CHAPTER TEN: STEP FIVE - COMPARING ALTERNATIVE PLANS

"Nothing is good or bad but by comparison." Thomas Fuller (1608-1661), English cleric.

"Step Five: Comparison of alternative plans." (P&G Section III.1.3.2(a)(5))

INTRODUCTION

The best plan can not be selected from among a set of good plans unless we have some way to compare them. *It is only by comparison that a plan is no longer good enough, or that a good plan becomes the best plan*. The purpose of the comparison step is to identify the most important criteria plans were evaluated against and compare the various plans across those criteria. Ideally, the comparison of plans concludes with a ranking of plans or some identification of the best course of action for the decision-makers. The comparison method must be transparent. That is, it must be easy to explain and easy for the public to follow and understand.

When all the important plan effects are measured in the same units, like dollars, the comparison can be simple. Financial decisions are often based on choosing the alternative with the largest net benefits or smallest total cost. More realistically, plan effects will be measured in a combination of dollars, habitat units, housing relocations, water quality changes, noise levels, navigation safety, changed erosion rates, or a host of other units, tangible and intangible. When that happens, planners have to advise decision-makers about **trade-offs**, i.e., **value judgments**. That's the hard part of comparing alternative plans.

Value judgments are made throughout the planning process. They are made throughout all screening activities. But, they take on special significance in the last three steps of the planning process as the study team, decision-makers, and other stakeholders move toward selecting the best most likely alternative future for a society. These value judgments are first made about the individual plan in evaluation. Is it good enough to warrant further consideration? The next step is to make a value judgments across all the plans. This is the comparison of alternative plans, the subject of this chapter.

STEPS RUNNING TOGETHER

As a practical matter, it is very difficult to neatly separate evaluation from comparison from selection, as the discrete chapters on each might imply. These three steps overlap, run together, and are in practice, most often indistinguishable from one another. They are discussed separately so the tasks can be clearly understood. The execution of these steps is much messier. So, if you find it difficult to separate these three steps in practice, relax; that's a good sign.

When more than one plan is being evaluated, it's impossible, in fact it's undesirable, to evaluate without comparing. Deciding whether a plan is good enough to qualify is a lot easier when we have some basis for comparison. As plans are being compared, some of them are being dropped from further consideration even though they may have been judged good enough to make it this far. That is selection. The planning team is selecting sets of plans to advance to the final rounds.

At this point in a planning study the steps seem to be all running together, and it is difficult to distinguish one activity from another. That's okay. What is important is that plans are evaluated, compared, and selected. What it looks like when you're doing it is unimportant. If the steps of the planning process seem to all be bleeding together at this point, let it bleed.

COMPARISONS OF WHAT?

Evaluation identifies the most important effects of your plans. These effects now need to be compared among plans. Comparison at any stage in the planning process should be based on the evaluation criteria at that same stage of the planning process. In other words, when you are looking for ways to compare plans, the place to look is at the plan impacts that were identified in the evaluation step. Comparison is based on the different contributions of the alternative plans to planning objectives and constraints, NED benefits and costs, environmental compliance requirements impacts, other plan impacts that are important to stakeholders, and the P&G screening criteria of completeness, effectiveness, efficiency, and acceptability. These are the things being compared. Water resources studies will involve different combinations of these impacts from those that the Corps' non-water resources studies will.

In an ordinary planning study it would not be unusual to have evaluated dozens of different impacts. Not all of them are equally important. For example, the Endangered Species Act requires the Corps to consider impacts on threatened and endangered species. Therefore, this should be an evaluation impact. If there are no threatened and endangered species impacts, then this is not important to the decision-making process, but it is important to say so.

"What should be compared?"

The answer to the question, "What should be compared?" is, compare the project impacts that will affect decision-making. These are the important impacts. Not all impacts evaluated will be equally important. It is the planning team's job to determine what subset of the evaluated plan impacts are important to compare. Importance depends on policy, partners, and the public.

Law and policy determine importance. For example, a civil works plan comparison should certainly include net NED benefits or incremental NED costs. That is a requirement. The Federal and non-Federal partners also get to say what they think is important.

The values and issues important to stakeholders and the public will also determine which impacts are important to plan comparison. If the planning team thinks the effects of ship wakes on erosion rates is a negligible factor, but it has been the number one topic of concern at public meetings, then ship wake erosion rates are important.

Comparisons are easier to make and easier to explain when fewer things are being compared. The trick and the challenge is to identify and compare all the important plan impacts, but only the important impacts. One starting point for determining importance would be to include those impacts that everyone on the study team agrees are important. Another could be to pretend you are the District Engineer or the non-Federal partner; what do you want to know before you sign the report? What is the public going to want to know about the plan before they support it? All other plan effects should be debated heartily and included only when persuasive, though not necessarily unanimous, arguments can be advanced.

Primary Methods of Comparison

Economic factors are a primary means of comparison. Any traditional water resources plan will require some sort of NED analysis. In most studies, that will mean a benefit-cost analysis in which net benefits, not benefit-cost ratios, are compared. For environmental and other projects where NED benefits are not estimated, the incremental cost of plans will be compared. Financial costs of plans will also be a component for virtually any planning effort, including military and other non-civil works planning.

COMPARING EFFECTS

Not to overlook the obvious, **comparing plans** *means looking at them and identifying differences among plans*. Plan A has lower net benefits than B. Plan B creates more wetlands than A or C. Of the five plans, Plan D has the highest costs. These are the types of comparisons that should be evident if the evaluation step of the planning process has been successfully completed.

When plans have different impacts, selecting Plan A rather than Plan B means foregoing the future Plan B would have offered. In other words, selecting Plan A means a future with fewer wetlands. Thus, pointing out the important differences among plans is not a trivial step.

It really is not so difficult to identify differences among plans once the planner has identified the important impacts to consider. The difficult part comes in weighing those differences, as when one plan contributes more to one objective and less to another. Suppose, for example, two plans have identical NED contributions and one creates more wetlands while the other protects bottomland hardwoods. Which is better? How do you compare things that are not comparable?

The NED Plan

Good planners do not formulate an NED plan. Good planners formulate plans that meet objectives and pass the screening criteria. Then an NED plan is identified from this set of objective achieving, complete, effective, efficient, and acceptable plans.

The NED plan is the NED plan only by comparison. A good planning process assures the NED plan is derived from a set of plans that make significant contributions to other planning objectives and screening criteria. Designation of the NED plan is one of the more significant outcomes of the comparison step for civil works projects.

COMMENSURABILITY

Ideally, we'd like an evaluation process that quantifies all plan impacts. When all impacts are quantified in the same units, they are said to be **commensurable**. Dollars, used to quantify benefits and costs, are the most widely used commensurable units of measure.

If all the important impacts of a plan to be compared are commensurable, the comparison of plans is simple and very transparent. You simply add or subtract all the impacts and identify the maximum or minimum value, depending on the situation, as the best of the plans. Such comparisons are easy to explain to the public and they have no trouble understanding the identification of the largest or smallest number.

For example, many private business decisions are based on profitability. It is a rather simple matter to add all the revenues and subtract all the costs to arrive at a most profitable option. The outcomes of some Corps studies may be determined purely on a financial basis. Others may be determined on environmental or other bases. These will be relatively rare instances.

INCOMMENSURABILITY

The more frequent situation will involve plans whose important impacts reflect a wide variety of concerns. There may be NED net benefits, construction noise disruption of migratory waterfowl, potential future oil spills, ship wake impacts on shoreline erosion rates, and so on. Although all the impacts can be quantified, there is no one unit of measure that can be used to quantify all of these impacts. Hence, there is no practical and transparent way to add or subtract these impacts and declare one plan better than another.

...incommensurability...makes comparison difficult.

Incommensurable plan impacts are more the rule than the exception. It is incommensurability that makes comparison difficult. *Pointing out the differences is easy. Weighing and trading-off those differences is the hard part.*

METHODS OF COMPARISON

Comparison, like all the planning steps, is an iterative process. Comparison of plans during early iterations can be quite abbreviated. Plans are often compared without a formal analysis. Ranking plans as better or worse, identifying plans that result in more or less effects of interest can be sufficient in early iterations. As the planning process moves toward a final array of plans, the comparison must be more formal and analytical to ensure that plans are responsive to the needs of the public.

There are many comparison methods that can be used early in the planning process. **Simple description** is perhaps the place to begin. Identifying differences that are important and pointing them out is the simplest form of comparison. For example, the NED section of Table 35 compares net benefits by a simple ranking from first to second.

Early in the planning process when the varying plan impacts are being explicitly compared, it can be convenient to rank impacts. The **rankings** can be from 1 to n, where n is the number of alternatives being compared. This is simple description and it can be used no matter what the unit of measure is for the impact being compared. Once the various differences have been described it may be possible to identify the plans from best to worst. For example, if one plan dominates all others by being first in every important impact category, it's the best plan. A plan that is last in all categories is the worst plan. *If a simple comparison clarifies the choices, don't use anything more complex*. This is another transparent comparison process.

Simple weighting is a more sophisticated approach to the comparison of plans. It's used when there are no dominant plans, and it's the simplest way to make trade-offs. Trade-offs are necessary when, once the important impacts of a plan are identified for comparison, one plan scores well on some impacts and not so well on others. For example, Plan 1 may be less costly but it destroys more wetlands, while Plan 2 is more costly and actually creates some wetlands. If costs and wetlands are both important, how can you compare plans like this?

One way to make trade-offs is to create a commensurable metric, we'll call a **ranking index**. First you describe the differences in plans and rank each plans' contribution to that impact. For example, if there are five (n) plans, the highest ranking plan on any impact gets 5 (n) points, the second best gets 4 (n-1) points, and so on through the last plan which gets 1 point. If all criteria are equally important, it's sufficient to sum the points to rank the plans.

In order to make the trade-offs someone must say what the relative importance of the impacts is. This can be done in a variety of ways. The easiest is to allocate 100 points (i.e., 100 percent) to the array of plan impacts being compared. Thus if we have only cost and wetlands we might say that cost gets a subjective weighting of 75 points and wetlands gets 25 points.

The simple weighting for this plan is shown in Table 35.

Table 35: Simple Ranking Index

1	2	3	4	5	6	7	8
Plan	Cost Rank	Cost Points	Cost Weight	Wetland Rank	Wetland Points	Wetland Weight	Ranking Index
A	1	2	75	2	1	25	175
B	2	1	75	1	2	25	125

The ranking index is given by:

$$\text{Ranking Index} = \Sigma_i \Sigma_j p_{ij} w_i$$

where p is the number of points awarded plan i for impact j and w is the weight for impact j. In other words multiply the points by the weight for each impact and add them up for a plan. In the example, the index is columns 3 x 4 plus columns 6 x 7.

This is a simple process and it is transparent insofar as it's easy to show how the index was derived. It is fundamentally a subjective process, however. It would be misleading and a mistake to lead anyone to believe there was any science behind the ranking index. It is, however, a simple way to reflect value judgments.

This simple weighting may be well suited to military studies and other efforts with a relatively circumscribed number of "publics" to satisfy and little controversy. The method can work in civil works studies, but its subjectivity can become an issue. For example, if we flip-flop the relative importance of wetlands and cost in the example above, the ranking indices flip-flop as well. When results are very sensitive to the weights assigned, this method might be less than transparent.

Figure 9 shows an **effects matrix**, an adaptation of the simple weighting method. The columns of the matrix are alternative plans. The rows show important impacts to be compared, i.e, planning objectives and the like. Each cell is divided by a diagonal line. Above the line is the measure of the impacts. A 1-to-10 scale has been used in the example to indicate the relative magnitude of the effect (or attainment of the objective). The 1 to 10 scale is an alternative to ranking projects as was done above. It allows finer degrees of differences in plan contributions. Plans 1 and 2 are equal in terms of their first two impacts, so questions of how to handle ties are easily resolved.

Figure 9: Effects Matrix

Objective/Effect	Plan 1	Plan 2	Plan 3	Plan 4
Reduce Flood Damages	+ 7 / 8	+ 7 / 8	+ 6 / 8	+ 8 / 8
Reduce Potential Loss of Life	+ 2 / 10	+ 2 / 10	0 / 10	+ 3 / 10
Maintain Fish & Wildlife Habitat	-3 / 7	0 / 7	+ 1 / 7	+ 2 / 7
Enhance Open Space Land Use Opportunities	-1 / 2	+ 1 / 2	+ 3 / 2	-2 / 2
Minimize Relocation of Homes & Businesses	0 / 5	-4 / 5	0 / 5	-6 / 3

In addition, the range of differences is more flexible. Under a ranking rule, the range in points awarded would be from 1 to 4. With a scale like this, the difference can be less as for the reduction of flood damages (3 points) or more as for relocations (6 points). The numbers may be positive or negative, depending on the nature of the impact.

Below the line another number from +1 to +10 is entered to indicate the relative importance, or weighting, of the plan effect to be compared. In both cases, 10 indicates the extreme value. Different interests may

Different interests may have differing opinions...

have differing opinions about the relative importance of plan effects. This matrix may be used as a summary or it can be used to calculate ranking indices as was done above. In that case, the ranking indices for Plans 1 through 4 would be 53, 58, 61, and 86 points, respectively. It is important at this point to bear in mind that these numbers are just information. They are not decisions. They reflect the judgments of the planners, who must deal with the potentially disparate points of view on plan effects, and they reflect what looks best based on that set of judgments.

There is nothing magical or scientific about these comparison methods. Other qualitative values may be used. High, medium, and low judgments could appear above the line. Very important, moderately important, and unimportant are examples of value judgments that could appear below the line. It becomes more difficult to trade-off such values, but the option does exist. If it works and it is transparent, use it.

There are more formal comparison methods. One commensurable set of methods includes **monetary evaluation methods**. These methods have focused on refinements of benefit-cost analysis and **cost-effectiveness** and make comparison a simple and straightforward matter. The range of methods is presented as a continuum in Figure 10. To be useful in multi-impact plan comparisons, it must be possible to reduce important plan impacts to monetary terms. This is clearly not possible at the present time, and many would argue it is not even desirable. Nonetheless, monetary evaluation methods, such as traditional NED benefit-cost and **net benefit analyses**, incremental cost analysis, life-cycle costing, and payback period analyses still play a critical role in the comparison of alternative plans.

Multi-criteria evaluation methods (MCEM) comprise another class of methods that can be used when it is either not possible or not desirable to express all plan effects in a single metric, such as dollars. Thus, more than one evaluation metric can be considered with these methods. The strength of these methods is that they enable planners to take into account a whole gamut of differing but relevant criteria when comparing plans. On the basis of this idea of multi-dimensional compromise, a series of MCEMs have been developed in recent years. Many of them are quite complex and we can do little more here than provide the briefest of overviews and a reference for further details. Their major difficulty is that they are not all transparent methods. Some are neither easy to explain nor easy to understand.

Trade-off analysis[12] is an MCEM method commonly used by the Corps. It can be as simple as the methods described above or as complex as you want to make it. In the least structured applications, this method frequently relies on professional judgment. Planners trade-off plans' various contributions to

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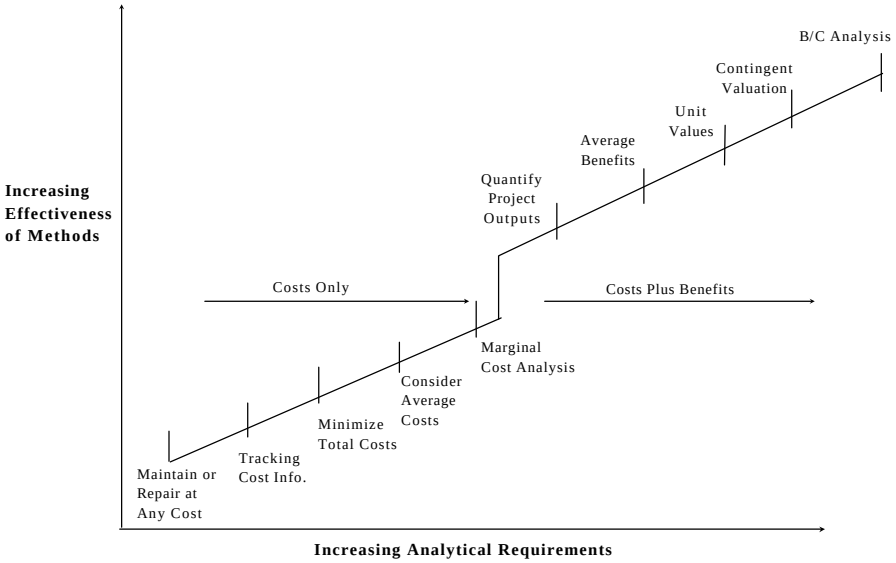
[12] See Edmunds, E. and J. Letey, *Environmental Administration*, McGraw-Hill, New York, 1973 for a discussion.

Figure 10: Monetary Evaluation Methods



objectives based on their accumulated technical expertise, general experience, and specific knowledge of the study area, including stakeholder views and values. In essence, planners sit down and decide a plan with "a little more of this" is better than a plan "with a little more of that." The trade-offs tend to be subjective.

There are a great many other trade-off methods. **Multi-dimensional scalogram analysis**[13] is a generalization and extension of the ranking index, also known as the **goals-achievement method**,[14] presented above. **Correspondence analysis**[15] is a method of pattern recognition between alternatives with different characteristics. Using a **principle component analysis** of the row and column values in a plan-effect matrix,[16] similar to that above, the relationships between certain

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[13] See Hill, M. and Y. Tzamir, "Multi-dimensional Evaluation of Regional Plans Serving Multiple Objectives," *Papers of the Regional Science Association*, vol. 29, pp. 139-165, 1972.

[14] See Hill, M. "A Goals-Achievement Matrix for Evaluating Alternative Plans," *Journal of the American Institute of Planners*, vol. 34, no. 1, pp. 19-29, 1968. Also see the Regional Science Institute's *Planning for Multiple Objectives*.

[15] See Spliid, I. "Use of Correspondence Analysis in a Planning Procedure for Local Governments," Paper Third Advanced Karlsruhe Summer Institute in Regional Science, Karlsruhe, 1974.

[16] In such a matrix, the plans form the columns (or rows) and the measured impacts form the rows (or columns). Each cell is a specific measured impact for a plan. Qualitative variables must be converted to nominal numerical values.

decision criteria and alternative plans can be examined on the basis of clustering procedures. Conclusions can then be inferred about the desirability of plans.

A **discrepancy analysis** sheds some light on the relative merits of a certain alternative, like the NED plan. This approach measures the difference between the NED plan and every other plan. Ranking the discrepancies among the other plans, a Spearman rank correlation coefficient can be used to establish an ordering of plans.[17]

Concordance analysis consists of **pairwise comparison** of alternatives. In the **analytical hierarchical process** (AHP)[18] the objectives are assigned subjective weights and the extent to which plans contribute to these objectives is resolved on the basis of a pairwise comparison of all plans. Indices reflecting these weights are generated and can form the basis for ranking alternatives.

These concordance analysis processes have become very accessible in recent years with the development of user friendly software like Expert Choice and Logical Decisions. They are recommended as reasonable methods for dealing with multi-objective decision-making. They offer tremendous advantages for sensitivity analysis and are powerful tools. However, they are not going to be transparent methods of comparison as far as the public is concerned.

Additional methods include the **dominance criterion**, **maximin criterion**, **maximax criterion**, **conjunctive method**, **disjunctive method**, **lexicographic method**, **elimination by aspect**, **simple additive weighting**, **weighted product**, **TOPSIS**, **ELECTRE**, and the **median ranking method**. A description of these methods and a good list of references can be found in Yoon and Hwang's 1995 monograph *Multiple Attribute Decision-Making, An Introduction*.

Despite the abundance of multi-criteria evaluation methods, trade-off analysis based on professional judgment remains the most common method. If comparisons based on seat-of-the-pants methods like this yield the best plan, there is no need for anything more complex.

WHAT ARE COMPARISON RESULTS?

First, when dealing with NED-oriented planning efforts, a true NED plan must be identified. Second, the comparisons should be made explicit. **Simple comparisons** can be straightforward statements like "Plan A is best because it maximizes net NED benefits." Simple comparisons will be more appropriate for early

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[17] Nijkamp, P. "Stochastic Quantitative and Qualitative Multi-Criteria Analysis for Environmental Design," *Papers of the Regional Science Association*, 1977.

[18] See Saaty, Thomas L., Luis G. Vargas, and Kevin P. Kearns, *The Analytical Hierarchy Process* 4 Volume Set.

planning phases and more abbreviated planning processes. More **complex comparisons** will offer either objective or subjective rankings of the final array of alternatives. These comparisons, whether simple statements or complete rankings, effectively represent the study team's advice to decision-makers based on stakeholders' views and the team's experience throughout the planning process.

Third, the comparisons must be objective. Despite our attempts to present the planning process as a scientific journey of discovery, the reality of the situation is that some studies begin with a **favored alternative**. In others, a favored alternative can emerge at any point in the study. There is nothing inherently wrong with the appearance of a favored alternative on the planning scene.

A problem arises if the planning process is manipulated to justify the selection of a favored plan. If the planning process is conducted in a professional, conscientious, and thorough manner, and the favored plan prevails, then it was clearly favored for good reason. However, the planning process must be objective. Favored plans can persist only when they are the best alternative from among a strong set of alternatives. To assure the integrity of the planning process, a rigorous comparison of plans is essential.

COMMUNICATING RESULTS

…tell people which plans are best and why.

If the comparison involves professional judgment and trade-offs among values they won't necessarily be obvious to everyone. The planning report must be able to tell people which plans are best and why. *The comparison should be transparent*. The planner is once again a story teller. How did you compare the plans to one another? What things did you look at? Which were most important? Why? How did you rank the plans? What were your criteria? What trade-offs are worth making? Why do you feel that way?

Rather than rely on stiff report-style writing, try to tell a story with a beginning, a middle, and an end. Tell the reader how it happened. Write so readers can understand. Save the details for appendices. See Chapter Fourteen for a discussion of how to tell your story.

SUMMARY AND LOOK FORWARD

Lesson One. Plan evaluation determines whether a plan is good enough to consider for implementation. Plan comparison rates all the plans considered for implementation against one another based on the most important impacts identified in the evaluation process.

Lesson Two. Comparisons can be qualitative or quantitative, simple or complex. There are many ranking techniques available. A trade-off analysis based on professional judgment is most often used. Use a transparent method.

Lesson Three. The NED plan arises from the comparison of plans.

Lesson Four. Finally, the comparison results should rate or rank the plans, identifying the best plan and the reason(s) it is best.

Though planners may do an exemplary job throughout the planning process, up to and including ranking the plans, decision-makers still select the plan for implementation. Selection of the recommended plan is the subject of the next chapter.

SUGGESTIONS FOR FURTHER READING

As is so often the case, relatively little has been written explicitly about this step of the planning process. There is some material found in the water resources planning references following Chapter Two. A great deal more has been written about the so-called multi-criteria evaluation/decision models. Suggestions for further reading about these models have been included at appropriate points in the footnotes of this chapter. Although these articles are good, many are dated and some are quite difficult to read if you are not familiar with the literature. Perhaps a better place to start is with Yoon and Hwang's monograph. It is informative and has a wealth of further references.