The Coastal Protection Services of Mangroves in the Philippines: Preliminary Workshop, July 2016: Day 1

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The Coastal Protection Services of Mangroves in the Philippines: Background

Purpose: To support the Government of the Philippines in the use of mangroves for coastal resilience.

- *G.o P's National Greening Program* includes the restoration of mangroves as part of its coastal protection strategy
- *G.o.P's Executive Order* "Expanding the Coverage of the National Greening Program" (EO 193 s. 2015) identified the critical role of forests, including mangroves, as a coastal protection strategy
- *Workshop in Manila, 2015* reconfirmed inclusion of mangrove CP services in Philippines national accounts (in addition to other values, including forest and non-forest mangrove products, waste assimilation services, carbon sequestration, ecotourism)
- *G.o.P's Risk Resiliency Program (RRP) and Risk Resiliency and Sustainability Program (RRSP)* may implement a Pilot Program for Climate Resilience jointly with the World Bank, which would include the use of mangroves as a coastal protection strategy.

Contacts: Sid Narayan (sidnarayan@ucsc.edu), Mike Beck (mwbeck@tnc.org), Maya G. Villaluz, Gem Castillo

The Coastal Protection Services of Mangroves in the Philippines: Project Objectives

1. Develop physical & monetary accounts for coastal protection services from mangroves in the Philippines
   - Under current and future sea level scenarios
   - At spatial scales appropriate for policy-making
   - Using the Expected Damage Function in the WB WAVES *Guidelines* and comparing to other approaches

2. Recommendations and policy implications for Philippines climate resilience programs based on spatial variation in the natural defense value of mangroves

3. Pilot (& improve) the recommendations in the *Guidelines*

The Coastal Protection Services of Mangroves in the Philippines: Products and Timeline

PRODUCT	DELIVERABLES	TIMELINE FOR COMPLETION
PRELIMINARY WORKSHOP/ TRAINING	a) Introduce Evaluation Methods/Models b) Discuss, Identify, Collect Data c) Discuss, Identify appropriate sub-national Case-Study Sites	July 2016
WORKSHOP	Presentation of preliminary findings with PH stakeholders	October / November 2016
TECHNICAL REPORT	Report on the CP services of mangroves in the Philippines, including: a) Mangrove Accounts b) Policy Implications and c) Documentation of data and methods	December 2016 – March 2017
Policy Note	Summary version of Technical Report	December 2016
Guidelines Assessment Report	Updates/Revisions to Guideline Recommendations based on Philippines case-study	December 2016 – March 2017

The Coastal Protection Services of Mangroves in the Philippines: Preliminary Workshop

Goal:

To provide a general understanding of approaches and tools for assessing flood risk; and the current knowledge on the coastal protection value of reefs and mangroves

Aim/Objectives:

1) To familiarize the audience with Approaches for Valuing Coastal Protection Benefits from Mangroves and Coral Reefs with a focus on recommendations from recent World Bank Guidelines;

2) To discuss and identify existing data, data needs, and potential case-study sites (1 to 2) for estimating mangrove protection values.

3) Assist similar future evaluation exercises in the Philippines by getting the conversation started

Audience: This training is meant for:

(a) biologists/ ecologists/GIS staff that are interested in valuing flood protection benefits, and

(b) risk managers/ engineers that are interested in understanding how ecosystems can be considered in their 'standard' models and frameworks.

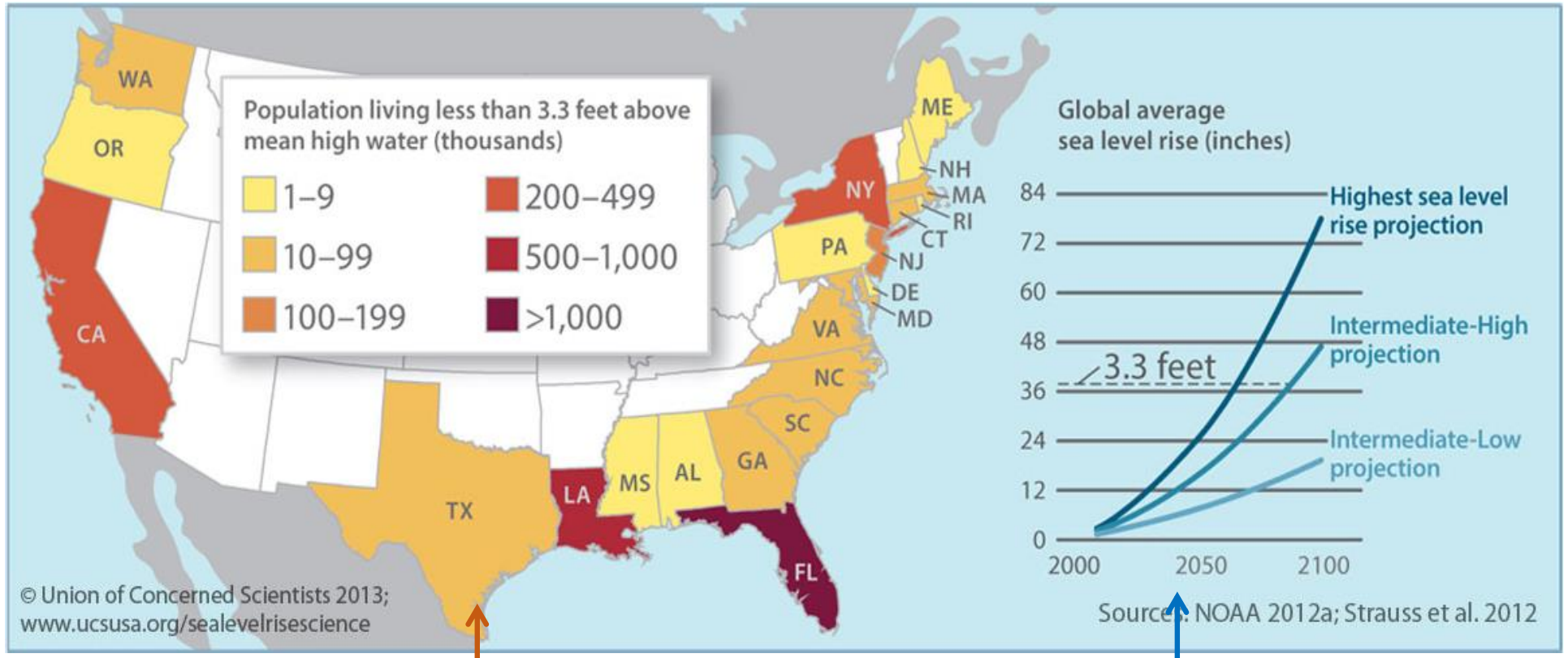
The Coastal Protection Services of Mangroves in the Philippines: Preliminary Workshop – Day 1, Session 1 (9:00 to 10.30)

OUTLINE:

- Introduction to Coastal Risk and Coastal Ecosystems (15 mins)
- WAVES: Managing Coasts with Natural Solutions (30 mins)
- Assessing Coastal Protection Value of Reefs and Mangroves: Review of Current Understanding (15 min)
- Assessing Coastal Protection Value of Reefs and Mangroves: Models, Processes and Methods (30 min)

INTRODUCTION TO COASTAL RISK AND COASTAL ECOSYSTEMS

Coastal Risk



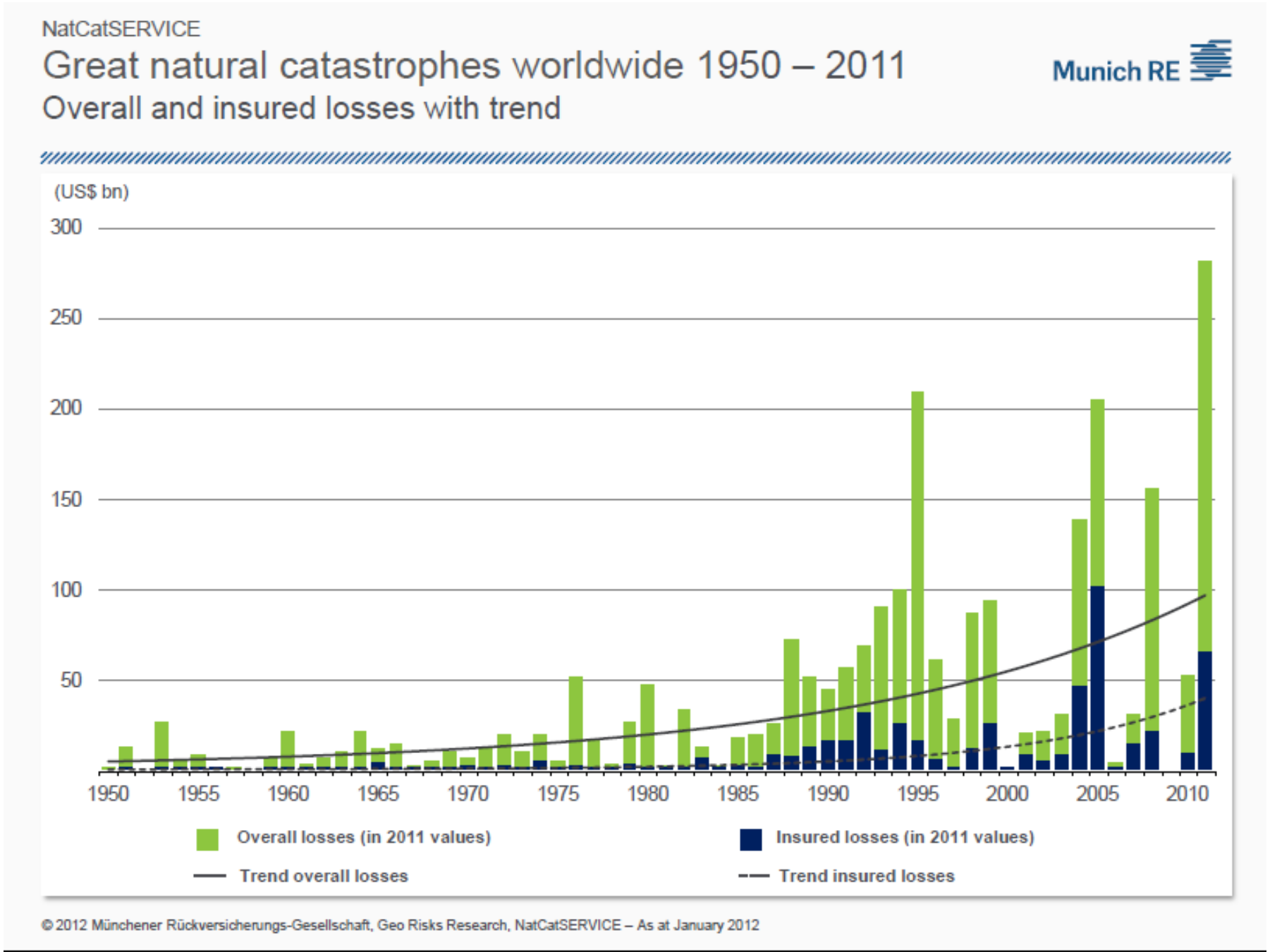
- Risk = Consequence X Hazard

- High at present, likely to increase

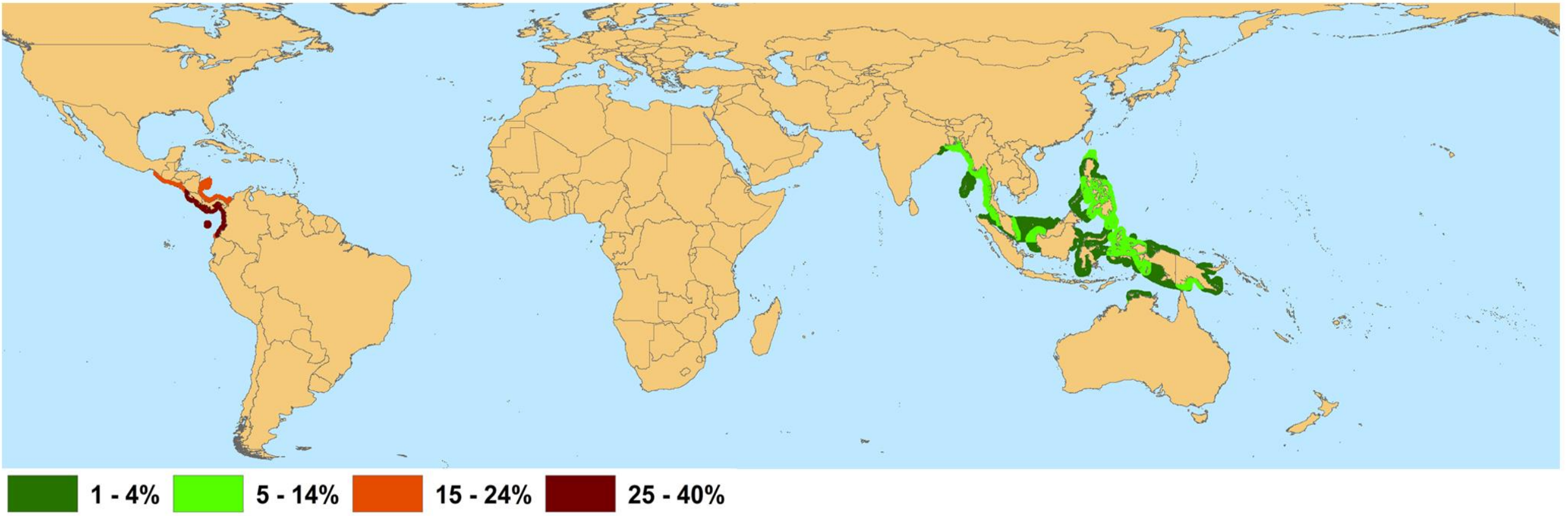
Coastal Risk: Hazards

Intensity and frequency – surges, waves, sea-level rise, erosion

Coastal Risk: Consequences



Coastal Ecosystems at Risk: Mangroves



Proportion of Threatened (Critically Endangered, Endangered, and Vulnerable) Mangrove Species.

Polidoro et al. 2010

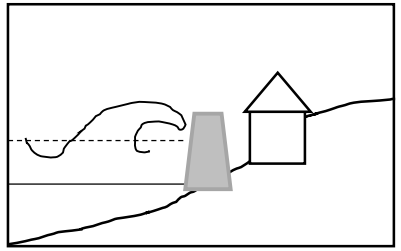
Coastal Ecosystems at Risk: Coral Reefs

Region	Reef Area (km^2)	Reef Area as % of global	% Reef Threatened (local threats)	% Reef Threatened (-2030)	% Reef Threatened (-2050)
Atlantic	25849	10	75	90	100
Australia	42315	17	14	90	99
Indian Ocean	31543	13	66	88	100
Middle East	14399	6	65	88	100
Pacific	65972	26	48	89	100
Southeast Asia	69637	28	94	99	100
Global	249713	100	61	92	100

Taken from Reefs at Risk: Revisited Report, World Resources Institute, 2011.

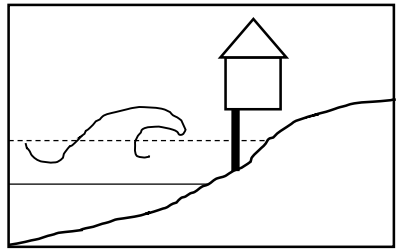
Coastal Risk: Management

Protect



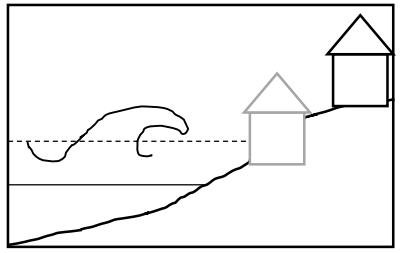
- Seawalls
- Sea dykes, levees
- Beaches, dunes
- Vegetated foreshores
- Storm surge barriers
- Offshore breakwaters, reefs
- Land Claim

Accommodate



- Flood proofing
- Flood hazard mapping and awareness
- Flood warning and evacuation
- Flood zoning / habitat restoration

Retreat

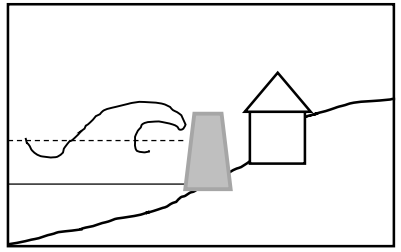


- Coastal setbacks
- Managed retreat/realignment

Adapted from Nicholls et al. 2007

Coastal Risk: Management

Protect



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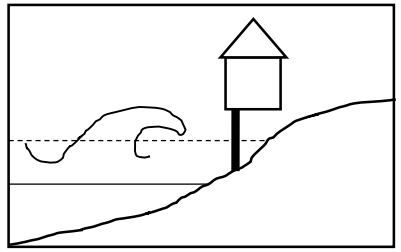

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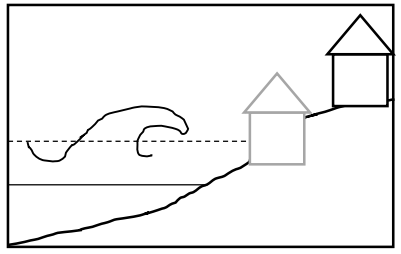
Retreat



- Coastal setbacks
- Managed retreat/realignment

Adapted from Nicholls et al. 2007

WAVES: MANAGING COASTS WITH NATURAL SOLUTIONS

Managing Coasts with Natural Solutions

Guidelines for Measuring and Valuing the Coastal Protection Services of Mangroves and Coral Reefs

Beck, MW, G-M Lange (eds)

https://www.wavespartnership.org/en/knowledge-center/managing-coasts-natural-solutions

WAVES
Wealth Accounting and the Valuation of Ecosystem Services
www.wavespartnership.org

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Juha Siikamaki, Sid Narayan

Chapter 2: Mangroves & Coastal Protection

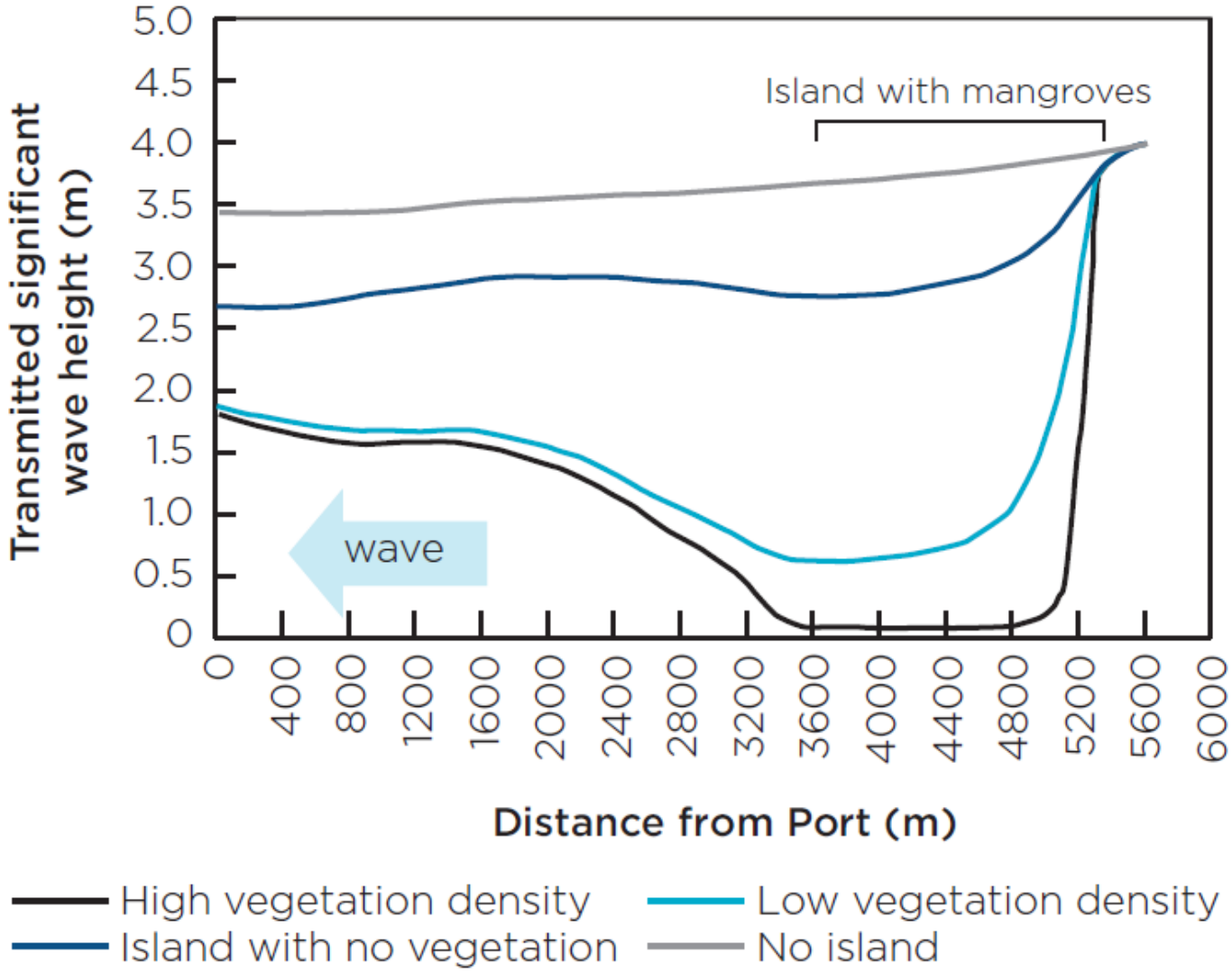
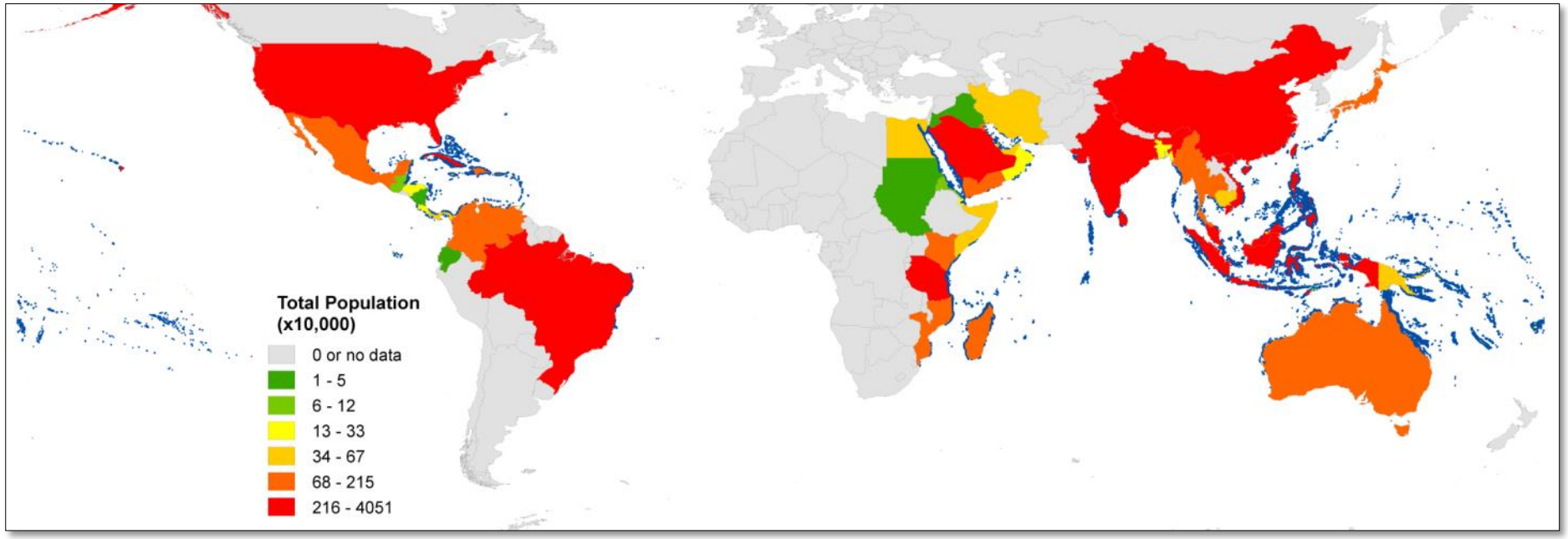


Figure 2.6: Demonstration of How Mangrove Coastal Defense Services can be Calculated using Appropriate Numerical Models (Adapted from Narayan, 2009).

Chapter 3: Reefs & Coastal Protection



197 million people live in at-risk coastal areas (below 10m elevation) and within 50km of coral reefs

World Risk Report 2012 & *Nature Communications* 2014

Chapter 4: Coastal Protection Assessment Tools and Methods

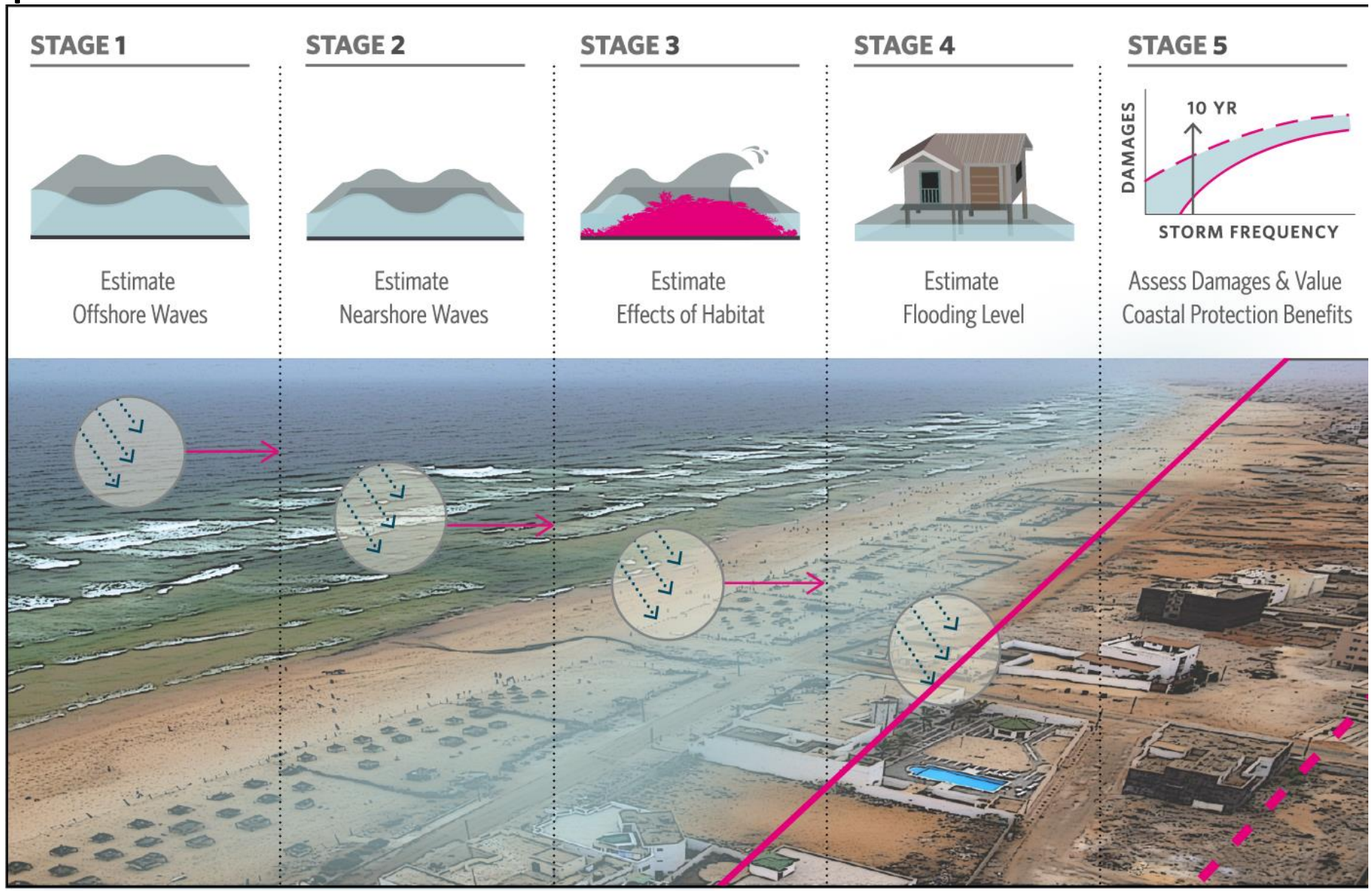


Figure 4.2: Conceptual Diagram of Process-based Steps for the Assessment of Flooding and the Role of Habitats in Flood Reduction

Chapter 5: Approaches for Valuing Coastal Protection Services by Ecosystems

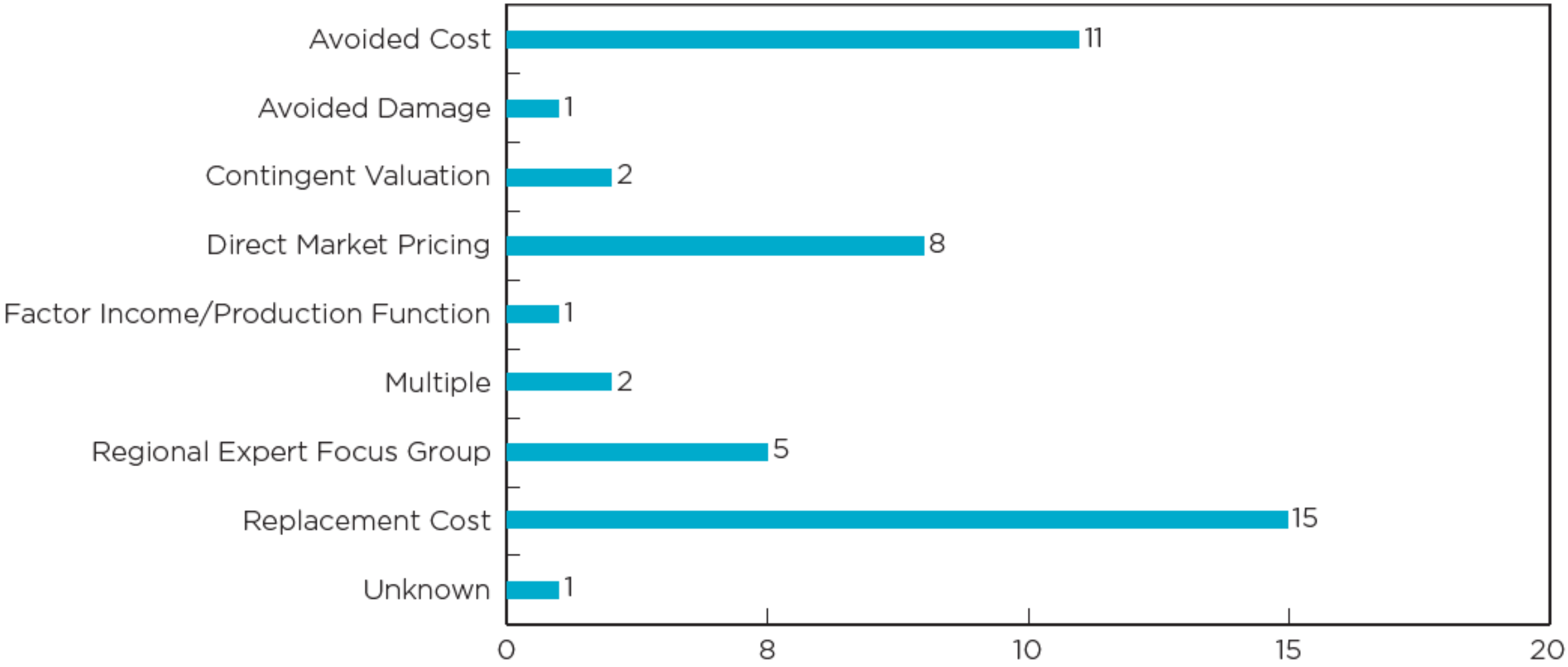


Figure 5.2: Value Estimates for Protective Services, by Valuation Method

Chapter 6: Nature-based Defenses Case Studies in Policy

Location	Decision Target(s)	Type of Information	Key Factors & Lessons Learned
Philippines	Senate Bill 2179, Coastal Greenbelt Act of 2014	• Literature-based Values	• Act under consideration for protection of mangroves for conservation & risk reduction. • Senator Aquino's introduction letter includes values of mangroves for reductions in waves and storm surge. • Act includes long-term program for community-based restoration.
Belize	Belize CZM Plan	• Scenario Analysis	• The CZMAI tasked with developing a CZM plan. Assessed alternatives with InVEST. • Scenario analysis helped identify likely trade-offs. • Difficult to get stakeholder input on alternative scenarios

Chapter 6: Nature-based Defenses Case Studies in Practice

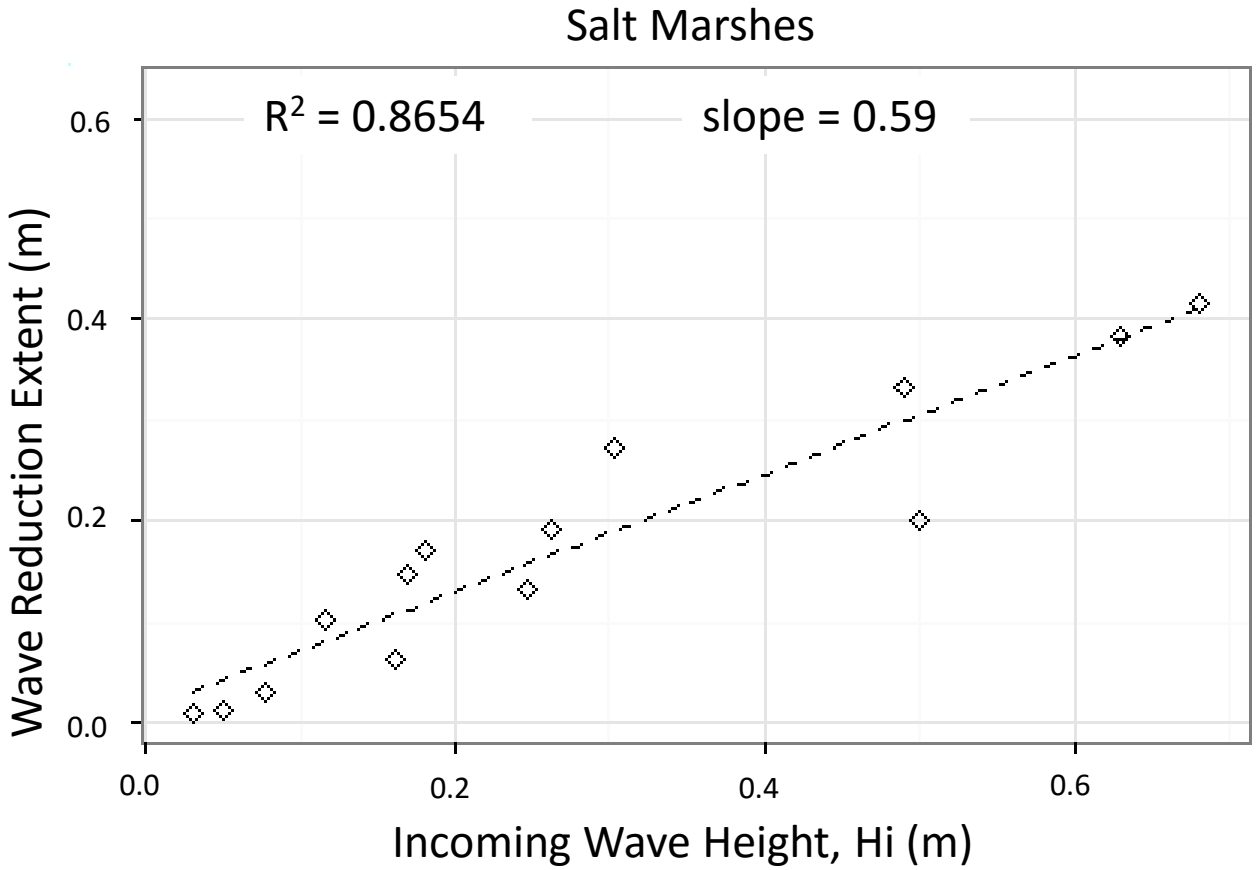
Mangrove Restoration in Indonesia,
Ecoshape Building with Nature Project

Pontee et al., 2015

Oyster Reef Restoration in USA,
TNC Living Shorelines project

NATURE-BASED DEFENSES:
REVIEW OF CURRENT UNDERSTANDING AND EVIDENCE

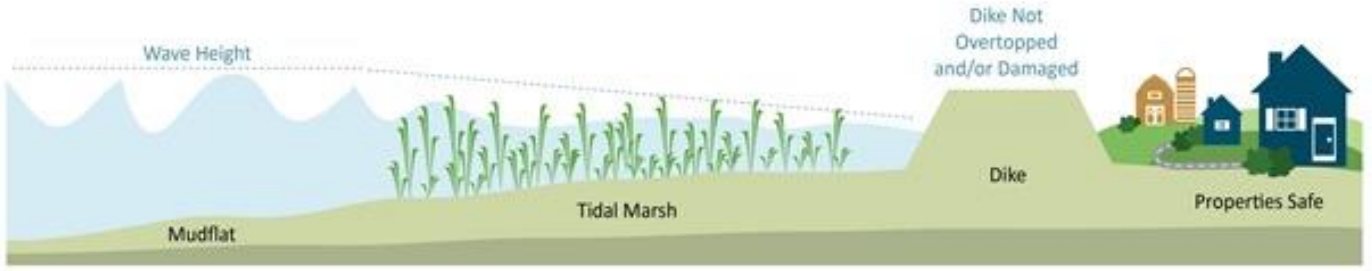
Ecosystems Are Effective at Reducing Wave Heights



Reefs: 70%

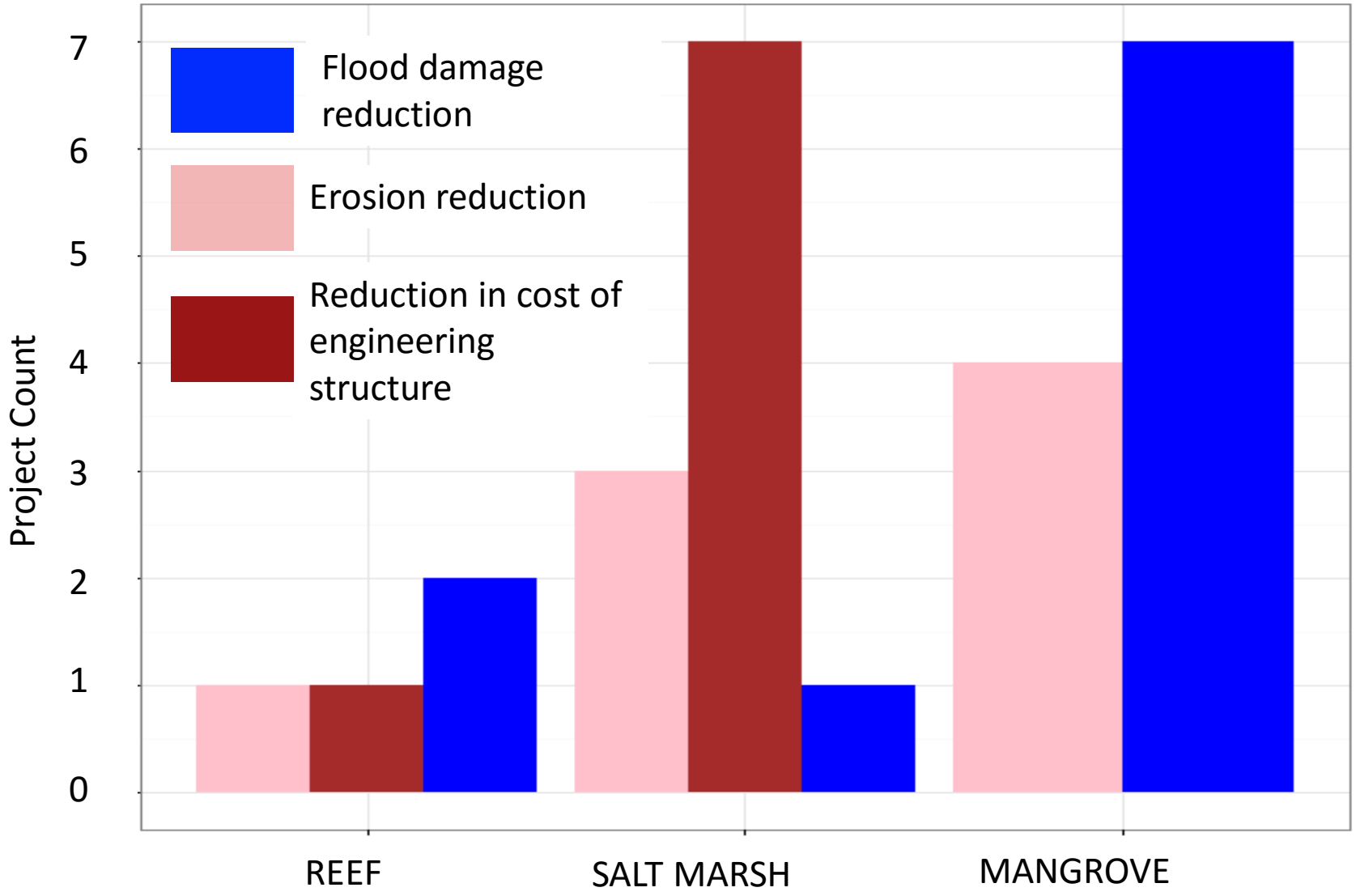
Mangroves: 31%

Seagrass/Kelp: 36%



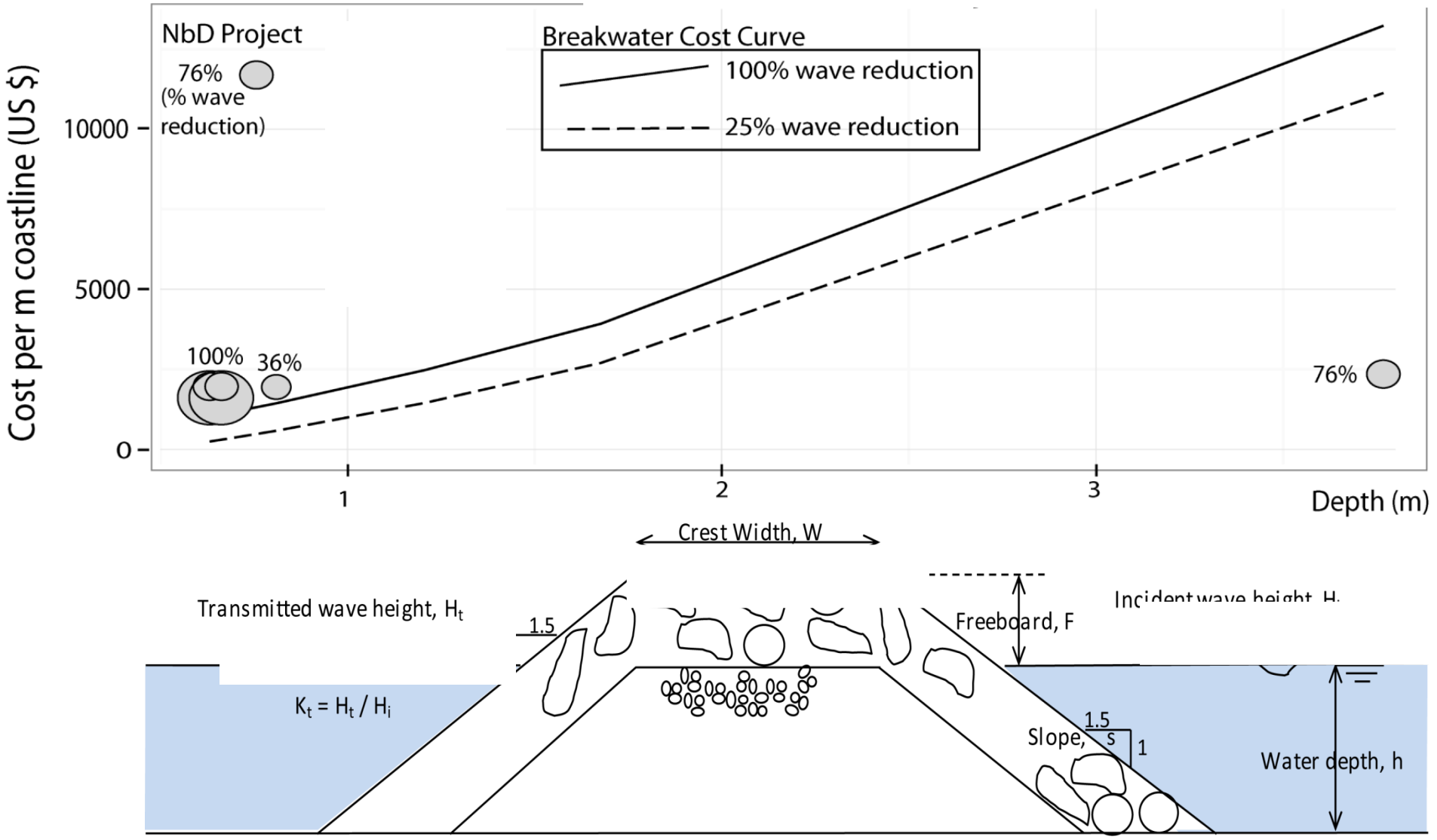
Narayan et al. 2016

Restoration Projects Provide Coastal Protection



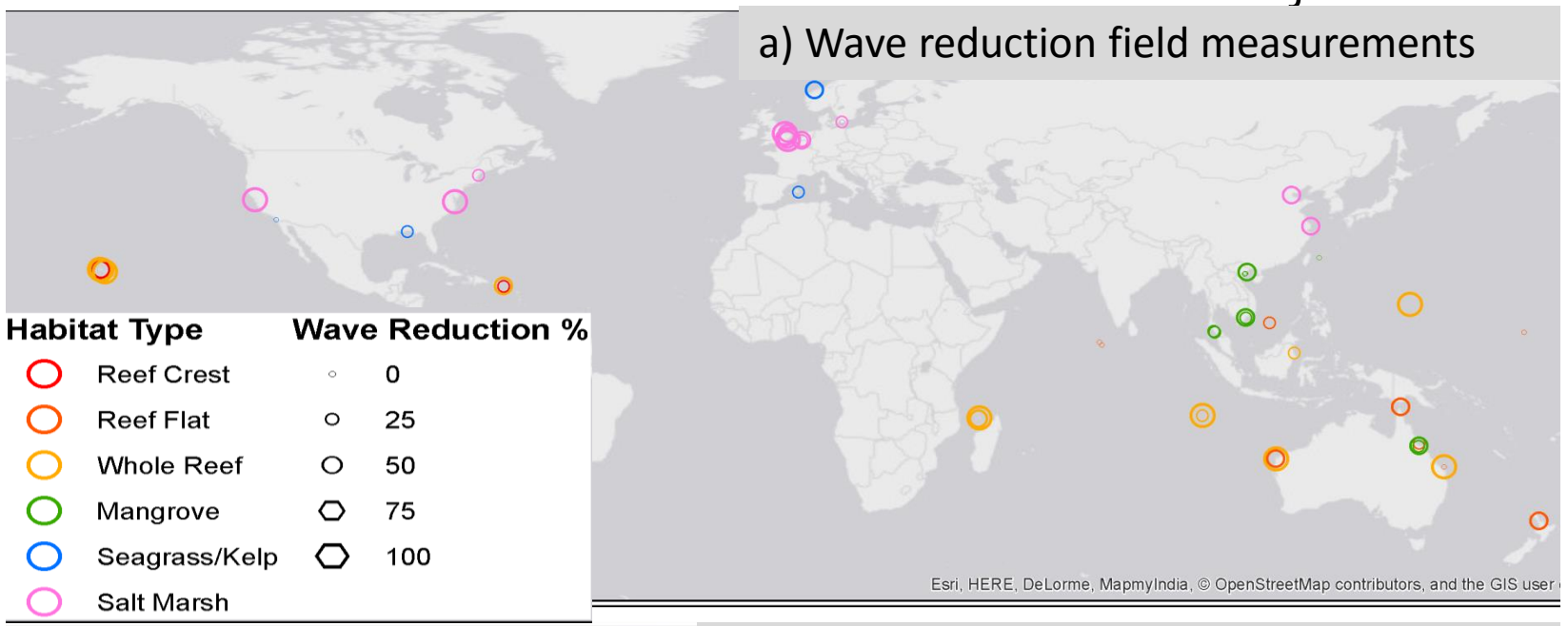
Narayan et al. 2016

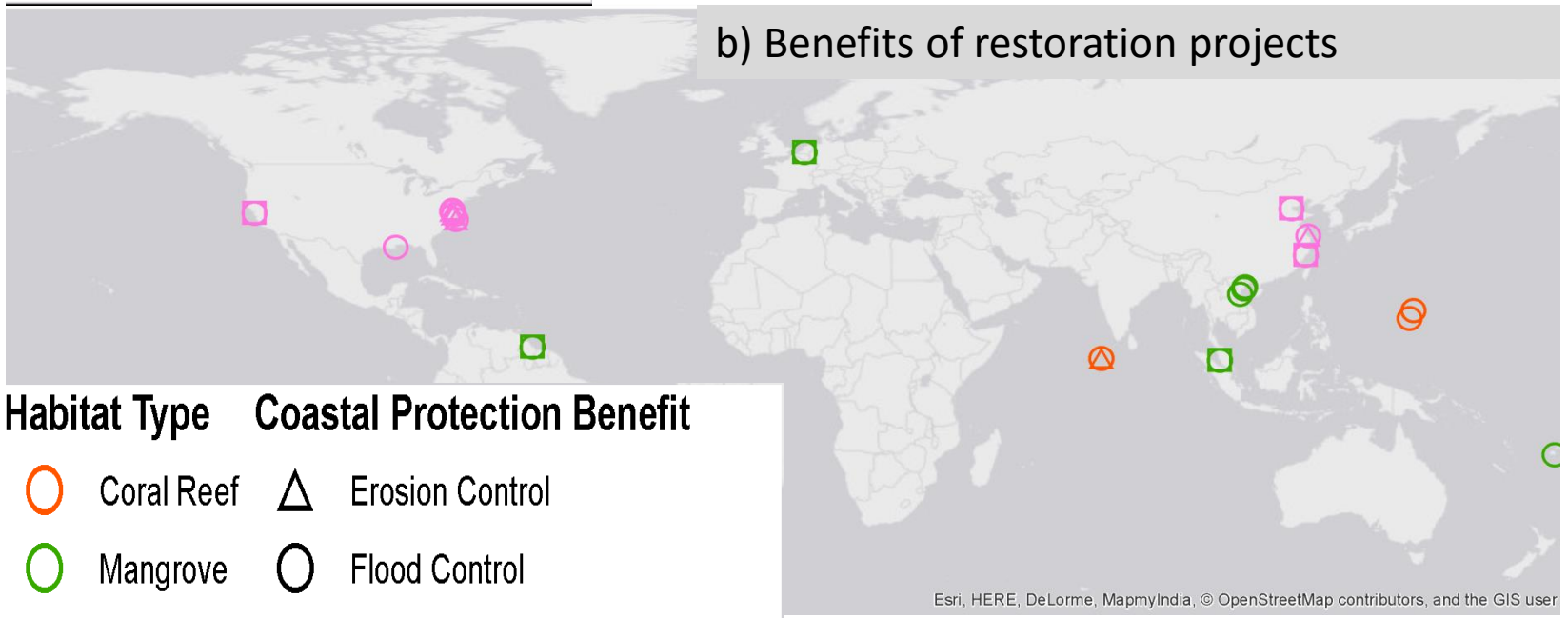
Restored Mangrove and Marsh Defenses are Cheaper than Breakwaters



Narayan et al. 2016

Global Database of Measurements and Projects

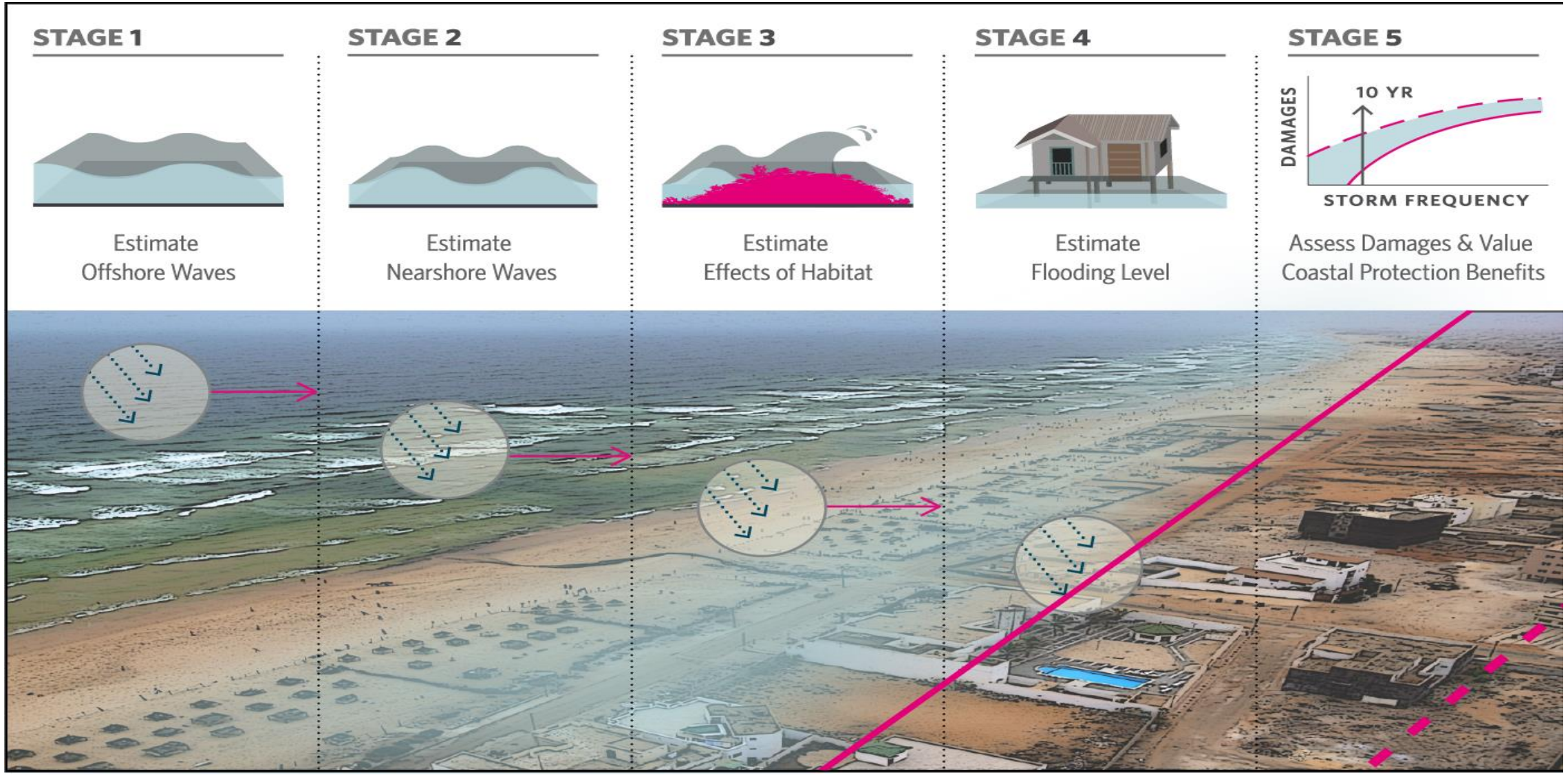




Narayan et al. 2016

ASSESSING COASTAL PROTECTION VALUE OF REEFS AND MANGROVES:
MODELS, PROCESSES AND METHODS

Framework for Estimating Coastal Protection Values



From WB WAVES 2016, Chapter 4

Framework for Estimating Coastal Protection Values

1. Define Coastal Profiles and Study Units (cross-shore profiles for every 2 km, grouped into 20 km study units)

2. Estimate Offshore Waves and Water Levels using global datasets

3. Estimate
   a) Nearshore Waves and Water Levels using best available data
   b) Effect of Ecosystem on Nearshore Waves and Water Levels

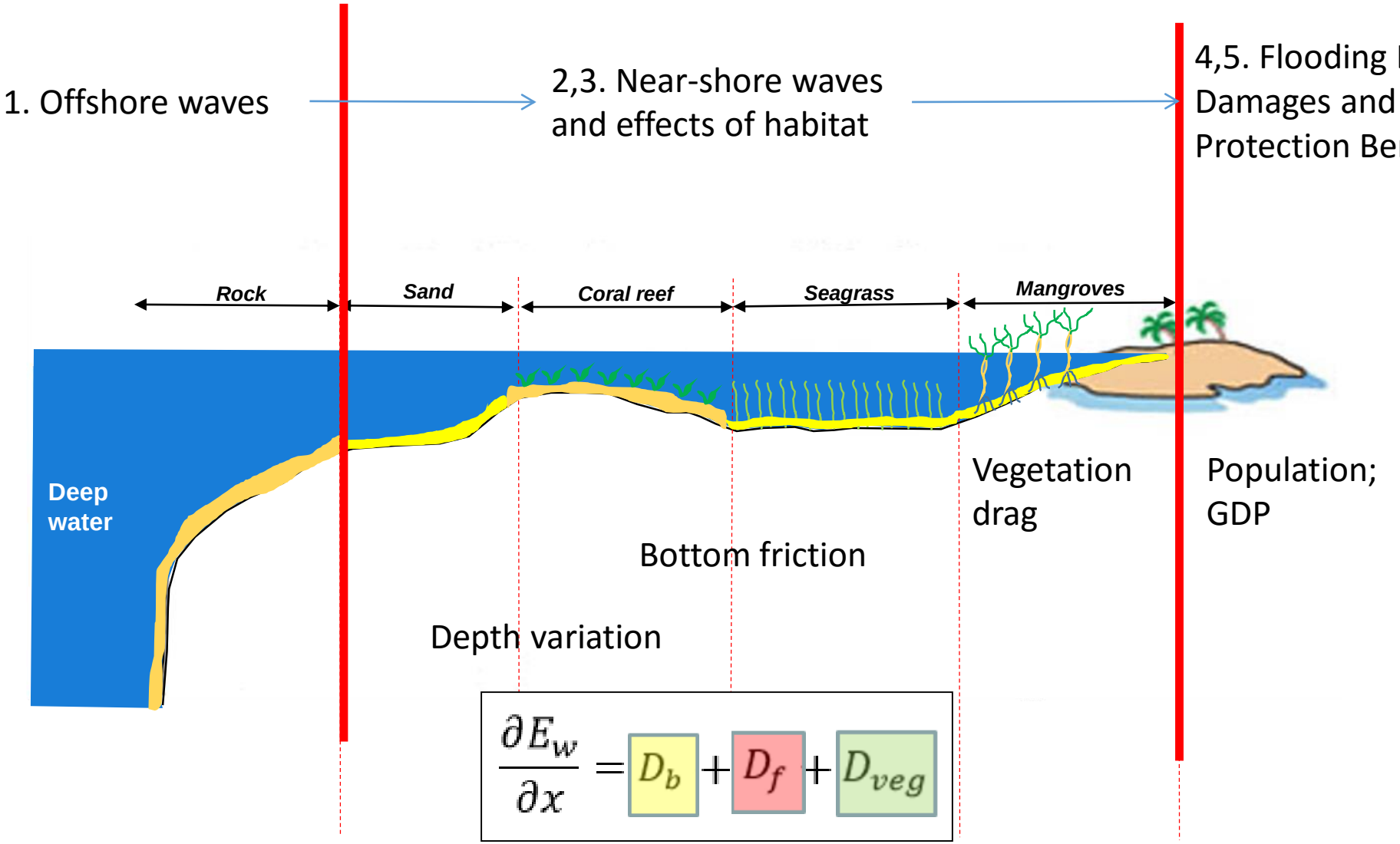
4. Define Extreme Waves and Water Levels along shoreline for 10, 25, 100 year storms

5. Identify land, people and built capital flooded using a global digital elevation model

6. Develop flooding scenario with and without ecosystem presence

Adapted from Beck et al. 2016 (In Review)

Framework for Estimating Coastal Protection Values



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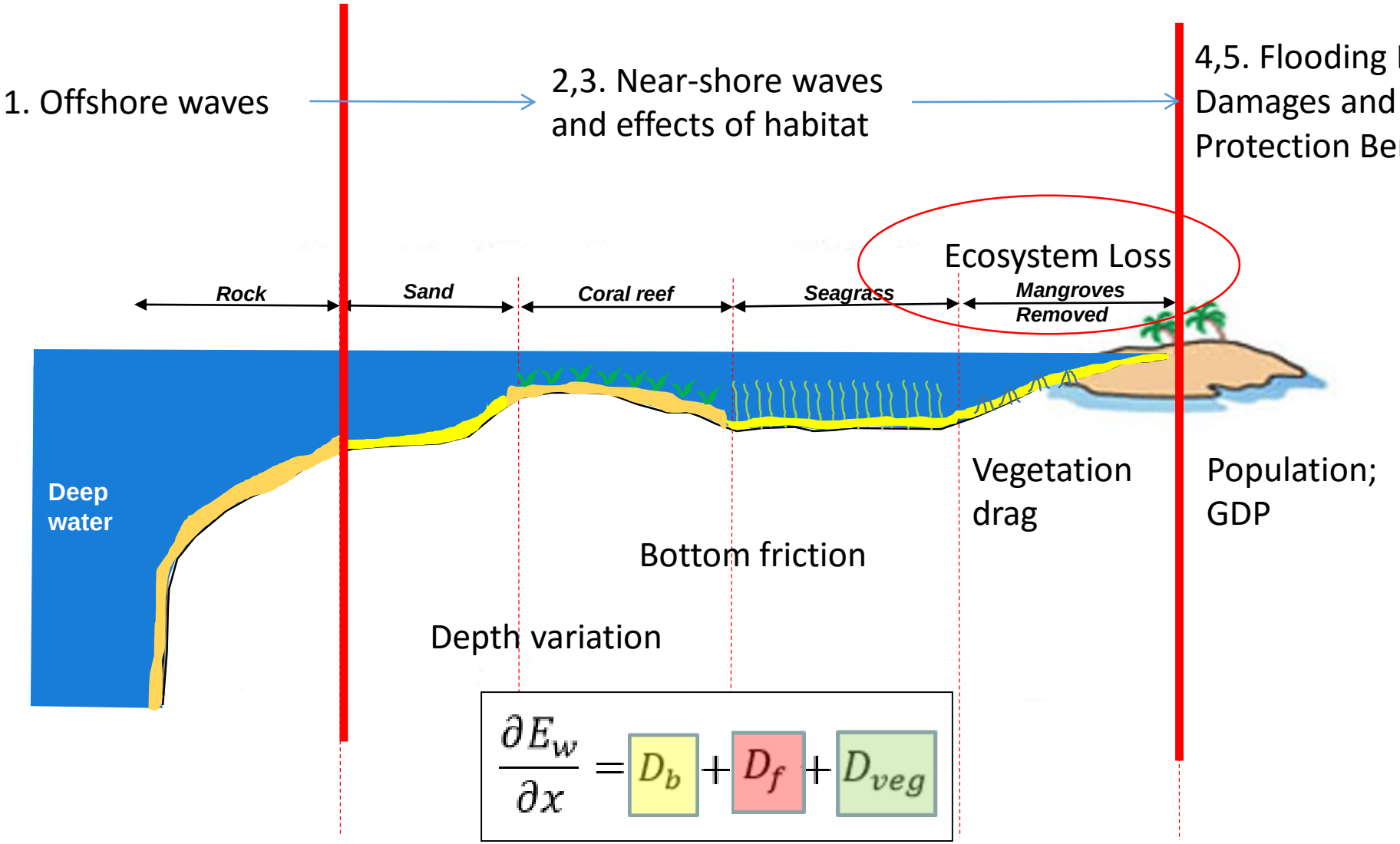
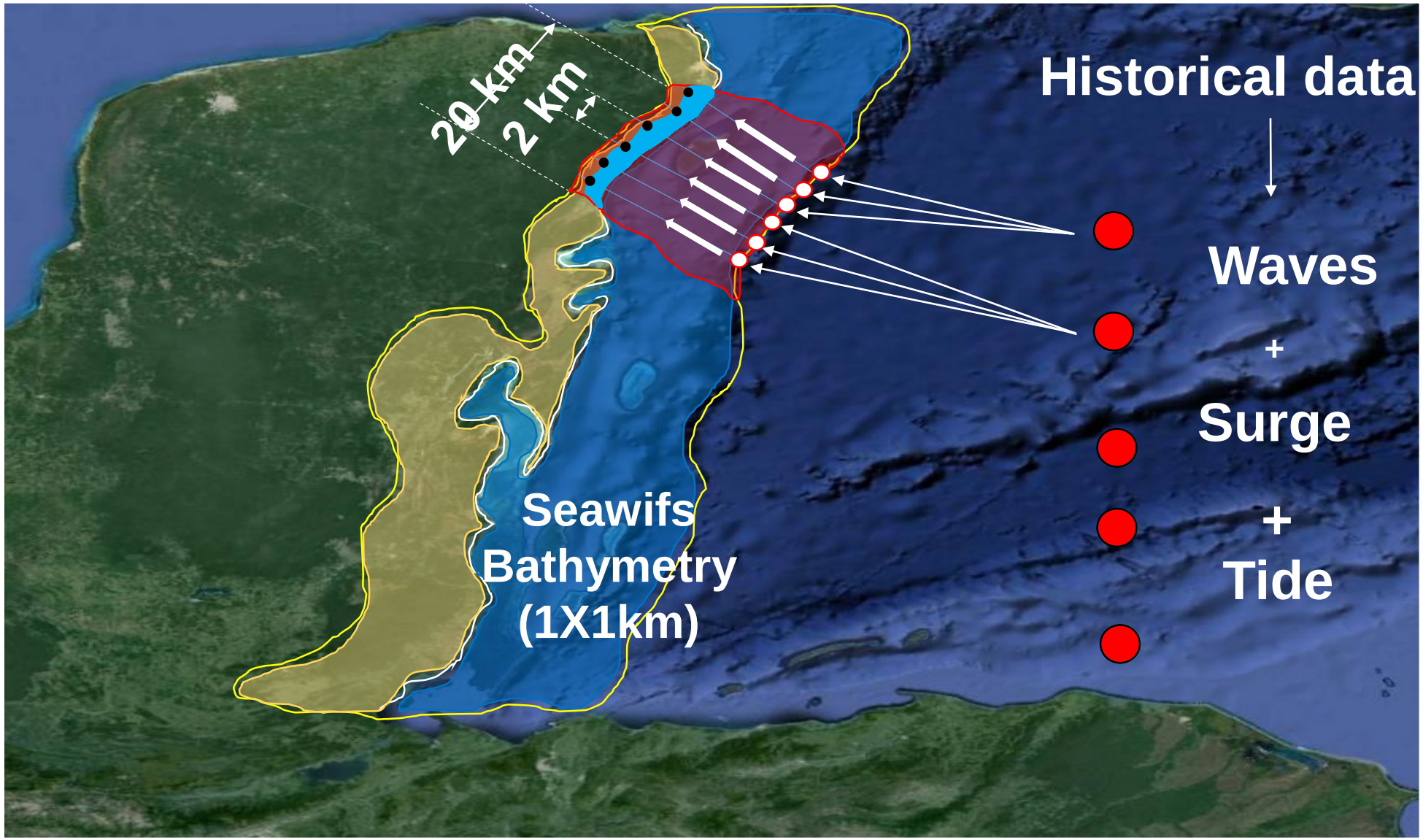
Framework for Estimating Coastal Protection Values



From WB WAVES 2016, Chapter 4

Coastal Protection Model – Setup for Global Model



Adapted from Beck et al. 2016 (In Review)

Coastal Protection Model – Data Requirements

Model Step	Parameters/ Indicators	Data Requirements (Other Parameters??)	Example Data Sources (from WB WAVES Report, Table 4.1)	Data Extent	Philippines Data Availability and Sites
1. Offshore Waves and Water Levels	Sea surface/ Water Level Storms Waves	Altimetry, Storm Tracks, Wave buoys	AVISO, NOAA; UNISYS, NHC, NOAA; Global Ocean Waves, WW3, ERA-20c	Global, 30-arc second (~ 1km)	Global, 30-arc second (~ 1km)

Adapted From WB WAVES 2016, Chapter 4

Coastal Protection Model – Data Requirements

Model Step	Parameters/ Indicators	Data Requirements (Other Parameters??)	Example Data Sources	Data Extent
2. Nearshore Waves and Water Levels	Surge Propagation Wave Propagation	…+ Bathymetry, Shoreline	GEBCO, ETOPO, SEAWIFS; NGIA, GSHHG	Global, 1 degree to 30 arc second
3. Interaction with Ecosystems	Surge Reduction Wave Reduction	…+ Ecosystem Properties: Presence (Extent/ Width) Depth/ Height Species (as proxy for): Density, Diameters, Roughness, etc.	ReefBase, CIESIN (Mangroves), WCMC (Seagrass), WCMC (Wetlands)	Global, 1km

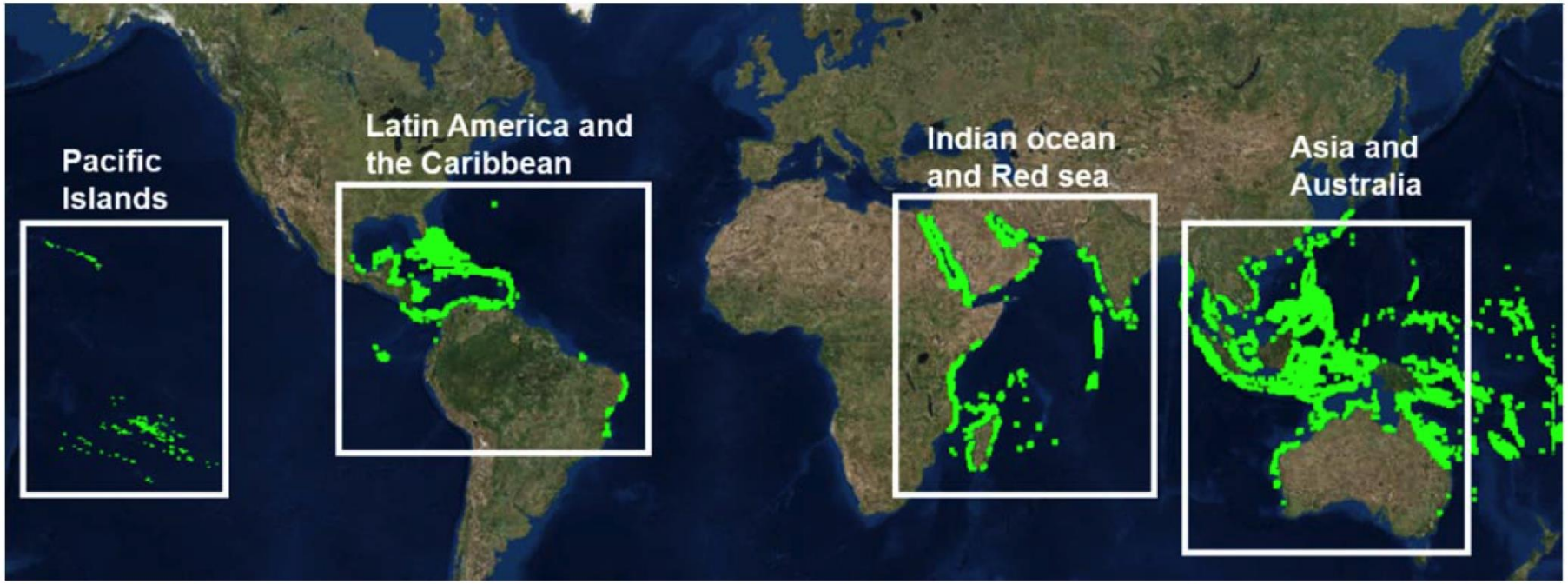
Adapted From WB WAVES 2016, Chapter 4

Coastal Protection Model –Data Requirements

Model Step	Parameters/ Indicators	Data Requirements (Other Parameters??)	Example Data Sources	Data Extent
4. Shoreline and Inland Flooding	By Surge By Wave run-up/ Overtopping	…+ Topography Shoreline Coastal Features Coastal Defenses	NGIA, GSHHG, LOICZ; ETOPO, SRTM 90 m	Global, 90 m
5. Flood Damage/Loss Estimation	Flood Extent Flood Height Flood Damage ($)	…+ Population Land Use/ Property Data SE Vulnerability Indices	World Bank, CIESIN-GPW, CIESIN-GRUMP DIVA	Global, 30 arc second (~ 1km)
6. Model Validation	Inundatioon Extent Mangrove Effects Historical Mangroves			

Adapted From WB WAVES 2016, Chapter 4

Global Coastal Protection Model – Reef Distribution



Coral reefs and analysis regions.
Green dots correspond to coral reef locations globally

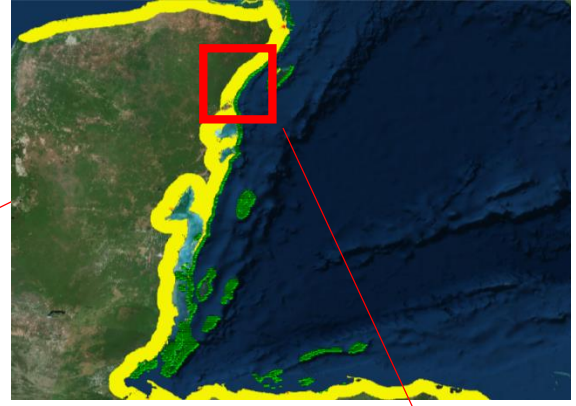
Beck et al. 2016 (In Review)

Global Coastal Protection Model – Estimating Damage

- Built Capital inferred using population data and ratio of Built Capital per Capita to GDP per capita
- % Built Capital Damaged, as function of flood depth
- Damages assessed for specific, with and without ecosystem presence
- Damages also annualized based on built capital versus return period curve

Beck et al. 2016 (In Review)

Global Coastal Protection Model – Outputs



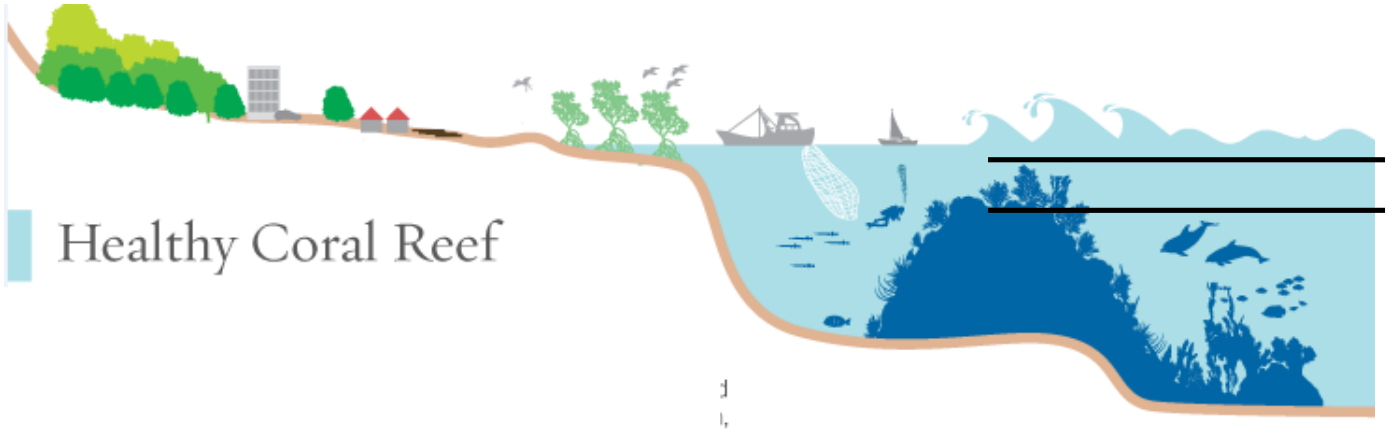
Flooding (25 - Year Event)

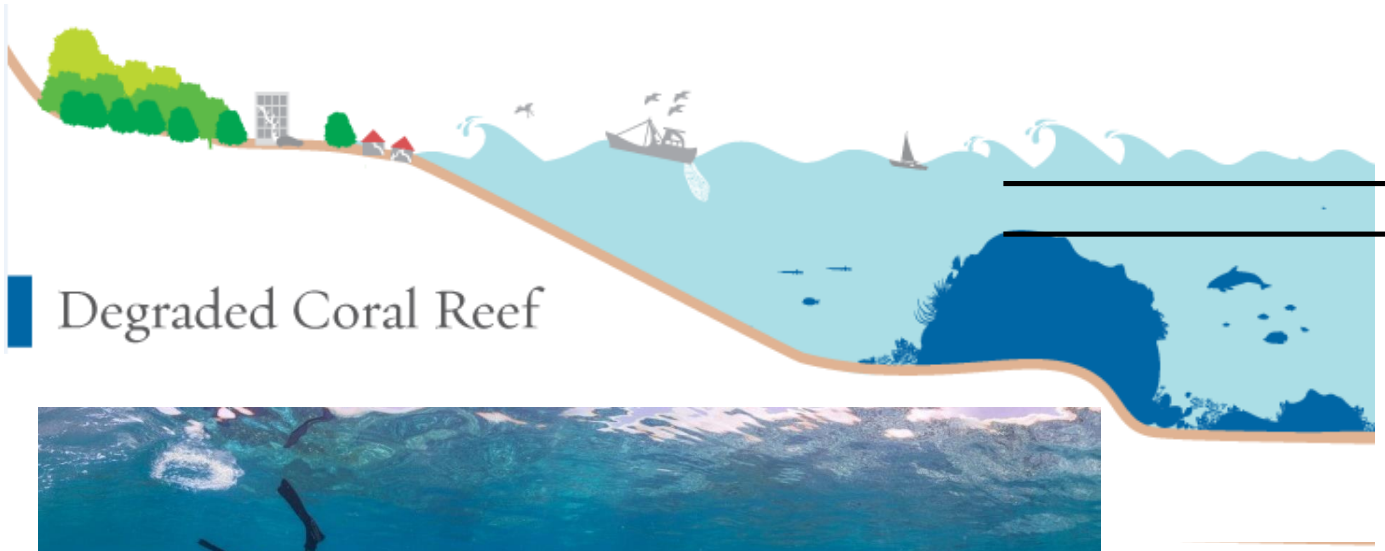
- Current Flooding
- Flooding With 1m Reef Loss

Playa del Carmen

Beck et al. 2016 (In Review)

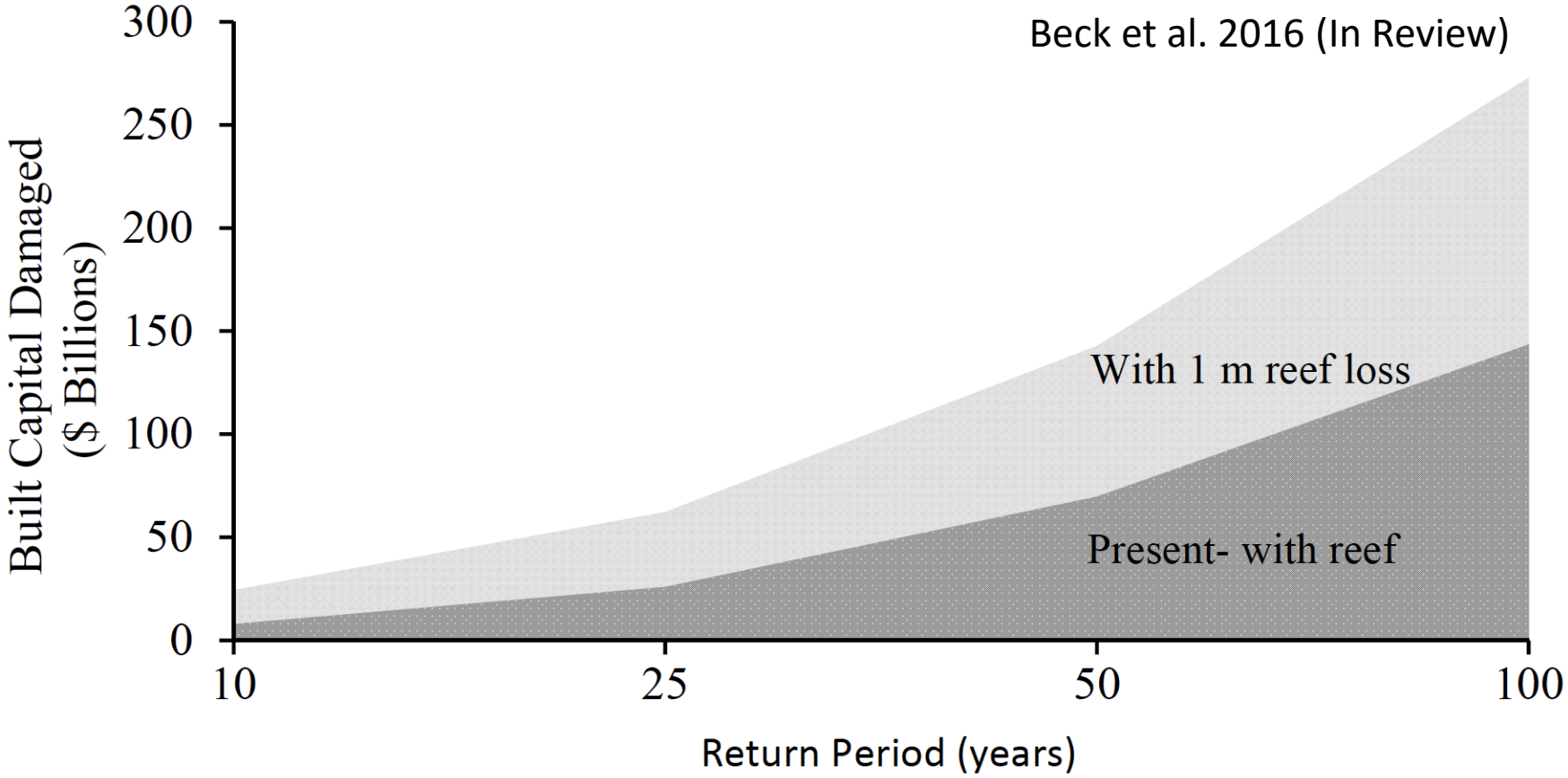
Global Coastal Protection Model – Modelling Coral Reef Loss





Beck et al. 2016 (In Review)

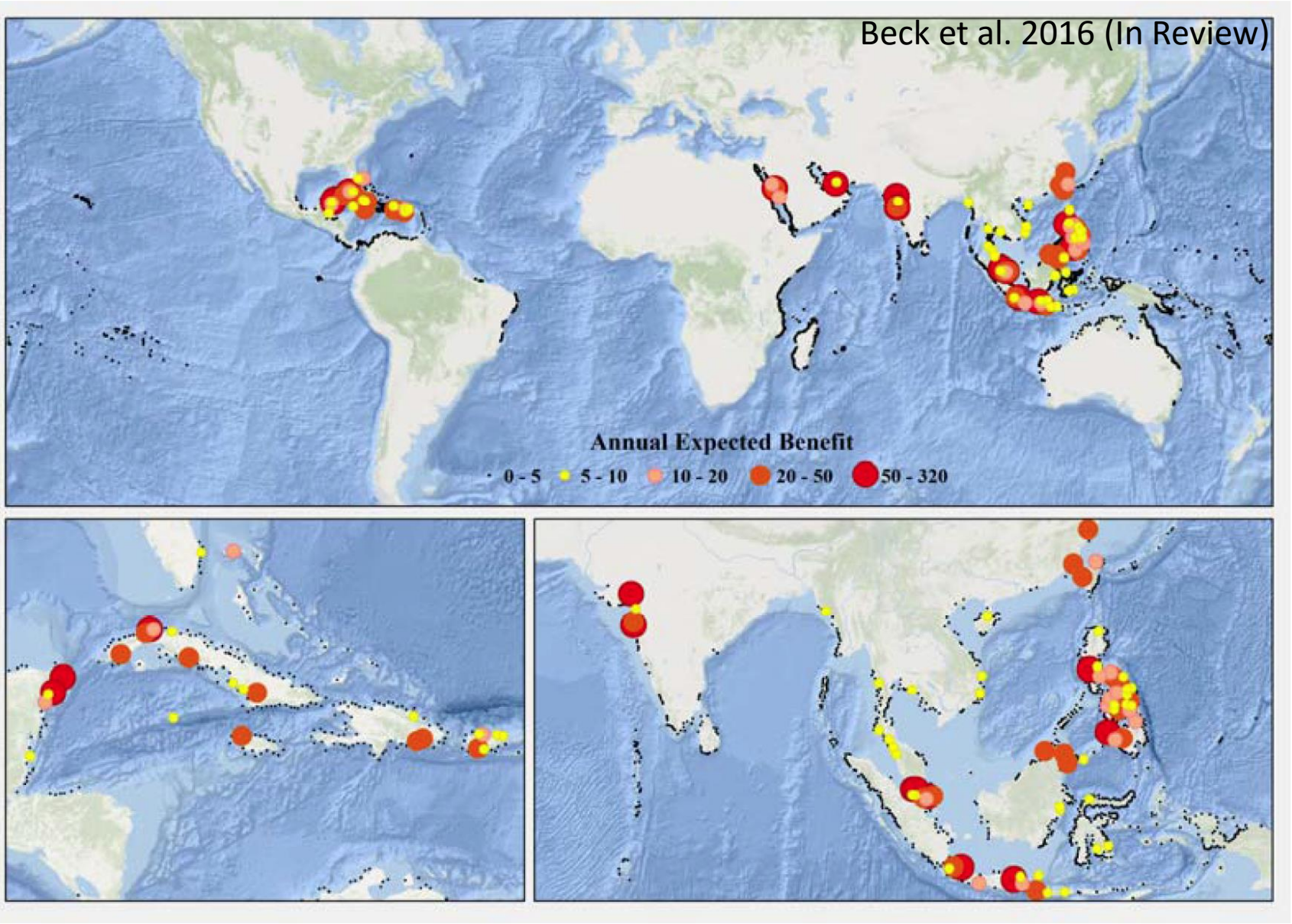
Global Coastal Protection Model – Expected Benefits from Reefs



The expected benefit of coral reefs for flood protection. The values are the damages to global built capital from flooding (in $US billions) at present and with 1 m loss of coral reefs by storm event return period.

Beck et al. 2016 (In Review)

Global Coastal Protection Model – Expected Benefits from Reefs



Annual expected benefits from reefs for flood protection in avoided flooding to land, people, exposed infrastructure and damaged infrastructure US$ million/year.

Beck et al. 2016 (In Review)

Global Coastal Protection Model – Expected Benefits from Reefs

Reef benefits for flood protection from 100-year event in terms of exposure of built capital to flooding with reef loss ($US billions) and relative to total national built capital.

	Built capital flooded (100-yr)		% of the national built capital	
1	Indonesia	36.48	Cayman Islands	6.81
2	Philippines	31.14	Belize	4.28
3	Malaysia	27.07	Grenada	3.76
4	Cuba	19.04	Bahamas	3.70
5	Mexico	18.87	Jamaica	2.67
6	United Arab Emirates	7.84	Cuba	2.61
7	Saudi Arabia	7.29	Philippines	2.37
8	United States	6.55	Dominican Republic	2.19
9	Dominican Republic	4.43	Malaysia	1.54
10	Thailand	2.86	Antigua and Barbuda	1.50
11	Jamaica	2.43	Seychelles	1.14
12	Vietnam	2.26	Turks and Caicos Islands	0.88
13	Taiwan	1.83	New Caledonia	0.83
14	Myanmar	1.04	Pitcairn Islands	0.74
15	Bahamas	0.77	Indonesia	0.72

Beck et al. 2016 (In Review)

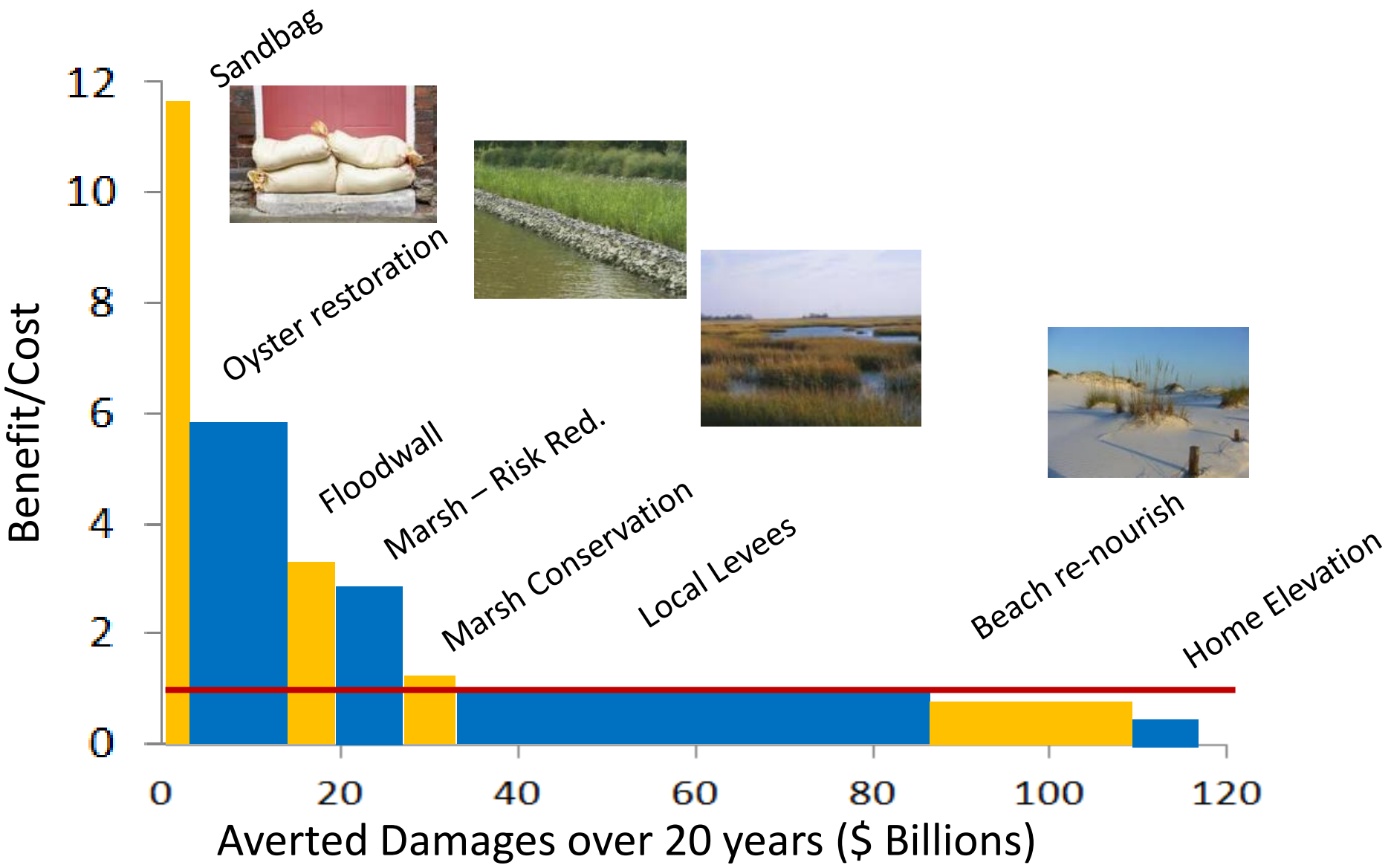
Global Coastal Protection Model – Expected Benefits from Reefs

Annual expected benefit of reefs for flood protection in terms of annual averted damages to built capital ($ millions per year) and relative to Gross Domestic Product (GDP).

	Annual Averted Damages ($ millions)		Annual Averted Damages/GDP	
1	Indonesia	639	Cayman Islands	0.98
2	Philippines	590	Belize	0.37
3	Malaysia	452	Grenada	0.30
4	Mexico	452	Cuba	0.25
5	Cuba	401	Bahamas	0.16
6	Saudi Arabia	138	Jamaica	0.14
7	Dominican Republic	96	Philippines	0.13
8	United States	94	Antigua and Barbuda	0.13
9	Taiwan	61	Dominican Republic	0.11
10	Jamaica	46	Malaysia	0.09
11	Vietnam	42	Seychelles	0.06
12	Myanmar	33	Turks and Caicos	0.06
13	Thailand	32	Guadeloupe	0.05
14	Bahamas	14	Indonesia	0.04
15	Belize	9	Solomon Islands	0.04

Beck et al. 2016 (In Review)

Other Examples: Parametric Model of Cost Effectiveness of Nature-based Defenses



Reguero, Bresch, Beck et al. 2015. Coastal Eng. Proc.

Other Examples: Coastal Wetlands and Flood Damage Reduction

WHITE PAPER (IN REVIEW)

COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models to Assess Natural Defenses in the Northeast US

June 2016

LLOYD'S TERCENTENARY RESEARCH FOUNDATION

UNIVERSITY OF CALIFORNIA SANTA CRUZ

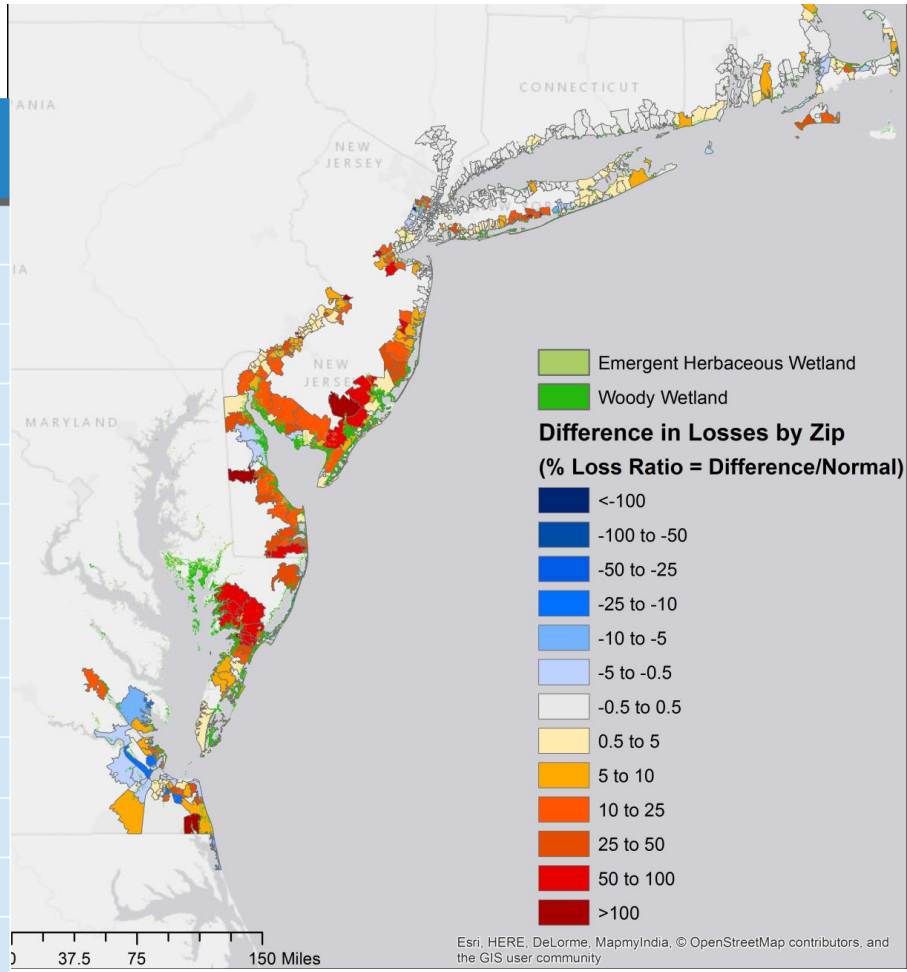
RMS

Narayan et al. 2016 (in preparation)

Other Examples: Coastal Wetlands and Flood Damage Reduction

Expected increase in surge losses without marshes during Hurricane Sandy

State	At Present ($)	With Wetland Loss ($)	Absolute Difference ($)	% Difference
Connecticut	2,181,600,000	2,181,000,000	400,000	0.02
Delaware	228,100,000	251,900,000	23,800,000	10.44
Massachusetts	1,452, 300,000	1,458,600,000	6,300,000	0.43
Maryland	15,500,000	20,000,000	4,500,000	29.07
Maine	17,600,000	17,600,000	3,000*	0.02
North Carolina	9,500,000	8,800,000	-600,000	-6.47
New Hampshire	29,600,000	30,500,000	900,000	3.06
New Jersey	14,014,600,000	14,443,300,000	428,700,000	3.06
New York	32,314,600,000	32,452,800,000	138,200,000	0.43
Pennsylvania	174,400,000	188,000,000	13,700,000	7.85
Rhode Island	72,100,000	72,400,000	300,000	0.43
Virginia	195,400,000	205,300,000	9,900,000	5.06
Total	**50,704,300,000**	**51,330,200,000**	**626,100,000**	--



WHITE PAPER (IN REVIEW) – INDICATIVE RESULTS ONLY

LLOYD'S TERCENTENARY RESEARCH FOUNDATION

UNIVERSITY OF CALIFORNIA SANTA CRUZ

RMS

Narayan et al. 2016 (in preparation)

The Coastal Protection Services of Mangroves in the Philippines: Preliminary Workshop – Day 1, Session 2 (11:00 to 12.00)

On-line Apps and Tools – Brief Intro to Some Resources (30 min)

- Coastal Resilience
- Mapping Ocean Wealth (Country Snapshots)
- Grenada Coral Reef Restoration- presentation and video
- Philippines Country Snapshot - Examination of Philippines Country Stats and Data from Global Analyses (e.g. MOW Atlas)

Assessment and Use of Nature-based Defenses – Example Videos

1. Grenada Coral Reef Restoration – 3.5 minutes

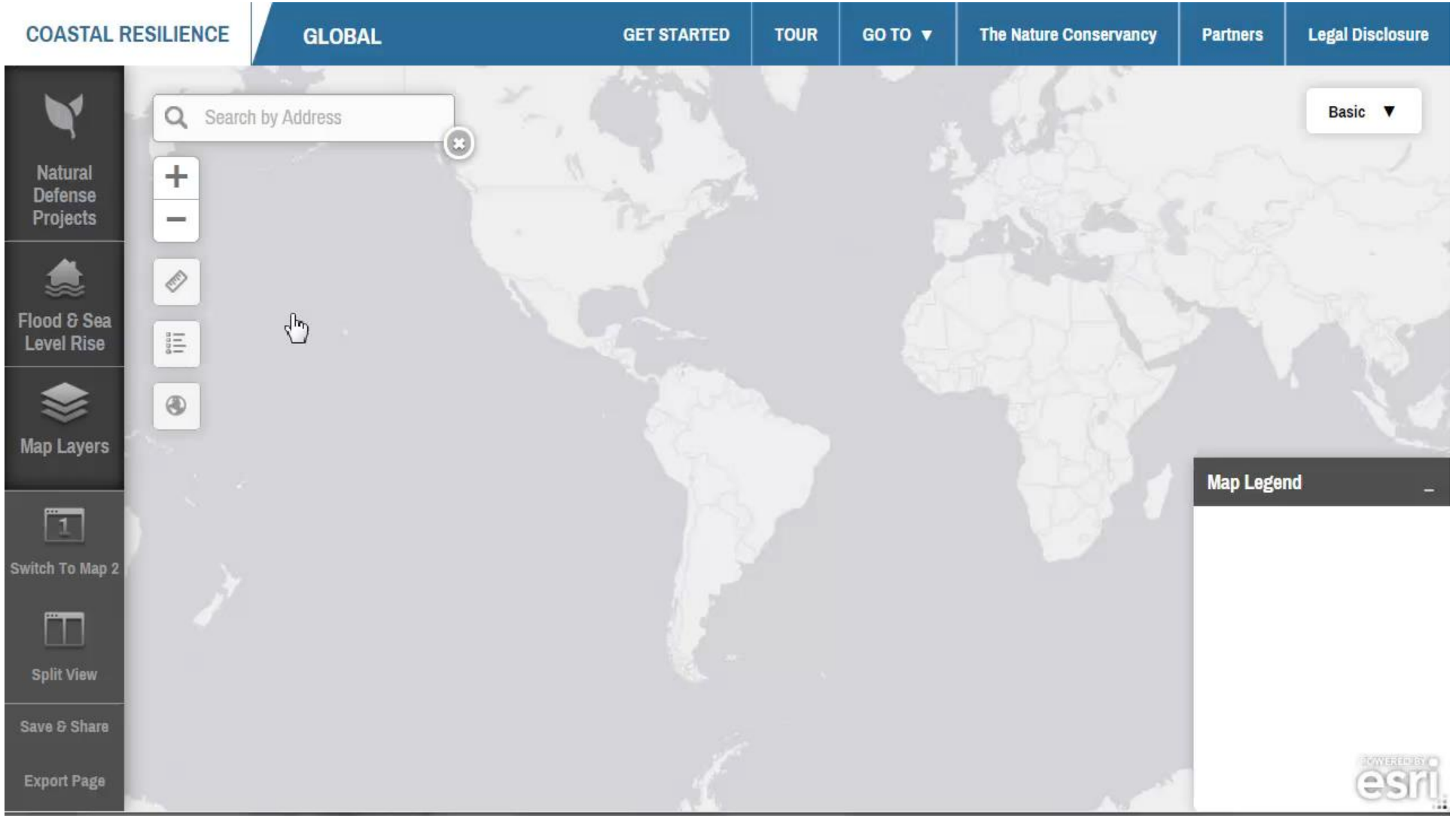
2. Building with Nature Indonesia (Dutch with Eng Subtitles) – 2.5 minutes

3. Coastal Resilience Videos
    a. Coastal Defense App in Florida – 1 minute
    b. Economics of Climate Adaptation Preview – 2.5 minutes

4. Ecosystem Model Parameters – IH Cantabria Flume Experiment – 1.5 minutes

SNAPP Natural Defense Projects Database

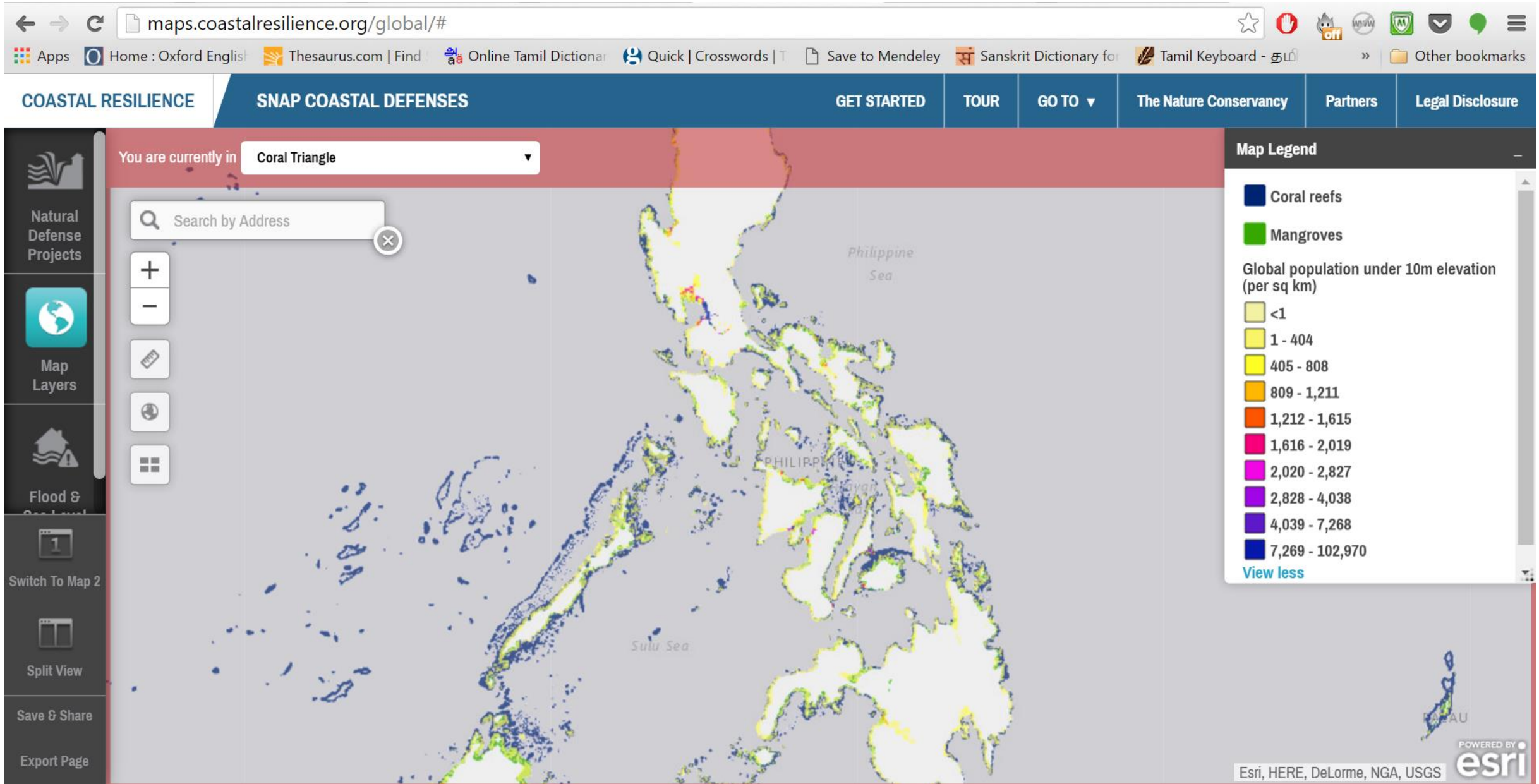
maps.coastalresilience.org/global – “Natural Defense Projects”



https://tnc.app.box.com/s/qzjka3q1wm859a7ux221xulweipw3or9

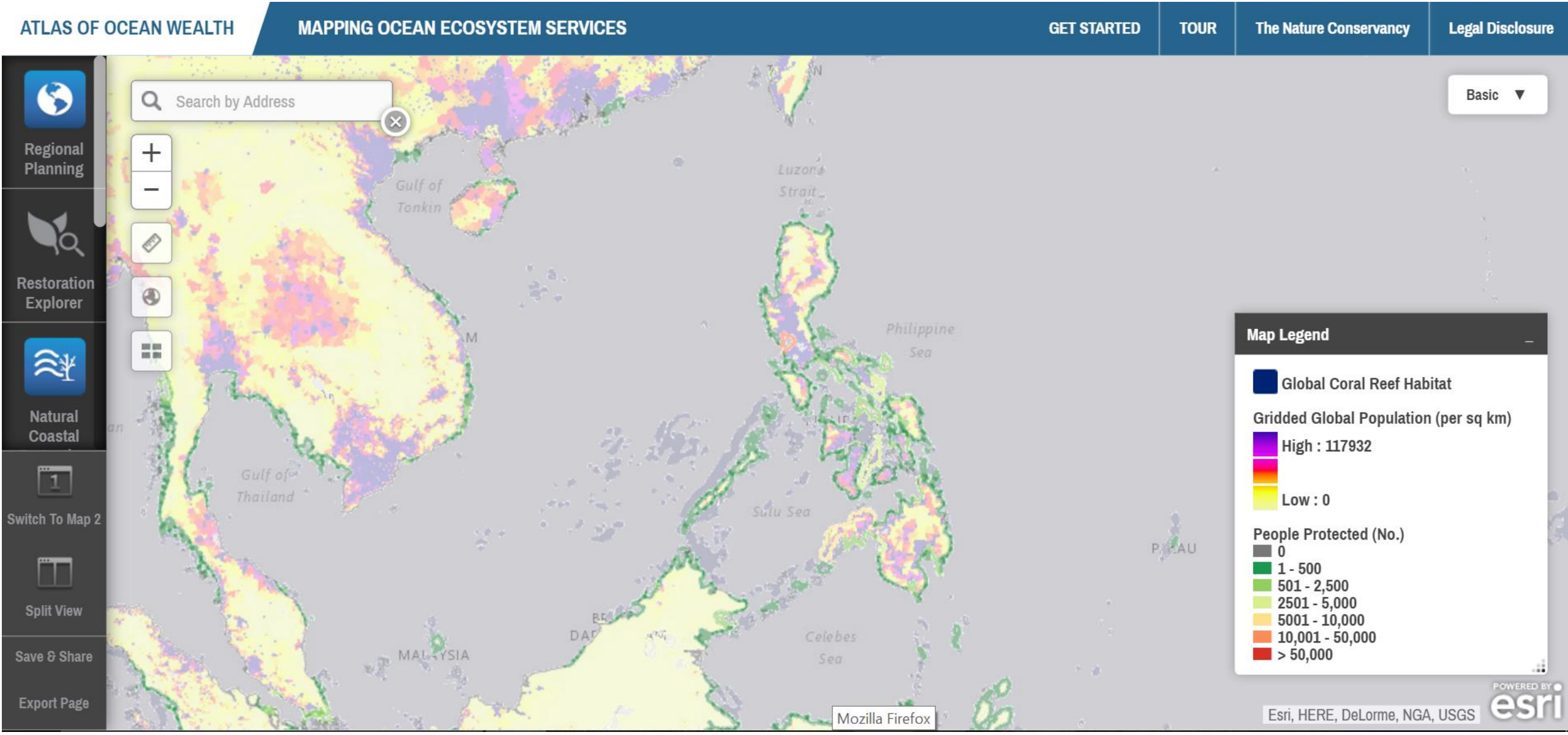
Coastal Resilience Mapping Tool

http://goo.gl/i3gXFJ - Coastal Resilience (maps.coastalresilience.org/global)



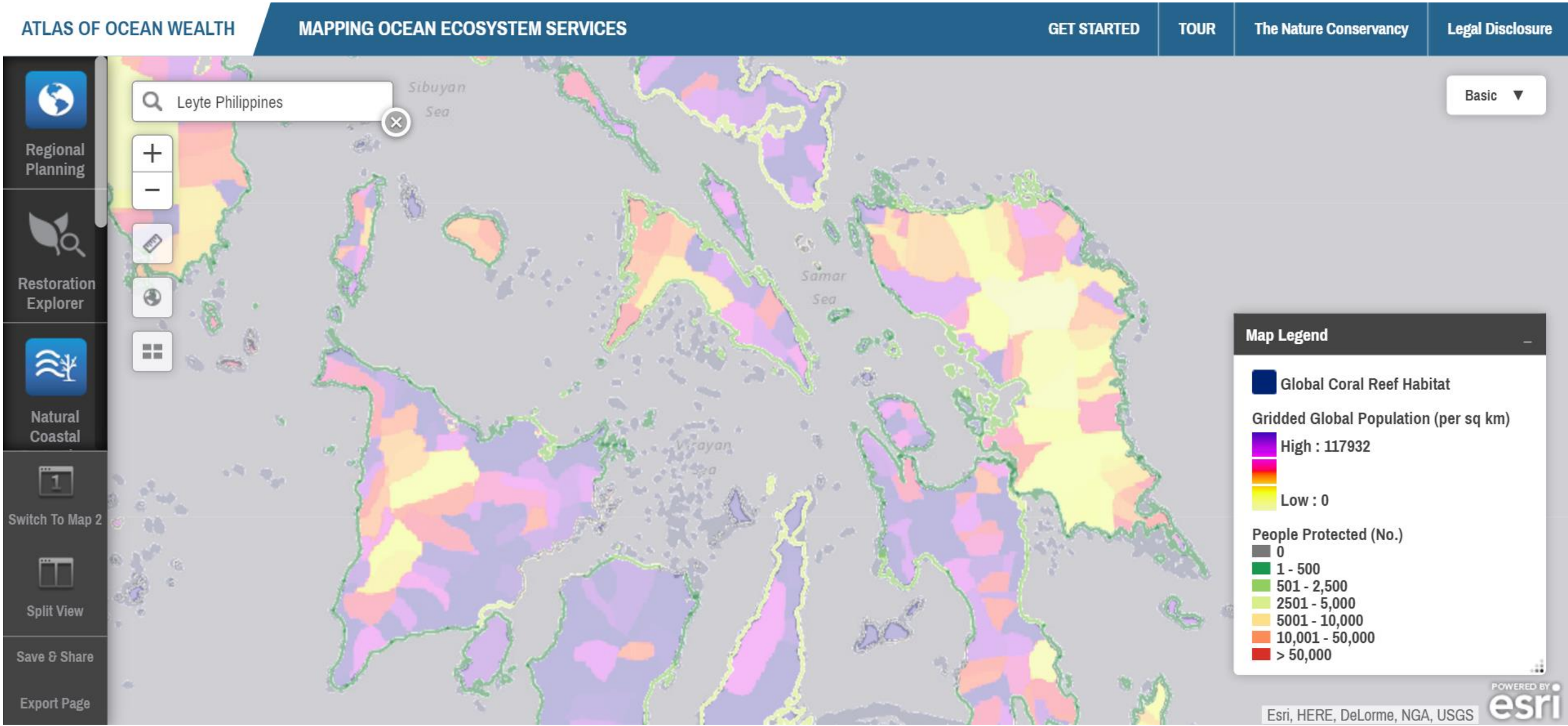
Mapping Ocean Wealth – People Protected by Reefs

http://goo.gl/lo2m0A - Mapping Ocean Wealth (maps.oceanwealth.org/#)

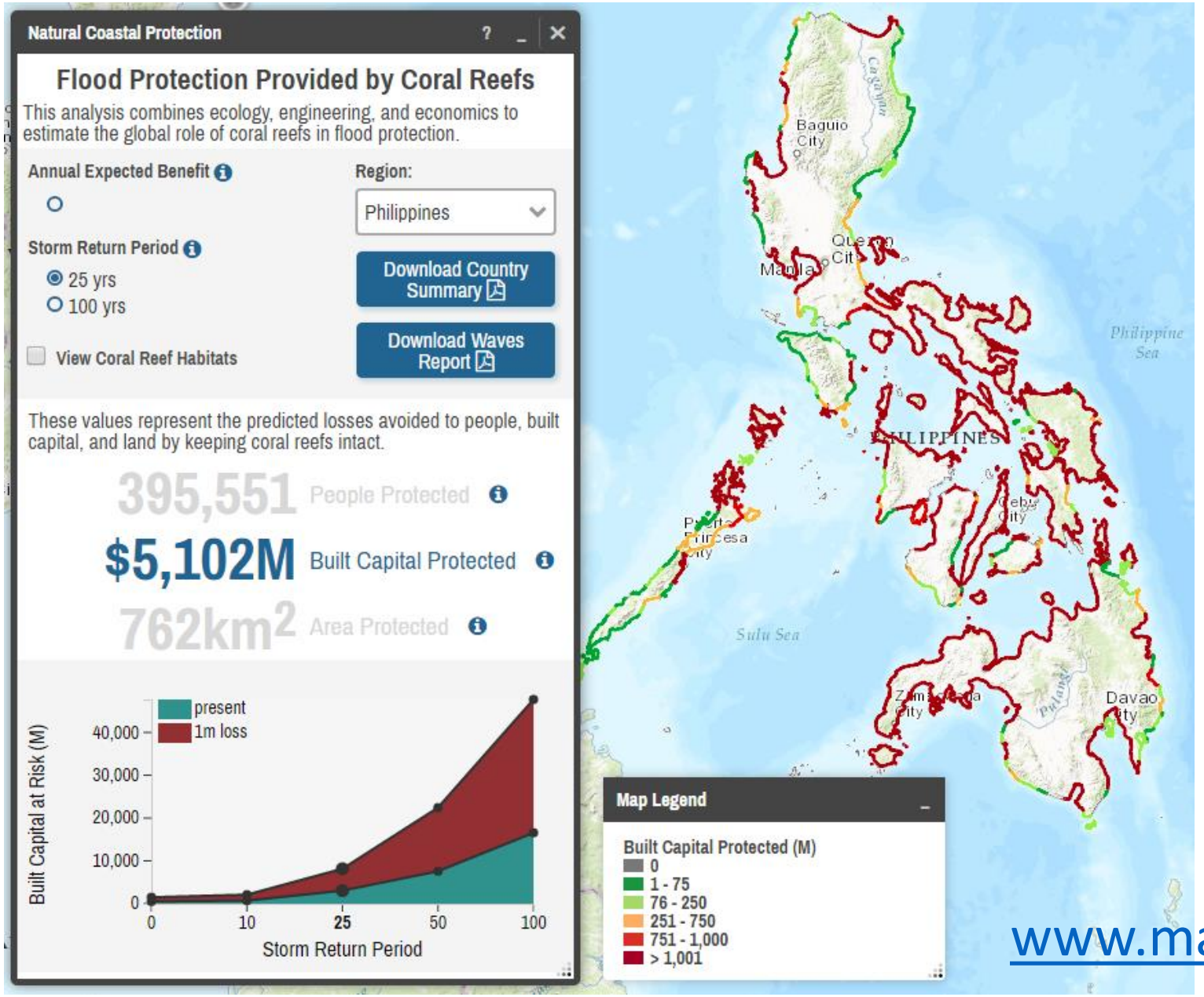


Mapping Ocean Wealth – People Protected by Reefs

http://goo.gl/BhTuqs - Mapping Ocean Wealth (maps.oceanwealth.org/#)



Mapping Ocean Wealth – Country Snapshot



www.maps.oceanwealth.org

ONLINE COASTAL RESILIENCE TOOLS

Some Online Coastal Resilience Tools and Apps

1. Flooding and Sea Level Rise App – 15 minutes (Ventura County, CA) – Flood and Erosion Risk, with Impacted Infrastructure / Land-Use

2. Coastal Defense App – 12 minutes (SE Florida, assessing wave reduction by coral reef restoration in Miami)

3. Risk Explorer App – 10 minutes (SE Florida, exploring multiple layers)

(NOTE: This is different from "Flood Risk Explorer" App on the same page)

To access on your laptop:

1. Go To http://coastalresilience.org/training/
2. Click on Try Me! in the Menu on the left
3. Scroll to find the App description and click on Get Started

DAY 1 PARTNER PRESENTATIONS

DAY 1 DISCUSSION

For Discussion

Philippines Data Availability for Model and Ecosystem Parameters

a) Nearshore Waves and Surges – Nearshore Bathymetry
b) Interaction with Ecosystems – Ecosystem Properties
c) Coastal Protection Value – Inland Population, Assets and Vulnerability
d) Model Validation – Historic Inundation, Damages, Other (??) Data

Ecosystem Evaluation Model – National Data Requirements

Model Step	Parameters / Indicators	Data Requirements (Other Parameters??)	Example Data Sources	Data Extent	Philippines Data Availability and Site
2. Nearshore Waves and Water Levels	Surge Propagation Wave Propagation	…+ Bathymetry, Shoreline	GEBCO, ETOPO, SEAWIFS; NGIA, GSHHG	Global, 1 degree to 30 arc second	Higher Resolution? NAMRIA Depth-Sounding Points Data
3. Interaction with Ecosystems	Surge Reduction Wave Reduction	…+ Ecosystem Properties: Presence (Extent/ Width) Depth/ Height Species (as proxy for): Density, Diameters, Roughness, etc.	ReefBase, CIESIN (Mangroves), WCMC (Seagrass), WCMC (Wetlands)	Global, 1km	Higher Resolution? PSA Land Cover data disaggregated by tidal inundation (to give primary species)??

Adapted From WB WAVES 2016, Chapter 4

Ecosystem Evaluation Model – National Data Requirements

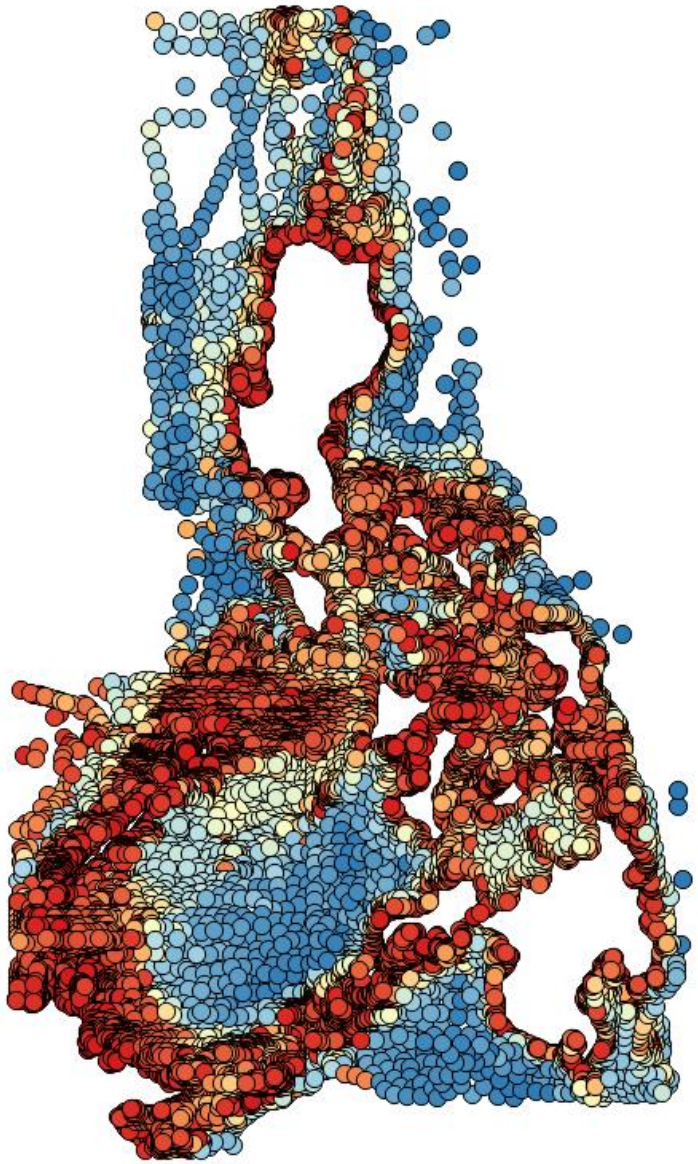
Model Step	Parameters/ Indicators	Data Requirements (Other Parameters??)	Example Data Sources	Data Extent	Philippines Data Availability and Site
4. Shoreline and Inland Flooding	By Surge By Wave run-up/ Overtopping	…+ Topography Shoreline Coastal Features Coastal Defenses	NGIA, GSHHG, LOICZ; ETOPO, SRTM 90 m	Global, 90 m	IFSAR 5 m resolution – NAMRIA Mapping Authority; PAGASA Inundation Maps; Philippines Hazard Maps (Erosion)
5. Flood Damage/Loss Estimation	Flood Extent Flood Height Flood Damage ($)	…+ Population Land Use/ Property Data SE Vulnerability Indices	World Bank, CIESIN-GPW, CIESIN-GRUMP DIVA	Global, 30 arc second (~ 1km)	Higher Resolution? PSA data from housing enumerations??

Adapted From WB WAVES 2016, Chapter 4

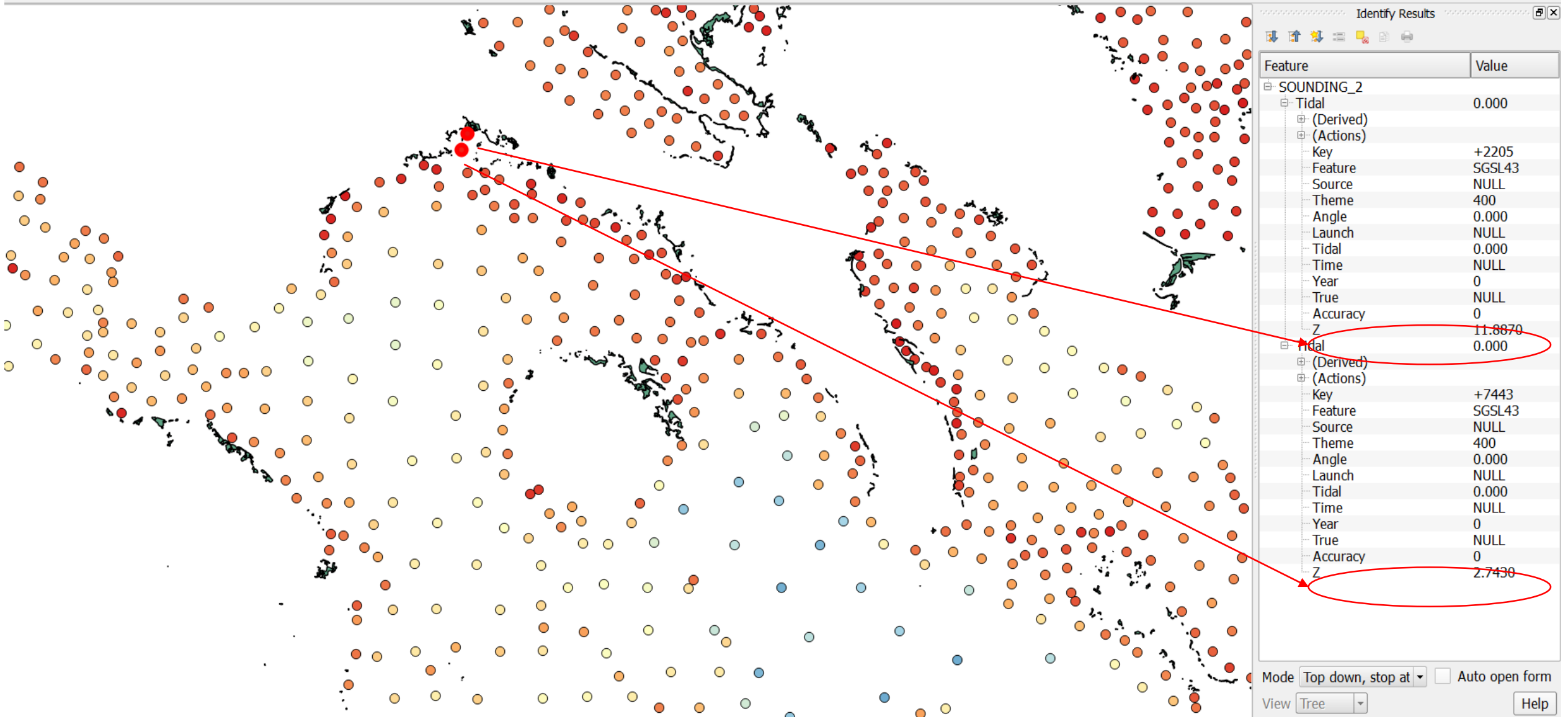
For Discussion: Ecosystem Evaluation Mode Study Sites and Requirements

Bathymetry	Mangrove Characteristics	Topography	Asset/Socio-Economic Data	Validation Data
Data: Habitat Maps Agency: CoRVA Extent/ Resolution: Availability (Time):??	Agency: PHIL-LIDAR (UP C-Eng) Funding: CCC Extent: National (Samar, Leyte Completed)	Agency: PHIL_LIDAR (UP C-Eng) Extent: Samar/Leyte Data: LiDAR (1 m) Availability: ??	Agency: Gem/ PHIL-LIDAR (UP C-Eng)/ Funding: CCC Extent: National (Samar, Leyte Completed)	
Agency: MSI Extent: El Nida Data: Bathymetry /Reef Maps Availability: Now.	Data: Habitat Maps Agency: CoRVA Extent/ Resolution: Availability (Time):??			
	Agency: Dr. Samson(De LaSalle)/ Dr Rollon (UP) Extent: ?? (Haiyan – Samar/Leyte) Data: Mangrove Community Structure/Sedimentation Rates Availability: ??			

Philippines Data Example: Depth Sounding Points from NAMRIA



Philippines Data Example: Depth Sounding Points from NAMRIA



DAY 1 WRAP-UP

(Information Requests for Day 2?)

THANK YOU!

- Links to some natural defense databases
  - http://www.maps.coastalresilience.org/global/# - SNAPP Coastal Defenses, USA
  - http://www.naturalcapitalproject.org/ - Natural Capital Project, USA
  - http://mycopri.org/ - Living shorelines Database, USA
  - http://el.erdc.usace.army.mil/ewn/ - Engineering with Nature, USA
  - http://www.ecoshape.nl/overview-bwn.html - Building with Nature, Netherlands
  - http://www.omreg.net/ - Managed Realignment Database, UK