Context

- Formalized risk decision analytical processes provide mechanisms for communication, transparency and learning through implementation.
- Requires commitment to choice of a course of action, and additional effort – over a range of complexity - in inclusion of stakeholders’ views and possibly other formalized models.
Decision Analysis

* Action*

What we can do

What we want

What we know

* Informs course of action

Modified from Stanford’s SDRM Decision Analysis Course
Range of Complexity - Progression

- Narrative
- Structured MCDA
- Stakeholder engagement
- More complex applications
  - Robust decision making – scenario analysis
  - Learning from implementation - adaptive management
  - Additional measurement - value of information
Narrative

- Often embedded in project documents
- What is/are your objectives?
  - Habitat vs. Population
- What would success look like?
  - Specify measurements (metrics) that reflect level of success
  - “What gets measured, gets done.”
- Metrics drive monitoring plan
Narrative

**Costs**
- Can be inconsistent
- May not reflect views of all partners, stakeholders
- There may be many objectives, and trade-offs are not usually specified

**Benefits**
- Ability to compare different designs to stated objectives
- Potential to identify partners with similar/different perspectives
- Clarity in project implementation, and determining degree of success obtained
Structured MCDA
Example from NY/NJ Harbor

Structured MCDA

Note each alternative evaluated technically and transparently in contribution to overall score.

USACE weighting

EPA weighting

Innovative solutions for a safer, better world
Structured MCDA

- **Costs**
  - Time consuming
  - May require external support
  - Should be started early in the process

- **Benefits**
  - Ability to separate preference for an alternative from the alternative itself (NIMBY)
  - Often generates new options based on the understanding of performance proposed measures
  - Can improve stability of decision, and support moving forward
Stakeholder Engagement
Horseshoe Bend, Kent WA

Example Stakeholder Interview Question
--begin question--

- Corps ERDC: Please rank the following criteria in order of importance (listed alphabetically): Community Resilience, Cost, Fish / Salmon Health, Flood Risk Management, Implementability, Levee Safety / Reliability, Tribal and Public Use, Water Quality.
- HBRST Member: Levee Safety / Reliability would be first, then Fish / Salmon Health, Cost, Implementability, Flood Risk Management and Community Resilience are about the same, then Tribal and Public Use, and Water Quality would be last.
- Corps ERDC: You indicated that Levee Safety / Reliability is most important. If Levee Safety / Reliability was given 100 points, how many points would you give to the other criteria relative to 100? The total number of points across criteria is not important.
- HBRST Member: 85 points to Fish / Salmon Health, 60 points to Cost, and 55 points to Implementability. Flood Risk Management and Community Resilience would both get 40 points, 22 points for Tribal and Public Use, and 5 points to Water Quality.

--end question--

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Ranking (1 - 8)</th>
<th>Score (0 - 100)</th>
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<tbody>
<tr>
<td>Levee Safety / Reliability</td>
<td>1</td>
<td>100</td>
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<tr>
<td>Fish / Salmon Health</td>
<td>2</td>
<td>85</td>
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<tr>
<td>Cost</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Implementability</td>
<td>4</td>
<td>55</td>
</tr>
<tr>
<td>Flood Risk Management</td>
<td>5</td>
<td>40</td>
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<tr>
<td>Community Resilience</td>
<td>5</td>
<td>40</td>
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<tr>
<td>Tribal and Public Use</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Water Quality</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

Water Quality  Levee Safety / Reliability  Cost  Flood Risk Management  Implementability  Fish / Salmon Health  Tribal & Public Use  Community Resilience

0 10 20 30 40 50 60 70 80 90 100

BUILDING STRONG®
Stakeholder Engagement - Response

- Stakeholder feedback
  - Two ‘winning’ designs
    - Feasibility
  - Interview read-ahead encouraged agency introspection
  - Process allowed for open communication in a safe environment
    - Teaching & learning moments
    - Solutions focused

- Lessons learned
  - MCDA results should be a midpoint for a larger discussion, not endpoint
  - Spend more effort on developing sub-criteria terms & definitions with stronger cross-agency consensus
Stakeholder Engagement

- Costs
  - Ideal to have individual interviews
  - Requires multiple meetings for feedback
  - Proper protocols and approaches increase value

- Benefits
  - Shows consideration of multiple perspectives
  - Identifies areas of disagreement in objectives and values instead of proposed action
  - Can improve cooperation and support development of novel approaches
More Complex Applications

“I have yet to see any problem, however complicated, which, when looked at in the right way, did not become still more complicated.”

- Poul Anderson

- Why would you want to add complexity?
- If that complexity impacts your decisions, and it is not captured, decisions won’t be appropriate.
Calculate “Payoff” under Scenario

The tool goes through possible inflow or “rain” drivers to the system – for each management alternative – calculating payoff from fish and bird population projections.
Estimates of Payoff and Robustness
Varying: Precipitation

(a) Bar charts showing expected payoff for different climates:
- Black: Current
- Blue: Wet
- Red: Dry

(b) Cumulative distribution function (CDF) graphs for different conditions:
- Red: Dry
- Black: Current
- Blue: Wet

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Adaptive Management

• Effects analysis forms the basis of a DM – Enhanced Adaptive Management (EAM)

• Integrates other models to anticipate effects

• Contains unknowns or uncertainties

Restoration Design(s)

Costs
LCCA Accounts O&M Monitoring

Habitat
Risk, Habitat, Population Recreation

Implementation
Feasibility, Disruption, Stability
EAM – Likely use

- Better prediction of outcomes based on refined models.
- Potential for alternative design and smoother implementation.

Predictions from Models, Judgment

LCCA Accounts O&M Monitoring

Risk, Habitat, Population Recreation

Feasibility, Disruption, Stability

Costs Habitat Implementation

Coordination/Refinement Learning
# Value of Information

## Nano-fabrication Case Study

<table>
<thead>
<tr>
<th>Alternative/Criterion</th>
<th>Energy consumption (GWh/kg)</th>
<th>Material efficiency (% in mass)</th>
<th>LCIA Score (EcoPoints)</th>
<th>Cost ($/g)</th>
<th>Health risks</th>
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<tbody>
<tr>
<td>GOAL</td>
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![Graphs and charts representing the data](image-url)
Nano-fabrication VoI Discussion

- Stability of “preference” determined by how important the uncertain elements are to your decision

- Can be used to determine which uncertainties are most important to resolve to have a clear “preference”
More Complex Applications

- **Costs**
  - Capturing complexity requires resources
  - May limit the number of participants “on board”
  - May introduce error

- **Benefits**
  - Provides a dynamic view of performance of a course of action
  - Can improve future management and project development
  - Provides best answer to “what if” and “what do we need to know” questions
Lessons learned about using Decision Analysis

- DA is a toolbox for increasing communication, clarity and archiving uncertainty. The more complex the application of DA, the more resources are required for implementation.

- As a trade-off the DA application can increase efficacy, engagement, robustness of actions, an understanding of complex systems and when additional information in critical to a decision.

- It requires a commitment to inclusion of different points of view, often through frequent and open communication. It is important to be clear about how the decision(s) will ultimately be made and the influence stakeholders can have on the decision.
Questions?

- Cases are a selection of RaDST work.
- *If you have specific interests or would like to discuss something further, please contact me.*

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