* Coastal Climate Change & Adaptation

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Presentation to the 3rd China- ASEAN Academy on Oceans Law & Governance, NISCSS Haikou, Hainan

PART 2 - Morning, November 10, 2017

*Coastal Climate Change & Adaptation - Outline

PART I – Morning

1. Introduction
2. Challenges for the 21st Century – Coastal Zones
3. Understanding Adaptation Needs – Profiling
4. Pillars of Sustainability – Reflecting Importance**

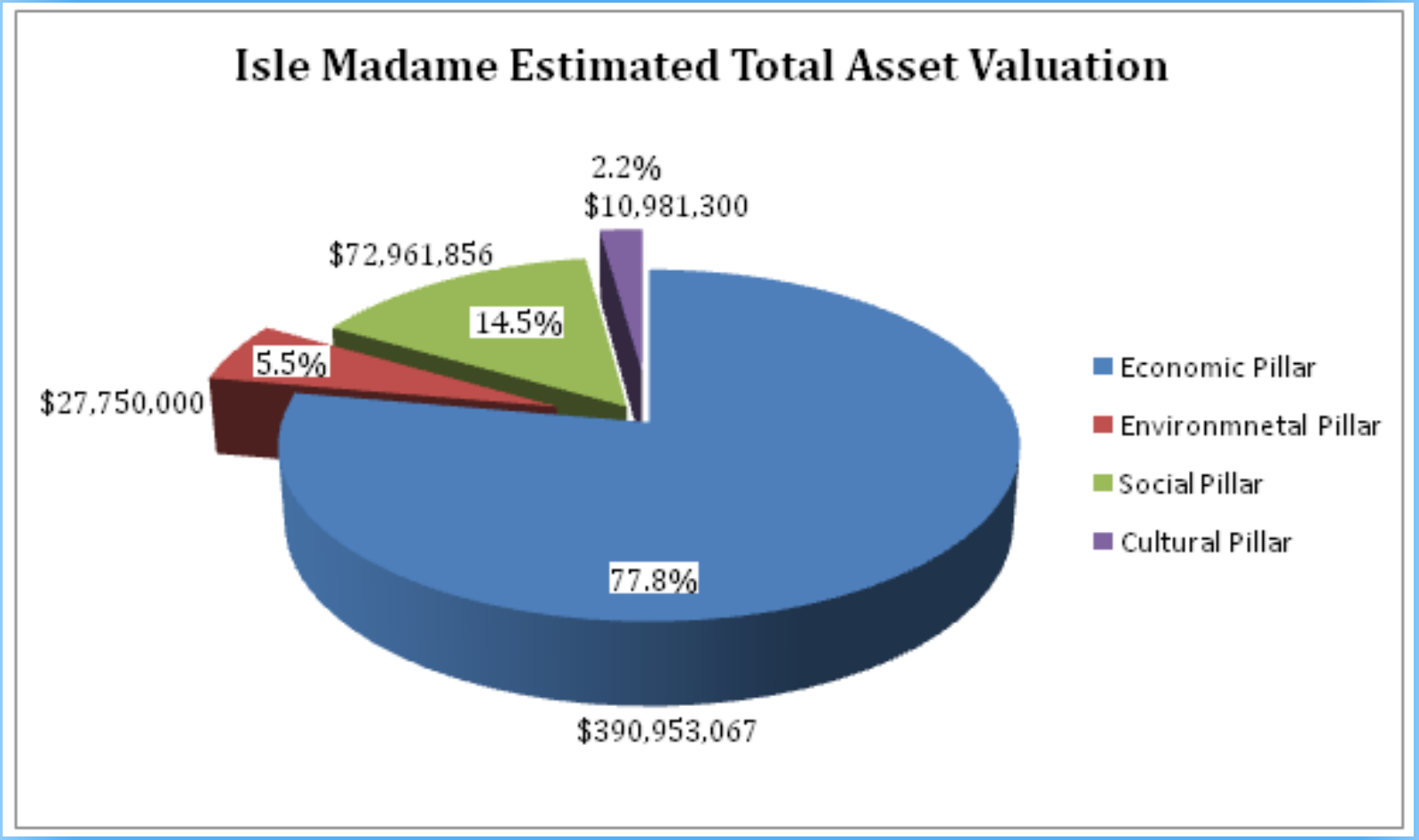
PART II

5. Assessing Vulnerabilities
6. Estimating Coastal Impacts
7. Adaptation Problem Solving and Strategy Options
8. Evaluating Decisions**
9. Climate Change Governance

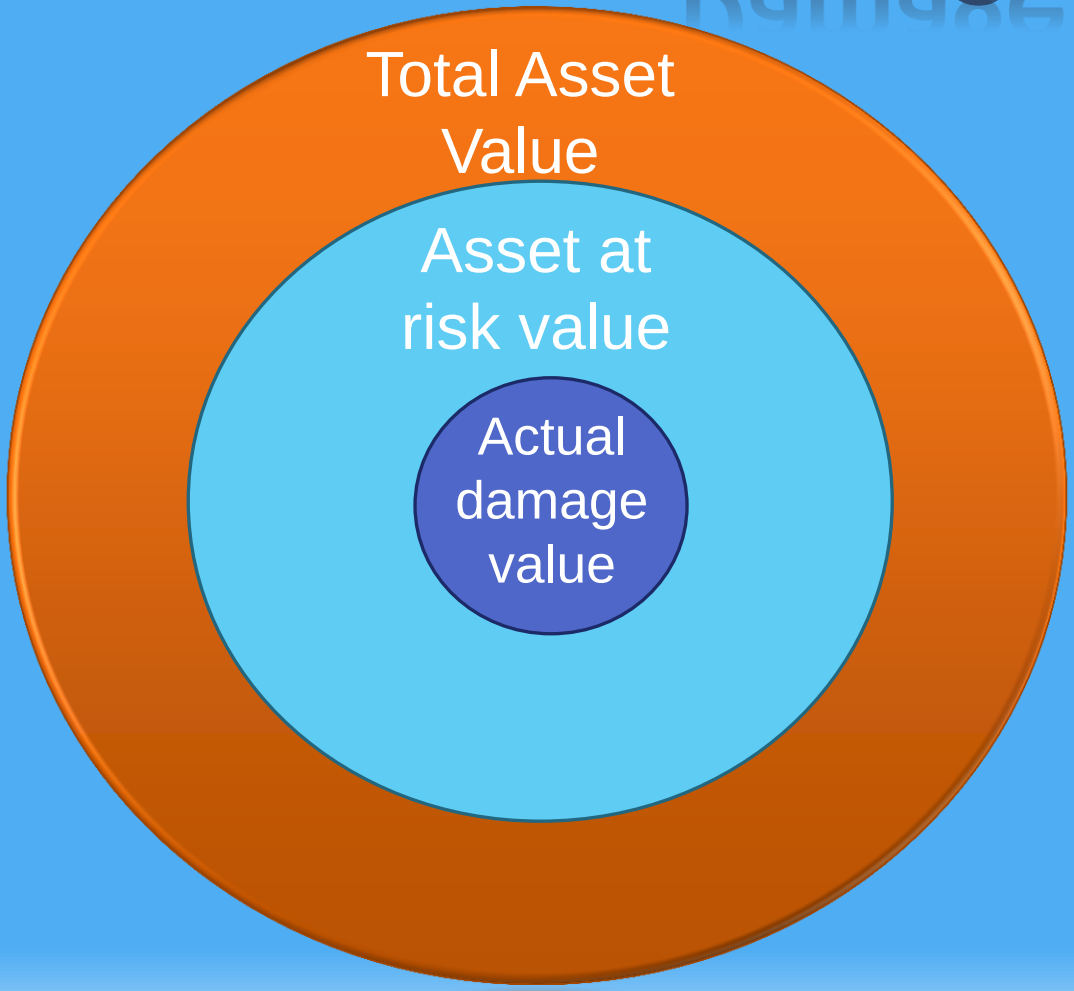
**Class Assignment

*5. Assessing Vulnerabilities

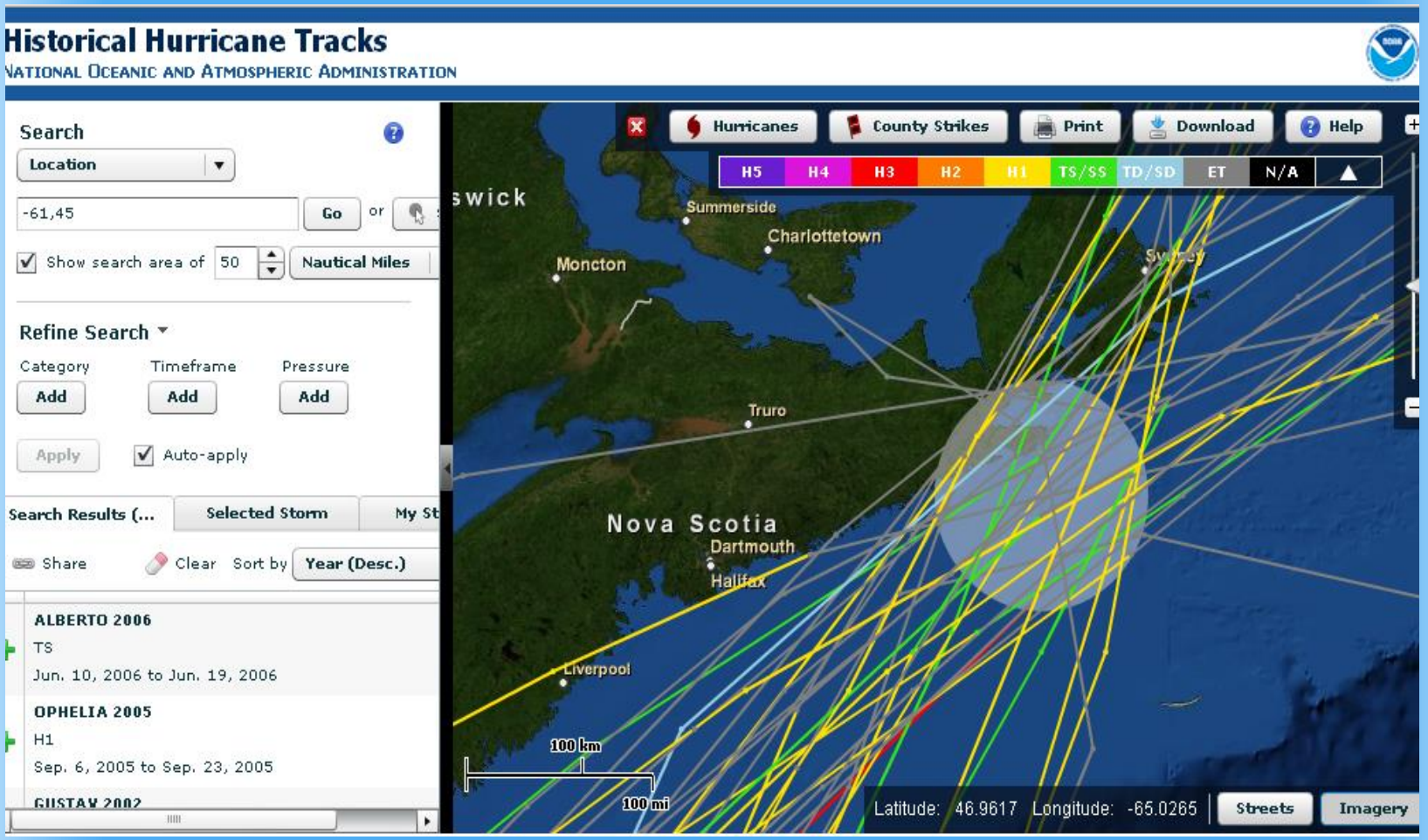
*Isle Madame Asset (Pakdel 2011)



*Asset - At-Risk Assessment-Damage Model



*Isle Madame Storms Review

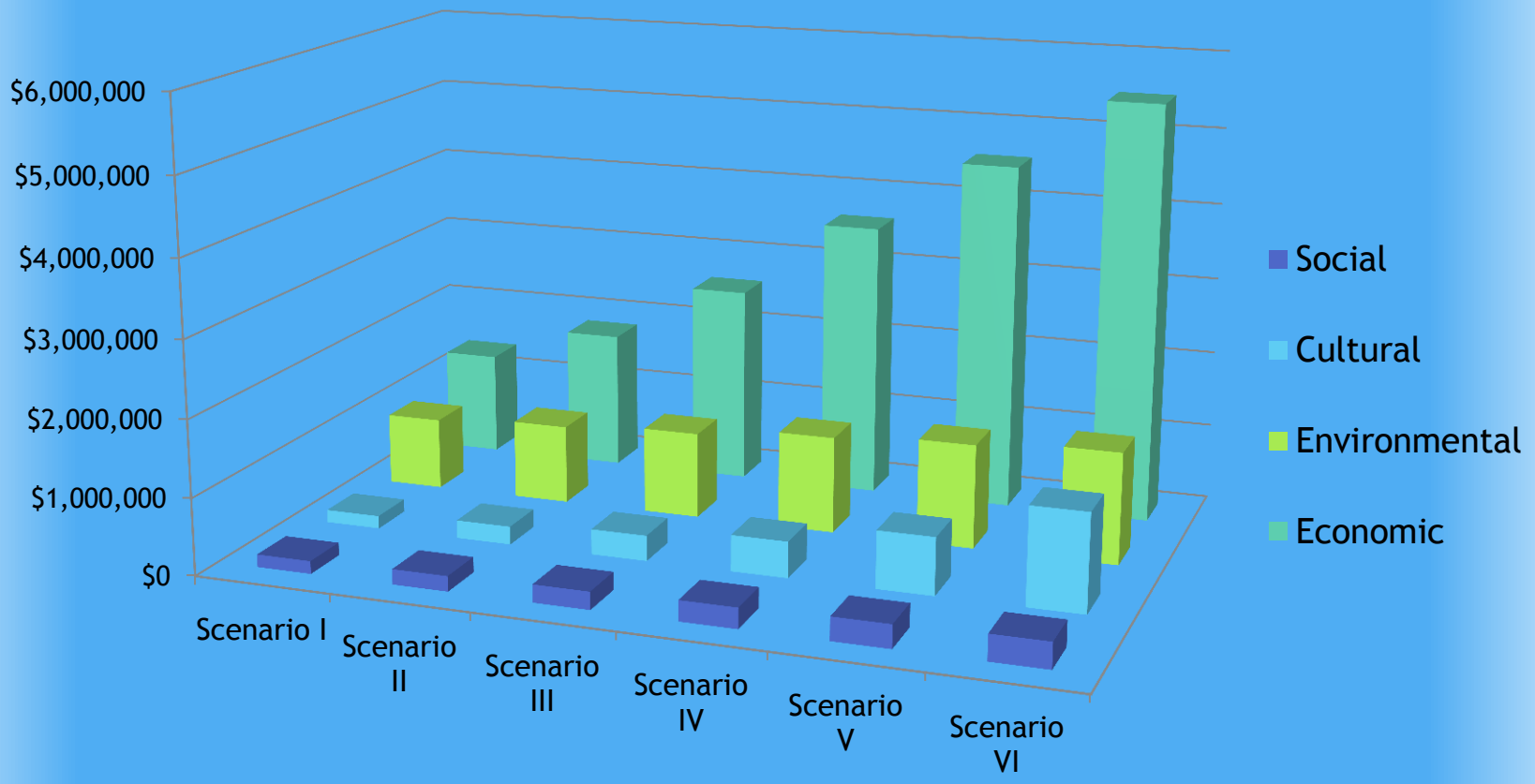


2. Assessing Vulnerability Premium Crab plant - Jan 2, 2010 "No Name" storm

Source:
www.coastalchange.ca
Gallery

*6. Estimating Coastal Impacts

Isle Madame
Total Estimated Damage Costs for Storm Scenarios I-VI

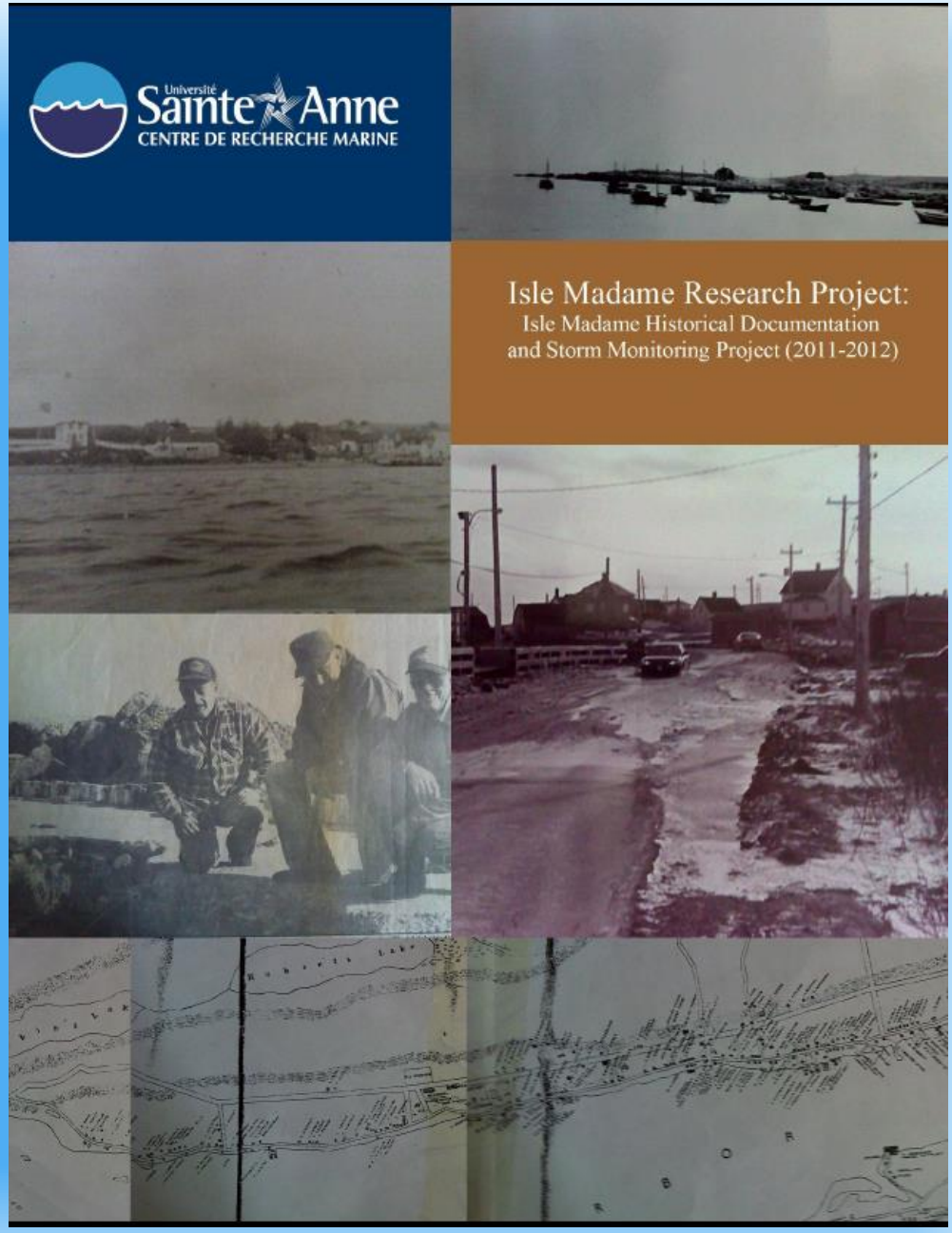


Université Sainte Anne

Isle Madame Vulnerability Report

Report Prepared by:

Aleasha (Boudreau) David,
Recherchiste,
Centre de recherche marine
and
Michelle Thériault,
Coordinatrice,
Centre de recherche marine



*Discuss

1) What are the impacts of Typhoon Sarika?

1) How can the costs of the impacts be determined?

1) How can the impacts of future typhoons be avoided or lessened?

*7. Adaptation Problem Solving and Strategy Options

* Objective: Adaptation Problem Solving

1. Profile the Community (Problem Definition & Data)
   * GIS, local issues, key participants, identify community preferences, pairwise comparison (tradeoffs) – AHP (*Lane et al 2015*)
2. Assess Vulnerability "hotspots" (Data Analysis)
   * Determine potential impacts based on historical events, develop adaptation alternatives and options, costs (*Camare & Lane 2015*)

Part I

Part II

3. **Simulate Strategic Systems (Modelling & Analysis)**
   * **System dynamics modelling, strategic planning period (*Lane et al 2017*)**
4. **Evaluate Strategy Alternatives**
   * **Apply indices for Vulnerability, Resilience, Adaptive Capacity (*Lane et al 2018*)**
5. Recommend, Implement & Monitor

* Adaptation Strategy Options (Pilkey & Young 2009)

(Photo: suburbanbloke/Flickr)

1. Protect

Hard armouring (sea walls, groins)

Soft armouring (mangroves, wetlands)

- No changes to buildings or use
- Costly - Requires expert design, needs periodic maintenance and upgrading

2. Accommodate

Continued use of lands / structures, with some changes

- Low costs / Low regrets
- No costs / No regrets (mangroves)

3. Retreat

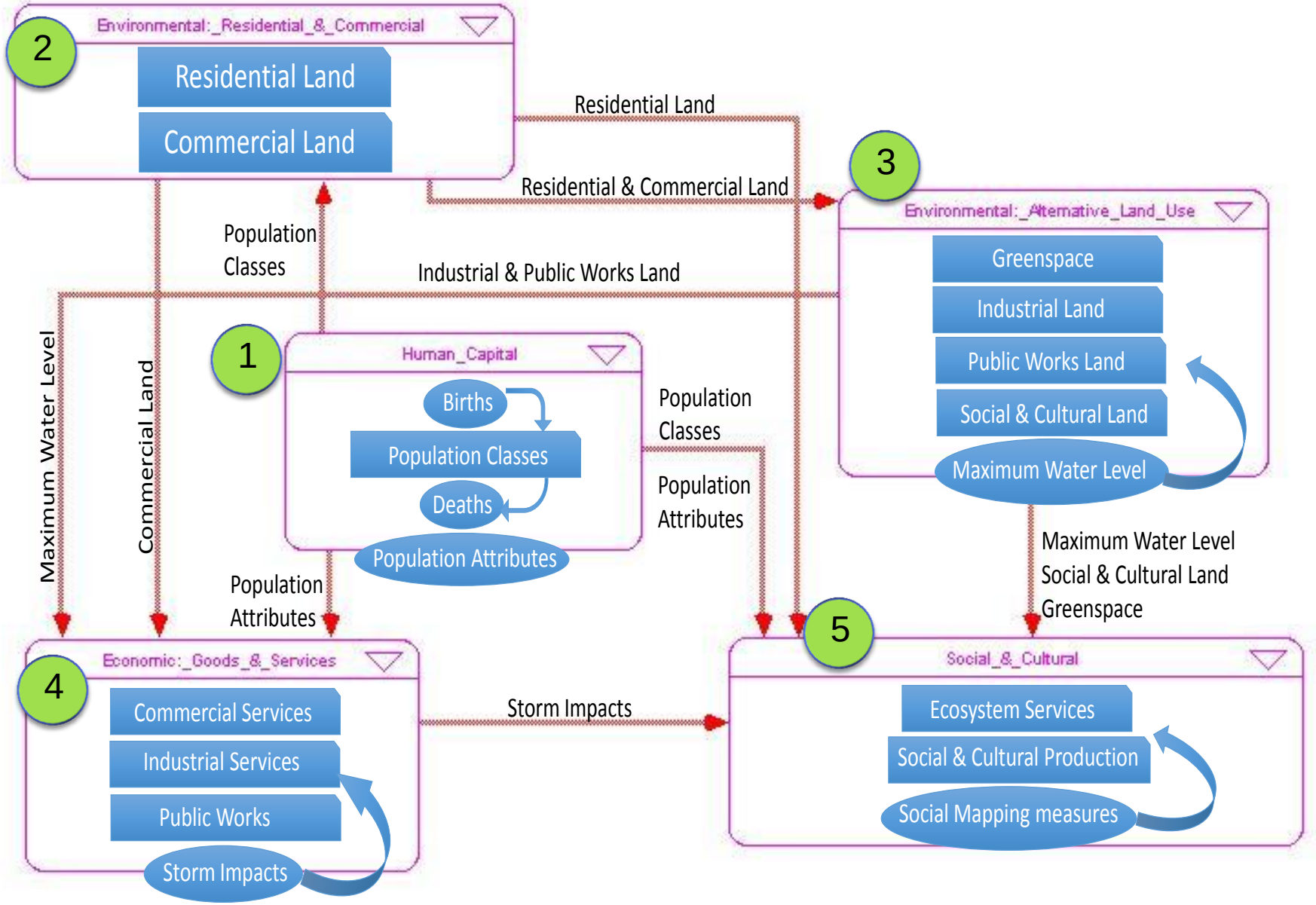
Accept flooding and damage will occur

- Protect/accommodate not feasible
- Change uses, move structures

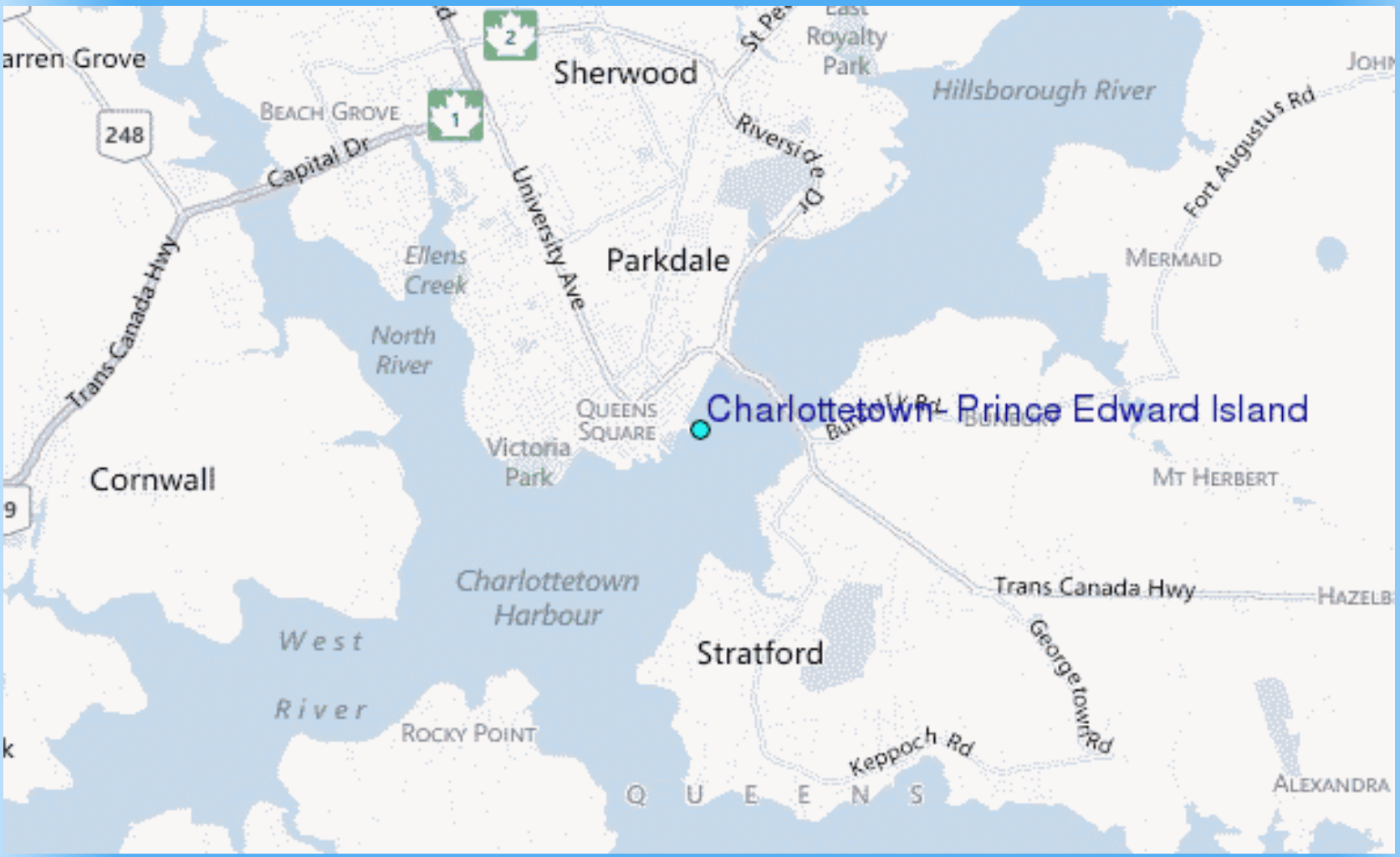
4. Do Nothing

Strategic Systems Simulation

- Development of specific adaptation strategies
  - Protect, Accommodate, Retreat, Status Quo (Do Nothing)
- Application of Static and/or System Dynamics model
- Pillars of Sustainability/Community Preference
  - Environmental, Economic, Social & Cultural
- Adaptation strategy evaluation indicators
  - Vulnerability, Resilience, Adaptive Capacity


2
Environmental:_Residential_&_Commercial
Residential Land
Commercial Land
Residential Land
Residential & Commercial Land
3
Environmental:_Alternative_Land_Use
Greenspace
Industrial Land
Public Works Land
Social & Cultural Land
Maximum Water Level
Population Classes
Industrial & Public Works Land
Maximum Water Level
Commercial Land
1
Human_Capital
Births
Population Classes
Deaths
Population Attributes
Population Classes
Population Attributes
Maximum Water Level
Social & Cultural Land
Greenspace
Population Attributes
5
Social_&_Cultural
Ecosystem Services
Social & Cultural Production
Social Mapping measures
4
Economic:_Goods_&_Services
Commercial Services
Industrial Services
Public Works
Storm Impacts
Storm Impacts

*City of Charlottetown



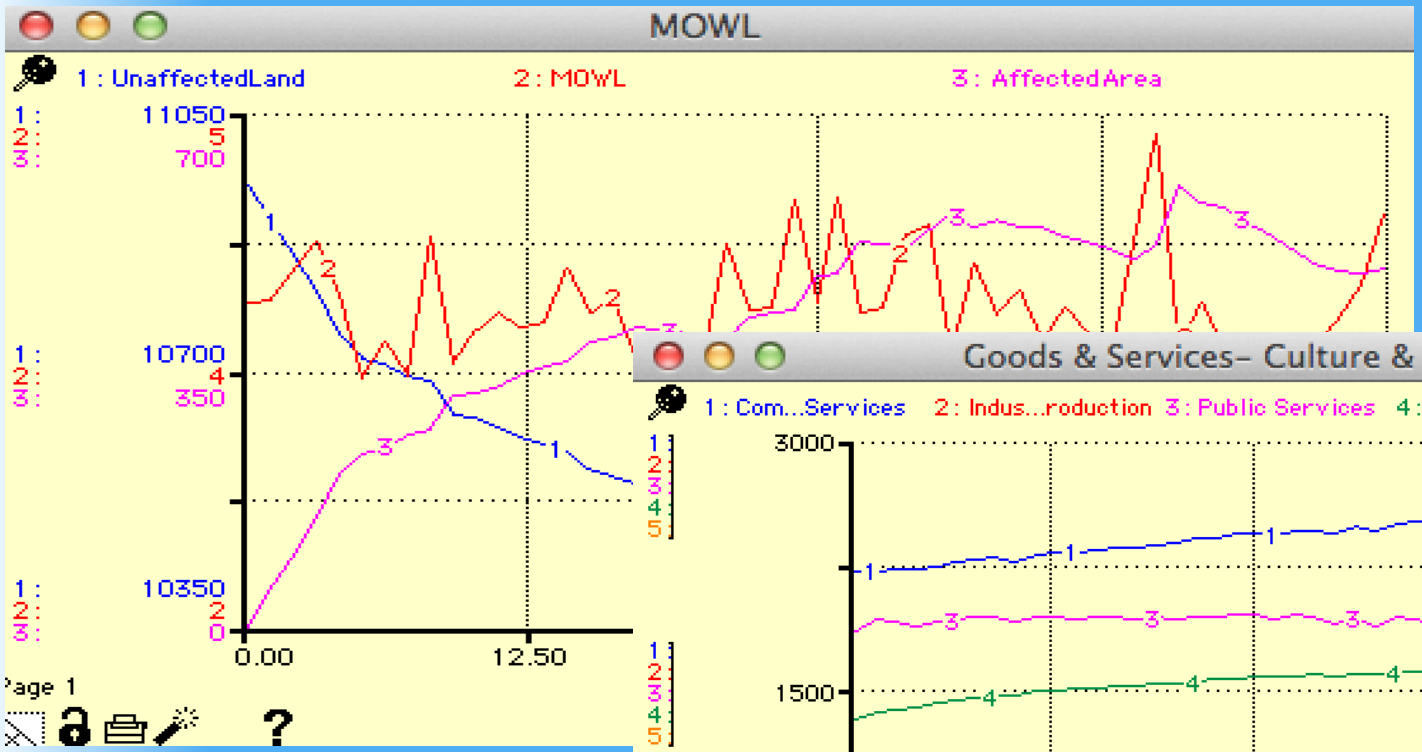
* Charlottetown Attributed Land Value Assets

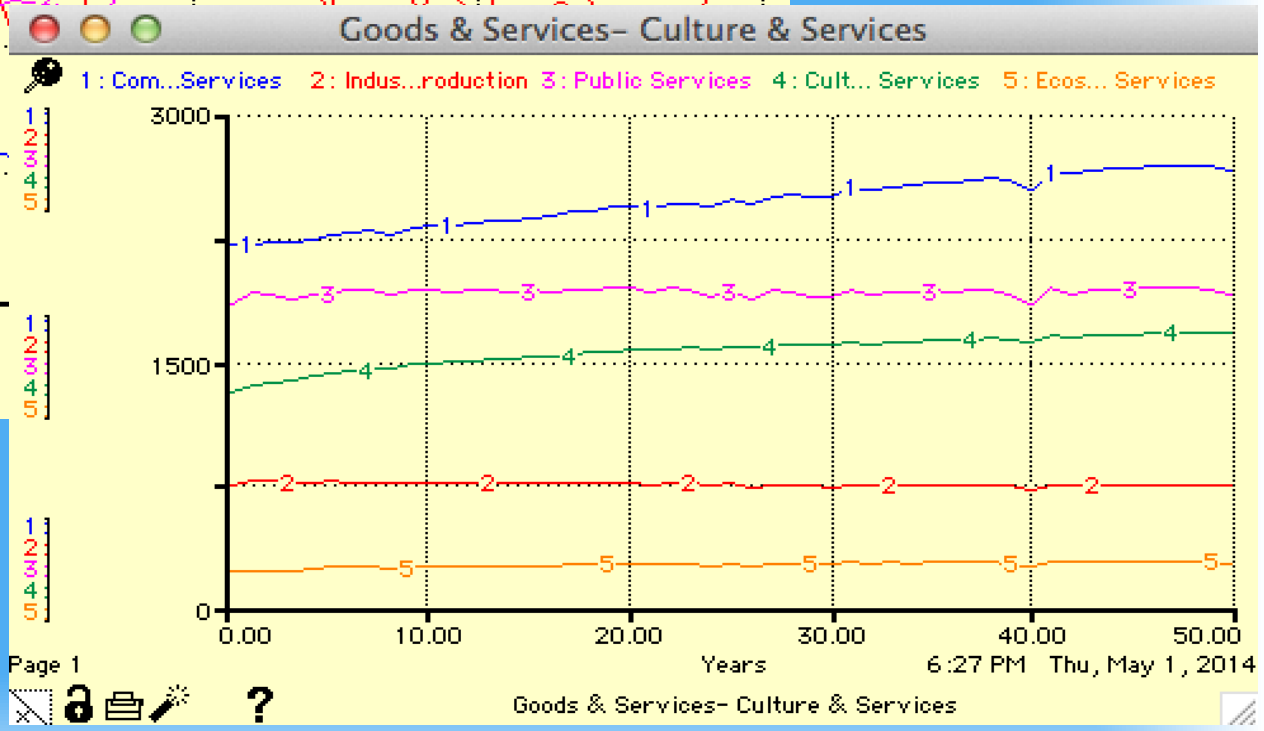
Land Use	Space (acres) (2012)	Land Value ($M/acre)	Description/Source
Residential	3,225	$2.855	Housing - average discounted selling value/acre for January 2016 Multiple Listing Service (MLS) Ottawa listings for detached bungalows prorated to 2012 Charlottetown average aggregate valuation; Royal LePage (2016)
Commercial	2,680	$3.484	Commercial property - average discounted selling value (to 2012) for January 2016 Multiple Listing Service (MLS) Ottawa listings for Business and Retail properties prorated to 2012 Charlottetown average aggregate valuation ; Royal LePage (2016)
Industrial	1,239	$4.149	Industrial property - average discounted selling value (to 2012) for January 2016 Multiple Listing Service (MLS) Ottawa listings for Industrial and Office properties prorated to 2012 Charlottetown average aggregate valuation ; Royal LePage (2016)
Green space	472	$1.500	Estimated value of city park lands, sport fields, trails, open recreation space (Charlottetown 2007)
Public works	2,011	$3.000	Estimated value of infrastructure for water, electrical power, and sewage/water treatment, roadways, bridges, maintenance (Charlottetown 2007, 2010)
Cultural & Social	1,326	$2.000	Estimated value of lands for schools, hospitals, community centres, libraries, arenas (Charlottetown 2007)

* Charlottetown Annual Storm Levels, MOWL

Storm Severity	Description	Application^	IPCC Analogy*
I. Low (Base Case)	Modal MOWLs signal storms that result in minimal damage to property and infrastructure. This is the assumed storm definition for the Base Case scenario	$\alpha = 2.0$ and $\beta = 0.303$ Max MOWL < 4.0m	RCP 2.6 – GHG emissions peak 2010-2020 then decline substantially
II. Historical	Modal MOWLs consistent with the historical data values for 1911-2005 and signal storms that result in occasional appreciable damage to property and infrastructure.	$\alpha = 3.0$ and $\beta = 0.303$ Max MOWL < 4.5m	RCP 4.5 – GHG emissions peak by 2040 then decline
III. Medium	Modal MOWLs signal storms consistent with the increasing historical trend since the beginning of the 21st century and result in considerable damage to property and infrastructure.	$\alpha = 3.5$ and $\beta = 0.303$ Max MOWL <5.0m	RCP 6.0 – GHG emissions peak by 2080 then decline
IV. High	Modal MOWLs signal storms predicted with high certainty into the 21st century and result in significant damage to property and infrastructure.	$\alpha = 4.0$ and $\beta = 0.303$ Max MOWL < 5.5m	RCP 8.5 – GHG emissions continue to rise throughout 21st century

*System Dynamics View – STELLA Results





*Charlottetown Profile SD Results

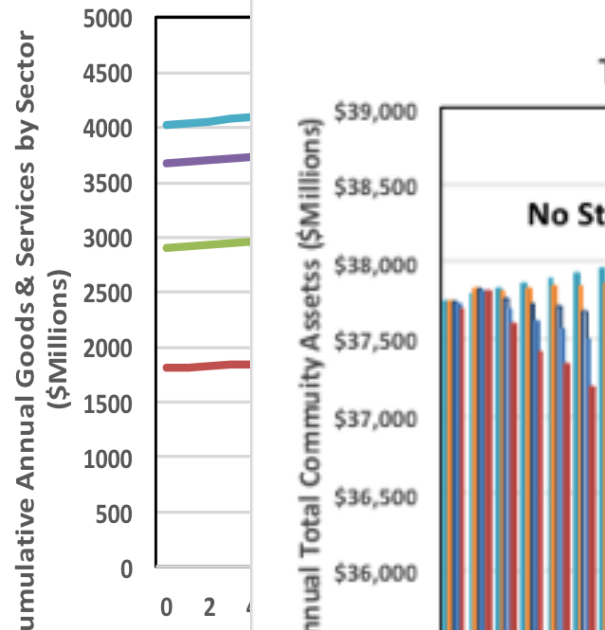
City of Charlottetown Annual Projected Land Value

on

City of Charlottetown Annual Projected Goods & Services

Zero

City of Charlottetown Annual Projected Cultural & Social Value



*Charlottetown Controls

Adaptation Strategy, A_i	Description	Application: City of Charlottetown, P.E.I.
1) Protect	Physical coastlines reinforcement; 'hard' engineering - seawalls, breakwaters, gabions and groins; 'soft' engineering - grading coastal cliffs, planting or maintaining existing vegetation (Ollerhead, 2006)	-Construct 3.75m sea walls -Labor skills adjustment (professional skills enhancement) -Public service increase in cost of $100m investment over 5 yrs
2) Accommo-date	Construction of structures to reduce storm damage (e.g., elevated houses), improve land-use, zoning plans to restrict permission of coastal constructions; legislation and increasing natural resilience by rehabilitating coastal dunes and wetlands (Pilkey and Young, 2009)	-Labor skills adjustment for structures -Attributed land as Public Works -Public service increase in cost of $50m investment over 5 yrs
3) Retreat	Abandon areas closest to the coastline, place temporary or dispensable structures only in these areas; avoid direct impact from storms; land swapping, or management strategies such as rezoning, insurance denial, or tax policies (Shaw et al., 2002; Natural Resources Canada, 2010)	Adjustment to work skills Attributed increase in land to Greenspace Public service increase in cost $75m investment over 5 years
4) Status Quo (Do Nothing)	Toleration of all storm damages without attempting to mitigate storm impacts; arguably most commonly adopted strategy (McCulloch et al., 2002)	No adaptation strategy (Do nothing/Status Quo)

*Charlottetown Simulation Scenarios

No.	Scenario Name	Controllable Variables - Adaptation Strategies for Charlottetown	Uncontrollable Variables - IPCC Analogy/Storm Severity for Charlottetown
R0	Base Case/ Benchmark	No adaptation strategy (Do nothing/Status Quo)	Low severity storms, IPCC, RCP 2.6: 2.0 and
R1	Worst Case	No adaptation strategy (Do nothing/Status Quo)	High severity storms, IPCC, RCP 8.5: 4.0 and
R2	Protect–Worst Case Storms	Protect with 3.75m seawalls Labor skills adjustment for sea walls construction (professional) $100m investment in 5yrs	High severity storms, IPCC, RCP 8.5: 4.0 and Strategy modification: IF MOWL<3.75m then 'No Impacts' ELSE 'Impacts'
R3	Accommodate – Worst Case Storms	Labor skills adjustment Attributed land as Public Works Public service increase cost $50m investment in 5 years	High severity storms, IPCC, RCP 8.5: 4.0 and Strategy modification: New MOWL = .75 Original MOWL
R4	Retreat – Worst Case Storms	Adjustment to work skills Public service increase cost Increase in Greenspace $75m investment in 5 years	High severity storms, IPCC, RCP 8.5: 4.0 and
R5	Accommodate – Historical Storms	Labor skills adjustment Attributed land as Public Works Public service increase	Historical severity storms, IPCC, RCP 4.5: 3.0 and Strategy modification: New MOWL = .75 Original MOWL

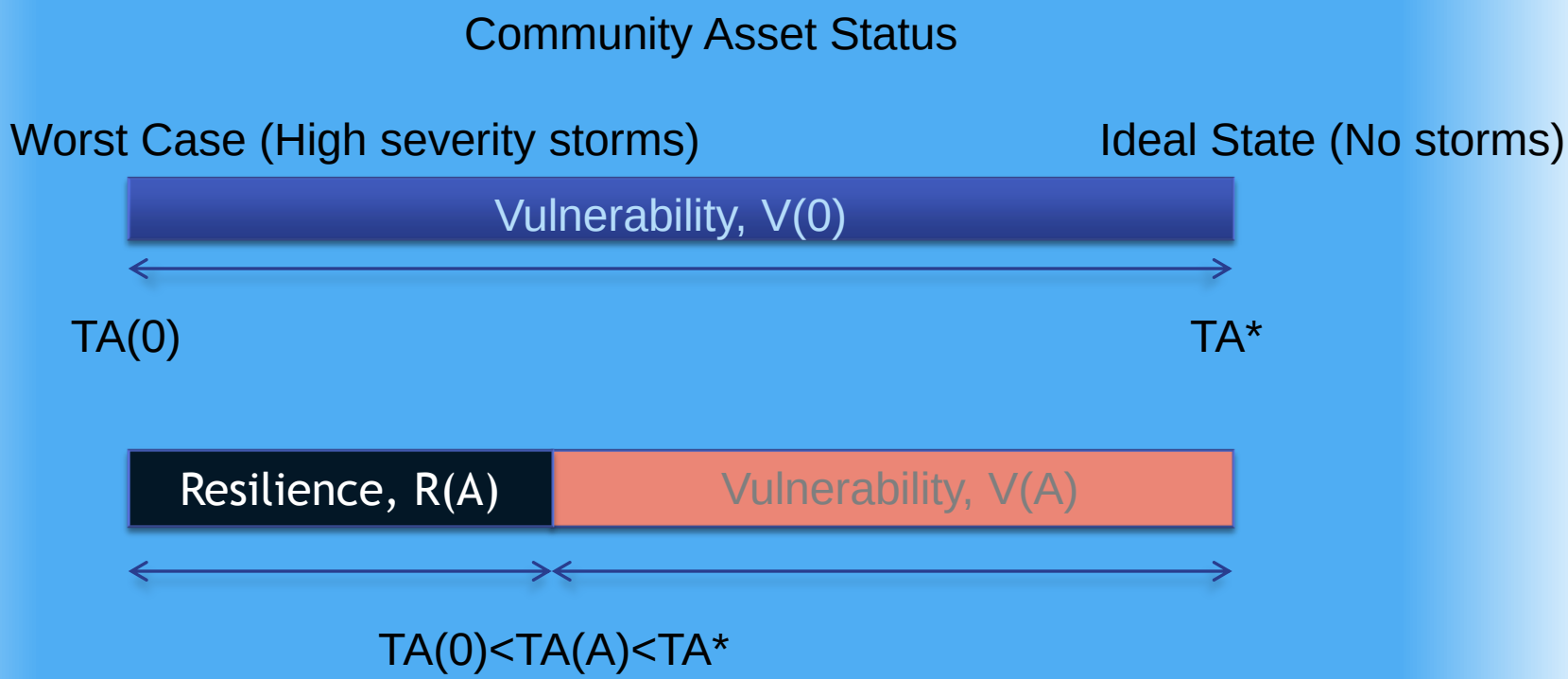
*8. Evaluating Decisions

Evaluation of Strategy Alternatives

* Methods:
  * Static analysis – AHP application, multiple participants (SEPS paper – *Camare & Lane 2015*)
  * Dynamic analysis – SD model over strategic planning period (50 years) – *Lane et al 2017, 2018*

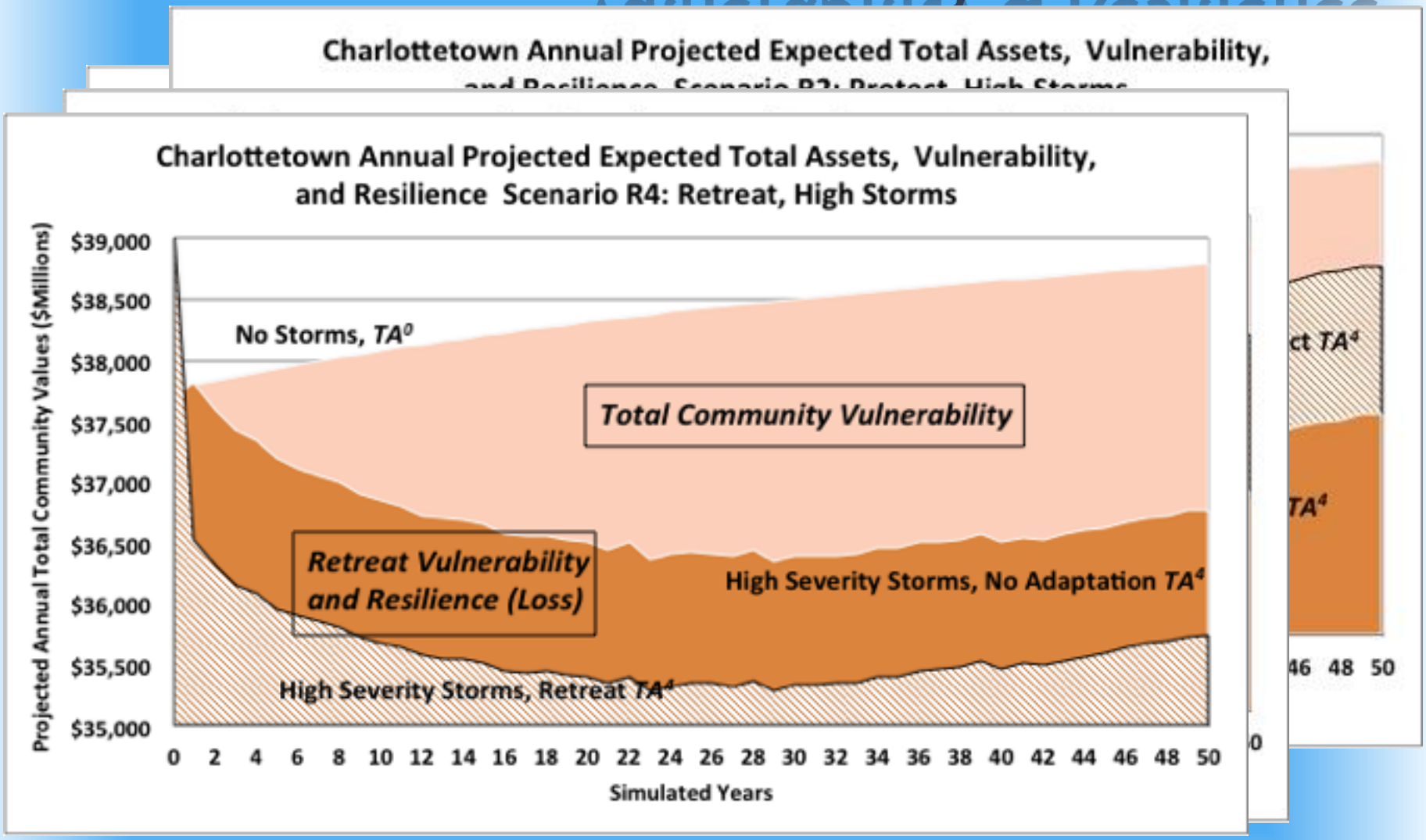
* Indicators:
  * Vulnerability – expected storm damage estimates by sustainability pillar
  * Resilience – function of adaptation strategy as reduction of 'no action' vulnerability
  * Adaptive Capacity – resilience (reduced vulnerability) as a proportion of total vulnerability

*Vulnerability Gap with Strategy
Lane et al 2018

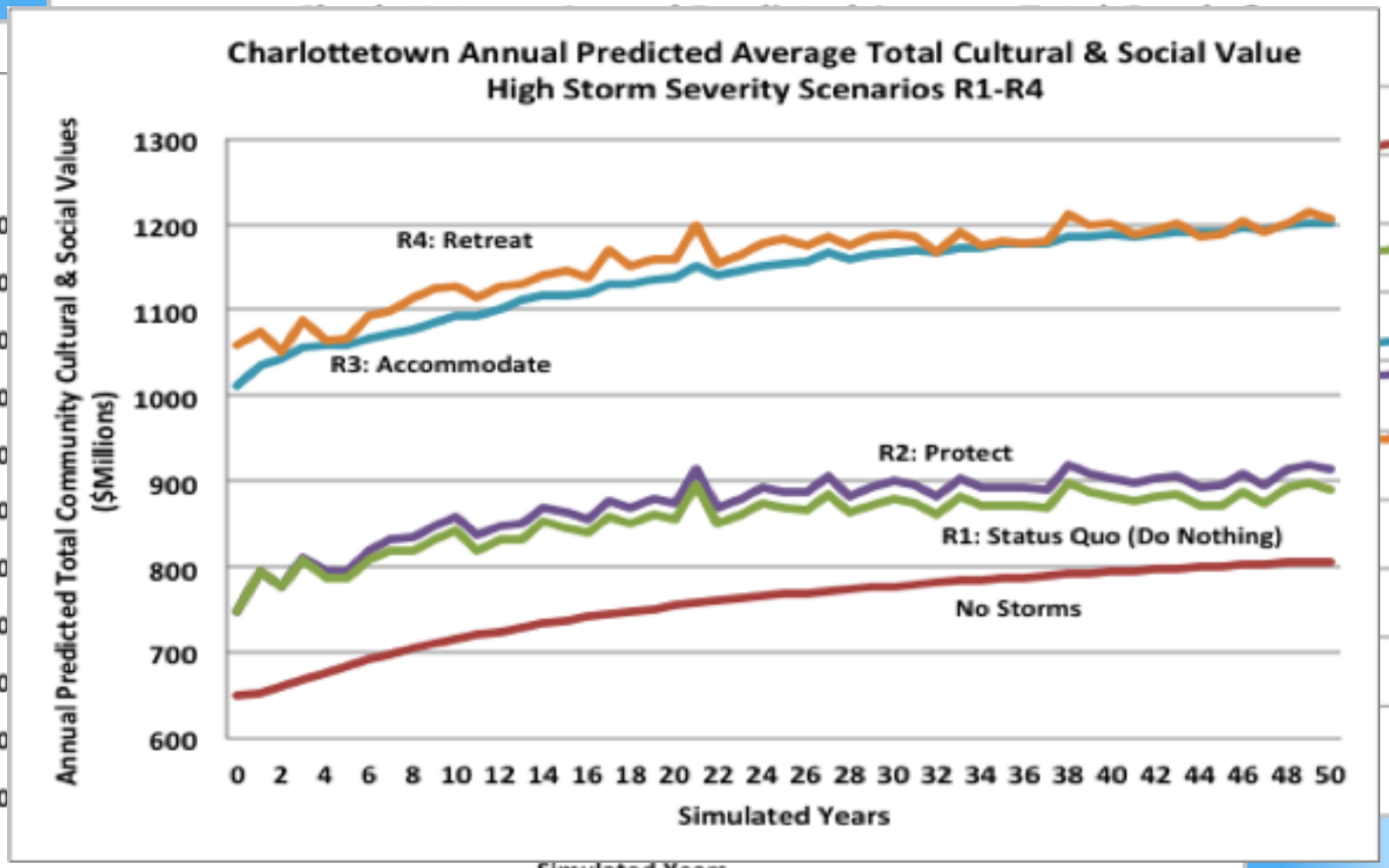


Adaptive Capacity: AC(A) = RA(A)/V(0)

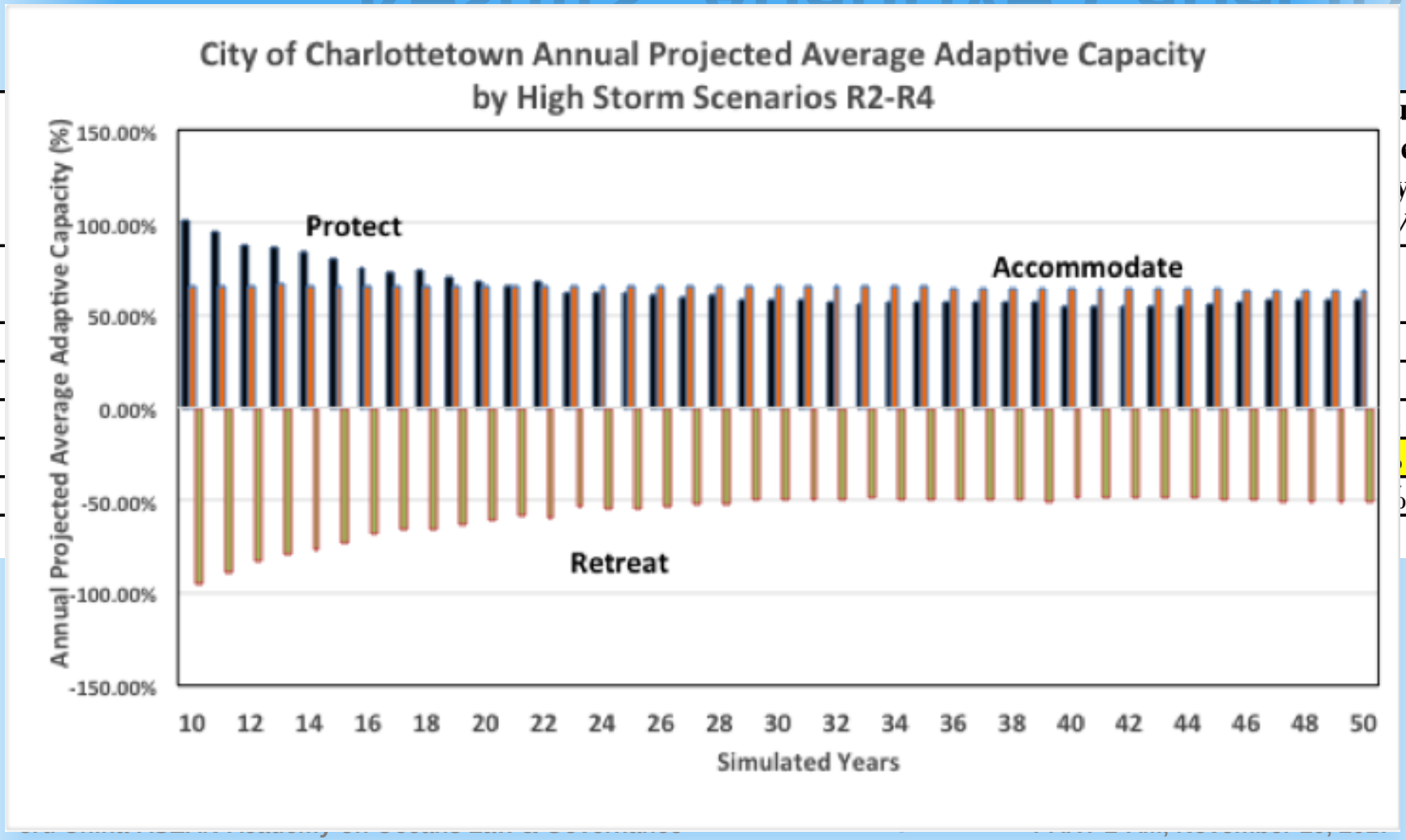
* Charlottetown Storm Simulation Results: Vulnerability & Resilience



* Charlottetown Storm Simulation Results



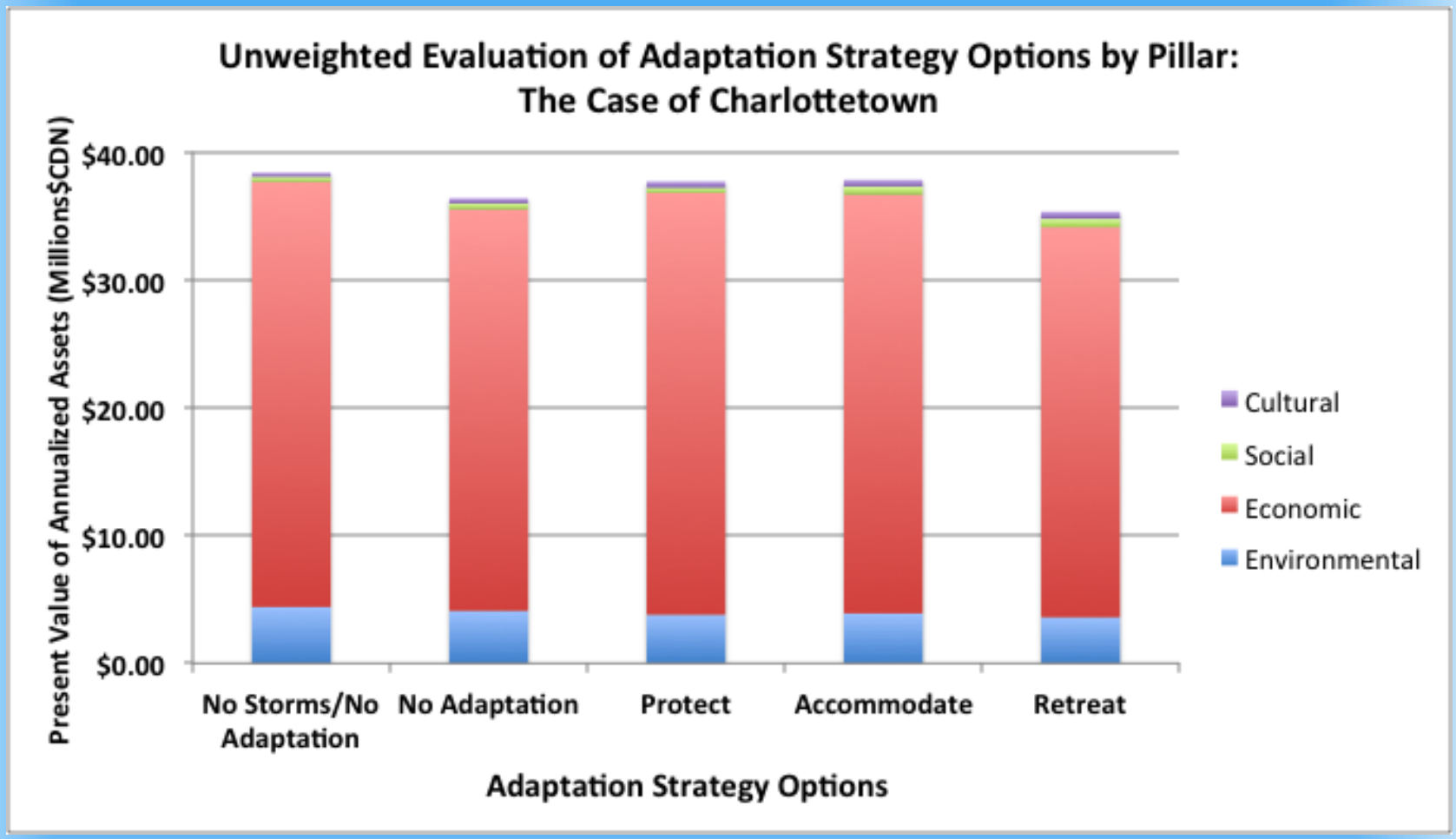
*Charlottetown Storm Simulation Results: Adaptive Capacity



Evaluating Weighted Assets by Profile Priorities

- Different communities/nations have different priorities re the Pillars of Sustainability
- Requires weighting the asset results corresponding to each adaptation scenario
- Consider analysis of the Charlottetown problem weighted by the participants of the China-ASEAN Academy
- Note similarities and differences among weights and preferred adaptation strategy options

* No Weights- Annualized Strategy Evaluation



*Participants' Exercise - Decision Evaluation

* Annualized Strategy Evaluation - table form with weights

National Group	Sustainability Pillar Normalized Weights: Environmental	Economic	Social	Cultural	Total	Sustainability Pillar Idealized Weights: Environmental	Economic	Social	Cultural
China-ASEAN	0.28378	0.29357	0.22073	0.20191	1.0	0.96665	1.00000	0.75188	0.68777
Indonesia	0.33694	0.24815	0.18384	0.23107	1.0	1.00000	0.73647	0.54560	0.68580
Malaysia	0.33502	0.30030	0.20727	0.15740	1.0	1.00000	0.89637	0.61869	0.46983
Singapore	0.27872	0.37927	0.20733	0.13468	1.0	0.73489	1.00000	0.54665	0.35509
The Philippines	0.29468	0.29088	0.19630	0.21814	1.0	1.00000	0.98711	0.66615	0.74027
Cambodia	0.27624	0.32720	0.19416	0.20240	1.0	0.84425	1.00000	0.59339	0.61857
Laos	0.21579	0.46498	0.21032	0.10890	1.0	0.46409	1.00000	0.45231	0.23421
Myanmar	0.23058	0.36069	0.20292	0.20581	1.0	0.63928	1.00000	0.56261	0.57060
Thailand	0.30455	0.39251	0.17029	0.13265	1.0	0.77592	1.00000	0.43385	0.33795
Vietnam	0.27112	0.30286	0.22902	0.19700	1.0	0.89522	1.00000	0.75620	0.65048
China	0.28349	0.24957	0.23532	0.23162	1.0	1.00000	0.88034	0.83009	0.81702

Charlottetown Flood Adaptation Strategy Asset Valuations — **Present Value of Annualized Assets (50 yr simulation, $CDN)**

	Adaptation Strategies	Sustainability Pillar Asset Valuation: Environmental	Economic	Social	Cultural	Total (Unweighted) Assets (Millions$CDN2010)
0	No Storms/No Adaptation	$4.40	$33.25	$0.40	$0.33	**$38.38**
1	No Adaptation	$4.10	$31.40	$0.47	$0.41	**$36.38**
2	Protect	$3.80	$33.00	$0.40	$0.50	**$37.70**
3	Accommodate	$3.90	$32.75	$0.65	$0.52	**$37.82**
4	Retreat	$3.60	$30.50	$0.67	$0.55	**$35.32**

* Decision form - to be completed by selected nation

(0) No Storms/No Adaptation

Weighted Results National Group	Sustainability Pillar Weighted Asset Valuation Environmental	Economic	Social	Cultural	Total (Weighted) Assets (Millions$CDN2010)
China-ASEAN	$4.25	$33.25	$0.30	$0.23	$38.03
<Your nation here>					

(1) No Adaptation

Weighted Results National Group	Sustainability Pillar Weighted Asset Valuation Environmental	Economic	Social	Cultural	Total (Weighted) Assets (Millions$CDN2010)
China-ASEAN	$3.96	$31.40	$0.35	$0.28	$36.00
<Your nation here>					

(2) Protect

Weighted Results National Group	Sustainability Pillar Weighted Asset Valuation Environmental	Economic	Social	Cultural	Total (Weighted) Assets (Millions$CDN2010)
China-ASEAN	$3.67	$33.00	$0.30	$0.34	$37.32
<Your nation here>					

(3) Accommodate

Weighted Results National Group	Sustainability Pillar Weighted Asset Valuation Environmental	Economic	Social	Cultural	Total (Weighted) Assets (Millions$CDN2010)
China-ASEAN	$3.77	$32.75	$0.49	$0.36	$37.37
<Your nation here>					

(4) Retreat

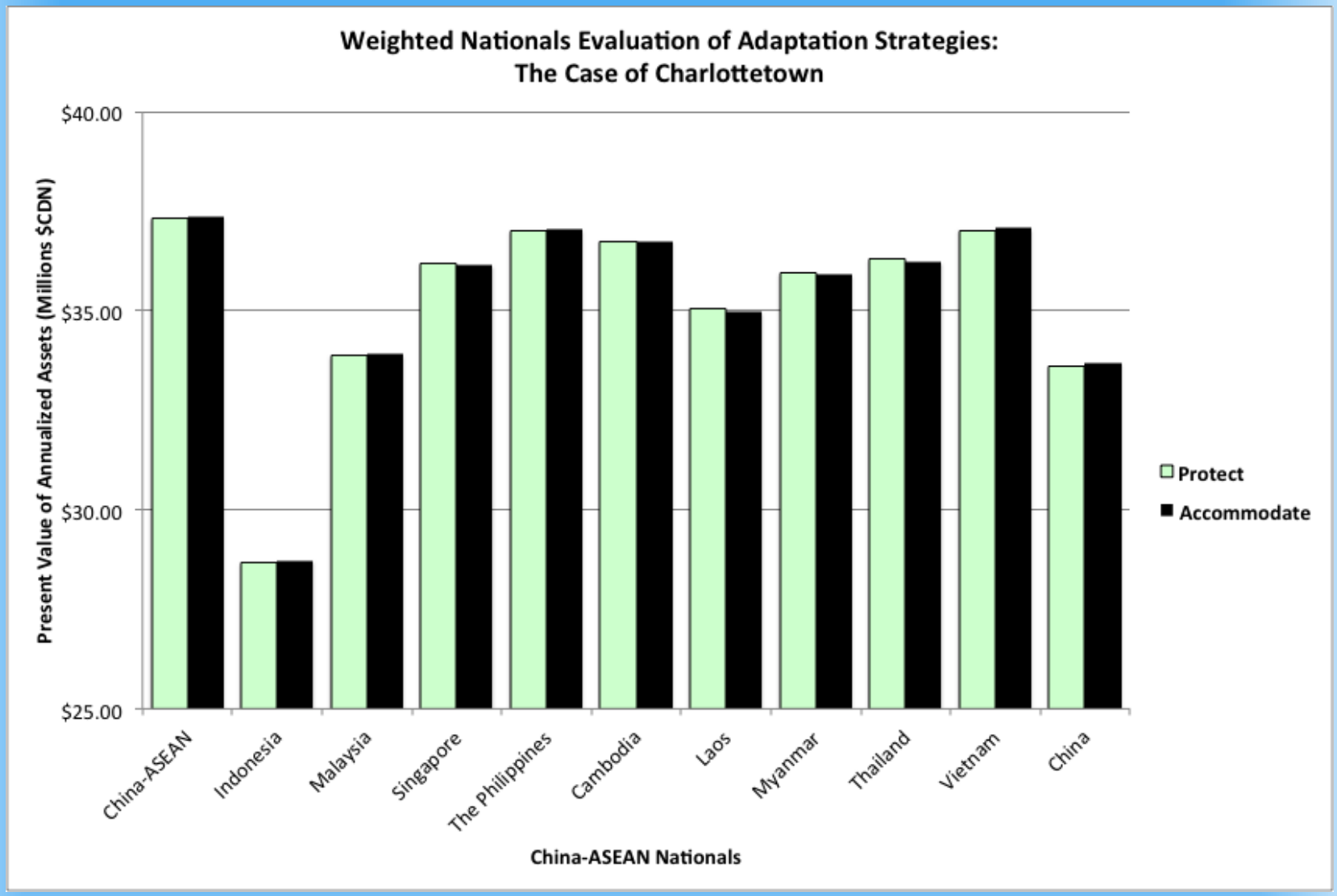
Weighted Results National Group	Sustainability Pillar Weighted Asset Valuation Environmental	Economic	Social	Cultural	Total (Weighted) Assets (Millions$CDN2010)
China-ASEAN	$3.48	$30.50	$0.50	$0.38	$34.86
<Your nation here>					

Nationals' Decision Evaluation

Total (Weighted) Annualized Assets (Millions$CDN2010)

Weighted Results National Group	No Storms/ No Adaptation	No Adaptation	Protect	Accommodate	Retreat	Preferred Assets Value	Preferred Decision
China-ASEAN	$38.03	$36.00	$37.32	$37.37	$34.86	$37.37	Accommodate

* Weighted Nationals Evaluation

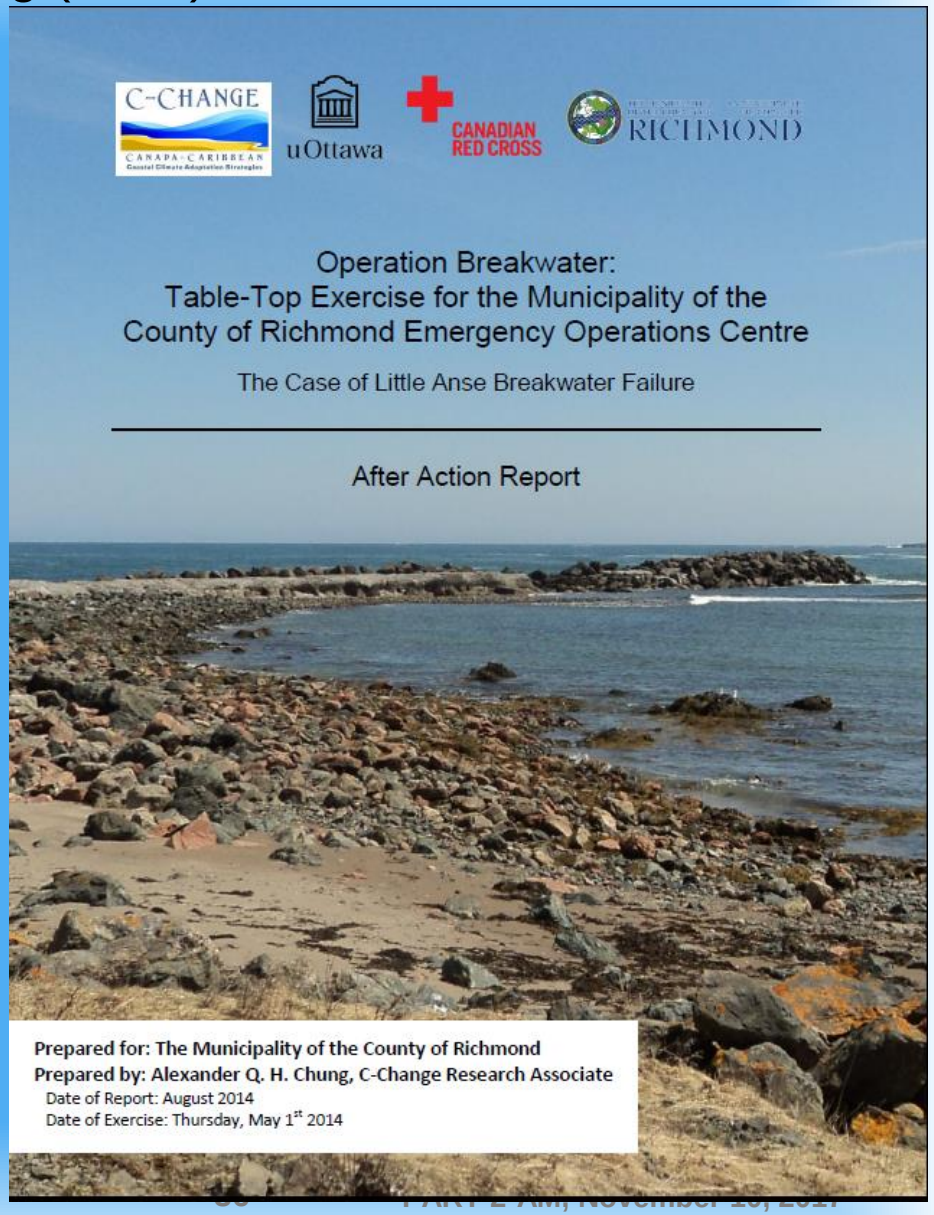


C-Change Little Anse Breakwater Workshop, May 1, 2014
Chung (2014)

Operation Breakwater:
Tabletop Exercise for the Municipality of the County of Richmond Emergency Operations Centre

The Case of Little Anse Breakwater Failure

Alexander Q.H. Chung
Telfer School of Management
University of Ottawa



Community Prepared-ness Index

Chung, Mercer Clarke and Lane (in progress)

Dimension	Attribute	Charlottetown	Isle Madame	Gibsons	Iqaluit
(1) Plans, Local Governance & Social Services (0.129)	Preparedness Planning (0.60)	0.734	**0.464**	0.339	0.339
	Local Governance (0.20)	0.750	**0.450**	0.450	0.450
	Social Services (0.20)	0.200	**0.800**	0.800	0.000
(2) Training, Education & Community Awareness (0.259)	Capacity Building (0.50)	0.500	**0.500**	0.250	0.375
	Public Awareness (0.50)	0.467	**0.305**	0.263	0.473
(3) Resources & Emergency Services (0.195)	Incident Command Sys. (0.333)	1.000	**1.000**	1.000	1.000
	Resources (0.333)	0.567	**0.279**	0.279	0.246
	Emergency Operations (0.333)	0.334	**0.334**	0.334	0.334
(4) Communication & Collaboration (0.195)	Early Warning & Public Information (0.666)	0.647	**0.500**	0.433	0.373
	Community Collaborative Networking (0.333)	0.600	**0.800**	0.500	0.700
(5) Monitoring & Forecasting (0.221)	Data Collection & Management (0.20)	0.333	**0.111**	0.167	0.056
	Hazard & Vulnerability Analysis (0.40)	0.820	**0.489**	0.410	0.302
	Environmental Forecasting (0.40)	0.778	**0.389**	0.389	0.611
Aggregate Preparedness & Response	**Index Value**	0.609	**0.477**	0.396	0.427

Conclusions toward improved community resilience:

- Enable community collaboration
  - Designing ‘community neighborhoods’; cell phones to inform community members or their neighbors’ status and needs Lu(2013)
- Encourage social networking activities
  - increasing access and basic training of community members in electronic and other social networking and communication activities (e.g., Facebook, Twitter)
- Support wellness, recreational lifestyle activities (Anielski, 2009)
- Develop community logistics for emergency events Liu(2014)
- Emergency preparedness workshops Chung(2014)
  - Table Top exercise to inform local residents of the available emergency procedures and support, engage volunteer contributions and participation of community members
- Disseminate preparedness to local schools to inform families

*9. Climate Change Governance

Climate Change Management

- Global Governance
  - UNFCCC, IPCC, COP21 (Paris), COP22 (Marrakech), COP23 (
  - Sendai Framework on SIDR
- International Protocols
- Canadian Initiatives
- Community Participation and Response

*UNFCCC COP21 - Paris Accord

- To keep global temperatures "well below" 2.0C (3.6F) above pre-industrial times and "endeavour to limit" them even more, to 1.5C
- To limit the amount of greenhouse gases emitted by human activity to the same levels that trees, soil and oceans can absorb naturally, beginning at some point between 2050 and 2100
- To review each country's contribution to cutting emissions every five years so they scale up to the challenge
- For rich countries to help poorer nations by providing "climate finance" to adapt to climate change and switch to renewable energy.

Paris Accord - Reaction

* Canada: Ottawa's climate-change focus now turns to reaching a detailed national climate strategy with the provinces by early March 2016 while also moving toward a North American agreement on energy and environmental issues;
* China: *Xinhua* called the deal "a particularly sweet victory for China, which emerged to take a leading role" in the negotiations. China's recent commitments on climate change as a sign of its new role as a world leader. In the past year, China has signed climate change agreements with the United States and France; submitted an Intended Nationally Determined Contribution to the UN, pledging to have emissions peaks by 2030; and committed 20 billion RMB ($3.1 billion) to help developing countries deal with climate change.
* ASEAN: A special working group on climate change focuses on addressing climate change in the global community. ASEAN acted in advance of COP21 (November 2015) in support of a global accord.

*COP23 - Bonn, Germany

* Opening Statement of COP23, November 6, 2017:
* "The need for urgency is obvious. Our world is in distress from the extreme weather events caused by climate change - destructive hurricanes, fires, floods, droughts, melting ice, and changes to agriculture that threaten our food security. All consistent with the science that now tells us that 2016 was a record year for carbon emissions."
* Honourable J.V. Bainimarama, CF (Mil), OSt.J, MSD, jssc, psc Prime Minister and Minister for iTaukei Affairs, Sugar Industry, Foreign Affairs and Water Ways

*Sendai Framework

- *Disaster Risk Reduction (weather events related)
- *Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disasters
- *Sendai framework (2015) – endorsed by the UN General Assembly following the 2015 3rd UN World Conference on Disaster Risk Reduction (WCDRR)
- *"*The Sendai Framework is a 15-year, voluntary, non-binding agreement which recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government, the private sector and other stakeholders.*" UNISDR Website

International protocols

- Some International organizations developing plans for climate change protection.

- UNDP
- ICLEI
- CARE
- FCM

*Local Community Response

- *Resource needs
- *Bottom up
- *Community participation - recycling, reusing, good practices
- *‘Teach the children well’!

References/Websites

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Questions/Discussions

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