

Decision-Making and Multi-Criteria Decision Analysis

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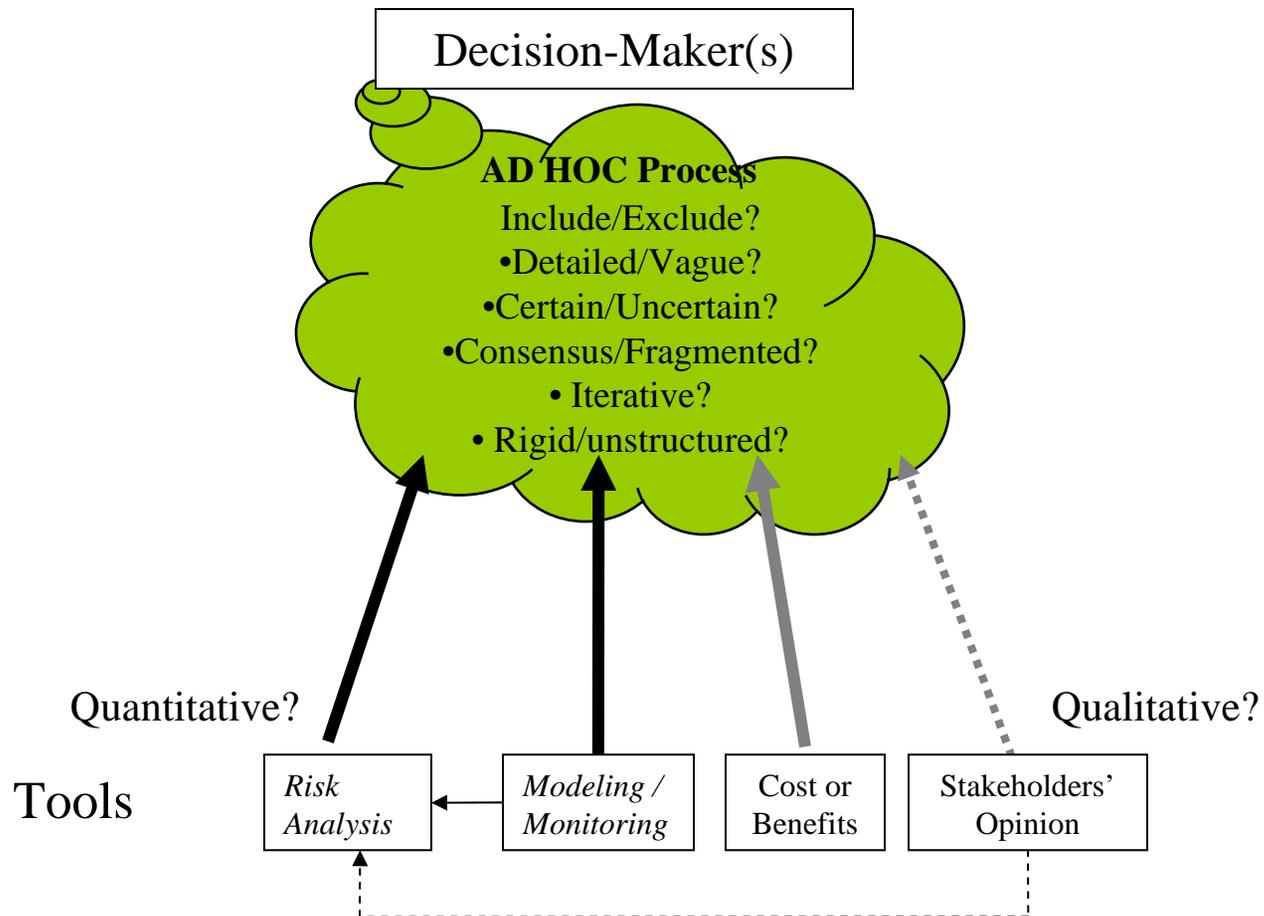
Challenges Posed by Complex Decision-Making

- “Humans are quite bad at making complex, unaided decisions” (Slovic et al., 1977).
- Individuals respond to complex challenges by using intuition and/or personal experience to find the easiest solution.
- At best, groups can do about as well as a well-informed individual.
- Groups can devolve into entrenched positions resistant to compromise
- “There is a temptation to think that honesty and common sense will suffice” (IWR-Drought Study p.vi)

The Decision-Making Environment

- Corps is under increasing pressure to justify and defend decisions on the basis of credible, quantitative data and analysis
 - Environmental modeling is key to sound science and engineering studies
 - Managing uncertainty is critical
- But having access to data isn't enough...
- The data must inform the decision
 - Linking data to the objectives motivating a project
 - Integrating data across data types
 - Combine data with the values of stakeholders and decision-makers

The Decision Process



Multi-Criteria Decision Analysis

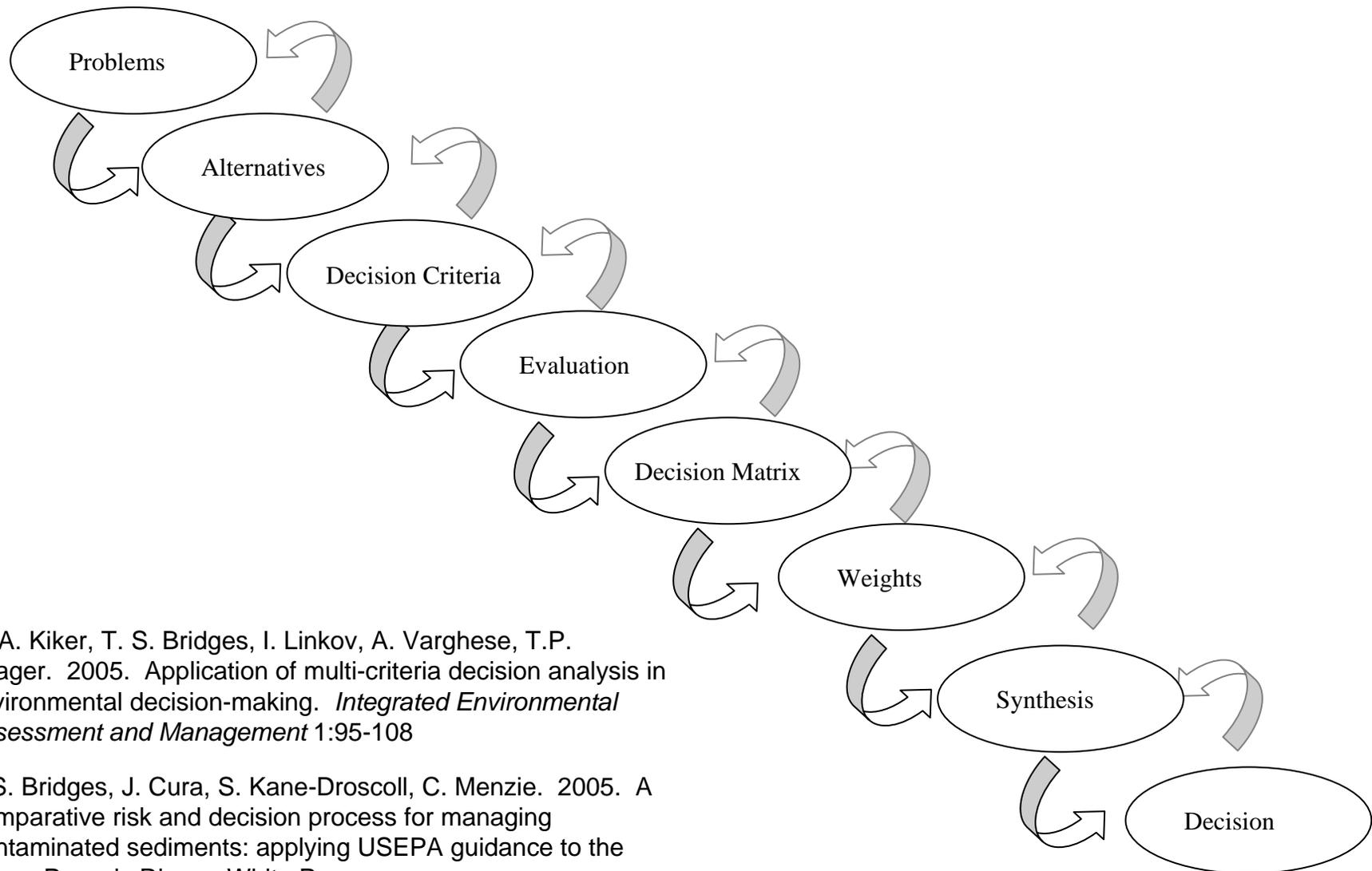
MCDA Process:

- Requires setting a stated goal or a decision statement
- Linked to measurable and logical criteria/subcriteria
- Maintains a record of the decision process
- Allows for sensitivity analysis (what criteria impacted our decision the most or the least)

• MCDA Provides:

- A structured process
- Integration of decision inputs
- Context for providing direction and focus for environmental studies, including modeling
- Means for resolving trade-offs among objectives

A Process for Structured Decision-Making

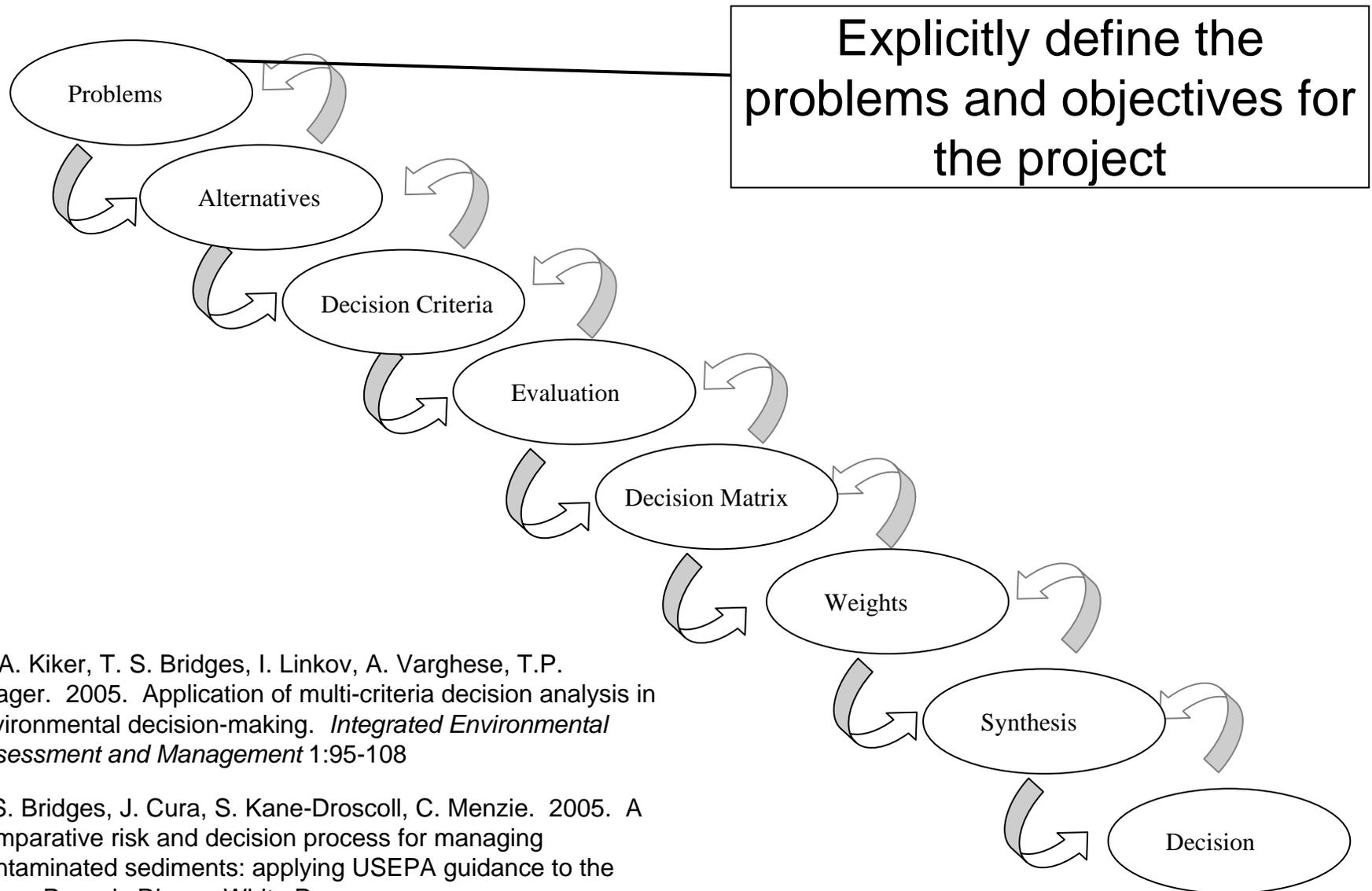


G. A. Kiker, T. S. Bridges, I. Linkov, A. Varghese, T.P. Seager. 2005. Application of multi-criteria decision analysis in environmental decision-making. *Integrated Environmental Assessment and Management* 1:95-108

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Adapted from Yoe (2002)

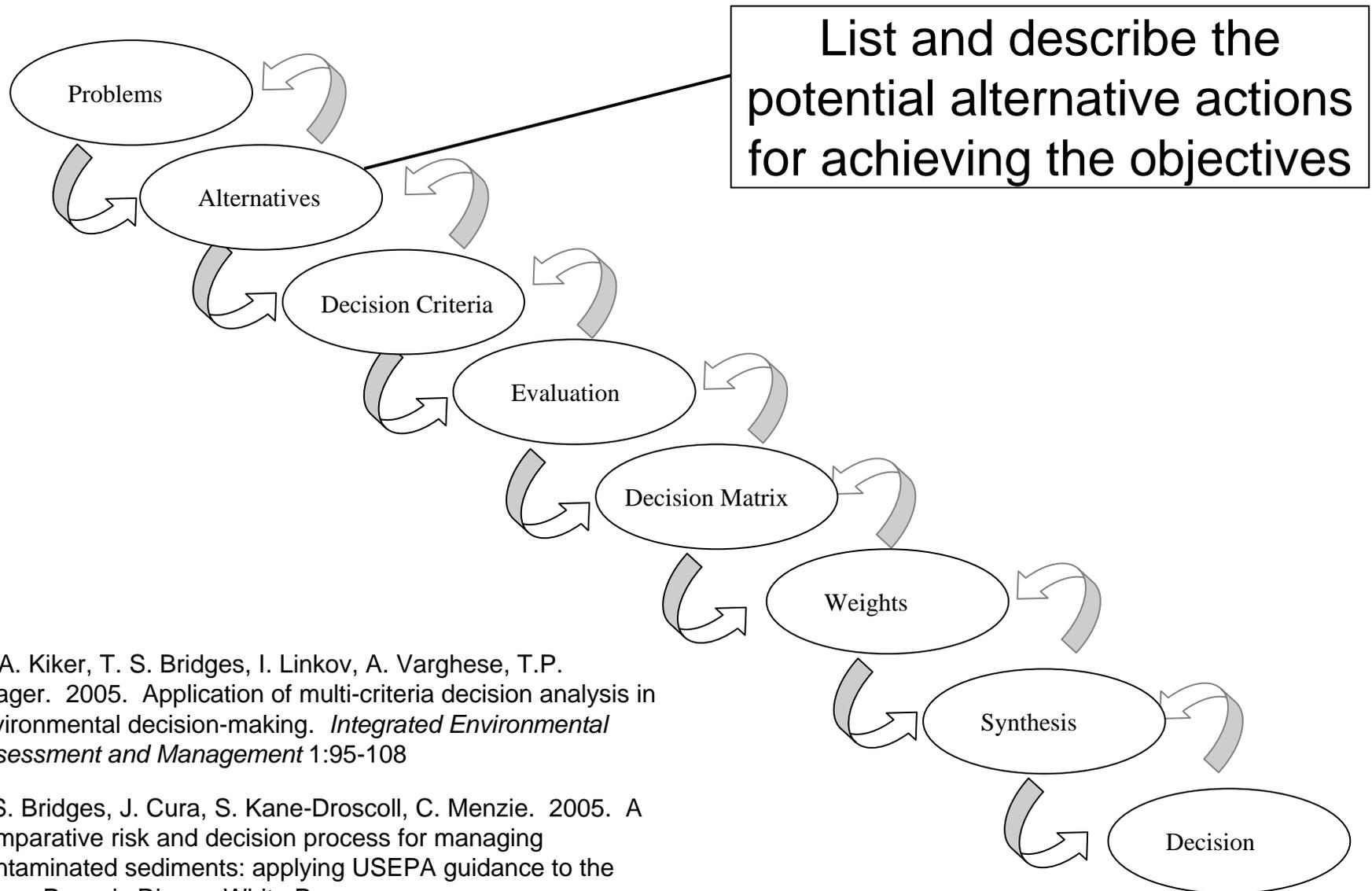
A Process for Structured Decision-Making



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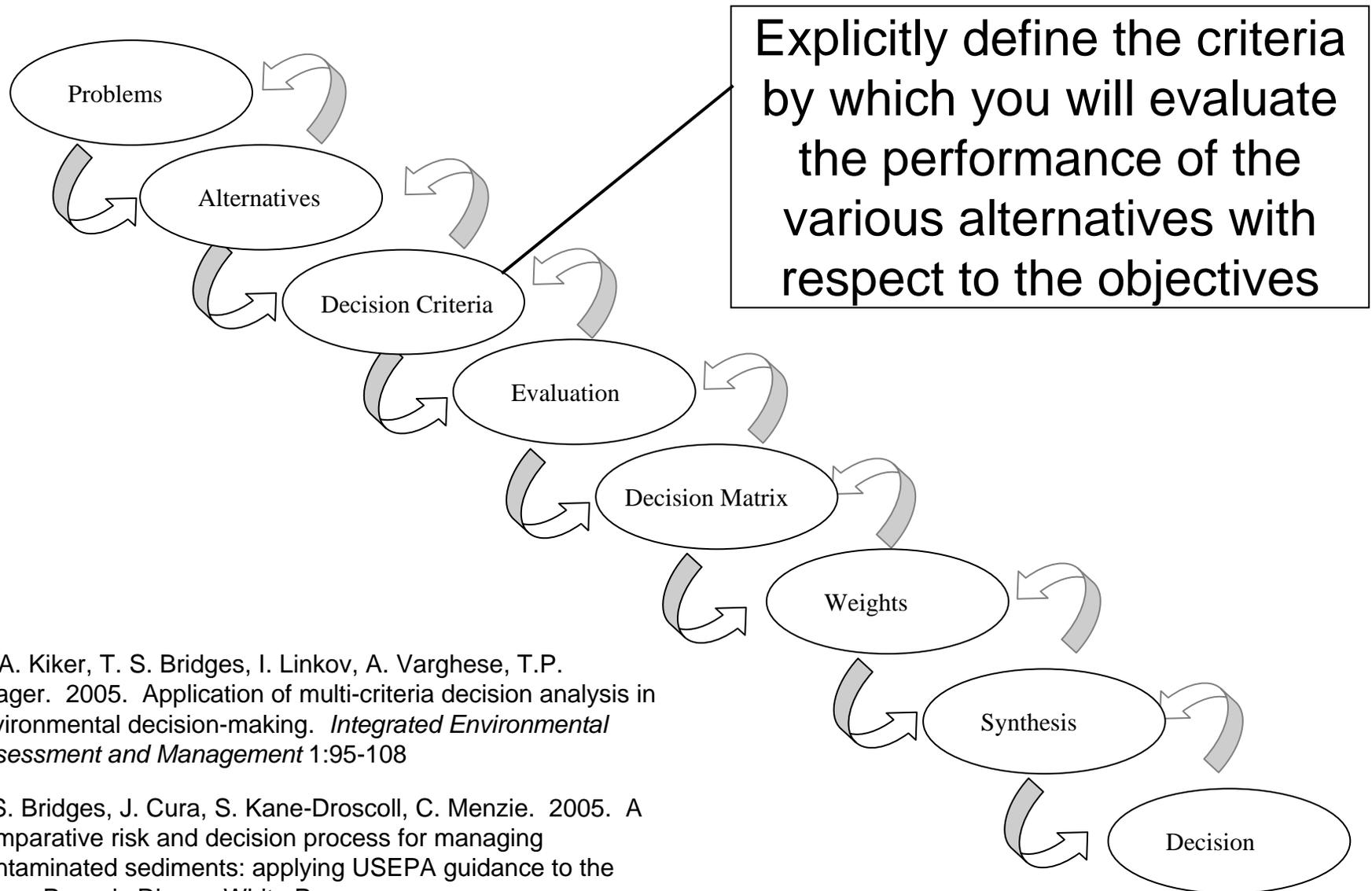
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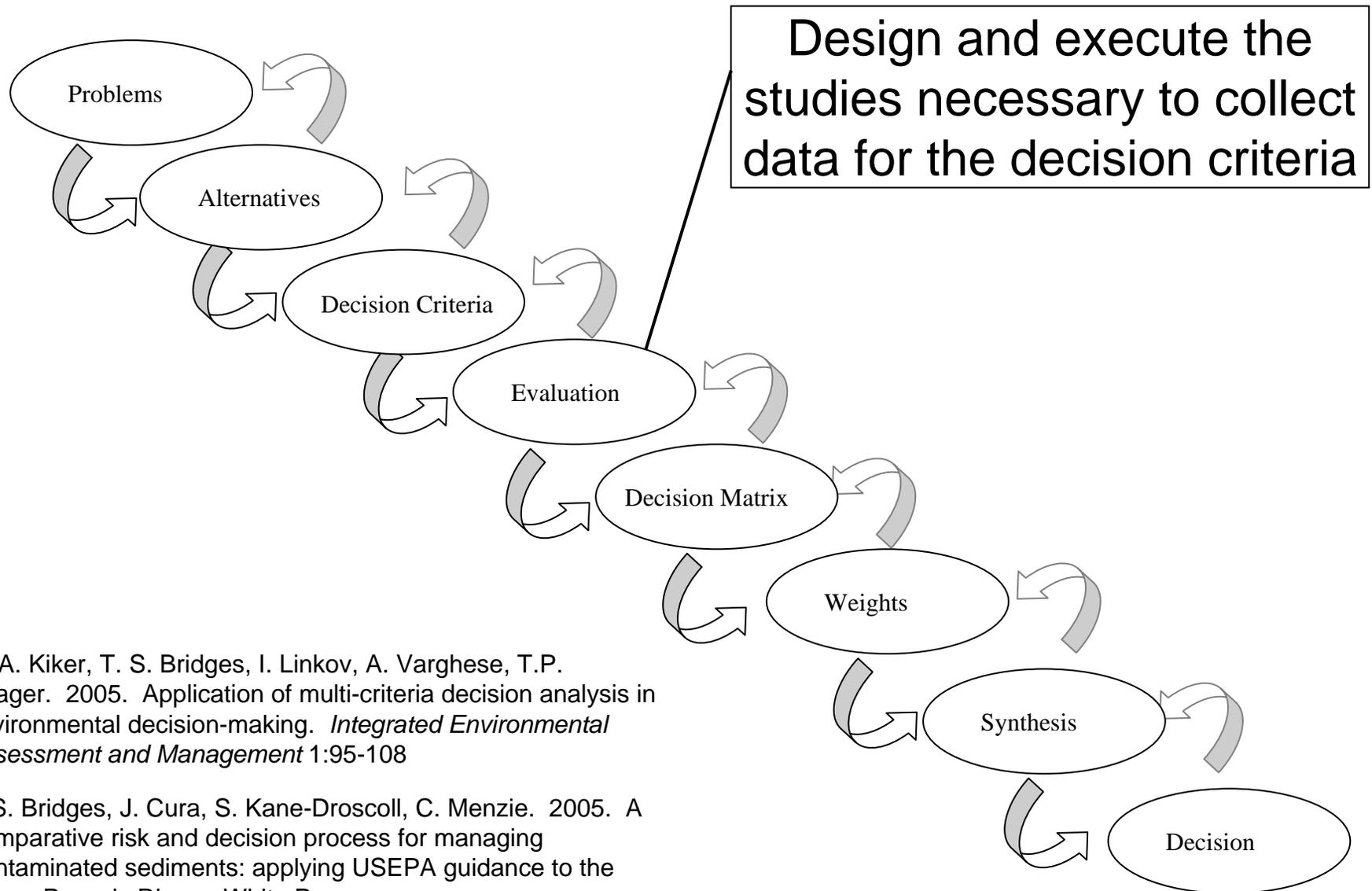
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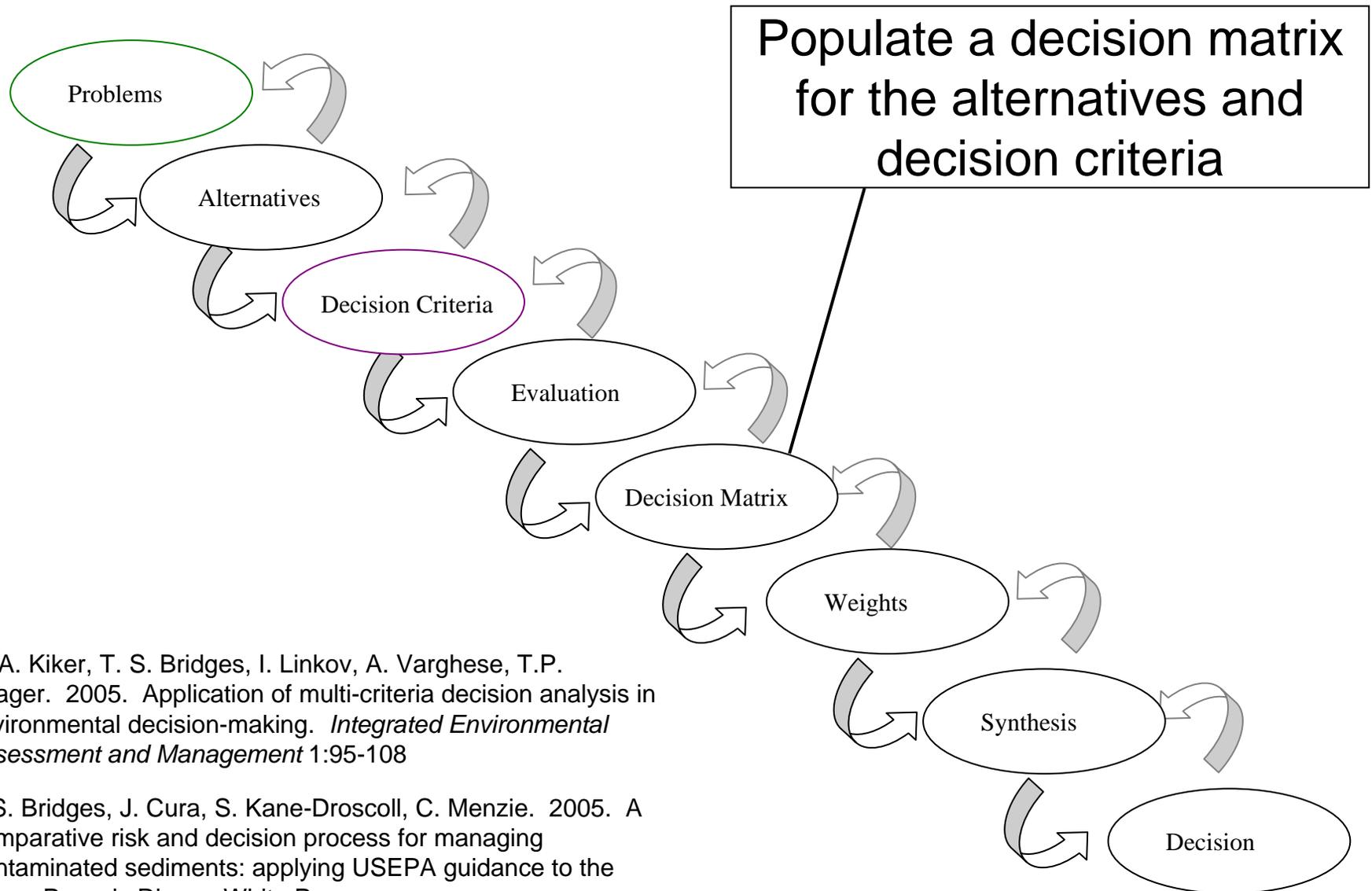
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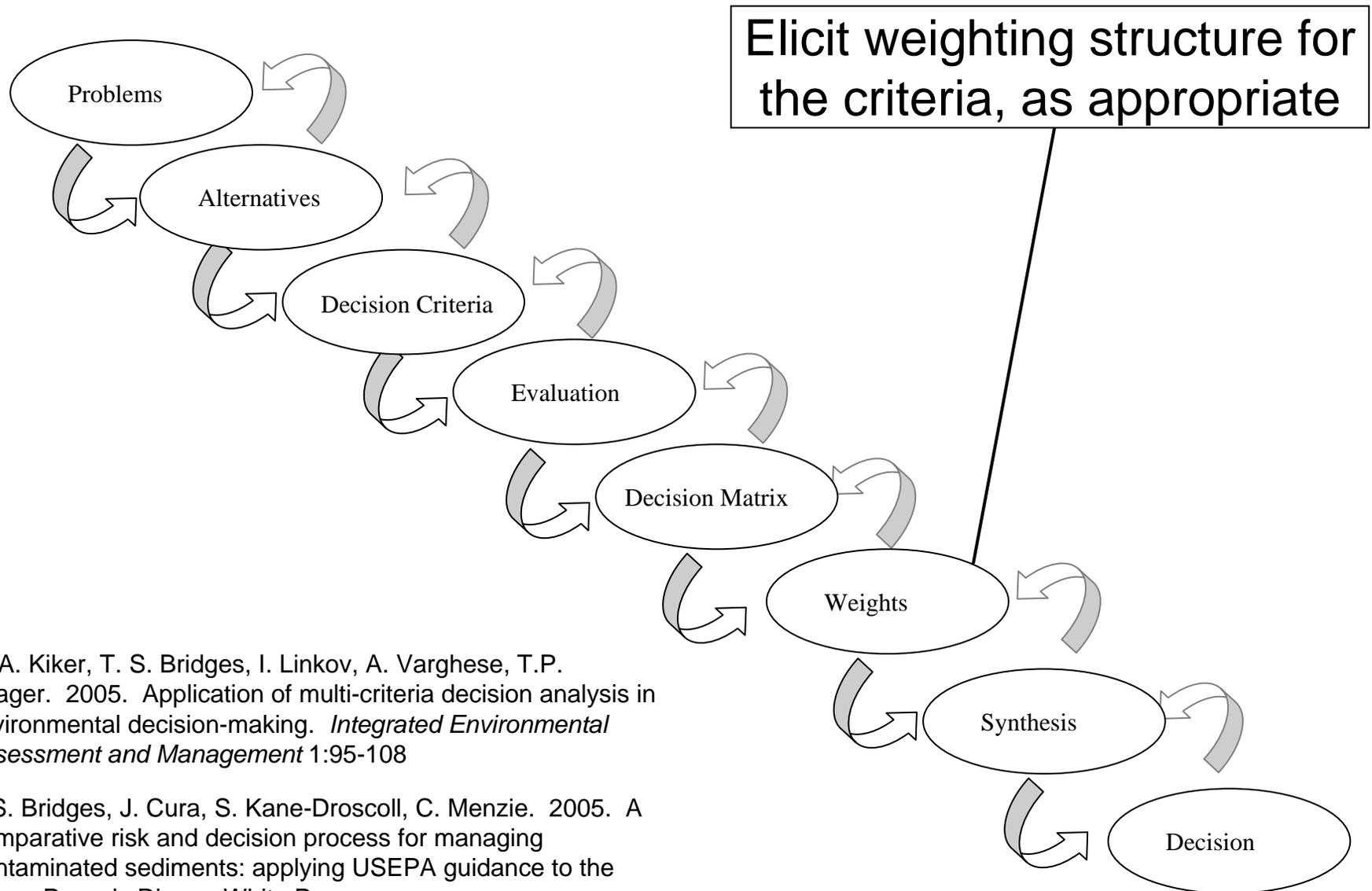
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Comparing Apples and Oranges (or Fish, Ducks and Money)

Plan	Cost	Fish	Ducks
A	100	10	5
B	100	5	10
C	150	10	10
D	150	10	15

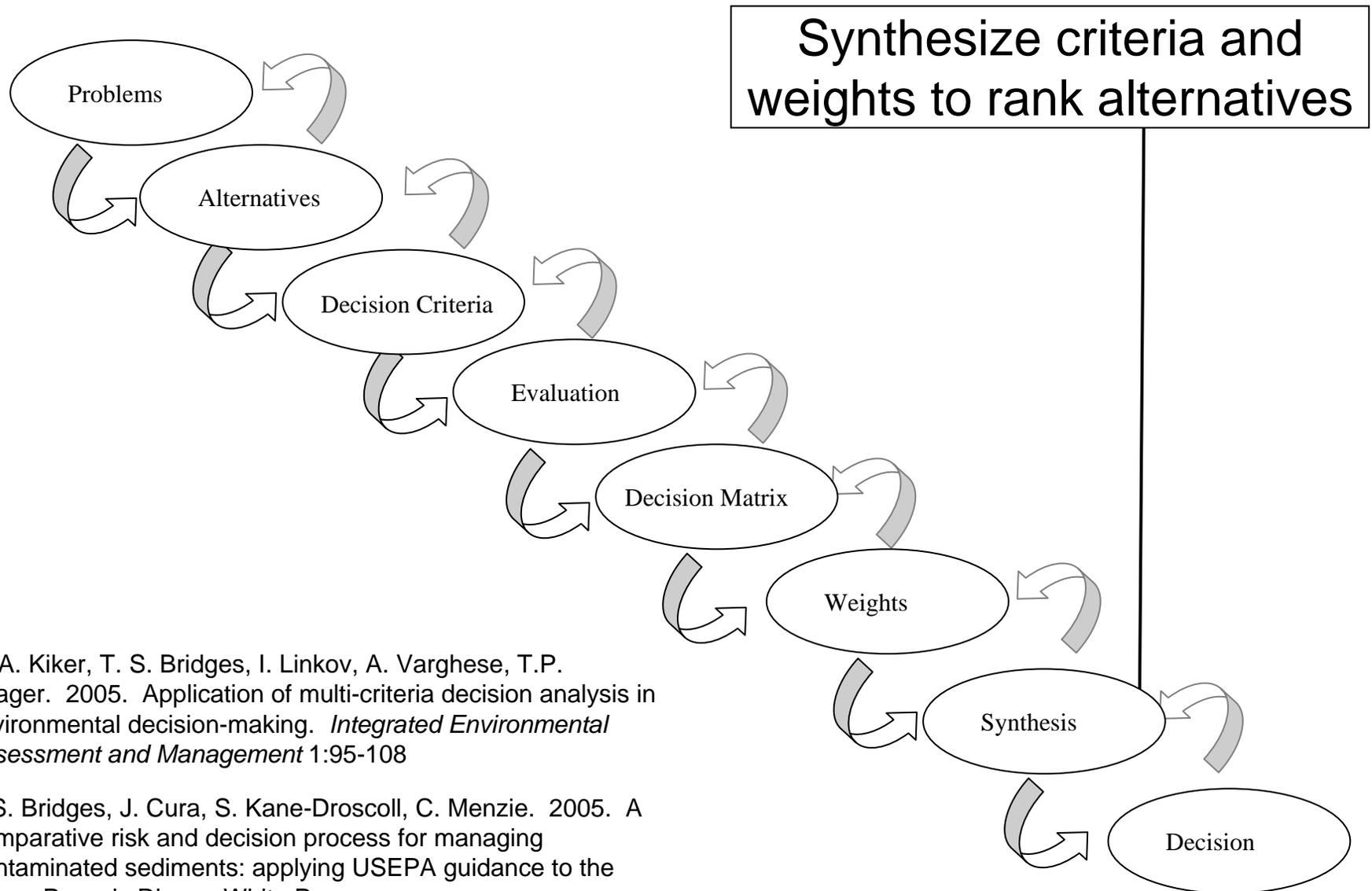
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Example Decision Matrix

How to combine these criteria?

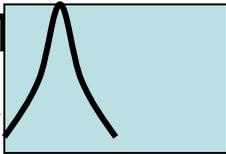
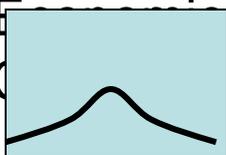
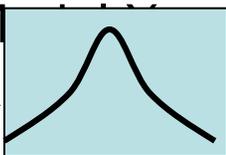


How to compare these alternatives?

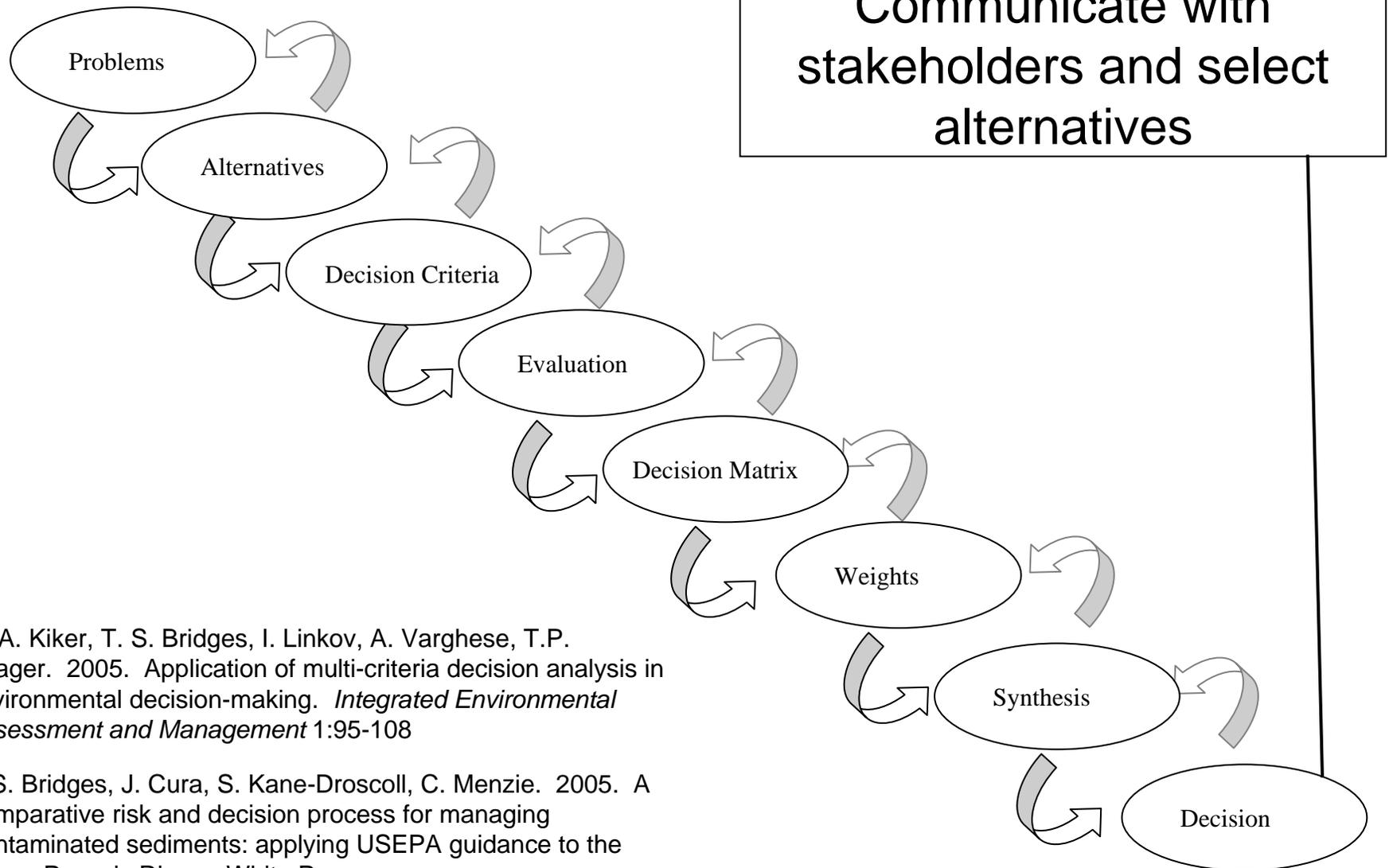


How to combine these results?



	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Alt.	Model X Result	Stakeholder Preference	Economic Cost	Non- monetary benefit
Alt.	Model Y Result 	Stakeholder Preference	Economic Cost 	Non- monetary benefit
Alt.	Model Z Result 	Stakeholder Preference	Economic Cost	Non- monetary benefit

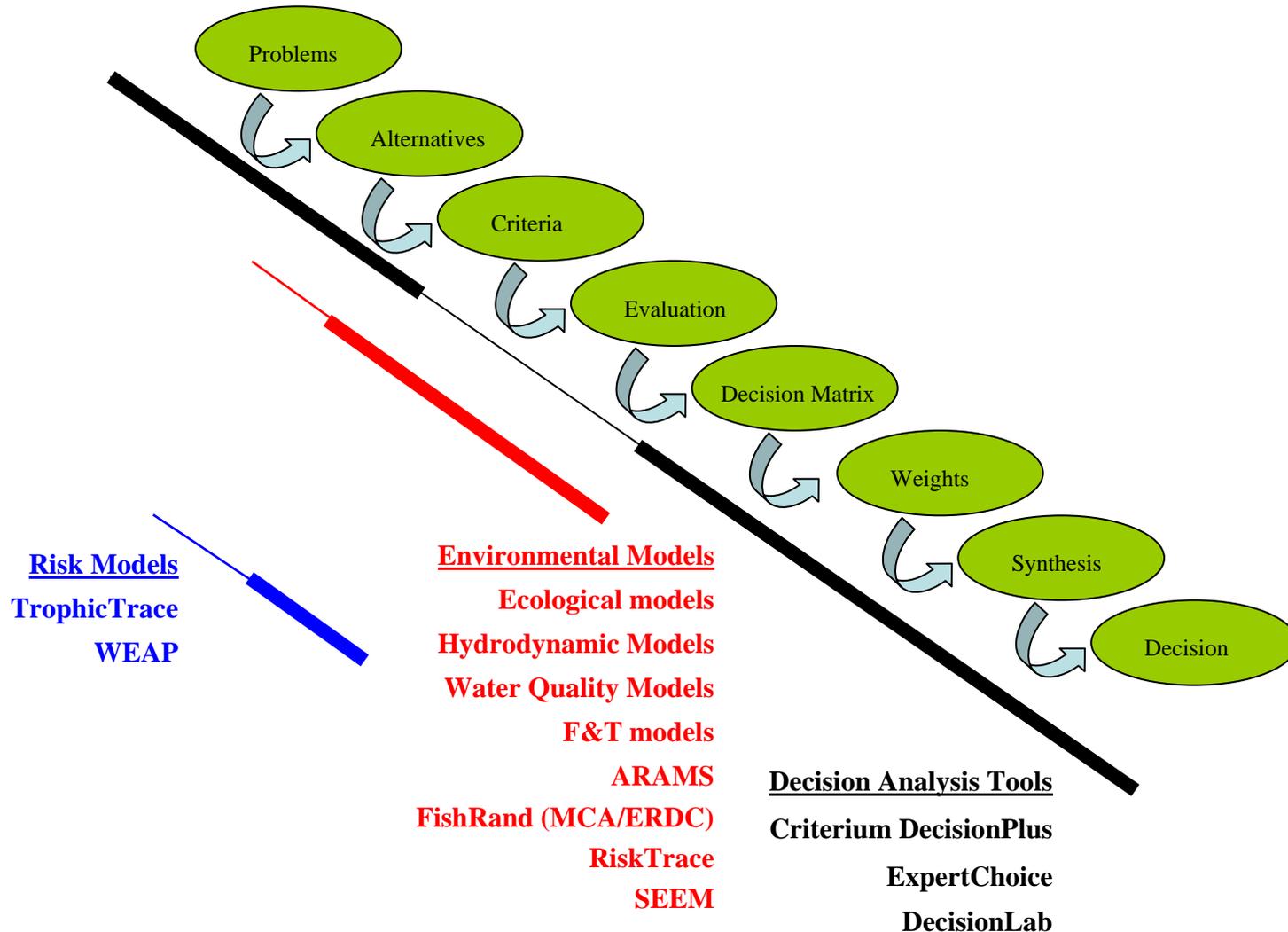
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Role of Analytical Tools in Decision Making



Applications of MCDA+Modeling

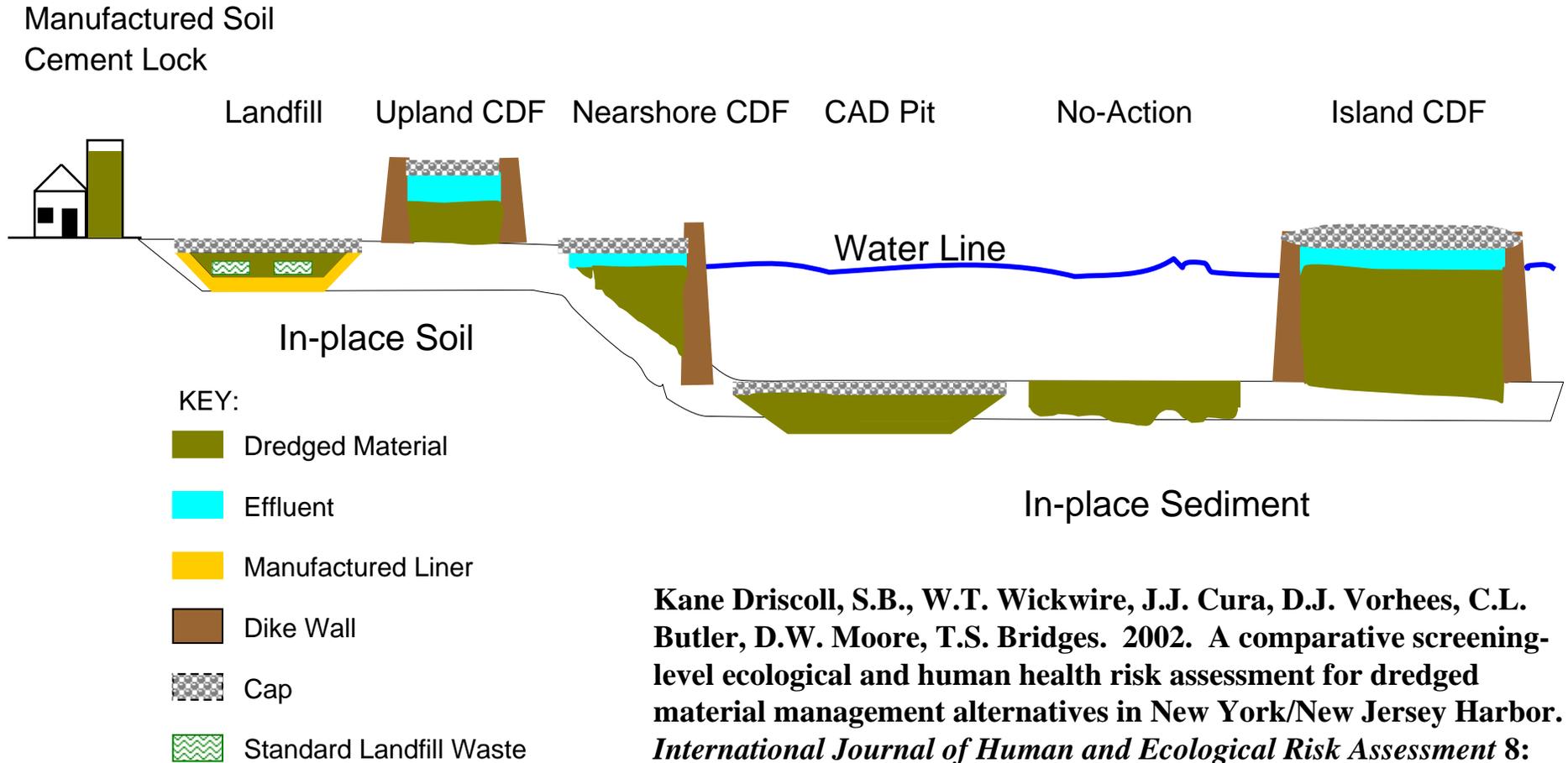
- Infrastructure
 - Flood and storm protection projects
- Environmental restoration
 - Oyster restoration in Chesapeake bay
- Navigation
 - Lock and dam investment
 - Dredged material (e.g., NY Harbor)



NY/NJ Harbor

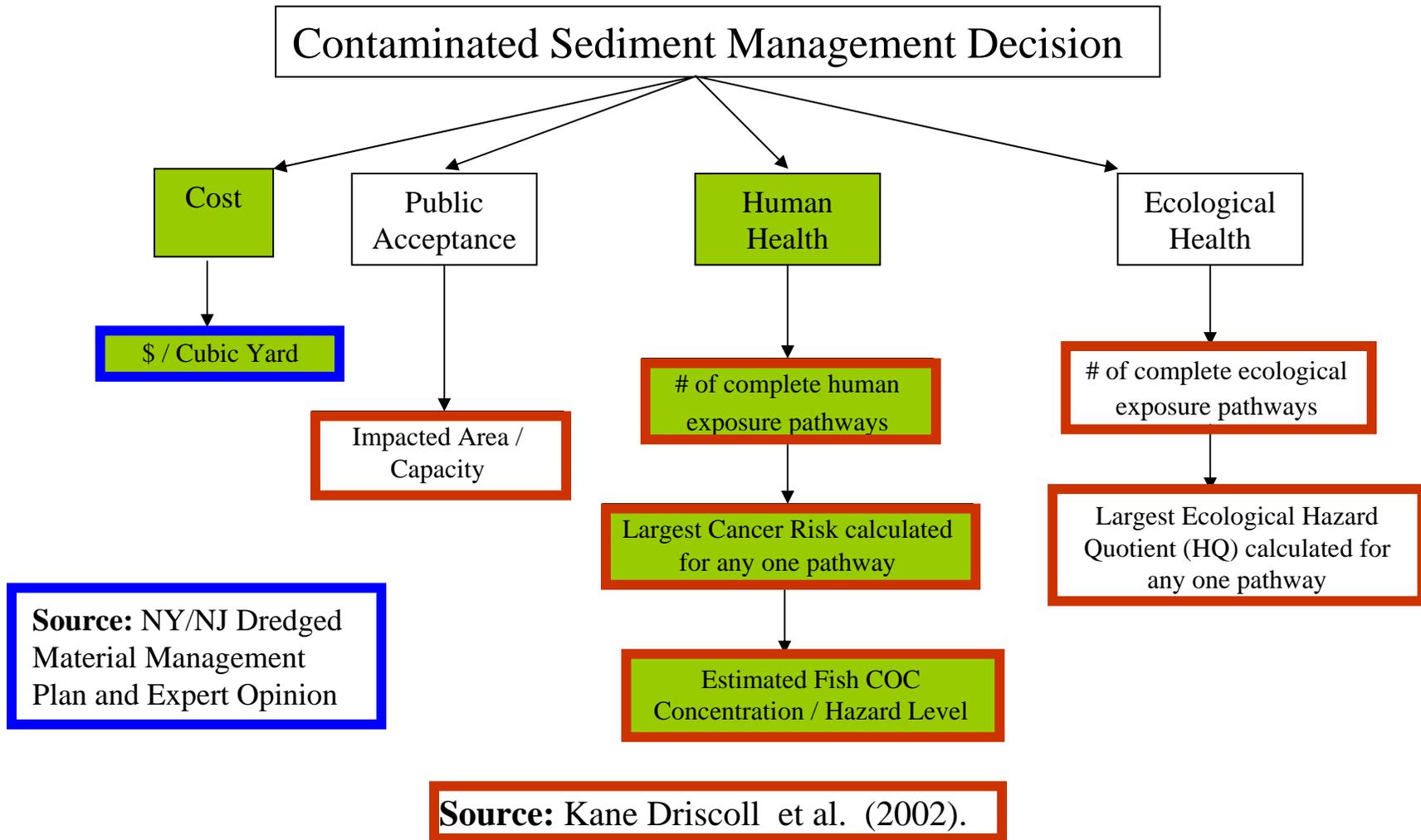


NY Sediment Management Alternatives



Kane Driscoll, S.B., W.T. Wickwire, J.J. Cura, D.J. Vorhees, C.L. Butler, D.W. Moore, T.S. Bridges. 2002. A comparative screening-level ecological and human health risk assessment for dredged material management alternatives in New York/New Jersey Harbor. *International Journal of Human and Ecological Risk Assessment* 8: 603-626.

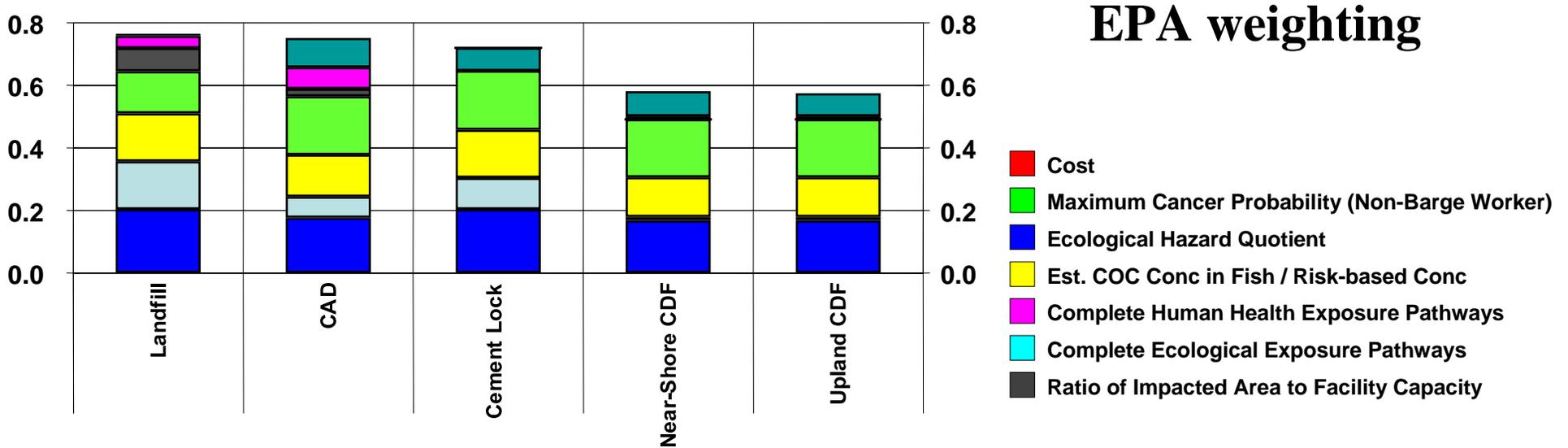
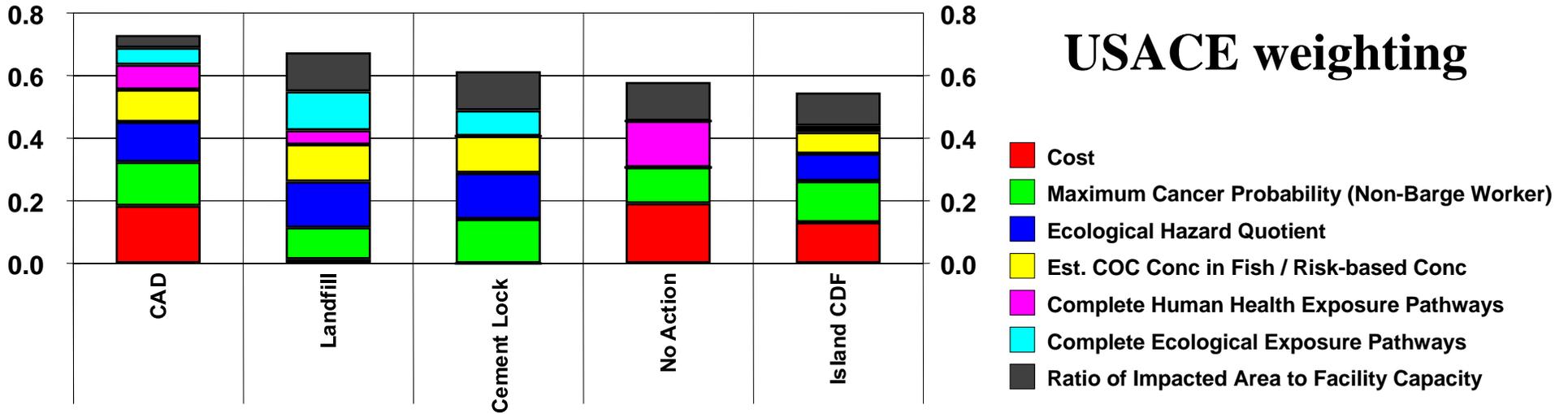
Decision Criteria: NY/NJ Harbor



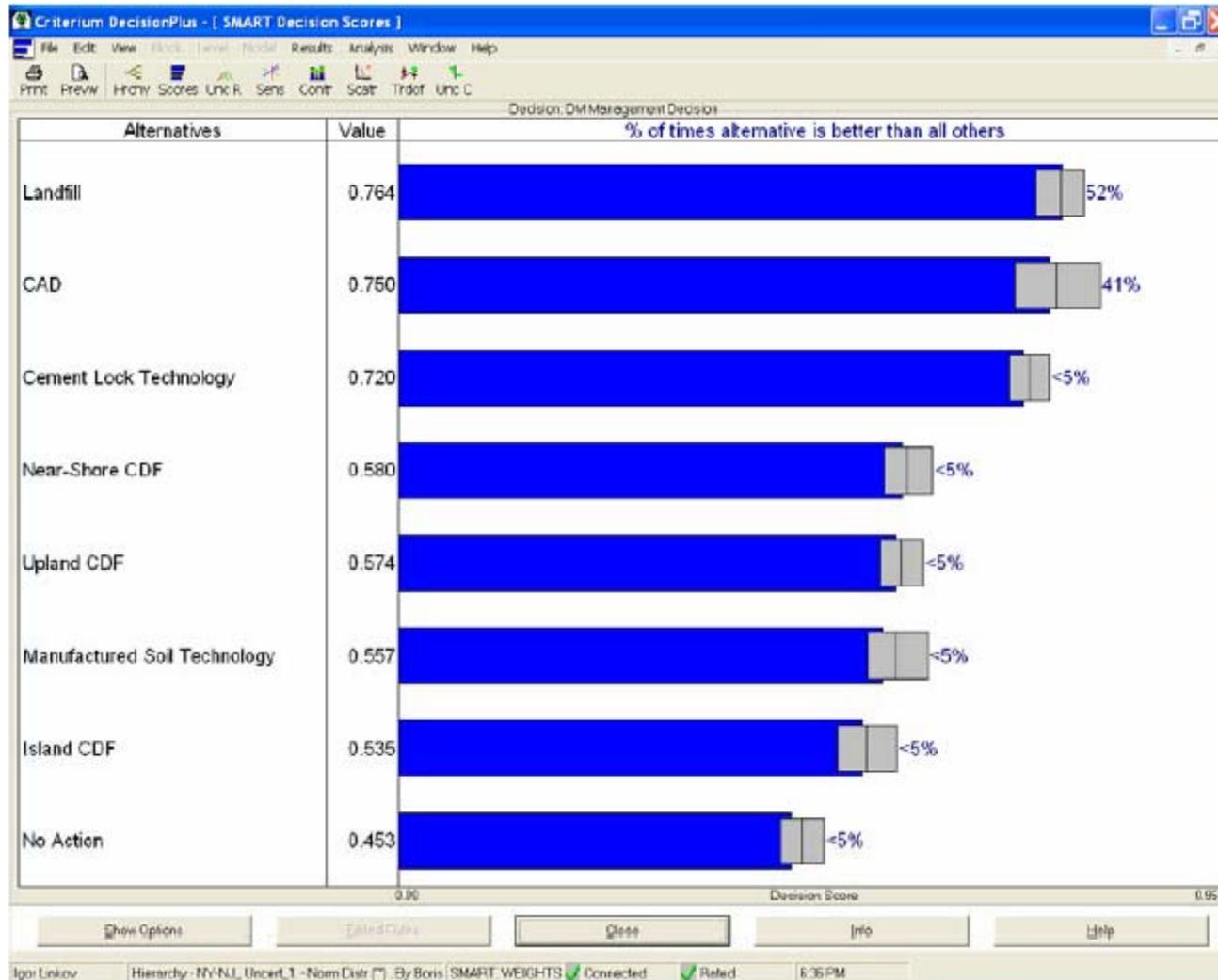
USACE/EPA Survey Results: Criteria Weights (%)

	EPA	USACE
Public Acceptability	7.4	12.5
Ecological Health	35.6	27.1
Human Health	47.0	40.7
Cost	10.0	19.7

Criteria Contributions to Decision Score



MCDCA rankings can and should consider uncertainty



What Every Decision Maker Needs...

- Alternatives
- Robust methods for predicting environmental benefits, risks and uncertainties
- Sensible methods for comparing benefits, risks and uncertainties among alternatives
- Structured and defensible methods for guiding decision-making
- Sound and cost efficient engineering technologies for managing risks and uncertainties

Benefits of MCDA+Modeling

- MCDA develops a context to provide:
 - Direction for modeling studies
 - An understanding of the meaning of modeling results
- Facilitates the use of modeling results in decision-making
- Allows for incorporating values in a way that is both reproducible and transparent

