Coastal Climate Change & Adaptation:

PART II – Evaluation/Exercises

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Presentation to the 5th China- ASEAN Academy on Ocean Law & Governance, NISCSS Haikou, Hainan

PART II –Morning, November 19, 2019

*Coastal Climate Change & Adaptation - Outline

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

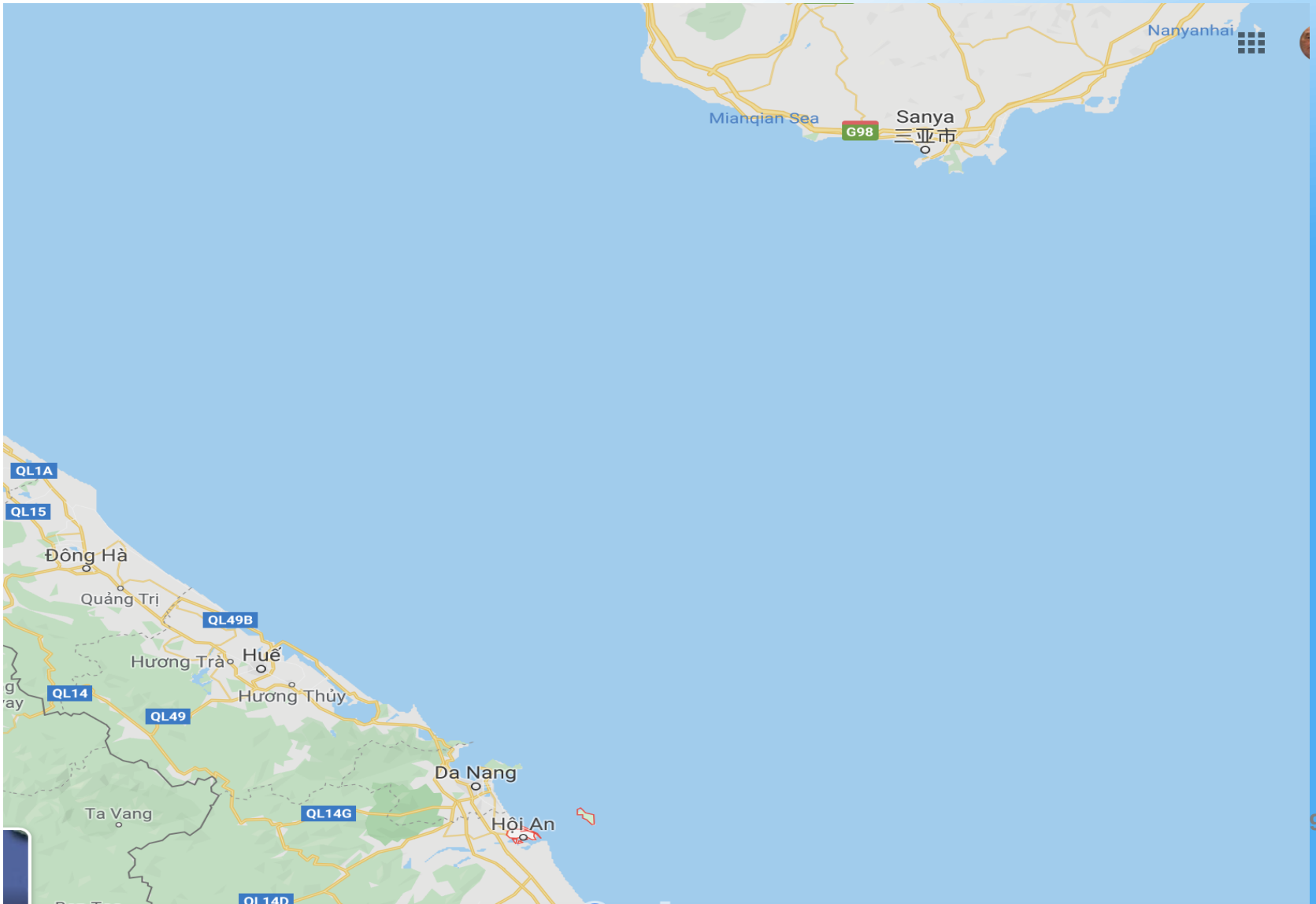
*5. Assessing Vulnerabilities

PART II November 19, 2019

2019 Named Storms

Named Storms	Dates active	Sustained wind speeds	Pressure	Areas affected	Damage (US$)	Deaths
Pabuk	Dec 31, 2018 – Jan 4, 2019	85 km/h	996 hPa	Natuna Islands, Vietnam, Malaysia, Thailand, Myanmar	$157 million	10
Wutip (Betty)	February 18 – March 2	195 km/h	920 hPa	Caroline Islands, Mariana Islands	$3.3 million	0
Wipha	July 30 – August 4	85 km/h	985 hPa	South China, Vietnam, Laos	$44.3 million	27
Francisco	August 1 – 8	130 km/h	970 hPa	Japan, Korean Peninsula	Unknown	1
Lekima (Hanna)	August 2 – 13	195 km/h	925 hPa	Caroline Islands, Philippines, Ryukyu Islands, Taiwan, China	$9.28 billion	90
Krosa	August 5 – 16	140 km/h	965 hPa	Mariana Islands, Japan, Korean Peninsula, Russian Far East	$20.5 million	3
Bailu (Ineng)	August 19 – 26	95 km/h	985 hPa	Philippines, Taiwan, South China	$28.2 million	3
Podul (Jenny)	August 24 – 31	75 km/h	992 hPa	Yap, Philippines, Vietnam, Laos, Thailand, Cambodia	$2.43 million	15
Faxai	August 30 – September 10	155 km/h	955 hPa	Japan	$7 billion	3
Kajiki (Kabayan)	August 30 – September 7	65 km/h	996 hPa	Philippines, South China, Vietnam, Laos	$12.9 million	6
Lingling (Liwayway)	August 31 – September 7	165 km/h	940 hPa	Philippines, Ryukyu Islands, Korean Peninsula, Northeast China, Russian Far East	$191 million	8
Marilyn	September 10 – 13	55 km/h	996 hPa	None	None	0
Peipah	September 13 – 16	65 km/h	1000 hPa	Mariana Islands, Bonin Islands	None	0
Tapah (Nimfa)	September 17 – 22	120 km/h	970 hPa	Taiwan, East China, Japan, South Korea	$7.9 million	3
Mitag (Onyok)	September 25 – October 3	140 km/h	965 hPa	Mariana Islands, Taiwan, Japan, East China, South Korea	Moderate	10
Hagibis	October 4 – 13	195 km/h	915 hPa	Mariana Islands, Japan, South Korea, Russian Far East	TBA	88

*Hoi An,East Vietnam Sea



Hoi An flooding - Typhoon Damrey

- Vietnam's death toll from Typhoon Damrey rises to 61, with heavy damage to more than 80,000 homes and roads. Hoi An is one of the cities seriously affected, but authorities say the coming Asia Pacific Economic Cooperation (APEC) summit of the region's leaders will not be disrupted.
- Video: https://www.scmp.com/video/asia/2118740/vietnam s-historic-hoi-flooded-typhoon-death-toll-rises (South China Morning Post, Nov 2017)

Hoi An, Vietnam Flood Map

6. Estimating Coastal Impacts

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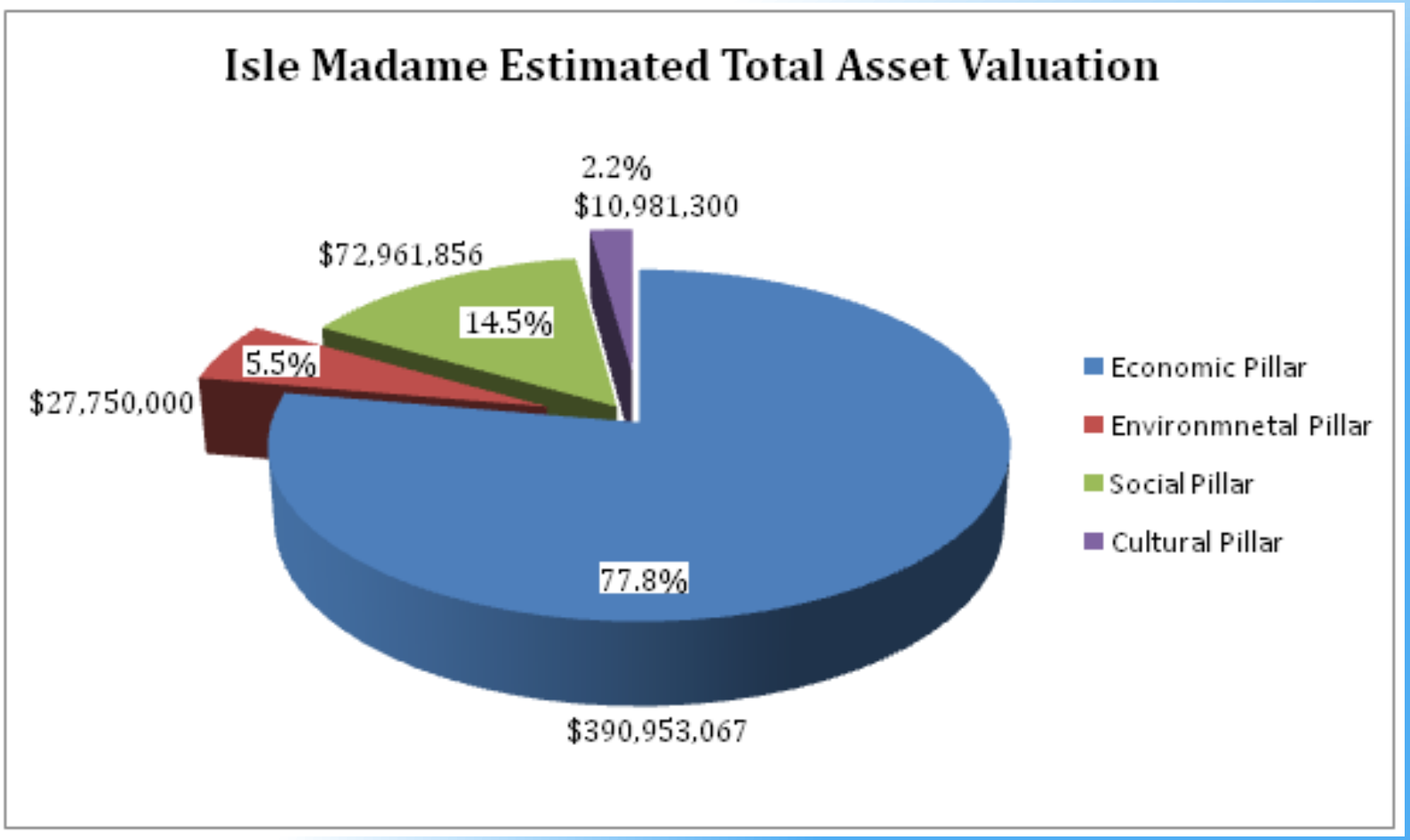
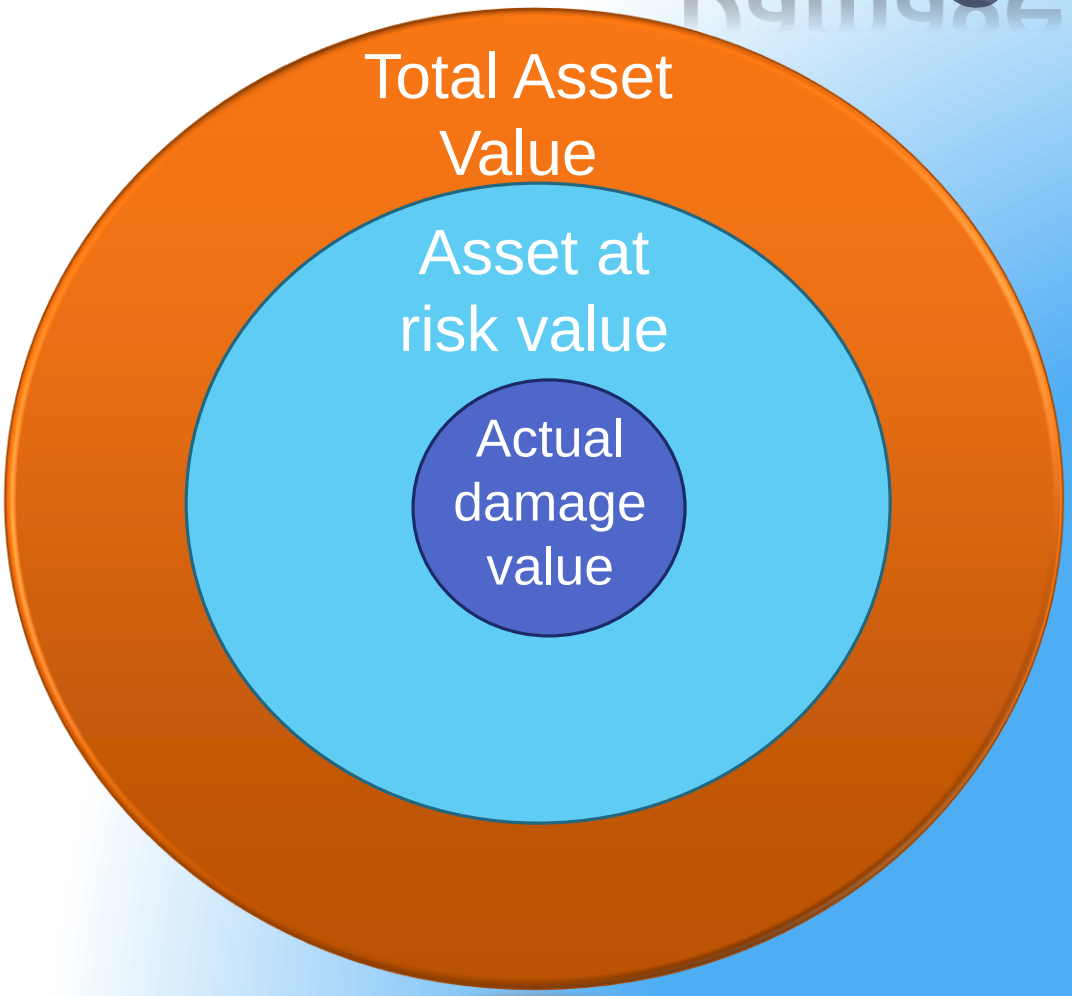
Isle Madame Assets (Pakdel 2011)



*Asset - At-Risk Assessment- Damage Model



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

Source:
www.coastalchange.ca
Gallery

*7. Adaptation Problem Solving and Strategy Options

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* Adaptation Strategy Options (Pilkey & Young 2009)

(Photo: subinfowebster/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

Protection options

- Thames River – constructed 1974-1982
- https://www.youtube.com/watch?v=Dvg2asACsG0
- Capital Cost = 534 million British pounds or 1.6 billion (2016)

Accommodate options

- Natural solutions – ponds, wetland maintenance, catchments https://www.youtube.com/watch?v=IKlcUY3gIqM
- Dutch water defences - https://www.youtube.com/watch?v=s-pJGhHrnGg
- Reinforced and alternate construction/flood plain management
- https://www.youtube.com/watch?v=21YAP8RF_sw
- Capital Cost = 1 billion Euro/year

Retreat options

- Move people away (to where?)
- Move buildings/structures away
- Science paper:
- https://science.sciencemag.org/content/365/6455/761
- Capital Cost ?

Do nothing

- Capital Cost = $0

* Hoi An Adaptation Strategies

Adaptation Strategy	Description	Application
1) Protect	Physical coastlines reinforcement; 'Hard' engineering: seawalls, breakwaters, gabions and groins 'Soft' engineering: planting, maintaining vegetation	Construct 3.75m sea walls Labor skills adjustment Public service increase in cost **Capital cost $100million/yr over 5 yrs**
2) Accommodate	Construction of structures to reduce storm damage, improve land-use, zoning plans to restrict permission of coastal constructions; legislation and increasing natural resilience by rehabilitating coastal dunes and wetlands	Labor skills adjustment for structures Attributed land as Public Works Public service increase in cost of **Capital cost $50million/yr over 10 years**
3) Retreat	Abandon areas close to coast; avoid direct impact from storms; land swapping, or management strategies such as rezoning, insurance denial, or tax policies	Adjustment to work skills Attributed increase in land to parks Public service increase in cost **Capital cost $75million/yr over 10 years**
4) Status Quo (Do Nothing)	Toleration of all storm damages without attempting to mitigate storm impacts	No adaptation strategy (Do nothing/Status Quo) **Capital cost of $0**

Hoi An Adaptation Strategy Decision?

- Based on Capital Costs of options?
- What do community participants think? What is their role?
- How precautious is the decision?
- How effective/risky is the decision?

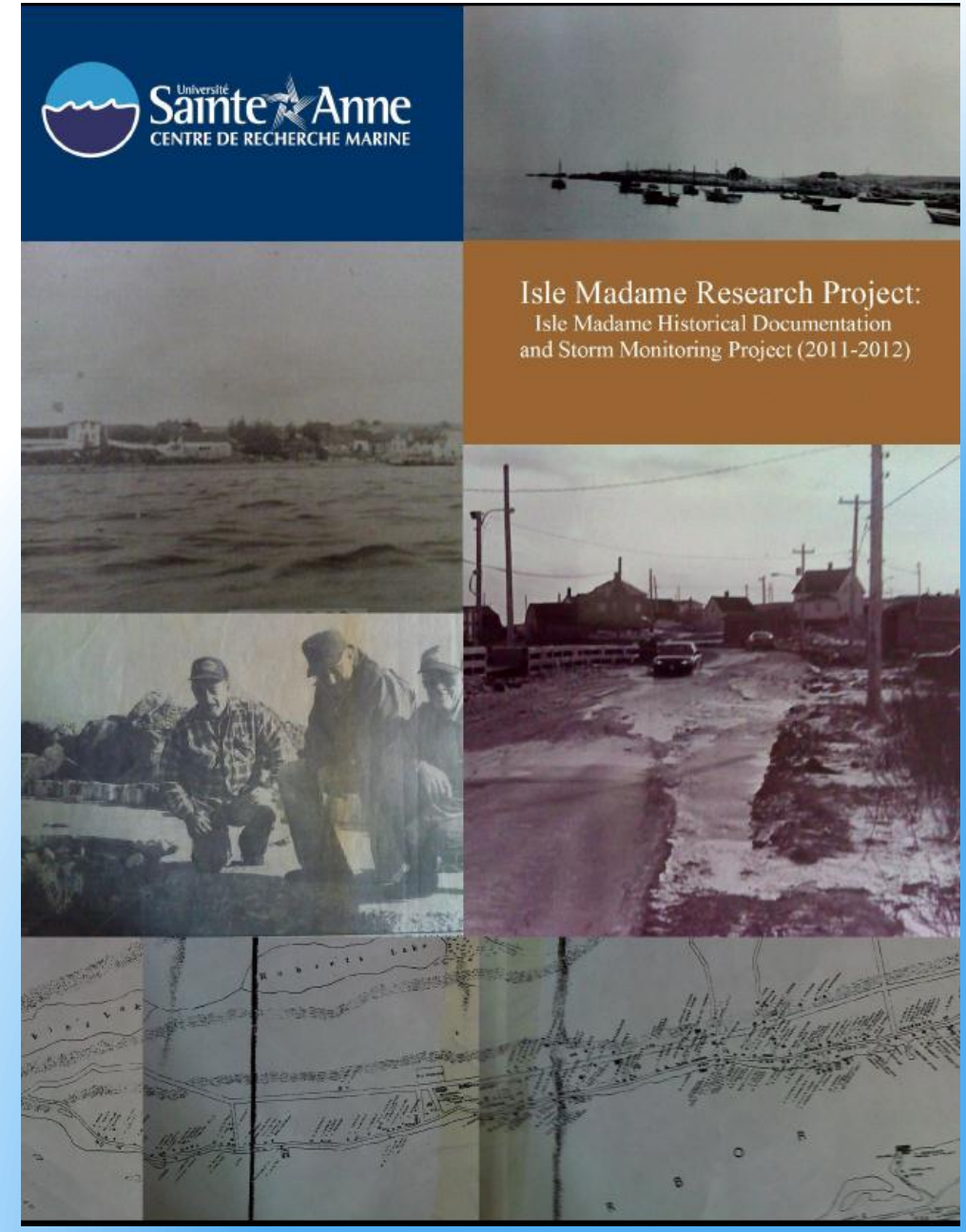
- What else should be considered in the decision?
  - Annual event – impacts/costs of Typhoon Damprey (2017)
  - Storm severity impacts differ from year-to-year
  - Tolerance of the decision to different severe storms

Université Sainte-Anne

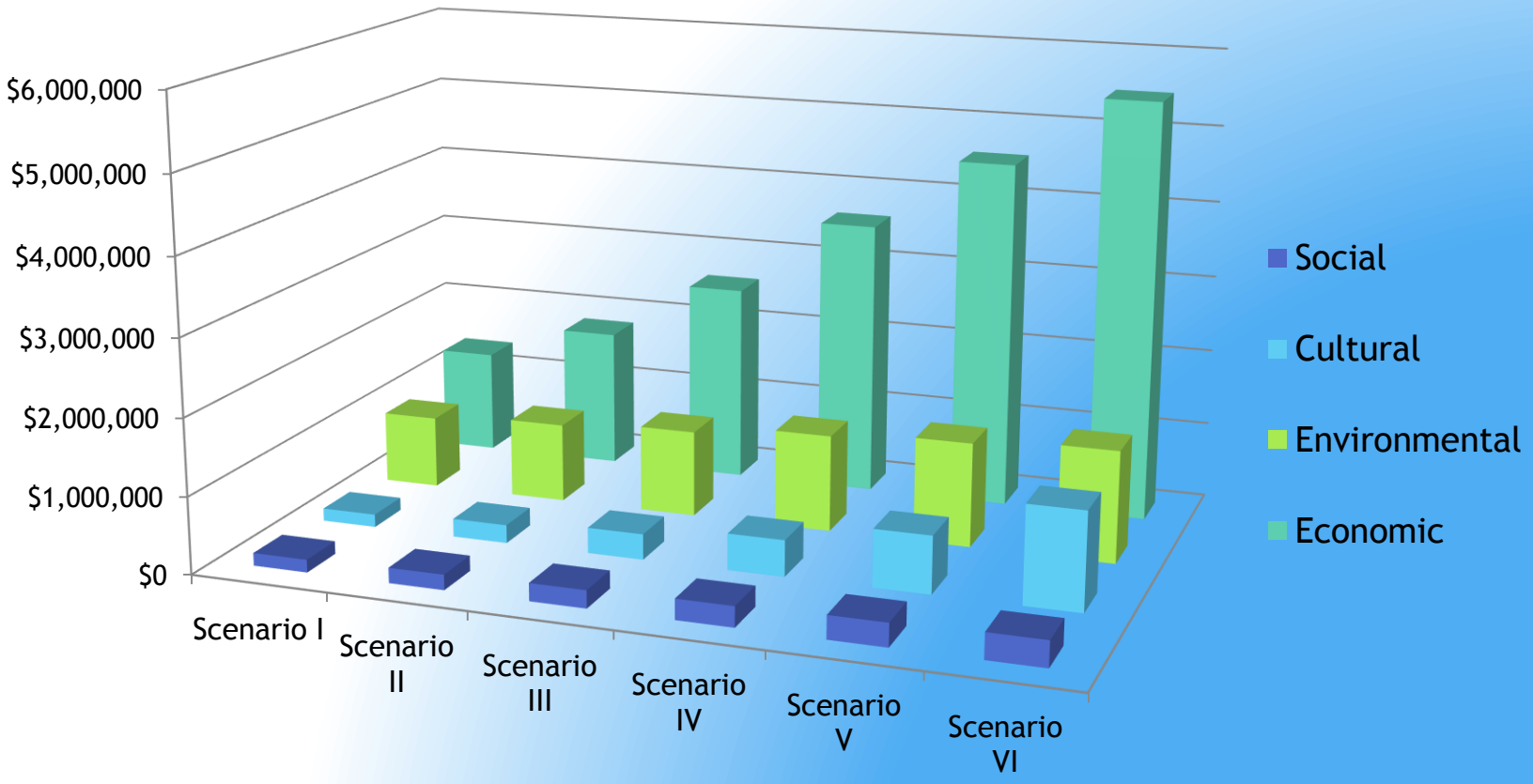
Isle Madame Vulnerability Report

Report Prepared by:

Aleasha David,
Recherchiste,
Centre de recherche marine
and
Michelle Thériault,
Directrice,
Centre de recherche marine

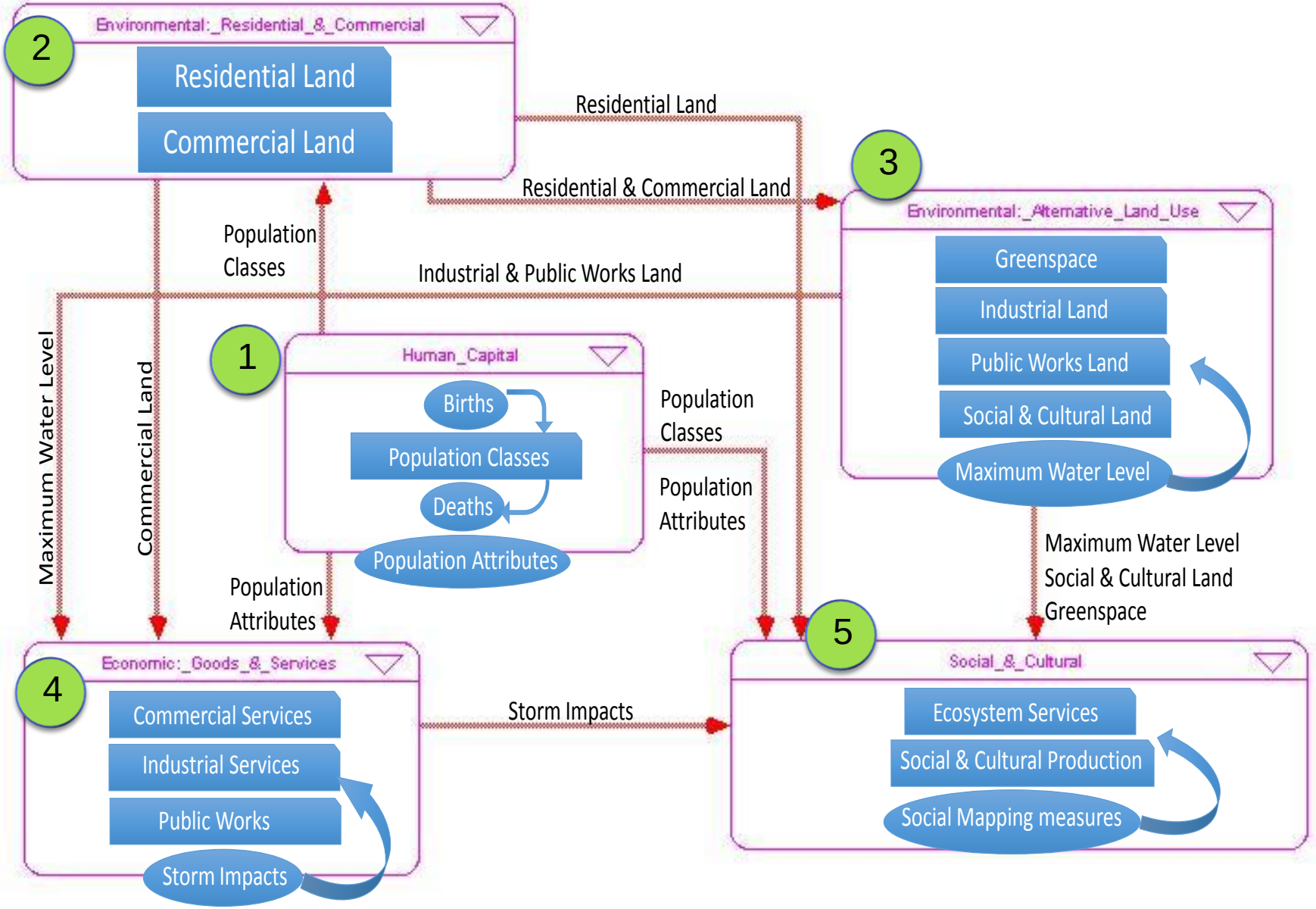


Isle Madame
Total Estimated Damage Costs for Storm Scenarios I-VI

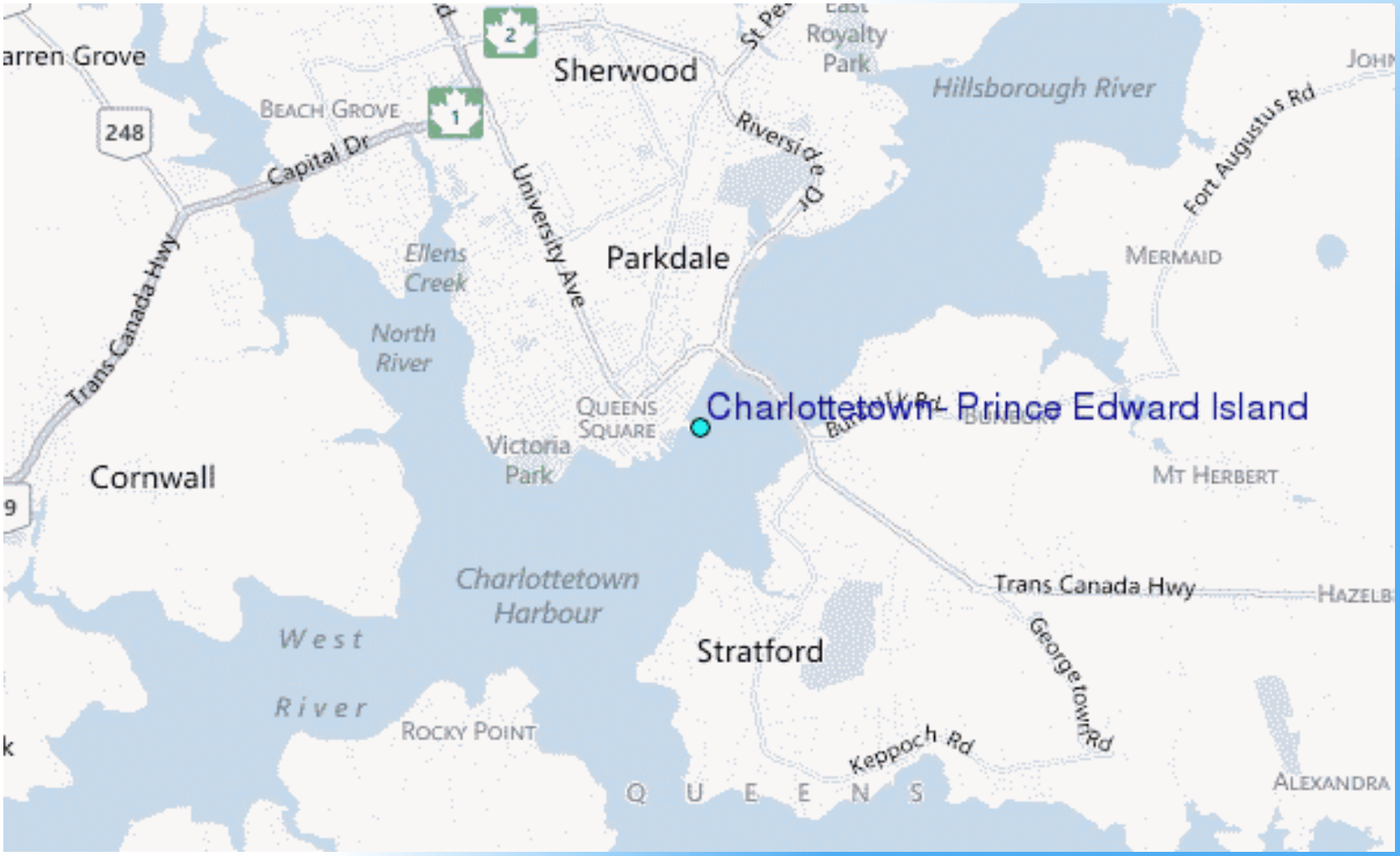


Strategic Systems Simulation

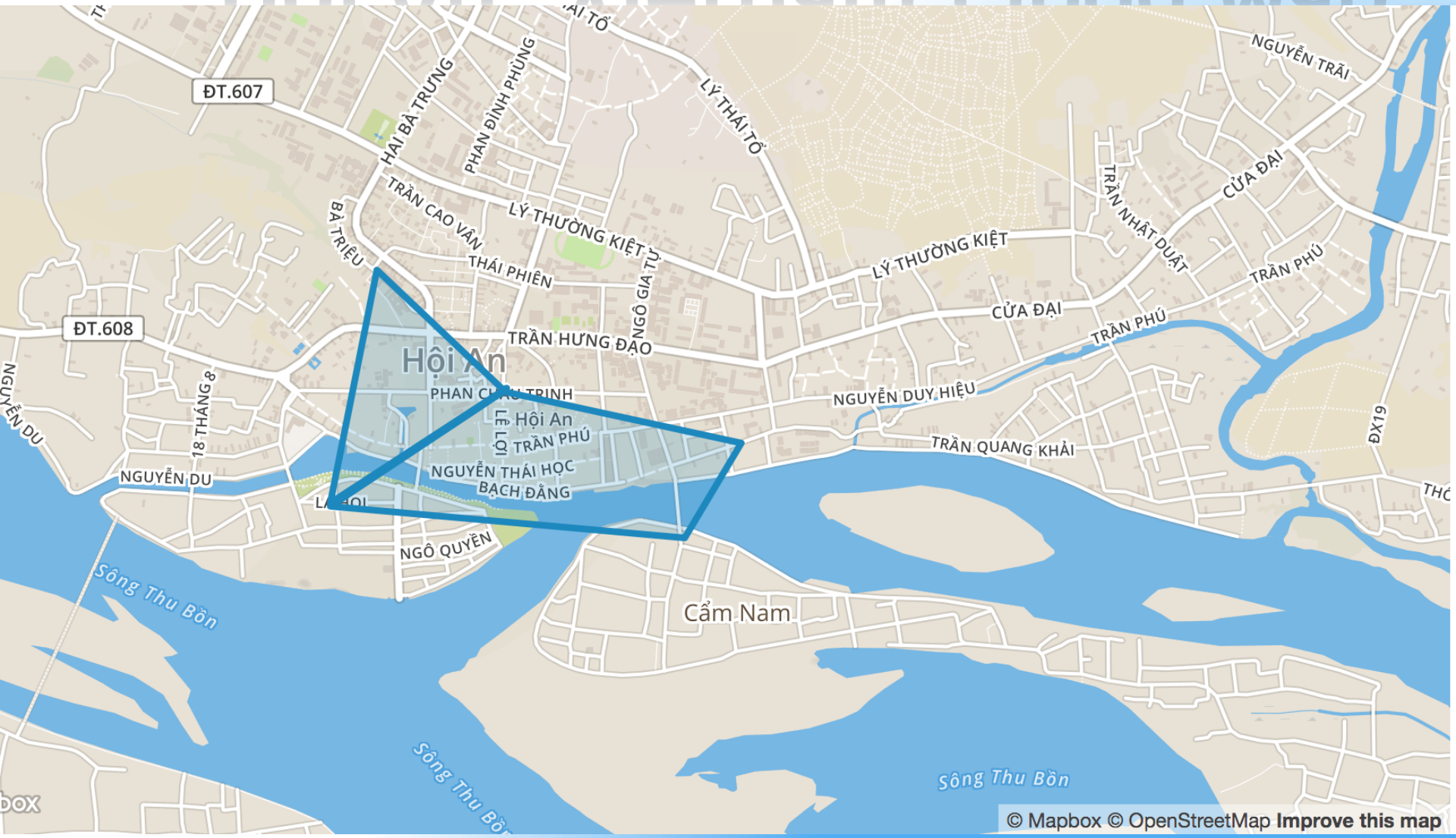
- Development of specific adaptation strategies
  - Protect, Accommodate, Retreat, Status Quo (Do Nothing)
- Application of Static and/or System Dynamics model
- Pillars of Sustainability/Community Preference
  - Environmental, Economic, Social & Cultural
- Adaptation strategy evaluation indicators
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



*Hoi An, Vietnam Flood Map



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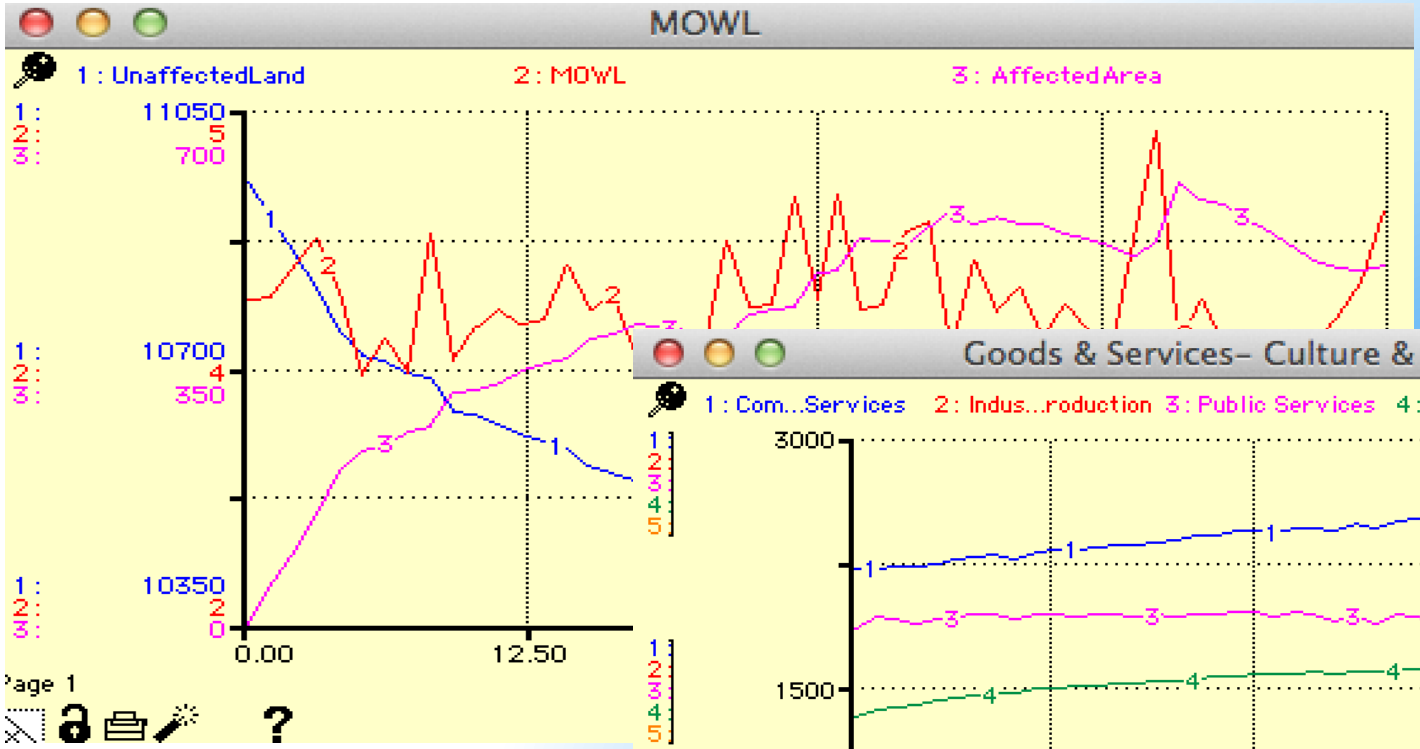
* Attributed Land Value Assets

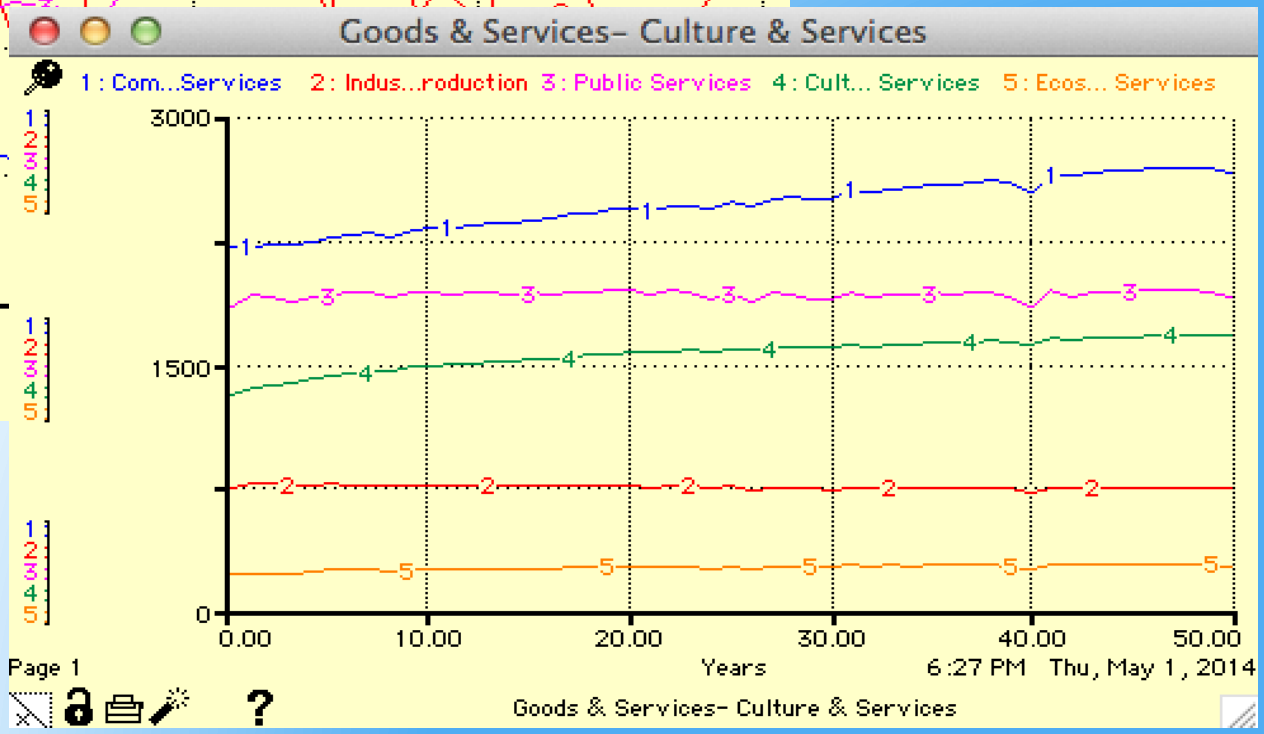
Land Use	Space (acres)	Land Value ($M/acre)	Description/Sources
Residential	3,225	$2.855	Housing - average discounted selling value/acre for listings for detached bungalows
Commercial	2,680	$3.484	Commercial property - average discounted selling value listings for Business and Retail properties
Industrial	1,239	$4.149	Industrial property - average discounted selling value listings for Industrial and Office properties
Green space	472	$1.500	Estimated value of city park lands, sport fields, trails, open recreation space
Public works	2,011	$3.000	Estimated value of infrastructure for water, electrical power, and sewage/water treatment, roadways, bridges, maintenance
Cultural & Social	1,326	$2.000	Estimated value of lands for schools, hospitals, community centres, libraries, arenas

* Annual Storm Severity Levels, MOWL

Storm Severity	Storm Description	Application	IPCC GHG Emissions
I. Low (BaseCase)	Modal MOWLs signal storms that result in **minimal damage** to property and infrastructure. Assumed storm definition for the Base Case scenario	$\alpha = 2.0$ $\beta = 0.303$ Max MOWL<4.0m	RCP 2.6–emissions peak 2010-2020 then decline substantially
II. Historical	Modal MOWLs consistent with historical data values; storms result in **occasional appreciable damage** to property and infrastructure.	$\alpha = 3.0$ $\beta = 0.303$ Max MOWL<4.5m	RCP 4.5–emissions peak by 2040 then decline
III. Medium	Modal MOWLs consistent with the increasing historical trend of the 20st century; result in **considerable damage** to property and infrastructure.	$\alpha = 3.5$ $\beta = 0.303$ Max MOWL<5.0m	RCP 6.0–emissions peak by 2080 then decline
IV. High	Modal MOWLs signal storms predicted with high certainty into the 21st century; result in **significant damage** to property and infrastructure.	$\alpha = 4.0$ $\beta = 0.303$ Max MOWL<5.5m	RCP 8.5–emissions continue to rise over 21st century

*System Dynamics View - STELLA Results





*Profile SD Results

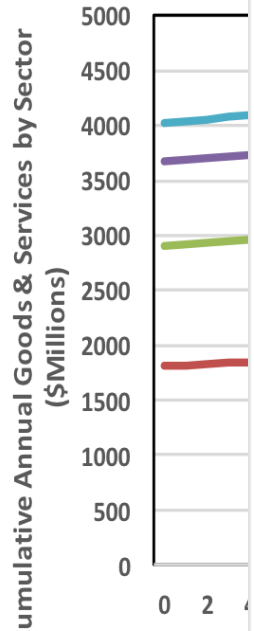
City of Charlottetown Annual Projected Land Value

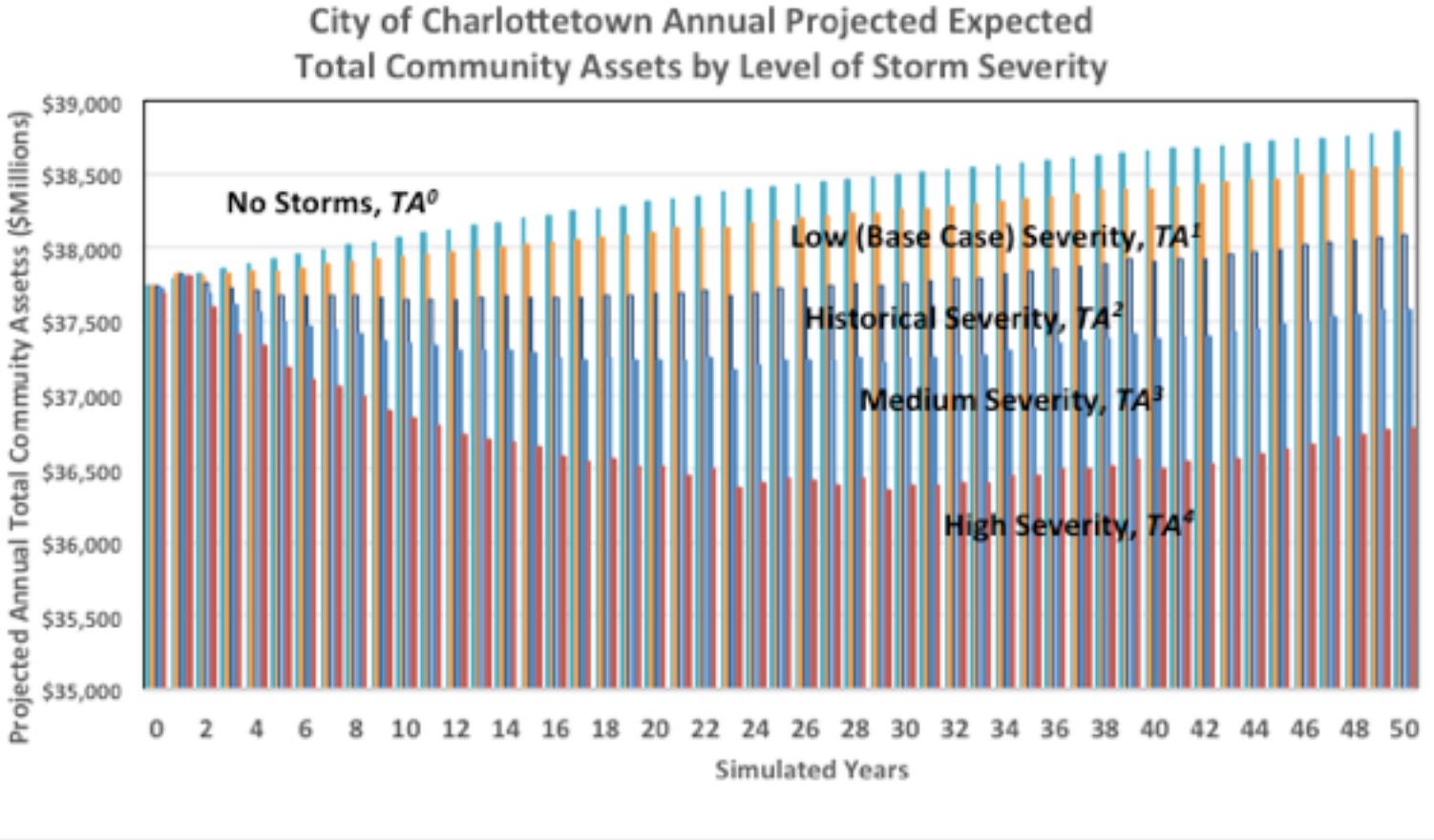
on

City of Charlottetown Annual Projected Goods & Services

Zero

City of Charlottetown Annual Projected Cultural & Social Value





Simulation Scenarios

No.	Scenario Name	Controllable Variables - Adaptation Strategies	Uncontrollable Variables - IPCC Analogy/Storm Severity
R0	Base Case/ Benchmark	No adaptation strategy (Do nothing/Status Quo)	Low severity storms, IPCC, RCP 2.6: 2.0
R1	Worst Case	No adaptation strategy (Do nothing/Status Quo)	High severity storms, IPCC, RCP 8.5: 4.0
R2	Protect–Worst Case Storms	Protect with 3.75m seawalls Labor skills adjustment for sea walls construction (professional) $100m/yr 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/yr over 10 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/yr over 10 years	High severity storms, IPCC, RCP 8.5: 4.0
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

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Evaluation of Strategy Alternatives

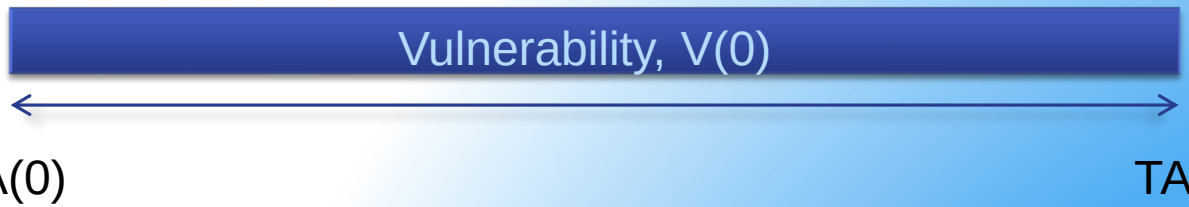
* Methods:
  * Static analysis – AHP application, multiple participants (SEPS paper – *Camare & Lane 2015*)
  * Dynamic analysis – SD model over strategic planning period (50 years) – *Lane et al 2017, 2018*

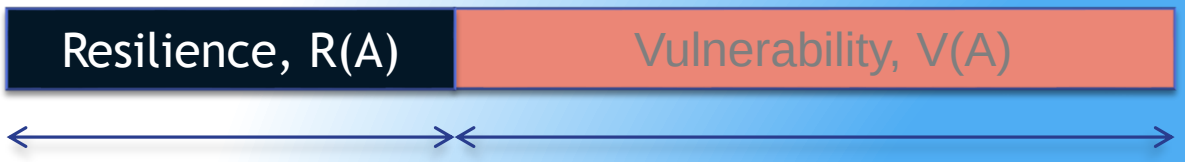
* Indicators:
  * Vulnerability – expected storm damage estimates by sustainability pillar
  * Resilience – function of adaptation strategy as reduction of 'no action' vulnerability
  * Adaptive Capacity – resilience (reduced vulnerability) as a proportion of total vulnerability

*Vulnerability Gap with Strategy
Lane et al 2018

Community Asset Status

Worst Case (High severity storms) Ideal State (No storms)

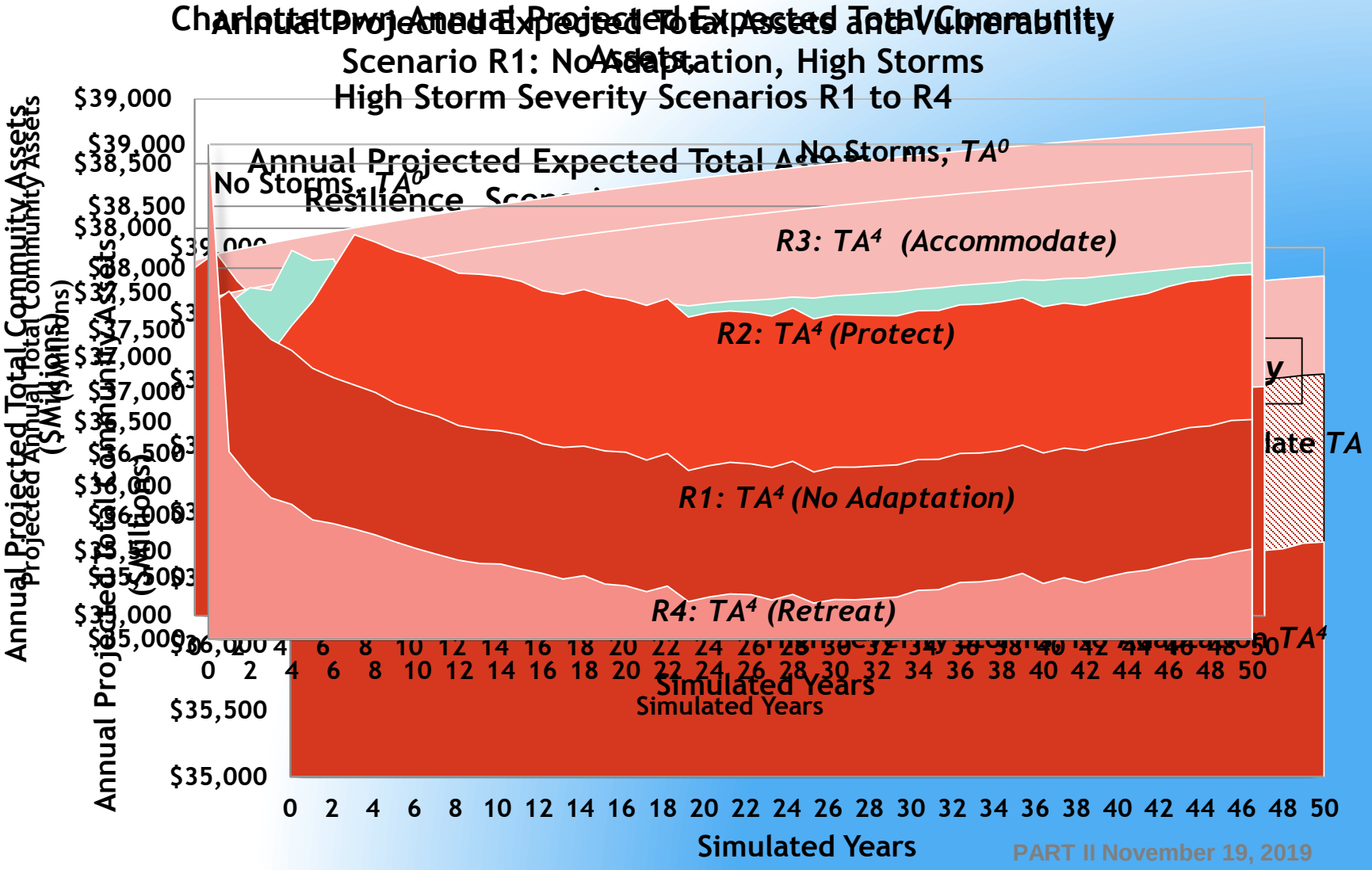




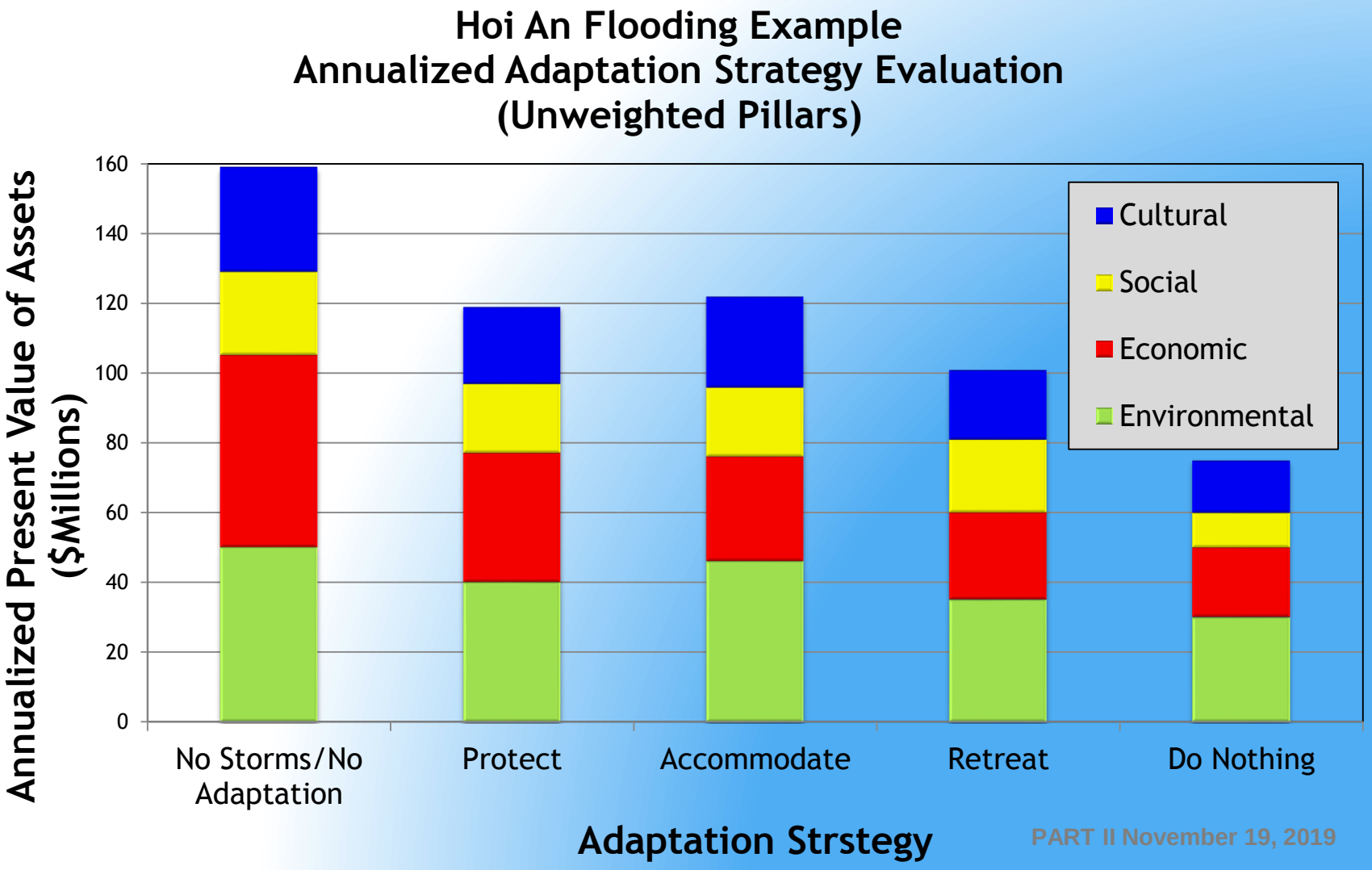
TA(0)<TA(A)<TA*

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

* Storm Simulation Results:Vulnerability & Resilience



* No Weights- Annualized Strategy Evaluation



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 Hoi An flooding problem weighted by the participants of the China-ASEAN Academy
- Note similarities and differences among weights and preferred adaptation strategy options

*Participants' Exercise - Decision Evaluation

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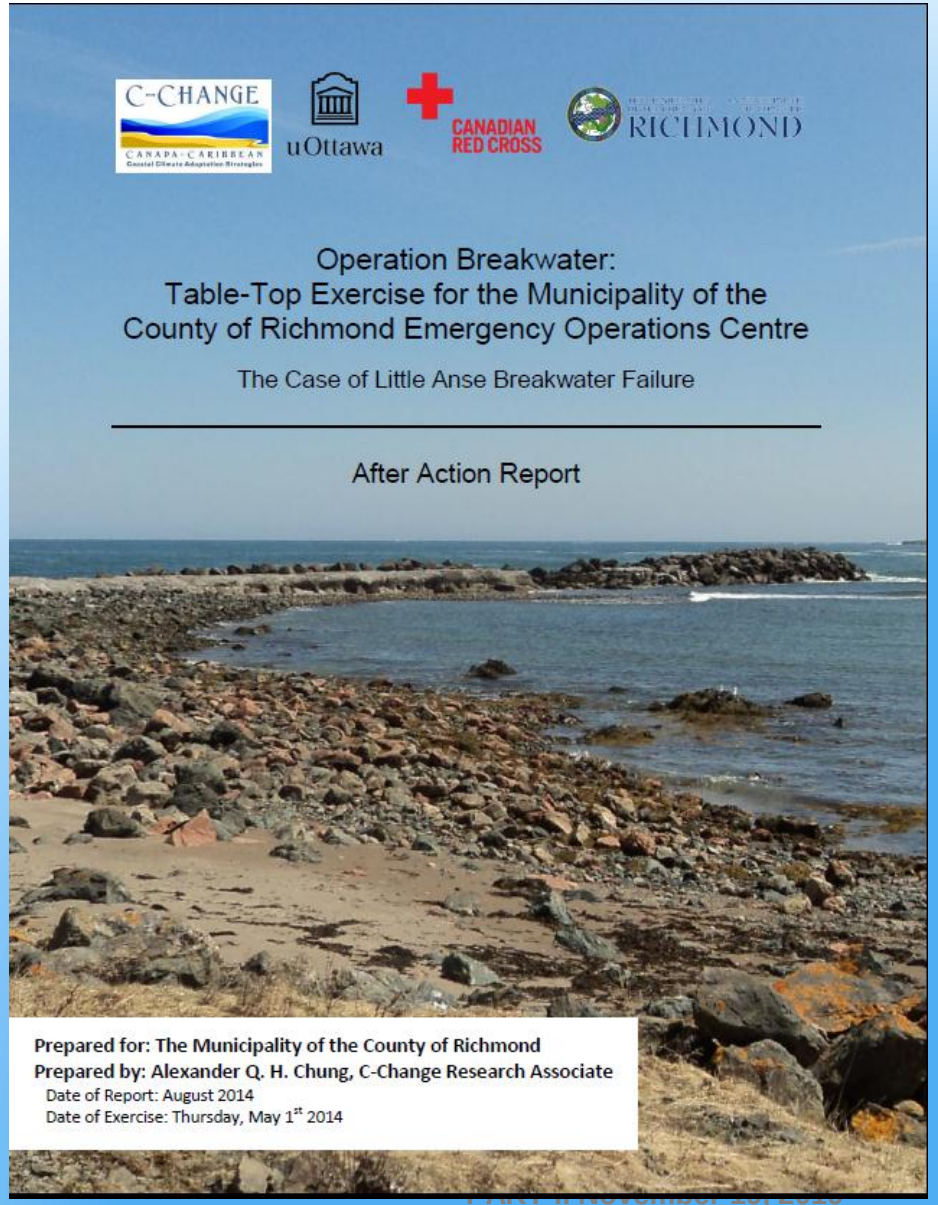
C-Change Little Anse Breakwater Workshop, May 1, 2014
Chung (2014)

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 Preparedness Index

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

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Climate Change Management

- Global Governance
  - UNFCCC, IPCC, COP21 (Paris), COP22 (Marrakech), COP23 (Bonn), COP24 (Katowice), COP25 (Chile/Madrid) – Dec 2019
  - Sendai Framework on SIDR
- International Protocols
- Canadian Initiatives
- Community Participation and Response

*COP 25 - Madrid,Spain

* Original host: Santiago, Chile
* Anti-government protests and social unrest in Chile led President Sebastián Piñera to renounce hosting the COP25 on October 30 (Forbes.com report Nov 4/19:https://www.forbes.com/sites/anagarciavaldivia/2019/11/04/madrid-to-organize-un-cop25-in-record-time/#391a8a372354)
* Dates: December 2-13, 2019
* From COP25 Vision: "Time for Action"
* The whole world is living a process of transformation towards a truly sustainable development. Raising the levels of ambition with a balance between mitigation and adaptation is essential. For this purpose, we need the participation of both the States and local governments, and the private sector.
* The COP must encourage concrete climate action, ensuring an inclusive process for all parties and the formal integration of the scientific world and the private sector. Our challenge is to achieve a transition towards increased action and that is perceived by the general public. Climate change is a reality now, not in 50 years' time.
* Website: ?

*Climate Change in the Pacific

2nd Symposium on Climate Change in the Pacific Region (Pacific Adapt 2019)
Lautoka, Fiji, 21st-22nd August 2019

International Climate Change Information Programme (ICCIRP)

organised in cooperation with the University of the South Pacific, the University of Fiji, the National University of Fiji and various partners from across the Pacific Region

The main aim of the event is to contribute towards the documentation and dissemination of climate change initiatives in the Pacific Region, which may lead to a greater resilience, and contribute to an increased adaptation capacity.

https://www.youtube.com/watch?v=I3fwCgSxTw8

Climate Change in Asia – IPCC AR5 report 2018

- ASIA (Chapter 24 AR5)
- https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap24_FINAL.pdf
- Decision making (Chapter 2 AR5): https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap2_FINAL.pdf

Local Community Response

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

Questions/Discussions

IOI-CANADA

Canadian Operational Centre of the International Ocean Institute

IDRC CRDI

SSHRC CRSH

C-CHANGE

CANADA-CARIBBEAN

Coastal Climate Adaptation Strategies