# ANALYZING TRADEOFFS IN CIVIL WORKS PLANNING- PART 2 – QUANTITATIVE TECHNIQUES

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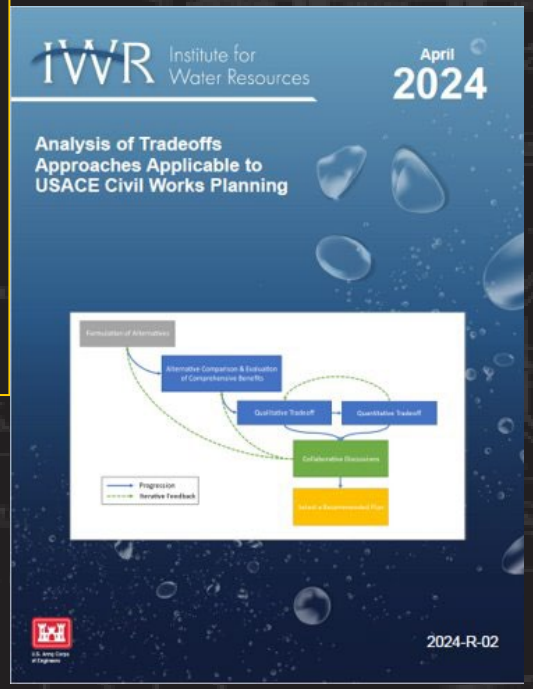


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# WARM-UP ACTIVITY

What is your experience level with doing quantitative tradeoffs analysis, such as multi-criteria decision analysis?

No experience

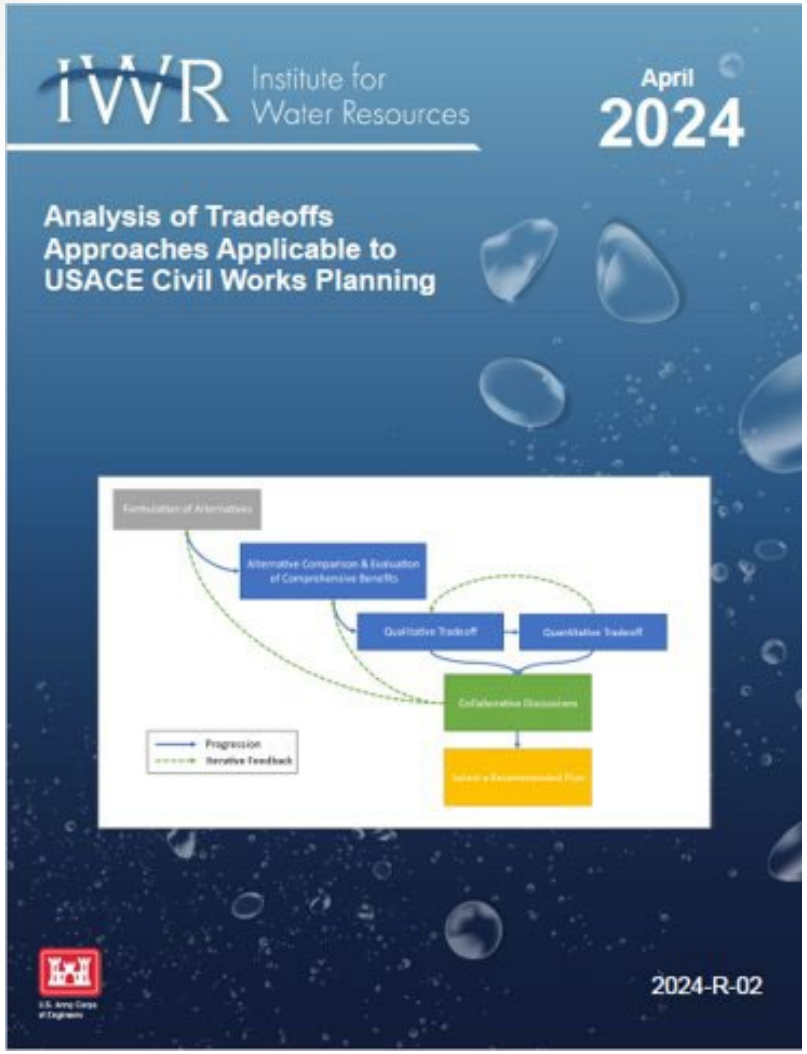
Limited experience

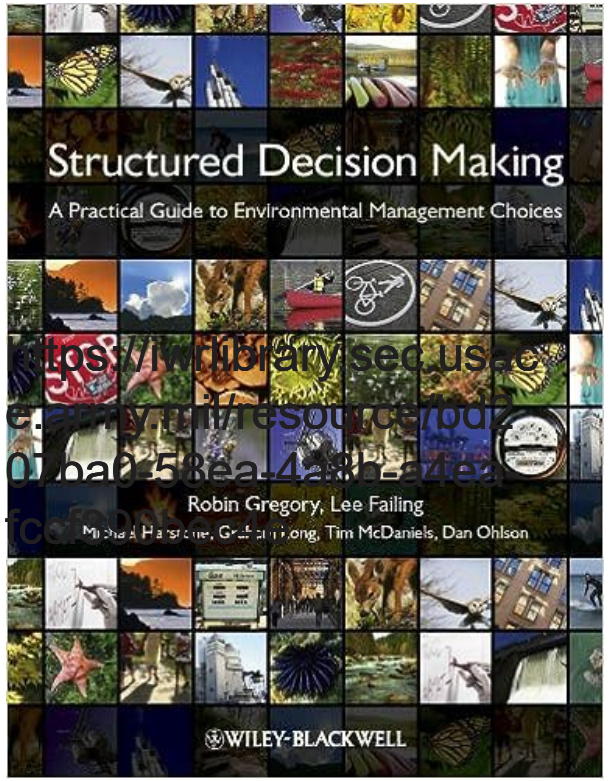
Some to expert practitioner

# WARM-UP ACTIVITY - PART 2

| | True | False |
|---|---|---|
| **Quantitative** Tradeoffs analyses require all decision/evaluation criteria metrics to be in quantified values | | |
| **Qualitative** Tradeoffs analyses can include numbers in the decision matrix | | |
| In multi-criteria decision analysis, weights should be averaged across participants | | |

# PRESENTATION SOURCES




# GOALS OF ANALYZING TRADEOFFS

- Avoid unnecessary tradeoffs and look for win-wins
- Uncover unavoidable tradeoffs
- Promote constructive discussion and deliberation

Tradeoff Analysis leads to:

- A shared understanding amongst participants
- Tradeoffs that are explicit and transparent
- Established rationale for decision

# SETTING THE STAGE FOR TRADEOFF ANALYSIS

***The success of a trade-off analysis (i.e. multi-objective decision process) is most often related to the organization and facilitation of the process, rather than the technical method used for analyzing tradeoffs.***

Important organization and facilitation questions to address:

Who will be involved, and to what degree?

Who will facilitate the process?

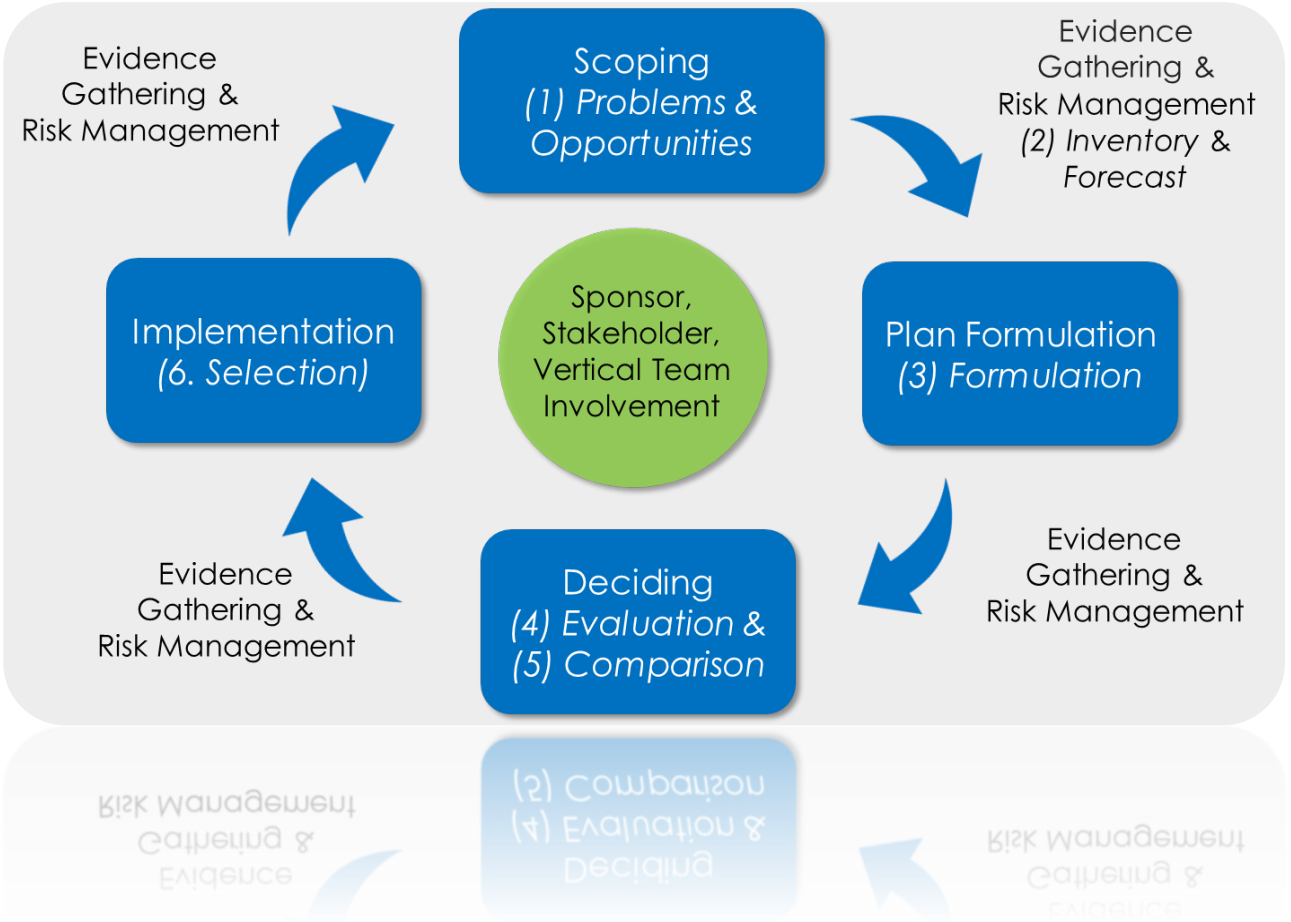
How will collaboration be structured?

How will info be gathered and shared?

Ultimately, how will decisions be made?

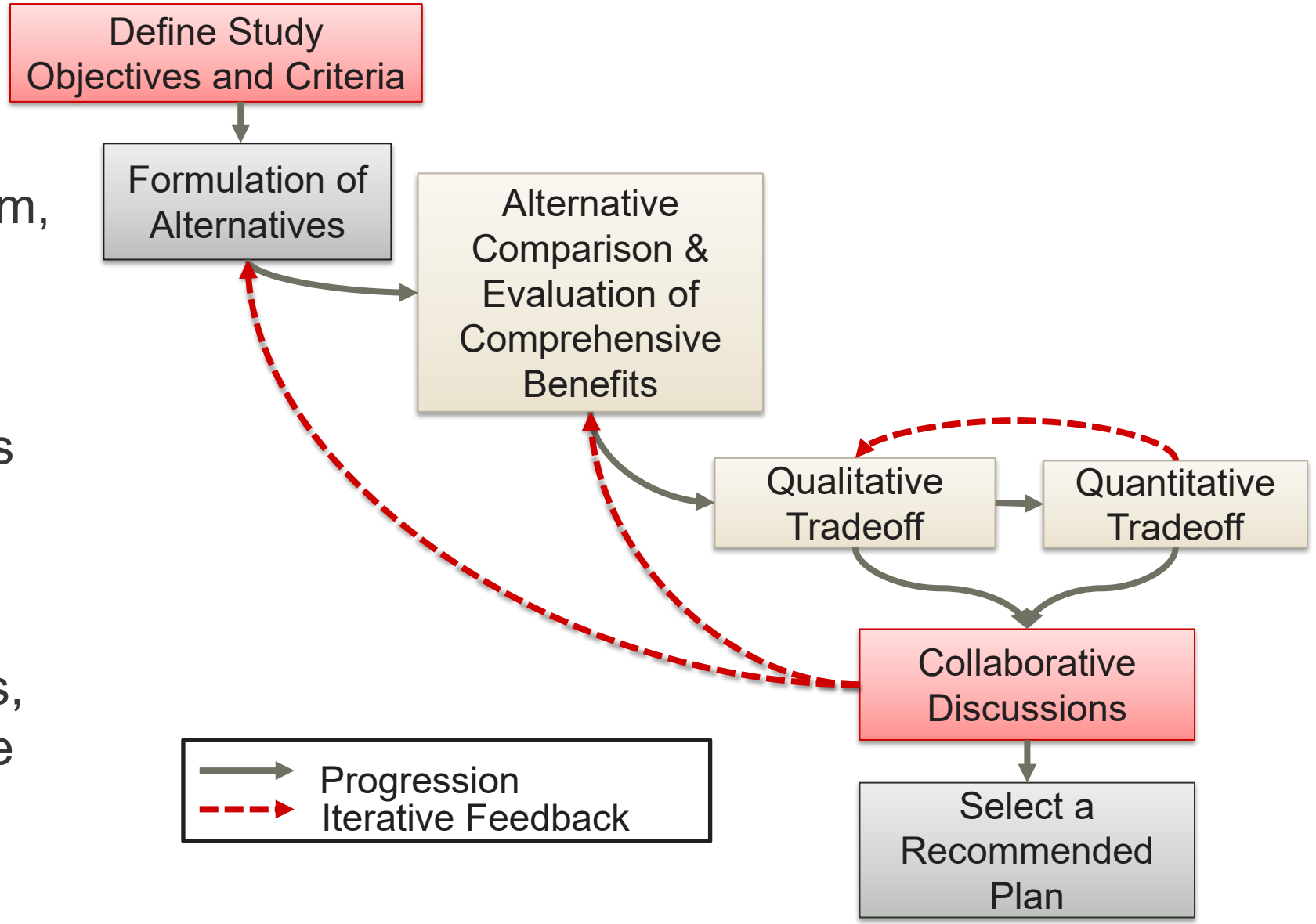
# SETTING THE STAGE FOR TRADEOFF ANALYSIS

- Prepare for tradeoff analysis 'from beginning'
  - Study objectives & decision criteria
- Identify who, how and when people will be involved
  - Include a skilled facilitator
- BEFORE decision-making, establish shared understanding of:
  - Study objectives
  - Decision criteria
  - Tradeoff techniques that could be used
  - And ultimately how decisions will be made



# TRADEOFF TECHNIQUES: WHERE TO BEGIN

- Planning decisions should use, at minimum, a qualitative tradeoff process
- Not every decision has to use a quantitative tradeoff analysis
- Scale tradeoff analysis, whether it is qualitative or quantitative, to complexity of project



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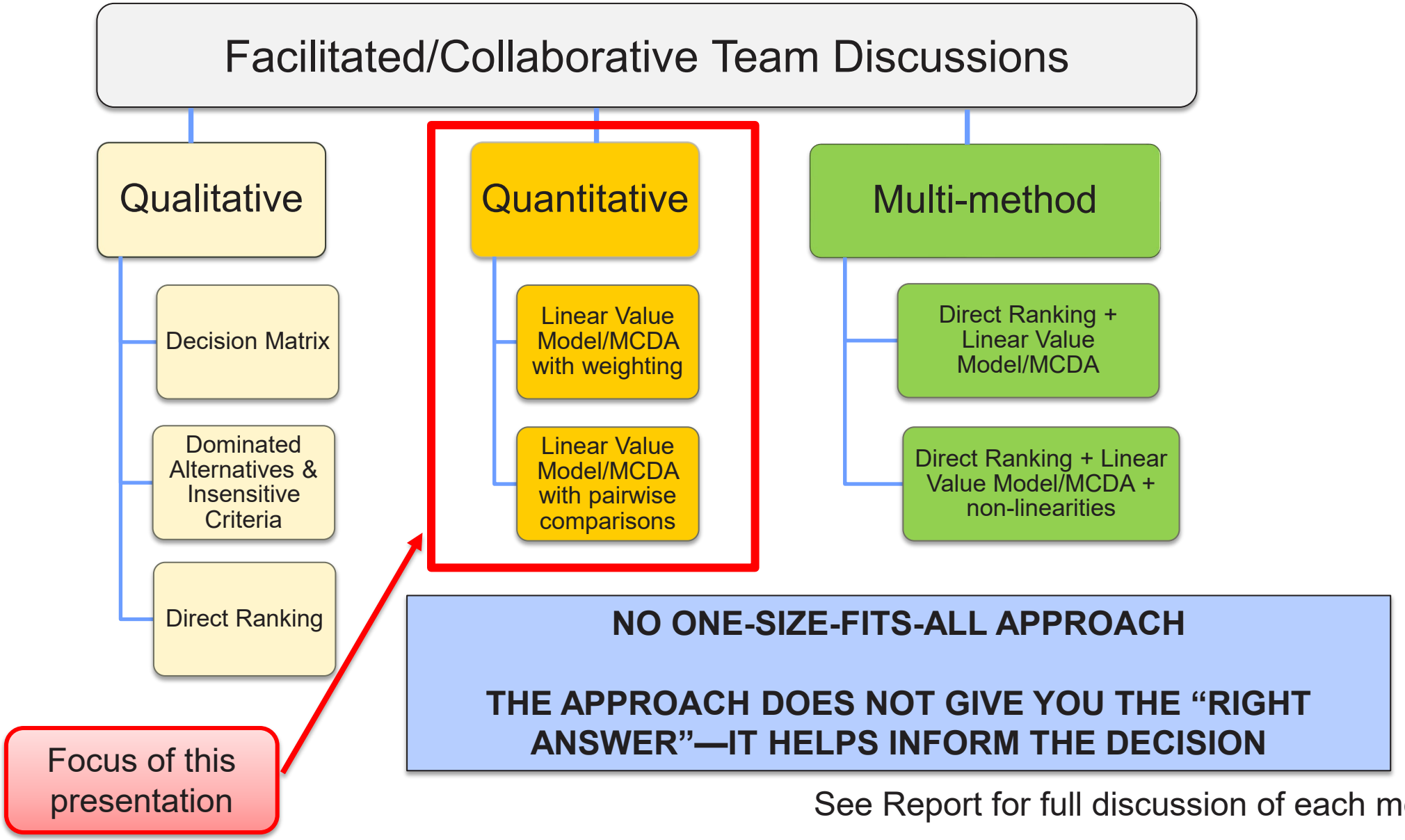
# REVIEW OF QUALITATIVE TRADEOFF APPROACHES

| Approach | Advantages | Disadvantages |
|---|---|---|
| **Matrix Table** | • Visual tool helpful for comparing alternatives and providing summary for facilitated discussions | • May confuse if colors/values/words are used without being defined |
| **Dominated Alternatives & Insensitive Criteria** | • Helpful for reducing alternatives (remove dominated alternatives<br>• Helpful for simplifying criteria (remove insensitive criteria | • May require value judgments for determining dominated alternatives and insensitive criteria (what does 'no change' mean?) |
| **Direct Ranking (of alternatives)** | • Simple to understand<br>• Helps focus facilitated discussions<br>• Helps find common agreements/disagreements | • Vulnerable to personal biases and errors |

ALL require collaboration and documentation

# POTENTIAL TRADEOFF APPROACHES




See Report for full discussion of each method

# TRADEOFF APPROACHES

Quantitative Tradeoff Approaches

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# QUANTITATIVE TRADEOFF ANALYSIS

- Quantitative tradeoff approaches use **explicit quantitative methods** to help evaluate and compare alternatives

- The goal of quantitative tradeoffs is to **analyze the value tradeoffs** (how much are you willing to give up of X benefit to achieve Y benefit), providing clarity, through defined calculations.

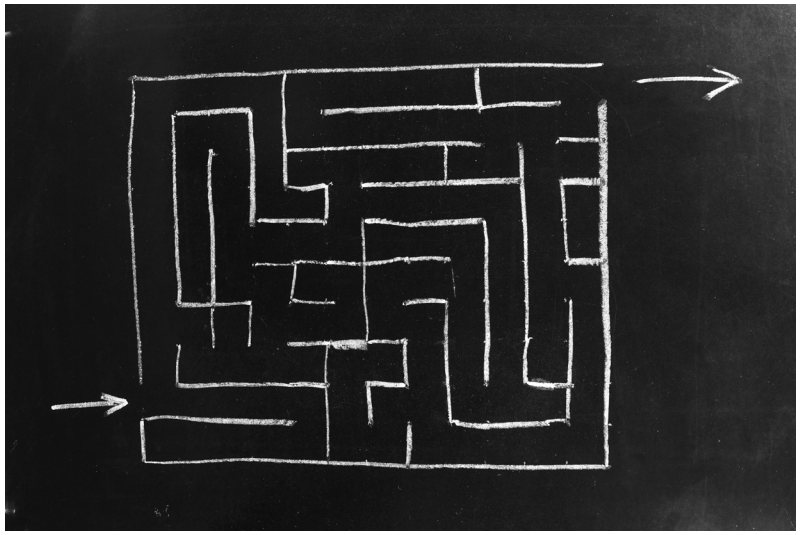
- **Multicriteria Decision Analysis (MCDA)** is a broad category of quantitative tradeoff analysis, that can be helpful for:
  - Clarifying tradeoffs across multiple and often conflicting criteria
  - Collaborative engagement and transparency in the decision-making process

# MULTICRITERIA DECISION ANALYSIS (MCDA)

MCDA allows stakeholders to express their preferences about different alternatives in a structured way.

- Improves the quality and consistency of value judgements, through explicit calculations
- Moves discussion from positions to performance-based assessments
- And helps clarify where dialogue will be most useful

Both the performance of alternatives and the subjective value placed on that performance are considered.



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# How Does MCDA work?

**MCDA involves four key components:**

- **Create Decision Matrix,** this includes criteria by which alternatives are evaluated and compared (likely based upon objectives and related metrics)
- **Develop Weights** – represents the relative importance of the criteria (eliciting weights in a systematic way is key to a MCDA approach)
- **Score and Rank Alternatives –** complete calculations using metrics and weights
- **Analyze Results with Decision-makers** – this includes stakeholder(s) and/or leader(s), whose input is represented in weights

# QUANTITATIVE TRADEOFFS DECISION MATRIX

| | | | Alternatives | | | | | |
|---|---|---|---|---|---|---|---|---|
| Objective | Metric | More/Less Better? | FWOP | A | B | C | D | E |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

- Describe each metric, its purpose and how it's measured
- Ensure specific, independent metrics (avoid double counting the same/similar benefits or impacts)
- Check linearity of values, determine if value functions are needed
- Explain the meaning behind numbers/colors since matrix may amplify small differences
- Note potentially impactful uncertainties to ensure they're incorporated in the results and discussed
- Need to explain if improvement in a metric is an increase or decrease in value

# WHERE CAN I DO MCDA?


https://www.iwr.usace.army.mil/Missions/Economics/IWR-Planning-Suite/

**Discuss and coordinate with your VT and relevant PCX prior to using MCDA in IWR Planning Suite.**

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# EXAMPLE STUDY & DECISION MATRIX

Overview of example Decision Matrix:

- Builds upon qualitative tradeoff analysis example
- Color coded with darker blue representing most positive outcomes, yellow least positive outcomes

| Metric | More/Less Better? | Alternatives | | | | |
|---|---|---|---|---|---|---|
| | | FWOP | B | D | E | G |
| Flood Damages Reduced (Ave. Annual $Million) | More | $0 | $45 | $100 | $80 | $62 |
| Habitat Created (Acres) | More | 0 | 1 | 0 | 1 | 1 |
| Permanently Displaced Population (Count) | Less | 70 | 20 | 50 | 60 | 40 |
| Community and Cultural Assets Exposed during 1% AEP Event (Count) | Less | 20 | 10 | 10 | 20 | 10 |
| RED Losses ($Million) | Less | $55 | $35 | $50 | $50 | $37 |

# STEP 1: NORMALIZE

Normalizing values, is a useful practice when comparing across different metrics.

For each cell in the decision matrix, **normalize** using the following formula:

$$\frac{X - X_{Minimum}}{X_{Maximum} - X_{Minimum}}$$

For metrics where less is better, subtract the normalized score from 1.

**Not Normalized**

| Metric | More/Less Better? | Alternatives FWOP | B | D | E | G |
|---|---|---|---|---|---|---|
| Flood Damages Reduced (Ave. Annual $Million) | More | $0 | $45 | $100 | $80 | $62 |
| Habitat Created (Acres) | More | 0 | 1 | 0 | 1 | 1 |
| Permanently Displaced Population (Count) | Less | 70 | 20 | 50 | 60 | 40 |
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| RED Losses ($Million) | Less | $55 | $35 | $50 | $50 | $37 |

**Normalized**

| Metric | More/Less Better? | Alternatives FWOP | B | D | E | G |
|---|---|---|---|---|---|---|
| Flood Damages Reduced (Ave. Annual $Million) | More | $0 | 0.00 | 1.00 | 0.64 | 0.31 |
| Habitat Created (Acres) | More | 0 | 1.00 | 0.00 | 1.00 | 1.00 |
| Permanently Displaced Population (Count) | Less | 70 | 1.00 | 0.25 | 0.00 | 0.50 |
| Community and Cultural Assets Exposed during 1% AEP Event (Count) | Less | 20 | 1.00 | 1.00 | 0.00 | 1.00 |
| RED Losses ($Million) | Less | $55 | 1.00 | 0.00 | 0.00 | 0.87 |

# STEP 2: ASSIGN WEIGHTS

**Weights** – represent the relative importance placed on each criterion or objective and related metric

"But wait, aren't weights subjective?" Yes!

However, they can be elicited in a structured way that provides insights into 'value tradeoffs.'

Weights are **always** assigned when making decisions (i.e. selecting an alternative); the only question is if it is **implicit** or **explicit**. Historically NED benefits/costs have been prioritized by policy – this is an example of implicit weights at **100%,** with other factors used as constraints**!**

Formal MCDA must be approved by HQUSACE, per ER 1105-2-103 2-4.f.(1)(c) : *"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."*

# ASSIGNING WEIGHTS: A CAVEAT

- The degree of variation in performance among alternatives (i.e. objectives and metrics) can greatly influence scores (as it should)
- However, it's important to think about the differences in achieving the criteria, when assigning weights to avoid unintended consequences.
- Weights are context dependent, so if the range of scores (benefits and effects) change then weights may also need to change.
- Therefore, the process for developing weights, should be documented and revisited to ensure shared understanding and consistency.

# WHO DECIDES THE WEIGHTS?

This is an important study decision, as the preferences of the participants will be represented.

- It matters ‘who’s in the room’ for value preference elicitation
- Diversity of perspective will strengthen process and deepen understanding

Participants could include planning leaders, study team members, project partners and stakeholders.

Encourage discussing the participant list with vertical team, planning leaders and project partners.

# GENERALLY HOW NOT TO DO WEIGHTS

-Determine a priori that all criteria will be weighted equally (before looking at the performance of alternatives, or the variation in that on criteria).

-Determine that all the big buckets (such as the 4 accounts) will be weighted equally, again without looking at the actual performance of the alternatives on those criteria.

-Elicit weights from team members and/or stakeholders and then average them. Weights from different individuals should not be combined. Ever.

-Work backward from a preferred alternative to determine what weights would result in that alternative being ranked first.

-Elicit weights from people but don't talk about the results with them to learn if this aligns with what they intended, and what their thoughts are regarding the ranked results.

-Elicit weights but fail to do a sensitivity or crossover analysis to determine how sensitive the ranking of preferred alternative is to slight variations in the weights.

# OTHER METHODS FOR ASSIGNING WEIGHTS – GENERALLY NOT RECOMMENDED FOR STUDIES

**Manual Weighting:** participants directly assign weights

Vehicle Example
Reliability = .75 and Fuel Efficiency = .25

- Reliability is 3 times as important as fuel efficiency
- Could express as fuel efficiency = 1 and reliability = 3

Rating (example: scale 1 to 10)
Fuel Efficiency = 2 | Reliability = 6 | Cost = 9
Develop your own rating and scale

Expression of relative importance of criterion

**Analytical Hierarchy Process (AHP)** uses **pairwise comparison:** participants rank criteria in one-on-one matchups.

Asking *how much more important* is one criterion relative to another (scale -9 to 9).

Works because:

- Easier to rank one-on-one matchups
- Knowing the ranking of all one-on-one matchups defines overall weighting

For more information:
https://planning.erdc.dren.mil/toolbox/webinars/21Sep9-MCDA.pdf

# RECOMMENDED: SWING WEIGHTING TECHNIQUE

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Develop indices of combined technical and value judgments to rank alternatives

The technique of **swing weighting** focuses on the decision criterion and how much variation ("swing") there is within each criterion.

Other weighting methods can be based on values for metrics and be agnostic to the swing (e.g., direct ranking).

| Metric | More/Less Better? | Alternatives | | | | | Min | Max | Range |
|---|---|---|---|---|---|---|---|---|---|
| | | FWOP | B | D | E | G | | | |
| Flood Damages Reduced (Ave. Annual $Million) | More | $0 | $45 | $100 | $80 | $62 | $0 | $100 | $120 |
| Habitat Created (Acres) | More | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| Permanently Displaced Population (Count) | Less | 70 | 20 | 50 | 60 | 40 | 20 | 70 | 50 |
| Community and Cultural Assets Exposed during 1% AEP Event (Count) | Less | 20 | 10 | 10 | 20 | 10 | 10 | 20 | 10 |
| RED Losses ($Million) | Less | $55 | $35 | $50 | $50 | $37 | $35 | $55 | $20 |

*How much does the variation Flood Damage benefits matter? How about the variation in cultural asset protection?*

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# SWING WEIGHTING METHODOLOGY - STEPS

1. **First**, determine the **best and worst value on each criteria** across the alternatives.

2. **Create hypothetical alternative scenarios** that have the worst value on all but one of the criteria, which is at its best (shown on next slide)

| Objective | Maximize Flood Damages Reduced | Provide forage habitat for migrating birds | Allow communities to remain in place in the face of SLC | Protect key community and cultural assets | Reduce business interruption from storm events |
|---|---|---|---|---|---|
| Metric | Flood Damages Reduced (Ave. Annual $Million) | Habitat Created (non-linear, 0=no habitat, 1=achieve adequate habitat) | Permanently Displaced Population (Count) | Community and Cultural Assets Exposed during 1% AEP Event (Count) | RED Losses ($Million) |
| Range | -$0 to $100' | 0 to 1 (non-linear) | 20 to 70 | 10 to 20 | $35 to $55 |
| More/Less Better? | More | More | Less | Less | Less |
| Best | $100 | 1 | 20 | 10 | $35 |
| Worst | $0 | 0 | 70 | 20 | $55 |
| | | | | | |
| Rank | | | | | |
| Points | | | | | |

# CREATE AND RANK HYPOTHETICAL SCENARIOS

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**Hypothetical alternative scenarios** that have the worst value on all but one of the criteria, which is at its best. Create a hypothetical alternative scenario for each objective/metrics. Also generate a hypothetical baseline where everything is at its worst on all the criteria.

| Objective | Maximize Flood Damages Reduced | Provide forage habitat for migrating birds | Allow communities to remain in place in the face of SLC | Protect key community and cultural assets | Reduce business interruption from storm events |
|---|---|---|---|---|---|
| Metric | Flood Damages Reduced (Ave. Annual $Million) | Habitat Created (non-linear, 0=no habitat, 1=achieve adequate habitat) | Permanently Displaced Population (Count) | Community and Cultural Assets Exposed during 1% AEP Event (Count) | RED Losses ($Million) |
| Range | -$20 to $100' | 0 to 1 (non-linear) | 20 to 70 | 10 to 20 | $35 to $55 |
| More/Less Better? | More | More | Less | Less | Less |
| Best | $100 | 1 | 20 | 10 | $35 |
| Worst | $0 | 0 | 70 | 20 | $55 |
| | | | | | |
| **Hypothetical Scenarios** | | | | | |
| Baseline | -20 | 0 | 70 | 20 | 55 |
| 1 | 100 | 0 | 70 | 20 | 55 |
| 2 | -20 | 1 | 70 | 20 | 55 |
| 3 | -20 | 0 | 20 | 20 | 55 |
| 4 | -20 | 0 | 70 | 10 | 55 |
| 5 | -20 | 0 | 70 | 20 | 35 |

# CREATE AND RANK HYPOTHETICAL SCENARIOS (CONT.)

**3. Elicit Rank Order** from participants for the hypothetical alternative scenarios, with 1 being the best. Note, ties are okay.

Participants consider, “If just one of the criteria could be moved from its worst to its best level, which would it be?” That scenario is ranked 1. The question is repeated until all alternative scenarios have been ranked.

**4. Rate** the hypothetical alternative scenarios by assigning points from 0 to 100. First start by assigning 100 points to the 1st ranked alternative scenario.

Participants are then asked, “How important is the range or swing from worst to best level of the rank 2 hypothetical alternative scenario compared with the range or swing from worst to best on the rank 1 hypothetical alternative scenario?” Points between 0-100 are assigned to that hypothetical alternative scenario.

This step is repeated sequentially for each of the remaining ranks.

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# CREATE AND RANK HYPOTHETICAL SCENARIOS

## Example Rank Order and Score for Participant 1

| Objective | Maximize Flood Damages Reduced | Provide forage habitat for migrating birds | Allow communities to remain in place in the face of SLC | Protect key community and cultural assets | Reduce business interruption from storm events | | |
|---|---|---|---|---|---|---|---|
| Metric | Flood Damages Reduced (Ave. Annual $Million) | Habitat Created (non-linear, 0=no habitat, 1=achieve adequate habitat) | Permanently Displaced Population (Count) | Community and Cultural Assets Exposed during 1% AEP Event (Count) | RED Losses ($Million) | | |
| Range | -$20 to $100' | 0 to 1 (non-linear) | 20 to 70 | 10 to 20 | $35 to $55 | | |
| More/Less Better? | More | More | Less | Less | Less | | |
| Best | $100 | 1 | 20 | 10 | $35 | | |
| Worst | $0 | 0 | 70 | 20 | $55 | | |
| | | | | | | | |
| **Hypothetical Scenarios** | | | | | | **Rank** | **Points** |
| Baseline | -20 | 0 | 70 | 20 | 55 | | |
| 1 | 100 | 0 | 70 | 20 | 55 | 2 | 75 |
| 2 | -20 | 1 | 70 | 20 | 55 | 1 | 100 |
| 3 | -20 | 0 | 20 | 20 | 55 | 3 | 65 |
| 4 | -20 | 0 | 70 | 10 | 55 | 4 | 40 |
| 5 | -20 | 0 | 70 | 20 | 35 | 5 | 25 |

# SWING WEIGHTING EXAMPLE

**5. Normalize the ratings:** divide each by the sum of all the ratings. The sum of all the of the normalized ratings will equal 1. The normalized scores are the swing weights for each criteria.

| Participant #1 | Rank | Points | Normalized |
|---|---|---|---|
| Generates $180M in flood damages reduced | 2 | 75 | 0.25 |
| Provides sufficient foraging habitat | 1 | 100 | 0.33 |
| Prevents displacement of 250 homes | 3 | 65 | 0.21 |
| Protect 40 community assets from the 1% AEP event | 4 | 40 | 0.13 |
| Reduces RED losses by $140M | 5 | 25 | 0.08 |

# SWING WEIGHTING METHODOLOGY – CALCULATE

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**6. Calculate a weighted sum for each alternative**

For each alternative, multiply each participant's swing weight by the normalized score for each metric. Add these to calculate a total score for each alternative.

Plan B's calculation:
(.25*0)+(.33*1)+(.21*1)+(.13*1)+(.08*1) = .75

| Metric | More/Less Better? | Alternatives B | D | E | G | Swing Weight |
|---|---|---|---|---|---|---|
| Flood Damages Reduced (Ave. Annual $Million) | More | 0.00 | 1.00 | 0.64 | 0.31 | 0.25 |
| Habitat Created (Acres) | More | 1.00 | 0.00 | 1.00 | 1.00 | 0.33 |
| Permanently Displaced Population (Count) | Less | 1.00 | 0.25 | 0.00 | 0.50 | 0.21 |
| Community and Cultural Assets Exposed during 1% AEP Event (Count) | Less | 1.00 | 1.00 | 0.00 | 1.00 | 0.13 |
| RED Losses ($Million) | Less | 1.00 | 0.00 | 0.00 | 0.87 | 0.08 |
| Swing Weighting Results | | 0.75 | 0.43 | 0.49 | 0.71 | 1 |

# SWING WEIGHTING METHODOLOGY – PRESENT, DISCUSS, AND DOCUMENT

**Present**

**6. Show the results in multiple formats:**

- a list of ranking of alternatives for each participant, based on their swing weights
- a matrix or table showing the weighted score for each alternative for each participant
- box plots showing the variation in weights on each criteria across participants

**Participant 1: B,G,E,D**
**Participant 2: B,E,G,D**
**Participant 3: G,B,E,D**

| | B | D | E | G |
|---|---|---|---|---|
| Participant 1 | 0.75 | 0.43 | 0.54 | 0.67 |
| Normalized | 0.31 | 0.18 | 0.23 | 0.28 |

| | B | D | E | G |
|---|---|---|---|---|
| Participant 1 | 0.31 | 0.35 | 0.23 | 0.28 |
| Participant 2 | 0.44 | 0.12 | 0.24 | 0.2 |
| Participant 3 | 0.33 | 0.1 | 0.23 | 0.34 |

Take each participant's results and normalize them. Present in a table with all the results of all the participants. What trends do you see?

# SWING WEIGHTING METHODOLOGY – DISCUSS, AND DOCUMENT RESULTS

1. Provide sufficient time to review results of the swing weighting with participants individually and as a group.

2. Ensure someone from the team documents key insights.

3. In some cases, discussion may lead participants to realize they didn't fully understand something that went into the weighting and need to do a second round of weighting.

4. If one or more alternatives can be removed from further consideration then a simplified subset of alternatives can be used for an additional swing weighting exercise.

5. Clarify general areas of agreement or disagreement and provide reasons.

# MULTI-PARTY MCDA ON RABBE RIVER EXAMPLE PROJECT - RABBE RIVER INTEGRATED FLOOD RISK MANAGEMENT DECISION MATRIX

| | Reduce the risk to public safety from flooding in the Rabbe River Basin | Reduce the risk of damages to residential, agricultural and commercial/ industrial areas | Restore aquatic habitat for the Rabbe River ecosystem | Restore natural stream processes in the Rabbe River | Improve water supply reliability and availability | Encourage the wise use of the floodplain | Cost | Mitigation (habitat, cultural, hydraulic) |
|---|---|---|---|---|---|---|---|---|
| **Unit of measure** | Life Loss | Estimated Damages $ | Aquatic habit restored | Acres hydrologic/ geomorphic processes restored | Acre-feet of water supplied or recharged | Wise use of floodplain | $ | Amount required |
| **Range** | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 |
| **Constructed Scale** with increments defined | 5) High LRR in urban/deep. 4) Moderate LRR in urban/deep. 3) Low LRR in urban. 2) No change/marginal/incidental. 1) Life risk increase | 5) High FRM damage reduction in urban/deep. 4) Moderate FRM damage reduction in urban/deep. 3)Low in urban. 2) No change/marginal/incidental. 1) FRM damage increase. | 5) High, lots of benefits for spp/acres/connectivity. 4) Moderate benefits. 3)Low benefits. 2) No change/marginal/incidental. 1) Adverse impact. | 5) High restoration of process. 4) Small/Moderate restoration of process. 3)No change. 2) Small/Moderate adverse impact to stream process. 1) High adverse impact to process. | 5) High benefits of acre-feet. 4) Medium. 3) Low. 2) None/Neutral. 1) Negative impacts | 5) Large areas protected 4) Flowage easement. 3) No change in FEMA designation. 2) Develop on floodplain. 1) On undeveloped urban floodplain. | 5) H. 4) M-H. 3) M. 2) L-M. 1) L | 5) Uniquely difficult. 4) Most areas require. 3) 1-2 areas require. 2) Few, common mitigation. 1) None. |
| **Desired Direction** | high | high | high | high | high | high | low | low |
| | | | | | | | | |
| **ER Only** | 4 | 4 | 4 | 4 | 3 | 5 | 4 | 4 |
| **FRM & ER** | 3 | 3 | 5 | 4 | 3 | 3 | 5 | 3 |
| **FRM & WS Alt 1** | 5 | 4 | 1.5 | 1 | 4 | 1 | 5 | 5 |
| **FRM & WS Alt 2** | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 4 |
| **FRM & ER & WS** | 5 | 5 | 4 | 3 | 4 | 4 | 2 | 3 |
| **ER & WS** | 4 | 4 | 4 | 4 | 4 | 5 | 4 | 5 |

# RABBE RIVER EXAMPLE PROJECT- RANKING TABLE OF ALTERNATIVES ACCORDING TO STAKEHOLDER PREFERENCES ELICITED THROUGH MCDA WITH SWING WEIGHTING

| Alternative | Person 1 | Person 2 | Person 3 | Person 4 | Person 5 | Person 6 | Person 7 | Person 8 | Person 9 | Person 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| ER Only | 10 | 10 | 9 | 8 | 10 | 9 | 10 | 9 | 7 | 12 |
| FRM & ER | 11 | 8 | 10 | 10 | 8 | 10 | 11 | 10 | 11 | 7 |
| FRM & WS Alt 1 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| FRM & WS Alt 2 | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 9 |
| FRM & ER & WS - 1 | 1 | 1 | 1 | 5 | 1 | 1 | 1 | 2 | 4 | 2 |
| FRM & ER & WS - 2 | 2 | 3 | 4 | 2 | 3 | 3 | 3 | 3 | 3 | 4 |
| FRM & ER & WS - 3 | 5 | 6 | 6 | 6 | 5 | 6 | 6 | 6 | 9 | 5 |
| FRM & ER & WS - 4 | 4 | 5 | 5 | 3 | 4 | 4 | 5 | 4 | 5 | 3 |
| FRM & ER & WS - 5 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 1 |
| FRM & ER & WS - 6 | 7 | 11 | 11 | 11 | 9 | 11 | 9 | 11 | 10 | 6 |
| FRM & ER & WS - 7 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 10 |
| FRM & ER & WS - 8 | 6 | 4 | 3 | 4 | 6 | 5 | 4 | 5 | 1 | 8 |
| ER & WS | 9 | 9 | 8 | 9 | 10 | 8 | 8 | 8 | 6 | 11 |

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# WARNING: DON'T AVERAGE!

Each participant derives their own swing weights, which are used to generate results by participant for each plan.

**Do not average** the solicited weights or the results across plans!

- Averaging makes it much harder to see the range of results
- Makes "who is in the room" more important since results are aggregated
- Makes it appear like the plan with the highest average is "the answer" when it isn't
- Leads to a loss of transparency and may hide key facets of results

# STEP 5: SENSITIVITY ANALYSIS

Sensitivity analysis acknowledges that uncertainties can impact the results of the MCDA.

Types of sensitivity analysis:

- Redo analysis with different weights to see the sensitivity of the results. Do small differences lead to different preferred alternatives?
- Revise the inputs in the decision matrix to model uncertainty in the inputs, since the matrix uses deterministic values.

In some cases, you can **weight** multiple sets of results. If an output is X with 90% certainty and Y with 10% certainty, can do an MCDA analysis for both values and weight them by their relative probabilities.

# WHAT DO YOU GET FROM THIS ANALYSIS?

MCDA does **not** tell you the answer. It provides a framework for discussing trade-offs and stakeholder values.

MCDA **spurs discussion** with stakeholders. Let them reflect on results and see if their inputs change.

It may help reveal “win-wins” that have not been considered.

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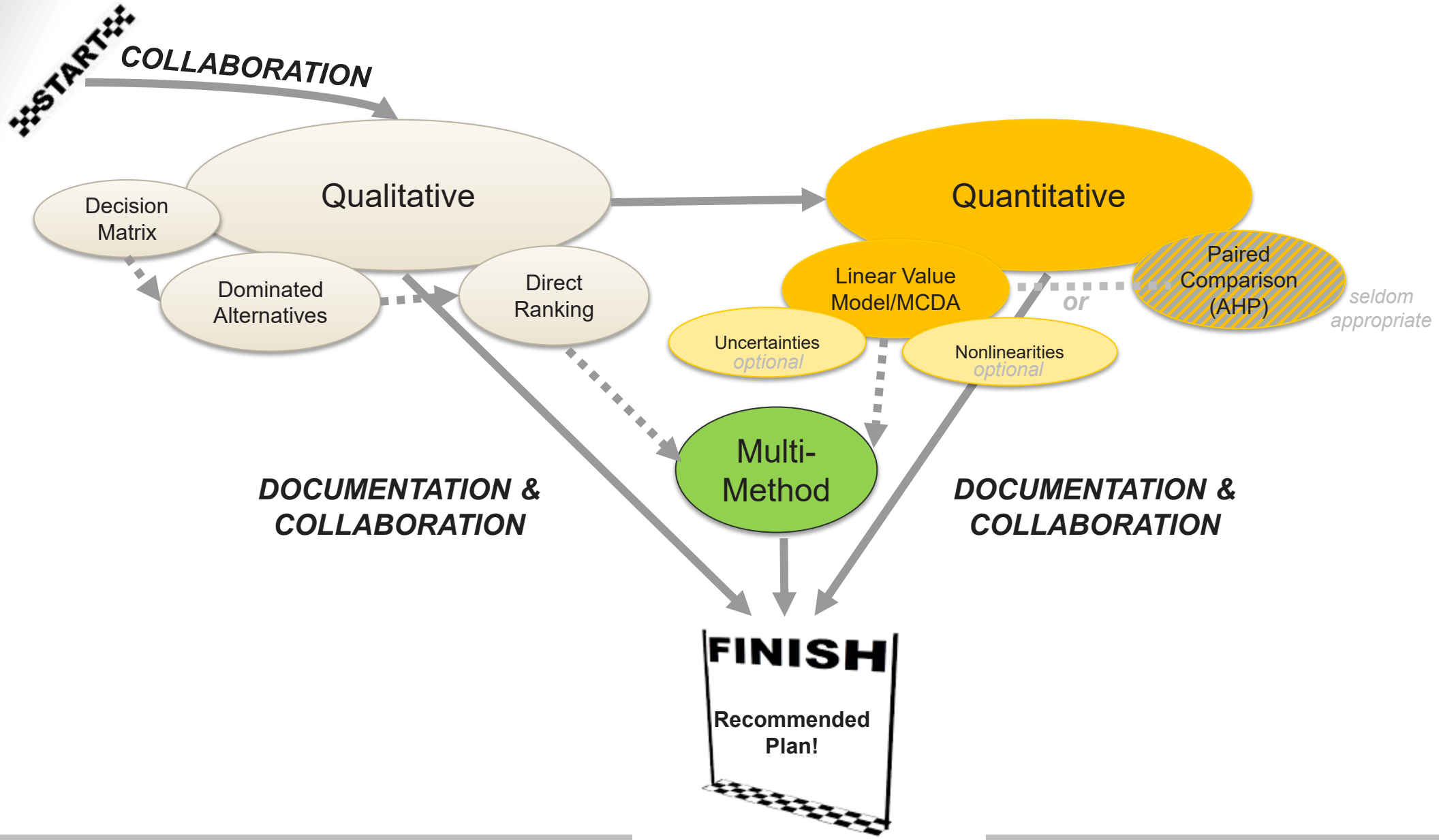
# QUANTITATIVE APPROACHES

| Approach | Advantages | Disadvantages |
|---|---|---|
| MCDA with weighting | Shifts dialogue away from personal opinions toward performance-based discussions<br>Participants explicitly quantify value preferences<br>Helps focus facilitated discussions<br>Helps find common agreements/disagreements<br>Plug and Play module in IWR Planning Suite | Mathematically complex<br>Requires time and effort to elicit weighting values<br>May be insensitive to emotions and intuition<br>Potential for false sense that the software provides the decision |
| Multi-Method: direct ranking and MCDA | Allows for the plain-language discussion used in direct ranking<br>Allows for comparison of results from direct ranking and weighted MCDA<br>Plug and Play module in IWR Planning Suite | Requires time for both direct ranking and MCDA<br>Requires time and effort to elicit weighting values |

Requires team collaboration and documentation

# TRADEOFFS ROADMAP



# MORE TO COME ON..

How to design a collaborative tradeoffs engagement

How to deal with uncertainties

How to deal with nonlinearity

More ideas on eliciting weights

How to use MCDA results - examples

How to do a multi-method approach

Getting to a Decision (selecting a preferred plan)

# TAKE HOME MESSAGES

- Decision-making is not objective. Analyzing tradeoffs involves incorporating subjective information (values and preferences).
- Be transparent about how subjective and objective information is separated and utilized.
- Effective organization and facilitation of the process is key to success.
- Plan for your process: resources, time for iteration, involvement, skills.
- Employ qualitive tradeoffs techniques using decision matrix / effect table.
- Assess if appropriate for quantitative or multi-method tradeoffs approaches.
- Tell the story.