

RECLAMATION

Managing Water in the West

Trade-Off Analysis Background

Lower Santa Cruz River Basin Study



U.S. Department of the Interior
Bureau of Reclamation

TRADE OFF ANALYSIS OVERVIEW

Goal:

- Provide a transparent evaluation and compare adaptation strategies that provide a variety of identified benefits at a range of costs

Objectives:

- Improve understanding of the relative importance of various effects of adaptation strategies
- Develop a framework to compare adaptation strategies and determine how much must be given up to get more of a desired output
- Determine if weights are needed to reflect the importance of various resources affected by adaptation strategies
- Provide an objective and transparent evaluation of adaptation strategies

MULTI-CRITERIA DECISION MAKING

Choice Problem

- Which adaptation strategies are best given specific identified criteria?

Sorting Problem

- Which adaptation strategies meet specific minimum criteria?

Ordering Problem

- How do adaptation strategies compare?

A framework to achieve a solution that is the best possible given range of impacts

Trade-Offs

- Simple Definition - Giving up one thing to get another. However, not all choices can be strictly defined as a trade-off.

Similar Concepts

- Optimization choices - Choices on the quantity of one good or service desired. Optimization choices do not entail trade-offs because it is typically minimizing or maximizing a single objective.
- One commonly used optimization criterion is maximizing net benefits. However, an economic analysis can miss important effects and considerations.

TRADE-OFF ANALYSIS 1.1

- Basic premise - There are benefits and costs that can be measured and monetized and other benefits and costs that cannot but are important and need to be considered when evaluating different adaptation strategies.
- Trade-off-analysis conforms with the types of analyses described in the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&G's).

TRADE-OFF ANALYSIS 1.2

- The PR&G's discuss maximizing net public benefits.
Public benefits:
 - Include environmental, economic, and social objectives
 - Can include monetary and non-monetary effects which may be quantified or unquantified measures.
 - Can include goods and services that are marketed as well as those that may not be marketed.

STEPS IN COMPLETING A TRADE-OFF ANALYSIS

1) Identify outputs associated with each adaptation strategy

- Examples include water supply reliability, ecosystem function, recharge potential, recreation

2) Quantify to the extent possible outputs associated with each adaptation strategy

- May be economic, financial, environmental, social outputs

3) Obtain economic values for identified outputs

- Quantify to extent possible (comparable across all output types)
- Not all outputs can or should be quantified

STEPS IN COMPLETING A TRADE-OFF ANALYSIS (CONTINUED)

4) Convert output values into comparable measures

- Example: Normalizing values as a “percentage” of highest value

5) Determine relative importance of outputs

- Important step that must be carefully considered
- Relative importance of objectives can completely change trade-off results
- Study partners will be relied upon to evaluate importance of objectives

6) Completion of Trade-Off Analysis

- Clear, transparent, reproducible description of process and results

COMPONENTS OF TRADE OFF ANALYSIS

Economic & Financial

- Estimate resource benefit values
- Compare adaptation strategy benefits to cost
- Evaluate strategy costs

Environmental & Social

- Evaluate effects which cannot be monetized
- Identify measures of effects for use in comparing strategies

Completion of Trade-Off Analysis

- Identification of criteria
- Determine importance of individual criterion
- Identify potential to combine strategies

Trade-Offs Defined

- Value trade-offs – Comparing adaptation strategies requires decision makers to place values on outputs/services generated by alternatives. Determination of these values must be transparent.
- Need for trade-off analysis – Need to account for effects that cannot be monetized as well as effects that can be monetized.

Simplified Trade-Off Example 1.1

- Suppose four alternative plans
- Assume three rating criteria/objectives

Alternative	Economics - Net Benefits	Economics - Project Costs	Wetland Acres
1	\$500,000	\$16.0 million	+400
2	\$200,000	\$19.5 million	+350
3	\$250,000	\$13.5 million	+300
4	\$300,000	\$17.0 million	+600

Simplified Trade-Off Example 1.2

- One method of comparing alternatives is to normalize according to the maximum value
- Note: Reciprocal of project cost is used to compare costs

Alternative	Net Benefits (NED)	Project Costs	Wetland Acres
1	1.00	0.84	0.67
2	0.40	0.69	0.58
3	0.50	1.00	0.50
4	0.60	0.79	1.00

Trade-Off Example 1.1

Then Can Apply Weights to Criteria: e.g.

- NED Benefits = .50
- Project Costs = .20
- Wetland Acres = .30

Example: Combining Criteria and Weights

- Alternative 1 = $(1 \times .5) + (0.84 \times .2) + (.67 \times .3) = 0.869$
- Alternative 2 = $(.4 \times .5) + (0.69 \times .2) + (.58 \times .3) = 0.512$
- Alternative 3 = $(.5 \times .5) + (1 \times .2) + (.5 \times .3) = 0.600$
- Alternative 4 = $(.6 \times .5) + (0.79 \times .2) + (1 \times .3) = 0.758$

Trade-Off Example 1.2

- Another example – Simple ordered ranking

Alternative	Net Benefits (NED)	Project Costs	Wetland Acres
1	1	2	2
2	4	4	3
3	3	1	4
4	2	3	1

GOALS OF TRADE OFF ANALYSIS

- 1) **Convert effects into comparable units**
- 2) **Generate comparable units based on rank or proportion for a specific objective**
 - Units of measure may be dollars, acres, tons of waste, etc.
 - Could also be based on a “best” to “worst” method
- 3) **Normalize Ranking of Individual Effects**
 - “Best” ranking becomes the basis for normalizing results
 - For example, if “best” benefits are \$100 and second ranked is \$80, then the normalized value for #2 is a unit-less 0.80
- 4) **Potentially combine individual effects into an Overall Comparison**