Problem Context and the Generation of Alternatives Within the IRP Process

Faye Anderson and Benedykt Dziegielewski
SIUC Water Group, Department of Geography
Southern Illinois University-Carbondale

Need for Improving IRP Decisions

Emerging from its use in the energy industry since the late seventies, Integrated Resource Planning (IRP) is presently being modified and tailored to the water industry's needs (Beecher, 1995). However, for IRP's methods and analyses to become widely accepted, this innovative planning approach must earn a reputation for providing sound decision making support. In attempting to develop this approach and build such a reputation, we must pay particular attention to all of the planning stages, and be concerned with consensus building and learning throughout the entire planning process. While recognizing the unity and dynamic nature of decision making, this paper focuses on the initial planning stages relating to problem context (problem identification, acceptance, and representation) and the generation of alternatives. These phases are important considerations as they set the entire stage for planning. The management science literature on decision making contains a number of findings which have direct relevance for the IRP process. By reviewing these findings and contrasting them with the experiences of IRP applications, we attempt to point out some important issues in the IRP process relating to these two critical decision stages.

The Meta-Decision of Planning Approaches

A sound process is a necessary condition for good decision making and can improve the likelihoods of attaining effective planning outcomes. Water resources planners and every other profession must deal with meta-decisions, i.e., decisions about how to make decisions. Johnson and Payne (1985) found that the decision making rules and processes that tend to be adopted are those that can strike a good balance between effort expended and expected decision quality within a given problem environment. The meta-choice of decision making approaches is usually conditioned by problem contexts, decision maker characteristics, available resources, and legitimation criteria for both process and outcomes.

In a very fundamental sense, good water resource decision making requires meta-analysis that evaluates the issues involved from a broad perspective (Kleindorfer, Kunreuther, & Schoemaker, 1989). The increased complexity of problem contexts and information processing are forcing such a systematic examination. Some key issues for such an evaluation include: problem definition, institutional arrangements, information gathering, final choice process and implementation. Under each rubric we must obtain answers to several critical questions about the meta-decision process.

Problem definition is the first step where the entire planning process may falter if the planners can not answer such questions as: What is the real problem we are trying to solve? What is its genesis and scope? How is this particular problem related to our goals, values and needs? Are we addressing the right problem? The entire planning effort may "miss the boat" if the problem is not adequately researched. Because water resource problems affect many people, they cannot be effectively solved by an agency with a narrow purpose. We must examine the existing institutional arrangements and the broadest dimensions of the problem by answering such questions as: Who are the stakeholders in this problem? How do they interact with one another? How can we include them in the planning process? How do we understand and incorporate their goals, views, objectives, and constraints? With respect to information gathering, the meta-decisions address such questions as: What information do we have? What data and determinations do we need? What biases exist towards data and how do we address them? What are the costs and benefits of collecting additional data? Finally, the consideration regarding the final choice of alternatives and their implementation include such questions as: Which should be considered? Who should decide? What are the trade-offs between approaches? What criteria are used? Can specific approaches be more successfully implemented by generating useful feedback, using legitimation criteria, and establishing control and accountability procedures?

The existing literature on IRP offers very little detailed guidance for addressing these specific questions.

Currently, the agencies who conduct the IRP process have to search for answers as they are going through the process, thus running the risk of undermining the confidence of the participants and various stakeholders in both the process and it outcomes.

Issues in Problem Context

Problem context is important as the decision sciences literature has long shown that the longer and more difficult this predecision stage, the greater the cognitive dissonance that emerges after alternatives are chosen (e.g. Festinger 1964). This cognitive dissonance and postdecision regret can have crucial implications for the implementation process and the eventual achievement of the objectives and goals. As chosen alternatives can have the tendency to change during implementation, this is an important consideration.

At the core of any useful planning model is the embodiment of triggers to signal the existence of a problem or need and to help define problem status (see Figure 1). Throughout water resources planning history, the trigger of "adequate supply" has dominated planning processes. The decision making environment has predominantly been monitored for cues of deviations from reference points relating to adequate water supply or related measures. As problem acceptance has centered almost exclusively on this aspect, our planning models have been unidimensional in nature.

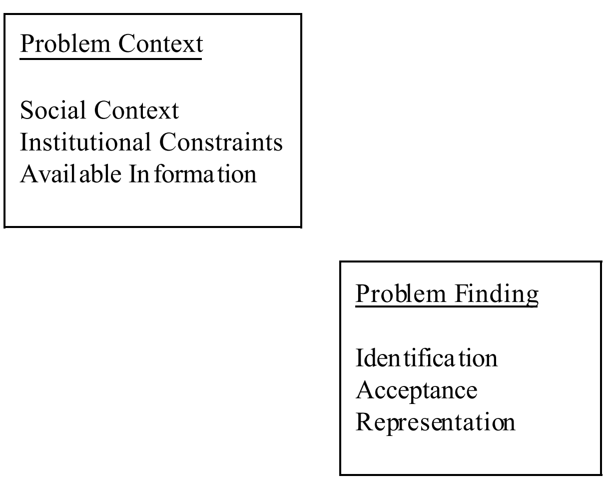

Figure 1. Problem Context and Problem Finding

Documentation of the previous and ongoing applications of IRP contains very little information on the analysis of problem context other than the projection of potential shortages of water in the future. Information on the baseline conditions of a water supply system and the nature of demands to be met is minimal at best. In cases when problems other than the expected future shortage of water in supply sources are recognized, they are not investigated to pinpoint the actual causes of the problem. For example, a problem of insufficient capacity to meet maximum-day demands is rarely defined in terms of the sources of peak demands or their distribution in time and space. The lack of detailed definition of the problem may preclude planners from identifying such alternative solutions as "shedding peak demands" in parts of the distribution system or providing distribution system storage. Similarly, the unknown distribution of peak demands in time may prevent any considerations of the options which would shift peaks of short durations to off-peak periods.

Miltroff and Kilman (1978) have identified three types of errors associated with problem acceptance: (1) detecting a problem when no problem exists, (2) not detecting a problem when there is one, and (3) detecting the wrong problem or a less important problem. Obviously, there are costs associated with each of these errors and water resources management has incurred many of these costs in various contexts. The first type of error is common in planning for urban water supply where the financial resources which are available to urban economies allowed many municipalities to expand the capacity of their supplies beyond the level of any foreseeable need. This type of error is very costly and invariably leads to higher than necessary cost of water supply to urban consumers. The instances of nondetection of the problem are often equated with poor management of the agency and the resources under its purview. Finally, a good example of the misdiagnosis problem can be found in the recent history of water supply planing for the Boston area. The system was reaching its safe yield thus pointing to the need for new sources of supply. However, a new management of the system under the Massachusetts Water Resources Authority revealed significant system losses which in combination with pricing and other demand management measures produced a significant drop in water demand well below the historical safe yield of the supply sources.

The nature of problem definition and problem acceptance in water resources is undergoing much change and, thus, the corresponding interest in alternative planning approaches has emerged. Many authors have addressed the reluctance of water professionals to accept any new triggers, problem definitions, and alternatives (Vickers, 1996; Beecher, 1996; Viessman, 1996). This reluctance then extends to IRP as well. This narrow problem acceptance (of what is/needs to be solved) may be related to nonexistent triggers, myopic triggers, improper evaluation of triggers, resistance or fear of accepting multiple objectives, and lack of confidence that newer problem definitions can be adequately resolved. An industry wide discussion of objectives and goals and their detailed clarification may help contribute to the acceptance of, and the eventual resolving of, the more "correct" problems facing water decision makers.

The "open and participatory" nature of the IRP process is an important step toward the improvement of problem contexts. For example, individual water users who participate in the IRP process may see water problems in a way that is radically different from that of utility planners. A remote possibility of "system failure" during a low-probability drought event may not be considered as a problem worth the planning effort. Thus, the discussion of problem contexts must adequately address the "for whom" question, that of stakeholders and relationships between these various groups. This could shed further light on the conflicts between various roles and the underlying values that give rise to them.

IRP researchers can help develop tools to focus the industry's attention on appropriate signals and information to help avoid or minimize these three types of errors related to problem structure. The more accurately the IRP model and process reflects what is achievable and what the status quo actually is, the more likely water resource decision makers are to accept problems that are both real and important. How the IRP process helps to structure the problem context is important. The values and goals that trigger problem finding are then the most likely guides to the eventual definition of when we assess that the problem is resolved, or at least ameliorated. The representation of the problem has a strong influence on the resulting problem solving activities and its framing can have a strong effect on the alternatives considered as well.

Issues in Generation of Alternatives

Alternatives are typically generated with particular problems, objectives and goals in mind. Given the relative narrowness of problem definition (as well as the sets of goals and objectives), we can think of the historical generation of alternatives in water resources planning as having been guided by a type of bounded rationality. This bounded rationality has been constrained by a myopic focus on a given set of supply side alternatives and has served to screen out the complexity of the planning problem, and perhaps opportunities for learning as well. The predominance of preferred alternatives have been close to the existing set of alternatives, i.e., the immediate decision neighborhood and in this sense water resources decision making has been conservative (while perhaps not in the fiscal sense given the costs associated with the traditional supply augmentation alternatives). Thus, the existing position has been the primary determinant of the set of feasible alternatives and it also influenced the satisfaction of the water community with the traditional set of alternatives. Often, the constraints on feasibility of solutions are introduced at an early stage of the search for alternatives thus excluding any unconventional set of options from the initial set.

Overall, new alternative generation has historically not been a priority in the decision making process. Yet, we know that the process of identification of alternatives is of the utmost importance in the decision making process. The need for decision making stems from the lack of an obvious or ideal alternative and the decision making process is intended to create one. Significantly, decision-makers often form a "model" of a desirable ideal alternative while in the early stages of the planning process. The distance from the status quo to this alternative gives us some measure of the conflict embedded in the problem. Indeed, the purpose of this decision-making is to solve this essential underlying conflict through the identification of alternatives (as opposed to removing the apparent conflict through advocacy or other means). This desirable ideal alternative becomes a point of reference against which choices are measured against our objectives and values (Festinger, 1964). However, the usefulness of the concept of such an ideal solution will depend on its discriminatory power, how well it aids the decision-maker in distinguishing among alternatives. It is progress or movement towards this ideal that brings about the instrumentality and expressibility of these values. The establishment of an ideal can also stimulate the generation process for new alternatives and provide direction to this process.

Typically, newer and perhaps more innovative alternatives are only considered after the dissatisfaction with the current situation is both recognized and accepted, i.e., a threshold level of dissatisfaction must be reached. Factors both internal and external to the decision maker will affect the attainment of this threshold level. In particular localized regions this threshold level has clearly been attained. It must eventually be recognized by the water industry as a whole for the widespread diffusion of a wider, more comprehensive set of alternatives. There is a role for researchers and professional organizations to study variables related to this diffusion process, both the factors that act as barriers to acceptance and factors inducing acceptance. In this way, the social context within which decisions are made in the water resources profession can be changed so as to encourage the consideration of a wider set of feasible alternatives.

The nonavailability of suitable alternatives or more specifically, the infeasibility of an ideal alternative, often triggers the conflict that motivates the search for a meta structure for decision making to "solve" the problem. Thus, the conflict can be traced to the set of available alternatives. In this way, alternatives, or more precisely a set of feasible alternatives, lie at the heart of any decision-making process. Objectives will only be achieved *in reference to* a given set of alternatives. Yet, a set of alternatives is rarely prescribed or given, most often, making a decision requires inventing new alternatives. Especially under the complex regime of water resources decision-making contexts described above, alternatives rarely present themselves as nicely ordered and clearly differentiated options. Within some problem contexts, the creative generation of new alternatives can be even more critical than the careful evaluation of those already existing. And it is the level and type of conflict that motivate the intensity of the search for new alternatives. In some sense, the overall aim of the process is to find an alternative(s) that will reduce the conflict to some acceptable level. Therefore, any alternative can be viewed as a particularly realizable configuration of the relationship between the means and ends of the decision making process, i.e., the objectives and the outcomes.

One of the premisses of IRP is the recognition that the agreement on the ideal solution can rarely be found. Accordingly, the IRP process recognizes the need to consider multiple and often conflicting objectives where each objective is aligned with a different set of alternatives. Within the outcomes of IRP, the best alternative is replaced by best alternative(s) for each of the multiple objectives and the information on explicit tradeoffs between competing objectives. A classic example is the tradeoff between the affordability (or cost) of water supply and its reliability. In terms of alternatives, those that are most affordable are rarely the same as those that maximize the reliability of water supply. However, the ability of decision makers would be severely constrained if the set of working alternatives excluded those that did not meet some high standard of reliability. A good example here is the exclusion of demand-side measures on the basis of the low reliability of projected water savings. Even when water conservation is included it rarely receives a status of a fully fledged alternative. Instead, it is included as a goal for demand reduction and the expected savings are deducted from the projected demands thus preventing evaluation of a true mix of supply-side and demand-side alternatives. The history of water resources planning and management and its shortcomings can be studied from this viewpoint of alternative identification and selection.

The insufficiency of alternatives is at least as important as the incompatibility of objectives. The aim of utilizing the IRP process critically highlights the importance of alternative identification and generation in water resources decision making. The important question for IRP is: How to effectively evolve the initial set of feasible decision alternatives? This is an important question because a poor initial set of alternatives will: (1) hamper and perhaps even stall the start of the decision-making process, (2) bias the evaluation of alternatives, (3) constrain the effectiveness of planning outcomes, and (4) subvert meeting the planning objectives.

The goodness of any set of alternatives is not necessarily a function of number. A good set of alternatives can be thought of as some reasonable number of sufficiently different alternatives that can provide useful information about the attainable limits of all relevant dimensions, criteria, or objectives. We should not expect that this good set is a static entity. Alternatives may be dropped from consideration at many points throughout the decision making process. Additionally, effective decision making often means creating new alternatives. This is a very important consideration because: (1) introduction of new alternatives may help to clarify the decision making process, (2) it may be costly to generate new alternatives, and (3) there is a danger in settling upon a set of new alternatives too quickly. However, the generation of new alternatives itself may be the most important outcome in the decision making process.

The importance of generating new alternatives is related to the distance of present alternatives to the ideal alternative. Yu (1977) and others have shown that the process of successful generation of new alternatives is facilitated by: (1) introducing new strategies, (2) searching for an ideal solution with all constraints relaxed, (3) breaking individual and institutional constraints on creativity, (4) learning how to invent new options, (5) modifying existing strategies in order to achieve new goals, (6) introducing new goals or criteria, or new levels of aspiration with respect to existing goals, (7) incorporation of new technical, organizational, and other areas of knowledge, (8) willingness to accept idea of new alternatives during an ongoing planning process, and (9) open and unbiased exploration of their feasibility.

In the process of alternative generation, it becomes readily apparent to participants that the alternative(s) and criteria are interdependent and thus unfold jointly. A new alternative can render some previously unimportant attribute important or could lead to the modification of some other criteria. And these criteria could then shed light on our existing set of alternatives. Thus, changes in the set of feasible alternatives affect the criteria set which in turn affect the alternatives and so on. Furthermore, after lengthy considerations of alternatives, the participants may come to the realization that there is no separation of ends and means, i.e., between our alternatives and objectives. We do not generate alternatives without having some notion of our objectives and goals in mind. And we cannot determine our criteria without having some notion of what is available. Objectives evolve on the basis of our set of available alternatives, which in turn are manipulated and regenerated in light of existing objectives and so on.

Examples of new alternative generation in water resources planning include some applications of the IRP process which led to the unconventional solutions to water supply problems. The most prominent new alternatives are the demand-side options for balancing supply and demand. The universe of those options is constantly growing and includes many very creative solutions. Many new alternatives which are usually termed as "supply management have been devised through a process of successful alternative generation. Dual water distribution systems, groundwater recharge and recovery, nonperpetual transfers of water rights and water marketing are good examples of new alternatives of this type.

The process of new alternative generation leads to the issue of when to stop investing in the creation of new alternatives as well. The decision sciences literature suggest looking for signals that either the creation of any new alternative is unlikely to be productive and/or the new alternatives generated are not sufficiently different from already existing ones (Zeleny, 1982).

Development of Planning Alternatives

Once the set of alternatives is generated, each alternative must be formulated to permit its evaluation during the IRP process. While it is relatively easy to prepare a list of alternatives, the availability of information on individual alternatives is likely to vary. As one should expect, the new and unconventional solutions are those that contain the least amounts of information that is needed in evaluation. On the other hand, the traditional supply side alternatives are most likely to have been around for a long time and have been the subject of detailed engineering investigations. It should not be surprising that the availability of information about these alternatives can bias the planners' decisions in favor of those alternatives that have been well researched. In addition to the availability of information on the traditional alternatives, the agencies who conduct the IRP process and many participants have much experience with implementing them. As a result, the odds against unconventional alternatives are stacked fairly high. Their inclusion in the list of alternatives under consideration is likely to have minimal impact on the final choice unless adequate resources are devoted to formulating them to a level of detail that is on par with the available information on the more traditional options.

The IRP process uses various qualitative or semi-quantitative procedures for screening a large set of initial alternatives in order to reduce the set to a manageable size. Again, the availability of information on individual alternatives is likely to have a significant impact on the results of the screening process. A useful criterion for correcting this bias is the concept of "fatal flaw". Under this criterion, only alternatives that exhibit some easily recognizable (and agreeable to all participants) fatal flaw are excluded from further considerations. Examples of fatal flows include prohibitive cost, lack of water rights, unacceptable water quality (especially salinity), impracticality of implementation, and similar constraints that are not likely to be overcome during the planning horizon. Beyond the criterion of fatal flaw, no easy safeguards exist to prevent elimination of unconventional alternatives when they are not well developed.

Another important consideration in the formulation of alternatives relates to their relationship to each other. Ideally, the planners would wish that all alternatives are formulated as independent entities which can be combined into mixes or sequences for meeting the objectives. This rarely happens in the real world. Almost all alternatives can be staged (or scaled) thus making them mutually exclusive. Other alternatives which are not subject to scaling may not be truly independent as their implementation would require a simultaneous use of some other alternative. Because the screening and detail evaluation looks at alternatives independently, the existing linkages between alternatives can complicate the process. We need to learn how to identify and formulate alternatives which could serve as "building blocks" for constructing resource sequences and strategies. Some practical methods for classifying alternatives and mapping out their interrelationships are needed to facilitate decision making within the IRP process.

Conclusions

The water resources profession has a long history of experiences concerning the traditional supply side planning approach. Experiences with IRP are new and just being implemented. Additionally, IRP is coming into the profession at a time when not everyone had even fully in practice bought into the requirements of the least cost planning approach. This opens the door for those supporting more innovative planning approaches, such as IRP, to advocate for these approaches. This advocacy will require concentrated information dissemination efforts about the implementation of the approach (how to) and evaluations of the processes and outcomes (how well did it work).

A significant opportunity exits for the dissemination of information about lessons learned from IRP about “new” alternatives and combinations of alternatives (Anderson, forthcoming 1997). This would aid decision makers in defining a wider set of feasible alternatives, dispel commonly held biases against newer alternatives, and provide benchmark type information. This information should allow decision makers to effectively incorporate new viewpoints and challenge existing assumptions and is critical to more effective alternative generation. Systematic research will help to unlock decision makers and institutions from their past experiences with problem solving (Kaufman 1991).

Are there ways to encourage and reward creativity and vigilance in the IRP process with respect to the generation of alternatives? Are there methods to organizationally and institutionally reward the expansion of the set of feasible alternatives? What new or improved tools and techniques can be provided to aid in this endeavor as well? IRP proponents must be concerned with the rate of acceptance of alternatives as it presents a significant barrier to effective decision making and to the adoption of IRP or any other innovative planning approaches. The improved quality of water resource planning outcomes depends upon the effectiveness of our procedures for establishing goals and objectives, generating new alternatives and developing data on all alternatives.

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THE AUTHORS

Faye Anderson is a Lecturer in the Department of Geography at Southern Illinois University-Carbondale where she teaches Environmental Economics, Environmental Impact Assessment, and Environmental Philosophy. She is currently writing her dissertation on Integrated Resource Planning in water resources.

Benedykt Dziegielewski is an Associate Professor of Geography at Southern Illinois University-Carbondale and is also the Director of the SIUC Water Research Group. His Ph.D. is in both Engineering and Geography. He specializes in demand management, drought planning, water use and pricing and has published numerous articles in these areas. He serves as a member of the AWWA Conservation Committee and its Conservation, Planning, and Evaluation subcommittee. Currently he is the technical project advisor for the Eugene Water and Electric Board's IRP Water Plan Project.