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Integrating Water Resources and Land Use Planning

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INTEGRATING WATER RESOURCES AND LAND USE PLANNING

by

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ABSTRACT

Information and recommendations were developed pertaining to the integrating of water resource and land use planning at a conceptual level. In the accomplishment of this goal, the report acts as a vehicle of information transfer to facilitate recognition of the interrelationships between land use and winter resources planning by practitioners in both areas. The approach that was used includes six basic components: 1) the clarification of current planning theory as it pertains to both water and land use planning, 2) analysis and review of historical and current land use planning practices, 3) analysis and review of historical and current water planning practices, 4) identification of problems and concepts which would affect the integration of land and water planning, 5) the design of a conceptual framework (the IRUM model) which would facilitate the integration of land and water planning, and 6) a case study of a selected planning region for small scale applications of the IRUM model. In connection with the case study, a general population survey was taken to identify social and environmental values, land and water use preferences, and other conditions which would affect an integrated planning effort. The recommendations developed in the report cover institutional issues such as culture, law, and organizational arrangements, and also methodological issues such as conceptual framework development and procedural problems which will confront actual efforts to integrate land and water resource planning.

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PREFACE

The interdisciplinary character of planning presents special difficulties for a study into the problems with the way the process is working and how those problems might be ameliorated by more effective integration of planning activities. The basic difficulty is that the diverse historical, intellectual, and experiential antecedents of planners, who include architects, engineers, physical and social scientists, systems theorists, and other types of professionals, are a major obstacle to a common understanding of cross-cutting planning problems and even more of an obstacle to reaching a consensus for dealing with them. As a result, the very term "integrated planning" has a variety of meanings, usually ill-defined, that derive from variations in planner antecedents, concepts, assumptions, and perspectives.

The heterogeneity of the planning community that needs to work together to improve integration of the planning process causes problems in presenting the analyses and findings of our study to diverse audiences accustomed to diverse levels of inquiry. We have tried to find a middle ground by organizing this report so that it can be useful to a large number of decision makers, planning professionals and students. Therefore, the material in certain chapters may be quite elementary and familiar to some persons, but provide useful references and background information to others. For example, the review of land use planning practices contains information well known to urban planning professionals, but not as familiar to water planners. The material will not be of much help to urban planners seeking to improve details in their planning practice but will be useful to other planners trying to coordinate activities, and that is the thrust of this report.

In trying to produce something of practical value for dealing with some basic issues affecting the integration and coordination of water and land planning, we have made an attempt to bridge some basic gaps 1) between theory and practice and 2) among alternative disciplinary perspectives.

In order to get to the heart of the institutional problem, it was necessary to explore some basic theoretical issues from technical literature seldom referenced by planners. The results are described in the report for the insights they provide to important theoretical and conceptual issues. Many practicing planners are in effect disclaiming "theory" as they exert little effort to familiarize themselves with theoretical developments in planning. It is not difficult to show that many avoidable failures of planning practice are occurring due to the resulting inadequate theoretical understanding or perspective. The theoretical knowledge on how to successfully undertake and implement integrative planning efforts is extensive. Practicing planners can only ignore such knowledge at a very high cost to the public. The full contribution that good planning can make to better public decision making will simply not be realized.

The findings of our study are presented in three parts. Part I, consisting of Chapters 2 and 3, reviews water and land use planning practices and activities respectively. Both chapters begin by identifying planning tools, methods, and approaches that have characterized each type of planning, focusing particularly on more recent experiences. Then the major problems and issues that are associated with the respective types of planning are identified and analyzed. Last, recommendations for improved planning are presented.

Part II, containing Chapters 4, 5, and 6, develops the philosophical and conceptual framework necessary for understanding why integrated resources planning is needed and how it can be accomplished. Chapter 4 begins with an analysis of the modern resource planning context. The changes that have occurred in this context are identified, and their effects on the planning process examined. The interrelationship between planning context and conceptualization is then discussed, and the implications for an integrated water and land planning approach considered. Last, the analysis is related to the rationale for the present study in terms of the problems and issues that affect efforts to integrate water and land planning.

Chapter 5 discusses the conceptual and philosophical perspectives that have affected land and water use in the past and continue to be influential today. The rationale for examining alternative conceptual perspectives is developed and followed by a brief consideration of ecological ideas that may be associated with land and water planning. Then a summary analysis is presented of the basic concepts that have affected attitudes and uses concerning natural resources. The chapter concludes by showing how various conceptions of land and water relate to some of the ways resource problems are defined and approached and discusses the relevant implication for an integrated planning perspective.

Chapter 6 examines the implications of the material presented in the previous chapters for a better integrated land and water planning perspective. Major methodological concerns are discussed in terms of the methods and procedures that need to be implemented to meet resource planning needs. The social and institutional aspects that affect the development and implementation of an integrated planning approach are discussed within a broader ecological framework. Recommendations concerning possible methodological and institutional improvements in the planning process are presented. Chapter 6 concludes by describing how the concepts needed in integrated planning are incorporated in the Integrated Resource Use Model (IRUM). The variables and equations of IRUM are introduced and its data requirements are presented.

Part III describes the development and application of IRUM. Chapter 7 provides a profile description of the Uintah Basin of Eastern Utah selected for a pilot application of IRUM and summarizes the land and water planning history of the area. After the discussion of regional baseline information, past and present resource planning activities are reviewed and related to the types of planning problems and issues examined in Parts I and II. The chapter concludes with a summary of personal interview and survey data that were collected for use as input into IRUM.

Chapter 8 describes the pilot application of IRUM to analyze planning problems of concern to residents of the Uintah Basin. The discussion and analysis emphasize the methodological issues and procedures which are likely to be encountered by a decision maker who implements IRUM.

Chapter 9, the final chapter of this report, presents the findings and conclusions from all three parts of the study with particular emphasis on the critical institutional problems. Some relevant speculations concerning the general direction of resource planning are made and related to possible extensions and improvements of IRUM. The chapter concludes with recommendations concerning the applications of models of comprehensive planning problems, focusing particularly on issues of implementation and use.

CHAPTER 1

INTRODUCTION

The goal of planning is to collect and present relevant information so that decision makers can weigh the facts. One very fundamental issue that planners must resolve in doing this job is the determination of what information is relevant. What facts need to be obtained because they truly contribute to more informed decision making; and what facts are not worth the effort of collecting? The obvious answers are that effective planning must present the facts that bring out differences in the desirability of the alternatives, and efficient planning does not waste time on collecting information of little concern to the decision makers. Obvious answers, though, are often easier to give than to apply. In this case, the answers may even yield inconsistent results: decision makers may be concerned with information unrelated to differences, leaving planners to choose between effectiveness and efficiency.

When the water resources planner tries to be effective, he finds that many hydrologic, economic, ecologic, and social linkages clearly cause water resources development and management programs to have major effects on land use. Conversely, land use has a major effect on water resources, and both types of planning affect the use of other resources. The clear implication is that water resources and land use planning ought to be integrated. Nevertheless, water supply and water quality planning, to say nothing of water and land planning activities are not being integrated effectively. The purpose of this study is to analyze why.

Study Objectives

Two of the basic problems in coordinating or integrating different areas of planning pertain to institutional arrangements and methodology. What forms of social and governmental organization will best promote optimum resource use? How can conflicts among values, interests and uses be reconciled as part of an effective resource management approach? What methods and procedures should be followed at different geographic and governmental levels so that a cohesive, congruent plan emerges and is implemented? The overall goal of this study has been to review and compare concepts and methodologies that have been used in separate approaches to water planning and land use planning, and to examine the implications for a more integrated planning approach, particularly with respect to institutional arrangements, organization, and procedures. As part of this goal, a methodology for integrating land and water resources planning would be developed and applied in the Uintah Basin, located in Northeastern Utah. The proposed objectives of the study were as follows:

1. In a selected planning region such as that of the Ashley Valley (Uintah Basin in Northeastern Utah), review and compare past water resources and land use planning practices, measuring the extent of separate as well as integrated resource planning by conceptually analyzing the water resources and land-use planning systems perspectives separately.
2. Define the conceptual and methodological perspectives that have traditionally characterized water planning systems, relating these to an integrated planning approach.
3. Define the conceptual and methodological perspectives that have traditionally characterized land-use planning systems, relating these to an integrated planning approach.
4. Examine and compare water resources and land-use planning perspectives to determine similarities, compatibilities, and points of conflict between them.
5. From a comprehensive perspective, develop a methodology to define an integrated system of water resources and land-use planning, grounded in existing practices when possible.
6. Develop a detailed set of guidelines and recommendations outlining the problem areas and research needs related to the coordination of water planning and land-use planning, and describe the conceptual perspectives and methodologies that would be most likely to lead to the successful implementation of an integrated approach in the two planning areas.

As the study progressed, it became clear that a three-pronged research effort was needed. First, a broad resource planning context and background needed to be established because the small amount of research in this area has not developed the needed framework. Second, various methodological alternatives were examined in developing a practical model to be adopted by planners in coordinating the use of water and land resources. Third, a detailed case study of the Uintah Basin was implemented to test and evaluate the concepts and methods developed in the other parts of the study. The research findings of this study are intended to contribute to improved integrated resources planning procedures through training of planning personnel at all levels of government.

Procedures

Because planning involves both concepts and activities, the first major stage of the study focused on an in-depth review of the literature to trace the conceptual development of planning ideas and past planning practices in the land and water resources areas that might be relevant to integrated planning. One objective of this first stage was to identify a conceptual framework appropriate for integrated planning. A second purpose was to find out as much as possible about the experiences of others, particularly those experiences that were innovative and recent.

The second stage of the study focused on the collection of water and land planning information about the Uintah Basin. An attempt was made to independently examine land planning activities and water planning practice. By examining each planning area separately, we could then determine what difference could be achieved if integrated planning were implemented. This phase included an analysis of historical data as well as predictive information. To carry out this part of the study, records were examined, planning and other public officials interviewed, and a survey of the public conducted.

The third stage of the study was concerned with development of a model that could facilitate integrated resources planning. A cross-impact matrix model was developed that emphasized values, uses, and planning constraints or conditions. The input data were then collected, and the model was applied to obtain evaluative information. The integrated resource use model (IRUM) that was developed appears to have considerable heuristic value and is fairly easily understood.

The research approach that was adopted contributed to examining the problems of integrated planning in a comprehensive way. Our findings are somewhat broad, but they have significant ramifications for resource planning activities at all levels. We believe, therefore, that the research results reported here can be of use to many individuals.

PART I

EVOLVING PRACTICES AND APPROACHES IN WATER RESOURCES AND LAND USE PLANNING

Until recently, relatively little effort had been made to integrate water resources and land use planning. The practices employed in the two types of planning evolved separately; and even within each type fragmented conceptualization and implementation has been a problem. Flood control problems are considered separately from water quality issues, and the reclamation of spoil banks left from mining is not coordinated with land use decisions in nearby towns. During the past several years, however, accumulated research findings and practical experience have demonstrated important interactions of water and land resources use and development. Consequently, the need for integrated planning has become generally recognized, and the concept is widely endorsed.

Unfortunately, implementation of proposals for integrated planning has not measured up to expectations. One reason for the slowness appears to be a failure to appreciate the implications of the separate institutional development of the new areas of planning expertise that need to be involved. Individual emphasis on particular resource problems has lead to the development of planning approaches and perspectives adapted to individual problems, but perhaps not well-suited to other problems. The resulting variety of planning perspectives leads to both 1) a common endorsement of integrated planning as planners of each specialty perceive the impacts of other resource uses on the implementation of their own plans, and 2) a lack of agreement on the practical meaning of "integrated water and land resources planning" because each specialty conceives the need from the perspective of its own planning focus and background.

In order to promote the basic agreement on fundamental planning concepts that is required for improvement of integrated resource planning, the necessary first step is to address the questions:

1. How have water and land planning been conducted historically?
2. What are the main problems and issues presently faced by water and land planners?

Chapters 2 and 3 provide a survey of land use and water resources planning, respectively, in order to answer these questions, and to form a common basis for considering how a more integrated planning approach can be implemented.

CHAPTER 2

REVIEW OF WATER PLANNING PRACTICES

The evolution of water planning practice parallels the increasing complexity in society as a whole. Most earlier planning efforts developed an engineered design to accomplish specific physical objectives. Whereas these early designs were analyzed largely from the viewpoint of the beneficiaries (those providing the financing), later approaches, confronted with more severe and more widespread adverse consequences to third parties, had to deal with increasingly complex relationships creating those consequences. It is only in recent years, as social and environmental interactions have become increasingly complex and their consequences increasingly severe, that the need for more sophisticated planning has been recognized by the passage of new federal and state water planning legislation. The result has been the development of more comprehensive planning concepts and more sophisticated methods to provide a "systems" approach for attempting to comply with these new requirements.

The differences in patterns of availability and manner of use between land and water have led to substantially different institutionalization of ownership and management responsibility, and these differences have in turn led to substantial differences between land and water planning practices. Land resources remain essentially fixed in location and constant in time. Ownership can be identified with particular parcels. The benefits of that ownership go to an owner who can increase them with good management, and the owner can in turn be made liable for any harm his land use (or change in land use) inflicts on others. Land use planning has essentially developed as an effort by society to prevent adverse (or promote beneficial) third party effects of land use decisions. Land use planning has looked for the ideal regulatory system.

Water, on the other hand, is a moving resource. Benefits accrue not so much as it is held as it is used. As it is used, it is lost to the atmosphere, to the ground, or to downstream flow; and in that process its quality and hence usability by others is altered. Ownership is essentially a right to try to capture or a hunting license to take available water at a given location (limited by times and amounts). It is a right to use so long as that use does not so alter the quality or quantity as to substantially harm those downstream. Water planning has essentially developed as an effort to make more water available more often for beneficial use. Since most alternatives for doing so require engineered facility construction (dams, canals, etc.), water planning has traditionally looked for the ideal structural design. Only recently has it begun to encompass nonstructural efforts that would alter use rather than supply patterns.

As water users had to go greater distances to find sufficient water to meet their needs and consequently had to raise a great deal of capital to pay for their projects, water planning acquired a broad regional emphasis. As land use planning was largely regulatory in nature and local communities tend to guard very jealously their right to control their own destinies, land use planning acquired a regulatory, control-oriented, local emphasis. As the area of regulated land use (urban areas) became large enough to affect runoff quantity and quality, the need to coordinate land with water planning in a total systems approach has become manifest.

The various differences in the two types of planning as they have evolved will be made evident in the review of water planning practices in this chapter. However, it will also be evident that the scope of the two efforts have now reached the point where one actually affects the effectiveness of the other and the need for better integrated resource planning is becoming more pronounced.

This chapter describes the series of methods and approaches that have evolved planning practices and concludes with a summary analysis of important water planning problems and issues. The description deals both with broad areas of concern and with more specific methodological techniques such as cost-benefit analysis.

Water Planning Approaches

A discussion of water planning methods and approaches should begin from a consideration of the development of present day practices as they evolved. Whereas, early approaches emphasized facilities or project-oriented water planning in order to accomplish specific physical objectives, the needs of a changing society have placed facilities planning within a more comprehensive area-wide, multi-objective scenario. Economic, environmental, and social feasibility tests have one by one been added to the requirement of a sound engineering design.

During the early part of its history, the United States had a trading economy with some light manufacturing and a large agricultural base. The country was receiving an ever increasing influx of immigrants, expanding in area, and making larger markets available to its industries. At this time primitive roads and waterways were the major form of transportation, so that even then water related planning was necessary. For example, it has been suggested that the famous report of Albert Gallatin (1808) on roads and canals could be considered the first "comprehensive" water planning study report. Gallatin surveyed the existing arteries of transportation in the United States and proposed systematic development of additional roads and canals so that agricultural produce could be profitably moved more than a few miles from farm to market.

Thus the impetus for early water planning and development was the desire for a growing and expanding economy. In those days, an improved transportation system was the key to economic expansion. Water resources planning during the early and middle 1800s focused on improvements to the nation's navigation system. It was during this period that the roots of a planning ideology were being established, and the stress was on economic growth and development. It was also during this period that such classical economists as Smith, Marshall, and Wellington developed the basic and applied economic tools that made the economic comparison of engineering alternatives possible.

Planning approaches may be divided into six main areas: single purpose, multiple purpose, single objective, multiple objective, spacial planning, and market planning. This taxonomy may only be used as a general guide since present day water planning practice does not entirely fit such discrete categorization. Within any category, one can find elements of some other areas. However, the categorization is useful in examining the general areas of emphasis.

Single Purpose Planning

The concept of single purpose planning is to compare the reasonable alternatives in order to select the best course of action for meeting a single tangible need such as water supply, protection against flooding, a navigable water route, etc. The task has traditionally been carried out by defining the engineering alternatives that could do the desired job, performing preliminary or planning designs in sufficient detail to be able to estimate costs, and choosing the least expensive method unless some intangible factor (one that could not be evaluated in monetary units) dictated otherwise. Practically, engineering judgment has often been substituted for more detailed planning in the decision making.

In the early 1800s, water supply, flood control and drainage, and waste disposal needs could be met by very small local projects or even by the efforts of single individuals who did not undertake formal planning because any individual investment was too small to be worth the trouble. The only type of investment in water resources development to meet a widespread public need and large enough to be brought into the national political arena (because desired projects often crossed state boundaries) was the development of waterways to meet basic transportation needs.

The first legislation implementing the single purpose approach to water planning on a national scale and subsequently giving it a construction, or project orientation, occurred in 1824 (National Water Commission, 1973). At that time the federal government gave the U.S. Army Corps of Engineers a small appropriation to remove obstacles which interfered with navigation on the Mississippi and Ohio Rivers.

The states also adopted this single purpose construction orientation and between 1789 and 1837 built 2500 miles of canals and authorized $60 million of credit advances for further development (Dworsky, 1962). The subsequent events which put an end to the strong emphasis on navigation did not, however, put an end to the concept of single purpose project oriented planning.

In the western U.S., the passage of the Wright Act in California (1887) signaled the birth of the irrigation district as a local water agency with a single purpose orientation. However, as the conflict over water rights generated increased litigation, the responsibility for water management and associated planning was placed in the hands of one state executive officer, commonly known as the State Engineer. This shift of responsibility to the state level did not do away with the single purpose approach, but did create the vantage point necessary for the development of multi-purpose "comprehensive" planning approaches.

White (1969) has stated that single-purpose construction is still the most widespread American water management strategy. The single purpose shifted from canal construction, to river navigation, and, as the country continued to expand, to the reclamation of the arid lands of the West, flood control, and today to protection of the environment from harmful waste discharges.

The single purpose construction approach to water planning determined the type of organizational structure created to plan for water development and implement those plans. The selection of navigation development as the first national water goal gave the implementing agency, the U.S. Army Corps of Engineers, institutional characteristics that continue to affect national water policy to the present day. According to Hoggan (1974):

> The early involvement of the Corps of Engineers in water resources development has had important implications for water resources planning in that it has given the Corps a prominent role, and has contributed to the dominance of engineers in the field of water planning. Engineers, reflecting their training and background, have basically approached planning problems as professional builders. Their training in engineering, mathematics, and the natural sciences has resulted in a tendency for them to adopt an axiomatic approach to problem solving that rarely led to questioning of fundamental postulates, particularly with respect to human behavior. Consequently, water planning has characteristically emphasized structural solutions that were calculated to be the most efficient physically and economically. Mounting criticism of this type of planning in recent years has been that it does not include the consideration of non-economic values, such as aesthetic quality and social welfare. But a much more fundamental and crucial criticism is that few planners ever consider social solutions to planning problems. The present response to the energy crisis is perhaps the first time that one can observe, on a primitive level, an attempt to change individual and social behavior to deal with a problem.

With the signing of the Reclamation Act of 1902, a second major national water resources development thrust began, and a new management agency, the Bureau of Reclamation, was created for its implementation. The activities of this agency have been even more construction oriented than those of the Corps of Engineers.

The attractiveness of planning to achieve a single physical purpose at least cost lies in the simplicity of plan formulation and implementation. Applications have been made to navigation, reclamation, power generation, municipal water supply, and water quality enhancement. According to White (1969):

> Single-purpose public construction brought tremendous changes in the face of the United States. In contrast to private single-purpose construction of rural water supply, drainage, irrigation, and hydroelectric power facilities, it is remarkably free from experimentation with alternative means. It is largely impervious to doubts as to economic justification. One type of construction came to be associated with one aim by one form of public agency--municipal, district, or federal. It is a ponderous strategy using a limited number of blunt instruments, insensitive to economic indicators, and highly conservative in dealing with risk and uncertainty. Aim, method, and administrative responsibility have come to be intertwined so that the preservation of one is linked with the integrety of all: Corps of Engineers, waterway channels, and rate reductions; Bureau of Reclamation, dams and new water or new farms; municipal sewer department, secondary treatment, and disease-free water. The strategy spells ease of execution, the creation of solid constituencies, inflexibility of method, hide-bound valuation, and a widespread deterioration in water quality in both humid and arid lands.

Multiple-purpose Planning

Multiple-purpose planning developed out of opportunities to use the same project to achieve two or more purposes. The same reservoir could be filled with spring runoff for summer water supply and be kept nearly empty during the winter flood season. Reservoir storage could be released downstream to augment low flows to make navigation easier, to dilute water pollution and thereby increase stream waste assimilitive capacity, and to improve fish habitat. A single reservoir could achieve several of these purposes simultaneously and more economically than could separate facilities. If a reservoir were built for a single purpose, it would generate by-product benefits for other purposes that should be considered in planning and decision making. The role of multiple-purpose planning was to determine how best to combine various purposes in a given facility and how best to operate a constructed facility to serve diverse needs.

As such large multi-purpose projects as Hoover, Grand Coulee, and Shasta Dams became operational, it became quite obvious that each project had major effects on others downstream just as it was affected by those upstream. The water, hydropower, flood control, and other needs of a river basin could not be met economically without coordinated sizing and operation of a large system of diverse facilities. The planning of multiple-purpose facilities had to be expanded to encompass the planning of large systems of reservoirs and related facilities throughout a river basin.

Congressional interest in multi-purpose, basin-wide planning began around 1900 (Schad, 1964). A National Waterways Commission was created in 1909. The commission, with six members from each House of Congress, made significant recommendations pertaining to navigation, flood control, and water power that became the basis for subsequent legislation (Hoggan, 1974). Basin-wide planning during the 1920s (the 208 studies) laid the groundwork for project construction followed until after World War II. A total systems approach had been adopted in which water and the watershed were treated as a unit.

Single Objective to Multi-objective Planning

Planning for an objective differs from planning for a purpose in that purposes are defined to be activities such as flood control, navigation, irrigation, and power generation, while objectives are defined to be goals such as economic efficiency, environmental quality, and social well-being.

Water resources engineering has traditionally built projects to fulfill many purposes, but alternative designs were compared with respect to only one objective, economic efficiency. The engineers made sure that the project was designed so as to really fulfill its intended function, and the economists formulated a project whose benefits would exceed its costs and for which the monies required to pay for construction could be obtained. While the economic efficiency objective was pursued through formal benefit-cost studies, empirical evidence clearly shows that other less explicit objectives (settlement of the arid west, providing income for the Appalachian poor, protecting fertile top soil, etc.) have always had an important role in project selection. Haveman (1965) developed a book-length presentation of how sections of the country with lower incomes have been able to get more than their share of projects.

Many reasons might be given for the traditional dominance of economic efficiency as a water planning objective. Perhaps the most basic is that projects cost money, and investors who have money want a return on their investment. Benefit-cost analysis provided a method for predicting returns. Economic science developed tools to meet these needs (James and Rogers, 1976). As the economy advanced and became more complex, two things happened. The more advanced technology and greater population density made environmental and social consequences more severe. The greater tax revenues accruing to government created funds that could be spent without requiring a financial return. In other works, the need to consider other objectives increased, and the ability to spend money to achieve them increased as well.

The intent of multi-objective planning is to optimize facility design with respect to two or more objectives (Majors, 1977). The procedure requires the following four steps:

1. Define the objectives to be obtained to satisfy public demands and needs.
2. Define both the resource and the institutional constraints that will affect the obtaining of any of the objectives.
3. Determine the possible relationships and impacts of the constraining factors on achieving the desired objectives.
4. Optimize the goal, which can mean satisfying the individual objectives, with respect to the parameters set by the constraining factors.

Water resources planning act. The legislation which required the multi-objective approach to water resources planning began with the Water Resources Planning Act of 1965 (P.L. 89-80). That act grew out of a need for consistent water planning practices among the various agencies. Title I of the act established the Water Resources Council to coordinate, at the cabinet level, the growing number and expanding scope of federal water resources planning and action programs. The council, composed of cabinet secretaries and heads of federal departments responsible for water resources administration, was directed to: 1) periodically assess the adequacy of water supplies in each region of the nation; 2) evaluate regional and river basin plans in relation to needs; and 3) establish procedures and standards for planning federal water projects to meet those needs.

Title II of the act, which is of particular significance to the integration of land and water planning, authorized the establishment of regional federal-state river basin commissions to prepare and keep up-to-date comprehensive water resources plans. Title III authorized federal grants up to $5 million annually to the states for improving state planning capability.

Water Resources Council. Considerable progress has been made in implementing the provisions of the Planning Act of 1965. The Council has been involved in the appraisal of proposed federal-interstate compact commissions for water management, studies of current federal cost-sharing policies on water projects, development of more appropriate standards for formulating and evaluating water projects, and matters pertaining to the seven river basin commissions which have been established to date. In addition to assessing water supply adequacy by region, the 1965 Act directs the Council to focus on environmental and water quality problems (Deweerdt et al., 1973). The first National Assessment was published in 1968 and the second, the 1975 assessment, in 1978. The 1975 assessment identified current and emerging water problems and the management decisions needed to solve the more pressing problems.

Principles and standards. The 1965 Act specifically directed the Council to establish common principles (supported by explanatory standards and detailed procedures) for all federal participants to use in regional or river basin planning studies. The first version of the proposed principles and standards was published for public review and comment in the Federal Register on December 21, 1971. The Principles and Standards proposed criteria for evaluating plans and projects encompassing economic, environmental, social, and regional objectives (Deweerdt et al., 1973). The result was the first officially required multi-objective approach to water and related land resources planning. Adverse and beneficial effects of a plan on environmental quality, economic development, and social well being were to be displayed from both regional and national viewpoints. The Principles provided the framework for planning, and the Standards provided uniform guidance for carrying out the details (Roose et al., 1972).

The Principles and Standards were reviewed, revised, and became effective on October 25, 1973. The final version specified the coequal objectives of Environmental Quality and National Economic Development and provided for a display of effects on Social Well Being and Regional Development. Planners are required to develop two alternative plans. One is to maximize national economic development, and the other is to minimize damage to environmental quality. The public is then given opportunity to state its preferences for either of the two plans or a compromise. By displaying project effects on national economic development, environmental quality, regional development, and social well-being, planners provide the public and Congress with the opportunity to express their views and evaluate fully the plan's effects on given objectives. Four tests are to be applied in formulating the plan: 1) the acceptability of the plan to the public and compatibility with institutional constraints; 2) the effectiveness of the plan in meeting component objectives; 3) the efficiency of the plan and its cost-effectiveness in achieving component needs; and 4) the completeness or accountability of the plan (Water Resources Council, 1973).

Spatial Planning

All planning involves a spatial element as plans take place in a defined physical area. The area may be defined in terms of political boundaries such as states and counties, in terms of natural boundaries such as hydrologic drainage basins, or in terms of economic units such as trade areas. All three have been used in water resources planning. Political units plan for the area under their jurisdiction. River basin studies look at watersheds. Urban water planning covers intensely developed areas that cross both political and watershed boundaries. The spatial scope of the planning should depend on 1) the areal extent of linkages among hydrologic and environmental impacts and 2) the organizational structure that will be required for plan implementation.

During the latter part of the 19th century, appropriations to the Corps of Engineers for navigation improvement and incidental control of floods on the Mississippi River (Hoggan, 1974) were regularly increased. Fox (1964) notes that:

> During the period from 1870 to 1900 many of the ideas about river basin development that hatched after the turn of the century were being incubated. Broader concepts of river basin development emerged and thought was being given to appropriate institutional arrangements for implementing these ideas.

Other influences that caused concern over the institutional arrangements arose because of the rapid industrialization of the country in the early 20th century. Small irrigation companies and municipal water systems of the 19th century could not meet the demands of 20th century industrialization and population growth. Both kinds of growth required energy, and the electrical energy generated from hydroelectric installations became a primary source. Hydroelectric power could be sold to pay for the larger projects.

As the social complexity created by this rapid industrialization increased, increased governmental intervention was felt necessary. As demands on the water resources increased, organizations to facilitate that demand increased also. The emphasis began to change from local planning to a basin-wide planning approach in order to cope with such large scale activities as power generation and flood control.

> The first large-scale planning program covering many of the major river basins of the nation stemmed from the Rivers and Harbors Act of 1925 and 1927. The 1925 act directed the FPC and the Corps of Engineers to prepare cost estimates for making surveys of rivers of the nation having power development potential. The list of projects emanating from this assignment was published in House Document 308,

69th Congress, First Session, and became the basis in the Rivers and Harbors Act of 1927 for authorizing the Corps to prepare a series of comprehensive reports on almost all of the major river basins of the nation. This was the most comprehensive water planning effort to be attempted up until that time. These "308" studies, which were continued through the middle 1930s, were the basis for most of the major river basin development during the next two decades. The extensive development of the Columbia and Tennessee Rivers, for example, was started from the "308" reports. (Hoggan, 1974)

The evolution of water resources planning from single purpose to multi-objective planning paralleled a change in planning orientation from the immediate area of concern to definition of the hydrologic river basin as the appropriate level of analysis.

The first attempt at river basin water resources management came in 1933 with the creation of the Tennessee Valley Authority. The TVA had all encompassing authority, as a federal corporation, for the planning, developing, and regulation of the water resources of the Tennessee River Valley. This was, of course, a federal organization created to achieve federally defined objectives.

During the 1930s a national planning board was formulated, and by 1939 the National Resources Planning Board (NRPB) had been created. The contribution of this board to water resources spatial planning considerations came through a Water Resources Committee. The committee, composed of federal agencies concerned with water projects, designated 45 drainage basins in the United States for planning and arranged for multi-purpose development of basin committees to be established in each one. Plans were prepared for each basin as a whole rather than on a strictly functional basis (Millett, 1947). According to Renne (1947):

> Some degree of state and local participation emerged at this time. Forty-one state planning boards were formed. State and local units of government as well as local offices of federal agencies were represented on the 45 basin committees.

Hart (1971) asserts that "modern comprehensive river basin planning" may be dated from the creation of the successor to the NRPB - the Federal Interagency River Basin Committee (FIARBC) which were created in 1943. According to Hoggan (1974):

> This "modern" planning is characterized by an interagency approach in which cooperation and coordination are essential elements. FIARBC was established by agreement among the major federal agencies concerned with water resources administration, and it operated on the basis of voluntary cooperation. The committee's work at the field level was carried out by interagency committees created in several of the major river basins of the country: the Missouri in 1945, the Columbia in 1945, the Arkansas-White-Red and the New York-New England Basins in 1950.

Several problems plagued this "modern" inter-agency attempt at comprehensive river basin planning. First, the basin interagency committees created under FIARBC lacked any statutory authority and thus had little impact on individual agency programs and projects. Secondly, even though the states did have representation on the interagency committees created under FIARBC, state representatives did not have the technical staff support required to interact as equals with the federal agencies. According to Hoggan (1974):

> In the Arkansas-White-Red study, none of the state water resources agencies were staffed to participate with the federal agencies in field studies. Each state representative did, however, take a keen interest in water development plans which affect his state and participated in negotiations concerning these plans.

This attempt at intergovernmental cooperation created a variety of institutional arrangements to deal with the problem of effective and representative river basin planning. Fox (1964) describes six alternative arrangements that have evolved since World War II:

1. The individual federal agency planning effort.
2. The individual agency with the assistance of an advisory committee.
3. The interagency committee.
4. The interagency river basin commissions.
5. State water resources planning.
6. A state-federal commission.

These arrangements have been evaluated or compared by the National Water Commission (1973), Smith (1971), Derthick (1974), Wendell and Schwan (1972), Muys (1971), and Hart (1971).

Spatial elements for water resources planning are specified in the Water Resources Planning Act of 1965. Title II of the act authorized the establishment of regional federal-state river basin commissions to prepare and keep up-to-date comprehensive water resources planning. To facilitate state participation and avoid some of the problems of FIARBC, Title III authorized federal grants up to $5 million annually to the states for improving state planning capability.

Public Law 92-500 (1972) typifies current legislative thinking with respect to the spatial element of water resources planning. This law recognizes that administrative and spatial problem areas do not always fall within the spatial areas defined by hydrologic criteria. An effort is made to deal with both areawide (political system) and basin (hydrologic system) planning.

Water Quality Planning

The evolution of water quality programs differs from the evolution of water quantity programs discussed in the preceding sections. The problem of water quality has traditionally been a more localized issue. The problems were caused by point sources of pollution, and the programs to eliminate the problems originated at the local level. Only in the last two decades has the federal government developed programs to control water pollution and supplement state and local programs (American Public Works Association, 1976). The increased role of the federal government in the control of water pollution as outlined in Public Law 92-500 stemmed from an overall Congressional dissatisfaction with the performance of the federal-state partnership established under the 1965 Water Quality Act of 1956 Federal Water Pollution Control Act.

As science showed that contaminated water caused disease, the protection of public health became a primary water management goal. Although the design, financing, and enforcement of pollution control programs varied from municipality to municipality and county to county, the basic means to achieve the goal were common to all: delegation of power to local governments to prevent or abate pollution nuisances; legislative mandates enforced by local officials with set fines and sentences; and authorization of civil suits for damages by aggrieved individuals (American Public Works Association, 1976). Thus, the local boards of health became the first public pollution control organizations.

The move from local pollution control to state level pollution control was necessitated by the tendency of municipalities to use the "disposal principle" of putting the raw wastes out of sight and out of mind (Hey and Waggy, 1976). As the amount of waste produced continued to increase and water intake points become closer together due to increasing population and industrialization, the natural purification capacity of the waterways became inadequate for pollution control. Wastes could neither be put underground (to contaminate water supplies) nor sent down the river (to contaminate the source for downstream diversion). This externality generating potential necessitated a larger enforcement area (which, incidentally, would avoid the long delays of private litigation procedures). The problem grew from a state problem to a regional problem, and interstate complaints were signed. The Ohio River Valley Water Sanitation Commission (ORSANCO) and the Delaware River Basin Commission (DRBC) are examples of such compacts.

ORSANCO was created in 1948 with representatives from the federal government and the eight member states. The DRBC was formed in 1961 and "provided the first pollution abatement compact within the context of a basin-wide water resource development and central program" (American Public Works Association, 1976).

Federal involvement in water pollution control began with indirect aid to state public health agencies. Following World War II, President Truman signed the Water Pollution Control Act of 1948 that became the basic federal water quality law. According to the American Public Works Association (1976):

> It provided for comprehensive planning, technical services, research, interstate cooperation, financial assistance, and enforcement. It authorized $2.3 million in annual low-interest loans for constructing sewage abatement facilities from 1949 to 1953. An additional $800,000 a year was authorized to develop plant designs. Congress extended the act in 1952, and in 1956 placed the Water Pollution Control Act on the books as permanent legislation. Larger pollution control expenditures were also authorized. The law granted $3 million a year to state agencies and $500 million a year for local sewage treatment construction from 1957 to 1966.

This act was amended in 1965 and 1966 to expand the role of the federal government as a pollution control agent. In the late 1960s the increased emphasis on environmental quality resulted in the National Environmental Policy Act. This act established EPA and gave it the responsibility for water pollution control. The most recent legislation to evolve in the area of water quality is the 1972 Water Pollution Control Act (PL 92-500).

The legislative-institutional history of water quality programs has evolved with program goals and means. The original goal of water quality control was economic. The emphasis later changed to public health and aesthetic goals. The means for achieving these goals have changed with technological advances. The technology has evolved through primary source treatment, wastewater treatment, and most recently the concept of recycling our water resources (Hey and Waggy, 1976).

Planning Provisions of the 1972 Act. For the first time, minimum acceptable water quality goals were set at the national level, and a federal program was formulated to make sure these goals were achieved. The Act declares policies and provides for four major planning programs: 1) Section 208, Areawide Waste Treatment Management Planning; 2) Section 201, Areawide Facilities Planning on a Cost-Effectiveness Basis for Construction Grants; 3) Section 209, Level B Planning under the Water Resources Planning Act; and 4) Section 303, Basinwide Plans and Continuing Planning Process Related to These Plans. Each of these sections meets the requirements of the program of discharge permits required by Section 402 (Shubinski and Fitch, 1977).

Section 201. Under Section 201 cost effective areawide facilities are planned to provide for point source oriented water pollution abatement. The plans are directed to upgrade a specific discharge from a defined service area to prescribed standards. Facilities plans are reviewed by federal and state agencies before actual detailed design. Each facilities plan focuses on a specific geographic area and no effort is made to consider regional solutions or problems (Shubinski and Fitch, 1977). Under Section 201 a state or local facilities plan must consider user charges, equitable cost recovery and excessive infiltration in order to qualify for federal construction grants (Lieber, 1975).

Section 208. Under Section 208, areawide planning is to address the total water quality problem resulting from urban and industrial concentrations. The 208 program couples planning with implementation. Two-year federal grants are provided to areawide planning organizations to prepare water quality management plans for the control of point and nonpoint sources of pollution and the control of land use and growth patterns. As a result of its land use provisions, Section 208 is the only section in the 1972 Act which deals with nonpoint sources of pollution such as agricultural or construction zone runoff (Lieber, 1975). The law further prescribes the development of a plan at a regional level with an areawide perspective for land use, taxation and decisions for pollution abatement (Lienesch and Emison, 1976). Accordingly, areawide planning districts or councils of government develop regional plans and are responsible for implementing the plans. Section 208 requirements have thus been viewed by many local and state officials as creating a new level of government between them and as a threat to their autonomy.

Section 209. Section 209 Level B river basin plans are designed to combine water and land resource considerations in the same plan. The Water Resources Council has had authority for these plans in the past under the provisions of the 1965 Water Resources Planning Act. Section 209 integrates the provisions of the Water Resources Planning Act with the planning provisions of the 1972 Act. The EPA is currently involved in integrating this section with the provisions of Section 208. Under the 1972 Act, all areas of the nation are to have completed Level B plans by 1980 (Lieber, 1975).

Section 303. Under Section 303, broad management basinwide plans are to be provided for large areas. Since 1970, federal regulations have required basin plans from the states. However, most states developed programs in which planning permits and monitoring were not related to one another (Lieber, 1975). Under Section 303, all areawide plans, point sources, monitoring and other planning activities are to be inputs to the overall process. Sections 201, 208, 209 and 402 activities are all to be included in the overall Section 303 planning process.

> A sequence clearly is implied by the Act. The first plan should be the 303, setting large basin-scale objectives. The last should be 201, forming the link between planning and design/construction. Between these, the 208 sits as an urban level plan (Shubinski and Fitch, 1977).

This stepped process was designed to promote coordinated water quality control programs.

A final comment with respect to the evolution of the spatial approach to water resources planning is necessary at this point. Water resources planning has evolved (spatially) along two lines: comprehensive river basin planning and metropolitan planning. According to Hoggan (1974):

> A significant observation with respect to the history of water planning that might be added here pertains to the distinction between regional or basin-wide planning and metropolitan or urban-oriented planning. In its review of water resources planning history, the Consulting Panel on Water Resources Planning (1972) found that water planning has evolved along two different lines. One of the forms of planning that has emerged is typified by the studies on a river basin basis that has been discussed herein. The other form of planning is typified by water supply, waste treatment, and drainage studies of urban-oriented agencies. Although consideration of the latter is beyond the scope of this report, it is appropriate to note that many writers on the subject of water resources planning have strongly recommended greater coordination

and integration of "urban" planning with "river basin planning." Kelnhoffer (1968) and Hufschmidt (1971) are examples of the literature on this subject.

Market Planning

Water resources as well as land use planning is done by individuals making their own decisions as well as by various levels of government. The preceding sections emphasize needs for various governmental units involved in land use planning, but all governmental planners need also to consider how their plans relate to individual water and land use decisions and the aggregate expression of those choices through market processes.

Consideration of the proper role for the market in water resources planning involves the philosophical issues in distinguishing public goods from private goods (Musgrave and Musgrave, 1973) and the pragmatic issue of whether public water management institutions are really able to improve market allocations sufficiently to justify their cost. Like most issues, the truth is that both public and private sectors have advantages and disadvantages. Wise planning is to be able to distinguish which is advantageous in a particular setting, and good management is to implement that alternative. The market approach is generally favored in situations in which economics are relatively more important than other criteria, the decisions have few external effects on third parties, and planners are unable to obtain reliable information for more comprehensive decision making. Governmental planning can make an important contribution in other situations, but it is very important for planners to remember that the plans they recommend need to be integrated with market decision making to be effective.

In the market approach, water (or some set of water-project produced goods) is defined so that it can be freely exchanged for a price between those who have it and those who want it. The laws of supply and demand then allocate available water according to the willingness-to-pay, expressed by price, and maximize public welfare, on the assumption that the most beneficial uses will be able to pay the highest price. Market planning requires creation of an institutional framework in which such exchanges can take place, whereas the other approaches use regulatory or other incentives to create a specific allocation of water among users to achieve some predetermined goal or set of objectives.

The market allocates resources to achieve the single goal of maximization of economic welfare. For cases where this is the primary goal, individuals charged with management of the water resource have directed their efforts towards the design of institutions to facilitate market processes rather than to undertake the very costly process of determining and implementing "best" use. In cases where it is not, constraints to market decision making can often still be used to make market implementation more effective than any of the alternatives.

Market price is based on perceived present worth of future value. That value, and the resultant market allocation, is a function of immediate contribution of the water to the income of the purchaser but is also affected by his perception of future value. As perceptions of the value of these uses change (as a product of changing social values), the value of the water right changes also. If water put to low value uses can be sold for higher value uses, the market will effect the change and increase the contribution to social welfare.

Water Rights Markets

Just one of may examples of the market transaction involving water and of how the market interacts with governmental decisions is in the area of water rights and the legal institutions which manage these rights. Water rights, or water use rights, have evolved along two lines in the United States. In the eastern U.S. and those parts of the country where arid lands and humid lands exist side by side (the Pacific Coast states and the high plains states from North Dakota to Texas) the doctrine of riparian rights has emerged (Trelease, 1971). This riparian right has traditionally limited the users of the common pool waters to adjacent land owners. The owners have a use right insofar as they do not disrupt the natural flow for downstream users. This natural flow doctrine has been gradually replaced by a policy of permitting owners any reasonable use. The downstream users are still protected, but are not guaranteed an unspoiled natural flow.

The appropriative doctrine has evolved in arid lands and lands where geologic features make a riparian doctrine impractical (in the Rocky Mountain region, for example). The essence of the appropriative doctrine is found in the priority use and beneficial use concepts. In accordance with these concepts the water use right is retained by the first user, providing that his use is a beneficial use. In years of low flow, the most recent appropriator loses his right while the first user retains his. This is in contrast with the riparian system where a low flow loss is averaged among all users. The value of the water as a private property unit, therefore, becomes a function of the priority of its acquisition.

Another essential characteristic of the appropriation doctrine is the ability to divert water from the original channel without consideration for natural flow or downstream interests not protected by prior rights. This makes the water right a much more marketable entity and enhances the flexibility of allocation to the most beneficial use.

Water Quality Markets. The market approach to water use planning and allocation is now being indirectly applied to the problem of water quality maintenance. This indirect approach involves the use of discharge taxes or fees to manipulate the economic decision calculus of the polluter (Nagel, 1977). As a disincentive to pollute, polluters are assessed a discharge tax or fee which will cover the cost of removing the pollutants. The use of discharge taxes and fees establishes the cost of environmentally acceptable waste control as a real production cost to be passed to the consumers in a competitive market. Those who benefit from use of the product produced also pay the total production costs, and equity is established (Kneese, 1964; Portney, 1978).

The market approach to planning, despite its value in achieving an approximation of welfare maximization through market transactions, suffers from the drawbacks of the private market that got government into planning in the first place and that makes complete reliance on market processes undesirable. The primary consideration here is that many third parties (apart from the buyer and seller in any transaction) are affected by the way water is used but have no voice in the transaction. Many of these values cannot be quantified through the pricing mechanism and will not be adequately represented in a monetary transaction. For example, the market cannot estimate a monetary value for a scenic river. Without this information, however, how can a trade off be made between the scenic river and an impoundment for the purposes of power generation? Those individuals who value the scenic river will be left out of the transaction process as the power company seeks to purchase the property from its former owner. These sorts of problems place many water planning decisions into the governmental sector.

Water Planning Tools

Water planning tools are the various techniques utilized to assess the feasibility of a proposed plan. The planning approaches discussed in the first half of this chapter are used to define the planning scenarios whereas planning tools to be discussed here are used to choose among them.

Planning tools have evolved (as have planning approaches) with the needs of an ever increasing complexity in society and with the capability of that society to be more sophisticated. Early planning tools, which were only concerned with predicting the functional performance of a given structural design, have given way to sophisticated techniques that attempt to present all impacts of a planning decision objectively. This section is concerned with the major tools used in contemporary planning. Many tools have been developed to determine feasibility, and this section will review four which have gained prominence for water resources planning.

Benefit/Cost Analysis

Benefit/cost analysis, a tool for economic feasibility assessment, was officially adopted for water resources planning in 1936 with the Federal Flood Control Act. Under this act, flood control was recognized as a proper activity of the federal government in the interest of general welfare. ". . . if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected" (PL 74-738, 1936).

Various problems and consequent agency differences in estimating benefits and costs were clarified in 1952 by the Bureau of Budget Circular A-47. Further clarification followed in 1962 in Senate Document 97. The latest effort to develop the benefit/cost analysis into a sophisticated tool appears in the 1973 Principles and Standards of the Water Resources Council. The relationship between benefits and costs is summarized in a ratio that has been mandated as an investment guide in nearly all water planning legislation since 1936.

The benefit/cost ratio is represented by the sum of the benefits divided by the sum of the costs. Benefits and costs are estimated by the formulas:

$$\Sigma B = B_1 + \frac{B_2}{(1+i)} + \ldots + \frac{Bn}{(1+i)} n - 1$$

$$\Sigma C = C_1 + \frac{C_2}{(1+i)} + \ldots + \frac{Cn}{(1+i)} n - 1$$

$$\Sigma B/\Sigma C \geq 1$$

In the equations B_n represents the benefits accruing as a result of the project in year n; C_n represents the costs expended on the project in year n; and, i represents the social discount rate used to reduce the aggregated benefits and costs to present worth amounts. Years are counted from n = 1 for next year indefinitely into the future.

The benefits are classified as: primary or secondary. Primary benefits are those which accrue to direct users of the project. An example of this is the supplemental water supplied to agricultural producers. Secondary benefits derive from economic or pecuniary linkages resulting from the direct use. These secondary benefits may be either "induced" by the direct benefits or "stem from" the direct benefits. "Induced" benefits accrue to industries which supply inputs to the direct users and "stemming from" benefits accrue to industries which process and/or market the outputs of the direct users. Further discussion may be found in Howe (1971), Hinote (1969), York et al. (1975), James and Lee (1971), Caulfield et al. (1974), and James and Rogers (1976).

The use of the benefit/cost analysis for an evaluation of public funds investment has come under attack in recent years (National Water Commission, 1973, Gloyna and Butcher, 1972). The benefit/cost ratio limits itself to questions of economic efficiency. It does not take into account those noneconomic activities such as environmental quality. It presents an incomplete picture of the planning scenario. Economic impacts are considered; noneconomic impacts are not. For this reason an enlarged evaluation system was developed. This is the system of account tools for water planning.

System of Accounts

The system of accounts method of water planning was created in response to a growing desire to combine economic efficiency with other planning objectives. The pressure for this method grew as planners pursuing multiple objectives encountered problems of resource scarcity which made trade offs among the objectives inevitable.

The system of accounts, as found in the Principles and Standards, is a process designed to classify and present information about all impacts of a proposed activity. A multiple objective approach is inherent to this effort with four objectives being currently recognized. According to the legislation (Water Resources Council, 1973):

> The system of public information accounts is an information system that displays beneficial and adverse effects of each plan on the objectives and on regional development and social well-being and provides a basis for comparing alternative plans. The development and environmental quality objectives and on regional development and social well-being will be prepared in such manner that the different levels of achievement to each objective and effects on regional development and social well-being can be readily discerned and compared, indicating the tradeoffs between alternative plans.
>
> The system of accounts calls attention to the important aspects of information which must be generated and displayed if the decision-making process is to be effective. The evaluation framework through the system of accounts provides for a systemic investigation of the full range and extent of effects of a plan and provides for a display for this information in a format which is clear and useful to all participants in the decision process.
>
> Four accounts will be used for displaying beneficial and adverse effects and for showing and analyzing the tradeoffs among plans. The four accounts to be used are national economic development, environmental quality, regional development, and social well-being.

The evolution of the Principles and Standards has been described earlier in this section as an approach to multi-objective planning. Further discussion can be found in Warner and Bromley (1974), Water Resources Council (1973), Caulfield et al. (1974), and National Water Commission (1973).

The four account system adopted in the Principles and Standards incorporates benefit/cost analysis into a system that recognizes both economic and noneconomic objectives. Moreover, the system of accounts provides a more detailed set of guidelines for the use of economic evaluation (Caulfield et al., 1974).

The major contribution of the system of accounts to water planning has been to organize and direct the plan impact assessment effort of many different agencies. The Principles and Standards specifies what parameters are to be considered in the assessment process. The following example is taken from the Principles and Standards.

> 4. Beaches and shores. The juxtaposition of attractive beaches, distinctive scenic shorelines, and adjacent areas of clean offshore water provides positive public aesthetic values and recreational enjoyment.
>
> a. Size and measure
>
> (1) Mileage
> (2) Acreage
> (3) Marshland acreage
> (4) Embayments
>
> b. A descriptive-qualitative interpretation, including an evaluation of the effects of a plan on designated or affected beaches and shores.
>
> c. Improvements:
>
> (1) Accessibility (public roads and trails;

easements)
(2) Public amenities
(3) Nourishment
(4) Other (specify or describe)

d. Protection and preservation:

(1) Physical (jettys, bulkheads, etc.)
(2) Legal (dedication, institutional, etc.)
(3) Special

By following this guide relevant impacts will be documented and presented for consideration in the plan formulation and evaluation. The system of accounts is a relatively new tool in water planning, and full implementation will be delayed until the necessary technical capabilities and institutional settings are created. There are many unanswered questions as to what procedures are to be used to quantify and present the impacts in the accounts since the Water Resources Council is still working on the procedures section. For this reason, the complete impact of the adoption of the Principles and Standards cannot yet be evaluated. The institutionalization of a common system of plan evaluation, however, has eliminated the uncoordinated and often dissimilar planning methods of numerous federal agencies.

Quantitative Modeling

Various quantitative models have been formulated to aid in feasibility assessment. A quantitative model is a set of equations that describes and represents the real system. A model defines the functional relationships between elements of the system, establishes the constraining parameters which form the system boundary, and transforms large amounts of information into usable aggregates necessary for the interpretation of large system activities.

Qualitative models may be broken down into two main areas: mathematical models and simulation models. The two differ in that mathematical models seek to optimize with respect to specified goals while simulation models present a state that will exist if certain conditions are present.

Haimes (1970) has described one possible way to classify the various mathematical models:

1. Linear vs nonlinear
2. Deterministic vs probabilistic (stochastic)
3. Static vs dynamic
4. Lumped parameters vs distributed parameters

This list is a generic guide only, since the variety and complexity of modeling efforts have continually increased with the development and research availability of modern digital and analog computers. A detailed discussion of these mathematical techniques utilized in hydrologic modeling can be found in Systems Analysis of Hydrologic Problems, the Proceedings of the Second International Seminar for Hydrology Professors (1970).

There also exist models to examine the other component parts to a complete water resources system. Models relating economic objectives to engineering analysis can be found in Maass, et al. (1962) and Linsley and Franzini (1972). Wagner (1975) has provided a compendium of general operations research techniques.

The essence of simulation is to reproduce the behavior of a system in every important respect (Maass, 1962). The system may be social, hydrologic, economic, environmental, or political. Simulation models have been developed to educate and train policy makers. The KSIM model (Kane et al., 1973) and the PROPDEMM model (Hoggan, 1974) are two examples. The KSIM model is designed to encourage group interaction and facilitate the recognition of complex interrelationships in the formulation of environmental policy. The PROPDEMM model is designed to provide an indication of the political feasibility of a set of proposed plans and to show policy makers those areas which enhance and detract from the political acceptance of a given plan. A discussion of these quantitative models as they are applicable to the general system of accounts method of water planning can be found in Caulfield et al. (1974).

Public Participation

"Public participation" refers to activities of individuals or groups not having governmental decision-making authority in trying to influence decision-making (National Water Commission, 1973). The U.S. Army Corps of Engineers has further defined the concept (Dodge, 1973):

> Public participation is a two-way communication process which involves (1) promoting full public understanding of the processes and mechanism through which water resources problems and needs are investigated and solved by the Corps; (2) keeping the public fully informed about the status and progress of studies and the findings and implications of plan formulation and evaluation activities; and (3) actively soliciting from all concerned citizens their opinions and perceptions of objectives and needs, and their preferences regarding resource use and alternative development or management strategies, and any other information and assistance relevant to plan formulation and evaluation.

Such participation may be found in many forms. The public meeting, the public hearing, and the citizens advisory committee are the more common forms, but can be extended through general population survey techniques.

The impetus for adoption of public participation as a tool for water resources planning was in the increasing public concern for natural resources policy as a result of the environmental trade offs recognized in the early 1960s. The movement toward citizen participation started at the federal level with the 1954 Housing Act (Rosenbaum, 1976) which called for the cities "to encourage citizen participation through the establishment of Citizens Advisory Committees to examine constructively the workable program goals." Participation requirements increased with the passage of the Economic Opportunity Act of 1964 (Ertel and Koch, 1976). A clause of that act suggested "maximum feasible (public) participation." Water resource planning activities soon began the process of implementation. Full implementation was slow in coming. According to Hoggan (1974):

> Although some previous planning studies had rather elaborate public information programs such as the one described by Bird (1964) for the Southeast River Basins Study, public involvement in the process of identifying and evaluating alternatives was minimal. None of the interagency comprehensive river basin studies which started in the early 1960's (with which this research report is particularly concerned) had significant public participation programs until late in the course of its planning program. Most of them never did have such a program, at least other than traditional public hearings. In analyzing the Grand River Basin Study, Warner (1971) notes that even after an extensive public information program was implemented and completed late in the study, a lack of public understanding about the concepts and needs indentified in the plan was clearly evident a short time later at the public hearing introducing the plan. The public had not been actively consulted and involved in the identification and evaluation of alternatives.

Public participation has received increased emphasis in recent years. During the 1960s and 70s many water projects were slowed down or halted by intense adverse publicity. Three recent federal laws require public participation in the formulation of a water resources plan. These are the National Environmental Policy Act of 1969 (NEPA), the Rivers and Harbors Act of 1970, and the Federal Water Pollution Control Act Amendments of 1972 (Willeke, 1976). Section 101(e) of the 1972 Act requires the EPA to provide for broad public participation for all aspects of the Act, and Section 208 calls for the establishment of a Policy Advisory Committee to advise the agency in developing a plan. In addition, public meetings are to be used to explain 208 plans and to build grassroots support for the plans. Section 505 also provides the citizen with a mechanism to sue for violations of the Act (Lienesch et al., 1976). The public participation requirements of NEPA are discussed in the previous chapter on land use planning practices.

The general guidelines for public participation at the federal level are found in the Principles and Standards. The specific statement is:

> The actual derivation and identification of components require several different approaches. An initial point of departure is the national and regional economic analysis and projections provided by the Council. These will be useful in a first cut definition of the economic parameters of the components of the objectives. More detailed definitions will require in-depth consultation with Federal, State, and local officials familiar with the planning setting. Direct input from the public involved at the local and regional level is important, and will be accomplished by:
>
> a. Soliciting public opinion early in the planning process;
> b. Encouraging periodic expression of the public's views orally, and recording their opinions, and considering them;
> c. Holding public meetings early in the course of planning to advise the public of the nature and scope of the study, opening lines of communication, listening to the needs and views of the public and identifying interested individuals and agencies;
> d. Making available all plans, reports, data analysis, interpretations, and other information for public inspection.
>
> Efforts to secure public participation should be pursued vigorously through appropriate means of public hearings, public meetings, information programs, citizens committees, etc.

> Definition and specification of the components of the environmental quality objective will require direct consultation with groups identified with environmental concerns as well as with those groups within a planning setting whose actions have significant impacts on the environment. A broad spectrum of public groups and interests must be considered and consulted in the identification of the components (Water Resources Council, 1973: 24827).

These recommendations apply to all projects in which the federal government participates.

Although the Principles and Standards does recommend public participation in planning and lists some of the forms that the participation can take, it fails to give any further guidance on how to use the resulting input in planning decisions. It is merely desired that public opinion be solicited early in the planning process and that meetings be held early in the course of planning to advise the public and listen to their needs and views.

Further information concerning the Principles and Standards and public participation may be found in Caulfield (1974) and National Water Commission (1973). Van Gigch (1974) presents a summary of the role of the public in planning and the various methods available to accommodate that role.

Public participation as a planning tool in water resources is not a panacea that will eliminate all value conflicts or relieve the planner of his burden. There are ever present limitations and requirements which retard the full effectiveness potential of public contribution. The limitations and requirements of public participation fall into two main areas: (1) Identification and representation of the relevant publics, and (2) education of the public. It is beyond the scope of this review to fully analyze these two areas. Relevant analysis may be found in Regan (1975), National Water Commission (1973), Van Gigch (1974), Tucker (1972), and Willeke (1974).

Water Planning Problems and Issues

Over the years, water planning has moved toward more comprehensive analysis of interactions in land-water systems and toward more careful projection of the environmental and social consequences of projects that change those systems. The trend has been forced by the more careful management required to supply the water demands of an expanding economy from a fixed water resource and by an advancing technology that can cause disastrous effects unless incipient problems are quickly corrected. The extra planning effort requires extra resources and has moved planning decisions away from the local people and toward higher levels of government.

As open land and clean water have become scarce, their uses have become closely intertwined, and the planning of their uses has begun to require a comprehensive, systemic approach. While the conceptual foundation for such an approach has been developed, these ideas must be made more practical in order to be implemented. The Principles and Standards of the Water Resources Council were an important step in this direction but still fall far short of actual planning requirements. Several trends in our society make it very difficult to achieve significant, realistic, and positive planning. These will be analyzed below, particularly as they affect the development and use of an integrated resource uses planning model.

The National Water Commission (1973), following its investigation of the strengths and weaknesses of current water planning, cites the following criticisms:

> (1) Water planning is not adequately integrated with planning for the land uses that water developments are expected to serve; (2) while much attention has been devoted to planning for large river systems, too little effort is made to relate that planning to the needs of metropolitan areas; (3) plans have taken too little account of the environmental consequences and water quality planning has been conducted apart from water planning in general; (4) plans often do not reflect the interest of the general public, large segments of which have little voice in it; (5) planning, especially that required of the States as a condition of future Federal assistance, is expensive and time consuming out of proportion to the States' need for it and the benefits that result from it; (6) plans, particularly river basin plans, tend to avoid setting priorities and to proceed unrealistically with early action proposals that would ultimately cost substantially more than is likely to be spent for the area involved; (7) in the absence of national priorities, planning leads to development conflicts among regions of the Nation; (8) planning is too rigid in its adherence to long-range forecasts in a world of rapid social, economic, and technological change; and (9) planning tends to bury in the arithmetic of benefit-cost analysis important issues that must be decided on a non-quantitative and judgmental basis.

These criticisms can be further condensed into two causes: First, water planning has been concerned with the water system rather than treating water as a component part of a larger social and environmental system; and second, the nature of the water system makes the definition of the appropriate spatial element (and its corresponding institutions) a critical variable in the planning process.

That the water system must be considered as but one element in a larger system is recognized in the Principles and Standards. That system of accounts tries to record the complex interrelationships that exist and must be accounted for in any planning involving the water resource. One difficulty in trying to combine these elements is because the quantitative hydrologic and economic aspects of water planning cannot be expressed in commensurate terms with the non-quantitative social, political, and aesthetic impacts.

The necessity of defining an appropriate spatial element for water planning is becoming a paramount problem. In the area of land use planning, it is recognized that land, as a stock resources, has a very definite locational attribute. With this attribute comes the recognition that externalities generated from the use of that land generally decline with the distance from that use. This gives the land use plan a manageable localized, controllable perspective.

The nature of water does not lend itself so readily to local control, unfortunately. Water is a flow resource, which as it travels to its final destination, may be used, reused, polluted, cleaned, consumed, and impounded. Its course may be altered from natural flow patterns. The problem with water lies in its potential (and opportunity) to generate significant external effects.

Water problems sometimes originate in one political jurisdiction and are transferred to another political jurisdiction, necessitating the intervention of some higher unit of political jurisdiction. The higher unit, however, plans from its own perspective. This creates a complex relationship of finance, sovereignty and goal definition. A representative example of this has been the implementation of the Federal Water Pollution Control Act of 1972 (PL 92-500).

The planning process envisioned by the 1972 Federal Water Pollution Control Act differs substantially from the way it is being carried out. "As practiced . . . the orderly sequence envisioned by the Act has been changed and, in some cases, reversed" (Shubinski et al., 1977). The timetable imposed on the EPA and the refusal of OMB to permit the EPA to develop its staff to cope with the Act's requirements have largely been responsible for the changes. The lack of qualified manpower at all levels of government, insufficient data bases, inadequate analysis techniques, jurisdictional conflicts and ineptness have all contributed to the difficulties of implementing the Act (Shubinski et al., 1977).

Perhaps the loudest criticism of the Act has come from those who contend that the Act amounts to extraordinary subordination by federal authority of state and local programs. State and local programs are subject to federal review and must conform to the nationally uniform federal standards, guidelines, and regulations. Many states take the position that the diversity of water problems in the various states are not solvable by simplistic, generalized solutions outlined by a central agency and that in many instances the Act is deficient in recognizing the institutional and environmental differences which exist among states (Lieber, 1975).

The funding process of the Act may also place areawide planning agencies in direct conflict with state and/or local units of government. Areawide planning agencies have the potential of determining land use control of industrial, residential, and commercial development and location, and even population movements. Under Section 208, areawide planning agencies or councils of governments receive federal funding, in a cost-sharing operation, to develop and implement regional plans for the placement of treatment facilities. These authorities, independent of state control, may regulate the construction of facilities and thus oversee land use planning (Lieber, 1975).

A recent presidential order directed the Chairman of the Water Resources Council, the Office of Management and Budget, and the Council on Environmental Quality to conduct a comprehensive review of federal water resources policy. The following problems have been listed for consideration in this review (Water Resources Council, July 15, 1977):

1. The system of accounts should be expanded to recognize social conservation and objectives.
2. Federal water policies are frequently not coordinated with overall federal policy.
3. The federal role in water resource development has become outdated by changing needs.
4. Direct federal water resources projects are formulated under the Principles and Standards but the related federal grant and loan programs are not.
5. The accuracy, propriety, and integrity of water resource project cost estimation and benefit derivation are being challenged.
6. Planning documents currently provide little or no information on who benefits from and who pays for water projects.

7. Methods have not been developed to compare environmental and economic impacts.
8. The social discount rate is too unstable for orderly planning.
9. Federal water resource planning is oriented to construction projects rather than to comprehensive management of the nation's water resources by all alternative means.
10. Procedures for coordination of water resources planning have not been implemented.
11. There is a lack of coordination between water quality and water quantity planning.
12. There is excessive variation in the implementation of project planning procedures and review processes by the individual water resources agencies.
13. The Principles and Standards have been isolated from the Environmental Impact Statement procedures.
14. Lack of effective project termination procedures lead to the frequent building of obsolete projects.
15. The varying form, length, and specificity of the Principles and Standards leads to difficulty in comprehension and use.
16. Water subsidies have resulted in competitive advantages for some uses, have prevented action to achieve some objectives, and have contributed to water quality degradation.
17. Water related laws and management practices have impaired the recognition of environmental values.
18. Many state water rights systems have developed without regard to the physical fact that surface water is related to groundwater and various sources of groundwater are related to each other.
19. Existing substantive water rights systems have resulted in institutional arrangements which may result in inflexibility, relative to the allocation and use of water which may lead to inefficiencies and inequalities.
20. Problems may still exist concerning the end quality of the opportunities for public input.

In summary, the water resources planning function has evolved from a position of resource abundance and a physical design orientation to a position of resource scarcity with an allocation and public representation orientation. New problems have arisen as new parameters have been introduced into the planning scenario. The total environment, social as well as physical, has entered the recognized "system" of water planning. Along with this transition, new tools have been formulated, but they do not really meet the needs of a comprehensive planning approach.

The most important problems and issues in water resource planning are inherent to an interface between the political boundaries of governmental units and the natural boundaries of hydrologic systems. This creates a level of analysis problem which has impact on both the natural and social systems.

CHAPTER 3

LAND USE PLANNING PRACTICES

Land use decisions in America have historically been dominated by private interests. During the 19th century the national policy was to "transfer land from the public ownership to private ownership as rapidly as possible" (Cribbet, 1973:54). In the early 20th century, neighborhoods began to feel the adverse effects of certain land uses and began to work through local governments to establish regulations to prevent undesirable practices. The principal justification for land use regulation has been to control public hazards and nuisances on adjacent properties. Local governments were the most reasonable justification for the regulating authority because nuisances and use conflicts were typically local in origin and effect. Moreover, local governments could be expected to be more responsive to the property holders affected, an important consideration to a people heavily committed to the right to private property.

Over the last 10 to 15 years, the increasing relative scarcity of land, water, and raw materials, together with increasing environmental degradation, have emphasized the need to be more careful in planning the use of natural resources. It is our intention to survey the present tools and approaches available to the land use planner and to examine the problems associated with coordinating land use planning as practiced with water resources planning. From the survey, we hope to be able to reach conclusions as to the adequacy of locally centered land use planning as practiced to meet water and other natural resource needs over larger areas and to make recommendations for more effective use and improvement of the land use planning process.

Local Land Use Planning Approaches and Tools

Land use is directly regulated by state and local governments, and indirectly by federal governments, in the interest of the general public's health, safety and welfare, under one of three sovereign powers: eminent domain (condemnation), police power, and the power of taxation. Since local governments have been the most active level in land use control, this section surveys practices of primarily local origin. In the exercise of their power of eminent domain, governments affect land use when acquiring land for schools, roads, parks, public buildings, urban renewal and other public purposes. Land cannot be taken from a private owner unless it is done in the public interest for public use and benefit. Property owners who have their land taken from them are entitled, under the Fifth Amendment to the Constitution, to just compensation or the fair market value of the property at the time of the taking. Land-use controls under the police power include zoning laws, subdivision regulations and building codes, and do not require compensation as long as the permitted uses provide a reasonable return to the land owner. Taxation powers used to control resource use generally take on the form of capital gains or property tax laws.

Eminent Domain

The power of eminent domain is routinely exercised to obtain land for such public purposes as highways, parks, schools, and other public building sites. With two major exceptions, urban renewal and open space acquisitions, eminent domain has seldom been used for controlling development in large tracts because of the high expense of compensation and fear of eroding the tax-base. These two exceptions recently became feasible only because the federal government contributed most of the necessary funding. In addition to problems of cost, financial expense of purchase and maintenance and the opportunity cost of denying economic use, exercise of eminent domain as a land use control measure requires justification showing that the acquisition is clearly for a public use.

One possible technique is excess condemnation--taking more than directly needed for a proposed improvement. Excess condemnations may be desirable for three reasons: 1) to prevent uses that would impair the primary purpose; 2) to obtain parcels that would otherwise be useless remnants; 3) to reduce costs, through resale (Levin, Rose, and Slavet, 1974:39). Excess condemnation and resale may also be a means to capture for public benefit the windfall gains that sometimes accrue to landowners adjacent to public developments.

Another innovative use of eminent domain is the purchase of scenic easements or development rights. Positive and negative easements can be acquired to promote and preserve amenities (especially open spaces) in areas of predominately private ownership. A positive easement secures a public right; a negative easement denies certain private uses.

At times it may be desired to purchase development rights for the protection of wetlands, airports and critical areas (Kaiser et al., 1974). One problem is that development rights often cost as much as a fee simple land purchase, particularly if the government waits to purchase the rights until development is just about to begin. A conservation group or governmental unit which wants to protect an area from development should, if possible, purchase the development rights before any significant development pressure occurs. In Wisconsin, the development rights adjacent to the Great River Road along the Mississippi River were purchased over 30 years ago for a few cents a foot. As a result, the area is fully protected from extensive development today (Strong, 1968; Whyte, 1959). Advance acquisition and land banking is another control mechanism communities may use to guide growth. By purchasing large amounts of undeveloped or sparsely developed land, a community may sell it a parcel at a time for the type of development they desire. Not only is land acquisition prior to development less costly; it also requires less detailed planning specifications at the time of acquisition and permits more planning lead time. Localities would thus be in a better position to make reasoned decisions on desirable development and to enforce those decisions. Columbia, Maryland, and Irvine, California, have employed a form of land banking. In these communities, developers purchased large tracts of land and provided the major infrastructure investments. The communities, by controlling the placement of residential, commercial, and recreational areas, grew in an efficient and organized manner (Council on Environmental Quality, 1974).

Public land banking schemes are relatively common in several countries. Britain has public corporations which undertake new town development on public land (Hall, 1973). Sweden has a controlled, well planned system of cities which incorporate greenbelts between residential communities and the central business districts and efficient transportation links between districts (Passoiv, 1970; Sidenbladh, 1965). A study of the Canadian experience showed that communities which used land banking had lower housing costs than those which did not (Federal Task Force, 1969).

Police Power

Zoning is the most common land-use planning mechanism. The modern U.S. version dates back at least to the 1920s when it was regarded as a means to protect property owners from undesirable or incompatible activities on adjacent parcels, and the power of the states to delegate this authority to political subdivisions was confirmed by the Supreme Court's decision in Euclid v. Ambler Realty (1926). Although zoning laws vary from locality to locality, they share the same general motivation: to provide a framework for orderly and harmonious development by creating zones of homogeneous use.

Usually a city or county master plan delimiting the zones is developed after examination of present use patterns, an assessment of probable interactive effects among expected land use types and the capability of the local natural environment to support them under expected growth pressures, and a determination of desirable future development. Once established, the master plan limits development of land in a given zone to the designated type of use unless a variance is granted. Once the master plan is approved, its implementation is typically turned over to zoning boards. The most common criticism of this arrangement is that:

> The shift of decision-making powers in land use to zoning boards of appeal has led to charges in many communities that comprehensive planning is a futile exercise continually undercut by politically oriented laymen. (Levin, Rose, and Slavet, 1974:8.)

A number of variations on the above "Euclidean zoning" concept have been initiated or proposed to improve the effectiveness of zoning as a growth management tool (Levin, Rose, and Slavet, 1974:17-24). Controlled sequential development links the pace and scale of construction to the availability of essential services and facilities. Developers can speed development by agreeing to provide the required infrastructure themselves. Floating zones have been suggested as a way to reflect the idea that optimal use of a parcel cannot always be known in advance. Under this system, zones are defined but not mapped. However, the notion of floating zones is legally somewhat suspect because of potential conflicts with the principles of equal treatment and the protection of investments by stabilizing use. Contract zoning refers to the practice of rezoning a parcel to a classification with fewer restrictions subject to an agreement between owner and zoning authority that certain conditions will be met. Incentive zoning involves arrangements where developers may reap extra profits provided that certain conditions are met. Finally, performance zoning defines zones by explicit consideration of the type of externality that might be imposed on adjacent property holders. Rather than, for example, light and heavy industry zones, the outputs like pollution and noise would determine zones.

Zoning is most commonly used by municipal and county governments. It has, however, also been used by some state governments. For example, the Hawaii State Land Use Commission divides land into four classifications, rural, agricultural, conservation, and urban. The Land Use Commission controls the boundaries of these classifications. State government agencies control the use of land within all areas except the urban districts which are controlled by the localities (Linowes and Allensworth, 1975). In Vermont, an Environmental Control Act requires the state to develop three zoning plans. The first is an interior capability plan setting forth the ecological constraints of the land. The second is a capability and development plan which would reconcile the state's ecological capability with citizen goals and needs. The first two plans have successfully been adopted. The third plan, a mapped statewide resource use plan, has yet to be accepted (Meyers, 1974; Council of State Governments, 1974).

A potentially effective tool for guiding the pace and location of new development is subdivision control. Subdivision regulations govern the division of undeveloped land into lots or sites for sale and/or building development. Subdivision regulation is a natural extension of zoning practices to circumstances where development of relatively large tracts is contemplated. Since the simultaneous development of numerous lots can place heavy demands on local services, localities may impose regulations at the planning stage to avert later problems.

The general procedure is to require that plans and plot for developments larger than a specified size are filed and registered with the local planning agency for review and approval. Developers of subdivisions are usually required to provide adequate streets, sidewalks, curb and gutters, water, sewer, gas and electrical hook-ups, storm drainage, street lighting and other improvements. Once the subdivision regulations, requirements and standards are met, the subdivision is approved. The basis of subdivision regulation is land registration, which the community has the power to grant or deny on its own terms.

Development rights purchases (or transfers) is another tool that can be used to control land use. An owner of a piece of property owns not only the land, but the right to do certain things to it. Generally he has the right to build a structure on it, cultivate crops, to make other improvements, etc. When he sells the land, he sells not only the property, but the rights to use the property. It is not, however, necessary to dispose of land to sell certain rights to its use. A public utilities company may obtain an easement to place power lines over, or gas lines under, a parcel of property. In either case the property owner sells his right to build where the power lines are located or to dig where the gas lines lay. A farmer may acquire the right to cross over part of another farmer's property to obtain access to his own. Similarly, development rights may be acquired in order to ensure that no development occurs. Such purchases are often called scenic or conservation easements (Council on Environmental Quality, 1974).

The transfer of development rights may find its most important application in preserving agricultural uses. A group of farmers who desire to maintain the agricultural character of an area may join together to transfer (donate) their development rights to a public body or a private non-profit preservation group. Besides no longer having to be concerned with interference with their farming activity from nearby urbanization, the property values will decline with the removal of development potential--hence property taxes will decline and the donations can be deducted from federal income taxes as a charitable gift. Residents in Mill Creek Valley near Philadelphia have used this approach for nearly 35 years (Council on Environmental Quality, 1974). The approach has also been used in the Brandywine Valley in Delaware and Southern Pennsylvania and for the conservation of areas in New England (Strong et al. 1968; Little, 1968).

A central issue of most land use control mechanisms is the problem of equity. A land owner who loses property rights loses ability to recoup the full value of his land. By separating certain development rights from ownership of a particular piece of land, the equity problem can be lessened. "Transferring development rights" is a mechanism whereby a land owner must have development rights in order to develop a parcel of land. The owner may already own sufficient rights on the tract of land he wants to develop, or he may transfer them from another piece of property. Transferring development rights has a couple of advantages. If the development rights are good only within one area, the tax base of that area is preserved. By limiting possible development zoning, agencies can preserve open space and low density development with minimal cost to the cities. The second advantage is that the mechanism helps alleviate the "wipeout" and "windfall" effects of many present land use control systems (Costonis, 1972, 1973; Marcus, 1974).

Taxation Powers

The taxing power of governments is another mechanism that can be used to control land use, although its potential for this purpose has not been exploited. The property tax has been an unpopular tool among analysts of land-use development because it has been said to: 1) discriminate against the poor, especially renters; 2) reward "hit-and-run" speculation; 3) impede regeneration by inducing underutilization; 4) encourage conversion of farm to non-farm uses; 5) create tax and service disparities between communities; 6) tempt the abuse of assessing power; and 7) give undue weight to fiscal zoning as a controlling element in development (Levin, Rose, and Slavet, 1974:43).

The property tax influences land use through economic incentives generated by the tax structure. By taxing land according to its value in its highest and best use, for example, owners of idle or undeveloped land are given an incentive to sell. By taxing improvements and buildings lightly, or not at all, developers are given an incentive to build or improve existing structures on the land. However, when buildings and improvements are taxed heavily and land lightly, the incentive is directed against new construction. Since it is sometimes desirable to promote the "highest and best use" and sometimes not, it is apparent that a uniform tax assessment may not be the best. When land is taxed lightly and improvements taxed heavily, the pressure to convert farmland to urban uses is reduced. But for land already devoted to urban uses, the same tax policy contributes to inner city deterioration by discouraging improvements on existing facilities.

Differential tax assessment laws may be implemented to reduce development pressures on certain parcels where there are farms, timber or forest areas, recreation areas or historical buildings. When development pressure increases on the fringe of an urban area, farmers and others are forced to sell their land if the resulting increases in the value of the land cause increases in the property tax assessment to levels that the previous use cannot support. To remove the pressure for development, special tax treatment can be afforded the farmer to permit a lower assessment or rate of taxation for farmland.

Since the first differential assessment law was passed in Maryland in 1957, 42 state legislatures have passed differential assessment laws (Hardy and Sibold, 1974a; Gloudemans, 1974). Differential tax assessment laws are generally classified into one of three categories: preferential assessment, deferred taxation, and restrictive agreement (Hardy and Sibold, 1974b). Preferential assessment taxation occurs when land is assessed according to its use rather than its fair market value. Deferred taxation allows the land to be assessed in the same manner as preferential assessment taxation except that if the land is converted to another use, the landowner is required to pay back taxes which were excused while the land was being taxed at less than the fair market value assessment. Besides including the provisions of deferred taxation, restrictive agreement forms of taxation require the owner to enter into a contract spelling out his rights and duties (Keene, 1976).

Special tax arrangements are also used to encourage new businesses to enter an area.

> Tax concessions generally provide exemptions for a finite period (ten years is the most common) from the larger part of property taxes, but also may involve one or more types of tax relief; eliminating specific taxes which places an undue burden on new industries; refraining from imposing certain types of taxes (such as income taxes and others aimed directly at manufacturing firms); allowing accelerated depreciation methods to relieve the income tax burden (used in New York and Pennslyvania); and a relatively recent innovation, exempting from property taxes those goods which are ear-marked for interstate shipment--a concept not unlike that of a free port in international trade. As of 1963 there were fifteen states in which direct tax concessions were legally offered. (It appears that they have been used illegally in other states.) However, their use is widespread in only seven states, most of them southern. Louisiana, the only state which handles tax exemptions on a state level and, therefore, the only one for which relatively complete data are available, exempted an average of $200 million in plant expenditures annually during the decade 1955-1964. (Lewis, 1968:32.)

State and Federal Land Use Planning Practices

A variety of land-use problems that local governments do not seem well-equipped to deal with have prompted a more active role by state and federal governments. Solutions to problems such as urban sprawl, conversion of prime farmland to urban uses, and degradation of the natural environment appear to require more than a local effort. Some of the state activities have taken the form of three innovations on the traditional land use controls discussed above, namely: comprehensive, critical areas, and key facilities planning.

Comprehensive Land Use Planning

Hawaii's resource use law is among the nation's oldest (Bosselman and Callies, 1971). Passed in 1961, it was the first statewide comprehensive land use law. The

State Land Use Commission divided the land into three classifications to be controlled by the following agencies: the Agriculture and Rural-Land Use Commission; the Conservation-Department of Land and Natural Resources; and the Urban-Local Zoning Ordinances. While the appropriate agencies control the use of the land within their respective zones, the Land Use Commission sets the boundaries of the zones. In setting and changing boundaries, the commission reconciles the following planning principles: prime agricultural land must be preserved, tourist oriented growth encouraged (without destroying the natural attractions of the area), and compact and efficient urban areas should be provided where people can live at a reasonable cost. All state projects require approval by the commission. This allows the commission to be certain that projects are located where secondary development is possible.

The Vermont Environmental Control Law of 1970 (Meyers, 1974a) was passed in response to the second-home and ski-resort boom of the late 60s. The intent was not to preclude recreational development, but to control it in order to minimize environmental degradation. The law required permits for: residential developments of more than five parcels or with less than ten acre plots; commercial or industrial development of more than ten acres; and development at elevations above 2500 feet. The developer submits an application to one of the eight district commissions and within 40 days a hearing is held where state agencies provide data on soil suitability, drainage and sewer conditions, etc. and concerned citizens voice their opinions. Generally, although not always, the applications are approved with qualifications and requirements for improvements which must be made. Acceptance or rejection of the permit application is based on consideration of ten specific criteria.

In April 1972, as a direct consequence of a reapportioned legislature and the worst drought in Florida's history, the Environmental Land and Water Management Act was passed (Meyers, 1974b; Council on Environmental Quality, 1972). It was a direct outgrowth of the American Law Institute's "Model Land Development Code" and proposed Federal Land Use Legislation and provided state regulation of areas of critical state concern (ACSC) or of development of regional impact (DRI). The act defines an ACSC as an area that: contains "environmental, natural, or archeological resources of regional or statewide importance;" is "affected by" or has "significant effect upon an existing or proposed major public facility or other area of major public investment;" or is a "proposed area of major development potential--such as a new community." The division of state planning initiates the ACSC process by defining boundaries of the areas, explaining why they are of critical state concern, and specifying development principles for the area. The governor and cabinet (all of whom are elected statewide) approve or disapprove of the boundaries and principles. The local government is given six months to develop regulations which comply with these boundaries and principles. The planning agency can prepare the regulations if the local ones are inadequate and take judicial action if the local government is not doing its job.

The act further defines a DRI as "any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county." The developer sets the process in motion by filing with the local government, regional agency, and the state planning office detailed information on how his development will effect the region's natural resources, public facilities, and economy. The law provides for public notice and hearing. The regional body has 50 days to prepare an impact review and recommendations which the local government must consider before deciding on the application. The developer, regional planning commission, or the state planning office may appeal to the governor and cabinet which sits as an adjudication board (Linowes and Allensworth, 1975; Council of State Governments, 1974).

Oregon has also implemented a statewide planning process. The Oregon process is not the result of a single land use planning bill, but rather the result of a package of bills. The Oregon land use package is composed of the famed "B" bills: The Bottle Bill; the Bicycle Law which allows for a percentage of the states' highway money to be used for bicycle paths; the Bond Bill for pollution abatement; the Beach Bill which designates the beaches of Oregon as public property up to the vegetation line; and the Billboard Bill, which requires billboards to be taken down. Other activities include the "Willamette Greenway" program and "Project Foresight" and "Feedback" which are projects designed to save the Willamette River Basin from environmental destruction (U.S. Senate, 1974).

Critical Areas Planning

The critical areas approach to planning is perhaps the easiest resource use planning approach to "sell" to the public since it is not difficult to show a need to protect shorelines and other environmentally sensitive areas. The fact that 10 states have critical area programs, 30 states have coastal zone managment programs, 20 states have flood plain management programs, and 18 states have wetland management programs clearly demonstrates that environmentally sensitive areas are a prime target of state action (Council on Environmental Quality, 1975). Under a critical areas program, a governmental entity identifies an environmentally sensitive area and attempts to protect it. Article 14 of the New York State Constitution stipulates that its 2.6-million-acre forest preserve "shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed." The Adirondack Park with six million acres and the Catskill Park with one-half million acres contain most of the preserves. In 1971, the states legislature established the Adirondack Park Agency with three purposes: to prepare a master plan for the state park lands; to prepare a development and resource use plan for the private lands in the park; and to control private development through a permit system until the development plan is completed. In July of 1972, the master plan was completed; and in August of 1973, the plan to regulate private land within the parks went into effect. The land was classified into eight categories for the state resource master plan and six categories for the private development plan. The uses of each area were carefully described and the plans utilize an intensity guideline approach. Each area was given an intensity scale which allowed a certain number of buildings per square mile. The scale was designed to allow for development rights transfers. It was envisioned that intensive development could occur in some areas by transferring the development rights of surrounding areas. This would result in pockets of development with surrounding expanses of undeveloped land. The state plan emphasizes local plans. The state planning agency, when assured that the local plan is compatible with the state plan, approves the local plan and allows the local government to contol its land use (U.S. Senate, 1974).

In 1969, the New Jersey legislature formed the Hackensack Meadowlands Development Commission. The legislature gave the commission planning and regulatory powers over a 28 square mile area of marshland. The area had been used as a dump and was in desperate need of reclamation. The state gave the commission several million dollars to plan, review, and redevelop the land. Fifteen cities and counties participated in the planning and review process (Linowes and Allensworth, 1975).

Maryland, a state where land use has traditionally been controlled by the counties, recently formed the Maryland-National Capital Park and Planning Commission to serve the Washington D.C. suburbs of that state. This agency has jurisdiction over 1000 square miles and 1 million residents. The commission has final subdivision control power given to it by the state (Linowes and Allensworth, 1975).

Key Facilities Planning

Another basic approach to land use planning is the key facilities or large development legislation. Essentially, it involves the state in regulating development that will have substantial secondary spread effects. Housing projects, airports, highways, schools, shopping centers, and power plants are examples of key facilities. The 1967-1968 jetport controversy in southern Florida is an example of the type of problem and controversy which can develop because of a key facility. The jetport was to be built in swamplands where it would have damaged the ecosystem's balance. The controversy which arose eventually caused the cancellation of plans for constructing the jetport (Carter, 1974).

In 1967, the Metropolitan Council of the Twin Cities Area was created by the Minnesota legislature. The Council prepared a plan for the area to serve as a basis for reviewing government key facilities construction proposals. The government bodies whose projects the council must approve include the Metropolitan Sewer Board, the Metropolitan Airports Commission, and the Metropolitan Parks Board. However, since the councils' review powers are not comprehensive, its power to implement its plan remains limited (Linowes and Allensworth, 1975).

States Land Use Planning Problems

Comprehensive land use planning systems in the states are not without their problems. Opposition to an increased state role in land use planning is often strong, and the conflicts among land use values are not eliminated simply by enacting comprehensive planning. In Florida, the legislative bargaining process resulted in compromises that weakened the land use planning bill by reducing the total area eligible for designation of areas of critical state concern (ACSC's), and cutting the staff and funding available for carrying the designation studies. Special legislation was therefore needed to give ACSC designation to the Big Cypress Swamp and the Florida Keys (Meyers, 1974a).

In Oregon, Senate Bill 10 was the first real attempt at land use planning. It simply required the cities and counties of Oregon to zone their land. If satisfactory progress was not made, the Governor could take over the job. SB 10, however, provided no standards for evaluating comprehensive plans, no mechanisms for coordinating among the counties, and no money for doing the job. A "Land Use Policy Group" proposed SB 100 to coordinate enforcement mechanisms and give the cities and counties guidelines upon which to base their plans. The law would have created a complex bureaucracy which included a new Department of Land Conservation and Development with a commission of citizen-appointees and a Joint Legislative Committee on Land Use of the House and Senate. The key coordinating organizations were 14 regional commissions. The Land Conservation and Development commission was to develop statewide land use goals and guidelines (to be approved by the legislature). In addition, the drafters of SB 100 were more specific as to the "areas and activities of critical state concern." By the time SB 100 got through the legislature, the "critical" areas and the regional planning commissions had been deleted, the counties were given the planning commission's responsibilities, and funding and staffing had been reduced (State of Oregon, 1974).

National Land Use Planning Legislation

Land use planning issues have already been addressed at the national level through such acts as the Coastal Zone Management Act, the Development Siting Act, the Strip Mining Siting Act, the Flood Plain Management Act, and the other acts which require state governments either directly or through powers given to local jurisdictions, to plan for the location of development and facilities. But comprehensive planning does not necessarily follow from legislation that, taken all together, provides comprehensive coverage. Coordination among agencies with diverse land use planning responsibilities at the federal level and among federal, state, and local agencies, is a major problem.

A major concern of proponents of national land use legislation has been the provision of assistance to states and localities for better land use planning. In 1970, Senator Henry Jackson's National Land Use Policy Bill became the first national land use measure to pass the U.S. Senate. Its purposes were to set up a grant-in-aid program so states could construct state land use plans; to assist states in resource inventory, collection and analysis of data; to provide technical assistance and training programs; and to set up a national information exchange center. The bill required a single state agency to administer and design a land use plan. Failure to comply would bring strong federal reaction. The President could recommend cuts in federal programs by 20 percent per year until the law was complied with and public land and right-of-way permits would be denied if the law was not followed (U.S. Senate, 1970).

In 1971, President Nixon submitted a resource use bill entitled the "National Land Use Policy Act of 1971." This act was designed to deal with "areas of critical environmental concern" and "key facilities." Areas of development of more than local significance would come under federal jurisdiction. The federal government was to issue program development and management grants. In order to acquire a management grant, the proposed state program had to include: an inventory of the designation of areas of critical environmental concern and key facilities; a plan for exercising control over these areas at the state level; a method for ensuring that local regulations would not interfere with developments of regional benefit; a method for locating and controlling new communities; a method for controlling water, air, and noise pollution; a revision methodology; an implementation schedule; regulation for coastal zones and estuaries; and a method to ensure public participation and mechanisms for coordinating with other states. The Secretary of the Interior was given the responsibility of reviewing and approving the grant application. The Interior Secretary, however, has to get the Secretary of HUD's approval for grants dealing with key facilities, large scale development, new communities and regional development. An important clause in the proposed legislation required federal compliance with local and state regulations except in the case of over-riding national concern (U.S. Senate, 1971).

In 1971, Congressman Meeds sponsored the Land and Water Resources Act of 1971 (U.S. House of Representatives, 1971). It required the Land and Water Resources Planning Council to become the comprehensive authority for the administration of a national resource use policy. The bill provided for a Federal Planning Information Center to serve as a clearinghouse for federal projects with resource use implications and a general data bank for land and water information. The council would make grants to encourage comprehensive resource use planning. The Meeds Bill was the subject of a great deal of discussion and criticism. HUD saw the need for flexibility and suggested that states not set up a super information agency to deal with controlling all land and water resources, but rather to concern themselves with critical areas and key facilities (U.S. House of Representatives, 1971).

Crawford J. Carroll, Chairman of the Committee of Environment of the National League of Cities, suggested that local dependence on property taxes be reduced, that local officials be given a major role in the development of state plans, that regional planning groups be largely under local control, that grants be made available to multi-jurisdictional agencies, and that the federal government be required to abide by local, state and regional plans. Carroll also suggested review of tax laws which subsidize single family dwellings, housing loan subsidies which encourage tract development rather than urban renewal, highway programs which promote more urban sprawl, and farm subsidy programs which encourage intensive mechanized farming and deprive many rural poor of their jobs (U.S. House of Representatives, 1971).

Neither the Nixon or Meeds bill allows for states and localities to develop their own mechanisms for promoting better resource use. The Nixon bill suggests using the critical areas and key facilities approach while the Meeds bill provides for comprehensive planning. It is not at all clear that either approach would provide the "best" or the publically acceptable mechanism for resource use planning.

The most recent land use bill to pass the Senate was SH268, Land Use Policy and Planning Assistance Act, submitted by Senator Jackson in July of 1973. The bill would have required states to develop an adequate planning process which concentrated on: areas of critical environmental concern, key facilities, large scale development, public facilities or developments of more than local benefit, and major land sales or development projects. The act encouraged states and localities to cooperate closely to develop and manage the planning process. The federal government would review project decisions to insure that a planning process had been established.

If and when a land use planning bill passes both houses of Congress, it seems likely that it will establish an information distribution center to collect and distribute land use information and data, allocate money to help train the planners and staffs that states and local governments will need, and provide funding for data collection and analysis. Provisions for public participation in the planning process will be required, and interstate coordination will be encouraged.

The National Environmental Protection Act

The most important national land-use control legislation is the National Environmental Policy Act of 1970 (NEPA). It established the Council of Environmental Quality and mandated the preparation of environmental impact statements (EIS) for certain proposed federal actions. The purposes of the act are to: improve information flows amongst resource use decision makers, increase cooperation between decision makers, increase citizen involvement, and increase the use of the interdisciplinary approach to resource use planning. The improvement of information flows among decision makers was an integral and important part of the act. The Environmental Impact Statement was to include:

> (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which could not be avoided should the proposal be implemented, (iii) alternatives to the proposed action, (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and (v) would be involved in the proposed action should it be implemented. (NEPA, Title I, Sec. 120 C.)

Along with this information, the federal guidelines required that "the responsible federal official shall consult with and obtain the comments of any federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved" (Bosselman and Callies, 1971). Along with the aforementioned data sources, the EIS should include: "where appropriate, a discussion of problems and objections raised by other federal, state, and local agencies and by private organizations and individuals in the review process and the disposition of the issues involved" (Environmental Protection Agency, 1971). In a series of court cases,[1] the United States Court of Appeals for the District of Columbia further explained and strengthened the provisions of the act in regards to the statement's comments. The agencies must: include the full range of views on the environmental impact of the proposed action; make a rigorous examination of the possible alternative of taking no action at all; and balance in a reasonable manner the environmental considerations with other considerations. The court decisions along with Executive Order 11514 and the resultant guidelines published by the Council of Environmental Quality on April 23, 1971, have significantly improved the information included in the impact statement.

The increased citizen involvement that has occurred as a result of the EIS process is an important contribution of NEPA and has

> . . . opened to public participation many government decisions that were previously made informally and without prior public notice. The council believes that NEPA's public comment process can be assimilated into agencies' existing planning and review procedures for new proposals and still delay decision making little, if at all. The comment process can be an important step toward a more open and responsive government when environmental issues are involved. (Council on Environmental Quality, 1973.)

Citizen involvement has also occurred as a result of court action. In the case of the Sierra Club v. Morton (the Mineral King case), the Supreme Court explained the law as to who had standing to sue the government in environmental matters (40 USLW 4397, 3 ERC 2039, 2 ERL 20191, D.C. Cir., 1972). In SCRAP v. United States, the court further delineated its position on standing (5 ERC 1418, D.C. Cir., 1973). In effect, if a person can show the possibility of damage or injury, they have standing to sue. "All persons who utilize the scenic resources of the country, and indeed all who breath it..."

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[1]Committee for Nuclear Responsibility v. Seaborg, 3 ERC 1126, 1 ERL 20469, D.C. Cir., 1971; Calvert Cliffs Coordinating Committee v. Atomic Energy Commission, 44 F. 2d. 1109, 2 ERC 1779, 1 ERL 20346, D.C. Cir., 1971.

were the injured parties in SCRAP v. United States. Citizen involvement has increased because of the citizens' ability to be included in the EIS process and their ability to go to court to force federal agencies to comply with the law.

The EIS process and actions by the Council on Environmental Quality (CEQ) combined to increase cooperation among federal, state, and local government agencies.

> In the past, different agencies have often responded to these problems in a piecemeal, uncoordinated fashion, largely because of the lack of a mechanism for shaping a comprehensive policy. By forging interagency consultation and attention to a broad range of effects and alternatives, Section 102 (the EIS program) fosters more sophisticated government decision making. The 102 process uncovers the need for more comprehensive policies and programs in areas such as energy and transportation. Thus it is a catalyst for more sensible policy formulation and program development. (Council on Environmental Quality, 1972.)

The Environmental Quality Improvement Act of 1970 (PL 91-224) and Executive Order 11514 call for increased coordination and consultation between federal, state, and local agencies. While there may be more conflict than cooperation among government agencies, the stage has been set for a reversal of this trend. Agencies are consulting with one another and exchanging information--albeit reluctantly. Cooperation is certain to become more prevalent in the future.

The interdisciplinary approach to planning is a concept advocated in most recent planning literature, yet the concept is seldom implemented in practice. The information requirements of the EIS have effectively increased the use of multidisciplinary approaches and caused an increase in the size and expertise of planning staffs.

> Agencies whose personnel have reflected a narrow focus of concerns are being required now to supplement their staffs with persons of different backgrounds relevant to environmental issues. NEPA's required interdisciplinary approach means that personnel must be hired who bring not only new skills but a fresh viewpoint into the agencies. Over time, this influx should lead to sharper questioning of traditional assumptions within the agencies. Out of it should emerge an institutional viewpoint that is more sympathetic to environmental values. (Council on Environmental Quality, 1972.)

States' Environmental Protection

Since the passage of NEPA, many states have passed related legislation. By April of 1974, 15 states and Puerto Rico had their own EIS requirements (Trzyna, 1974). Thirty states have some sort of strip mining regulations and 25 states have power plant siting regulations (Linowes and Allensworth, 1975). Strip mining is regulated in varying degrees. North Carolina, South Dakota, and Montana have laws requiring the reclamation of disturbed landscapes. Virginia requires the mining company to submit a plan for reclamation with its mining application. There are a number of states which tax mining projects. Missouri charges on the basis of acreage and reclamation requirements. West Virginia taxes the mines $60 an acre for land mined and inspects the site every 15 days to insure that reclamation is occurring. Injuctive relief is possible if necessary to force compliance. West Virginia has also placed a moratorium on mining in 22 of its 55 counties for two years. Some states have set up bonding mechanisms. Illinois requires bonds to guarantee the cost of reclamation. These bonds must be submitted when the reclamation plan is submitted. Arkansas also has a bonding requirement, and in Ohio bonds are withheld until proof of reclamation is received. Some states like Maine include strip mining in their land use planning process under the jurisdiction of Land Use Regulation Commissions (Council on Environmental Quality, 1972).

Interestingly enough, the energy crisis also brought an increased awareness of the environmental impacts of power plant siting. In Texas, the Governor's Advisory Committee on Power Plant Siting was formed to report on factors to be considered in establishing criteria to be considered when deciding where to place power plants. The governors of Oregon, Washington, and Idaho requested no further energy development on the Middle Snake River and Hells Canyon because further facilities were unnecessary and would cause irreparable damage. In California, the Energy Resources Conservation and Development Commission acts as a one-stop regulatory commission. The commission is empowered to approve or disprove, with a limited number of exceptions, all energy sites. In Maryland, the state purchases proposed electric plant sites so that when the time comes for development, the appropriate site is available. Long range planning by electric utilities and early hearings on site approvals allows for better decisions to be made concerning power plant sites. Arizona's program provides for long range planning by utilities and approval of sites only with a certificate of environmental compatibility. Proposed federal legislation calls for long range planning by utilities, continuous 10-year projections of power needs, advance review 5 years prior to beginning the construction of a power plant, and the reviewing agency having the power to reject environmentally undesirable plant sites (Council on Environmental Quality, 1971, 1972).

In 1963 Massachusetts passed the first state wetlands protections law. It limited development in wetlands areas and required permits for development. In 1965, additional legislation allowed the Massachusetts Department of Natural Resources to issue protective orders which defined the boundaries of the coastal wetlands areas and prohibited development except under carefully controlled circumstances. Before finalizing protective orders, public hearings are held and individual landowners are contacted. Massachusetts is considering the regulation of inland waterways based on land capability. In California, the San Francisco Bay Conservation and Development Commission (BCDC) had its authority expanded to protect the Bay's wetlands and prevent inappropriate filling of the Bay. The commission's jurisdiction extends over development within 100 feet of the Bay and the commission has taken a firm stand against any development other than for water related uses (Bosselman and Callies, 1971; Council on Environment Quality, 1971).

The voters of California, recognizing the public interest in the California coastal zone and the delicate balance of its ecosystem, approved the Coastal Zone Conservation Act in 1972. The act defines the coastal zone, and establishes a permit system to control development, administered by six regional commissions and the state's Coastal Zone Conservation Commission. In order to obtain a permit, a developer must prove no substantial adverse environmental effects from the proposed development. The permit system is a central feature in implementing the act's intent to develop a "comprehensive, coordinated enforceable plan for orderly, long range conservation and management." The plan is to be developed by the regional commissions and the Coastal Zone Conservation Commission, guided by four objectives: the overall quality of the zone must be maintained, restored and enhanced; the optimum population of all species of living organisms must be continued; the utilization and preservation of all living and non-living coastal resources must be provided for in an orderly, balanced way; and, irreversible and irreparable commitments of coastal zone resources must be avoided (Linowes and Allensworth, 1975).

In June of 1971, Delaware passed a stringent coastal zoning act. The act prohibits new heavy industrial development strictly regulates all other new industrial development within a 1 to 6 mile strip along the 100-mile Delaware Bay Coast and along the 25 mile Atlantic Coast. The intent of the law was to preserve the land for recreation and tourism, rather than to permit industrial use. Recently, a proposal to build a transhipment terminal in the Delaware Bay was denied as a result of this law (Council on Environmental Quality, 1971, 1972). The state of Washington was the first to submit a coastal zone program for federal review. It passed its own coastal zone managment law by referendum in November 1972. All major shorelines 20 feet from the mean high tide line were designated areas of special statewide significance. The program's high priority items are: protecting the natural character of the shorelines, favoring long term over short term benefits, protecting the resources and ecology of the zone, and making publically owned areas more accessible to the public. Local governments in the state drew up the plans and local-state interaction served to revise the plans to meet state standards (Council on Environmental Quality, 1975).

It is to be expected that the implementation of a new planning technique, like the Environmental Impact Statement, will have to resolve unforeseen problems. One of the major problems with state EIS programs is their limited coverage, which does not extend to local government or private developments, and is a generally inadequate enforcement mechanism (Trzyna, 1974). Another shortcoming in the state EIS legislation is its failure to adequately provide for the citizen participation in decision making upon which environmental improvement and conservation must ultimately depend. Only two states, California and North Carolina, have periodic centralized lists of impact statements, and only two other states, Wisconsin and Massachusetts require newspaper notices for all statements. Only Wisconsin has required public hearings for all impact statements (Trzyna, 1974). Until such time as the states strengthen their public participation measures, make provisions for requiring local and private projects to file statements, and create laws requiring impact statements concurrent with strong local planning laws, the EIS process will not be entirely effective.

Citizen Involvement in Land Use Planning

Land use controls involve a wide range of impacts on the direction of community development by guiding the use of private property and public resources. In a democracy it is therefore imperative that a carefully designed citizen involvement program be a central feature of the land use planning process. Traditionally, advocates of citizen participation have emphasized involvement in the electoral process. The policy preference expressed in a vote, however, is not always clear, making the vote an indirect and somewhat unreliable method of insuring government responsiveness to public demands. This is especially true in states where broad decision making authority has been delegated to bureaucratic agencies.

The scope of administrative discretion has made obvious the need for more direct citizen involvement in administrative decisions. The response to this need has taken two basic forms (Rosenbaum, 1976:14-19). One has been the passage of statutes establishing procedural standards for administrative decisions. The other approach is the inclusion in substantive legislation of requirements for citizen involvement.

The Administrative Procedures Act (APA) of 1946 is the landmark federal legislation facilitating citizen access to administrative decisions. The APA requires that advance notice be made in the Federal Register of rule changes. This requirement provides a citizen the opportunity to participate in rulemaking through submission of written data, views or arguments. A citizen may also petition to issue, amend, or repeal a rule, and may go to court under certain circumstances for review of an agency decision. Since the APA was enacted, most states have adopted similar legislation covering decisions of state agencies. The states have also been active in promoting the cause of citizen participation by procedural reforms. Statutes requiring that all meetings of administrative agencies be open to the public--the "sunshine laws"--originated in the states.

Citizen participation rights received renewed emphasis in the 1960s as a result of citizen activism and the enactment of ambitious social programs. With the passage of the Freedom of Information Act of 1966, a significant improvement was made in public access to government documents. The Act requires government agencies to make available on demand identifiable documents not specifically exempted, and places the burden of proof of exemption on the agency when an information request is denied. The effectiveness of the Act has been a matter of some controversy, especially because of the ambiguous wording of its nine exemptions. But it seems to have weakened the disposition of secrecy (Hunter, 1972).

The National Environmental Policy Act (NEPA) of 1970 is another major piece of legislation affecting public involvement in administrative decisions. NEPA requires environmental impact statements, with provision for public review and comment, for certain kinds of proposed actions of all federal agencies. The Act also contains provision for litigation in cases where the impact statement is claimed to be deficient (Anderson, 1974).

The establishment of procedural standards has been viewed by some as an insufficient method of insuring agency responsiveness. The passive nature of these standards does not fulfill the requirements of citizen participation defined as "a dynamic and incremental process of furthering involvement in the planning process on the part of all citizens, and particularly those citizens who have traditionally been unwilling or unable to be involved" (Council of State Governments, 1975:11). It is now common, therefore, to establish active programs for citizen involvement in the provisions of substantive policy acts. The first major statute of this sort was the Federal Housing Act of 1954, although the concept of systematic participation programs is usually associated with the Community Action and Model Cities programs of the mid 1960s.

One of the most widespread techniques for obtaining systematic public input is the citizen advisory council. A 1971 survey indicated that 79 percent of counties and 84 percent of cities have used citizen groups for advisory purposes (Perry, 1971). In Vermont, citizen action is fostered by lay people serving as decision makers. The eight regional commissions which are the workhorses of Vermont's planning process are composed of lay citizens (Council of State Governments, 1975). The State of Washington used a Statewide Task Force of citizens representing all points of view to articulate a set of state resource use goals and guidelines. In California citizen panels review and comment on successive rounds of the coastal zone plan.

A variety of other techniques for soliciting citizen views are used. These include public surveys, advisory referendums, presentations in the mass media, and even a computerized telephone voting system (Rosenbaum, 1976). The techniques to be employed in any given program depend on the combination that matches technique to the policy sophistication and available time of participants, and the public resources available for the public involvement program. It should always be kept in mind that the primary objective of such programs is to improve the responsiveness of government to those affected by public policies.

An effective citizen participation program can be expected to enhance the public trust in government and rationality in decision making necessary for effective and efficient government (Rosenbaum, 1976:71-73). Public confidence is enhanced by the improved openness, accessibility, and fairness of administrative decision making that results from an effective participation program. Rationality of decisions is improved by the contribution of an involvement program in identifying and clarifying public preferences, encouraging their explicit incorporation in decisions, and requiring an explanation of the reasons for a given decision.

Land Use Planning Problems and Issues

If land use planning is to ensure that land resources are put to their most desirable uses, it must be approached from a broad perspective. Within the conventional planning process of goal formulation and action implementation, land use planning should incorporate the external factors which are often overlooked. For example, the conventional process for planning a highway considers the use of land along the highway, but generally not such long-term widespread effects as those on housing patterns, transportation patterns, demands for additional public facilities, and other effects on surrounding neighborhoods.

Most experts agree that broadly based land use planning is desirable and necessary. The planning and decision making process should be capable of identifying potential adverse consequences of proposed land use developments, and modifying, postponing, or cancelling those with significant undesirable effects. Disagreements and uncertainty arise with respect to the limits and effectiveness of the techniques available to implement planning goals and the proper division of land use planning responsibility among local, state, and national governments.

Eminent Domain Issues

The use of eminent domain as a tool for land use control at the state and local level has had mixed results. Although the legal basis has been established for its use for purposes like open space acquisition and urban renewal, the costs of both acquisition and tax revenues foregone discourage its use. Furthermore, the recent growth in popular opposition to local taxes from which acquisition costs must be paid, makes the expense of compensation an even more formidable obstacle. Urban renewal projects appear to meet the economic objection since the lands acquired are resold, but resale has been criticized as ignoring the needs of low income residents.

The Police Power Issues

Exercise of the police power is not only the primary traditional land use control device, it also seems to be the most attractive approach to meeting new land use control and needs. In contrast to eminent domain, police powers have few apparent direct costs and can be directed more precisely to the perceived land use problem. But the traditional forms, zoning and subdivision control, have a checkered history. Local government reliance on the property tax levy generates revenue maximizing incentives that are not always consistent with balanced development. Healy (1976) cites the example of a New Jersey community which had virtually zoned out people, while zoning in an airport and industries. As a result, the town has about two dozen residents, a single public school student backed by some $75 million in assessed valuation, and the second lowest tax rate in the county (Healy, 1976:20).

Too often, subdivisions receive the premature approval of zoning and planning agencies in communities throughout the country. Many of the subdivision lots are never developed.

> In California, for example, 1971 data shows that houses had been built on only 3 percent of the lots sold during the land boom of the previous decade. In one Florida subdivision, only one house was reported built after nearly a decade of raw land sales in which over 73,000 lots were sold. The City of Albuquerque is ringed with vacant subdivisions--enough to house 941,000 people, nearly the entire population of New Mexico (Urban Land Institute, 1974:7.)

In Arizona where the pace of land promotion is feverish, the magazine Changing Times (1973) estimated that if all the approved subdivision lots were sold it would create a new population of 3,500,000, 1 million people more than the state's projected population for the year 2000. Most of the land in Arizona is being sold without the improvements and facilities necessary for building homes.

The premature approval of dividing land into subdivisions has often resulted in environmental degradation.

> Numerous subdivisions have been platted in Florida, Pennsylvania and New England where municipal sewers are years away and where the soil or terrain is unsuitable for septic tanks. The result of development under such conditions is known as "Poconoization": massive poisoning of the ground water and extensive pollution of streams and lakes such as that which has spoiled much of the Pocono Mountains in eastern Pennsylvania. (Urban Land Institute, 1974:9.)

Premature subdivisions represent an adverse impact on the land use planning of communities, which do eventually grow out to meet them, in providing for the necessary services to the new residents.

> One California coastal county was shocked to find itself holding the bag for a $2 million repair job for roads and drainage ditches washed out by a moderate winter rainstorm in a large, recently platted subdivision. (Urban Land Institute, 1974:9.)

The popularity (among proponents of increased public land use control) of the power to regulate has made more acute the issue of reasonable limits of regulation. Police power extends only to a "reasonable" extent of regulation of property use and impairment of owners rights. Beyond this limit government action constitutes a taking, and compensation is required. The acquision of open space, for example, has been viewed as beyond the authority of regulation. In general regulations for the prevention of public harm do not require compensation, while those for encouragement of public good do (Bosselman, Callies, and Banta, 1973:218). But this principle is rather vague, and the present situation is reflected in the Supreme Court ruling that "there is no set formula to determine where regulation ends and taking begins" (Goldblatt v. Hempstead, 369 U.S.C. 594,1962).

Four theories of what constitutes a taking have been advanced (Michelman, 1967; Sax, 1964). The first is the physical invasion theory. If the government uses the land and takes it from you, a taking has occurred, even though no transfer of title took place. In Pumpelly v. Green Bay Company (80 U.S. 166, 1871) the Court held that the flooding of the complainant's land persuant to a state law providing for construction of dams for flood control constituted a taking. The second is the nuisance abatement theory. It is best illustrated by Mulger v. Kansas (123 U.SD. 623, 1887). The court upheld a Kansas law forbidding the manufacture and sale of intoxicating liquor. Since the states have the power to protect the health, safety and welfare of the citizens, they can regulate to do so and should not have to pay compensation to halt an undesirable activity. The third taking theory is the balancing theory. It simply entails determining the facts of a particular case, and then weighing the benefits against each other. If the public benefit outweighs the private loss, no compensation is necessary. The problems with this theory is that the greater the public gain, the less the compensation. In practice, however, the greater the public gain the more willing is the public to pay for the taking. The final theory is the diminution of value theory. Simply stated the greater the economic loss to the individual, the greater the compensation. The most troublesome aspect of this theory is how much economic harm is necessary for the theory to apply? In Pennsylvania v. Mahan (260 U.S. 413, 1922), Justice Holmes set up the diminutive theory by saying "when it reaches a certain magnitude" or "goes too far" regulation will be recognized as a taking. The problems is how far is "too far" or of "a certain magnitude?" There are very real and practical problems in determining how to regulate without "taking."

The judicial rulings are not particularly explicit and abound with definitional and computational difficulties. Yet they are useful in combating land use problems. The physical invasion theory has evolved to the point that air, noise, or water pollution can constitute physical invasion and taking (United States v. Causby, 328 U.S. 256, 1946). The nuisance abatement theory has similarly evolved to the point where resource use can be regulated to halt adverse environmental impact (Hadacheck v. Sebastian, 239 U.S. 394, 1915). The balancing theory has likewise been a useful tool in environmental decisions. The diminution theory is under going a re-examination. The Court seems to be shifting toward a wider use of the police powers doctrine. The notion of land as a commodity to be used in the interests of private gain is being replaced by the notion of land as a resource of interrelated uses to be conserved.

Taxation Issues

Local governments' dependence on the property tax and the rapid growth of local government expenditures have combined to inhibit high density development.

> The search for additional revenue has led communities to overzone for industry and commercial development. It is in large part responsible for the excessive strip commercial development that disfigures most cities.
>
> The desire to avoid additional public expenditures has been a primary reason for large lot zoning, for the limitation or prohibition of apartments, for restriction or prohibition of mobile homes, and for the excessively high zoning, subdivision, and building code standards that have impeded the provision of low and moderate cost housing. (Siegan, 1972:123.)

Ironically, the evidence suggests that those uses not allowed because of perceived high public costs and low public revenues are in fact high revenue and low cost developments which add to the public tax structure (Kristol, 1968).

It is often suggested that a large percentage of farmland sales for development occur primarily because of the profit squeeze felt by the farmer, especially in rural-urban fringe areas, and because real property taxes constitute a significant and rising component of a farmer's costs (Keene et al., 1976). In some areas differential tax assessment schemes were devised to combat the problem. But one study of these measures concluded that "the burden of property taxes is only one of many factors affecting the farmer's decision to sell." And "few farmers will be deterred from selling by a reduction in property taxes." The investigators also conclude that:

> . . . its [differential assessment] effectiveness with respect to the goal of maintaining current use is measured only in terms of the small number of farmers who are contemplating sale in a given year and who may be deterred from selling by a reduction in their property taxes. Even if differential assessment has marginal effectiveness for achieving this goal, it is an expensive way to do it. (Keene et al., 1976: 9.)

While many areas are attempting to give farmers a tax break, they are also attempting to encourage new businesses to locate in their areas and old businesses to expand. The belief is that by giving a tax break to businesses they will expand and employ more people. The economic improvement which can occur will offset the reduced taxes. Unfortunately, these tax schemes are not very effective either.

> We should have to conclude that in general, government financial incentives to industry, at least in the form generally adopted, are not of significant value in attracting new industry to an area or encouraging expansion of already existing industry in an area. Even if it were found that such programs would attract industry, it is obvious that the expansion of these programs to other localities and states, as has happened, would eventually negate the original value of the programs in all states. The net result would be a general subsidization of industry by the state and local governments with no obvious benefits accruing to the government or locality. (Lewis, 1968:44.)

Not only does the tax relief mechanism not do what it is supposed to, it creates other problems.

> The tax base is subject to more or less continual erosion as more property is exempted from taxation. . . The offering of financial subsidies to new firms is unfair to those companies in the area which received no such subsidies, particularly where these two groups are competitors. There is some evidence that where tax exemptions are widespread there is a corresponding low level of public services in which case both the firm and the community will suffer. The credit rating of the state or municipality will be impaired by an erosion of the tax base or by large-scale issue used to finance industry. (Lewis, 1968:44-45.)

Allocation of Land Use Control Authority

One of the principal issues in developing a more comprehensive land use planning system has been the proper division of responsibility among local, state, and national governments for achieving the goals of land use development. The consensus among those who have studied land use patterns is the local governmental institutions are not capable by themselves of effectively dealing with the land use problems that have emerged as the result of large scale urban growth. Healy (1976:6) has provided a convenient summary of the kinds of situations where state intervention in land use control might be warranted: 1) when problems spill across boundaries of legal jurisdictions; 2) when local interests diverge from the interests of a broader public; 3) when problems arise on lands not subject to effective local control; and 4) when required for the implementation of state policies or the carrying out of state investments.

The redistribution of land use control authority, however, raises sensitive political, economic, and social issues (Healy, 1976:162-185). Shifts in land use authority are likely to result in a relative reduction in local control, whether local control is interpreted to mean landowner discretion, control by and for community interests, or control by local decision makers. At the same time, increased authority in a broader jurisdiction requires closer attention to provisions for public participation, which imply a weighting of local and non-local interests.

Although there is no evidence that state land use controls have had an overall negative economic impact, it is undeniable that they have had some. Generally, controls restrict development of some land directly (flood plains, coastal zones, wetlands, etc.) and redistribute development to other parcels. Quality controls (building codes, FHA requirements) usually raise unit costs, at least some of which is passed on to the consumer. Recent requirements for impact studies slow the decision process, which raises costs due to inflation. Moreover, the studies themselves are expensive, and add a risk to business calculations that may favor large developers since the study cost outlay comes prior to approval. Land use restrictions can also be expected to lower the value of affected lands, resulting in a loss of local tax revenues which will have to be made up elsewhere.

Finally, the imposition of land use controls raises issues of equity and fairness. Public land use decisions can result in windfall gains and losses to some and often have different consequences for the economic prospects of different groups. The most frequently heard complaint is that land use controls at best do not help the poor and usually impose a hardship on them--e.g. quality standards raise housing costs, low income housing zones are not sufficient to meet needs, property taxes are regressive, etc. Thus, the design of mechanisms to meet new land use problems must incorporate considerations of the distribution of land use control benefits and burdens.

The above discussion of the problems associated with land use planning emphasizes gaps in authority, duplications of effort, and conflicting programs that can result from a lack of coordination. The facts that housing authorities promote low income housing while land use planning mechanisms restrict it, that commercial development agencies give tax breaks to businessmen and thereby lower the tax base while land use planners and city officials try to increase the tax base, and that the Army Corps of Engineers builds flood control projects to minimize flood damage and thereby encourages development on flood plains, all combine to demonstrate the need for integrated land use planning. Water and land resources, human resources, and financial resources must all be considered in the planning process.

Implied Problems for Coordinating Land with Water Planning

Comparison of the tone and substance of the above reviews of water resources and land use planning history and practice suggest a number of difficulties for efforts to coordinate the two activities:

1. Water resources planning is essentially a process of providing for growth while land use planning is essentially a process of shaping or even preventing growth. These conflicting goal orientations can be very difficult to reconcile.

2. Water resources planners employ engineered construction as their primary development tool while land use planners employ legal regulations. The training required to employ these two divergent tools is quite different and provides little commonality for productive exchange.

3. Water resources planners compare costs in selecting alternatives whereas land use planners seldom consider the costs inherent in their regulatory schemes.

4. Water resources planners have established criteria and are close to standardized criteria for planning guidance whereas it is quite obvious from this chapter that land use planners have many tools but no objective guidance for choosing among them. This basic difference in the philosophy of how to go about planning severely complicates coordination.

PART II

CONCEPTUAL FOUNDATIONS OF INTEGRATED WATER RESOURCES AND LAND USE PLANNING

In developing a clearer conception of the relationship between water resources and land use planning, we began with an examination of the history of and current practices used in the two types of planning and found considerable divergence between them as to goals, tools, and methods. In this part of the study, the problems that need to be solved in laying a foundation that can really achieve integrated planning is pursued at a more general level. The ideas discussed in Chapters 4, 5, and 6 are unified by the convictions that 1) the improvement of integrated resource planning must be rooted in an understanding of the environmental and societal contexts of resource problems, and 2) the differences in planning, perspectives, and the consequent differences in conceptions of integrated resources planning, are serious obstacles to improvements in the planning process.

Chapter 4 addresses the need for explicit definition of the family of ideas that include general, comprehensive, and integrated water and land planning. Chapter 5 examines the key concepts that are the elements of a comprehensive perspective on man-environment interactions. Finally, the institutional and methodological implications of the ideas presented are brought, in Chapter 6, to a focus of attempting to achieve better integration through of the conceptual framework of the Integrated Resources Uses Model (IRUM).

CHAPTER 4

THE IDEA OF PLANNING AND ITS CHANGING CONTEXT

Planning is not conducted in an historical, social or intellectual vacuum. Past events, the processes and forces in society, and a variety of assumptions and preconceptions influence the way planning processes evolve and are implemented. The need for integrated planning exists as much because of differences among planners as because of differences in the problems plans address. But the approach to integrated planning depends on perspectives and definitions that differ according to context and the background or experience of the interpretor. For example, an urban land planner trained in a school that has an architecture tradition is likely to have quite different goals and procedures in mind when he undertakes integrated planning than does a civil engineer with regional water planning experience. Similarly, the perspective of a utility company official will differ from that of a federal water agency employee.

Most individuals agree that variations in meanings of planning exist, but there is not much evidence that conceptual differences are considered critical to the success or failure of the planning process. Little research to investigate the consequences of such differences has been conducted, although experiences in other cultures suggest that neglect of these conceptual issues can lead to disastrous results (Bennett, 1974). Therefore, to determine how various types of planning can be better integrated, we should investigate the nature of these differences, how they have developed, and the implications of their existence. How and why does the present situation make integrated planning desirable or necessary? We should further determine whether prevailing planning concepts and practices are adequate to meet the identified needs, or whether alternative concepts and approaches should be adopted. Finally, we must work toward a concept of planning that results in actual decisions for implementation. Planning which does not lead to practical policy formulation and a program of implementation to carry out the selected policy is a public waste and a discredit to the profession.

Changes in the Planning Context

In examining the societal changes that affect planning, social scientists and planning theorists tend to focus on two basic kinds of changes: technological and conceptual (Jantsch, 1969b; Moore, 1974). The role of technology as the major force underlying social change is generally recognized (Bauer et al., 1969; Mesthene, 1970). For example, Ozbekhan (1969:59) argues that technology is "one of the most potent agents of change known to man; technology alters, multiplies, speeds up or slows down, or in other words, controls natural processes." Ackoff (1974) specifically suggests that the developments in communications, measurement (precision instruments), and computing technology form the basis for post-industrial society. These three technologies have expanded our capacities to access and process information by several orders of magnitude, thereby dramatically increasing the social and environmental options available to us.

Technological development has not only increased our options and choices, but it has also increased the number and complexity of interactions in our society. It has had and is having a crucial impact on the nature and rate of change in society, with important ramifications for planning. Maruyama (1973: 346) notes that:

> We are now entering an era of transition of a different nature. It is a transition from a chain of stationary or quasi-stationary patterns, which the population accepted as given, to a duration of perpetually transforming patterns which depend on people's will and choice. It is a transition between types of transitions.

Observations similar to Maruyama's have been made by many planners, social scientists, and others who have been especially concerned with problems of social change (Friedman, 1973; Godschalk, 1974; and Michael, 1973; Bell, 1973; Etzioni, 1968; and Theobald, 1970 and 1976). They generally agree that rapid and continuing change is causing fundamental shifts in world view and a different understanding of the nature of social reality (Ackoff, 1974; Bolan, 1974; Godschalk, 1974; Jantsch, 1969c; Michael, 1974).

Technological and conceptual or intellectual forces influence one another in mutually causal ways. But there is a danger that technology has become too dominant in its effects. As Maruyama (1973:351) points out:

Culture is in danger of becoming a tool for technology. This, of course, is putting the cart before the horse. Obviously we need to generate cultural goals ahead of technology and orient technology toward cultural goals.

Probably the most widely held concept of planning is that the process needs to order technological change to achieve fundamental social and cultural goals. If indeed planning as practiced is unable to do so, whether because of biased perspective, inadequate tools, or an inability to communicate with the public, basic changes will be needed in the assumptions, conceptual perspectives, and methodologies of planning.

Emerging Planning Perspectives

If planning is not fulfilling achievable social goals, the planning conceptions and actions of a large majority of individuals who influence, guide, or make decisions affecting the future must be significantly altered in order to structure and present the social choices required for a viable society. As Bolan (1974:14) suggests, planning should be based on a new and thorough understanding about "the fundamental issues of how men see reality, how they think, how they relate to each other and to the natural environment, and how they act." In this way planning concepts, theories, and procedures can be in tune with the social preferences as well as with the constraints caused by technological realities. It is in this light then, that emerging planning perspectives should be interpreted as has been observed by Etzioni (1973:107), among others, who remarks that "It is so vital to realize that conceptions of planning and its mechanisms do not stand isolated, but are reflective of the society in which planning occurs."

Many believe that a basic change is needed in the nature and practice of planning, and that planning theorists as well as practitioners will need to re-orient their conceptual perspectives and their activities (Ackoff, 1974; Friedman and Hudson, 1974; Grabow and Heskin, 1973; Jantsch, 1969b and 1969c; Maruyama, 1973; Michael, 1974; and Ozbekhan, 1967 and 1974). These writers differ in their perceptions of the specific changes needed, but areas of agreement can be delineated (Bolan, 1974; Friedman and Hudson, 1974; Galloway and Mahayni, 1977). One is an increasing concern with metaplanning, giving more attention to planning how to plan, as demonstrated in the following comments by Galloway and Mahayni (1977:68):[1]

Consequently, new theory is needed which attempts to bridge current planning strategies and the urban physical and social systems to which strategies are applied.

...it is becoming increasingly essential for planners and students of planning to translate and transcend this turbulence both in the conceptual, and more importantly, in the work-a-day world of planning practice (emphasis added).

To explicate emerging trends in planning perspectives, it is useful to examine the language and planning approaches that have been discussed by various writers. As shown in Table 1, a search for the planning traditions, modes, strategies, or theories identified in the theoretical planning literature reveals a diverse set of classification systems. It is difficult to select the categories that should guide the development of planning theory. Our inclination is to believe that the most significant departures from traditional planning approaches are of two kinds. One strand emphasizes the challenge of dealing with complexity, interrelatedness, and rapid change. Planning from a "general systems" perspective is advocated by Jantsch (1969b and 1969c), Ozbekhan (1969 and 1974), Maruyama (1973), and Ackoff (1974). A second strand focuses on human satisfaction and human potential. This perspective, labeled "The New Humanism" (Friedman and Hudson, 1974) is represented by such writers as Hampden-Turner (1970), Friedman (1973), and Michael (1973).

General systems planning and humanistic planning have a number of ideas in common and are convergent, but their relevance for contemporary planning is quite different. General systems planning focuses more on the methodological and procedural problems in achieving desired planning goals. It is less normatively oriented than humanistic planning, which is particularly concerned with establishing planning goals or ends that fall within the humanistic tradition. Because this study specifically aims to improve integration of the means of water and land planning, the ideas developed by general systems oriented writers are especially useful. The contribution of their recommendations should be evaluated in terms of the specific kinds of changes in modern society that affect the planning context in ways that require correction by new planning methods.

The language employed by general systems theorists is abstract and may be unfamiliar to many planning practitioners, but its concepts have real meaning in explaining events. For example, Ackoff (1974:182) argues that our evolving society will develop "a new intellectual framework in which the doctrines of reductionism and mechanism and the analytical mode of thought are being supplemented by the doctrines of expansionism

[1] According to Maruyama, planning is necessary for transitions or change, while metaplanning is needed for determining how to choose among types of transitions (changes in change).

Table 1. Suggested classifications of planning traditions, modes, strategies, or theories.

Peterson (1966)	Grabow and Heskin (1973)
Deduction	Rational - Comprehensive
Utopian	Rational - Spontaneous
Inductive	
Bolan (1967)	Friedman and Hudson (1974)
Probabilistic Programming/	Philosophical Synthesis
Comprehensive - Classical	Rationalism
Coordinator - Catalyst/	Organizational Development
Comprehensive - Systems Analysis	Empiricism
Disjointed Incrementalism/	
Cost - Effectiveness	Ackoff (1974)
Advocacy Planner/	
Quasi - Keynesian	Inactivist
Adaptive or Contingency Planner/	Reactivist
Ad Hoc Opportunism	Preactivist
	Interactivist
Krueckeberg (1969)	Krieger (1974)
Rational	Scientific Systems - Formal
Innovative	Phenomenological
Comprehensive	Language Philosophical
Middle-range	Linguistic
Allocative	Pragmatic
Advocative	Active
Incremental	

and teleology, and a new synthetic (or systems) mode of thought." Maruyama (1973) identifies "mutual causality" and "mutualistic symbiosis" as key ideas that should become part of every planner's conceptual tool kit. The resulting planning approach would then emphasize conscious, adaptive direction for society and an holistic systems awareness of societal interactions and planning activities. In practical terms, this means that planning theorists and practitioners should:

1. Know explicitly what assumptions and perceptions govern their view of "reality," and that of others.
2. Be much more familiar with a larger range of subjects, such as sociology, administration, data management, etc.
3. Have access to and be able to process large amounts of information and knowledge.
4. Perceive characteristics of problems, issues, and activities in their totality, integrating these into a system of planning.

To the extent that those who influence or make planning decisions do not fulfill these conditions, planning will be less successful, and society will be the worse.

To summarize, in the empirical reality of the world of facts to which planners must respond, technology is the major engine of change. As a result of technology, the empirical world is growing more complex, has a faster rate of change, and is increasingly vulnerable to conditions of resource scarcity. In social reality, the world of human interactions, motivations, values and ideas, the process of planning represents, to a major extent, a response to empirical change. As society has become more complex and is changing more rapidly, the boundaries and distinctions between physical and social systems are becoming more blurred. General, comprehensive, and integrated planning are in effect, part of a trend in the planning context toward a broader-based, holistic "system" planning. It is within the perspective of this larger trend that the need to improve integrated resources planning should be addressed.

Conceptualizations of Integrated Planning

What exactly is integrated planning? How do individuals conceive of integrated planning? How is it practical? How should it be conceptualized? How should it be practiced? These questions are the main concern of this study. They have not been answered well, nor in sufficient detail, in our opinion, partly because of the obstacles caused by conceptual differences. It is therefore useful to begin with a discussion of the basic conceptual and practical issues affecting the definition of integrated planning. The meanings of "planning" and "comprehensive planning" particularly need to be examined.

Meanings of Planning

A planning perspective focuses on the conceptual and social context that form the basis for planning implementation. Its definition requires identification of the direct and indirect influences on planning as part of a systemic, or societal process, rather than on the analysis of planning itself. What, in more exact terms, does planning mean and what has it meant to different individuals in different circumstances? To answer this question it is necessary to identify basic factors that make planning meaningful. These factors include context, definition, and implementation. The distinctions among these three aspects of planning are useful because they enable us to better evaluate the complexity, consistency, and development of planning theory and practice. We can then more accurately identify possible areas for improvement.

Figure 1 depicts the significant semantic interrelationip among planning context, definition, and implementation. Here context refers to the social, psychological, and physical environmental influences that affect the perceptions and perspectives of the individuals who direct or participate in the planning process. Context is a major determinant of the definitions of planning, which are the conceptual and procedural specifications of the planning activity. Both planning context and definition impact implementation. Ideally, planning would be implemented in a manner exactly congruent with a definition that would be theoretically and practically correct. In actuality, the gap between the definition and implementation of planning is frequently quite large, demonstrating that the distinction between theory/knowledge and practice is all too real.[2] The main reason for such a gap is the lack of conceptual-theoretical clarity which prevents individual planners from developing and employing a common framework or perspective. This implies that the first, major step toward more effective planning integration should be to establish common semantic agreements that planners from all perspectives can understand and apply.

A review of the origins and progress of regional and river basin planning experiences shows that certain patterns of change are

[2] It is assumed, of course, that an accurate theory (and definition) is eminently realistic and practical.

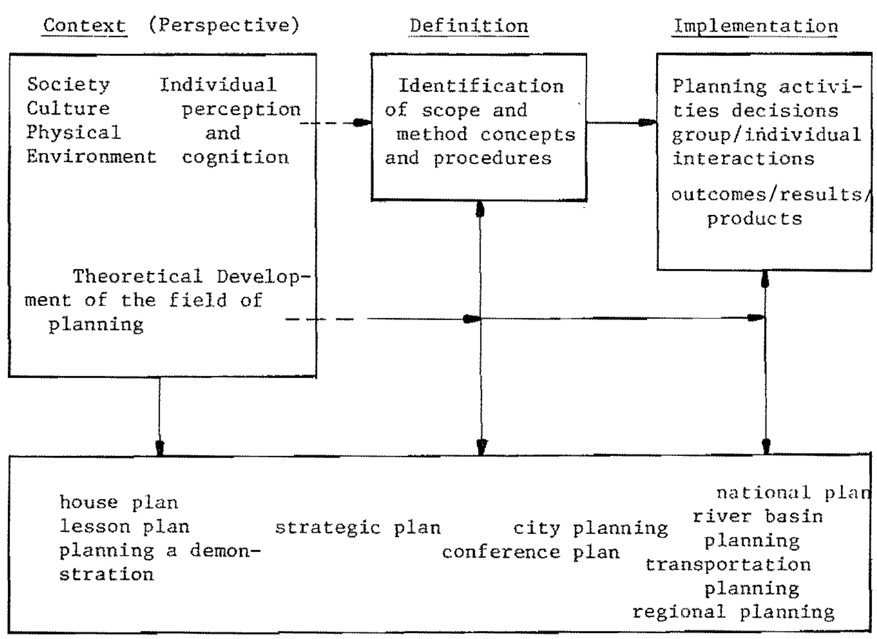

Figure 1. Semantic aspects of the term "planning."

reflected in the meaning of planning.[3] Trends in the development of regional water and land planning have been traced by a number of authors including Clawson (1973), Fox (1964), Hoggan et al. (1974), Linsley (1976), Ortolano (1976), Renne (1954), Schad (1962, 1964, and 1976). Their writings illustrate the difficulty of assessing what planning means, if anything, in the minds of the general public. Instances of project planning as a consciously organized, implemented activity occurred before 1900, but they were not well enough coordinated to result in a socially assimilated conception of planning. To the extent that planning had any meaning in practice, it was narrowly conceived as an activity to prepare for the construction of projects, usually, in water resources applications, to improve river navigation. Localized town or city "planning" could be said to exist, but such planning had virtually no meaning in a regional sense.

A more organized conception of planning developed in the early 1900s from changing perceptions on the role of government in planning. The governmental reform movement lead to better rationalized management and organizational practices. In water planning, the Corps of Engineers was authorized in 1927 to survey the development potential of most of the rivers in the country, resulting in the "308" reports. In city and land planning, Frederick Law Olmsted, Jr., Edward M. Bassett, and Alfred Bettman laid the foundation for the urban general-plan concept (Kent, 1964). In economics, the beginnings of analytical and methodological techniques were being formulated that would later become the basis for the field of regional economics.

From the 1920s to the present, the meaning of planning has shifted in relation to a number of factors, and the shifts were different for water than they were for land planning. However, certain changes were common to the two areas. These include:

1. Planning has become more data-based. Its meaning has come to include a larger, more generally recognized information component.

2. Planning has become a more fluid, flexible concept. It is an activity that is no longer interpreted as a series of relatively independent stages; instead, it is seen as a process-oriented, iterative endeavor.

3. Planning incorporates an increased sensitivity to the practical implications of values and value conflicts as expressed in social and political processes.

4. The scope of planning is seen to be broader. It is interpreted to involve humanistic and social matters, as well as physical-natural elements.

In a sociological sense, both water and land planning, as applied to regions, have become clearer and more sharply defined in the minds of more people, while at the same time becoming increasingly comprehensive in meaning. A convergence has been taking place among different kinds of planning toward a broader, more inclusive approach which is manifested as regional science, regional planning, and comprehensive planning.[4]

Regional and Comprehensive Planning

As in the case with the meaning of planning, the concepts of regional and comprehensive planning have also undergone identifiable if somewhat lesser shifts over time. Regional planning first began to develop in the 1920s (Friedman, 1964). The National Resources Committee (1935) defined it as "dealing with the physical resources and equipment out of which socio-economic progress arises." During the 1930s and 1940s regional planning dealt largely with water resources and adjacent land areas in units geographically delimited in terms of a watershed or river basin. When transportation needs and urban problems became a major concern in the 1950s, regional planning changed its geographical focus from watersheds to metropolitan areas. More recently its meaning has broadened again to include river basins as well as areas defined in terms of other criteria such as economic trade area.

Whereas regional planning has been defined primarily in terms of geographical scope, concomitant with economic and some institutional analysis, comprehensive planning can perhaps best be distinguished with respect to its methodological concern.

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[3] Our primary aim here is to explore the meaning of planning as practiced within a regional perspective, and as understood in a social sense, rather than to present a more narrowly conceived analysis of definitions of planning. Several of the cited references dealing with planning theory have done the latter already. Other writings that examine definitions of planning include Chadwick (1971), Hoggan et al., (1974), Davidoff and Reiner (1962), Dror (1963), and Seeley (1962).

[4] Each of these terms has had a different intellectual and social history and tradition, but their meanings in practice are becoming the same.

The idea of comprehensive planning developed as a response to the need for improved functional coordination. For example, in water planning, and more generally in regional planning, the focus of planning activities tend to be project-oriented and concerned with economic development. As environmental and social issues became more important, and as awareness of the significance of interrelationships among diverse projects increased, it became recognized that planning should more explicitly take into account a larger number of variables and functions. Thus the theoretical planning objective evolved from project-oriented, single-purpose through multi-purpose and multi-objective planning to comprehensive planning.

While actual water planning experience shows (Hoggan et al., 1974) some success in moving toward comprehensive planning, methodological, procedural, organizational, and institutional obstacles prevent necessary coordination. Many decisions are made and activities undertaken without coordination. In the meantime, increasing sensitive to interventions by special interests has increased the need for special effort at coordination. Planning activities must become more closely interrelated, and more detailed interfacing of different types of planning activities requires additional special effort to make an evolutionary step toward the actualization of systemic, holistic, or integrated planning.

Integrated Planning

There appears to be little consensus as to the meaning of integrated planning, at least not to the extent that it has existed for regional and comprehensive planning. For example, we are not aware of any writing that specifically analyzes the idea of integrated planning and its implications. When the term has been used, it has usually been employed with reference to regional and comprehensive planning. However, integrated planning can appropriately be defined as an alternative form of planning which provides an added degree of coordination through the salient distinctions shown in Table 2.[5] The specific emphasis is on coordination of procedures and methods. Further along this same continuum, systems or holistic planning adds still additional analytic and synthesis conceptions. But whereas integrated planning is emerging as an activity that can already be implemented, systems planning needs to be further developed before it can be applied.

To obtain a more detailed conception of integrated planning it is useful to examine the requirements that need to be met in large-scale, basin-wide planning. Broadly interpreted there are two basic requirements. These include:

1. Improved coordination of an increasingly diverse variety of human activities.

2. Interrelation and utilization of larger amounts of information.

With respect to the integration of water and land planning these requirements have the following implications for a working concept of integrated resources planning:

1. An integrated plan must explicitly identify the factors and interrelationships, including the relevant information and knowledge, that form the basis for planned and implemented activities defined in relation to resource use goals.
2. The degree of interaction among activities that is made explicit as part of the planning process should be logically related to the degree of coordination that is needed, which in turn depends on the complexity of the planning issues and the goals that need to be achieved.
3. Procedures and methods are implemented in such a way that the interrelationships among resource use decisions and resulting actions at all levels are identified as clearly as possible and represent an optimum decision set in terms of the public interest.[6]

Operationally, these statements can be interpreted in a number of ways. Nevertheless, their fundamental operational sense is that, ideally, resource use decisions and actions for a defined region are compatible and congruent with one-another in terms of an explicitly identified set of values and objectives. The necessity for studying the issues and processes involved in approaching an integrated planning ideal can be demonstrated by identifying and examining the difficulties that presently confront planning efforts.

[5] The distinctions can be much more refined, and the types of planning can be defined differently. Specifically, it can be argued that both regional and comprehensive planning involve the other types of coordination. We hold, though, that the distinctions are representative of the differences that have existed as planning developed, particularly as it has been practices. At the same time, we recognize that regional science as it has been advanced would be virtually the same as integrated planning.

[6] "Public interest" is an agreed resolution among the values of affected interest groups.

Table 2. Distictions among forms of planning.

Forms of Planning	Planning Emphasis and Scope: Geography	Function	Procedure/ Methodology	Analysis/ Synthesis
Regional	X			
Comprehensive	X	X		
Integrated	X	X	X	
Systems	X	X	X	X

The Case for Integrated Resources Planning

The arguments that establish the rationale for integrated resources planning can be made in terms of four basic concepts:

1. Ecological balance
2. Equity
3. Effectiveness
4. Efficiency

The latter three concepts have been generally used in arguments for improved regional planning and increased coordination. They have also been used to make a case for centralized planning, but this does not mean that integrated planning necessarily implies centralization, although it does involve coordination.[7]

The need for ecological balance at all levels and its importance to planning have been long-recognized (Johnson, 1970; Odum, 1969; Isard, 1975; McHarg, 1969; National Water Commission, 1973; Meadows et al., 1972; Mesarovic and Pestel, 1974), but it has not been explicitly analyzed in relation to the organization and process of planning, although Cooper and Vlasin (1973) discuss certain basic institutional questions. The materials balance approach developed by Kneese, Ayres, and d'Arge (1970) represents a methodological extension of the ecological balance idea into the economic sphere. In related work, INTASA (1976) has shown "how a water balance relationship can be a key integrating force in a regional planning effort conducted by various agencies." Another similar concept, that of carrying capacity, has also been employed in integrating resources planning.

The ecological balance argument for integrated planning is based on the observation that separate, uncoordinated planning activities are likely to lead to an imbalance in resource use because the availability of one resource in a natural ecology is closely related to the use of another. This interdependence among resources may be less clearly delineated or understood if separate planning activities are undertaken for single resources and individual localities. For example, planning for energy development in the Uintah Basin, if it is not closely tied to land and water planning, could well result in undesirable land use patterns and unforeseen water shortages. Similarly, the intensive use of a resource in one area, such as oil shale in the Uintah Basin or agricultural land in the Imperial Valley of California, might prevent the use of another resource in other areas: for instance, coal in Southern Utah or agricultural land in Arizona. Thus it can be argued that integrated resources planning is necessary to achieve and maintain ecological balance, and thereby optimize resource use and insure that the carrying capacity of a region is not overtaxed.

The concept of equity assumes that there is some fair or just distribution of resources to individuals, groups, organizations, and society. The nature of this distribution is politically defined and constrained by various traditions. Planning activities strongly affect resource distribution, so that the equity issue is a matter of some importance in the planning process. Questions of equity are becoming increasingly important, and also very difficult to resolve, as resources become more scarce. Fragmented, uncoordinated planning in an interdependent resource system frequently results in spill-over effects that change the distribution of resources. Individuals and groups can lose access and rights to resources that they need or want and may initiate court cases. The increasing use of litigation in recent years to deal with resource use conflicts demonstrate to some degree the lack of planning and policy development. But court cases may represent only a small fraction of the equity conflicts that actually occur. For example, many individuals and groups are unable to represent their interests before the courts. The resolution of inequities in the existing resource use system will to a significant extent depend on improvements in the planning process that require more coordination and better integration of planning activities.

[7]Centralized planning refers to activities that are organized under a single authority, while coordinated planning refers to activities that are organized cooperatively among several authorities.

Effectiveness and efficiency are perhaps the most familiar criteria used to argue in favor of integrated resources planning. Effectiveness is a measure of the accomplishment of desired functions and goals. Efficiency is a measure of the accomplishment per unit cost in achieving specified functions and goals. Both criteria must take into account the level and scope of the various functions, goals, and objectives that can be identified in the planning process. The two concepts also involve an analysis of the methods, procedures, and institutional arrangements that can improve planning.

The distinction between effectiveness and efficiency is often not made explicit. For example, both criteria enter into the problems identified by the National Water Commission concerning functions of federal water agencies (1973:409-413):

> A number of problems involving duplicative, unnecessary, or unintegrated functions of certain Federal agencies in the water resources field have been called to the attention of the National Water Commission.

Three problem areas were identified: 1) data collection and dissemination, 2) duplication of engineering functions, and 3) scattering of water technology functions.

The criterion of effectiveness as related to the need for better integrated planning basically involves two types of problems: 1) the resolution of conflicting functions, goals, and objectives, and 2) coordination and cooperation. These two problems areas have been particularly well-described by Senator Jackson when he first introduced the National Land Use Policy in 1970:

> (Re conflicts among different federal programs.) These conflicts have resulted from a lack of coordination; a failure to relate national programs to local aspirations; and institutional inability to factor in the full range of national and local values as part of the planning process for specific Federal projects.
>
> (Re coordination and integration.) Most of these plans are necessary and desirable. The problem is this however; to date, no one in the Federal government has <u>ever</u> put these plans together to <u>see if</u> they are consistent, to see if they make sense, and to see if they are compatible with local goals and aspirations.

The criterion of efficiency as pertaining to integrated planning primarily involves issues of duplication and overlap, but also concerns the added costs that may result from unnecessary projects or planning mistakes. In the prior case, separate planning activities often duplicate efforts and overlap activities in ways that can be reduced by improved coordination. The collection of overlapping data sets and the construction of interfering or competing projects provide example inefficiencies. In the second case, arguments can be made that independent planning activities can operate at cross-purposes and can result in errors that might be avoided if planning were more integrated. For example, one agency might fund the construction of sewer facilities that stimulates population growth and industry in an area, whereas another builds a dam for irrigation to encourage agricultural development, while insufficient water is available for both purposes.

In summary, the goals of efficiency, effectiveness, equity, and ecological balance combine to make a strong case for integrated resources planning. Although movement in such a direction has been taking place, it has not been enough. Forces toward fragmentation and conflict exert a strong pressure on the system and exact a high toll from our resources. If we are to deal adequately with our social and resource needs, it is evident that we must develop and strengthen the institutions and methods to integrate resources planning. We must strengthen coordination without creating a bureaucracy that becomes so focused on procedures as to be unable to achieve the declared goals of efficiency, effectiveness, equity, and ecological balance.

CHAPTER 5

CONCEPTUAL AND PHILOSOPHICAL ISSUES AFFECTING LAND AND WATER PLANNING

The way a society relates to the natural environment depends on its state of economic and technological development, the nature of its economic base (mining, farming, fishing, industry, etc.), and the attitudes of its members toward nature. Environmental attitudes depend on the concepts and philosophical perspectives concerning the elements of nature. These perspectives affect and are affected by, perceptions and motivations that govern humnan activity. A philosophy of water and land planning must therefore consider the interrelationships among resource concepts and human interactions with the environment. If the goal of resource planning is to develop some optimal balance between human needs and the use of natural resources, the concepts that fundamentally affect this balance must be examined.

Perceptions and attitudes are seldom clearly defined. We know that different cultures perceive their environments differently and that differences in perceptions exist within the same culture. We know that the farmer views his acreage differently than the suburbanite his quarter-acre plot, and the latter in turn sees his land differently than does the artist his landscape or the hiker his woods. Even when differences can be defined, it may be difficult to understand their origins. Still, some useful generalizations can be made about alternative conceptions of land and water.

Two basic dimensions characterize man's relationship with nature, one ecological, the other philosophical or conceptual. The ecological dimension measures elements of the natural environment, which can be used to satisfy human needs with the available level of technology, on a scale which ranges from scarce to abundant. The philosophical dimension measures the degree of hierarchy in man's conception of his relation with nature. At one extreme man's dominance over nature is seen as absolute, and his role as exploitative. Western culture tends to this extreme. At the other extreme, nature's priority over man is advocated. Hindu culture exemplified some aspects of this view.

These two dimensions of man-nature relations have important ramifications for the way resources are used and are therefore fundamental to any planning approach that tries to interrelate water and land planning. Figure 2 illustrates how water might be used in systems dominated by the different ecological and philosophical dimensions of man-nature relations.

The Ecology of Land and Water and Human Society

Land and water form major links in ecological systems, which require the use of nutrients and flows of energy to maintain themselves and which provide the basic support for human society. In order to develop and use land and water resources in accordance with the ecological principles that assure sustained support for human society (National Water Commission, 1973:20), resource planning must be based on an understanding of the linkages involving land and water in ecological systems.

The most fundamental interrelationships in ecological systems are among populations of organisms and the forms of energy such systems evolve. Five ideas are basic to an understanding of ecology: interrelationship, population, energy, succession, and complexity.[1] Interrelationship as a concept refers to the mutual influences that operate among the parts of an ecological system such that a change in one part affects the other parts. Population identifies the living organisms that occupy various niches defined by the available energy or material resources. An ecosystem evolves by capturing and maintaining a flow of solar energy through cycles of resource utilization. As the pattern of energy flow changes in some fundamental way, the system changes and ecological succession takes place. Generally, ecosystems develop from less complex states to more complex ones, where complexity can be defined in terms of the number and diversity of interrelationships.

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[1]The literature on ecology is extensive. Some useful writing concerning the present analysis include Cody and Diamond (1975), Commoner (1970), May (1973), and Odum (1970).

Philosophical	Ecological	
	Scarcity	Abundance
Man's Dominance Over Nature	Strong competition for water where use is determined by actual control or possession by force.	Less competition over water within a legitimated system of water rights
Nature's Dominance Over Man	Religious ideas and sanctions govern access and use of water	Common access and use of water with little systematization of ideas about control or use of water.

Figure 2. An example of possible relationships between ecological or philosophical characteristics in determining water use.

Land and water planning should be tried to ecological processes, as has been persuasively argued, for example, by Commoner (1970). The imperative for an ecological approach to planning is the pressure on society resulting from the web of interrelationships among natural environment, human population, and technology. At the general level, ecological planning, and therefore land and water planning, is concerned with the control of succession (growth, development, evolution) and complexity by regulating the patterns of energy (land, water) use in an ecological community, including human beings.

The segmented approach that has characterized traditional resource planning needs to be supplemented by the more comprehensive holistic perspective implied by ecological planning. What are the knowledge requirements and institutional conditions necessary for such planning? Progress in environmental and ecological research has been significant in the last ten years. Our knowledge about the processes, stability, and development of ecological communities has been rapidly advancing (Cody and Diamond, 1975; May, 1973). Understanding of the social processes as these affect the welfare of the natural environment and society has been improving slowly. The lag between 1) the need to implement social institutional processes and mechanisms for dealing with ecological problems and 2) our knowledge of the processes and mechanisms that are appropriate has been increasing and may become critical. The research described in this report addresses the broader ecological concern by examining a methodology to better integrate land and water planning.

Figure 3 shows how the ecological ideas that have been discussed can be applied to land and water planning by depicting the interrelationships among the natural, human, and technological components of an ecological system. The salient ecological features of

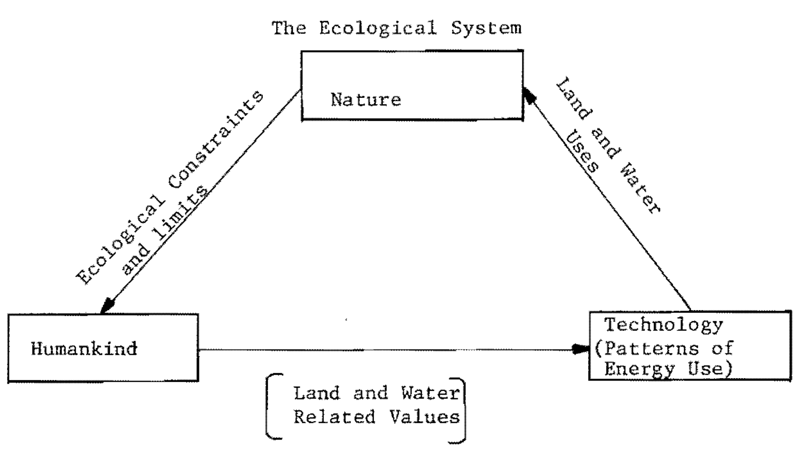

Figure 3. Ecological context of land and water planning.

human societies are the values that are held and the way these values affect the pattern of energy use. The concept of value is useful when it is employed to depict the relationship between a human population and its technology, which represents the means for extracting energy from the natural environment in terms of resource uses. The concept of value is also important because it is basic to an understanding of human behavior. It follows that an effective resource planning effort must not only be based on an analysis of resource uses but must also focus on the role of values in shaping the behaviors that relate to those uses. The large majority of planning efforts have not given sufficient explicit attention to the impact of values.

Philosophical Perspectives Affecting Concepts of Land and Water

Human cultures develop as adaptive responses to the problems of collective survival posed by the local natural environment. Societies selecting certain behaviors from the much broader range of possible behaviors. At the core of the selection process lie the philosophical perspectives, or fundamental assumptions, of reality. Values are abstract expressions of philosophical perspectives. Values are conceptions of what is desirable in states of affairs and ways of living. Values thus establish action-guiding relations between individuals who subscribe to them and the objects towards which attention is directed. Values assume their central role in rational action through the medium of language. Through language, values can be communicated and clarified, and alternative actions and their consequences can be contemplated before actually performing them. Perceptions of change in the natural environment, whether induced by human action or otherwise, attain significance and coherence as instances of the concepts expressed in language that are elements making up philosophical perspectives. Figure 4 outlines the relational network that binds human beings to their environment. An examination of the philosophical perspectives that affect resource concepts is especially pertinent because society is entering a new ecological relationship with the natural environment. We need to ask what conceptions of resources and resource use are most appropriate for modern society. Specifically, we are here concerned with the analysis of land and water concepts and their implications for an integrated approach to land and water planning.

What are the fundamental ways of relating human beings to their natural environment and how do these relationships affect institutions? This question is basic to any analysis of resource planning approaches. It may be answered in a general manner by examining the implications of Figure 4 and by identifying the nature of institutions. Institutions consist of roles defined by rules of behavior that govern human interactions in a socially defined area of concern. Institutions thus reduce uncertainty by specifying the actions open to individuals in specified circumstances and promote collective action in pursuit of common goals.

By combining this definition of institutions with the concepts discussed earlier, Figure 5 outlines some basic interrelationships among physical environment, technology, and social environment. The important point to be emphasized in the diagram is that there are two paths by which the impacts of resource utilization are perceived. The one that is likely to dominate is labelled consumption because its organizing concept is the satisfaction or attainment of the particular goals sought by an application of technology. The other path is generated by the impacts on the natural environment generated by applying the technology to increase consumption. This source of perceptions may in practice not be adequately considered in decisions to employ a technology because the effects of technological by-products may be poorly under-

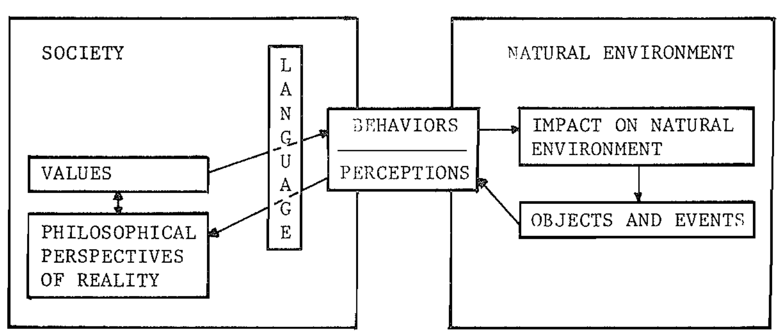

Figure 4. Relevance of philosophical perspectives and values in the environment and man relationship.

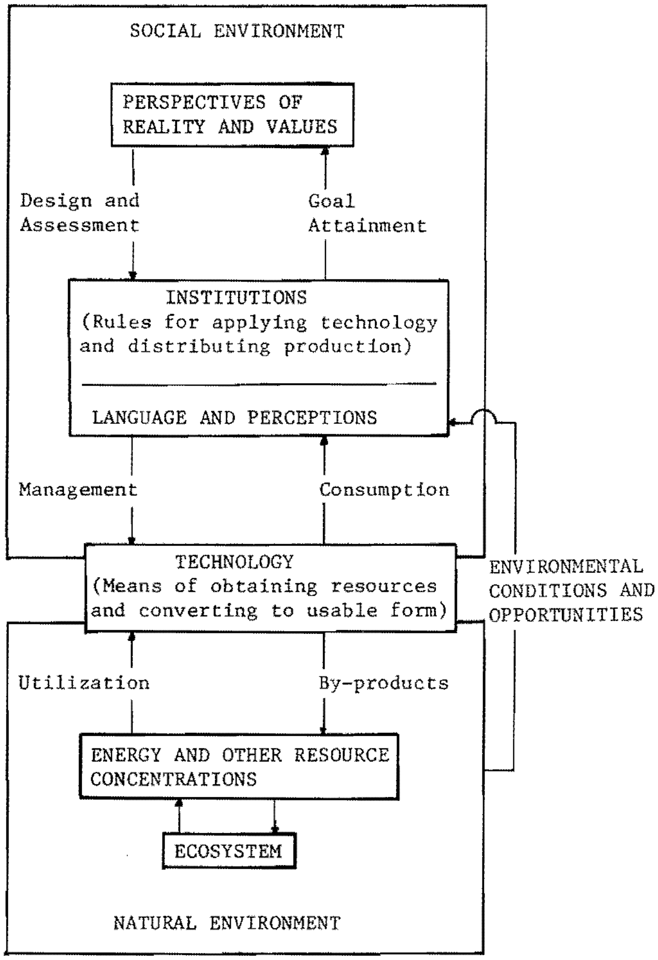

Figure 5. Basic interrelationships among natural environment, technology and social environment.

stood, dispersed in time and space, or not directly related to the goals pursued by the decision maker. However, since the impact of technological by-products affects subsequent environmental opportunities undesirable consequences may follow from allowing decisions on technology applications to be determined by efficiency in achieving narrowly defined goals.

If we accept the analysis implied by Figure 5, we can then redefine the basic resource planning task as the determination of the rules of interaction that relate our society to the natural environment. This leads us to study the implications that ecological and philosophical/conceptual perspectives have for the rules that govern relevant man-nature relationships. In terms of the present study, the focus is on the physical and philosophical meanings of land and water.

Land

What are the meanings of the term "land," and what are the implications of its various meanings for resource planning? Perhaps the best way to approach this question is to determine what kinds of distinctions can be made when one refers to land. Specifically, it is useful to identify the distinctions that are consciously made by society in the way its members relate to land. There are at least four important definitional perspectives that a society can adopt with respect to land, namely: 1) a non-distinct element of nature, 2) a territory or domain, 3) a resource, and 4) an element in the ecology of human development.

The concept of land is least distinct when land is simply considered to be an element of nature, and no other meanings are attached. In this sense, land is seen in much the same way as air is usually perceived. The concept implies that there are no institutions, no social rules, that govern how an individual should relate to land as a separate entity in the natural environment. The relationship between a human and land is entirely and purely physical, based on sustenance. This idea of land can probably only exist among very primitive human groups, if it exists at all.

When human groups compete for space, the idea of land as a bounded surface area becomes socially relevant. The notion of land as territory or domain is a natural result of the need to establish claims over the area from which a group derives sustenance under conditions of scarcity. At this early developmental stage, the interrelationships among the various social and ecological concepts are already evident, demonstrating their fundamental significance.

Scarcity is a state defined by the interaction between a population and the energy available to it, taking into account available technology. Scarce resources become valuable as they are controlled, and control when applied to land leads to the notion of territory. The concept of territory gives rise to the rudiments of social institutions. For example, among sedentary groups, territory becomes a basis for social identification and the emotional ties of some peoples to their land, not simply because of the familiarity (motherland, fatherland) of the "homeland," but also because of the feeling of belonging with the land.[2] The beginnings

[2] For example, the popular song "This Land Belongs to You and Me" refers to land in this sense. The "belonging" referred to in the lyrics clearly does not make a property or ownership claim.

of political and legal institutions can also be associated with the notion of territory. Territory implies a claim of control over an area, which further implies the two basic political functions of external defense and internal regulation. Legally, for example, the phrase "law of the land" refers to the highest inclusive law, demonstrating that territorial boundaries are the prime determinants of legal jurisdiction.

A further analysis of the concepts of territory and scarcity makes the conceptual and social significance of land even more apparent. In the territorial meaning of land, we find the beginning of a concept of property. The basic element in the idea of property is the notion of exclusive discretionary use. The owner(s) of property claim(s) the right to exclude others from its use (or to determine who may use it and how it may be used). Land as controlled territory therefore became one of the earliest forms of property. The ideas of scarcity and territory combine to imply another socially and ecologically important concept, namely that of competition. Of course, property and competition are concepts fundamental to economic institutions.

An important feature of the concept of land is that it exhibits the characteristics of what is known in logic as a "mass term." The primary feature of such terms--including terms like "water," "gold," and "air"--is the lack of an individuating or measurement standard inherent in the term itself. For example, if one tract of land is added to another, one does not say that there now are "two lands." This can be contrasted with words that are logically called "count nouns," such as "chair," "house," and "apple." Thus, if one chair is added to another chair one can speak of two chairs. The measuring standard is included in the grammar of count nouns but not in that of mass nouns. The point is that mass terms are "countless," by definition so that their measurement must be conventionally or socially determined. That is, social rules must be devised to individuate or partition such elements as land or water.

In most societies, land was originally partitioned by meters and bounds defined by rivers, ridges, landmarks, etc. Because prominent land marks change over the years, surveying techniques have been developed that permit partitioning land in reference to a selected point of reference. Another advantage of such a standard is that it does not ordinarily interfere with any use of the land, including further subdivision. We can observe then, how nicely partition by area fits traditional notions of property, particularly as a commodity. In the traditional American interpretation, to own a piece of land is to be entitled to do practically anything to it, so long as such use does no harm to another (in a fairly direct way). Among the things that one might do with the land is to sell all or part of it, so that it becomes a commodity in a market economy. One ramification of the view of land as a divisible property or commodity is that it localizes the orientation of land-related regulations because very large tracts of land are not as easily bought and sold.

The development of the ideas of land as a property and commodity is based on the definition of land as resource coupled with a belief in man's dominance over nature. Land is perceived to become more valuable to the degree that it can be exploited. Technological innovation takes on more significance because it provides the means for increased resource exploitation. The concept of land as resource becomes more pervasive as technology develops. At the same time an increasing number of distinctions must be made with respect to land because there are more ways of using and being aware of it. For example, more distinctions need to be made between land as such and various types of resources "under" the land, above it, or next to it. As a result there are increasing pressures to devise more and more rules governing resource use. Difficulties become compounded when issues of scarcity arise, as is presently the situation in American society.

Figure 6 suggests a pattern in the changes in conceptual perspectives of land by stages of societal development. The suggested pattern is that we have entered a new phase of societal development which necessitates an holistic, ecological conception of land and of natural resources in general. The articulation of this new conception of land is induced by the increasing scarcity of good unused land--by the recognition, in other words, that land is a limited resource. A parcel of land comes to be viewed as a resource to be used in accordance with the impact on its capacity to support other uses, and on the availability of other parcels for those uses.

This conception has major implications for resource policy and planning by changing the analytical and methodological approaches that must be adopted for integrated land and water planning. Specifically, more attention must be given to policy/planning ramifications of the institutional mechanisms and processes that will be needed to define the types, means, and rules of interactions affecting man-nature relationships.

Water

The conceptual development and related attitudes on water planning are quite different from these on land, although certain basic similarities exist. As might be expected, the primary differences in conceptual perspectives can be traced to physical differences that relate human beings. Man's tie to water is physiologically more direct than to land. If this appears to be a small distintion, its relevance is quickly

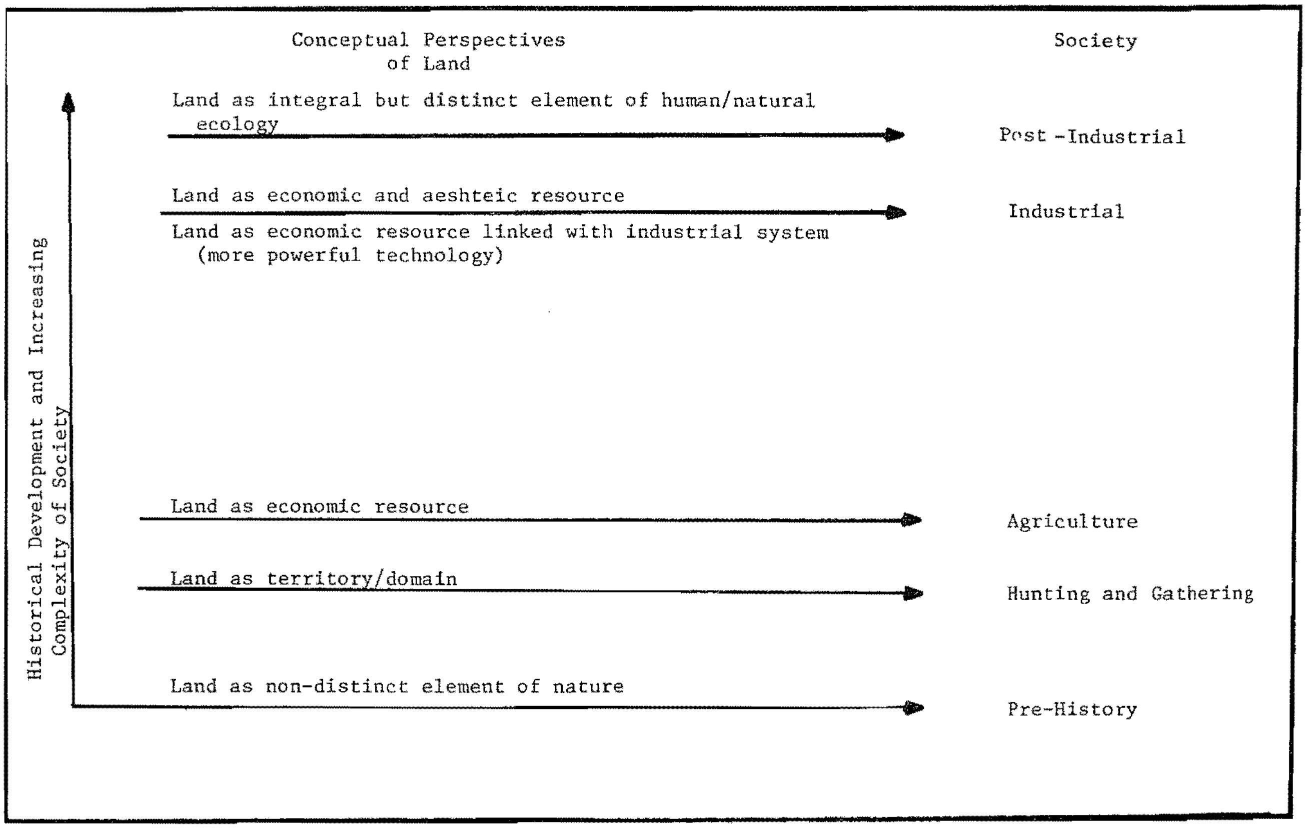

Figure 6. Perspectives of land concept as related to societal development.

made clear by an extended stay in the desert with little water. As a consequence of our regular need for water, the meaning of its availability to society has not been as much influenced by cultural and technological changes as has been the meaning of land. Until recently, conceptual/ philosophical perspectives about man-nature relations have had relatively little impact on our conception of water, except in cultures and areas where water scarcity has been prevalent. Because of our physiologic need for water, our conception of it has been more distinct and tangible than that of land. Whereas the meaning of land has been closely related to economic and social conventions, ideas of water in almost all cultures have generally been more utilitarian. For instance, water has usually not been associated with such ideas as status, attachment, or patriotism, although there have been a few cultures, such as those of the Australian aborigines, where concepts of water have had an important religious significance. Most cultures define water in terms of its use as a substance. In this sense, the concept of water has been more similar to the idea of food than of land.

An important factor that accentuates the differences between water and land is water's unique, fluid nature. Water flows, drains, and evaporates. It is more difficult than land to capture and hold as property. It is difficult to claim ownership over a specifiable amount of water. It is also more difficult to deny water to an individual whose life is at stake. In this context, riparian water rights are derived from ownership of adjacent land. Even under conditions of scarcity, the idea of water as private property is not prevalent. For example, in the American West individuals do not "own" water but have rights to "shares" of water for certain periods of time.

The conceptual differences between land and water were most salient in our early history. Water was perceived as a fairly distinct element in nature that did not have much territorial meaning other than as it was associated with a certain land area. Therefore, the possession of water did not generally obtain the strong emotional connotations that went with possession of land; however, for agriculture in arid areas, water began to have an important economic meaning, and its possession could be even more important than that of the land that was valueless without it. With technological advances and the industrial revolution, water has become an increasingly important economic resource and has also taken on significant aesthetic meanings.

At present the demand for water is considerable. In the United States, water withdrawals in 1900 were about 40 billion gallons per day (Picton, 1960). These increased to 370 billion gallons per day in 1970 (Murray and Reeves, 1970) and are projected to increase to 1,368 billion gallons per day by 2020 (U.S. Water Resources Council, 1970). Water scarcity has become a major concern as projected use approaches hydrologically limited supply. The many different demands for water have made its allocation among those who want it a critical factor affecting man's natural, economic, and social welfare. Because of the resulting interrelated and interdependent network of concerns, water, just as land, must be conceptualized within a more holistic, ecological perspective.

Toward an Integrative Conceptual Perspective of Land and Water

The basic aim of planning is to insure that desired values are fulfilled or impacted in a certain way. Thus, in land use planning we may want to create space for activities we consider important while in water planning we may desire to insure adequate water to grow our food. If the important values can be met "without a plan," then planning is not necessary and will not occur. Therefore, planning can be defined as the design of interventions which modify existing trends to effect desired impacts on our values (see Mulder, 1974). Two types of interventions are possible: 1) changes in the physical/natural environment and 2) changes in human behavior. Basic constraints are of the same two types--physical and behavioral. At a given time and in a given situation it is beyond our will or power to modify certain aspects of the physical environment or to change certain behaviors and our alternatives for choice become constrained.

As technological advances occur and societies become more complex, change takes place more rapidly and trends become increasingly more difficult to predict. The need for planning increases, but it becomes more difficult to plan and more difficult yet to implement those plans. Planning becomes more difficult because system components become more interrelated and interdependent. Any intervention or planning effort that focuses on only one part of the system is likely to have undesirable effects on another part. The only way to avoid the problem is for land and water planning to be integrated. How is this to be accomplished? Ultimately planning can only be more integrated or systemic if its focus is more fundamental and generalized, and therefore more abstract. Specifically, planning needs to focus on basic economic, environmental, or social values to be obtained by land or water resource use and to move from the arena of controversy over the uses themselves.

The greater difficulty in implementing plans has come in spite of technological advances that would seem to make construction easier. In part the greater difficulty may stem from the inefficiency of democratic institutions in achieving prompt resolution of more complex and hence more controversial issues. More basic causes that can be suggested are the greater difficulty of determining equitable solutions in more complex situations and the greater difficulty in managing more complex systems. These last two difficulties are probably the dominant problems that must be overcome for more effective water and land planning.

The situation can also be represented in terms of the relationships depicted in Figure 7. Planning aims to institute certain arrangements, means of interacting (technology) and rules of interacting (institutions) among human beings and on the physical environment. These arrangements, cooperative and/or competitive, are designed to affect the physical environment and/or the human culture. The concepts that are operationally most basic in pursuing these aims are <u>resource use</u> and <u>value</u>. Actual achievements of desired resource uses and values in our society depends on ecological constraints and conceptual perspectives.[3] An integrated or more comprehensive planning approach must not overlook any of these relationships, as shown in Figure 7.

In summary, an approach that will achieve the benefits people want from their land and water resources must integrate land and water planning. In order to achieve these benefits in the long run, the planner must evolve an ecological, systems perspective concerning the natural environment and must similarly include the consideration of philosophical and cultural factors. Of course, planning has in theory long advocated a general ecological approach, but has given little attention to the significance of concepts and values, particularly as these affect plan implementation. Actual planning practice has tended to lag behind the theory to a significant extent.

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[3] For an interesting discussion on the interrelationships between physical and cultural factors affecting resource planning see Bennett (1974).

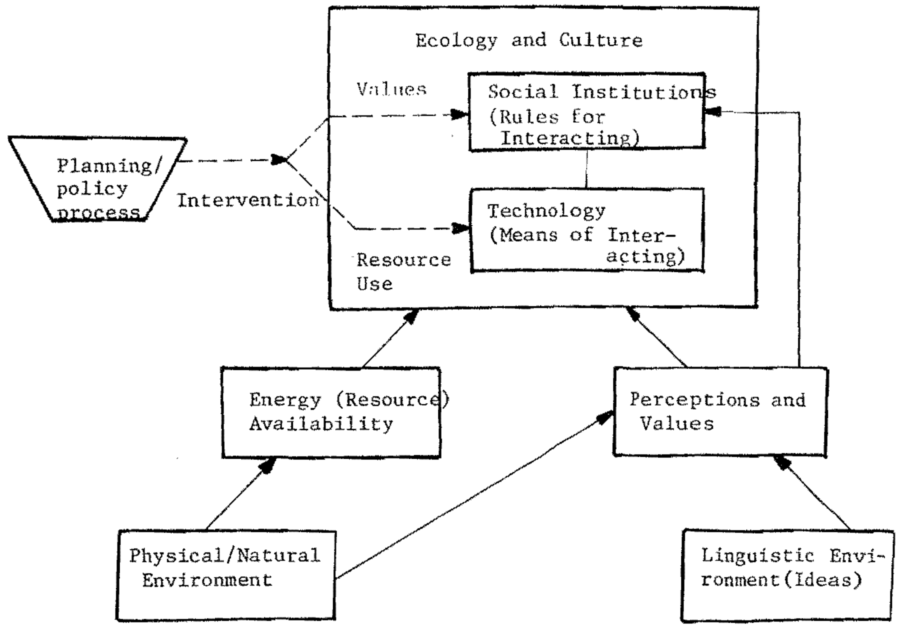


Figure 7. Planning as an intervention process to direct the basic interrelationships among natural environment, language (culture), and social institutions.

CHAPTER 6

INSTITUTIONAL AND METHODOLOGICAL IMPLICATIONS FOR INTEGRATED LAND AND WATER PLANNING MODELS

In order to develop an approach or model that can effectively integrate land and water planning, it is important to identify the forces and factors that need to be included. Some background was developed in Chapters 5 and 6 where it was argued that, given certain human attitudes and limitations on resources, technology results in increasing the scale of management decisions and the interaction among them and that environmental protection therefore necessitates complexity and change necessitating a more holistic planning approach. Chapters 2 and 3 showed that land and water planning now require actions by government and segments of society that have not been traditionally involved in collective decisions on land and water use. This chapter attempts to translate the institutional and methodological implications of these findings into specific approaches for integrating land and water planning.

The arguments supporting integrated land and water planning are based on the following assumptions: 1) improved technology increases the possible ways to use resources, 2) improved technology increases the number of interactions among the use of resources, 3) technological improvement generates more impacts that have irreversible negative effects, 4) values and attitudes are the fundamental delimiters that govern the adoption of technology and hence the extent to which resources are used and exhausted, 5) human values and attitudes are formed by individuals interacting with their culture in the course of becoming members of society.

These five statements provide a basis for determining the type of resource planning that needs to be implemented in modern society. Statements 1 and 2 establish a rationale for a more comprehensive integrated approach to planning resource use. Statement 3 emphasizes the urgency of improved planning to control factors that could have disastrous future consequences. Such control can only be effective if potential irreversible negative effects are recognized and prevented and that will be easier to achieve if a holistic integrated resource planning perspective is adopted. The critical point is that human perceptions and demands drive the use of land and water resources. Therefore these need to be influenced not necessarily through planning advocacy or control, but preferably through information dissemination, clarification, and participation.

The implications of the above statements are subtle and complicated. The relevant issues include basic theoretical questions on the structures and policies of modern society and the resulting trends as well as practical applied questions having to do with such matters as the technology of water pollution control. How can a planning approach be developed that takes into account all the many factors and variables that relate to land and water use? Our study only deals with part of the question. It is concerned with the identification of the salient factors and parameters that affect land and water planning, and the development of an operational planning model that can assist decision makers in organizing complex information.

The next two sections of this chapter present an analysis of the institutional and methodological implications of resource use in our society for integrated land and water planning. The discussion on institutional implications will primarily focus on the human and organizational factors that affect resource planning. These include culture and related behaviors of individual human beings, the decision makers who control the direction of the planning efforts and the resultant outcomes, organizational patterns, and the rules that are designed and implemented to govern resource use. The section on methodological implications will examine what the appropriate methods and techniques for integrated resource planning should be, given the basic resource use trends in modern society. The methodological analysis will prepare the groundwork for the discussion of the Integrated Resource Use Model (IRUM), which will be introduced in the final section of this chapter.

Institutional Implications

The arguments in Chapter 5 emphasized the central role of social institutions and culture in determining land and water use. Their importance has been recognized by most social scientists, but that recognition has not had much impact on planning practice. Planners and decision makers have tended to take the cultural context and the institutional situation as given, without examining whether these should be modified or changed. Consequently, planning has put more effort into accessing more resources to satisfy the requirements of current use rates than into using available resources more efficiently. In a resource-abundant environment, such emphasis may be justified; but as resources become scarce, cultural preferences and institutional practices must change. Planners have an important contribution to make so that those decisions will be as wise as possible.

To understand why the analysis of cultural and social institutions is becoming crucial to resource planning, it is useful to examine how resource demands change as technology improves. In primitive society, the demands for resources occurred in a cultural and institutional context where the basic interest of the group and individuals was survival. The introduction of more sophisticated technologies created a fundamental change in the nature of resource demands. Because technology enables society to exploit resources more easily, efficiently, and effectively, the fundamental survival demands were more than met and the basis for resource demands shifted from one of need related to survival to a basis of want related to culturally determined values and beliefs. As a result, <u>the interest of the group or of society defined in terms of survival</u> is not necessarily congruent with private interests that are defined in terms of cultural wants, norms and values.

It is the responsiblity of planners and policy makers to insure that the private demands for resources do not threaten the public interest. There are basically two ways to influence or control private demands: 1) Educational institutions, such as the family, media, and schools, can influence individuals to exercise voluntary restraint, 2) governmental institutions can influence individual actions through the enforcement of public laws and regulations. Of the two, voluntary changes in behavior are much to be preferred and considerably more effective, Planners need to focus on stimulating voluntary individual behavior in the common interest. Policy makers and planners have recognized this to some extent by placing increasing emphasis on public involvement and participation. But their efforts are not likely to be successful as long as the socialization process encourages attitudes and behavior inappropriate to the reality of limited resource supply. More attention needs to be given to how the planning process, and the alternatives chosen by it, can affect values and attitudes towards resources. This approach to resource allocation has yet to be attempted in any comprehensive, systematic way.

In order to understand the obstacles to integrating land and water planning, four institutional aspects of society need to be examined. These include: 1) the complex of values, attitudes, and behaviors affecting land and water uses, 2) the background and knowledge base of decision makers and planners who develop and implement plans, 3) the organizational patterns in resource planning, and 4) the regulatory and legal system. Each institutional aspect needs to be examined in relation to patterns of resource use and access to resources.

This examination begins with a description of the existing institutionalization of planning and processes practices so that the existing system can be compared with the type of system needed to achieve integrated planning. Such comparison identifies differences and hence the difficulties and obstacles to integrated planning in the existing institutional patterns and ultimately their effects on resource use. By examining these differences, the institutional implications for integrated land and water planning become clarified and can be analyzed.

Culture and Individual Values, Attitudes and Behavior

Culture is the sum total of the ways of living built up by a group of human beings and transmitted from one generation to the next. It is the aggregate expression of the concepts, values, beliefs, and attitudes of the individuals in a society that determines group behavior and governs interactions among individuals. Culture influences the development of languages and the expression of ideas. Chapter 4 described how cultural differences relate to difficulties that water and land resource planning groups have in interacting with one another. The point of this section is to discuss how both planning groups are affected by their conceptions of the relationship of man to nature.

One of the pervading themes in western culture since the industrial revolution has been a belief in the dominance of man over nature, a conception of technology as a tool whereby man can dominate nature to obtain what he wants. Separate application of this common conception to land and water planning separates the two planning efforts because the two resources are generally seen as meeting different needs. If technology can develop the space man needs to grow food and support urban activity from available land resources and separately develop the water man needs for homes, agriculture, and industry, there is little need to integrate the two; and this view is widely held among the public and even among planners in both groups.

More recently a counter theme that we are reaching the end of the economic expansion that technology can achieve from our limited available resources has gained widespread acceptance. This theme logically leads to prediction of impending disaster unless water and land planning are coordinated from a holistic, ecologic perspective. If technology cannot supply increasing human wants from available land and water resources, we must very carefully plan our use of both to maximize what we can achieve. We must reduce our wants to what we can provide. Planners must seek ways to change basic cultural values so that mankind won't destroy basic resources through overuse.

As is often the case, the truth does not lie in either extreme position. Technology can increase what we can produce from our land and water. Important physical constraints, however, limit what we can do; and important economic constraints limit what we can afford to do. Already the counter theme of the last paragraph is meeting opposition from the poor who see a slowing of economic growth as means of the middle class for holding them in perpetual poverty. They ask how can we stop the technological progress that has brought millions out of poverty while other millions are still there.

What is the reasonable role for land and water planning in this context? It is to determine what more technology can do for us and work out the details to implement what progress is possible. It is to determine what technology cannot achieve (at least for the present) and to counteract public beliefs and attitudes that would seek the impossible. How does this relate to cultural constraints? When prevailing cultures favor extreme positions, planners need to moderate extremism by presenting facts. In the final analysis, nothing makes planning implementation more difficult than a prevailing culture that believes in achieving its goals through ways that good planning can show will not work.

As an example of the implementation problem, many planners saw a necessity to reduce petroleum consumption by reducing highway speeds. Most of the public, and in fact if one had good data perhaps even most planners and environmentalists, do not believe the situation is serious enough to require them to comply with the 55-mile-per-hour speed limit. Without a supportive cultural base, widespread changes in resource use patterns cannot be ultimately successful. The reason for this is that culture determines individual values, attitudes, and behaviors. For example unless the culture creates an holistic ecological perspective in individuals, their actions will not be responsive to environmental pressures until predicted problems become realities. At present, our values, attitudes and related behaviors are want-based and luxury oriented. Where environmental constraints make it undesirable to achieve these wants, our behavior should become more need-based and sufficiency oriented to achieve the better balance between human demands and nature's resources availability.

The review of water planning factors in Chapter 2 showed that water planning has relied primarily on structural measures to develop the resources. In contrast, Chapter 3 showed that land planners have emphasized legal and regulatory means to control resource use. In the short run, both techniques have produced acceptable results. Nevertheless, in the long run, both approaches are bound to fail if individuals don't curb their insatiable demands for more water and internalize the values that underlie the laws and regulations that have been enacted. This means that planners and policy-makers need to make individuals more aware of the resources consequences of their values, attitudes, and behaviors. Specifically, individuals should know more about trade offs and opportunity costs involved in alternative resource uses. Only when this awareness is present throughout the society, can there be an adequate cultural foundation for successful integrated resource planning.

Perhaps it is at this point that market planning can make its greatest contribution. Few signals are more successful at catching public attention than high prices for goods that could once be obtained for very little. Public policy has long held prices for land, water, and energy artificially low so that more could enjoy them. Now we find that all are being overused. A major change in pricing policy would seem to be in order.

Background and Knowledge Base of Resource Planners and Policy Makers

If land and water planning are to be integrated, the individuals making public resource use decisions will obviously have a critical role in getting the two groups of planners together. These decision makers will have to demand information that neither group can develop individually. The integration can therefore be best promoted from an understanding of the planning information really used to make their decisions. Part of the problem is that the persons making resource use decisions are part of the general culture and would, therefore, tend to make the same assumptions that dominate that culture, unless the information the planners provide stimulates alternative perspectives. Currently, most decision makers have little experience that would encourage a comprehensive holistic perspective, and the information provided by land and water planners does not provide that perspective. Consequently, integrative planning has little meaning for public officials. To help planners provide a basis for the needed integration in the information they develop, it is useful to investigate the informational and experiential background acquired by the majority of planners and policy makers.

A good place to begin is by looking into the information and background that would be required to do a good job of integrated planning to develop a standard for comparison with actual conditions. We estimate that successful decision making would require a minimum knowledge base equivalent to at least four years of formal specialized graduate level education in the social sciences, information management, natural resources, and engineering planning plus at least one year of holistic, systems education. Many may find this estimate exaggerated, but nearly 2,500 years ago Plato argued in the Republic that top level planners (for a town of less than 10,000) should be intensively educated until age 30, at which point they would be eligible to serve as apprentices. We submit that the education and experience of the majority of resource decision makers and planners does not come close to providing the needed knowledge base and that this is the basic cause of the lack of success in resource planning.

It is a nearly impossible task to determine how many individuals make resource use decisions at responsible levels in government. Decision makers include federal, state, and local government officials, government planning staffs and consultants, and citizen boards. It seems safe to state that their educational experience varies widely and that it is unlikely to be generalist and holistic in a professional sense if for no other reason than that generalist, holistic education does not really exist, except perhaps at the doctoral level in some universities. Even the education of professional planners tends to be relatively short and narrowly focused. As a result, and given the usual political pressures to do something quickly, most resource use decisions are likely to emphasize specialized short-run considerations.

The experience of the majority of resource use decision makers is likely to be even more narrow and specialized than their education. Most of their work roles are fairly narrowly defined and quite repetitive in nature. We are therefore inclined to believe, for example, that after one year of experience most decision makers would have few significantly different or new insights that would help them make better resource use decisions. On-the-job learning would likely be incremental and be strongly constrained by a specialized, fragmented perspective which would hinder the effective understanding of broader-based, holistic solutions to modern resource use problems. The learning that does take place relates mostly to more perceptive reaction to political considerations in making decisions. Certainly, these comments have been speculative, but we base our opinions on the conviction that informed analysis of most resource use decisions would substantiate our claims. In any case, there can be little doubt of the need for broadening the training and education of planners and professionals with decision making responsibility.

The same reasoning suggests that the educational standards for planning students need to be reoriented and raised. Both formal and continuing education activities should be upgraded to provide a broader, more complete, and updated knowledge base. To insure that individuals possess the needed expertise, guidelines should be established that can provide a framework for planning literacy standards. The public should be stimulated to expect and insist on minimum performance and knowledge standards. Personnel evaluation procedures should be implemented and the possibility or desirability of licensing studied. Only when these types of measures are instituted it is likely that significant improvements in resource use decision making and planning will take place.

Institutional/organizational Arrangements

Improvements in the expertise of planners also requires constructive changes in the patterns that characterize resource planning activities. Present patterns display a diffuseness and segmentation that frequently obstructs meaningful comprehensive planning, characteristics that emerged as a result of a process by which organizations with resource planning responsibilities were established in response to separate specific needs. Consequently, many resource planning organizations that exist in various levels of government have overlapping, competing, and often conflicting responsibilities. For example, in the area of federal water management, a National Water Commission report noted that, "A number of problems involving duplication, unnecessary or unintegrated function of certain federal agencies in the water resource field have been called to its attention" (1973:409). When the entire resource management area is considered, the problem of designing and implementing effective institutional/organizational patterns and linkages is overwhelming.

The main reason for the existing segmentation of resource planning activities lies in political and historical factors that derive primarily from a crisis-orientation context. As Perloff and Klett observe,

> ...Americans have wanted to have the results of good planning in terms of a better environment and more orderly life, but in many cases have been unready to pay the price in terms of limits that planning might impose on money making and of necessitated changes in life patterns--except when conditions become intolerable or when life patterns are seriously challenged by uncontrolled change (1974:162).

The traditional approach has predominantly been to establish agencies or assign resource planning responsibilities as particular problems or needs create a sufficiently strong political pressure to require action. As a result, the many different water and land use planning activities described in Chapters 2 and 3 are characteristically carried out by different organizations and agencies with varied functions, responsibilities, interests, and methodological styles.

There are however, advantages to the existing organizational segmentation. These include broader political representation, more interorganizational checks, and certain economic efficiencies arising from competitive practices. The benefits from pluralistic arrangements are legitimately pursued only if higher costs are not incurred for the public as a whole. It is the planning profession that needs to make the analyses that distinguish when society is better off from pluralistic as opposed to centralized decision making. At least to this extent, the optimal balance will only be achieved when holistic, systemic interests are represented in society's resource planning institutions, and this will require major, and presently not well-understood changes in institutional/organizational patterns. Whether and how needed patterns can be implemented is difficult to determine, and a large number of factors need to be taken into account.

An institutional analysis must take into account the assumptions that are made about the nature of the planning process. Such an analysis should depend as well on assumptions concerning the appropriate model and methodology for integrated land and water planning. That is to say, a thorough institutional design analysis should start by determining what model of integrated land and water planning is most representative and what planning methods and procedures would be implied by such a mode. Then the appropriate institutional/organizational arrangements could be analytically derived.[1]

Ideally, institutional design would involve the following steps:

1. Identify relevant land and water planning variables, constraints, and relations.
2. Identify appropriate indicators and their measures for evaluating a given set of values for the variables.
3. Examine and analyze the land and water planning variables as one holistic system to determine the appropriate resource planning activities that should be undertaken.
4. Examine and analyze the selected set of resource planning activities to identify appropriate institutional and organizational arrangements to make them succeed.
5. Monitor the selected institutional organizational arrangements for effectiveness as measured by the selected indicators.

These five steps present an elementary institutional design process that avoids many complicated issues. Cooper and Vlasin (1973), present valuable, more detailed discussions of some of these issues. Beer (1972) has probably developed the most sophisticated, cybernetics-based, scheme for institutional design so far developed. The theoretical work of these individuals and others must be made operational if better integrated resource planning is to be achieved.

Rules and the Legal System

Perhaps the most significant trend in land and water planning has been the expansion and increasing pervasiveness of new regulations governing resource use. Many of these regulations are creating special problems by requiring the technically impossible (Garber, 1977), concentrating attention on minor problems while severe ones are neglected (Westman, 1977), or being illogical extensions of basic preservational and conservational goals (Whipple, 1977). The obvious reason is that legislators are enacting laws, administrators are coding rules to enforce them, and the courts are residing disputes without sound technical information on the consequences of their actions and without benefit of any integrated or holistic analysis of the situation needing correction. The trend toward uninformed regulatory action bodes ill for the environment that is not really being protected and for the society that needlessly loses valued freedoms and consequently over reacts.

The existing regulatory system is generating increasing tension. Individuals and groups pursue their own interest without limiting their activities in accord with the public interest and their own long-term survival. Government has responded to popularly perceived violations of the public interest by using a direct control approach through laws, regulations, and government enforcement units. Since government has had to respond without benefit of the holistic information required for sound regulation, the process has resulted in a spiraling that

[1]Of course, this type of analytical procedure represents an ideal for heuristic purposes. A large number of constraints operate in reality to limit institutional design options.

imposes wider and stricter controls on more individuals and organizations at a very high cost to society as a whole. It would seem clear that we have passed the point, some time ago, where additional laws and regulations provide a marginal benefit.

The proliferation of laws and regulations has caused numerous conflicts, much duplication of effort, and considerable overlap. For example, examining only the system of federal grants to states and communities, it can be noted that the advisory commission on intergovernmental relations has focused a large part of its effort on providing assistance to the states in finding their way through the maze of regulations, guidelines and forms. The situation, with respect to resource laws and regulations, may be worse. Conflicting and also overlapping agency mandates exist at the same level as well as among levels of government. There is a great need to sort out the way our resource use is regulated and to institute a better working system at less cost through a systematic research and planning process.

The laws and regulations that are passed in an effort to protect natural resources from unreasonable exploitation are being rendered ineffective by two basic problems. The first is that the mere inactment of new laws does not bring automatic compliance, particularly by those who stand to lose considerably by doing so, and government seldom provides the administrative units the money and personnel required to do an effective job. The second is that different laws and regulations adopted at different times often conflict and certainly do not show coordination when viewed as a whole. A widely supported alternative (d'Arge, 1973) is to replace many legal controls with indirect incentives such as taxes and charges. Movement in this direction should be instituted as part of a large effort to review and evaluate the major laws and regulations affecting resource use in order to minimize conflicts, duplication, and overlap. Both legal and financial incentives should be examined in any integrated planning effort.

Methodological Implications

The kinds of comments that can be made about institutional patterns are analogous to those that apply to resource planning methodology. That methodology is characterized by a plethora of mathematical techniques, computer models, and analytical procedures that are frequently incompatible. Although there is a certain value to this state of affairs, considerably more value could be derived if a greater degree of methodological concensus and standardization could be obtained. As has been stated previously, the Principles and Standards of the Water Resources Council are a promising development in such a direction.

A first step toward integrated resource planning would be to develop a common shared methodological perspective anchored in two fundamental ideas: normative-adaptation and ecology. The concept of normative-adaptation essentially emphasizes the need for a scientific and methodological approach that takes norms or values as a starting point in the relation to an adaptive or evolutionary goal orientation in policy making and planning. The concept of ecology implies that integrated planning methods and techniques should explicitly fit within a perspective that encompasses the total system of resources and their use.

The type of perspective that governs the methodology employed in an integrated planning effort has important implications for the collecting and processing of information. The answers to such questions as, what data should be collected in what format, how should the data be interrelated, and how should the data be presented and used have a major effect on the planning results. In this regard, it is useful to distinguish two methodological concerns. One concern focuses on research; the other emphasizes the use of information. The methods, techniques, and models that are employed to deal with specific research problems are the responsibilities of the substantive experts, such as engineers, ecologists, and economists. The model that is used as part of a management information system must be decided upon by the planner or policy analysts. It is this latter type of model that has been developed as part of the study.

Resolution of Land and Water Planning Problems through an Integrated Resource Uses Approach (IRUM)

Water and land use planning problems have traditionally been resolved separately by water and land use planning agencies. Water problems are generally classified as quality or quantity problems, while land use problems relate more to protecting property values preserving community esthetics, or providing desired infrastructure. Once a problem is identified or seems imminent, the relevant system or process is defined, isolated and water development projects and/or state and local land and water use regulations are established to remedy the problem.

To resolve problems or plan for a comprehensive system or process, boundaries must be established to include reluctant parts or subsystems. Systems properties can be discovered at the subsystem level of analysis by reducing large units to smaller ones and subsystems properties can be identified at the systems level of analysis by constructing large units out of smaller ones. Segmented planning has developed over time as a result of different disciplines establishing different boundaries within the whole universal occurrences and concentrating their efforts on what they deemed important enough to study. Boundaries allow the specialists to view the subsystem they are analyzing in isolation. However, these same boundaries destroy the ability of the specialist involved in segmented planning to view the entire process or system. This division of the aggregate into separate disciplines of study and the conclusions based on the independence of the disaggregated subsystem from the entire system have resulted in a lack of coordination and integration of planning efforts, irreconcilable and incompatible courses of action, bottlenecks, duplication, and the wasteful use of scarce resources.

Models habe been designed to assist planning agencies in developing project plans or regulations to deal with water and land use problems of a given system. However, most models deal with only one segment of the overall water-land interface problem; e.g., water quality models, land development models, land use management models, etc. Few models take into consideration the overall interactive impacts of land use on water quantity or vice versa. Available models are too segmented, and so-called comprehensive models are comprehensive only to the extent that they analyze the interrelationships of narrowly defined systems. An exhaustive and definitive modeling approach to provide for a systematic exploration of intrasystem and intersystem interdependencies within an all-inclusive interrelated global system is lacking. Problem solving through an integrated analysis technique will begin with the development of an integrated planning information system.

An integrated planning information system should neet certain basic requirements. It should be comprehensive in presenting the salient interrelationships for planning and decision making purposes; the information should be easy to access; and, the information should be at a level that can be understood by non-experts. The integrated resource uses model (IRUM) approach developed in this research study is directed at meeting these requirements through the use of a cross impact analysis methodology. Such a methodology can depict a large number of relationships in a visually easily recognizable form and allows for accessible computer-interactive decision making. However, the IRUM approach should be primarily conceived as a management information system for combining relevant findings obtained through complementary methods and techniques. It is designed as an instrument to facilitate and improve planning and decision making.

The IRUM Approach

The IRUM methodology is an information management system that displays the cross-impacts (interconnections) of economic, legal, social, political, and environmental systems. Each system is embedded in a comprehensive system, affects it, and is, in turn, affected (impacted) by it. The use of IRUM is designed to assist decision makers in coordinating and integrating planning efforts to reduce the inefficiencies of segmented planning, which results in bottlenecks, duplication of effort, and the wasteful use of scarce resources.

This methodology also acknowledges that variables considered in different disciplines are not only interrelated among themselves but are also interconnected with variables of other disciplines mutually influencing one another in an all-inclusive interrelated global system. By considering these interfaces, the IRUM approach accounts for external effects of one system upon another system as well as the internal effects of a given system upon itself. Transportation planners, in planning the transportation network of an area to service the needs of a new industry may neglect the impact that a new road will have on existing social, physical, and economic activities in the area. Increased accessibility to a region will affect the quality of the environment, the spatial pattern and distribution of the population and housing, the function of the city center, economic and social activities of the area, the infrastructure requirements of the area, the income levels of the population, land use and water use requirements, and political and legal institutions and structures. Economic planners, planning for economic growth of an area and concerned with the returns to economic capital, may neglect the externalities which influence the quality of the environment and the return to natural capital. Physical and environmental planners, on the other hand, may neglect the externalities of their actions which influence the returns to economic capital in planning for the spatial layout, water and land use, and protection of the environment in their area. Only by considering all of the variables of each planning system, and the interface between the systems, can external effects be accounted for.

In using this type of methodology, the major decision to be made concerns the variables and events to be analyzed. In the model employed in this study and, described in the remainder of this report, three broad categories are defined: 1) resource related values, 2) resource uses, and 3) environmental conditions. Each category represents a subsystem of the IRUM methodology.

The IRUM approach utilizes nine variables which represent the main ingredients of the analysis: water uses and land uses (from the uses subsystem), water values and land values (from the values subsystem), and economic, legal, social, political, and environmental conditions (from the conditions subsystem). Uses, values, and conditions assume determinate and determinant roles within the methodology in that they are interconnected, interrelated, and intercausal. There is, however, no absolute limit to the number of sub-uses, sub-values, and sub-conditions that can be considered. The values, uses, and conditions which define the boundaries and domain of the applied IRUM methodology in the following section are listed in Table 3.

A graphical illustration of the IRUM approach shows it to be a subsystem of the land resource management planning system and the water resources planning system (Figure 8). The boundaries of the simulation represent the land-water resource uses interface. This interface (IRUM) is itself composed of three subsystems defined by user selected variables: the uses subsystem, the values subsystem, and the conditions subsystem.

Nine general relationships and 81 secondary relationships and matricies constitute the IRUM approach. The uses subsystem is composed of three general relationships and 18 secondary relationships. The conditions subsystem contains three general relationships and 45 secondary relationships. The boundaries of these general and secondary subsystems are flexible, however, with no theoretical limit to the number of elements each of the nine variables may contain. The intricate use of interconnections and interrelations between the uses, values, and conditions variables in the IRUM approach can be examined at its most complex level when the subsystems are exemplified matrically.

The scope of the IRUM methodolgy is determined by the boundaries specified. The

Table 3. Values, uses, and conditions.

Land Uses	Water Uses	Land Values	Water Values	Conditions
I. Agricultural	I. Agricultural	I. Aesthetics	I. Aesthetic	I. Economic
a. ranching	a. irrigation			a. population
b. timber	b. stock	II. Productivity	II. Purity	b. resource devel-
c. crop farming	watering	of resources		opment level
d. dairying		a. surface	III. Location	c. employment
	II. Industrial	b. subsurface	a. availa-	d. tourism
II. Industrial	a. injection		bility	e. investment level
a. oil/gas	b. drilling	III. Location	b. economic	
b. oil shale	c. cooling	a. economic	profita-	II. Political
c. electric	d. steam	profita-	bility	a. intracounty
d. mining		bility		cooperation
e. manufacturing	III. Municipal	b. geographic	IV. Water rights	b. intercounty
	a. domestical	c. social heri-		cooperation
III. Municipal	use	tage or com-	V. Regularity	c. Ute Indian
a. residential	b. commercial	munity pride	a. drainage	cooperation
b. commercial	use		b. flood	
c. recreational	c. recreational	IV. Property rights	control	III. Social
d. transporation	use		c. stream	a. societal health
		V. Geologic	flow	b. educational
IV. Recreational	IV. Recreational	features		facilities
a. wildlife	a. fishing	a. terrain		c. cultural
b. camping/	b. boating	b. slope		facilities
hiking	c. skiing			
c. scenic	d. swimming			IV. Legal
d. historic				a. federal environ-
e. off-road				mental laws
vehicle				b. state environ-
				mental laws
				c. city/county
				ordinances
				d. Ute tribal code
				V. Environmental
				a. precipitation
				b. salinity level
				c. crop acreage
				d. reservoir
				evaporation
				e. export of water

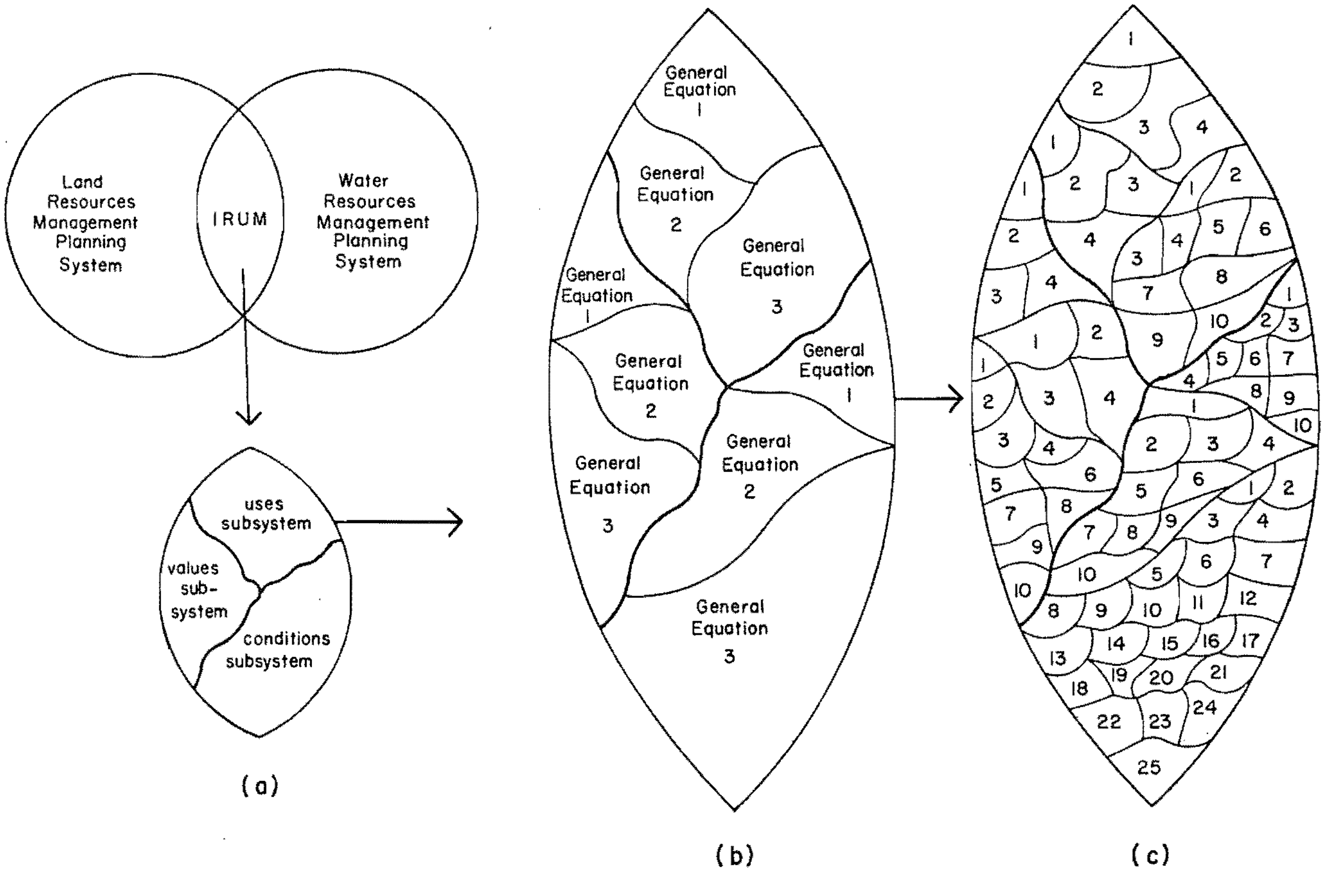


Figure 8. IRUM domain and structure.

nine variables represent the boundaries addressed in this report and define the domain of this IRUM simulation. This domain is not intended to be rigidly defined and can be expanded or contracted to fit the needs and priorities of the practical user at all levels of the decision making process. The boundaries of the IRUM approach are determined by the objectives and level of analysis of the decision maker.

The Subsystems

The Uses Subsystem

The uses subsystem is constructed of three general relationships and 18 secondary, or specific, relationships outlining the intercausal relationships between the uses, values, and conditions. The general relationships can be expressed as:

1) U = f(V/C, U, V)
2) U = f(U/V, C, U)
3) U = f(C/V, U, C)

Relationship 1 states that a use is a function of a value given conditions and the uses and values; relationship 2 states that a use is a function of another use given values, conditions, and other uses; and relationship 3 states that a use is a function of a condition given values, other uses, and conditions. The determinates of the uses subsystem are the land and water uses and the economic, social, political, legal, and environmental conditions.

The 18 secondary, or specific, relationships which represent possible interrelationships for the uses subsystem are expansions of the three general relationships based on the nine specified variables. General relationship 1 can be expanded into the following specific relationships

1a) WU = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
1b) WU = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
1c) LU = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
1d) LU = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)

4) V = f(V/C, U, V)
4a) WV = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
4b) WV = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
4c) LV = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
4d) LV = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
5) V = f(U/C, U, V)
5a) WV = f(WU/LU, LV, WV, EC, SC, PC, LC, EVC)
5b) WV = f(LU/WU, LV, WV, EC, SC, PC, LC, EVC)
5c) LV = f(WU/LU, LV, WV, EC, SC, PC, LC, EVC)
5d) LV = f(LU/WU, LV, WV, EC, SC, PC, LC, EVC)
6) V = f(C/U, C, V)
6a) WV = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
6b) WV = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
6c) WV = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
6d) WV = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
6e) WV = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)
6f) LV = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
6g) LV = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
6h) LV = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
6i) LV = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
6j) LV = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)

The Conditions Subsystem

The conditions subsystem is composed of three general relationships and 45 specific relationships and associated matricies outlining the interrelationships between uses, values, and conditions.

7) C = f(V/U, V, C)
7a) EC = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
7b) EC = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
7c) SC = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
7d) SC = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
7e) PC = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
7f) PC = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
7g) LC = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
7h) LC = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)
7i) EVC = f(WV/LV, LU, WU, EC, SC, PC, LC, EVC)
7j) EVC = f(LV/WV, LU, WU, EC, SC, PC, LC, EVC)

8) C = f(U/V, U, C)
8a) EC = f(WU/LU, WV, LV, EC, SC, PC, LC, EVC)
8b) EC = f(LU/WU, WV, LV, EC, SC, PC, LC, EVC)
8c) SC = f(WU/LU, WV, LV, EC, SC, PC, LC, EVC)
8d) SC = f(LU/WU, WV, LV, EC, SC, PC, LC, EVC)
8e) PC = f(WU/LU, WV, LV, EC, SC, PC, LC, EVC)
8f) PC = f(LU/WU, WV, LV, EC, SC, PC, LC, EVC)
8g) LC = f(WU/LU, WV, LV, EC, SC, PC, LC, EVC)
8h) LC = f(LU/WU, WV, LV, EC, SC, PC, LC, EVC)
8i) EVC =f(WU/LU, WV, LV, EC, SC, PC, LC, EVC)
8j) EVC =f(LU/WU, WV, LV, EC, SC, PC, LC, EVC)
9) C = f(C/V, U, C)
9a) EC = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
9b) EC = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
9c) EC = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
9d) EC = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
9e) EC = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)
9f) SC = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
9g) SC = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
9h) SC = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
9i) SC = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
9j) SC = f)EVC/LU, WU, LV, WV, EC, SC, PC, LC)
9k) PC = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
9l) PC = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
9m) PC = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
9n) PC = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
9o) PC = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)
9p) LC = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
9q) LC = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
9r) LC = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
9s) LC = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
9t) LC = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)
9u) EVC = f(EC/LU, WU, LV, WV, SC, PC, LC, EVC)
9v) EVC = f(SC/LU, WU, LV, WV, EC, PC, LC, EVC)
9w) EVC = f(PC/LU, WU, LV, WV, EC, SC, LC, EVC)
9x) EVC = f(LC/LU, WU, LV, WV, EC, SC, PC, EVC)
9y) EVC = f(EVC/LU, WU, LV, WV, EC, SC, PC, LC)

Impact Assessment

The IRUM methodology provides for an iterative exchange of information between specialists of various planning disciplines. Through the exchange of interdisciplinary information, the impacts of one subsystem upon another can be established and expressed as an impact of cell value in the appropriate matrix. Since the IRUM approach involves a multi-disciplinary assessment with potential use by both expert and layman, a common frame of reference is incorporated through the use of an ordinal impact assessment scale:

-3 = strong negative impact
-2 = moderate negative impact
-1 = mild negative impact
0 = independence or no impact
+1 = mild positive impact
+2 = moderate positive impact
+3 = strong positive impact

Some form of judgmental evaluation must be conducted in order to assess the level and direction of impact. The cell impact values can be determined by specialists, or decision makers, or through public participation, or by a combination of the aforementioned. Several judgmental techniques have been developed, including the Delphi and the Graphic rating scale. The techniques are similar in purpose, except the Delphi procedure attempts to extract consensus on the evaluation. The thrust of the technique is to gage ratings of various interrelationships by experts on the general public.

The applicability and practicability of the IRUM approach rests on the accuracy and quality of information comprising each impact cell value. It is the impact value contained in each cell of each matrix, representing the interrelatedness of the variables, upon which the practical user will base his decision. Information sources could include baseline studies, development plans, environmental impact statements, studies conducted by universities, federal and state agencies, private research institutes and businesses, surveys, journals and magazines. The output of other models can be used as information sources for the IRUM methodology.

The IRUM methodology can be applied at different levels of analysis or aggregation--natural, regional, or local. Information obtained at lower levels of aggregation can be incorporated into the model at higher levels. The level of analysis, objectives, time, and financial budgetary constraints of a decision maker will determine if he should utilize selected relationships of the IRUM simulation or apply the model in its entirety. Federal, state, and local agencies would appropriately utilize the IRUM methodology to differing degrees since their levels of analysis, objectives, and constraints usually differ. A small town mayor considering the interrelationship between a new subdivision and a possible increase in flooding would selectively draw on specific relationships and matricies from the three general subsystems that best fit his objectives and his time and monitary constraints. On the other hand, a federal agency confronted with energy development problems throughout the intermountain states would employ the methodology in its entirety.

PART III

APPLICATION OF THE INTEGRATED RESOURCE USES METHODOLOGY TO A CURRENT PLANNING PROBLEM

Parts 1 and 2 of this report have pointed out reasons why land use and water resources planning need to be integrated and outlined important considerations that need to be resolved in order to achieve the necessary integration. In this section, those considerations, treated as recommendations, are incorporated in the Integrated Resource Uses Model (IRUM), a methodological framework for integrated planning. Chapter 7 develops the conceptual underpinnings of the methodology through use of a cross-impact matrix format. This format recognizes land and water uses, land and water values, and political, environmental, economic, social, and legal conditions which constrain actions on the land-water interface. The cross impacts are represented on a seven-point ordinal ranking scale to provide a common frame of reference for analysis. Chapter 8 includes two parts. First, a description of the study area, the Uintah Basin of Northeastern Utah, provides information on a current land use-water resource planning problem. Second, this information is used in a computer model based on the IRUM framework. The quantification of the planning problem and the interpretation of the output are analyzed to identify the modeling problems involved and make recommendations concerning the future development of this integrating methodology.

CHAPTER 7.

DESCRIPTION OF STUDY AREA

Description and Regional Profile of the Uintah Basin

The Uintah Basin is 130 miles from east to west and 100 miles from north to south. The basin is bound by the Wasatch Mountain Range to the west, and Uintah Mountain Range to the north, the Tavaputs Plateau to the south, and the White and Yampa River drainages to the east. The Mormon settlers who explored the Uintah Basin in the early 1860s reported that the land was "measurably valueless except for hunting, Indians, and holding the world together" (Daughters of

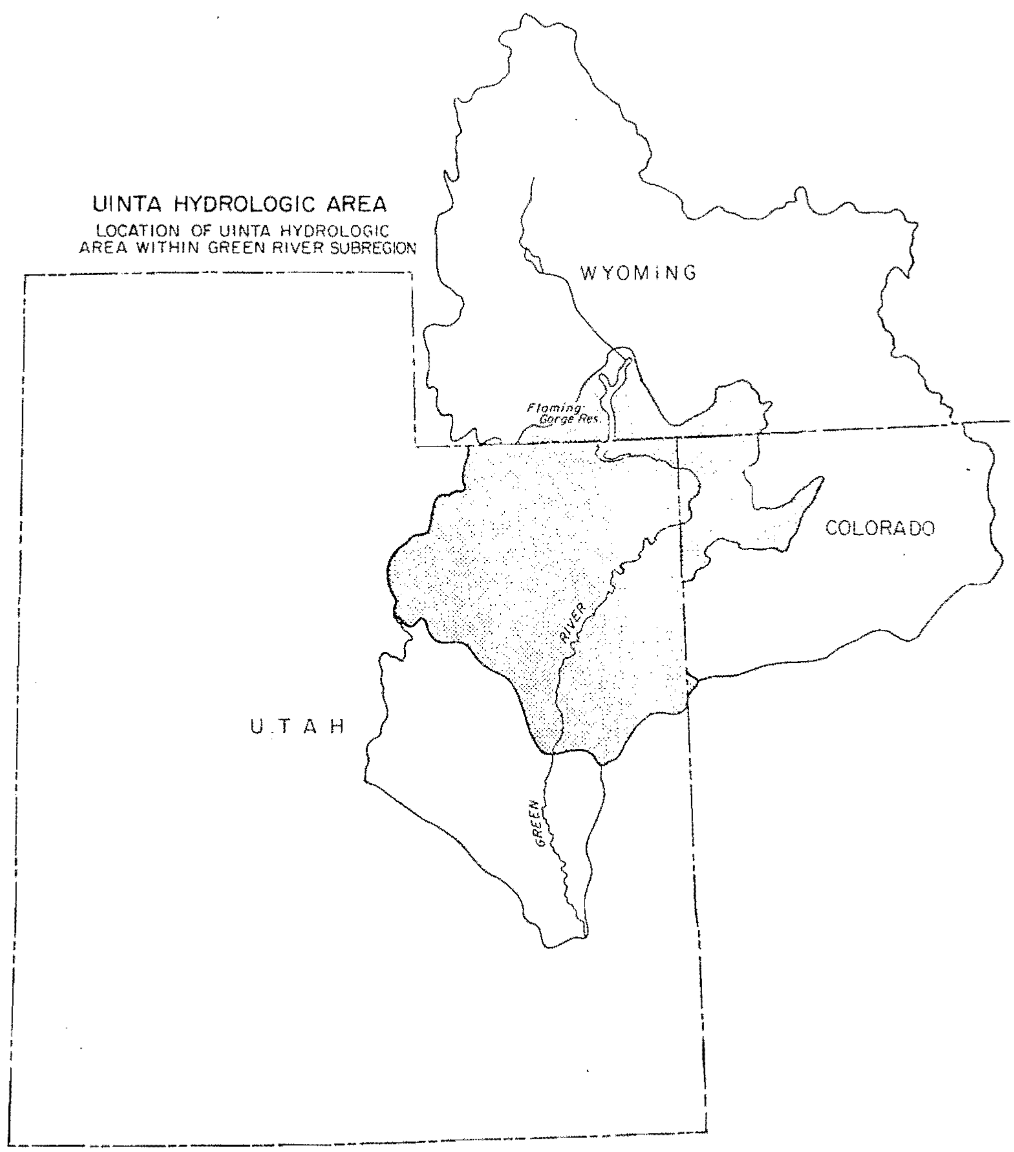


Figure 10. Location of study area.

the Utah Pioneers, 1947). As a result, the basin was left unsettled for another 20 years. In 1861 President Lincoln declared part of the basin as an Indian reservation because of the scarceness of white settlers (Crawford, 1975). As the population of the Wasatch Front grew, enterprising individuals again entered the basin, finding, because of mild winters, an ideal winter grazing area. By 1905, the demand for land had increased enough to force the opening of the Indian reservation to homesteading. More than $25,000,000 has been awarded to the Ute Indian tribe since 1950 for the illegal or uncompensated taking of Indian lands (Horne, 1973). The Uintah Basin has since developed from an agricultural area to an area of diversified economic activity, particularly since the surge in population resulting from the 1969 discovery of vast reserves of energy producing materials.

Land and Water Use

Water and land uses in the Uintah Basin serve agricultural, industrial, municipal, and recreational activities. The soils of the Uintah Basin are generally characterized as thin and poorly developed, low in organic matter and nitrogen, and high in alkali and other minerals (Calif, 1948). Drainage is often poor, and much of the low lands are consequently high in accumulations of alkali. Salts are leached from the soil by the irrigation of crops and contribute to the salinity level of the Colorado River. Only 3 percent of the basin is presently cultivated. The cultivated area lies at the base of the Uintah Mountains, where accumulations of mountain soil have been deposited by erosion and glacial activity. Field crops constitute 9.6 percent of the total agricultural land uses, hay and pasture constitute 26 percent; hayland, 57 percent; conservation, 1 percent; temporarily idle, 1.7 percent; orchards, 0.09 percent; and open land formerly cropped, 4.3 percent (Horne, 1973).

Eighty-nine percent of the water that falls on the Uintah Basin is used on the site where it falls by the soil and plants and returned to the atmosphere through evapotranspiration. Evaporation accounts for approximately 7.3 percent of the loss of usable water. Most of the water used by people is used for irrigation (Horne, 1973). Because of the irregularity of the streamflow and the scarceness of recoverable water, water rights, availability, and purity are important considerations. Dry years have brought severe water shortages. Basin residents are dependent on the trapped watersheds of the Uintah Mountains. The municipalities in the basin use approximately 1 percent of the available water supply for culinary purposes, the majority of which is supplied to them by the Ute Indian tribal water system (Horne, 1973). Measures to control the regularity and availability of water in the basin were first introduced by early Mormon neighborhood groups who formed irrigation companies in the basin to construct canals, settling ponds, and reservoirs (Daughters of the Utah Pioneers, 1947). With the construction of the Flaming Gorge Dam, portions of the Central Utah Project, various public and private ponds, canals, reservoirs, and recreational water bodies throughout the basin, it is now possible to capture and control most of the usable water. Eighty percent of the recoverable water in the basin is used for irrigation purposes. Eleven percent of the water is exported primarily to the Wasatch Front area via the Central Utah Project facilities. The large extent of grazing in the basin requires a significant allotment of water for livestock (Horne, 1973).

Economy

The major occupations associated with agricultural water and land uses include ranching, timber production, crop farming, and dairying. Agriculture is still one of the major facets of the economy in the Uintah Basin and accounts for 35 percent of the region's employment (Utah Industrial Development Information System, 1974). Although the number of people employed in agricultural pursuits has declined, agricultural productivity has increased due to technological improvements in equipment and methods. As a result small basin family farms are being replaced by larger cooperative enterprises. Livestock production is the focal point of agricultural endeavors in the basin. The five major agricultural products of the basin are cattle, sheep, wool, milk, and hay. The total acreage in grazing allotments constitutes 80 percent of the land area in the Uintah Basin, however, not all of the allotments are amenable to grazing due to limitations in terrain and forage. As with most western states, the federal government owns a large percentage of the land in the Uintah Basin, making the Bureau of Land Management and the Forestry Service important institutions in the area. Ownership of the grazing areas is as follows: Non-federal pasture and range, 23.7 percent; non-federal forest grazing, 13.5 percent; forest service, 23.6 percent; and the Bureau of Land Management, 39 percent (Horne, 1973).

Forests cover approximately 40 percent of the land area of the Uintah Basin. Timber from the basin has been utilized locally for many years, but timber exports do not represent a significant source of income for basin residents. In recent years only an average of 10 million board feet has been harvested annually, and only a limited amount of the forest area is classified as commercial forest lands. Ownership of forest lands includes non-federal, 32.1 percent; forest service, 52.4 percent; and Bureau of Land Management, 15.4 percent (Horne, 1973).

Most of the 9.6 percent of the agricultural land planted to field crops is used to provide feed for livestock. Feed crops include alfalfa, corn, wheat, barley and oats. Most of the farms and municipalities are located on the slopes of the mountains where better soil conditions exist, and the rest of the basin is used for grazing, wildlife management, or oil and mineral production.

The basin is the second most productive oil and gas province in Utah. With the opening of the Altamont field in 1970, the bulk of the oil production shifted from Uintah to Duchesne county (Massa, 1976). Oil activity has been the major impetus to economic growth in the basin, and the prospects for the future are even more promising. Much of the Uintah Basin is underlain with deposits of oil shale. The total oil in the shale deposits is estimated at 900 to 1,300 billion barrels, enough oil to provide the projected oil needs of 1985 in this country for 200 years (Horne, 1973). Several sites have been leased to major oil companies for oil shale development, and much research has gone into investigating this resource. Major planning efforts are currently underway to provide sufficient water, skilled labor, housing, transportation, infrastructure facilities and capital for the industry. The growing level of oil production in the basin has created a demand for water for injection into oil beds to raise the level of oil reserves for pumping. Water is also required for the cooling and lubrication of drill bits and machinery in the drilling process of oil recovery. In addition, oil refineries, thermo-electric plants, etc., require water for cooling processes, and plans are being formulated to provide adequate water reserves for oil shale mining operations in the future.

Another significant industrial land use in the area is the Flaming Gorge Dam, a major producer of hydro-electric energy in the Uintah Basin. Because of the vast reserves of energy producing materials in the basin many thermo-electric power plants may be constructed. Plans are being developed for the construction of a dam on the White River to serve the needs of the oil shale industry (Vernal Express Newspaper, 1976).

The Uintah Basin is the only area in the United States where solid hydrocarbon gilsonite is found. The main deposits lie near Bonanza, a small community in Uintah County. Phosphate is also an important resource in the area. The mining of phosphate began in 1961, and present operations are centered around Brush Creek, 15 miles north of Vernal. Another valuable resource is rock asphalt or bituminous sands. This mineral is used in the basin for paving roads, but has never been produced commercially on a large scale. The mineral is a potential source of oil and may be developed before oil shale operations become fully operational. Other minerals in the basin include molybdenum and trona.

Manufacturing activities in the basin include a furniture factory which the Ute Indians own and operate, oil drilling rig and tool companies, and assorted leather-goods firms. The tribe also owns and operates a cattle enterprise, Bottle Hollow Resort, and a research laboratory. The tribe has an annual income of $950,000 primarily composed of revenues from oil, gas, forestry, mineral and ranching leases (Horne, 1973). Ute lands contain undeveloped reserves of oil shale, asphalt, gilsonite, coal and phosphate.

Of the non-agricultural employment in the basin, state, local and federal agencies maintain approximately 25 percent of the payrolls. Trade and mining are next with about 20 percent each followed by the service sector which accounts for about 15 percent. The remaining 5 percent is divided among manufacturing, transportation, communications, public utilities, contract construction, finance, insurance, and real estate activities (Utah Industrial Development Information System, 1974). The mining sector is gaining in employment largely due to oil shale development, and contract construction is increasing as a result of the housing shortage in the area. Because of the seasonal nature of most major employment sectors, unemployment is usually higher in the basin than the state average. Federal and state governments have invested millions of dollars into water development projects in the region and private oil companies have likewise invested millions into oil shale development in the leasing of oil shale lands in the southeast corner of the Uintah Basin.

Commercial activity in the basin is service-oriented with restaurants, service stations, banks, motels, and oil tool service companies responsible for most of the enterprise. Largely due to the absence of railroads, an extensive system of roads has been constructed to connect the municipalities with surrounding areas. U.S. Highway 40 connects Salt Lake City with Denver via the Uintah Basin and the State of Utah has paved roads into the Flaming Gorge area. Many county roads are unpaved but are in good condition. The State of Utah is currently studying plans to construct an access road connecting Vernal or Roosevelt, or both, with the leased oil shale lands of the basin (Vernal Express Newspaper, 1975).

Only 1 percent of the land area is urbanized with 56 percent of the population residing in the urbanized areas and the remainder living on farms (Horne, 1973). Since the discovery of oil reserves in 1969, basin municipalities have experienced unprecedented population growth, including a 192 percent increase in Duchesne, a 139 percent increase in Roosevelt, and a 34 percent increase in Vernal over the 4 year period 1970-1974. As of July 1974, the population of the basin was approximately 28,300. The Ute Indian tribe has 1,700 registered members (Utah Industrial Development Information System, 1974).

Government

Most of the larger towns in the Uintah Basin have a mayor-council form of government, zoning ordinances, and city engineers. The three counties of the Uintah Basin compose one of the seven intercounty planning districts in Utah (Edmonds, 1978). The Uintah Basin Association of Governments (UBAG) was created in 1970 to assist municipalities and counties in planning and promoting basin-wide development. UBAG works for inter-governmental coordination and sponsors and administers federal grants and programs for counties and municipalities in the basin. UBAG also aids local officials in the preparation and revision of plans and guidelines for resource development. The Uintah Basin Energy Planning and Development Council (UBEPDC) formed in 1974, serves as UBAG's clearinghouse for oil related planning and development activities within the basin (Executive Order of the State of Utah, 1974). The three counties in the basin, Daggett, Duchesne, and Uintah, have a commissioner form of government. 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 trust by the Bureau of Indian Affairs which occupies office space in Fort Duchesne.

Education

Educational facilities in the basin include the Utah State University Extension Services, the Uintah Basin Area Vocational Center, and Northwestern Colorado Community College. The quality of education in the public schools of the basin is about average for the State of Utah. The population is quite dispersed, perhaps resulting in a crime rate that is slightly below the state average (Utah Law Enforcement Planning Agency, 1974). Most of the farmers and businessmen are of Mormon descent; whereas, the oil workers who entered the basin after the 1969 oil discovery are of different backgrounds. The Ute Indians also constitute a separate community within the basin with their own legal code and standards of behavior (Crawford, 1975).

Recreation

The Uintah Basin, an area of extreme variation in topography and climate, is surrounded by recreational areas of national magnitude. Flaming Gorge National Recreation Area, the High Uintah Primitive Area, Dinosaur National Monument, Desolation Canyon, Ouray National Wildlife Refuge, and Sheep Creek Canyon geologic area are all prominent recreation centers. Fishing, hiking, camping, and sightseeing are major activities in the basin. The Uintah Basin is recognized by many as the top area in Utah for big game hunting, and Flaming Gorge Reservoir is renowned for its record sized German Brown trout. Tourists are attracted from around the nation to basin resorts and recreational areas, and tourism represents a major source of income to basin residents. The basin draws many of its tourists from the heavily populated Wasatch Front area in Utah. Municipal zoning ordinances require that parks and recreational facilities such as swimming pools, baseball and softball fields, general parks, fairgrounds, and rodeo grounds be provided.

Eighty-thousand acres of land in the basin has been allotted for use as a deer winter range (Horne, 1973). The basin is one of the state's largest producers of big game and serves as a winter grazing area for mule deer, elk, and moose. There are two upland game bird farms and two waterfowl management areas in the basin.

The State of Utah Division of Wildlife Resources has rated the streams of Utah along a 1 to 6 scale, with 1 being the best fishing areas. The Uintah Basin contains 46.6 percent of the class 1 streams; 17.6 percent of the class 2 streams; 14.4 percent of the class 3 streams; 18.4 percent of the class 4 streams; 1 percent of the class 5 streams; and 13.5 percent of the class 6 streams in the state (Horne, 1973). The basin also contains numerous lakes and reservoirs which are rated as excellent for fishing. Flaming Gorge Reservoir is likewise famous for its boating. Major marinas dot the lake, and the Green River below Flaming Gorge Dam is renowned for its fishing and boating expeditions. Most major reservoirs in the basin serve as areas for water skiing, fisheries, and waterfowl habitats. Many beaches have been developed for swimming and picnicking.

Integration and Coordination of Water Resources and Land Use in the Uintah Basin

Issues

Water planning in the Uintah Basin has generally led to large water development projects. Most of these required the cooperative efforts of mutual irrigation associations or other local entities working with federal agencies such as the Bureau of Reclamation and Soil Conservation Service. The Bureau of Reclamation, during its 71-year history, has invested over 380 million dollars in the State of Utah--a large percentage of which was allocated to the construction of Flaming Gorge Dam and the Vernal Unit of the Central Utah Project, both of which are located in the Uintah Basin.

Most of the project planning not funded by the Bureau of Reclamation has been carried out by the Ute Indian Tribe (Bureau of Indian Affairs) located in Fort Duchesne, Utah. The Utes sell water to many municipalities in the basin including Roosevelt, LaPoint, Ballard, Ouray Park, and the Johnson Water System. In the early 1950s, the Ute's hired an engineer to survey tribal water needs. An inventory of Ute lands and potential land uses was compiled, and water rights claims were made based on the inventory results. In 1965 the tribe signed a deferral agreement to defer some of the water rights until 2005 so that the Central Utah Project could proceed. Much controversy has developed within the tribe over this agreement. Several tribal members have sued the Central Utah Project to stop the Strawberry Aqueduct until the Uintah and Ute Units of the Central Utah Project have been completed to service Indian lands. The Utes suing the Central Utah Project want to be assured that their needs will be met before water is transported out of the basin and into the Great Basin to serve the Wasatch Front communities.

As the economy of the Uintah Basin and the surrounding regions has grown, the waters of the basin have become over-appropriated and the competition for the available water has intensified. Indian, agricultural, municipal and industrial water users within the basin and downstream have come to feel that the important decision is no longer whether or not to develop water but rather which of the competing uses will be allowed to develop the water. The intrabasin competition must further be resolved in conformity with the Colorado River Compact and the Mexico Water Treaty. Integrated water and land use planning is important because the quality and quantity of the water flowing downstream from the basin depends on land use in the basin. Land management as well as water management is needed to get the most from the available water within the basin and satisfy downstream users at an acceptable cost.

The discovery of oil and natural gas reserves within the Uintah Basin in 1969 began a period of rapid economic growth throughout the region. Counties and municipalities did not possess the expertise or financial capabilities to plan for orderly development. Industrial, planners had not informed the municipal planners of the water requirements of the plant and the city had allotted the refinery only 25 percent of the water supply that it needed to operate at capacity.

Several courts using self-sustained sewer units had problems with surface seepage of septic tank effluents. Subdivisions were constructed without paved streets, curb and gutter, sidewalks, or sewer, electrical and water hook-ups. An oil refinery was built in 1969 within one tourist-dependent community, adjacent to a residential district, on the main highway into town. When the refinery was constructed, it was not able to operate at capacity due to a shortage of water. Industrial planners neglected the externalities of their actions on the municipality. The lack of coordination and integration of industrial and municipal planning efforts resulted in incompatible courses of action. Industrial planners had not informed the municipal planners of the water requirements of the plant and the city had allotted the refinery only 25 percent of the water supply that it needed to operate at capacity.

Many of these problems have since been rectified. However, the Uintah Basin is now confronted with the possibility of future growth and needs to organize more effectively to plan for the probable development of oil shale resources within the region. In an attempt to provide for orderly growth and minimize the negative environmental impacts that oil shale development would create in the basin, industry, governments, and concerned citizen groups have recognized the necessity of integrating and coordinating their activities and plans. Committees, councils, panels, and other organizations have surfaced to support a coordinated effort.

Institutions

At the federal level, the Department of the Interior has established the Area Oil Shale Supervisor's Office (AOSSO) and the Oil Shale Environmental Advisory Panel (OSEAP) to coordinate oil shale related information affecting water resources and land use planning within the basin. As an agency of the U.S. Geological Survey, AOSSO supervises oil shale development, coordinates other government agencies' work related to oil shale, and acts as a repository of raw data on oil shale development. The other government agencies involved with oil shale development include the Bureau of Land Management, the Bureau of Reclamation, the Federal Energy Administration, the Energy Research and Development Administration, and the Environmental Protection Agency.

The federal oil shale prototype leasing program got underway in January, 1974, to generate information in order to determine the economic and environmental viability of commercial sized oil shale operations. The leases require the leasees to compile baseline environmental data on their leased area to establish environmental conditions before, during and after actual oil shale development occurs. Companies holding leases on oil shale tracts submit quarterly baseline reports to AOSSO. The objective of the baseline environmental program is to determine the environmental impacts of oil shale development on water and land resources, flora and fauna, and air quality. The results of the baseline impact studies and monitoring programs are published as a detailed development plan (DDP) for the tract operations and are submitted to AOSSO. The DDP outlines expected development on a federally-leased tract, the environmental impacts of the development, and the post-development plans for restoring the tract to an environmentally stable condition. AOSSO then distributes the DDP to various government agencies and public libraries. Public hearings are held on each

DDP and the Oil Shale Environmental Advisory Panel reviews the documents. AOSSO then accepts or rejects the DDP based on the findings.

The Oil Shale Environmental Advisory Panel (OSEAP), established in early 1974 by the Interior Department, advises AOSSO and the District Managers of the Bureau of Land Management in their supervision of oil shale development. The panel functions as a microcosm of at-large interest groups. Panel members represent different federal, state and local government agencies, universities, concerned citizens groups, environmentalists, and industry. OSEAP's advisory role combines public participation with inter-governmental coordination at all levels of government. The panel provides for the exchange of information between various federal, state and local governments, universities and special interest groups; however, its role is strictly advisory.

At the state level, other associations, councils, and committees have been formulated to coordinate oil shale related information and activities affecting land and water resources within the Uintah Basin. State agencies are coordinated through the State Planning Advisory Committee (SPAC). SPAC coordinates the responsibilities of state agencies to both federal and local issues and brings state agencies under an umbrella of priorities and policies as set forth by the governor and legislature. SPAC is the state's clearinghouse for environmental impact statements. In addition, it reviews legislation and is responsible for developing a unified state policy as regards state and federal programs (Office of State Planning Coordinator, 1975).

SPAC is composed of 15 members from various state agencies and is chaired by the state planning coordinator. The State Planning Coordinator's Office has established the Environmental Coordinating Committee (ECC) and the Federal Resources Development Coordination Program (FRDCP). The ECC is composed of representatives from various state agencies who decide whether or not to issue development permits for industrial projects that may have environmental effects. The committee may also suggest project modifications that an industry could implement in order to obtain a development permit. The ECC functions to coordinate information and activities at the state level amongst various state agencies. Local agencies review environment impact statements on projects affecting their localities and advise the committee. The FRDCP, on the other hand, acts as a liason agency to coordinate communications between local and federal agencies on resource development of federal lands.

Statewide coordination of information and activities at the local level is managed by the Governor's Advisory Council on Local Affairs. The Advisory Council's membership is made up of representatives from the seven associations of government established in May of 1970, representing multi-county planning districts in the state. The 21 member council meets monthly to serve as a forum to identify and discuss statewide problems regarding the functioning of local government. In addition, the council provides for the exchange of information and data to insure effective communication among various government levels. The council also reviews and coordinates state and federal programs pertaining to local affairs in order to insure that the best interests of local governments are considered. Members of the council discuss local-state related problems and advise the Governor and the Department of Community Affairs. Coordination of energy related information at the state level is handled by the Interdepartmental Coordinating Council for Energy Affairs. Council members represent the Department of Natural Resources, the State Planning Coordinator's Office, the Community Affairs Department, the Department of Development Services, the State Transportation Department, the Departments of Agriculture, Business Regulation, Public Safety, Finance and other agencies.

At the local level, oil shale related activities affecting land and water resource development are coordinated by the Uintah Basin Association of Governments (UBAG) and its Energy Planning and Development Council. UBAG is a multi-county planning district serving Daggett, Duchesne, and Uintah Counties. The association works for intergovernmental cooperation within the basin and between the counties and the state. UBAG sponsors and administers federal grants and programs for the counties and municipalities in the basin and aids local officials in preparing, adopting and revising plans and guidelines for resource development.

The Uintah Basin Energy Planning and Development Council (UBEPDC) functions as a local clearinghouse for oil planning and development activities within the basin. UBEPDC guides and coordinates oil development related activities to facilitate planning and decision making between all branches of government as well as private business and reports its recommendations and findings to UBAG. The council functions as a liason and communication body between private investors, federal, state and local government agencies directly related to basin oil projects. In addition, UBEPDC acts as advisor to the state on energy matters before the Department of the Interior, secures funding from government and private agencies to assist in oil related planning development efforts, and directs oil development planning for basin municipalities and counties at the request of the local governments. The 13 voting members of UBEPDC represent the basin counties and municipalities and state representatives. A 32-member technical committee of experts from industry, federal, state and local governments, universities and water conservancy districts collects data and prepares studies and documents related to oil development as requested by UBEPDC. The technical advisory committee provides for the exchange of information between government, university, and industry specialists and conducts the research for the council.

Although the Oil Shale Environmental Advisory Panel, the Environmental Coordinating Committee and the Uintah Basin Energy Planning and Development Council provide for the exchange of information and advice at the federal, state and local levels respectively, with the exception of the ECC which issues development permits, the bodies have no decision-making authority. Coordination of planning efforts between federal, state, and local governments, industry, and the Ute Indian reservation has largely been voluntary. This lack of authority to deal with conflicting interests has made coordination difficult and has resulted in duplication of effort as agencies planned for common situations from various viewpoints.

The executive order which established UBEPDC recognized this problem.

> To fulfill the purposes of this order, any agency of local, state, or federal government, any state or private university, or private developer initiating studies, plans, or specific development proposals, affecting the utilization of oil resources in the Uintah Basin shall first submit such studies, plans, or development proposals to the Council for their review and recommendations to insure optimum coordination of energy resources development. (Executive Order of the State of Utah, 1974.)

UBEPDC, at the local level, and OSEAP at the federal level are coordinating bodies without decision-making authority. These agencies act in an advisory role providing recommendations to UBAG and AOSSO respectively. UBAG likewise lacks authority in that it functions at the request of local governments, within the basin. AOSSO does decide to reject or accept detailed development plans (DDP) submitted by industry; however, the DDP provides data on land and water resources, air, quality, and flora and fauna, but ignores the socio-political impacts of development.

If effective land use planning is to be implemented, the basin needs an intergovernmental regional coordinating agency with decision-making authority that would function as a centralized information clearinghouse for the consolidation of social, economic, political, environmental, and legal oil shale related information. The regional coordinating agency would determine what studies have been completed, what studies are underway, and what additional studies are needed, as well as who is best qualified to do them. The regional coordinating agency would only be effective as it could manage the data it collected for timely delivery to decision makers who need it. The integrated resource uses model (IRUM) is a comprehensive information management system model developed for this purpose.

IRUM is designed to assist decision makers in coordinating and integrating economic, political, social, legal, and environmental information in order to reduce bottlenecks, duplication of effort and the wasteful use of scarce resources. IRUM is constructed to handle sizable amounts of information. The model provides for panoramic conclusions in that it relates the variables considered in one study both among themselves but also as they are interconnected with variables of other studies through systematic exploration of intrasystem and intersystem interdependencies.

The model provides for an extensive exchange of information between specialists of various planning disciplines. The model provides a systematic framework to account for the social, economic, political, legal, and environmental impacts of one study's set of variables upon another study's set of variables. While the model provides the mechanism for handling massive amounts of information, the impact cell values provide the insight into the interrelationships and the impact values upon which the decision-maker will base his decision. The impact values contained in each cell of each matrix within IRUM define the interrelatedness of the variables.

Many sources of information can be used to obtain the needed impact values. The quality of information received depends on the quality of the data collection process and the availability of information sources. Identification of information sources should be the first task of a regional coordinating agency. The sources in the Uintah Basin would include the baseline studies and detailed development plans submitted to AOSSO by the leasees, environmental impact statements, studies conducted by universities, federal and state agencies, private research institutes and businesses, surveys, journals, magazines, and federal, state, university, city and county libraries. The intergovernmental regional coordinating agency could use IRUM as an information transfer system. The model would provide decision makers with an assessment of the types of studies needed to evaluate the environmental and socio-economic impacts of development.

Survey Results

In order to identify the categories of uses, conditions, and values used in integrated water and land use planning considerations, a review of the relevant literature and in-depth interviews with key individuals in the Uintah Basin were undertaken by the research staff. In addition, a general population survey of attitudes and values related to land and water use in the Uintah Basin was conducted in March of 1976 by the Opinion Sampling Research Institute. Details of the survey are presented in Appendix A.

Table 3 (in Chapter 6) lists the land and water uses, values, and conditions synthesized from the information gathered. Land uses within the Uintah Basin are grouped into the four general categories of agricultural land uses, industrial land uses, municipal land uses, or recreational land uses. Water uses are likewise grouped into one of four general categories: agricultural water uses, industrial water uses, municipal water uses, or recreational water uses. The land values identified were grouped into five general categories: aesthetics, productivity, location, property rights, or geologic features. Water values were also grouped into five general categories: aesthetics, purity, location, water rights, or regularity. External conditions affecting the integration of land and water resource use planning systems are classified into the general categories of economic conditions, social conditions, political conditions, legal conditions, and environmental conditions.

CHAPTER 8

APPLICATION OF IRUM METHODOLOGY TO UINTAH BASIN

A pilot application of the IRUM methodology was made to the Uintah Basin to illustrate the methodological problems which may be encountered in attempting to implement a simulation based on this approach. Guidelines for development of a scaled-down IRUM simulation were:

1. The application should deal with important planning considerations in the Uintah Basin study area.
2. The application should be in enough depth to illustrate potential methodological problems and approaches.
3. The simulation should be sufficiently developed to serve as a basic guide for making the refinements needed so that the IRUM approach can be developed into an effective planning tool.

The Uintah Basin proved to be a good site for this pilot test of the conceptual model because of the numerous water and energy related resource use activities in the area which illuminated the need for an integrated resources uses information management model. The relevant relationships to simulate were selected through the general opinion survey discussed in Appendix A, in-depth personal interviews of key persons within the basin, and the literature review.

The formula used to develop a simulation model from the IRUM methodology rests on the following assumptions:

1. Since the output of the formula is to be aggregated into ordinal ranking categories, adequate representation of the relationships can be accomplished through the use of linear equations.
2. Since the model does not attempt to infer value judgments as to the desirability of a given trade off beyond the point of the initial categorization, the model's output is designed to predict impacts on the maximum utilization of resources.
3. The model makes the behavioral assumption that all resources will be utilized to maximum potentials (this assumption forces trade offs which might not exist at less than full utilization).

For a full-scale application of the IRUM methodology, these assumptions would have to be modified to provide for a more realistic scenario of the planning situation and to allow for segmented effects.

General Model Description

The computer model equations represent various physical trade offs among the five areas of examination. The formulae are area specific, and the numerical values cannot be generalized to areas outside of the basin. Linear equations were selected as a reasonable first approximation to reduce the cost of the computer demonstration run. These equations provide for variations from the status quo to be measured through an ordinal ranking that appears in the final output matrix of the printout. This procedure allows for a semi-standardization of numerical impact values that could then be used in an overall assessment of impacts utilizing a trade off analysis.

The transformations were accomplished by using percentage calculations. If the impact of a determinant variable on a determinate variable was between 0 and 15 percentage point variation from the status quo, the change was assigned a -1 or +1 for a mild negative or mild positive impact, depending on the direction of the change. If, however, the impact was between 15 and 35 percentage points, a +2 or -2 was assigned to the empirical impact values of Table 4. Finally, if the impact was greater than 35 percentage points change, a +3 or -3 was assigned. The selection of these cut-off points for assigning ordinal impact values was determined arbitrarily for illustrative purposes only. However, very accurate cut-off points could have been determined by the use of a sophisticated Delphi survey technique. This survey would allow basin-wide decision makers and other interested persons to determine the magnitude of percentage change from the status quo that would be considered a mild, moderate, or strong positive or negative impact of a determinant variable on a deter-

Table 4. IRUM raw output.

	LU1 Irrigated Acreage (Acres)	LU2 Oil Production (BBLS.)	WU1 Agricultural Water (AC. FT.) per acre	WU2 Industrial Water (AC. FT.)	WV1 T.D.S. (Tons)
LU1 Irrigated Acreage					
288000.		975109.	4.55	258404.	90469.
295000.		854657.	4.45	226484.	92544.
310000.		596543.	4.23	158084.	96992.
270000.		1284845.	4.86	340484.	85132.
250000.		1628996.	5.25	431684.	79202.
LU2 Oil Production (BBLS.)					
100000.	338856.		5.37		105548.
50000.	341762.		5.41		106409.
250000.	330139.		5.23		102963.
1250000.	272025.		4.31		85732.
1000000.	286554.		4.54		90000.
WU1 Acre Feet Ag. Water					
800000.	175439.	2912015.		771684.	57095.
1000000.	219298.	2157298.		571684.	70099.
1303700.	285899.	1011260.		267984.	89846.
750000.	164474.	3100694.		821684.	53843.
1250000.	271123.	1213902.		321684.	86354.
WU2 Acre Feet Ind. Water					
26484.	338860.	99940.	5.37		86333.
100000.	322738.	377358.	5.11		82372.
250000.	289843.	943396.	4.59		74290.
350000.	267913.	1320755.	4.24		68902.
425000.	251466.	1603774.	3.98		64861.

minate variable. By use of the Delphi technique, personal value judgments would be converted to the ordinal ranking parameters through an interactive process. The IRUM approach would then be a valid representation of an area rather than a representation imposed on an area by outside interests and values.

For example, if irrigated acreage remains at its current level of 288,000 acres, this will have no impact on the availability of water for industrial purposes, WU2, and a zero appears in Table 5. However, if the irrigated acreage is increased to 295,000 and 310,000 acres respectively, it will have a mild and then a strong negative impact on the availability of water for industrial purposes as shown in Table 5. But, if the irrigated acreage is decreased from 288,000 acres, to 270,000 and 250,000 acres respectively, it will have a moderate (+2) and strong (+3) positive impact on the availability of water for industrial purposes and so on. The transformation from Table 4 to Table 5 is accomplished by the use of the percentage calculations described in the previous section.

Table 6 extends Tables 4 and 5 to show the impacts of differnet levels of irrigated acreage (determinant) on the other variables (determinates). This is done by following estimations of these impacts by estimates of how these impacts will in turn (as determinants) affect the other variables (as determinates). Thus, a chain of causation is extended to secondary effects. The primary effects are given in Tables 4 and 5 and the secondary effects are given in Table 6. Since certain relationships are asymmetric, their reversed form does not result in an impact value for that position in the output matrix. Thus, in the output matrix a series of stars, or blanks, is printed for such cases and for situations where an item acts upon itself as occurs in the main diagonal of the final output matrix.

An example is helpful in illustrating these two orders of effects. If irrigated acreage is 288,000 acres, from Table 4 we know that this will allow for a maximum oil shale production of 975,109 barrels, an agricultural water supply level of 1,313,280 acre-feet or 4.55 acre-feet per acre application rate, an industrial water supply level

Table 5. IRUM ordinal output.

	LU1 Irrigated Acreage (Acres)	LU2 Oil Production (BBLS.)	WU1 Agricultural Water (Ac. Ft.)	WU2 Industrial Water (Ac. Ft.)	WV1 T.D.S. (Tons)
Irrigated Acreage					
288000.		3	0	0	0
295000.		3	-1	-1	-1
310000.		3	-1	-3	-1
270000.		3	1	2	1
250000.		3	2	3	1
Oil Production (BBLS.)					
100000.	-3		2		-2
50000.	-3		2		-2
250000.	-3		1		-1
1250000.	-3		-1		1
1000000.	-3		0		0
Acre-Feet Ag. Water					
800000.	-3	3		3	3
1000000.	-2	3		3	2
1303700.	0	3		3	0
750000.	-3	3		3	3
1250000.	-1	3		3	1
Acre-Feet Ind. Water					
26484.	-3	3	2		1
100000.	-3	3	1		1
250000.	-3	3	0		2
350000.	-3	3	-1		2
425000.	-3	3	-1		2

Table 6. IRUM secondary output.

		LU1 Irrigated Acreage (Acres)	LU2 Oil Production (BBLS.)	WU1 Agricultural Water (Ac. Ft.)	WU2 Industrial Water Ac. Ft.)	WV1 T.D.S. (Tons)
Irrigated Acreage	288000.0		3	0	-1	0
Oil Production (BBLS.)	975109.4	-3		0		0
Acre-Feet Ag. Water	1313280.0	0	3		3	0
Acre-Feet Ind. Water	258404.0	-3	3	0		2
Irrigated Acreage	295000.0		3	-1	-1	-1
Oil Production (BBLS.)	854656.6	-3		1		-1
Acre-Feet Ag. Water	1345200.0	1	3		3	-1
Acre-Feet Ind. Water	226484.0	-3	3	1		2
Irrigated Acreage	310000.0		3	-1	-3	-1
Oil Production (BBLS.)	596543.4	-3		1		-1
Acre-Feet Ag. Water	1413600.0	1	3		3	-1
Acre-Feet Ind. Water	158084.0	-3	3	1		1
Irrigated Acreage	270000.0		3	1	2	1
Oil Production (BBLS.)	1284845.3	-3		-1		1
Acre-Feet Ag. Water	1231200.0	-1	3		3	1
Acre-Feet Ind. Water	340484.0	-3	3	-1		2
Irrigated Agreage	250000.0		3	2	3	1
Oil Production (BBLS.)	1628996.2	-3		-1		1
Acre-Feet Ag. Water	1140000.0	-1	3		3	1
Acre-Feet Ind. Water	431684.0	-3	3	-1		2

of 258,404 acre-feet and a sediment load of 90,469 tons. From the first line of Table 5 we know that these figures translate into the ordinal impact values +3, 0, 0, and 0 respectively. However, once we know that the maximum oil shale production potential level is 975,109 barrels given an irrigated acreage figure of 288,000 acres, we can use this quantity of 975,109 barrels as a determinant to ascertain the impact that this level of oil production will in turn have on the other variables (determinates). For example, from Table 6 we can see that an oil shale production level of 1,628,996 barrels as determined by an irrigated acreage figure of 250,000 acres will have a -3 or strong negative impact upon the maximum allowable level of irrigated acres, a -1 or mild negative impact upon the availability of water for agricultural purposes and a +1 or mild positive impact upon the sediment load of the rivers in the basin. What this means is that if irrigated acreage decreases from the current level of 288,000 acres to 250,000 acres to permit an increase in oil shale production from 975,109 barrels to 1,628,996 barrels, the increase in oil production will severely restrict any possibility of increasing irrigated acreage (-3 impact), will slightly reduce the availability of water for agricultural uses (-1 impact) and will slightly reduce the sediment load of rivers in the basin (+1 impact). The sediment load will decrease because irrigated acreage and the diversion of water for irrigation purposes decreases. A series of stars appears in the main diagonals of Table 6 as they do in Tables 4 and 5 since the relationships are asymmetric. The IRUM model is designed to provide for a series of causation linkages between variables assuming both determinant and determinate roles. Table 6 illustrates two levels of analysis. The conceptual model, if applied in its entirety, would require, given its nine variables, nine levels of analysis. As previously stated, the above derived equations are at this stage of development simplistic linear relationships and area specific. However, the objective of this section was to illustrate the potential usefulness of applying the IRUM conceptual model described earlier.

Derivation of Equations

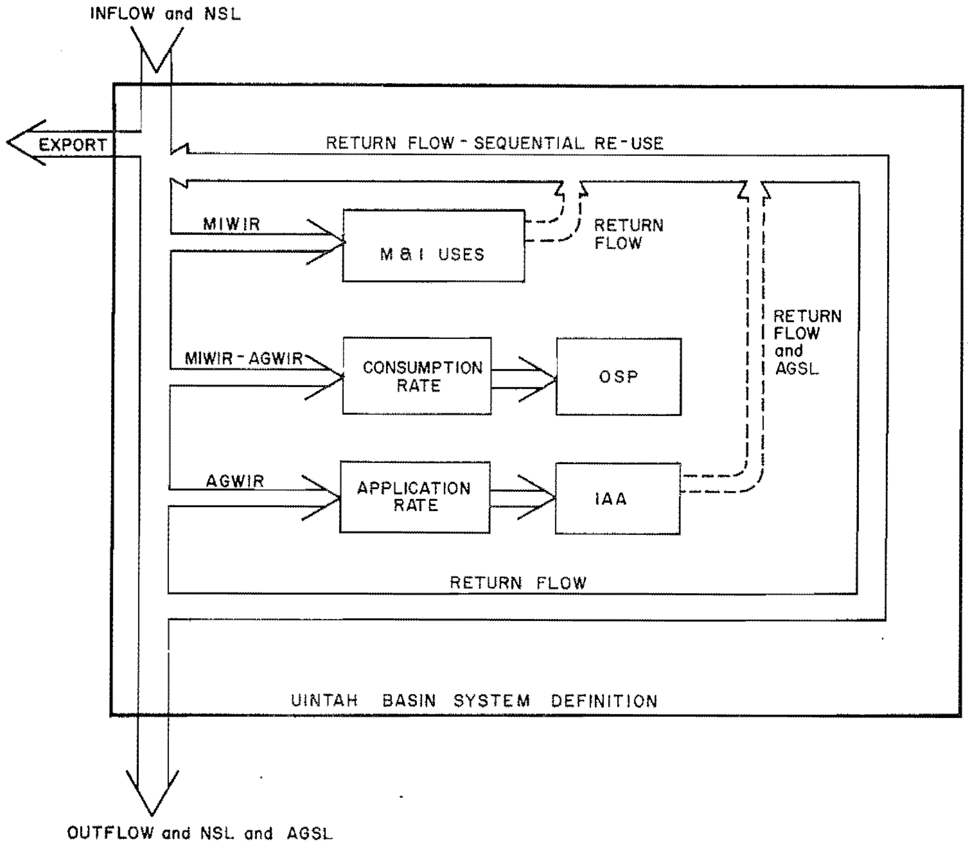
A general opinion survey of the Uintah Basin population revealed that the residents were primarily concerned with five issues: the retention of agricultural activities within the basin, the development of an oil shale industry in the basin, an adequate water supply for agricultural expansion, an adequate water supply for industrial development, and the maintenance of present water quality levels. These five concerns were expressed with the IRUM framework as represented in Figure 11. This figure illustrates several of the land use and water use characteristics with the IRUM framework as represented in Figure 11. This figure illustrates several of the land use and water use characteristics of the simulated area. The interrelationships of these characteristics form the basis of the IRUM application. Although this application includes only a few of the variables which influence proper land and water use in the Uintah Basin, the calibration of the model with these quantitative relationships should provide a reasonable pilot application of the IRUM approach to a real planning situation. Table 7 represents the water budget derived for illustrative use in the IRUM application.

Table 7. Water budget.

Water Use Category	AF/Year
Agricultural Water	
a) Surface diversions	1,303,700
b) Groundwater	8,000
Potential water development for export in the Central Utah Project	177,900
Potential water development within Basin use from Central Utah Project Units	55,600
Current M-I water use within Basin	
a) Surface diversion	14,484
b) Groundwater	12,000
Total estimated water supply	1,571.684

All amounts are estimations taken from Hyatt et al. (1970) p. 81-82, Thurston et al. (1973) p. 27, and Western Environmental Associates, Inc. (1975) p. 130.

The five variables used in the pilot study were irrigated acreage, oil shale production (bbls), agricultural water supply (acre-feet), industrial water supply (acre-feet), and total dissolved solids (tons of sediment per acre). The first two variables in the nomenclature of the IRUM methodology are land uses one and two (LU 1 and LU 2) respectively, the second two variables are water uses one and two (WU 1 and WU 2) respectively, and the last variable represents water value one (WV 1). Four of the variables (irrigated acreage, oil shale production, agricultural water supply, and industrial water supply) assume both determinate and determinant roles. These variables are listed vertically in Table 4. The fifth variable, sediment load (WV 1), assumes only a determinate role because within the Uintah Basin total dissolved solids do not become sufficiently concentrated to impact



INFLOW = The total annual inflow of water into the Uintah Basin from the main rivers and tributaries.

MIWTR = The present amount of water consumed in municipal-industrial use, estimated to be 26,484 acre feet (Western Environmental Associates, 1975).

OSP = Oil shale production. The current oil shale production in the basin is zero, but can be increased to over one million barrels (bbl.) per day. Water consumption is .265 af/bbl. (Western Environmental Associates, 1975).

AGWTR = The present amount of water consumed in agricultural use, estimated to be 1,311,700 acre feet. Of this withdrawn amount, 4.56 af/acre is the calculated annual application rate (Hyatt, et al., 1970).

NSL = Natural sediment load. This sediment load is present regardless of other water allocations in the basin.

IAA = Irrigated agricultural acreage. The current estimated acreage is 288,000 acres (Hyatt, et al., 1970).

AGSL = Agricultural use sediment load. This loading is caused by the use of water for purposes of irrigation. It is an addition to the natural sediment load.

OUTFLOW = There exists certain legal allocation requirements which require that a minimum outflow be maintained from the basin to contribute to the Colorado River flow at Lee's Ferry.

Figure 11. IRUM representation of planning issues.

the other four variables either negatively or positively. Downstream from the basin, the impact becomes significant, but this analysis only addresses interactions occurring within the basin. The numbers shown in Table 4 represent the impacts of the determinant variables (listed vertically) on the determinate variables (listed horizontally). As estimated by the equations derived below, the relationship between LU 1 and LU 2 is that within an irrigated acreage of 288,000 acres the maximum potential level of oil shale production would be 975,109 barrels. If irrigated acreage is 295,000 acres, then the maximum potential level of oil shale production would be 854,657 barrels, and so on. The following sections describe how the data compiled in Table 4 was derived.

Irrigated Acreage

The relationship of irrigated acreage (determinate) and the other variables (determinants) used in the model is represented by four equations. The first equation:

$$\frac{1,571,684 - (4.56\ (IR.AC))}{.265} = \text{oil shale production potential}$$

was derived from the water budget in Table 7 and represents the potential for oil shale production, LU 2, that will remain after the withdrawal of water for use in irrigation. The total water available for all uses in the basin is 1,571,684. The equation assumes that any increase in irrigated acreage (IR.AC) will require an increase in agricultural water amounting to 456 acre-feet/acre annually. This application rate is a system level average. The water not used by agriculture is then divided by the production coefficient of 0.265 acre-feet/barrel in order to estimate the maximum potential level of oil shale production for a given acreage (IR.AC) in irrigated agriculture.

The second equation:

$$\frac{1,311,700}{IR.AC} = \text{application rate of agricultural water}$$

represents the variation in the long term average annual rate of agricultural water application (1,311,700 acre-feet of water to agriculture) that would have to occur if the irrigated acreage (IR.AC) is increased or decreased. Thus, the impact can be ordinally ranked in terms of applied quantity per unit rather than total quantity available.

The third equation:

$$1,571,684 - (4.56\ (IR.AC)) = \text{total water available for industrial use}$$

represents the amount of water which would be available for use in all industry (not constrained to oil shale production as in the first equation) if the water supply utilized in agriculture changed due to the fluctuation of irrigated acreage (IR.AC).

The fourth equation was derived from a linear regression of the sediment load on irrigated acreage based on the data in Table 8 for the Uintah Basin:

$$.2965\ (IR.AC) + 5076.97 = \text{tons of sediment load per irrigated acre}$$

Again, this equation represents a basin wide average and not the specific sites within the basin. The correlation coefficient (R) was 0.7389. The output of this regression equation is expressed in tons of sediment annually and ranked ordinally according to the variation in the present level of sediment caused by variations in the level of irrigated acreage (IR.AC).

Oil Shale Production

The relationship of oil shale production (determinant) to the other four variables (determinates) is represented by three equations. The first:

$$\frac{1,571,684 - (.265\ (OSPL))}{4.56} = \text{maximum irrigated acreage potential}$$

represents the effect of oil shale production on irrigated acreage, LU 1 (agricultural land development). This formula, similar to the one used to measure the impact of irrigated acreage on oil shale production, projects the maximum irrigated acreage which could exist if the present irrigation application rate is maintained and the amount of water allocated to agriculture is that which remains when the product of the production coefficient (0.265) and the oil shale production level (OSPL) is deducted from the total water available in the basin (1,571,684 acre-feet).

The second formula represents variations in the irrigation application rate as impacted by oil shale production:

$$\frac{1,571,684 - (.265\ (OSPL))}{288,000} = \text{irrigation application rate}$$

In this equation, irrigated acreage is held constant at 288,000 acres and the water allocated to this acreage is a function of the oil production coefficient and the oil shale production level (OSPL).

The third equation is a combination of the regression equation developed previously and the maximum irrigated acreage potential equation listed above. This third equation:

$$\left(\frac{1,571,684 - .265\ (OSPL)}{4.56}\right) .2965 + 5076.95$$

represents the tons of sediment load per irrigated acre given the results of the first equation. In other words, this third equation:

$$\frac{1,571,684 - .265\ (OSPL)}{4.56} = \text{maximum irrigated acreage potential (MIAP)}$$

$$.2965\ (MIAP) + 5076.97 = \text{tons of sediment load per irrigated acre}$$

calculates the tons of sediment load per irrigated acre given the maximum irrigated acreage potential (MIAP) as determined by the first equation. Since the first equation measures the impact of oil shale production on irrigated acreage, the chain of causation or relationship of oil shale production levels and the tons of sediment load per irrigated acre is established.

A fourth equation relating oil shale production level impacts on the availability of water for industrial purposes was not developed because there is no significant competition for water between industries in the basin. Since oil shale production is essentially the only industry using significant amounts of water, no trade offs or impacts between that industry and others could be established.

Agricultural Water Supply

The relationship of agricultural water supply levels (determinants) and the other four variables (determinates) used in the computer adaptation is represented by four equations. The first:

$$\frac{(AWSA)}{4.56} = \text{maximum irrigated acreage potential}$$

represents the relationship of agricultural water supply to irrigated acreage. The equation yields the maximum potential for irrigated acreage if the present application rate of 4.56 acre-feet/acre is maintained and the total water supply allocated to agricultural use (AWSA) is varied.

The second equation:

$$\frac{1,571,684 - (AWSA)}{.265} = \text{maximum potential output of oil shale}$$

measures variations in potential oil shale output. This formula first computes the amount of water which will remain for oil production when a specified amount is allocated to agricultural use (AWSA), and then divides this amount by the oil production coefficient to arrive at the maximum potential output of oil.

The third equation:

$$1,571,684 - (AWSA) = \text{maximum potential industrial water}$$

simply illustrates the trade off between agricultural and industrial water supplies in the basin.

The fourth equation is a combination of the regression equation developed previously and the maximum irrigated acreage potential equation listed above. This fourth equation:

$$\left(\frac{(AWSA)}{4.56}\right) .2965 + 5076.97$$

calculates the tons of sediment load per irrigated acre as a result of changes in agricultural water supply levels. This fourth equation:

$$\frac{(AWSA)}{4.56} = \text{maximum irrigated acreage potential (MIAP)}$$

$$.2965\ (MIAP) + 5076.97 = \text{tons of sediment load per irrigated acre}$$

measures the tons of sediment load per irrigated acre given the maximum irrigated acreage potential (MIAP) as determined by the first equation. Thus the linkage or chain of causation between agricultural water supply levels and the tons of sediment load per irrigated acre is established. The amount of irrigated acreage expected for a given water allocation to agriculture is first computed while maintaining a constant per acre application rate. The previously described regression equation is then used to arrive at the expected sediment tonnage level. Again, the equations represent a system average in a static situation with no feed-back considerations for a subsequent time period.

Industrial Water Supply

The relationship of industrial water supply levels, WU 2, (determinant) and the other four variables, LU 1, LU 2, WU 1, and WV 1, (determinate) used in the applied model is represented by four equations. The first:

$$\frac{1,571,684 - (OSPWS)}{4.56} = \text{maximum potential irrigated acreage}$$

represents the maximum potential irrigated acreage which would be possible if the present per acre application rate (basin-wide average annual) was held constant and the water supply allocated to oil shale production (OSPWS) was varied.

The second equation:

$$\frac{\text{(OSPWS)}}{.265} = \text{maximum potential oil shale production level}$$

represents the maximum level of oil shale production that could be achieved given the present oil shale production coefficient and a specified amount of water allocated to industrial use (OSPWS).

The third equation:

$$\frac{1,571,684 - \text{(OSPWS)}}{288,000} = \text{agricultural application rate}$$

first computes the amount of water which would remain for agricultural use if a specified amount (OSPWS) is allocated to industrial use. This amount is then divided by the current level of irrigated acreage to arrive at the new agricultural water application rate. The variation in the agricultural application rate is then ordinally ranked according to the extent of variation.

Based on the sediment yield regression, the fourth equation is:

$$\frac{1,571,684 - \text{(OSPWS)}}{4.56} \; .2965 + 5076.97$$

$$= \text{tons of sediment per irrigated acre}$$

and estimates the sediment load per irrigated acre given the maximum potential irrigated acreage as determined by the first equation. Thus the linkage between industrial water supply levels and sediment load per irrigated acre is established. However, rather than using the above approach, a new regression formula was derived to show the relationship between sediment load and total acre-feet diversions of water from agriculture rather than irrigated acreage. It was felt that if there was a strong correlation between irrigated acres and sediment load that there would likewise be a strong correlation between acre-feet diversions of water to agriculture and sediment load. That is, sediment load could be measured in terms of the number of acres irrigated, with the application of water held constant, or in terms of the amount of water diverted to irrigate those acres, with the total acreage held constant. The new regression:

$$.05388 \text{ (OSPWS)} + 3078.069$$

$$= \text{tons of sediment load per acre-feet diversions of water to agriculture}$$

was derived from information on Table 8.

Using the above data, a correlation coefficient of $R = .76845$ was determined.

The fourth equation:

$$1,571,684 - \text{(OSPWS)} \; .05388 + 3078.069$$

calculates the level of sediment load expected for a given allocation of water to industrial uses (OSPWS). Recall that 1,571,684 acre-feet is the total available water supply in the Uintah Basin. Thus, the linkage between industrial water supply levels (OSPWS) and the tons of sediment load per acre-feet allocation of water to agriculture is established.

Table 8. Sediment load, irrigated acreage, and total diversions by subregion.

Hydrologic Subregion	Sediment Load (tons)	Irrigated Acreage (acres)	Total Diversions (AF)
Duchesne Above Duchesne	3000	15000	54200
Duchesne Above Randlette	28000	118500	469000
Green River Above Jensen	3000	4500	23500
Green River Above Ouray	5000	9500	39600
Little Snake River Basin	8000	21600	150800
Yampa River Basin	47000	66700	287300
Ashley Creek Basin	12000	23000	74600
White River Basin	20000	29200	204700
	126000	288000	1303700

Methodological Considerations

The principal objective of this research report was to begin development of a methodology (IRUM) to integrate water and land use planning. In order to keep the development as practical as possible from the beginning, a scaled-down pilot version was formulated first to determine what methodological problems would be encountered by a decision maker attempting to implement IRUM. Time and money did not permit full application of the IRUM model to the Uintah Basin. Consequently, the majority of the conditions, values and uses interrelationships of Table 3 remain unexplored.

One of the problems encountered in the pilot implementation of IRUM was that of determining the linkages amongst the uses, values, and conditions variables in order to represent the interrelationships of Table 3. The uses, values, and conditions listed in Table 3 outline the boundaries and domain of the aggregate IRUM model for the Uintah Basin. Many interrelationships were easily handled, such as the relationship between agricultural water use and the sediment loading of basin rivers or the relationship between available agricultural water and irrigated acreage development. Reliable data were available to establish these relationships. Scattergrams were constructed to determine the nature of the relationships (linear or nonlinear) between irrigated acreage and sediment loading and between total diversions and sediment loading. The relationships needed for the model proved to be reasonably linear and had fairly high correlation coefficients. The high correlations meant that between the origin and any maximum potential value, the derived equations yielded a close approximation to the actual situation.

Other relationships are more difficult to handle; e.g., the link between irrigated acreage and the demand for public education facilities, or the link between irrigated acreage and total employment, or the link between employment and crime rate, or the link between oil shale production and the demand for health facilities, etc. Even though empirical data may show associations among data of these sorts in a given context, one needs to be very careful before inferring any definitive relationship. The relationship between oil shale production and sediment loading developed for the pilot version of IRUM was inferred from the empirical data and appeared reasonable in light of what is known to occur when irrigated land is taken out of production. A full scale application of IRUM would require a relationship matching the water use of cropland irrigation to the economic condition employment of Table 4. No obvious relationship exists in this situation and simple regression analysis may not give reasonable results because of the complexity of the relationship. Indirect employment multipliers could be developed as an alternative method to project the indirect (non-farm) employment associated with the direct employment in agriculture. Direct farm employment could then be compared with non-farm employment in selected areas within the planning region to generate a regression equation for the region for estimating incremental changes in non-farm employment generated by changes in direct farm employment. The problem with this approach is its implicit assumption that the direct farm employment (the exogenous or determinant variable) caused the non-farm employment (the endogenous or determinate variable) when this may or may not be the case. Non-farm employment may change as a result of many interrelating factors too complex to represent in a manageable model.

The implication of empirical data is one of correlation, not causation. Indirect causation can only be quantified by examining the intermediate relationships. For example, one way to begin may be to establish a link between irrigated cropland and total cropland per average farm (an acre specific consideration). This may then be linked to the average farm employment or populus engaged in farming activity per average farm. At this point several alternatives are available. The farm employment level (weighted by indirect farm employment as a function of farm output per irrigated acre) could be statistically linked to the non-farm employment level giving total employment in a region; or, the farm related population could be linked to the non-farm populus with the total population of an area linked to a projected employment level for that particular area. Non-farm employment caused by non-agricultural economic activity would of course have to be projected in some other manner.

Several significant problems arise when extended linkages are utilized. The first and most important, within the IRUM framework is that the errors in the estimation of each single linkage accumulates through the chain; and unless linkages have an extremely high correlation with one another, the accumulated error will render the linkage useless for planning purposes.

The second problem which arises is the nature of the assumptions used to form the linkage chain. In choosing linkages to connect two variables, certain assumptions about causality are made. If A causes B and B causes C, then A can be linked to C through B. An unsuspecting model user may, however, incorrectly conclude that A causes Z, Z causes Y, Y causes K and K causes (statistically) A. Recursive path analysis, an extension of multiple regression, allows testing a theoretical model of causation, thereby specifying the linkages existing within the system. Finally, there may or may not exist a trade off between the greater conceptual validity of a lengthy set of extended linkages and the greater accuracy of a shorter set of linkages.

Another problem in the implementation of IRUM is the availability of useful data. The information for the pilot implementation of IRUM was collected from searches of published data. The boundaries of the regions covered by the studies varied considerably. Hydrologic basins were defined by drainage divides, political and economic regions were defined by county and state lines, and administrative units were defined by natural environmental criteria (forest lands and water conservancy districts), historical patterns (Indian Reservations), or purely arbitrary criteria such as the mixing of state owned lands within areas administered by the Bureau of Land Management. Many of the defined regions matched the study area well enough to present no problem (political and economic regions); the data collected on others, however, had to be adjusted to fit the Uintah Basin proper. A planner attempting to implement IRUM should employ an empirically grounded approach in assessing socio-economic impacts. Data should be collected from previous (reliable) studies, public and private records and surveys and interviews of the general public and key officials.

Since the IRUM framework utilizes ordinal ranking criteria to illustrate socio-economic and environmental impacts, some criteria must be used to judge whether an impact is mild, moderate, or strong. Some form of judgmental evaluation must be conducted in order to understand the level and direction of the impact. Several judgmental techniques have been developed, including the Delphi and the graphic rating scale. They are all basically similar in purpose, but the Delphi procedure attempts to extract consensus on the evaluation. The thrust of the judgmental techniques is to gage ratings of various items by experts or the general public. The approach used in this study translated the empirical impact values (Table 4) into ordinal evaluations (Tables 5 and 6) on a seven point rating scale. Use of the same seven values for each variable provided a semi-standardization of numerical impact values that could then be employed in an overall assessment of trade offs among impacts. The break-point percentages used to define the rating scale were determined arbitrarily for illustrative purposes; however, the cut-off points could have been determined by the use of a sophisticated Delphi survey technique. This survey would allow interested persons to determine the magnitude of percentage change from the status quo that would be considered a mild, moderate, or strong positive or negative impact. Personal value judgments would be converted to the ordinal ranking parameters through an interactive process. The IRUM scale would then represent the viewpoint of the people of an area rather than values dictated by the viewpoint or convenience of the planner.

There is no "best" type of formula for expressing the linkages required by IRUM. Whether he uses simple regressions or complex difference equations, the user must assess the validity of the formula for the IRUM ranking process. This aspect might serve as a limiting factor in selecting the scope of the particular IRUM application since the costs of the formula derivation would tend to increase as the complexity of the formula increased.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented in this chapter should be prefaced by a qualification concerning the meaning and need for comprehensive resource planning. It has been argued throughout this report that the problems confronting society require a more holistic approach to resource planning. Such an approach requires some basic and drastic changes in the orientation and level of expertise of the personnel who are responsible for planning and in the use made of planning by our institutions. Perhaps the greatest need is to disseminate available knowledge on holistic approaches to planning. Planners who do not know how to plan holistically will continue to produce plans that remain segmented and not very effective in achieving goals that can be accomplished by better coordination of land and water uses.

The difficulty, however, runs deeper than the absence of functional procedures. Presently there is not even a common understanding of what integrated planning is all about. Furthermore, the current cultural and institutional context for planning does not encourage planners to move in that direction. Efforts to do so are handicapped by the fact that the very terms used by different planners may be considered unclear or trivial until an accepted context exists for their interpretation and implementation.

Fundamentally, the obstacles to integrated resource planning arise from the absence of a common frame of reference or planning perspective. The roots of these obstacles are manifested in the diversity of cultural responses, institutional forms, and methodological approaches that characterize planning activities. It can therefore be argued that a strategy to integrate resource planning must come to grips with the problem of developing a common frame of reference.[1] In this context, for example, the Principles and Standards represent an attempt to bring about more uniformity. However, given the deep-seated nature of the factors that prevent better integration of resource planning, the implementation of the Principles and Standards should be seen as only a preliminary phase in a larger continuing effort. Without such a broader implementation oriented approach, the impact of the Principles and Standards is likely to be minimal.

Although our research focused on the integration of water and land planning, it has become clear in the course of the study that the road to comprehensive resource planning cannot end there. Water and land uses have become so intertwined with other resource uses that planners need to consider virtually the entire spectrum of interactions between human society and the natural environment. Thus it is within this broad perspective, which ultimately aims to develop a more uniform planning frame of reference, that our conclusions and recommendations deal with cultural, institutional, and methodological issues and questions in the following areas:

- I. Cultural
    - A. Concepts and Terminology
    - B. Education and Training
    - C. Citizen Participation
- II. Institutional
    - A. Organizational Arrangement
    - B. Law and Regulation
- III. Methodological
- IV. Implementation

From this holistic perspective previous thinking about planning has not been sufficiently ambitious in scope. The comprehensive planning rhetoric has overlooked its far-reaching practical implications. There has not been the awareness or commitment to bring about the changes in the culture of planners that are needed to effectively implement comprehensive, integrated planning. To transform the rhetoric of interdisciplinary, integrative planning into reality, some traditional ways of thinking must be discarded and a stronger commitment made to basic improvements in the cultural context of planning.

Culture

The culture of a group is defined by the ideas, values, beliefs and attitudes that are commonly held by the members of that group.

[1]Of course, too much uniformity is not desirable. A certain degree of balance with diversity is necessary, the problem being to determine what an appropriate balance might be.

The current culture among policy makers and planning officials, and among the general public, does not have a cohesive, holistic, ecological planning perspective. The absence of such a culture remains the most formidable obstacle to integrated resource planning. Its absence is manifested by a lack of congruence among the concepts, values, and attitudes concerning the nature of planning, so that the implementation of an integrated planning approach is virtually impossible. The development of a cohesive, more uniform planning culture will require considerable intervention in socialization processes through education and training and more effective public participation.

Development of the needed cultural context requires a major change in value orientation toward a more active, conscious concept and implies considerable intervention in socialization processes in order to increase public awareness about the expanding complexity and interrelatedness of human society and its natural environment. Unfortunately, much of the discussion about the relationship between modern American society and the natural environment has been diffuse and speculative. There is not much systematic study of this area, except perhaps in the related subject of technology assessment; while those studies that have been done appear to have had little impact on policy formation and/or implementation. Our conclusions regarding culture and integrative planning can therefore best be posed as questions.

1. How does culture affect the response and adaptation of a society in relation to the natural environment?
2. What is the nature of the interrelationships among culture, technology, and natural environment?
3. In what ways does culture in our society affect or constrain planning and policy formation/implementation?
4. How can or should the culture be structured and developed in a conscious, directed manner?

Recommendation 1:

A thorough, systematic survey should be undertaken to identify the effects of culture-technology-resource use interactions in modern society on resource planning and policy, and vice versa.

Concepts and Terminology

The fact is that the formation and implementation of comprehensive, integrated plans necessitates some agreement about the use and application of quantitative as well as qualitative concepts and ideas. In many planning efforts, even minimal agreement does not exist. For example, in the survey conducted by the researchers, it was found that such basic concepts as "goals," "objectives," and "purpose" were interpreted in critically different ways or were not understood to be meaningful by individuals with various water planning responsibilities in the same planning region. Under these circumstances, it is not possible to integrate the planning activities in the different areas of a region and achieve some desirable optimum. Clearly, there is a great need to develop more uniformity and conceptual standardization among resource planners and policy makers.

Recommendation 2:

A task force should be established to explore and identify appropriate areas for conceptual uniformity and standardization of planning terminology using modern linguistic analytical techniques.[2]

Education and Training

The cultural constraints to better resource management imply a need to educate the general public on technological capabilities and limitations and on environmental constraints. Additionally, there is an even greater need to broaden the education and training of individuals with planning responsibilities. Both information dissemination and technology transfer are thus very important if more effective resource management is to be achieved. Three target audiences can be distinguished: (1) the general public, (2) non-professional, "citizen planners" who influence or make planning decisions, and (3) professional planners. The education of the first two groups is particularly important for integrative planning because such planning must counter special interest tendencies and narrow functional perspectives.

Organized programs for the planning education of the general public and citizen planners are virtually nonexistent, largely because so little is known about how to structure a program to best meet resource management needs. More also needs to be known about educational needs and standards for professional planners. The kind of knowledge that is lacking concerns the nature of the appropriate content, form, and method of planning education for the three types of audiences. Without this knowledge, no effective educational policy can be formulated and implemented to insure that a supportive institutional planning context can be developed in the society to deal with complex holistic resource problems.

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[2]This kind of effort would seem to be a natural prerequisite for implementing the Principles and Standards, for example.

Recommendation 3:

The necessary research should be conducted so that an effective educational policy can be developed and implemented to better prepare the general public, citizen planners, and professional planners to understand and cope with complex interactions between technology and the environment. Research questions that should be examined include:

1. What kinds of knowledge should be processed by the general public, citizen planners, and professional planners in order to participate effectively in resource planning processes?
2. What is and should be the role of formal and informal planning education to impart the necessary knowledge to the three audiences?
3. How should educational standards be applied and evaluated?

Citizen Participation

Awareness of needs of cultural change is promoted through communication and participation. Active citizen participation can be a positive force in developing the cultural context that is needed to implement integrated planning approaches. In the last several years, research on citizen participation has resulted in considerable knowledge about its limitations and potentialities for planning. This knowledge needs to be identified and applied in the implementation of resource planning programs, especially those that involve the integration of varied planning activities. Citizen participation in such programs are particularly important because they are most vulnerable to the political pressures that are generated by citizen and special interests.

Recommendation 4:

Resource planners should give special consideration to the role of citizen participation in defining the cultural and political context that affects the implementation of integrated planning efforts. This consideration should go beyond the concern with promoting participation to focus on the effects of increased or decreased citizen participation on implementation.

Institutional Factors

If our society is to work systematically to solve its future resource problems, initiatives will have to be taken by individuals and at all levels of government. However, it is difficult to determine what kind of governmental body or what patterns of institutional organization can best stimulate the implementation of a practical and effective holistic planning process that takes into account the diverse elements and interests concerned with the use of natural resources. How would the various institutions relate to the society and one another? We need to develop more systematic policies to deal with these and related questions.

Organizational Arrangements and Forms

It is clear that the organizational arrangements that structure an integrated planning effort are important to its success. Much research has been conducted to determine what organizational arrangements are most appropriate for certain aims, but this research has not had much impact. As Derthick (1974) has observed, political realities and pressures of the moment predominately govern actual planning efforts. Therefore, relatively little can be achieved to improve planning through an organizational approach until other supporting institutional and cultural changes have taken place. This means that the public, various social and political groups, and decision makers need to develop a stronger basis for a shared understanding of planning problems and processes.

Of course, certain broad observations about organizational forms for integrated resources planning can be made. One observation is that in our pluralistic system, only coordinative and cooperative arrangements are likely to have an impact. The provisions for such arrangements should include assurances that implementation will occur. A second observation is that mechanisms for information dissemination and communication could greatly enhance the integration of resource planning activities. These two observations refer to possible organizational improvements that are feasible within the existing institutional and cultural framework. Additional improvements can be made once it is understood about the effectiveness of organizational forms when subject to different institutional and societal constraints.

Recommendation 5:

The implementation of an organizational arrangement to improve planning integration should be based on the realistic assessment of the political and cultural constraints that will influence its effectiveness. Special attention should be given to the degree of coordination and centralization which is feasible in relation to expected plan implementation.

Recommendation 6:

Greater effort should be made to establish organizational arrangements that can significantly improve communication and the flow of information among affected government entities and other groups in a planning region. This might be accomplished through regular committee meetings, special "communication units," and the use of computer technology.

Laws and Regulations

The effects of laws and regulations on the resource planning process have been well recognized, but planners and the public have been much less successful in employing them in resource management. In effect, their influence has tended to be much stronger as determinants of planning outcomes--a case of tails wagging the dogs. The increasing complexity of resource systems and the traditional institutional response of "passing a law" when something goes wrong have contributed to this trend. Certainly, laws and regulations should be the product of planning rather than the reverse. To achieve a better balance between the legal system and the planning process, a comprehensive review of resource related laws and regulations should be undertaken. In addition, research should be supported and implemented to investigate alternative approaches to regulatory and enforcement methods for control of resource use.

Recommendation 7:

An independent task force should be established to review and evaluate existing legislation and regulatory controls to determine the degree of conflict, duplication, and overlap that presently exists and to identify appropriate corrective methods. This task force should work closely with the congressional offices and staff.

Recommendation 8:

A research program should be instituted to identify and develop methods of controlling resource uses that encourage self-disipline through a system of incentives and education rather than through direct enforcement techniques.

Methodological Issues

The major conclusion of the present study concerning the methodology for integrating water resources and land planning pertains to the degree of fragmentation and incompatibility that presently exists. Further, most methods that are employed in planning studies tend to be inaccessible to the majority of decision makers. A detailed analysis of the issues and problems that characterize the methodology for planning has been presented by Mulder in another study (Keith et al., 1977). Much effort and money could be saved, and planning made more effective, if there were more concensus and agreement about methodological procedures. To develop a practical concensus, a two-pronged approach should be implemented focusing on the methodological framework or models that are appropriate and methodological procedures that can be used, and the specific methods or techniques that can be applied. Standards should be developed as has been done by some professional societies in other fields, and more training should be undertaken.

Recommendation 9:

A major effort should be launched to establish guidelines and standards for methodological procedures for resource planning. The effort could be implemented similarly, to that used in developing the "Principles and Standards."

The optimal implementation of comprehensive, integrated planning programs must involve the development of an appropriate, methodological framework and special models to meet complex requirements. These include the resolution of multiple goals, objectives, and interests; the organization of activities and decisions at several levels; and the analysis and presentation of large amounts of information. It is not clear what the trade offs would be in promoting the general use of one broad methodological approach versus use of a variety of models and methods according to the tastes of individual planners. In any case, there is a need to learn more about the methodological approaches, procedures, and methods that can best be applied in integated resource planning efforts.

Recommendation 10:

A study should be conducted to determine the methodological state of the art with respect to comprehensive, integrated planning to identify methodological needs, limitations, and potentialities to effect improvements in the integation of water, land, and related areas of planning.

Implementation

Given that the ubiquity of plan implementation problems is generally recognized, it is remarkable how little systematic knowledge is available about implementation. Comprehensive, integrated planning presents an embarrassing case-in-point because of the official rhetoric that has long characterized this type of planning without much attendant practical success. The implementation of comprehensive plans in an integrative manner has by most standards not been successful. Some have attributed the lack of success to the nature of comprehensive planning but the arguments have been theoretical in nature and cannot be said to be conclusive; however, equally strong arguments in favor of comprehensive planning have been made. Certainly, it is not clear what combination of factors in the planning context or in the planning process tend to block implementation. Considering the monetary and manpower resources that our society in devoting to large-scale comprehensive policy development and planning, there is an increasingly urgent need to know more about implementation.

Recommendation 11:

Research should be supported to determine what factors promote or block successful plan implementation, and to identify how various planning contexts and approaches are influenced by these factors.

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APPENDIX A

SURVEY PROCEDURES AND RESULTS

A general opinion survey of a sample of residents of the Uintah Basin was conducted between March 5 and March 10, 1976, by the Opinion Sampling Research Institute. The purpose of the survey was to identify public attitudes regarding land and water use and perceptions of natural resources planning issues. A sample of 300 basin residents was drawn, proportionately stratified by area and sex to insure a representative group. The sampling error was determined to be not more than ± 5.5 percent at a 95 percent confidence level. Demographic characteristics of the sample are summarized in Table A-1. Telephone interviews were used for 100 individuals and the remaining 200 were interviewed in person. The open ended format of the questions produced a range of responses that are not amenable to statistical summary. A verbal summary of response patterns is provided instead.

Responses to question one of the survey (What are the major uses of water in your area?) fell into one or more of four general water use categories: municipal, agricultural, industrial, or recreational water uses. Residents of towns mentioned municipal uses most frequently while the rural participants mentioned agricultural uses most frequently. Of the municipal uses, domestic uses and then commercial uses were recurrently mentioned. Agricultural uses were the second most repeatedly mentioned water uses. Irrigation was the most commonly named agricultural use, followed by stock watering. The third most commonly enumerated category was industrial uses, including water for extraction of oil and gas, electrical power generating facilities, and mining operations. The least recurrently enumerated category was recreation.

Table A-1. Demographic characteristics of Uintah Basin survey sample (n = 300).

Characteristic	Number Sampled
Area:	
Roosevelt, Utah	70
Vernal, Utah	105
Rangely, Colorado	35
Fort Duchesne, Utah	10
Rural Areas*	80
Sex:	
Male	150
Female	150
Age:	
Under 30	85
30-44	95
45 and older	117
Length of Residence:	
5 years or less	87
More than 5 years	213

*Includes Altamont, Arcadia, LaPoint, Neola, Randlett, and Myton

Culinary and irrigation uses were the most frequent replies given to question two (Which one of these uses do you consider the most important?). Respondents from rural areas were more likely than town residents to rate agricultural uses most important.

Responses to question three (What are the major uses of land in your area?) fell into one or more of four general land use categories: agricultural, industrial, municipal, or recreational land uses. With the exception of the Rangely area, where industrial oil well production was listed as the major use of land in the area, agricultural uses were most often cited. Next in industrial activities was the second most frequently cited land use, including oil and gas production and mining (phosphate and asphalt). Municipal uses was the third most frequently mentioned. Recreational uses with hunting, then game refuges, then scenic wilderness, and finally off-road vehicle use were the least frequently cited land uses.

The residents of the basin overwhelmingly listed agricultural land uses (crop farming, ranching, and grazing) as the most important (except for Rangely respondents who tallied industrial oil production first, followed by industrial uses (oil), municipal uses (housing and commercial), and recreational land uses. In answer to question five (What qualities or attributes would you list as valuable or important in the land around your region?) the majority of the respondents stated that the land was rich in natural resources--oil, gas, oil shale, forests, phosphate, and other minerals and thus very productive. Fertility of the land for crop farming, gardening, and pasturing and grazing of stock were frequently mentioned. The scenic beauty or aesthetic qualities of the land and geographic remoteness from large urban centers was often cited. The recreational potential of the land was also mentioned, as was the abundance of open spaces. Geologic features were credited for providing the residents with a fairly dependable supply of water from the mountainous watershed area.

In replying to question six (What qualities or attributes would you list as valuable or important in the water around your region?), most of those surveyed felt that the water in their area was soft, clean, pure, clear, free from mineral contamination, abundant, readily available, and tasted good. Rangely respondents, however, said their water was dirty, too high in mineral content, and tasted terrible. In addition, water was valued because it provided for electrical power and, through irrigation, made the land productive. Recreation potential, especially fishing, was also mentioned. The Ute Indians valued the economic profitability of their water rights. Tribal waters service many of the surrounding non-Indian municipal, agricultural and industrial activities.

A substantial majority of the respondents felt that the key water issue (question seven) was the controversy over the Central Utah Project which would send water out of the basin that was needed for the growth of the Uintah Basin. Many respondents felt that there was a shortage of water in the basin and that residential hook-ups for sewer and water were difficult to obtain. Several persons felt that there existed a conflict between agricultural interests in water and the use of water for culinary purposes to accommodate the growth of the cities. Other respondents pointed to the dispute between Utah and other states over the water rights to the Green and White Rivers. Some of the residents polled complained that the price of water was too high and that it was very difficult to obtain water rights. Several persons noted that water supply delivery systems were in poor condition and that much water was wasted. The Ute Indians surveyed felt that the key water use issue was the controversy over tribal rights to water in the area. Rangely residents felt that the key issue was the poor quality of water in Rangely.

In responding to question eight (What do you foresee as the major water use issues in the next 5 to 15 years in your area?), the participants thought that there would not be enough water available to sustain the growth of the region. They pointed to the Central Utah Project sending water out of the basin and to the dispute between Utah and other states over the water rights to the Green and White Rivers. Because of the anticipated shortage of water, the residents saw a conflict between municipal, agricultural and industrial interests in the available water. Most respondents foresaw housing and commercial building and oil shale development driving the farmer out of the area.

Question nine (In your opinion what are the major land use issues in your area today?) responses pointed to a conflict between municipal and agricultural interests. The increased use of land for residential and commercial building is reducing farm acreage and forcing the farmer out of the area. Residential and commercial construction is also presenting a zoning problem. Many respondents felt that their property rights were being violated by the cities' zoning ordinances. Others complained that the city government was not allowing the town to grow and that building permits were difficult to obtain. Several participants thought that the price of land in the area was too high. Numerous persons protested government control of much of the land in their area for conservation and were especially upset with the Bureau of Land Managments' control over grazing rights and the high cost of grazing fees. Some people metioned the controversy over possible strip mining for oil shale, the disposition of spent shale, and problems with reclaiming the land and preserving the natural environment. A few residents grumbled over the dwindling game population, the closure of some grazing areas to off-road vehicles and the control of much of the land in the area by the Ute Indian tribe. Several Ute Indians complained that attemps were being made to take parts of the reservation away from the tribe.

In replying to question ten (What do you foresee as the major land use issues in the next 5 to 15 years in your area?), many of those surveyed stated that the development of oil shale could create growth and environmental problems in the area. Many respondents expected increased housing and commercial construction to substantially reduce farming activities in the area and predicted conflicts between developers and agricultural and environmental groups. Several participants foresaw further subdivision and zoning ordinances which they believe would interfere with their property rights. Others foresaw increased land values, the possibility of uncontrolled building patterns and problems associated with strip mining for oil shale, reclaiming the land and disposing of the spent shale. Many respondents predicted increased government land use control in the area for environmental purposes and further conflicts with the BLM over grazing permits. Several people thought that the dispute over Indian ownership of much of the land in the basin would be a significant land use issue.

Of the 300 persons interviewed in the Uintah Basin, only 11 disapproved and 28 didn't know if they approved or disapproved of oil shale development (question eleven). Of those disapproving or who didn't know, the majority were farmers, retired farmers or Ute Indians who felt that oilshale development would ruin the rural atmosphere of the area or damage the land.

Question twelve (What problems, if any, do you foresee which would limit the development of oil shale in your area?) evoked the following answers. Most of the participants in the survey thought that the primary problem would be the cost of developing the oil shale and the lack of public and private funds. Secondly, they felt that environmentalist groups and the EPA would limit development in their opposition to strip mining and air and water pollution. Environmental disputes over the construction of a new dam on the White River was sometimes given as an example. Third, the respondents anticipated a shortage of water impeding development and a conflict over what interests would obtain the scarce water--municipal, agricultural, or industrial. Fourth, government red tape, controls, and regulations were viewed as creating uncertainty and interfering with the development of oil shale. Other responses included concern over the slow development of oil shale technology, the lack of local skilled workers, the adequacy of infrastructure to accommodate the expected influx of workers and their families, the opposition of some residents to the expected rapid growth, the inadequate planning to deal with these problems.

QUESTIONNAIRE FORMAT

Hello. I'm ______________ from Opinion Sampling Research Institute. We're conducting a public opinion survey concerning water and land uses in your area. May I have five minutes of your time?

1. What are the major uses of water in your area?________________

____

____

2. Which one of these uses do you consider the most important?________

____

3. What are the major uses of land in your area?________________

____

____

4. Which one of these uses do you consider the most important?________

____

5. What qualitites or attributes would you list as valuable or important in the land around your region? ________________

____

____

6. What qualitites or attributes would you list as valuable or important in the water around your region? ________________

____

____

7. In your opinion what are the major use issues in your area TODAY?

____

____

____

____

8. What do you foresee as the major water use issues in the next 5 to 15 years in your area? ____________________

____

____

9. In your opinion what are the major land use issues in your area TODAY? ____________________

____

10. What do you foresee as the major land use issues in the next 5 to 15 years in your area? ____________________

____

____

11. Do you approve or disapprove of oil shale development in your area?

approve__________1
disapprove__________2
don't know__________3

12. What problems, if any, do you foresee which would limit the development of oil shale in your area? ____________________

____

13. What is your age?

less than 30__________1
30 - 44__________2
45 - 60__________3
over 60__________4
Refuse to answer__________5

14. What is the occupation of the head of your household?__________

____

15. How long have you lived in this area?

5 years or less__________1
6 - 15 years__________2
16 - 30 years__________3
over 30 years__________4

16. Education

less than High School__________1
High School Graduate__________2
some college__________3
College Graduate__________4
Trade School__________5

17. Sex

Male__________1
Female__________2

18. What clubs, groups, or organizations do you belong to and how often do you attend their meetings?

Name of Organization	Percentage of Regular Meetings Attended				
____________________	0	1/4	1/2	3/4	All
____________________	0	1/4	1/2	3/4	All
____________________	0	1/4	1/2	3/4	All

APPENDIX B

COMPUTER DOCUMENTATION

The small scale application of the IRUM model was programmed for use on the Burroughs B6700 machine. The included printout shows the program and its related subroutines in their entirety.

The following data shows the machine requirements for the current size of the IRUM model.

```
NO ERRORS DETECTED. NUMBER OF CARDS = 110.
COMPILATION TIME = 25 SECONDS ELAPSED. 1.73 SECONDS PROCESSING.
D2 STACK SIZE = 14 WORDS. FILESIZE = 140 WORDS. ESTIMATED CORE
     STORAGE REQUIREMENT = 1115 WORDS.
TOTAL PROGRAM CODE = 669 WORDS. ARRAY STORAGE = 276 WORDS.
NUMBER OF PROGRAM SEGMENTS = 7. NUMBER OF DISK SEGMENTS = 45.
PROGRAM CODE FILE = (480047)IRUM ON PACK, COMPILER COMPILED ON
     10/05/76(FORTRAN ON PACK)
```

In addition to the program cards, the model utilizes the standard Burroughs B6700 control card deck:

```
R - Job "I.R.U.M."
R - User  user number/password
R - Begin
R - Compile IRUM fortran
R - Data
      { Program deck }
R - Data file 5
      { Data deck }
R - End job
```

The R in column one represents the required invalid punch for control cards.

Input Data Requirements (Variables and Values):

<u>Variable A</u>

Column(s)	Format: 5f11.3
1 - 11	The variable (A) is a ten digit variable
12 - 22	which represents the projected levels
23 - 33	of the factor. Five values are inputted
34 - 44	for each factor being considered.
45 - 55	

Variable B

Column(s)	Format: 5f11.3
1 - 11	The variable (B) is a ten digit variable
12 - 22	which represents the original states of
23 - 33	the factors being analyzed. Four cards
34 - 44	must be used with the value (.001) in-
45 - 55	serted in cases of asymmetrical relationship.

Variable ANAME

Column(s)	Format: 4A6
1 - 24	The variable ANAME represents the names of the five factors being analysed. Five cards are inputted, each with one factor name.

Card Order

Card No. 1	Five projected levels for factor 1
3	Five projected levels for factor 2
5	Five projected levels for factor 3
7	Five projected levels for factor 4
Card No. 2	Original state levels for the factors
4	Original state levels for the factors
6	Original state levels for the factors
8	Original state levels for the factors
Card No. 9	Name of factor 1
10	Name of factor 2
11	Name of factor 3
12	Name of factor 4

```
                                                                          START OF SEGMENT 002
      DIMENSION A(4,5),B(5,5,4),C(4,5),N(5,5,4),ANAME(4,4),F(4,5)         C  002:0000:0
100   FORMAT(5F11.3)                                                      C  002:0000:0
105   FORMAT(4A6)                                                         C  002:0000:0
300   FORMAT("1"T60,"I R U P  MODEL APPLICATION",///)                     C  002:0000:0
305   FORMAT(//,T20,"IRRIGATED",T40,"OIL",T60,"AGRICULTURAL",T80,         C  002:0000:0
     1"INDUSTRIAL",T100,"T.D.S.",/,T20,"ACREAGE",T40,"PRODUCTION",        C  002:0000:0
     2T63,"WATER",T83,"WATER",T100,"(TONS)",/,T20,"(ACRES)",              C  002:0000:0
     3T40,"(BBLS.)",T61,"(AC. FT.)",T80,"(AC. FT.)",)                     C  002:0000:0
310   FORMAT(2X,F8.0,T22,I3,T40,I3,T65,I3,T84,I3,T101,I3)                 C  002:0000:0
306   FORMAT(//,1X,4A6)                                                   C  002:0000:0
313   FORMAT(//,T42,"IRRIGATED",T62,"OIL",T82,"AGRICULTURAL",T102,        C  002:0000:0
     1"INDUSTRIAL",T122,"T.D.S.",/,T42,"ACREAGE",T62,"PRODUCTION",        C  002:0000:0
     2T85,"WATER",T105,"WATER",T122,"(TONS)",/T42,"ACRES)",               C  002:0000:0
     3T62,"(BBLS.)",T83,"AC. FT.)",T102,"(AC. FT.)")                      C  002:0000:0
316   FORMAT(3X,4A6,F9.1,T42,I3,T62,I3,T85,I3,T104,I3,T122,I3)            C  002:0000:0
333   FORMAT(2X,F8.0,T20,F8.0,T40,F8.0,T60,F4.2,T80,F8.0,T100,F8.0)       C  002:0000:0
      R=0                                                                 C  002:0000:0
      DO 11 I=1,4                                                         C  002:0000:4
      READ(5,100)(A(I,J),J=1,5)                                           C  002:0002:0
                                                                             FIB IS 0006 LONG
      READ(5,100)(C(I,J),J=1,5)                                           C  002:0010:2
11    CONTINUE                                                            C  002:001E:2
      DO 7 I=1,4                                                          C  002:0020:3
      DO 7 G=1,5                                                          C  002:0022:0
      F(I,G)=A(I,G)                                                       C  002:0023:0
7     CONTINUE                                                            C  002:0028:0
      DO 12 I=1,4                                                         C  002:002C:2
      READ(5,105)(ANAME(I,J),J=1,4)                                       C  002:002D:0
12    CONTINUE                                                            C  002:003B:2
      CALL PROPAK(B,F,R)                                                  C  002:003D:3
      WRITE(6,300)                                                        C  002:004C:0
                                                                             FIB IS 0006 LONG
      WRITE(6,305)                                                        C  002:0044:2
      DO 44 L=1,4                                                         C  002:0048:2
      WRITE(6,306)(ANAME(L,K),K=1,4)                                      C  002:0049:0
      DO 43 J=1,5                                                         C  002:0056:2
      WRITE(6,333)(A(L,J)),(B(J,K,L),K=1,5)                               C  002:0057:0
43    CONTINUE                                                            C  002:0069:2
44    CONTINUE                                                            C  002:006B:3
      CALL RNKPAK(B,C,N)                                                  C  002:006D:4
      WRITE(6,300)                                                        C  002:0070:2
      DO 54 L=1,4                                                         C  002:0074:2
      WRITE(6,305)                                                        C  002:0075:0
      WRITE(6,306)(ANAME(L,K),K=1,4)                                      C  002:0079:2
      DO 53 J=1,5                                                         C  002:0086:2
      WRITE(6,310)(A(L,J)),(N(J,K,L),K=1,5)                               C  002:0087:0
53    CONTINUE                                                            C  002:0099:2
```

```
54 CONTINUE
   R=1
   CALL PROPAK(B,F,R)
   CALL RNKPAK(B,C,N)
   WRITE(6,300)
   DO 75 J=1,5
   WRITE(6,313)
   DO 74 L=1,4
   WRITE(6,316)(ANAME(L,K),K=1,4),(F(L,J)),(N(J,K,L),K=1,5)
74 CONTINUE
75 CONTINUE


   SUBROUTINE PROPAK(B,F,R)
   DIMENSION B(5,5,4),F(4,5)
   DO 22 K=1,5
   B(K,1,1)=.001
   B(K,2,1)=(1571684-(4.56*F(1,K)))/.265
   B(K,3,1)=1311700/F(1,K)
   B(K,4,1)=1571684-(4.56*F(1,K))
   B(K,5,1)=(.2965*F(1,K))+5076.97
   IF(R.EQ.0) GO TO 25
   F(2,K)=B(K,2,1)
   F(3,K)=4.56*F(1,K)
   F(4,K)=B(K,4,1)
25 B(K,1,2)=(1571684-(.265*F(2,K)))/4.56
   B(K,2,2)=.001
   B(K,3,2)=(1571684-(.265*F(2,K)))/288000
   B(K,4,2)=.001
   B(K,5,2)=(((1571684-(.265*F(2,K)))/4.56)*.2965)+5076.97
   B(K,1,3)=F(3,K)/4.56
   B(K,2,3)=(1571684-F(3,K))/.265
   B(K,3,3)=.001
   B(K,4,3)=1571684-F(3,K)
   B(K,5,3)=((F(3,K)/4.56)*.2965)+5076.97
   B(K,1,4)=(1571684-F(4,K))/4.56
   B(K,2,4)=F(4,K)/.265
   B(K,3,4)=(1571684-F(4,K))/288000
   B(K,4,4)=.001
   B(K,5,4)=((1571684-F(4,K))*.05388)+3078.069
22 CONTINUE
   DO 23 T=1,4
   DO 23 S=1,5
   DO 23 K=1,5
   IF(B(K,S,T).EQ..001) B(K,S,T)="    "
23 CONTINUE
   RETURN
   END
```

```
 C   002:009B:3
 C   002:009D:4
 C   002:009F:2
 C   002:00A0:5
 C   002:00A3:3
 C   002:00A7:2
 C   002:00A8:0
 C   002:00AC:2
 C   002:00AD:0
 C   002:00C7:2
 C   002:00C9:3

  START OF SEGMENT 005
 C   005:0000:0
 C   005:000C:0
 C   005:000C:0
 C   005:0001:0
 C   005:0004:1
 C   005:000E:2
 C   005:0014:3
 C   005:001C:4
 C   005:0024:2
 C   005:0025:3
 C   005:0029:4
 C   005:0030:3
 C   005:0034:3
 C   005:003E:2
 C   005:0042:1
 C   005:004C:2
 C   005:0050:1
 C   005:005E:2
 C   005:0064:2
 C   005:006C:2
 C   005:007C:1
 C   005:0076:3
 C   005:008C:2
 C   005:0088:2
 C   005:008E:2
 C   005:0096:2
 C   005:009A:1
 C   005:00A4:2
 C   005:00A6:3
 C   005:00A8:0
 C   005:00A9:0
 C   005:00AA:0
 C   005:00B6:1
 C   005:00BC:4
 C   005:00BD:1
SEGMENT 005 IS 00C3 LONG
```

```
      SUBROUTINE RNKPAK(B,C,N)
      DIMENSION B(5,5,4),C(4,5),N(5,5,4)
      DO 33 J=1,5
      DO 33 L=1,4
      DO 33 K=1,5
      IF(B(J,K,L).GT.1.02*C(L,K).AND.B(J,K,L).LT.1.15*C(L,K))N(J,K,L)=1
      IF(B(J,K,L).GE.1.15*C(L,K).AND.B(J,K,L).LT.1.35*C(L,K)) N(J,K,L)=2
      IF(B(J,K,L).GE.1.35*C(L,K)) N(J,K,L)=3
      IF(B(J,K,L).GE..98*C(L,K).AND.B(J,K,L).LE.1.02*C(L,K))N(J,K,L)=0
      IF(B(J,K,L).GE..85*C(L,K).AND.B(J,K,L).LT..98*C(L,K))N(J,K,L)=-1
      IF(B(J,K,L).GE..65*C(L,K).AND.B(J,K,L).LT..85*C(L,K)) N(J,K,L)=-2
      IF(B(J,K,L).LT..65*C(L,K).AND.B(J,K,L).GT..001) N(J,K,L)=-3
      N(J,5,L)=N(J,5,L)*(-1)
      IF(B(J,K,L).EQ..001)N(J,K,L)="    "
      IF(B(J,K,L).EQ."    ")N(J,K,L)="    "
   33 CONTINUE
      RETURN
      END
```

```
 START OF SEGMENT 006
  C   006:000C:0
  C   006:0000:0
  C   006:000C:0
  C   006:0001:0
  C   006:0002:0
  C   005:0003:0
  C   006:0017:5
  C   005:002D:0
  C   006:0039:5
  C   005:004E:5
  C   006:0064:0
  C   006:0079:1
  C   006:008B:2
  C   006:008F:2
  C   006:009B:1
  C   006:0CA6:1
  C   006:00AC:4
  C   006:00AD:1
SEGMENT 006 IS 00B2 LONG
```

I R U M MODEL APPLICATION

	IRRIGATED ACREAGE (ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER (AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE					
298000.	********	975109.	4.55	258404.	90469.
295000.	********	854657.	4.45	225484.	92544.
310000.	********	596543.	4.23	153084.	96992.
270000.	********	1284845.	4.86	340484.	85132.
250000.	********	1628996.	5.25	431634.	79202.
OIL PRODUCTION (BBLS.)					
100000.	338856.	********	5.37	********	105548.
50000.	341762.	********	5.41	********	106409.
250000.	330139.	********	5.23	********	102963.
1250000.	272025.	********	4.31	********	85732.
1000000.	286554.	********	4.54	********	90040.
ACRE FEET AG. WATER					
800000.	175439.	2912015.	****	771634.	57095.
1000000.	219298.	2157298.	****	571634.	70099.
1303700.	285899.	1011260.	****	267984.	89846.
750000.	164474.	3100694.	****	821684.	53843.
1250000.	274123.	1213902.	****	321684.	86354.
ACRE FEET IND. WATER					
26484.	338860.	99940.	5.37	********	86333.
100000.	322738.	377358.	5.11	********	82372.
250000.	289843.	943396.	4.59	********	74290.
350000.	267913.	1320755.	4.24	********	68902.
425000.	251466.	1603774.	3.98	********	64861.

I R U M MODEL APPLICATION

	IRRIGATED ACREAGE (ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER (AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE					
288000.	***	3	0	-1	0
295000.	***	3	-1	-1	-1
310000.	***	3	-1	-3	-1
270000.	***	3	1	2	1
250000.	***	3	2	3	1

	IRRIGATED ACREAGE (ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER (AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
OIL PRODUCTION (BBLS.)					
100000.	-3	***	2	***	-2
50000.	-3	***	2	***	-2
250000.	-3	***	1	***	-1
1250000.	-3	***	-1	***	1
1000000.	-3	***	0	***	0

	IRRIGATED ACREAGE (ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER (AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
ACRE FEET AG. WATER					
800000.	-3	3	***	3	3
1000000.	-2	3	***	3	2
1303700.	0	3	***	3	0
750000.	-3	3	***	3	3
1250000.	-1	3	***	3	1

	IRRIGATED ACREAGE (ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER (AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
ACRE FEET IND. WATER					
26484.	-3	3	2	***	1
100000.	-3	3	1	***	1
250000.	-3	3	0	***	2
350000.	-3	3	-1	***	2
425000.	-3	3	-1	***	2

I R U M MODEL APPLICATION

		IRRIGATED ACREAGE ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE	280000.0	***	3	0	-1	0
OIL PRODUCTION (BBLS.)	975109.4	-3	***	0	***	0
ACRE FEET AG. WATER	1313280.0	0	3	***	3	0
ACRE FEET IND. WATER	258404.0	-3	3	0	***	2

		IRRIGATED ACREAGE ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE	295000.0	***	3	-1	-1	-1
OIL PRODUCTION (BBLS.)	854656.6	-3	***	1	***	-1
ACRE FEET AG. WATER	1345200.0	1	3	***	3	-1
ACRE FEET IND. WATER	226484.0	-3	3	1	***	2

		IRRIGATED ACREAGE ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE	310000.0	***	3	-1	-3	-1
OIL PRODUCTION (BBLS.)	596543.4	-3	***	1	***	-1
ACRE FEET AG. WATER	1413600.0	1	3	***	3	-1
ACRE FEET IND. WATER	158084.0	-3	3	1	***	1

		IRRIGATED ACREAGE ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE	270000.0	***	3	1	2	1
OIL PRODUCTION (BBLS.)	1284845.3	-3	***	-1	***	1
ACRE FEET AG. WATER	1231200.0	-1	3	***	3	1
ACRE FEET IND. WATER	340484.0	-3	3	-1	***	2

		IRRIGATED ACREAGE ACRES)	OIL PRODUCTION (BBLS.)	AGRICULTURAL WATER AC. FT.)	INDUSTRIAL WATER (AC. FT.)	T.D.S. (TONS)
IRRIGATED ACREAGE	250000.0	***	3	2	3	1
OIL PRODUCTION (BBLS.)	1628996.2	-3	***	-1	***	1
ACRE FEET AG. WATER	1140000.0	-1	3	***	3	1
ACRE FEET IND. WATER	431684.0	-3	3	-1	***	2