Rank=1
Federal Acreage												
10.6 Mill Fed Ac	-1	1	1	2	-3	-2	-2	0	2	3	P=.10	Rank=5
10.1 Mill Fed Ac	0	0	1	2	-3	-1	-2	0	2	2	P=.10	Rank=4
9.6 Mill Fed Ac	0	0	0	1	-2	0	-1	0	1	1	P=.38	Rank=3
9.1 Mill Fed Ac	0	0	0	1	-2	0	0	0	0	0	P=.15	Rank=2
8.7 Mill Fed Ac	1	-1	0	0	-1	0	0	0	0	0	P=.10	Rank=1

COST FACTORS

COST LEVELS

	CA 1	CA 2	CA 3	CA 4	CA 5
Environmental State 1	3	3	3	3	3
Environmental State 2	3	3	3	3	3
Environmental State 3	3	3	3	3	3

	GRP 1	GRP 2	GRP 3	GRP 4	GRP 5	GRP 6	GRP 7
Cost Consciousness	3	3	2	2	2	3	3

GROUP AFFECT

Group 1	0.	-2.	0.	1.	3.	2.	1.
Group 2	-1.	0.	2.	0.	-2.	2.	-1.
Group 3	-2.	3.	0.	2.	-1.	-1.	1.
Group 4	0.	0.	1.	0.	0.	0.	0.
Group 5	3.	-2.	-2.	1.	0.	2.	1.
Group 6	3.	3.	-2.	1.	1.	0.	3.
Group 7	1.	1.	1.	0.	1.	2.	0.

DOGMATISM VALUES

GRP 1	GRP 2	GRP 3	GRP 4	GRP 5	GRP 6	SEL V
5.	3.	4.	2.	3.	4.	3.

PUNISHMENT-REWARD VALUE VECTORS

GRP 1	GRP 2	GRP 3	GRP 4	GRP 5
-1	2	-2	2	3

GROUP VALUE VECTORS

Interest Group	Impact Values									
	ECON	RURA	NATU	REC	PVT	INDU	MUNI	COMM	AG W	ENV
Agriculture	1	3	1	2	3	-3	0	2	3	1
Energy Development	3	1	3	1	0	3	1	-2	-2	-1
Indians	2	3	2	3	2	0	1	2	3	2
Developed Rec.	0	3	-1	3	-1	-2	0	2	2	-2
Control Development	2	3	0	2	-2	1	3	3	1	2
Decision Maker	2	2	2	1	1	1	1	0	2	-1
Objective Vector	2	3	1	2	0	0	1	2	2	1

GROUP SALIENCE

Interest Group	Impact Values									
	ECON	RURA	NATU	REC	PVT	INDU	MUNI	COMM	AG W	ENV
Agriculture	5	6	4	3	6	5	4	6	7	5
Energy Development	6	5	7	3	3	6	5	6	6	6
Indians	5	4	5	6	6	6	6	5	6	5
Developed Rec.	3	3	4	6	5	4	4	5	4	6
Control Development	7	6	6	4	5	6	6	7	6	5
Decision Maker	5	5	6	3	5	5	5	6	6	5
Objective Vector	5	5	5	4	5	6	5	6	6	5

NAMES OF THE 10 IMPACT VALUES:

Economic Growth
Rural Atmosphere
Natural Resource Dev.
Rec Opportunity
PVT Control Property
Industrial Wtr.
Municipal Wtr. Fac.
Community Cultural
Ag. Water Supply
Env. Protection

ENVIRONMENTAL IMPACT VALUE VECTORS

Environmental Factors	ECON	RURA	WATR	REC	PVT	INDU	MUNI	COMM	AG W	ENV		
Population												
43795 People	3	-1	3	1	0	2	3	-3	-3	-2	P=.17	Rank=4
41804 People	3	-2	3	1	0	2	3	-3	-2	-2	P=.32	Rank=2
39814 People	3	-2	3	0	0	1~	2	-2	-2	-1	P=.47	Rank=1
37824 People	3	-2	3	0	0	1	1	-2	-2	-1	P=.29	Rank=3
35833 People	2	-3	2	0	0	1	1	-2	-2	0	P=.15	Rank=5
Precipitation												
19.2 Inches	2	0	0	2	0	2	0	0	1	0	P=.30	Rank=1
18.3 Inches	1	0	0	1	0	1	0	0	0	0	P=.45	Rank=2
17.4 Inches	0	0	0	0	0	0	0	-1	-1	-1	P=.30	Rank=3
16.5 Inches	-1	0	-1	-1	0	-1	-1	-2	-2	-1	P=.25	Rank=4
15.6 Inches	-2	0	-1	-2	0	-2	-1	-3	-3	-2	P=.15	Rank=5
M-I Water Supply												
74456 M-I Ac Ft	3	-2	3	-2	-1	3	3	-2	-3	-2	P=.15	Rank=5
71072 M-I Ac Ft	2	-2	3	-2	-1	3	3	-2	-3	-2	P=.35	Rank=4
67688 M-I Ac Ft	2	-1	2	-2	0	2	2	-1	-3	-1	P=.38	Rank=3
64304 M-I Ac Ft	1	-1	2	-1	0	2	2	-1	-2	0	P=.30	Rank=2
60920 M-I Ac Ft	0	-1	1	-1	0	2	2	0	-2	0	P-.20	Rank=1
Irrigated Acreage												
287500 Irr Ac	2	3	-3	2	3	1	0	3	3	1	P=.22	Rank=3
275000 Irr Ac	1	3	-2	2	3	1	0	2	3	1	P=.30	Rank=1
262500 Irr Ac	0	2	-2	1	2	0	0	1	2	0	P=.46	Rank=2
250000 Irr Ac	0	2	-1	1	2	0	0	0	2	-1	P=.17	Rank=4
237500 Irr Ac	0	2	0	0	2	0	0	-1	1	-1	P=. 5	Rank=5
Value of Mineral Products												
$111 Mill Minrls	3	-3	3	0	0	3	1	-3	-3	-2	P=.15	Rank=4
$106 Mill Minrls	3	-3	3	0	0	3	1	-3	-2	-2	P=.35	Rank=3
$101 Mill Minrls	2	-2	3	0	0	2	0	-2	-2	-2	P=.38	Rank=1
$ 96 Mill Minrls	2	-2	3	0	0	2	0	-2	-1	-2	P=.20	Rank=2
$ 91 Mill Minrls	1	-1	3	0	0	1	0	-1	-1	-1	P=.40	Rank=5
Oil Shale Production												
350K BBL/day	3	-3	3	-2	0	3	2	-3	-3	-2	P=.26	Rank=1
300K BBL/day	3	-3	3	-2	0	3	2	-3	-2	-2	P=.40	Rank=2
200K BBL/day	2	-2	3	-1	0	2	1	-3	-2	-2	P=.35	Rank=3

OPENNESS TO CHANGE INDICES

FORMULA IS: $OC = (S)(AFF(K,O)/(1+ID)) * ((SSN(O) * GRPPWR (O))/(SSN(K) * GRPPWR (K))/Dog (K)$

Level 1

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
UB 1	0.7	-0.2	1.0	0.1	0.8	0.9	0.8
UB 2	1.2	-0.2	-1.1	0.2	1.5	1.0	0.9
UB 3	1.0	0.2	1.3	0.2	0.4	1.1	1.0
UB 4	1.0	-1.0	0.5	0.1	0.7	1.4	0.9
UB 5	1.2	-1.3	0.4	0.0	0.4	1.4	0.9

Level 2

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
UT 1	1.4	0.7	0.3	1.8	-0.3	0.6	1.4
UT 2	1.5	0.6	0.3	1.7	-0.3	0.6	1.4
UT 3	0.8	0.1	0.3	1.7	-0.4	1.3	1.2
UT 4	0.4	-0.0	-0.2	1.2	0.5	2.3	1.7
UT 5	0.9	0.6	0.0	1.4	0.3	0.4	0.7

Level 3

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
CRB 1	1.6	1.2	0.1	1.0	0.1	0.3	2.2
CRB 2	0.6	-0.0	0.5	0.4	0.3	1.0	1.2
CRB 3	0.8	0.0	0.1	0.6	0.8	1.3	1.0
CRB 4	0.7	0.1	-0.0	0.5	0.7	1.3	1.0
CRB 5	0.7	1.6	0.0	1.6	-0.8	0.3	2.0

POTENTIAL FOR CHANGE INDEX

FORMULA IS: $PCI = (S)(SSN(O) * GRPPWR (O))/(SIP(K) + Dog (K))$

Level 1

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
UB 1	8.8	9.5	9.3	13.2	8.6	7.1	8.2
UB 2	8.4	12.8	11.9	13.2	8.6	8.0	8.7
UB 3	11.4	9.9	11.4	16.7	9.9	8.4	10.3
UB 4	9.4	13.6	10.8	13.8	9.0	8.8	9.6
UB 5	9.7	13.7	10.6	15.3	9.2	8.9	9.5

Level 2

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
UT 1	5.2	5.6	4.4	6.9	5.9	4.9	5.2
UT 2	5.2	5.7	4.4	7.0	5.9	4.9	5.2
UT 3	7.5	4.8	6.7	9.3	8.0	5.9	7.0
UT 4	5.6	7.7	6.7	8.5	7.0	6.0	6.5
UT 5	3.6	4.9	3.2	4.8	3.9	4.2	3.5

Level 3

Course of Action	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Selected Vector
CRB 1	4.0	4.4	3.6	6.0	4.4	3.7	3.7
CRB 2	2.6	2.9	2.6	3.8	2.8	2.3	2.3
CRB 3	2.4	3.2	2.6	3.4	2.4	2.4	2.4
CRB 4	2.5	3.3	2.7	3.5	2.4	2.5	2.5
CRB 5	4.6	4.0	3.3	5.9	5.4	3.7	3.7

NON-SYSTEMIC POLITICAL FEASIBILITY INDEX

THE LARGER THE INDEX VALUES, THE MORE FAVORABLE THE COURSE OF ACTION
FORMULAE ARE: SSN = (S) SSAL/(TSAL-SSAL) + TSAL/10, (SEE TEXT)
NSPFI = SSN * GRPPWR * NSIP

Level 1

GROUP	SSN	CA #1 NSIP PWR (NSPFI)		CA #2 NSIP PWR (NSPFI)		CA #3 NSIP PWR (NSPFI)		CA #4 NSIP PWR (NSPFI)		CA #5 NSIP PWR (NSPFI)	
Agriculture	5.4	1.40	3	2.91	4	0.73	2	2.71	4	1.96	3
		(22.7)		(63.0)		(7.9)		(58.6)		(31.6)	
Energy Development	5.7	2.99	3	1.32	3	3.32	5	2.31	3	2.16	3
		(51.1)		(22.6)		(94.5)		(39.5)		(36.9)	
Indians	5.6	2.35	1	3.01	1	1.73	1	3.61	1	3.45	1
		(13.2)		(16.9)		(9.7)		(20.3)		(19.4)	
Developed Rec.	4.6	1.82	3	3.00	3	1.45	3	2.85	5	1.61	5
		(24.9)		(41.0)		(19.9)		(65.0)		(36.8)	
Control Development	6.3	2.36	3	2.96	4	2.33	5	3.06	6	2.37	6
		(44.2)		(74.0)		(72.9)		(114.7)		(89.0)	
Decision Maker	5.4	3.61	5	3.44	6	3.37	6	4.26	4	3.47	4
		(97.5)		(111.6)		(109.5)		(92.1)		(75.0)	
Objective Vector	5.5	2.69	5	3.89	5	2.40	5	3.82	5	3.25	5
		(74.0)		(106.8)		(66.0)		(105.1)		(89.3)	
Total NSPFI		(156.1)		(217.5)		(204.9)		(298.2)		(214.0)	

Level 2

GROUP	SSN	CA #1 NSIP PWR (NSPFI)		CA #2 NSIP PWR (NSPFI)		CA #3 NSIP PWR (NSPFI)		CA #4 NSIP PWR (NSPFI)		CA #5 NSIP PWR (NSPFI)	
Agriculture	5.4	2.13	1	2.05	1	0.03	1	3.26	4	2.46	1
		(11.5)		(11.1)		(0.3)		(70.4)		(13.3)	
Energy Development	5.7	2.58	2	2.50	2	3.82	5	1.32	4	0.87	1
		(29.4)		(28.5)		(108.8)		(30.1)		(5.0)	
Indians	5.6	2.66	4	2.64	4	1.00	3	2.91	3	2.17	3
		(59.9)		(59.4)		(16.9)		(49.1)		(36.7)	
Developed Rec	4.6	2.32	1	2.20	1	0.89	1	3.41	1	2.49	1
		(10.6)		(10.0)		(4.1)		(15.6)		(11.4)	
Control Development	6.3	2.16	2	2.06	2	0.75	2	2.75	2	3.09	1
		(27.0)		(25.7)		(9.4)		(34.4)		(19.3)	
Decision Maker	5.4	3.76	2	3.64	2	2.72	2	3.28	2	2.10	1
		(40.7)		(39.4)		(29.4)		(35.5)		(11.4)	
Objective Vector	5.5	3.01	2	2.94	2	1.61	2	3.63	2	3.35	2
		(33.1)		(32.3)		(17.7)		(40.1)		(36.8)	
Total NSPFI		(138.4)		(134.8)		(139.3)		(199.6)		(69.6)	

Level 3

GROUP	SSN	CA #1 NSIP PWR (NSPFI)		CA #2 NSIP PWR (NSPFI)		CA #3 NSIP PWR (NSPFI)		CA #4 NSIP PWR (NSPFI)		CA #5 NSIP PWR (NSPFI)	
Agriculture	5.4	1.84	1	1.74	1	2.66	1	2.34	1	0.89	1
		(10.0)		(9.4)		(14.4)		(12.7)		(4.8)	
Energy Development	5.7	2.65	1	2.57	1	1.56	1	1.21	1	3.56	1
		(15.0)		(14.6)		(8.9)		(6.9)		(20.2)	
Indians	5.6	2.58	3	2.44	1	2.71	1	2.39	1	1.96	4
		(43.6)		(13.7)		(15.2)		(13.4)		(44.2)	
Developed Rec	4.6	1.81	1	1.89	1	2.71	1	2.78	1	1.40	1
		(8.3)		(8.6)		(12.4)		(12.6)		(6.4)	
Control Development	6.3	1.90	2	2.13	1	3.25	1	3.33	1	1.64	1
		(23.7)		(13.3)		(20.3)		(20.8)		(10.3)	
Decision Maker	5.4	3.83	2	3.79	1	3.11	1	2.73	1	3.75	2
		(41.5)		(20.5)		(16.8)		(14.7)		(40.5)	
Objective Vector	5.5	3.11	1	3.03	1	3.89	1	3.61	1	2.34	1
		(17.1)		(16.6)		(21.4)		(19.8)		(12.9)	
Total NSPFI		(100.5)		(59.7)		(71.1)		(66.3)		(85.9)	

COST INDICES AND NON-SYSTEMIC ISSUE POSITIONS

THE NSIP AND XCL ARE INVERSELY RELATED
FORMULAE ARE: XCL = (S) (CL*CC)
NSIP = PIP/XCL

Level 1

Course of Action	XCL	GROUP 1 PIP	(NSIP)	GROUP 2 PIP	(NSIP)	GROUP 3 PIP	(NSIP)	GROUP 4 PIP	(NSIP)	GROUP 5 PIP	(NSIP)	GROUP 6 PIP	(NSIP)	SELECTED VECTOR PIP	(NSIP)
UB 1	54	75.4	(1.40)	161.6	(2.99)	126.8	(2.35)	98.4	(1.82)	127.2	(2.36)	194.8	(3.61)	145.4	(2.69)
UB 2	54	157.4	(2.91)	71.4	(1.32)	162.4	(3.01)	161.8	(3.00)	159.8	(2.96)	185.8	(3.44)	209.8	(3.89)
UB 3	54	39.4	(0.73)	179.2	(3.32)	93.2	(1.73)	78.4	(1.45)	126.0	(2.33)	182.2	(3.37)	129.6	(2.40)
UB 4	54	146.4	(2.71)	124.8	(2.31)	195.0	(3.61)	154.0	(2.85)	165.2	(3.06)	229.8	(4.26)	206.4	(3.82)
UB 5	54	106.0	(1.96)	116.8	(2.16)	186.2	(3.45)	87.2	(1.61)	128.2	(2.37)	187.2	(3.47)	175.4	(3.25)

Level 2

Course of Action	XCL	GROUP 1 PIP	(NSIP)	GROUP 2 PIP	(NSIP)	GROUP 4 PIP	(NSIP)	GROUP 4 PIP	(NSIP)	GROUP 5 PIP	(NSIP)	GROUP 6 PIP	(NSIP)	SELECTED VECTOR PIP	(NSIP)
UT 1	54	114.8	(2.13)	139.4	(2.58)	143.8	(2.66)	125.2	(2.32)	116.8	(1.90)	207.0	(3.83)	162.8	(3.11)
UT 2	54	110.8	(2.05)	135.2	(2.50)	142.6	(2.64)	118.8	(2.20)	111.2	(2.13)	204.8	(3.79)	163.4	(3.03)
UT 3	54	1.4	(0.03)	206.4	(3.82)	54.0	(1.00)	48.2	(0.89)	40.4	(3.25)	168.2	(3.11)	209.8	(3.89)
UT 4	54	175.8	(3.26)	41.4	(1.32)	157.2	(2.91)	184.4	(3.41)	148.6	(3.33)	147.2	(2.73)	194.8	(3.61)
UT 5	54	132.8	(2.46)	47.0	(0.87)	117.4	(2.17)	134.6	(2.49)	167.0	(1.64)	202.4	(3.75)	126.4	(2.34)

Level 3

Course of Action	XCL	GROUP 1 PIP	(NSIP)	GROUP 2 PIP	(NSIP)	GROUP 3 PIP	(NSIP)	GROUP 4 PIP	(NSIP)	GROUP 5 PIP	(NSIP)	GROUP 6 PIP	(NSIP)	SELECTED VECTOR PIP	(NSIP)
CBR 1	54	99.6	(1.84)	142.4	(2.64)	139.4	(2.58)	98.0	(1.81)	102.4	(1.90)	207.0	(3.83)	167.8	(3.11)
CBR 2	54	94.2	(1.74)	138.6	(2.57)	131.8	(2.44)	102.0	(1.89)	115.0	(2.13)	204.8	(3.79)	163.4	(3.03)
CBR 3	54	143.6	(2.66)	84.2	(1.56)	146.2	(2.71)	146.6	(2.71)	175.4	(3.25)	168.2	(3.11)	209.8	(3.89)
CBR 4	54	126.4	(2.34)	65.6	(1.21)	129.0	(2.39)	147.6	(2.73)	179.6	(3.33)	147.2	(3.73)	194.8	(3.61)
CBR 5	54	48.2	(0.89)	192.0	(3.56)	106.0	(1.96)	75.8	(1.40)	88.6	(1.64)	202.4	(3.75)	126.4	(2.34)

ENVIRONMENTAL VALUE MODIFICATION VECTOR INDICES

THE SMALLER THE INDEX VALUE, THE CLOSER THE FIT BETWEEN
EXISTING CONDITIONS AND A SET OF GROUP VALUES
FORMULAE ARE: XEMV = ABS(EIVV-GRPVAL)/GRPSAL

Level 1

Environmental Cond.	PROB	GROUP 1 XEMV	GROUP 2 XEMV	GROUP 3 XEMV	GROUP 4 XEMV	GROUP 5 XEMV	GROUP 6 XEMV	Selected Vector
39814 People	47	6.0	1.6	5.2	7.6	4.4	2.9	4.2
18.3 Inches	45	3.3	2.5	3.7	4.1	2.8	1.9	2.5
57688 M-I Ac Ft	38	6.2	2.6	5.0	7.3	4.6	3.2	4.3
262500 Irr Ac	46	2.7	4.3	2.8	2.5	3.4	2.0	2.4
$ 91 Mill Minrls	40	4.6	2.1	4.5	5.6	4.2	2.4	3.7
300K BBL/day	40	7.6	2.2	6.5	8.8	5.7	4.5	5.6
387K Af/Y Indian	45	5.3	6.0	5.4	5.2	4.9	6.0	5.0
$5000 Per Cap	40	2.8	2.7	2.8	3.9	2.6	1.7	1.6
102K Af Export	43	4.2	2.0	4.7	3.9	4.0	2.8	3.4
9.6 Mill Fed Ac	38	3.6	4.0	3.9	3.7	2.5	2.9	2.7

Level 2

Environmental Cond.	PROB	GROUP 1 XEMV	GROUP 2 XEMV	GROUP 3 XEMV	GROUP 4 XEMV	GROUP 5 XEMV	GROUP 6 XEMV	Selected Vector
39814 People	47	6.0	1.6	5.2	7.6	4.4	2.9	4.2
19.2 Inches	30	3.3	2.7	3.3	4.3	2.4	2.0	2.0
60920 M-I Ac Ft	20	5.1	2.9	4.9	5.9	3.9	3.3	3.7
275000 Irr Ac	30	1.6	5.3	1.9	3.1	2.7	2.9	1.9
$101 Mill Minrls	38	5.7	1.5	5.3	3.1	2.7	2.9	1.9
350K BBL/day	26	7.7	2.3	6.7	9.0	5.9	4.7	5.8
193K Af/Y Indian	15	3.5	3.8	3.9	3.5	3.3	3.7	2.8
$6000 Per Cap	37	4.7	3.3	3.5	6.1	3.9	2.6	3.7
No Exports	15	3.7	3.2	2.5	6.0	2.5	2.3	2.3
8.7 Mill Fed Ac	10	3.8	3.5	4.2	4.1	3.2	2.8	3.0

Level 3

Environmental Cond.	PROB	GROUP 1 XEMV	GROUP 2 XEMV	GROUP 3 XEMV	GROUP 4 XEMV	GROUP 5 XEMV	GROUP 6 XEMV	Selected Vector
15833 People	15	5.2	2.1	4.6	7.3	4.2	2.7	3.6
15.6 Inches	15	6.2	4.2	7.0	5.2	6.1	5.4	5.8
74456 M-I Ac Ft	15	7.8	2.5	5.6	8.6	5.2	4.7	5.8
237500 Irr Ac	5	3.2	3.7	3.4	3.2	3.6	2.0	3.0
$ 91 Mill Minrls	40	4.6	2.1	4.5	5.6	4.2	2.4	3.7
50K BBL/day	10	5.1	1.9	4.8	6.5	4.4	2.6	3.8
$4000 Per Cap	5	5.9	4.3	5.5	5.2	4.9	4.5	4.6
197K Af Export	41	5.5	3.2	6.2	5.3	5.4	4.4	5.0
10.6 Mill Fed Ac	10	3.3	5.6	3.9	3.9	3.3	4.1	3.3