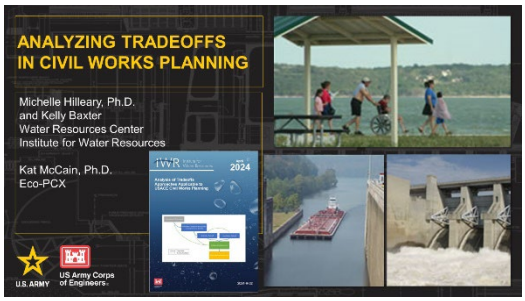
Analyzing Tradeoffs in Civil Works Planning
5 & 19 September 2024
Q&A Summary

This mini-series provided an overview of Qualitative (Part 1) and Quantitative (Part 2) Approaches to Tradeoff Analysis in Civil Works Planning. Under current and future USACE planning guidance, tradeoff analysis is required to fully evaluate, compare, and recommend an alternative. Both webinars were presented by Michelle Hilleary (Supervisory Environmental Planner, IWR), Kelly Baxter (Economist, IWR), and Kat McCain (Operating Director, ECO-PCX).



Tradeoff Analysis Resources:

- January 2021 Assistant Secretary of the Army for Civil Works Comprehensive Benefits Memo
- Engineer Regulation 1105-2-103: Policy for Conducting Civil Works Planning Studies
- IWR publication Analysis of Tradeoffs Approaches Applicable to USACE Civil Works Planning
- Proposed Agency Specific Procedures (ASPs) to Implement the Principles, Requirements, and Guidelines for Federal Investments in Water Resources Federal Register Notice

The summary of the Question/Answer session of the webinar is not a transcription; questions and responses have been edited and reordered for clarity.

General Tradeoff Analysis Considerations

When analyzing tradeoffs and benefit types, how are teams expected to balance or prioritize the benefits directly related to the study purpose and the social, economic, and environmental benefits (and impacts) beyond the study purpose?

Teams should consider the full range of benefits within the confines of formulating solutions for the water resource issue within the authorized study purpose. The formulated alternatives must address the study purpose (flood risk management, ecosystem restoration, navigation, etc.) and, as stated in ER 1105-2-103, "planning teams should formulate alternatives to achieve economic, social and environmental objectives" (c. Step 3 Formulating alternative plans, (4) Formulation to Objectives). For example, teams should not formulate plans to maximize an Other Social Effects (OSE) benefit if the measures do not also address the water resource issue within the primary study purpose (i.e., reduce flood risk management impacts on vulnerable populations or reduce flood risk management impacts through seeking natural/nature-based solutions).

Is tradeoff analysis used to justify the recommended project, or is it only used to demonstrate other benefits of a National Economic Development (NED)-justified project?

Tradeoff analysis is helpful throughout the planning process. Early on, tradeoff analysis supports the development and screening of preliminary alternatives. It can also help identify potential resources and associated effects that may drive the decision-making process, therefore requiring additional analysis. During the evaluation and alternative selection study phases, tradeoff analysis can demonstrate each alternative's wide range of effects in the final array of alternatives, and provide a framework for identifying the recommended plan. If an alternative to the NED plan is recommended, the current policy requires a policy exception from the Assistant Secretary of the Army for Civil Works (ASA(CW)).

How should different sea level rise scenarios be incorporated into tradeoff analysis for coastal storm risk management studies?
Tradeoff analysis incorporates risk and uncertainty for changing conditions, such as sea level rise, by showing how sea level scenarios will impact the appropriate metrics (i.e. project performance under a range of plausible conditions during the project lifetime). The approach for evaluating relative sea level change (RSLC) should be consistent with guidance: ER 1100-2-8162 and EP 1100-2-1 (updates in progress). Within ER 1100-2-8162, there are three general approaches when considering RSLC:

1) Select a single sea level scenario for alternative formulation and selection, and after the tentatively selected plan has been identified, assess its performance under the remaining two scenarios to confirm that it will perform acceptably under the full range of plausible future conditions.
2) Formulate and assess all alternatives under all sea level scenarios, selecting the plan that is the best, and most robust, across the full range of scenarios (rather than having the best performance under any scenario).
3) After undergoing the process in approaches (1) or (2), reformulate alternatives to include the aspects of the considered plans that were found to be most successful, creating a new plan that includes the most desirable elements of each plan in the initial array.

In cases where a study involves the development of a programmatic National Environmental Policy Act (NEPA) document and only qualitative tradeoff analysis approaches are used, would the study team be expected to come back to the tradeoff analysis in a subsequent supplemental NEPA document to incorporate quantitative approaches?
Tradeoff analysis is not required for NEPA documents, however, similar to Corps planning studies, utilizing tradeoff analysis for a NEPA document helps provide structure to the evaluation and alternative recommendation process. Similarly, there is no requirement to change from a qualitative tradeoff analysis to a quantitative tradeoff analysis if the study team is developing a supplemental NEPA document. If the qualitative tradeoff analysis adequately meets the needs of the study by finding an acceptable balance across goals or objectives, then that analysis for the programmatic NEPA document and supplemental NEPA documents is likely adequate. Teams are also encouraged to discuss these questions with their vertical team to gain a better understanding and acceptance of the chosen process.

Clarifying Tradeoff Analysis Terminology

Are "tradeoff analysis" and "multi-criteria decision analysis" synonymous?
No. Tradeoff analysis encompasses qualitative and quantitative tradeoff analysis. Multi-criteria decision analysis is a type of quantitative tradeoff analysis.

What are "dominated alternatives?"
A dominated alternative is an alternative that underperforms across all decision criteria relative to other alternatives.

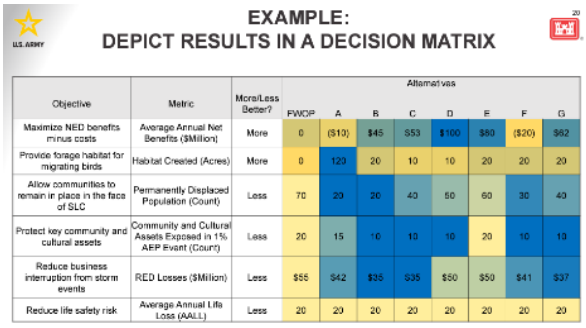
Creating and Using a Decision Matrix

Since the use of color in graphics sometimes conflicts with Section 508 requirements (which requires federal agencies to make their information and communication technology (ICT) accessible to people with disabilities), what are the best practices for developing 508-compliant matrixes (e.g., should they

be developed in grayscale)?
Section 508 requirements and best practices would be followed as described in the available guidance. The specific needs of developing 508-compliant products, including colorful tradeoff analysis products such as decision matrix or other figures, will likely need to be addressed on an individual study and project team basis, and will need to meet the needs of the specific study activities (scoping, public information sessions, etc.) and/or products developed. Check-in with Section 508 compliance experts to receive direction on specific activities and products.

How many metrics should a team use when evaluating tradeoffs?
The number of metrics depends on the project. The set of metrics should be complete, concise, sensitive, meaningful, and independent. The analysis should include metrics that matter when choosing among alternative plans, whether or not they are easily measured. They should be understandable, and able to capture the difference between alternatives, including the degree of uncertainty. There is not a golden number. Too few metrics may miss important information needed to compare plans. Too many metrics often result from including metrics that do not meaningfully distinguish between alternatives. If an analysis considers too many metrics, the likelihood of double counting increases. Additionally, having too many metrics makes it more difficult to focus on the important tradeoffs inherent to the decision. Teams are encouraged to discuss this type of question with their vertical team to help identify the appropriate metrics to consider.

How would a group of stakeholders come to a consensus on a decision matrix that ranks attributes of different alternatives by labeling them as high/medium/low? Would this need to be done via a group discussion, individual surveys, or some other method?


EXAMPLE:
DEPICT RESULTS IN A DECISION MATRIX

Objective	Metric	More/Less Better?	Alternatives							
			FWOP	A	B	C	D	E	F	G
Maximize NED benefits minus costs	Average Annual Net Benefits ($Million)	More	0	($10)	$45	$53	$100	$80	($20)	$62
Provide forage habitat for migrating birds	Habitat Created (Acres)	More	0	120	20	10	10	20	20	20
Allow communities to remain in place in the face of SLC	Permanently Displaced Population (Count)	Less	70	20	20	40	50	60	30	40
Protect key community and cultural assets	Community and Cultural Assets Exposed in 1% AEP Event (Count)	Less	20	15	10	10	10	20	10	10
Reduce business interruption from storm events	RED Losses ($Million)	Less	$55	$42	$35	$35	$50	$50	$41	$37
Reduce life safety risk	Average Annual Life Loss (AALL)	Less	20	20	20	20	20	20	20	20

First, caution is advised anytime stakeholders and consensus are discussed due to Federal Advisory Committee Act (FACA) considerations. The question seems to be related to generating the cells in a decision matrix, which is done to assist tradeoff analysis in evaluating alternatives. The inputs for the cells in the decision matrix should come from models, data, or expert elicitation. These are not value preferences or opportunities for general stakeholder input. If there are uncertainties about what values go into the cells, due to competing models or other sources, those can be captured and included in the table or in additional diagrams and documentation. If the team is doing a decision matrix during the planning charette, before having any data/models, the inputs can be captured as High/Medium/Low, or in whatever scale best fits the context. In this case, it should still be experts who provide inputs into rows or columns to show alternative scores in relation to a metric. Different experts should provide input for different criteria, as some will have a greater understanding of the different environmental, economic, social, etc. metrics. A structured expert elicitation process can be used to capture these inputs. For more information, reach out to the IWR-WRC Tradeoffs team.

Is a decision matrix that uses numbers still considered qualitative analysis?
Yes. A qualitative tradeoff analysis usually involves metrics (i.e. benefits and impacts) that are reported as numbers (either monetized and/or another numerical unit). Likewise, a quantitative analysis can also

be completed with metrics that are reported using qualitative metrics (i.e. non-quantified or descriptive assessments of effects). “Qualitative analysis” means that the value preferences inherent in selecting a preferred alternative are not directly elicited or calculated. In other words, no additional calculations or weighting of criteria is completed on the values to inform the tradeoff analysis. A qualitative assessment of a metric for the decision criteria is the basis of the tradeoff analysis.

How should matrices factor in the costs of alternatives? Or should costs not be factored into any of the metrics for consistency purposes?
Costs are typically an important consideration when evaluating an alternative and should be considered as part of the alternative recommendation process. However, it may be helpful to first evaluate alternatives using simplified metrics for the different decision criteria. Once the number of alternatives and decision criteria have been reduced, project costs can then be incorporated into the decision matrix. When including costs in the decision matrix and tradeoff analysis, it is important to specify which costs have been included and how they are reported. For example, costs should be identified as “Total Project Costs” or “Average Annual Costs,” or as life-cycle costs such as OMRR&R (operations, maintenance, repair, rehabilitation, and replacement), monitoring, and adaptive management. Teams are encouraged to consult with their vertical team on appropriate metrics to consider.

When eliminating insensitive criteria (criteria with the same value across all alternatives) from a decision matrix, are those criteria eliminated from consideration or only from the matrix?
The criteria can be eliminated from the matrix but may still be required to be considered for the study. It is important to document the completed steps of the tradeoff analysis since a decision matrix is iteratively simplified.

Would "provide forage habitat for migrating birds?" be considered an objective or an opportunity?
This potential statement could be included as either an objective or opportunity depending upon the primary authorized purpose of the study. If this statement is about an FRM-authorized project, it would likely be appropriate as an opportunity (assuming an objective may be to achieve FRM benefits through incorporating natural or nature-based features).

How should the development and use of tradeoff analysis be documented in a Review Plan? Who approves the criteria and approach selected?
The development and use of tradeoff analysis can be recognized in a Review Plan, however, it is not an explicit requirement unless the PDT anticipates using quantitative tradeoff analysis (or multi-criteria decision analysis). As stated in ER 1165-2-217, Review Policy for Civil Works, the PDT is responsible for recommending the necessary type(s) of reviews as well as the disciplines/expertise needed for the review (ER 1165-2-217, 7(b)). If the PDT anticipates using quantitative tradeoff analysis, often referred to as multi-criteria decision analysis, the following requirement applies: “Formal multiple criteria decision analysis methods are available, but not required. If a formal multiple criteria decision analysis method is proposed for use, the planning team must coordinate with USACE Headquarters (HQUSACE) and obtain approval for the criteria and procedures to be used in the analysis” (ER 1105-2-103, 2-4.f.(1)(c)).

Are Agency Technical Review (ATR) certified reviewers expected to have the expertise to evaluate decision matrixes?
Not necessarily. Decision matrixes are tools for summarizing information to help compare alternatives.

ATR-certified reviewers will be expected to understand the metrics within the decision matrix and assess if they are appropriate, calculated correctly, and applied to the right decision criteria.

While multi-criteria decision analysis and Cost-Effectiveness and Incremental Cost Analysis (CE-ICA) are tools contained in the certified IWR Planning Suite, do these decision matrixes require approval/certification to be used as Planning models for decision-making?
Decision matrixes in and of themselves are not models that need approval for use or model certification because they are not models that are performing calculations. They may be used for qualitative tradeoff analyses that inform decision-making. If the PDT anticipates using quantitative tradeoff analysis, often referred to as multi-criteria decision analysis, the planning team is required to coordinate. As stated in planning guidance, "If a formal multiple criteria decision analysis method is proposed for use, the planning team must coordinate with USACE Headquarters (HQUSACE) and obtain approval for the criteria and procedures to be used in the analysis" (ER 1105-2-103, 2-4.f.(1)(c)).

Weighing Criteria for Quantitative Tradeoff Analysis

How can Planners avoid introducing bias and maintain the defensibility of analysis and outcomes when determining metric weighting?
Through tradeoff analysis, the goal is to accurately depict value preferences through quantitative or qualitative approaches, and in close collaboration with team members, decision-makers, and stakeholders. Metric weighting should represent a value perspective, using a transparent process that demonstrates how those values influence the ranking of alternatives. It is important to plan properly for the weighting elicitation, including using experts trained in values elicitation techniques and providing sufficient time to train the individuals whose weights will be elicited on the techniques. Finally, allow for opportunities for discussion around the insights and findings from the quantitative tradeoff analysis. A mixed method approach, which elicits both the direct ranking of alternatives (the holistic intuitive input) and the weighted score (the deliberative, value-focused input) can highlight potential gaps in understanding or unsupported biases toward/against alternatives.

Is normalization conducted for each value in the decision matrix table, or is it done by metric?
Normalization is by metric. The following tables provide an example of normalizing values based on the min and max values reported for each metric.

Metric	More/Less	FWOP	B	D	E	G	Min	Max
Flood Damages Reduced	More	0	45	100	80	62	0	100
Habitat Created	More	0	1	0	1	1	0	1
Perm. Displaced Pop	Less	70	20	50	60	40	20	70
Comm & Cultural Assets Exposed	Less	20	10	10	20	10	10	20
RED Losses	Less	55	35	50	50	37	35	55

Metric	More/Less	FWOP	B	D	E	G
Flood Damages Reduced	More	0	0.45	1	0.8	0.62
Habitat Created	More	0	1	0	1	1
Perm. Displaced Pop	Less	1	0	0.6	0.8	0.4
Comm & Cultural Assets Exposed	Less	1	0	0	1	0
RED Losses	Less	1	0	0.75	0.75	0.1

Is it appropriate for the public to provide input to determine how metrics should be weighted? Can multiple team members compile their swing weights to create a usable aggregate group swing weight?

The study team may want to elicit weights from stakeholders or members of the public to better understand how public value preference differences influence their preferred ranking of alternatives. This information can be used to determine if there are opportunities for refined alternatives that provide greater value across the metrics and benefit types. There should not be any expectation that stakeholders are providing input on how metrics should be weighted, as the agency retains the decision authority.

In general, taking group averages from a PDT is not appropriate for swing weighting or any weighting technique. Weights can be elicited from individuals within a team and used to show the ranking of alternatives from that value perspective. Taking weights from multiple team members and showing if that influences the ranking of alternatives can be a useful exercise to ascertain the robustness of the alternative ranking to intra-team value preference differences, or uncertainty in the values that best represent the agency perspective. It may be beneficial for the team to discuss and then re-evaluate if there is a need for a single set of weights to represent the agency perspective. This could also be the case for cooperating agencies, if they are requested to provide their weights to inform the tradeoff analysis deliberations.

If multi-criteria decision analysis software other than through the IWR Planning Suite is used, is a planning model certification or approval for use needed?

Yes, at this time multi-criteria decision analysis software other than what is included in the IWR Planning Suite would require model certification per Engineer Circular 1105-2-412: Assuring Quality of Planning Models and the Modification of the Model Certification Process and Delegation of Model Approval for Use memorandum from the Director of Civil Works.