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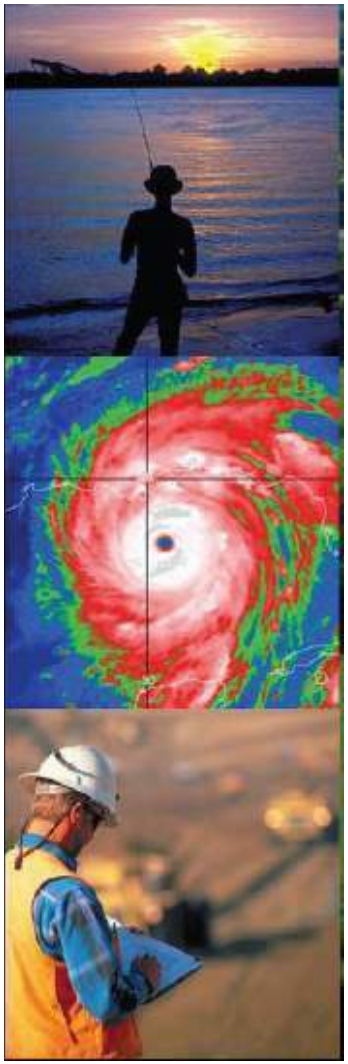
Louisiana Coastal Protection and Restoration



Applying Multi-Criteria Decision Analysis in Storm Damage Reduction Planning

Timothy Axtman, P.E.

Tulane Engineering Forum
9 May 2008

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Our Decision Problems

- Complexity due to:
  - Nature of the systems we manage
  - Number and diversity of interested and affected parties

- Risk-informed decision making includes approaches for:
  - Resolving multi-attribute risk-decision problems
  - Analyzing relevant uncertainties
  - Informing policymaking, planning and operations

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Objectives for Risk Informed Decision Making

- Support planning and decision making
  - Quantitative analysis of objectives, risks, and tradeoffs across the system of accounts
- Provide a process that supports deliberation among decision makers, partners, stakeholders
- Promote transparency in decision making
  - show to decision makers and the public the risks, costs, and consequences of plans

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Multidimensional Nature of Risk

- Diverse nature of the outcomes of interest
  - human health and safety,
  - economics,
  - environmental impacts,
  - affects on social systems, etc.

- Human dimensions
  - Human responses to risk are a function of values and risk perceptions and attitudes

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Multi-Criteria Decision Analysis

- An approach for structuring and analyzing decision problems

- Emphasis given to:
  - Defining the problem
  - Establishing explicit objectives
  - Defining output metrics for evaluating alternative solutions/plans
  - Incorporating human values and risk attitudes
    - Through weighting and utility functions
  - Ranking plans based on quantitative scores derived from outputs

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Car-Buying Example of MCDA

Metric (Weight)	Units	Cars				
		Option 1	Option 2	Option 3	Option 4	Option 5
Cost (25)	Dollars	27,000	45,000	30,000	35,000	12,000
Resale Value After Three Years (5)	% of Original Value	44	56	57	49	33
Repair-Maintenance Cost / Year (5)	Dollars	100	500	1,000	250	500
Fuel Efficiency (15)	MPG	30	25	45	27	32
Passenger Compartment Space (15)	ft^3	150	170	165	160	145
Style and Comfort (5)	Qualitative	Finest	Finest	Average	Average	Poor
Safety Rating (30)	NHTSA Safety Rating	2	3	3	5	2

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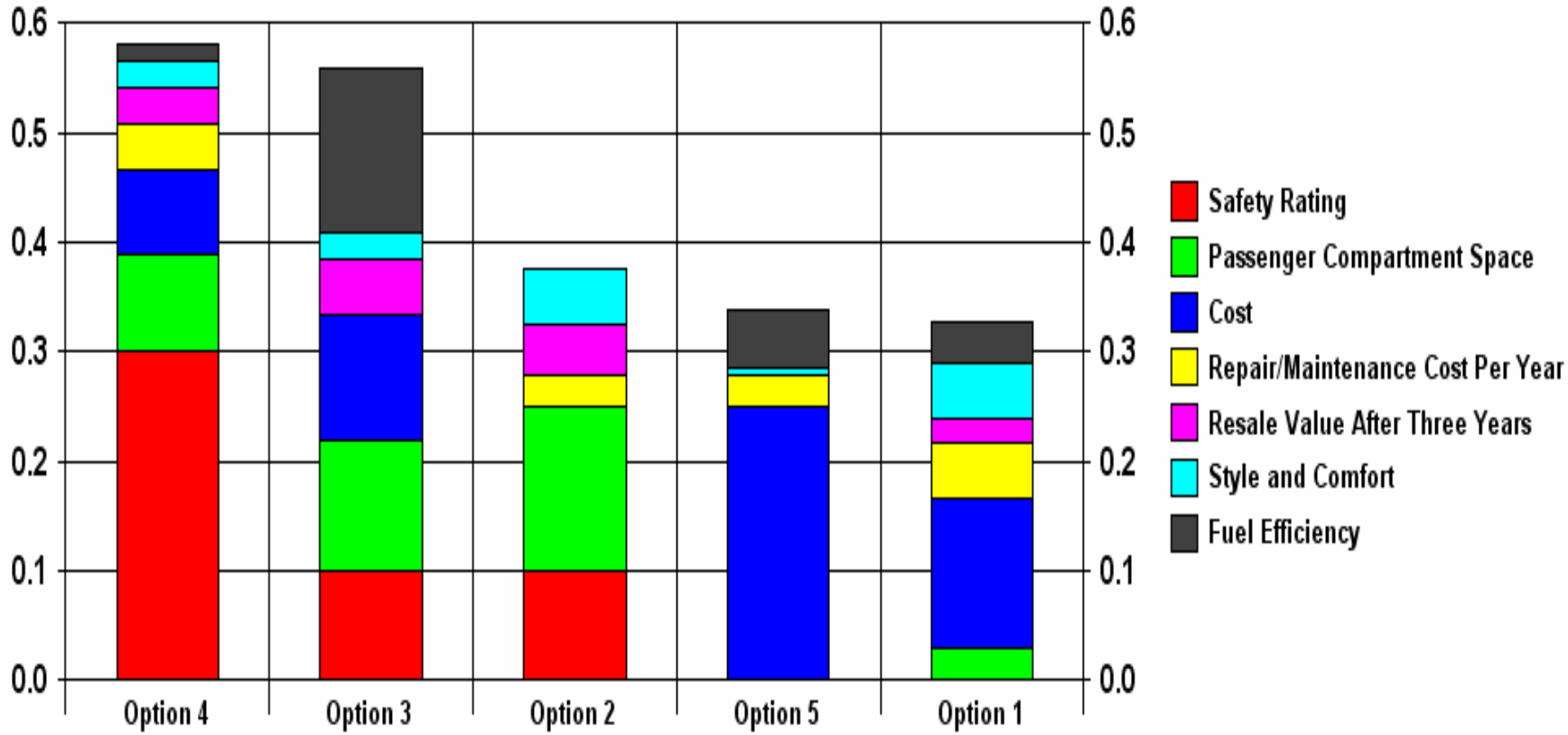
Ranking and Contributions by Metric



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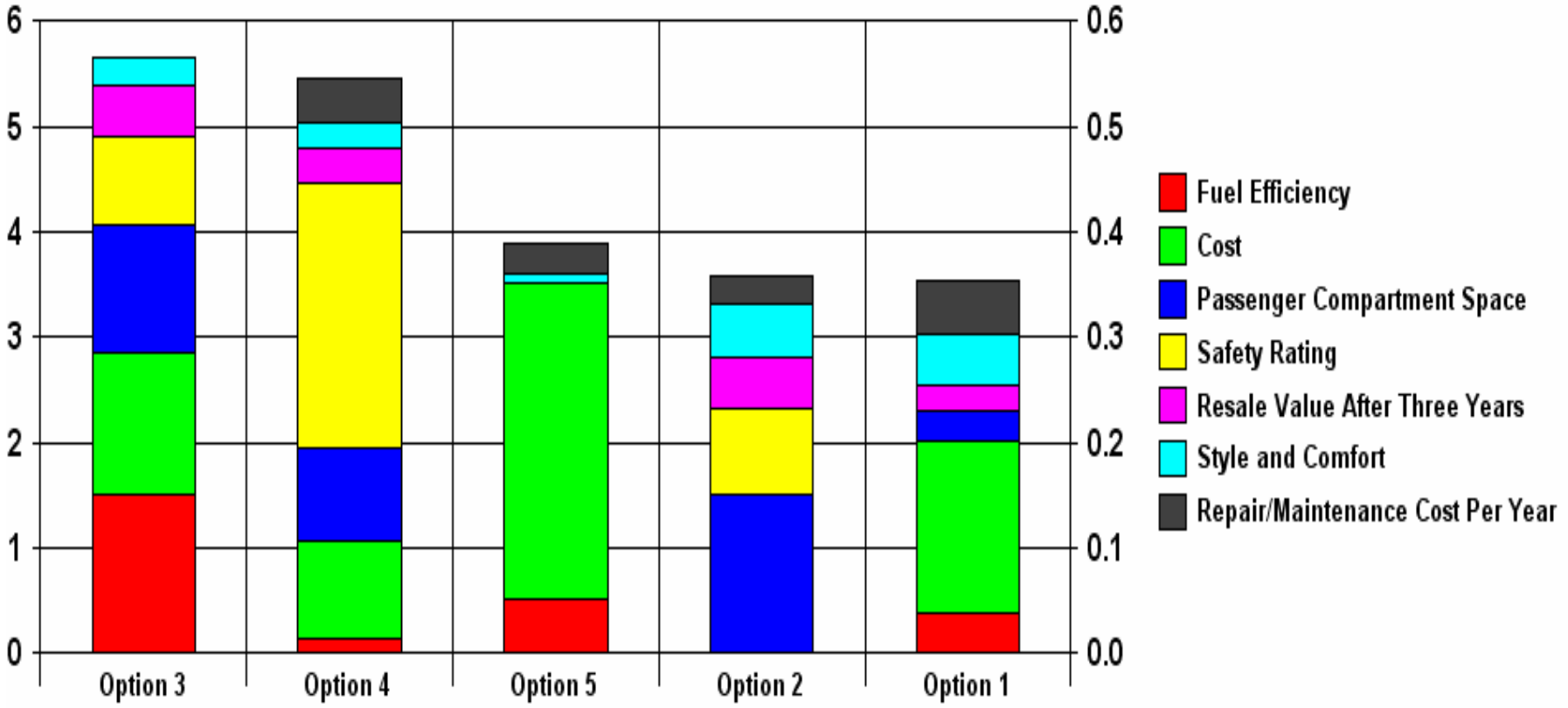
Contributions by Metric with Adjusted Weight

Cost: 25 to 30 Safety: 30 to 25



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LACPR Objectives and Metrics

Planning Objectives

- Reduce risk to public safety from catastrophic storm inundation
- Reduce damages from catastrophic storm inundation
- Promote a sustainable ecosystem
- Restore and sustain diverse fish and wildlife habitats, and
- Sustain the unique heritage of coastal Louisiana by protecting historic sites and supporting traditional cultures

Output Metrics

- National Economic Development
  - Residual damages
  - Life-cycle costs (Implementation, O&M)
  - Construction time
- Regional Economic Development
  - Gross regional output
  - Employment
  - Income
- Environmental Quality
  - Spatial integrity
  - Wetlands restored and/or protected
  - Direct impacts
  - Indirect impacts
  - Historical properties protected
  - Archeological properties protected
- Other Social Effects
  - Residual population impacted
  - Historical districts protected

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Engaging Stakeholders in Decision Making

- Allows individual stakeholders to consider and document risk / value preferences
- Ensures plans remain aligned with objectives
- Facilitates deliberation
- Captures stakeholder value information for allocating weight to outputs and risks
- Allows exploration of variation in values among stakeholders and its implications
- Is an initiation point for risk communication

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Initial LaCPR Stakeholder Value Input

Five meetings in October 2007

- Baton Rouge (Federal and State Government) (22)
- New Orleans (PU1 & PU2) (23)
- Houma (22)
- Lake Charles (20)
- Abbeville (22)

- Federal and State
  - LDNR, FEMA, FHWA, USGS, USFWS, NMFS, NOAA, USEPA, LADOTD, etc.
- Local and Parish
  - New Orleans, St. Bernard, St. Tammany, Jefferson, Terrebonne, Vermillion Parishes, Ports, Levee districts, Congressional offices, mayors, etc.
- NGOs and Academia
  - BTNEP, CRCL, LPBF, Audubon, NWF, UNO, LSU, Ducks Unlimited, etc.
- Busines/Developers
  - ConocoPhillips, Shell, Tower Land Co., etc.

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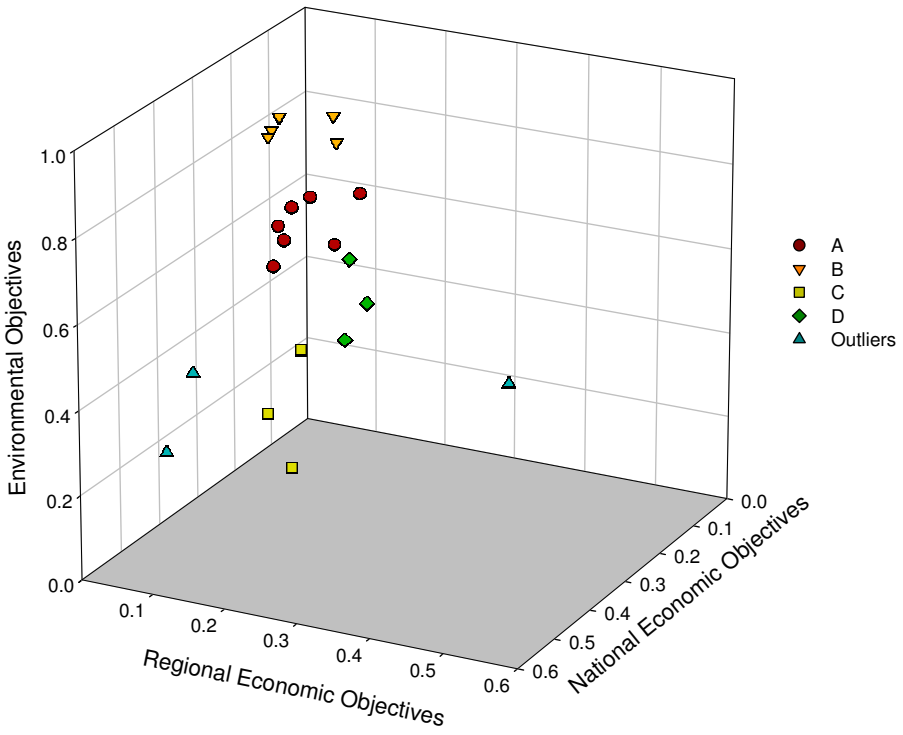
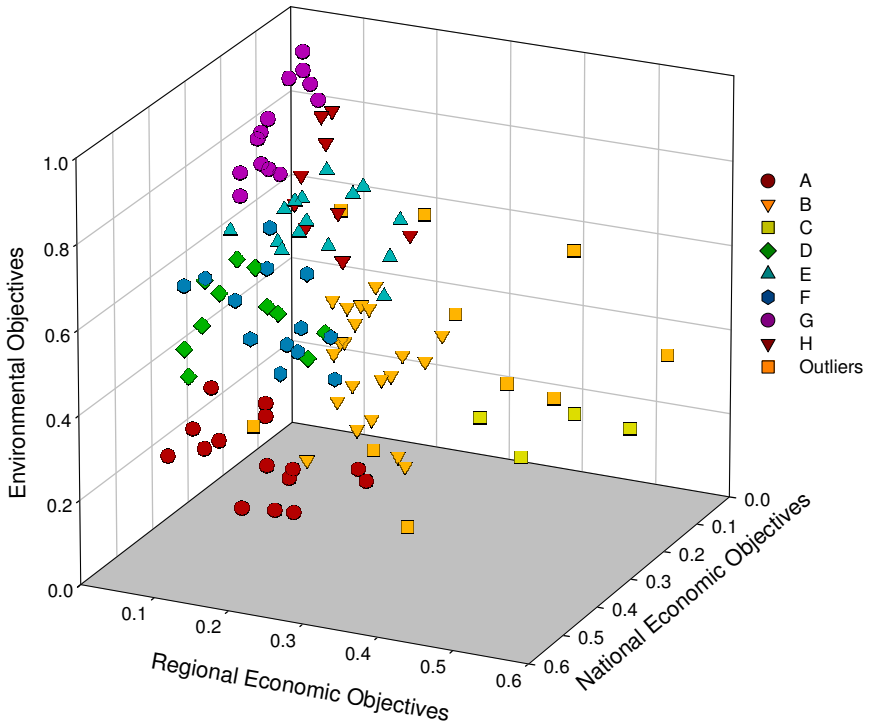
Initial LaCPR Value Weight Data

Weight allocation for gov't agencies (a) and all stakeholders (b)

(a)



(b)



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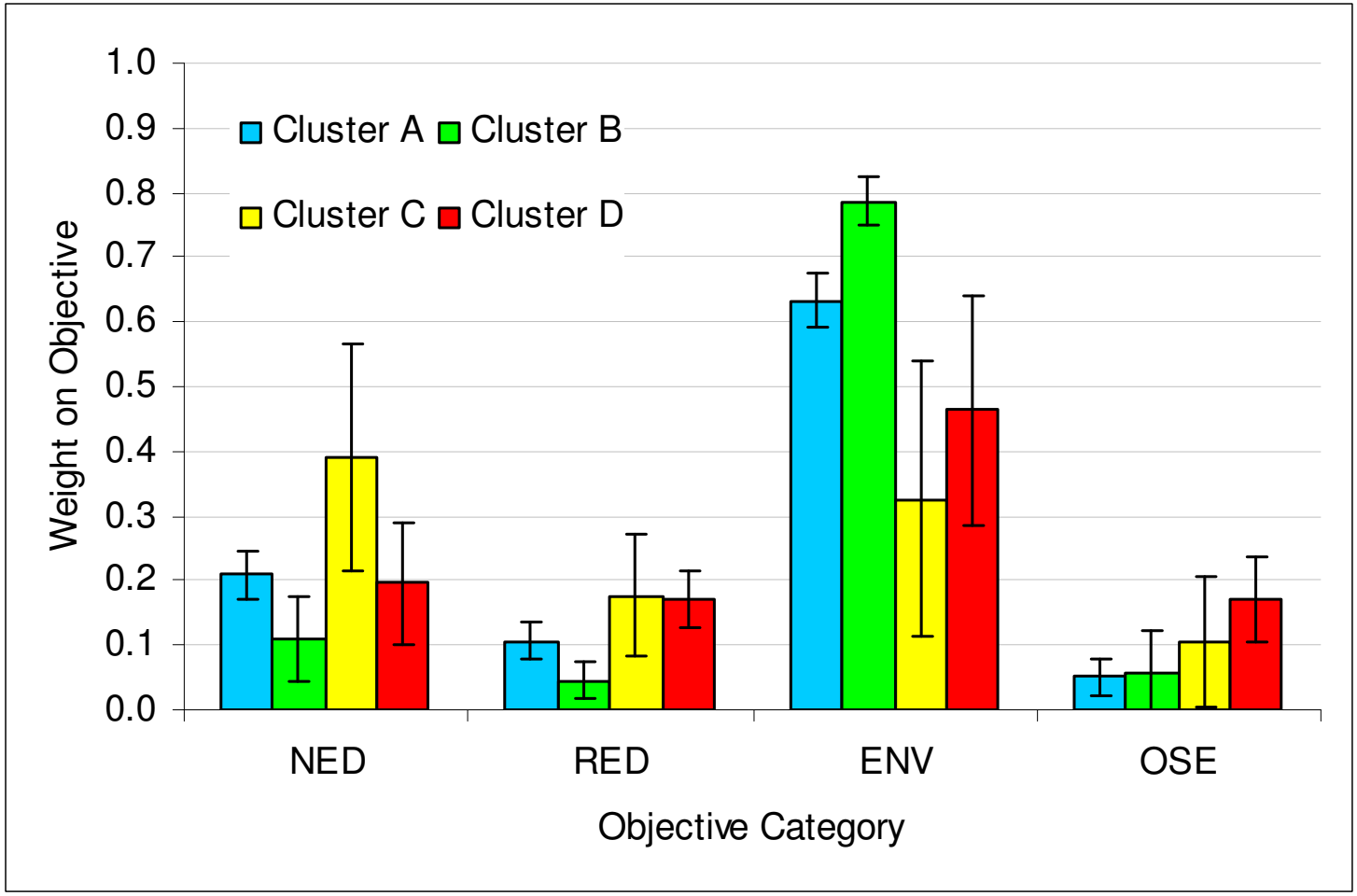
Distribution of Value Weighting

Mean weights by aggregate planning objective for gov't agency clusters A through D (± 95% confidence limits)



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Alternative Plan Output Data

Planning Unit:	1	Alt. No.	PU1-HL-b-400-3	Category	Coastal Restoration + Structural Measures
Alternative Description:	Maintain coast with coastal restoration and build high level plan providing 400-year design level of risk reduction to Southshore of Lake Pontchartrain, LaPlace and Slidell.				
Coastal Component:	R2 (pulsed diversions)			Nonstructural Component:	None
Structural Component:	See alternative description.				

		Metric Results by Scenario with Uncertainty Bands								
		Life-cycle Cost	Resident Population Impacted	Residual Damages	Gross Regional Output Impacted	Employment Impacted	People's Earned Income Impacted	Archeo. Sites Protected	Historic Properties Protected	Historic Districts Protected
		$ Billions	Ann. Equiv. #	Ann. Equiv ($ 1000's)	Ann. Equiv ($ 1000's)	Ann. Equiv #	Ann. Equiv ($ 1000's)	# Sites	# Properties	# Districts
Scenario 1	Low		51,489	1,178,484	913,544	4,074	245,111	243	140	48
	Mean	53.94	53,975	1,375,076	1,119,100	4,820	297,730	273	143	50
	High		58,018	1,740,945	1,491,314	6,260	396,399	303	143	51
Scenario 2	Low		51,944	1,213,640	986,760	4,307	266,783	243	133	45
	Mean	54.35	54,826	1,432,557	1,199,986	5,040	318,161	273	141	49
	High		59,057	1,865,446	1,826,456	7,092	472,967	303	143	51
Scenario 3	Low		43,051	1,089,055	596,350	3,173	180,038	243	140	48
	Mean	53.94	45,528	1,277,069	766,668	3,856	225,926	273	143	50
	High		49,242	1,625,816	1,106,918	5,302	321,310	303	143	51
Scenario 4	Low		43,344	1,121,766	651,431	3,340	195,841	243	133	45
	Mean	54.35	46,119	1,328,206	832,319	4,046	243,851	273	141	49
	High		49,952	1,746,122	1,388,230	5,929	380,702	303	143	51

Other Metric Results							
Construction Time (years)	16	Wetlands Created/	Scen 1&3	Scen 2&4	PV Cost of	Scen 1&2	Scen 3&4
Direct Wetland Impacts (acres)	-5,661	Protected (acres)	214,687	220,284	NS Comp ($		
Indirect Impacts	-1	PV Cost of Coastal			Billions)	N/A	N/A
Spatial Integrity	0.478	Component ($ Billions)	10.67	10.90			
		PV Cost of Structural Component ($ Billions)	43.27	43.45			

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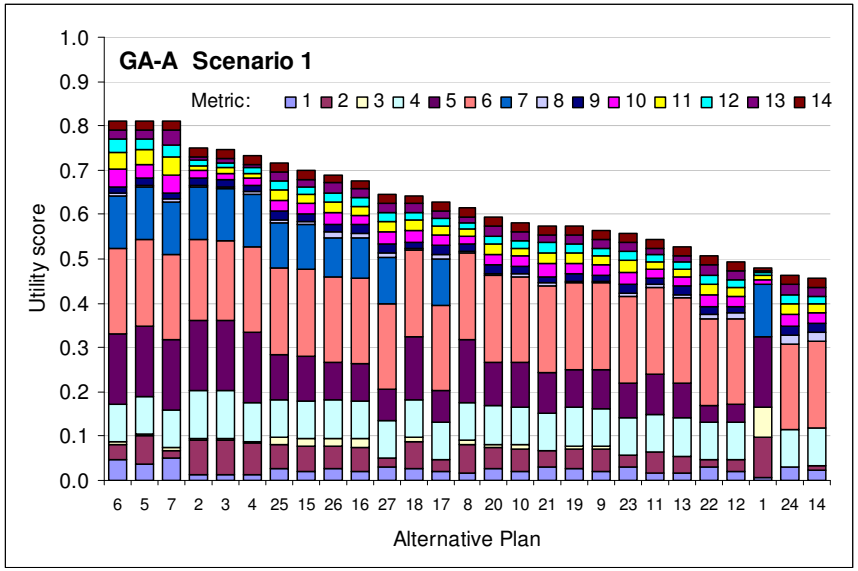
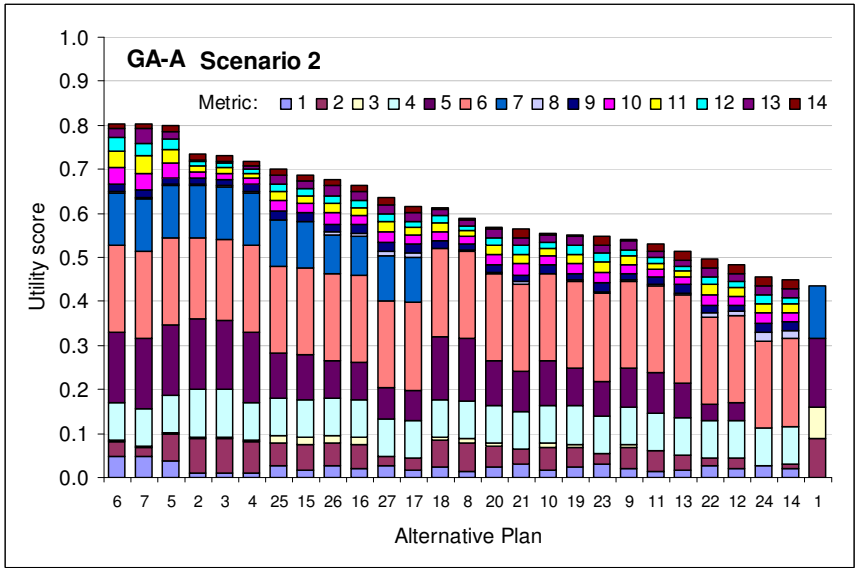
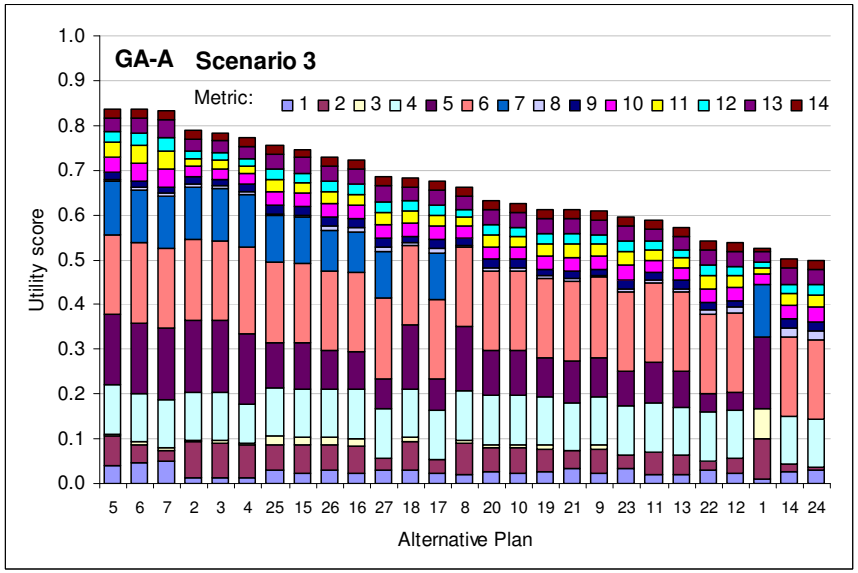
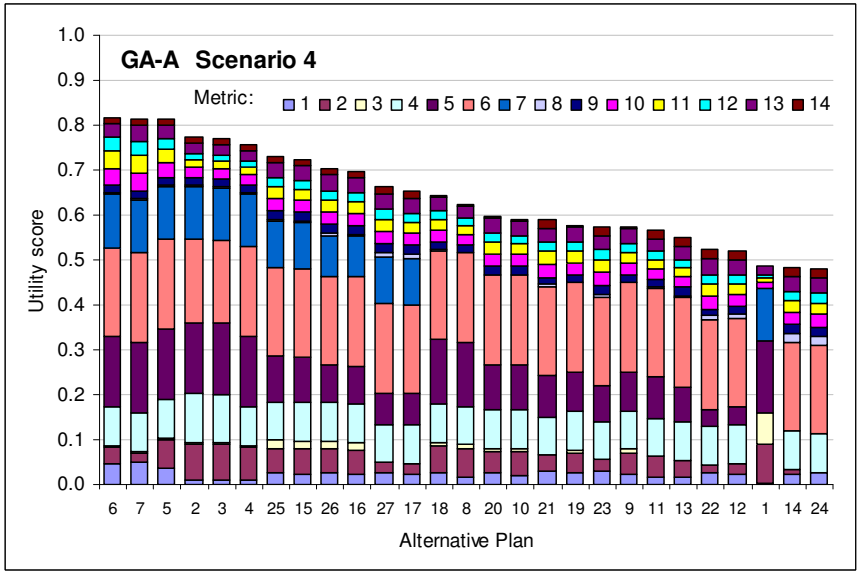
Gauging Effects of Preference on Plan Ranking









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Comparing Rankings Vs Preference Patterns

Comparative MCDA Rankings Planning Unit 3b				
Plan Rank	Weight-1A	Weight-1B	Weight-1C	Weight-1D
1	RL-100-1	RL-100-1	RL-100-1	RL-100-1
2	RL-400-1	C-RL-100-1	RL-400-1	RL-400-1
3	C-RL-100-1	RL-400-1	C-G-100-1	F-1000-1
4	NS-1000	NS-1000	C-F-100-1	C-F-100-1
5	NS-400	NS-400	G-100-1	C-F-400-1
6	C-F-100-1	C-RL-400-1	F-100-1	F-100-1
7	F-100-1	C-F-100-1	F-1000-1	C-G-100-1
8	C-RL-400-1	F-100-1	C-RL-100-1	F-400-1
9	NS-100	NS-100	NS-1000	G-100-1
10	C-F-400-1	R1	NS-400	C-RL-400-1

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Constructing a Path to Decision Making

- Identify the combination of plans that maximizes utility for the state as a whole
- Consider supplementary information on cost-effectiveness and incremental cost
  - Analysis could consider life cycle project costs and 2 risk reduction benefits, treated separately
    - Property: monetary damages avoided
    - Health and safety: residential population protected from inundation
- Move Federal decision-makers through the deliberation process
  - Consider stakeholder preference patterns
  - Consider cost effectiveness and incremental cost information
  - Consider what output values represent the Federal interest
  - Performed MCDA in real-time
  - Rank and compare plans relative to stakeholder results

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Refining the Process

- Seek improvement of output metrics – focus on the most meaningful measures of performance
- Apply swing-weighting method to determine output weights – inform stakeholders of the range of plan performance
- Hold successive stakeholder weight elicitation meetings – keep working to narrow value differences
- Seek broader range of stakeholders – local, regional, & national
- Expand the Understanding of Decision Technique


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