



Multicriteria decision evaluation of adaptation strategies for vulnerable coastal communities

Hooman Mostofi Camare
M.Sc. System Science
University of Ottawa



Introduction

- ▶ Coastal community climate impacts
- ▶ Multi dimensionality of communities (Economic, Environmental, Cultural and Social)
- ▶ Vulnerability of coastal communities
- ▶ Multiple Stakeholders (Government, Industry, NGOs, Professionals, Community members)

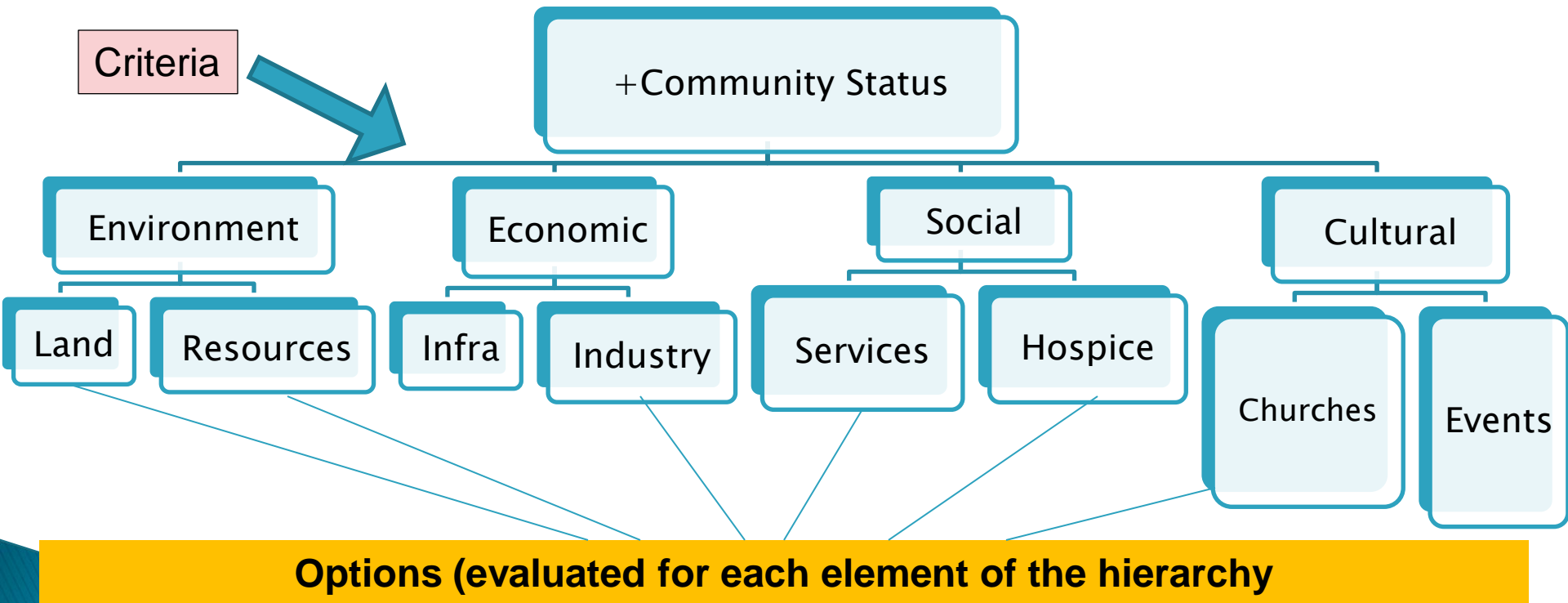


Objectives

1. Profiling the community along four pillars (Environment, Economic, Social and Cultural)
2. Understand storms and their impacts
3. Examine community vulnerability
4. Support decisions by engaging the community and applying priorities



Decision Hierarchy / Community Profile



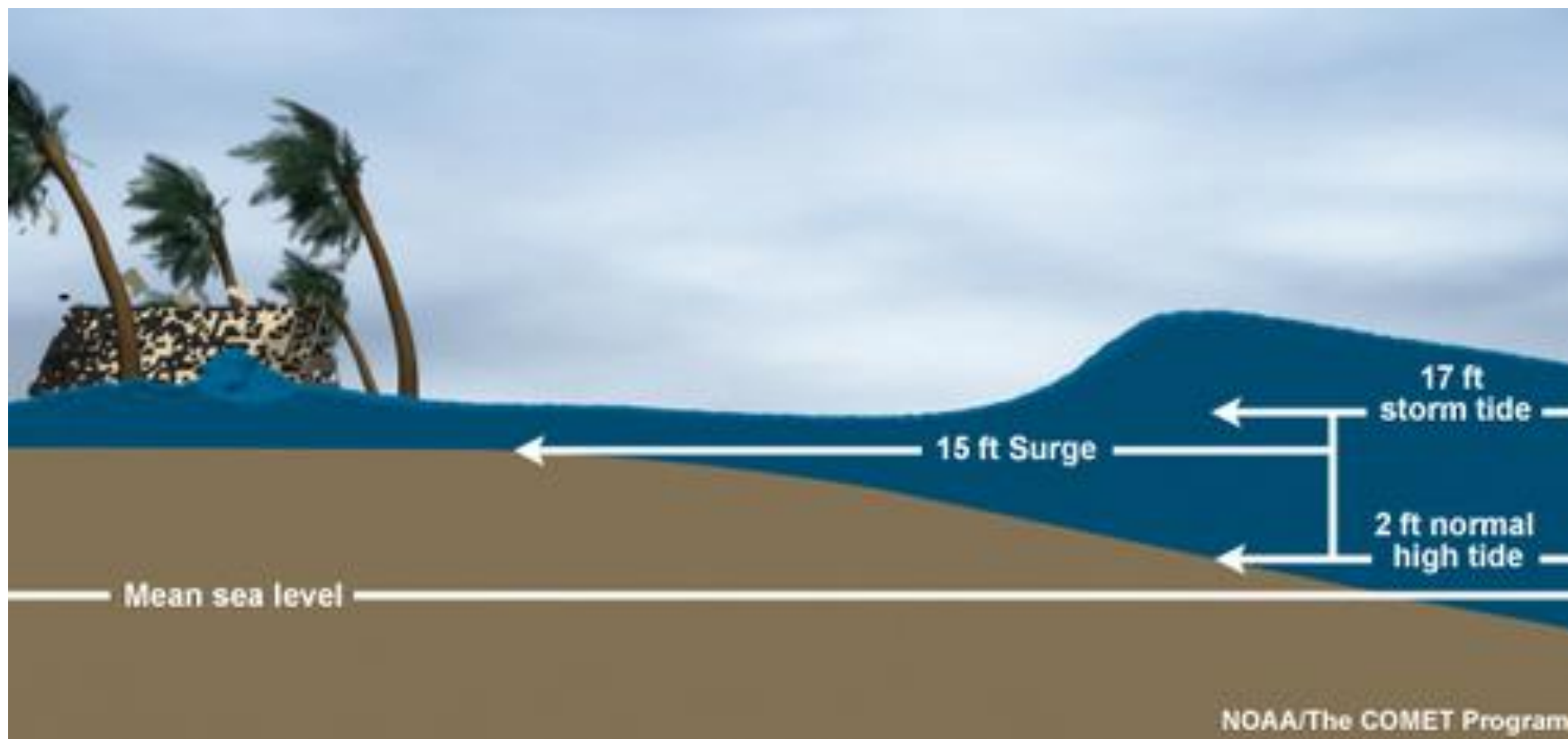
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Coastal Climate Adaptation Strategies



Storm surge vs. storm tide

Source: NHC (2010)

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Coastal Climate Adaptation Strategies

Scenario	Storm	Water level	Speed (kph)		Wind (kph)		Pressure (mb)	
			Scenario	Storm	Scenario	Storm	Scenario	Storm
II	Bertha	1.48	40-49	35	57-78	130	1000-1009	973
III	Lili	1.63	50-59	70	79-100	75	990-999	995
IV	Subtrop 1989	-	60-69	81	101-122	110	980-989	984
V	Evelyn	2.05	70-79	59	123-144	130	970-979	996
VI	Michael	-	80-89	87	145-166	160	960-969	965

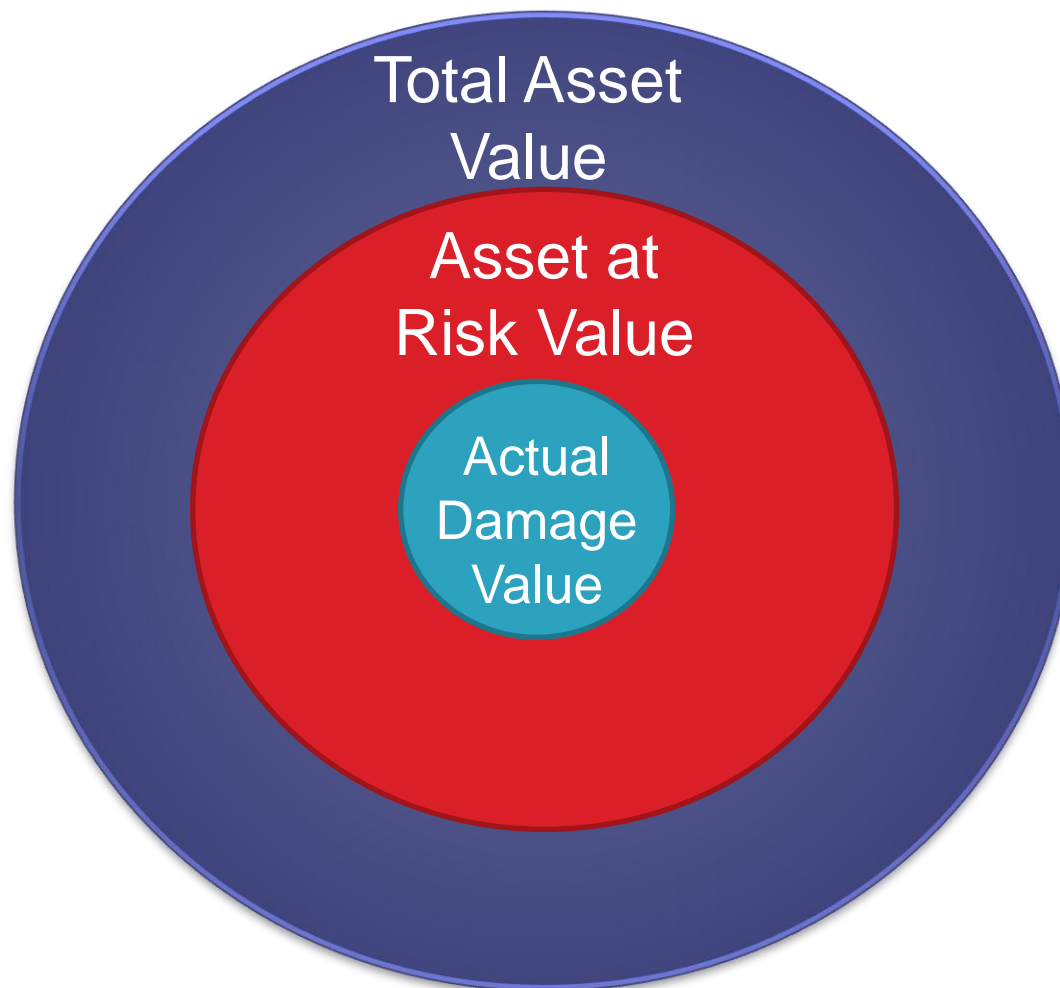
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Coastal Climate Adaptation Strategies



Storm Scenario Pillar	I	II	III	IV	V	VI
Environment	\$940,500	\$1,034,040	\$1,128,660	\$1,266,360	\$1,363,140	\$1,461,000
Economic	\$1,356,034	\$1,812,502	\$2,589,790	\$3,605,955	\$4,555,173	\$5,482,897
Social	\$165,104	\$198,296	\$231,488	\$267,481	\$302,872	\$336,064
Cultural	\$165,875	\$236,650	\$332,425	\$473,400	\$749,825	\$1,276,250
Total	\$2,627,513	\$3,281,488	\$4,282,363	\$5,613,196	\$6,971,010	\$8,556,211

Isle Madame Storm Damage Estimates

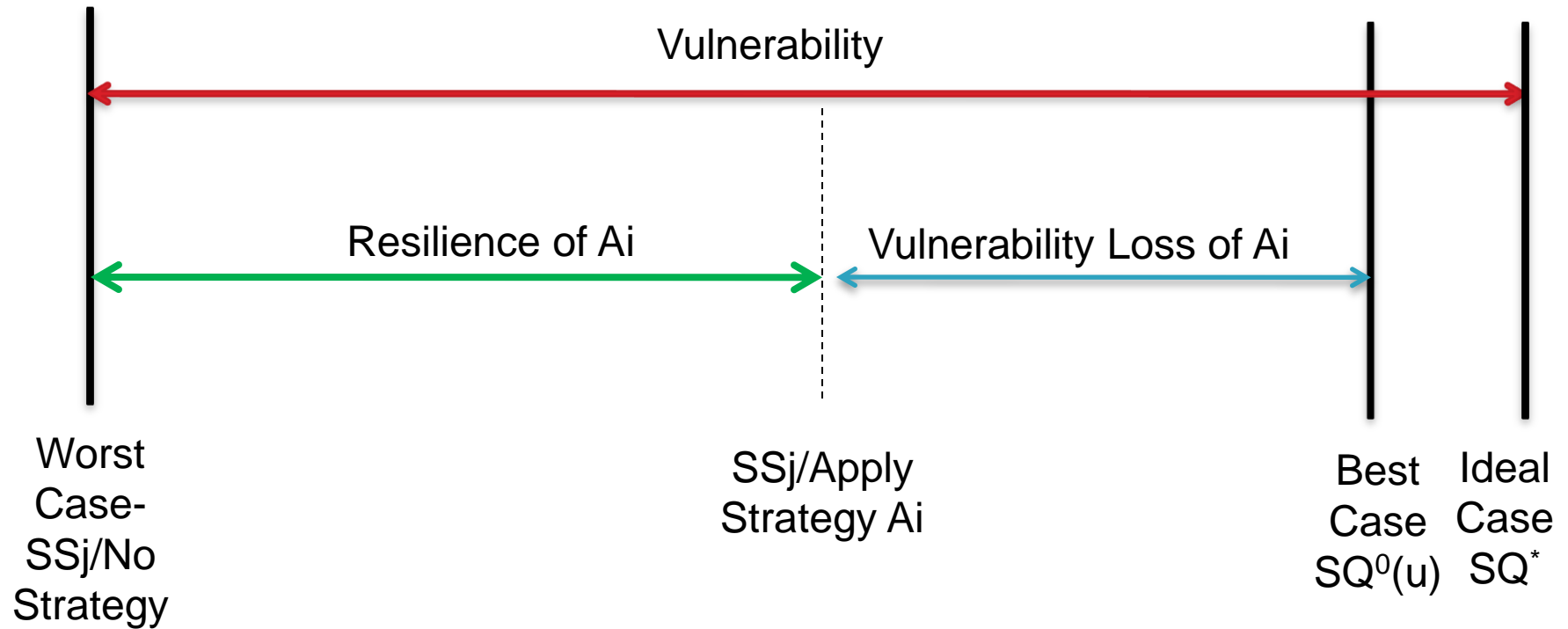
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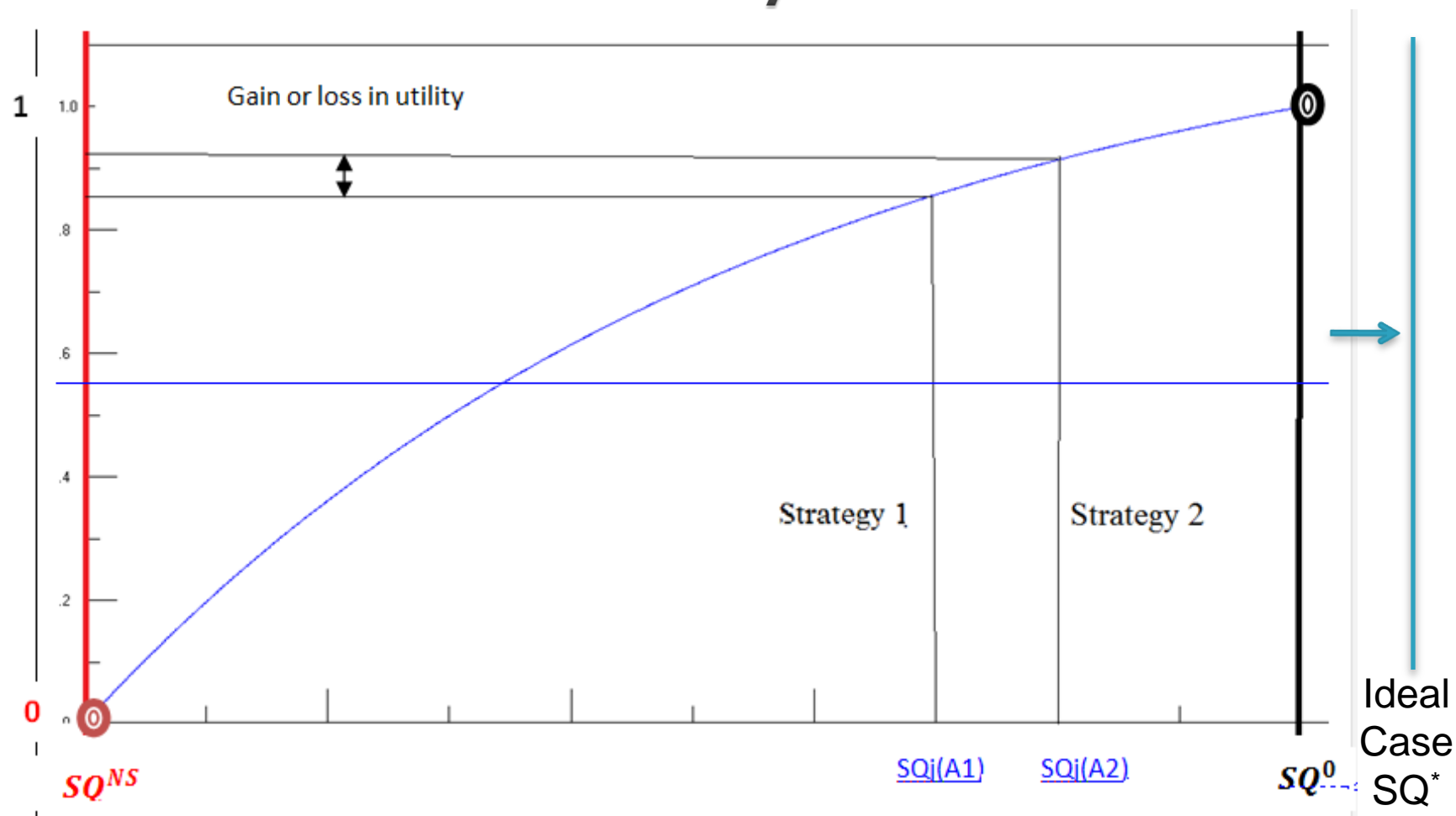


Vulnerability: $V^j(u) = SQ^j(u) - SQ^0(u)$

Resilience: $R^j(A_i, u) = SQ^j(u) - SQ^j(A_i, u)$



General utility function



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Case Study: Little Anse Breakwater



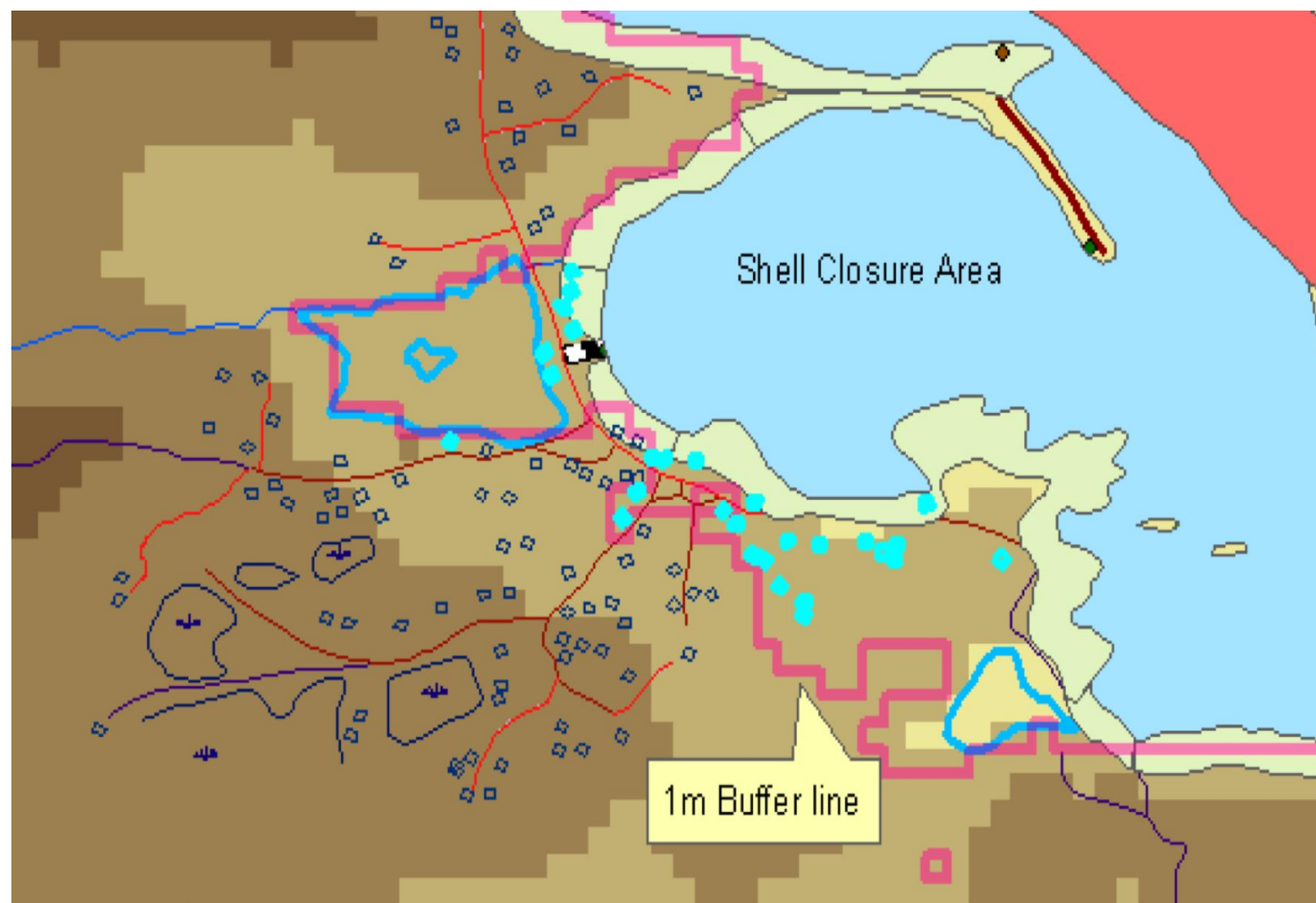
The Reporter (2010)





Little Anse Strategy Evaluation

- ▶ Define Community Profile and Status Quo assets
- ▶ Define Storm Scenario and estimate “at risk”, and damages
- ▶ Feedback from all participants – priorities for criteria
- ▶ Combine all participants
- ▶ Rank alternatives





Little Anse Hierarchy and water level scenarios

Goal: Adaptation of Little Anse community to storm surge events

▶ Economic

- Built Environment
 - Houses
 - Private buildings
- Public Works
 - Roads
 - Wharf
 - Wells
- Cost of adaptation

▶ Environmental

- Land Use
 - Residential land
 - Lake
 - Trees

▶ Cultural

- Community center
- Church grounds

▶ Social

- Labour earnings
- Safety (people over 60 years of age)
- Safety (people under 14 years of age)

Table 3.7. Water level for each scenario

Scenario	Water level
I	1- 1.25
II	1.26 – 1.5
III	1.51 – 1.75
IV	1.76 – 2.00
V	2.01 – 2.25
VI	More than 2.25



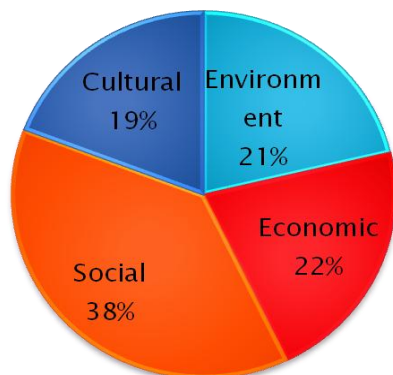
MCDM + Multiple Participants

1. **Community**: representatives of the community at large
2. **Local Government**: representatives of local (municipal) government
3. **Business/Industry**: community industries
4. **Professional**: professionals providing service to the community, e.g., lawyers, doctors, nurses, engineers, etc.

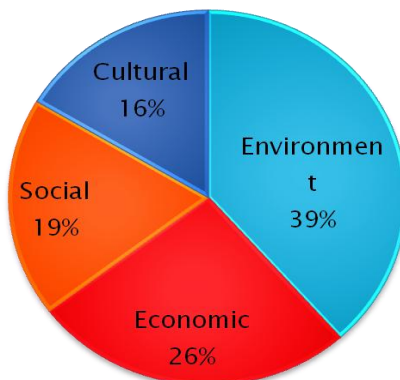


Participants

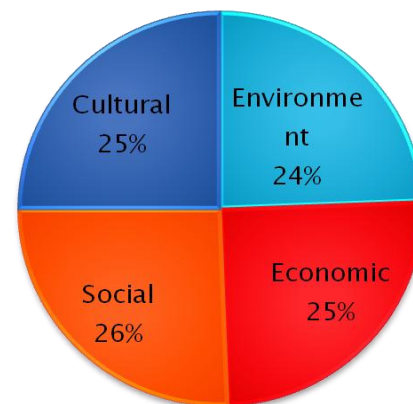
Local Government



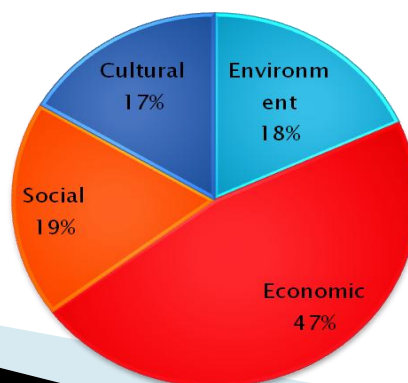
Professionals



Community



Business/Industry



Goal: Adaptation of Little Anse community to storm surge events

Economic (L: .285)

Built Environment (L: .278)

Houses (L: .668)

Buildings (L: .332)

Public Works (L: .484)

Roads (L: .451)

Wharfs (L: .245)

Wells (L: .303)

Adaptation cost (L: .238)

Environment (L: .224)

Land Use (L: 1.000)

Residential Land (L: .511)

Lake (L: .260)

Trees (L: .229)

Cultural (L: .197)

Community Center (L: .507)

Church grounds (L: .493)

Social (L: .294)

Income loss (L: .272)

Safety at risk (people over 60) (L: .412)

Safety at risk (people under 14) (L: .316)

Combined weights of AHP hierarchy



Adaptation Strategies

1. Protection

- Close the existing opening and create a new north facing opening(\$4.6M)
- Create a modified opening with a new breakwater arm extending from the south (\$5.05)
- Rehabilitation of the existing breakwater (\$1.7M)

2. Accommodation

- New road build up (\$1.74M)

3. Retreat

- Move people/houses (\$2.33M)

4. Status Quo – do nothing



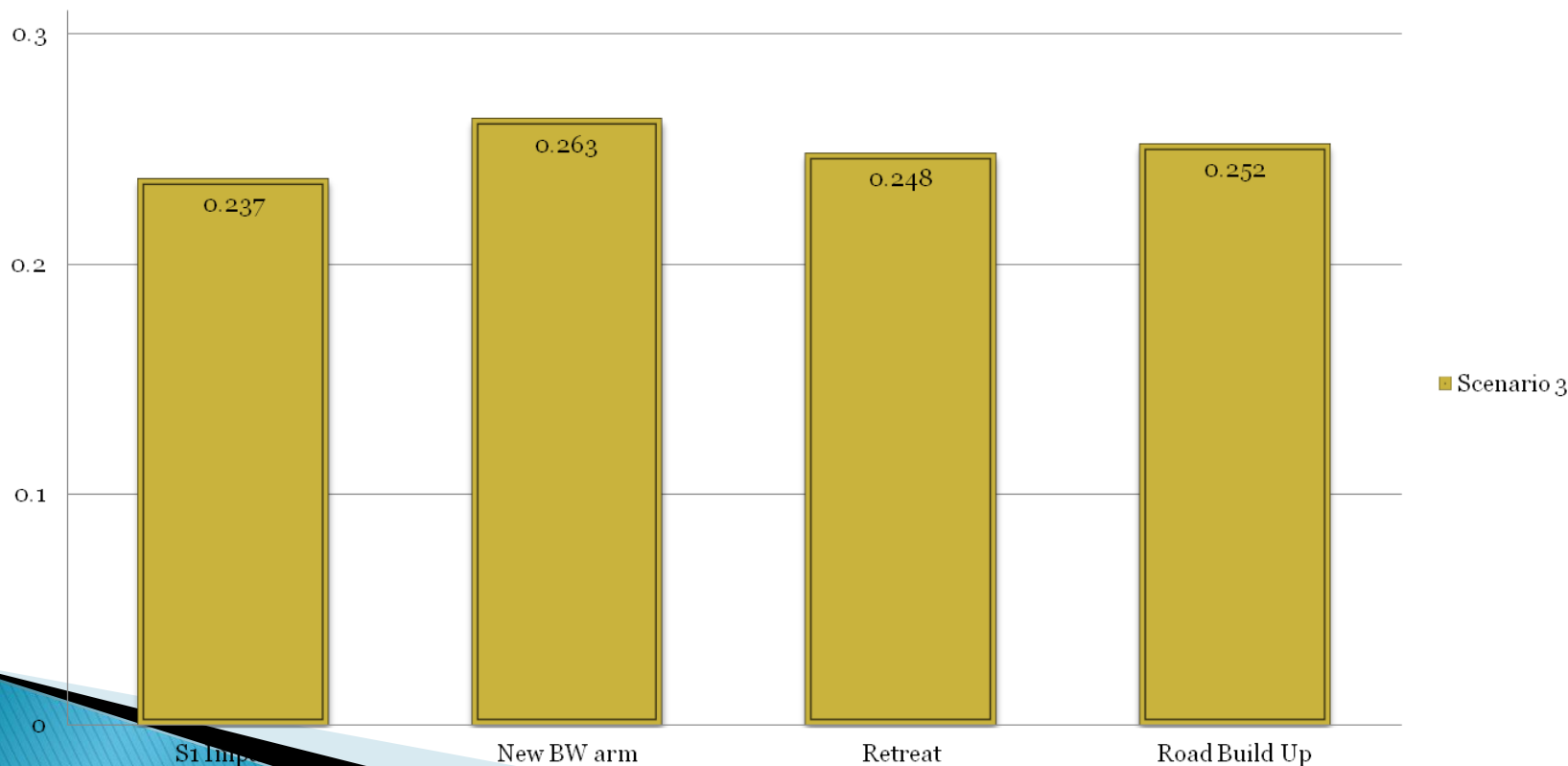
Breakwater strategies





Comparison of “Retreat”, “Road Build Up” and “New breakwater arm” strategies on Storm Scenario III impacts (Combined results)

Scenario 3



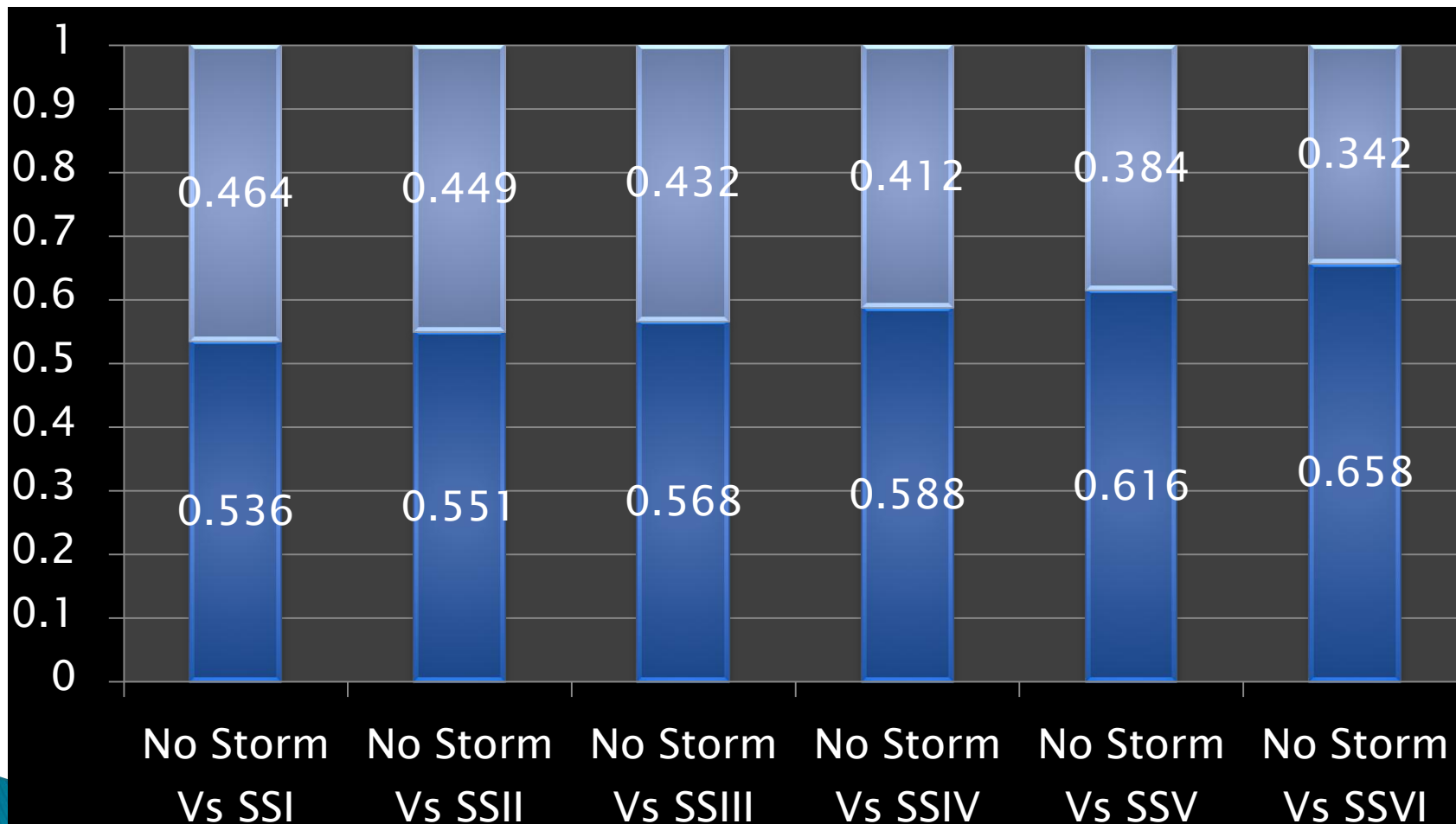
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Conclusion

- ▶ Multi criteria decision making does not push for a single strategy, it only shows the tradeoffs.
- ▶ The AHP framework for evaluating adaptation strategies is important for small communities decision support.
- ▶ Multi criteria decision making engages multiple participants and analysis of decision options.