A Methodology for Decisionmaking in Project Evaluation in Land Management Planning

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Abstract: In order to evaluate alternative plans, wildland management planners must consider many objectives, such as timber production, recreational use, and community stability. The method presented utilizes the type of qualitative and intuitive information widely available to wildland management planners, and structures this information into a format suitable for decisionmaking. The method makes possible the determination of a measure of overall desirability for alternative plans, and permits the evaluation of plans under alternative value systems. Alternatives are compared through a small set of values assigned to each one. Each number in the set represents a measure of desirability not directly comparable to the others. The planner assigns weights to each measure and obtains a unique number for each alternative. The method is simple to use and flexible, to permit modifications as planners gain expertise in its use.

INTRODUCTION

The method proposed consists of a set of steps which provide a structured framework for choosing among alternatives, when multiple objectives or criteria have to be considered, and uncertainty exists. At each step, the method provides for the participation of decisionmakers, specialists, analysts, and possibly, the general public.

The scheme requires the limited participation of decisionmakers and deviates little from generally used organizational patterns. Several concepts which are essential for correct and efficient evaluation are emphasized:

(a) Screening, which allows the elimination of alternatives simply on the basis of "rough cut," general evaluations.

(b) Evaluation of the accuracy and certainty of information used in the determination of the impacts of the alternatives.

(c) Reduction to a manageable number of the impacts necessary for the evaluation of alternatives.

(d) Visual presentation of results in tables and "scoreboards" which present information to the decisionmaker and to the public in a clearer way and with a simpler format of analysis.

(e) Generation of potentially attractive new alternatives, through modification and combination of already defined alternatives.

Concepts (c) and (d) are essential in presenting the decisionmakers with a clear summary of the impacts with respect to the declared goals. Note that with this scheme there is no need for the decisionmaker to specify his utility function or explicit preferences. Although these weights simplify the selection of the preferred alternatives, they introduce serious methodological complications rooted in the complexity of utility functions.

The scheme is applicable to a broad range of planning problems. It is presently being used in the decision process for a recreation area project (skiing and summer activities) in the Tahoe National Forest, in California. The main goal of this project is to provide recreation facilities to satisfy increasing demand in a location with very attractive possibilities. The site will be developed by private capital, but a large percentage of the land needed belongs to the Forest Service, U.S. Department of Agriculture. As a public agency, the Forest Service must consider, when evaluating alternatives, the preservation of environmental quality, as well as the socioeconomic impacts a recreation complex will have on neighboring communities.

The steps of the scheme will be illustrated with examples, most of which are drawn from this recreation project.

THE SCHEME

The basic steps are the following:

1. Define the boundaries of the problem: the area of study, the types of alternatives to be considered (e.g., Area--Tahoe region; Types of alternatives--develop recreation facilities for winter use or for winter and summer use).

2. Identify decision-influencing elements, criteria, or goals. Goals can be defined at different levels of aggregation: (1) a general goal, such as to preserve environmental quality, which can be refined into (a) preserve air and water quality, (b) maintain wilderness, etc.; or (2) a primary goal, such as to enhance social well-being of the population, and secondary goals such as (a) promote acceptable patterns of employment, (b) avoid overcrowding of services, etc.

3. Identify major forms of activities and areas in which they can be carried out (e.g., logging and range in unit A).

4. Define basic alternatives to be considered (e.g., alternatives emphasizing recreation, logging, preservation of wilderness, etc.)

5. Define the major types of impacts of each alternative in relation to the goals established. Include secondary effects only if they are important.

6. Screen the alternatives. Determine a set of criteria which would make an alternative unacceptable. Based on these criteria, find which alternatives can be eliminated without additional collection of data or finer analysis (e.g., general analysis may be sufficient to determine that a practice of intensive timber cutting in a given area results in unacceptable environmental and recreation impacts. Then, any alternative with that practice would be screened out). Screened-out alternatives will be reconsidered later in the light of the additional insights gained from the analysis.

7. For those alternatives passing the screening process, determine their impacts in a disaggregated and quantified form in relation to the declared goals. Several models can be used for estimating partial impacts (i.e., econometric models to predict ski demand, input-output models for estimating income and employment effects, etc.).

Impact information can appear in different forms:

(A) Hard information: data which is quantified, relatively accurate and certain.

(B) Nonquantifiable information: impacts which may be estimated from accurate and certain input-output data, but which are expressed as qualitative ratings and therefore depend on subjective evaluation (e.g., the acreage and condition of wilderness and scenic areas may be known but the impact of management alternatives can only be assessed intuitively).

(C) Soft information: insufficient information exists about conditions or about the consequences of management (e.g., impacts on timbered areas where no appropriate survey has been made).

(D) Uncertain information: impacts that cannot be predicted with precision. The sources of uncertainty may be:

(a) Uncertainty about the "future of the world" (e.g., what is going to be the rate of increase on overall demand for recreation in the future).

(b) Technical uncertainty in projections, that is, the impossibility of predicting exact impacts, even if the setting in which they occur is known with certainty.

(c) Uncertainty about the implementation of each phase of the project exactly as it is defined in the study.

8. Reduce the number of impacts to be considered in this evaluation for each alternative by discarding and aggregating impacts according to the goals established.

This step is needed to reduce the normally large number of impacts generated in Step 7 to a much smaller number of representative impacts, which will make the evaluation process in relation to the declared goals more manageable.

The reduction of impacts to evaluate is accomplished by eliminating from consideration the impacts which are not likely to affect the decision (i.e., exclude impacts of negligible importance, or those that do not vary much among the alternatives), and aggregating sets of impacts into one representative of the set which may be quantified through an index (i.e., aggregate into one those impacts which may be considered as one goal or subgoal, such as different measures of water quality, or which are highly correlated under all alternatives, such as wilderness and wildlife impacts).

The elimination and aggregation process may be modified as new alternatives are generated. Control over this process can be maintained by reverting to Step 7 at any stage.

9. Check the legal, institutional, environmental, political, and economic acceptability of each alternative.

The detailed and aggregated information of Steps 7 and 8 allows for this analysis, which can be carried out according to the specifics of the situation. For example, a disaggregated impact of Step 7, such as air pollution measures, allows a check for compliance with legal requirements, while the aggregated use of impacts of employment, in housing and community services, regional economy, etc., facilitate a political evaluation of the alternatives.

10. Generate new, potentially attractive, basic alternatives which are significantly different from those already proposed, and return to Step 6. This step can be carried out through major mitigating actions (modifications of alternatives) or by combination of "good" elements of alternatives already specified.

The steps for generating new alternatives are these:

(A) For each basic alternative, describe the main actions and their location.

(B) For each action evaluate the main positive and negative impacts on the defined goals. Also analyze composite effects of the global project.

(C) For each impact, determine which changes in primary conditions would reduce negative effects, or increase positive effects.

(D) For changes in primary conditions which would improve impacts, determine which actions would bring about those changes and what are the trade-offs implied (i.e., which other impacts are also affected through those actions).

(E) (a) For major mitigating actions, determine which actions have acceptable trade-off to improve impacts. Generate new alternatives introducing these actions.

(b) For combination of alternatives, determine, for two or more alternatives studied, which actions lead from one to another in some aspects. This procedure is used to determine combinations of elements of each alternative to generate a new one.

Alternatives generated must be technically and economically feasible.

A partial example of the procedure is the following:

(A) Basic alternative: one action is to build a large ski facility in a designated area.

(B) One negative effect: overflow of visitors from the area in winter creates serious social problems in neighboring communities.

(C) This negative impact can be mitigated by reducing the number of people going into the neighboring towns.

(D) Actions which would bring about this reduction are to reduce the size of the planned ski facility or to increase substantially the lodging and eating facilities in the recreation complex (to keep visitors in the area).

(E) Consider a major mitigating action with a substantial increase in lodging and eating facilities. The trade-off of this action, which in this case consists of additional negative impacts, is increased water usage, waste disposal problems, reduced attractiveness of the resort, reduced profitability of the project. If the trade-off seems acceptable, a new basic alternative can be generated incorporating the new lodging and eating facilities.

11. Determine if new areas of concern or types of impacts need to be defined. If yes, go back to Step 6 and check alternatives. This step acts as a control, as new knowledge is gained in the process.

12. Present the summarized results in adequate visual format. Impacts will be presented in tables by indexes (expected values and ranges will be used). Colors may be used to highlight differences among alternatives. See tables 1 and 2 as examples.

These tables show visual presentation possibilities for the described recreation project, for three proposed alternatives--A, F, and G.

A: Accept a project proposed by the Walt Disney Corporation to build a large winter and summer recreation complex in a designated area.

F: Leave the designated area untouched, promote the expansion of existing recreation sites.

G: Call for bids for a smaller recreation complex in the designated area.

Table 1. Reduced Impact List

Impact	Alternatives		
	A	F	G
Environmental			
Overall Physical-Biological	(-2,-3,-5)	(0,-1,-2)	(-1,-2,-3)
Water, Air, Waste	(-7,-8,-9)	(-2,-3,-4)	(-4,-5,-6)
Effect on Tahoe Basin	(+3,+4,+6)	(-3,-5,-6)	(+1,+2,+3)
Economic			
Impact neigboring counties	(+5,+6,+8)	(-1, 0, 0)	(+2,+3,+4)
Economic feasibility	(+5,+7,+8)	(+2,+2,+3)	(+1,+3,+4)
Regional, Tahoe Basin impact	(1,+2,+2)	(+1,+2,+2)	(0,+1,+1)
Social			
Pressure on social structure, Traffic congestion	(-5,-6,-9)	(-1,-1,-2)	(-3,-5,-6)
Pressure on services, controllability of growth, distribution of negative effects	(-3,-4,-6)	(-2,-3,-4)	(-1,-2,-3)
Effect in Tahoe Basin	(+2,+3,+5)	(-6,-7,-9)	(+1,+2,+3)
Recreation			
Winter	(6,8, 8)	(4,5, 6)	(3,4, 5)
Summer (include wilderness recreation lost)	(4,5, 6)	(0)	(1,3, 4)
Effect Tahoe Basin	(2,+4, 5)	(-3,-5,-6)	(+1,+2,+3)
Institutional			
Effect on other FS activities	(-3,-4,-5)	(-1)	(-1)

Table 1 is a list of main impacts. Impacts are rated from 0 to 10 for positive impacts, 0 to -10 for negative impacts (+10, -10 correspond to the most positive and the most negative respectively). In each case, the circled number corresponds to the expected value of the impact, the other two represent the range due to uncertainty. (Note: creating a recreation complex in the designated area will take away pressure from the Tahoe basin). Colors (not shown in table) are used to highlight differences, e.g., most positive values are circled in blue, next values in green, etc.

Table 2--Impact list with information about causes of uncertainty

The main causes of uncertainty are:

1 Growth of Reno (Reno is a fast-growing city, with high tourism, which shares with the designated area the freeway linking to the main population center in the region, the San Francisco Bay Area.)

2 Secondary impacts on neighboring counties

3 growth of overall recreation (ski) demand

□ not sufficient information (soft information)

△ technical incertainty

Impact	Alternative		
	A	F	G
Environmental			
Overall Physical-Biological	|-3||	|-1|	|-2|
Water usage	③|△-8||②	|-3|	③||-6|②
Waste disposal	③|-8|②	||-3|	③||-5|②
Air quality	③|-7|①②	|-4||①	③|-5|①②
Effect on Tahoe Basin	③||+4|	③||-5|	|+2|
	□	□	□

In this case, water usage for alternative A for example is: ③\|△-8\|\|② and is equivalent in Table 1 to (-7,(-8),-10). The information provided is:

② If secondary impact is larger than expected, water usage impact tends to grow in absolute value.

③ If ski demand is less than expected, water usage impact tends to decrease in absolute value.

△ There exists technical uncertainty in the projection.

Table 2 is a more detailed list of impacts in a different format. The number between vertical lines represents the expected impact. The number of vertical lines indicate the level of uncertainty in each direction, and the circled numbers refer to notes on the causes of this uncertainty.

13. Evaluate alternatives presented in Step 12. Determine the most attractive alternatives (or the better alternatives). To make this determination, sensitivity analysis should be carried out on uncertain, soft, or nonquantified data. Sensitivity analysis should include two aspects.

(a) The analysis of the stability--or robustness--of solutions. For example, an alternative may look very attractive when expected values are considered. However, once uncertainty is included, it may look much less desirable, due to a high probability of the least desirable outcome.

(b) The indication on where more and better information is needed, for sound decisionmaking. For example, an estimate with 15% error in the projection of timber demand may be sufficient in some cases. In others, a finer estimate may be crucial in the decision as to a project's financial soundness.

The overall impact of each alternative should also be considered; that is, besides a comparison of each attribute, it is important to view the global effect of the alternatives, and to include the intangible impacts in this assessment.

If none of the alternatives selected appears completely satisfactory, study what new aspects should be considered to generate new alternatives (i.e., new decision-influencing elements, criteria to improve overall impact or evenness of alternatives, criteria to reduce uncertainty, etc.). Then go back to Step 5. Otherwise continue to Step 14.

14. Generate new potentially attractive alternatives, marginally different from the ones selected in 13. This is done through proposing minor mitigating actions or combination of characteristics of the (similar) alternative selected. The mechanics of this step are similar to Step 10, where now detailed characteristics are considered. A minor mitigating action might be a small modification in the time stream of timber logged, to provide a more even supply to nearby mills. Alternatives generated at this stage should be technically feasible and economically efficient. Go back to Step 7. If no new alternative is generated, go to Step 15.

15. Select preferred alternative.

CONCLUSION

The scheme presented here has been well received by the professionals in charge of the Tahoe National Forest recreation project, and is currently being used in the decision process.

The scheme allows for flexibility, and some variations may be recommended in different applications. It can be used effectively in a variety of plan-

ping situations. For example, for the Tahoe project it was determined that the screening process--Step 6--should be introduced after Step 9 to permit a thorough evaluation of the major impacts for every alternative. This was done in order to avoid the adoption of intransigent opposition by interest groups whose preferred alternative might be screened out.

The method presented is designed to be used for land management planning, e.g., alternatives which emphasize the multiple use and value of land: timber, range, recreation, wilderness, ecology, etc. This form of decisionmaking is somewhat different from the evaluation and selection of single projects, as in the case of the recreation project, since it involves the determination of a combination of different forms of activities on areas with diverse characteristics which will make up a land management plan for a forest or land unit. This multiplicity of activities allows for a richer variety of possibilities in combining elements forming a plan and must be considered particularly in Steps 3, 8, 10 and 14.