Coastal ADAPT
(Coastal Adaptation Decision And Planning Tool)

An Adaptation and Resiliency Toolkit for Coastal Communities Vulnerable to Sea Level Rise and Climate Change

Dr. Cheryl Hapke
Dr. Dave Revell
Dr. Craig Jones (Integral Consulting)

Coastal Science Solutions

integral consulting inc.

Revell Coastal

Adaptation Tool Kit:
Sea-Level Rise
and Coastal Land Use

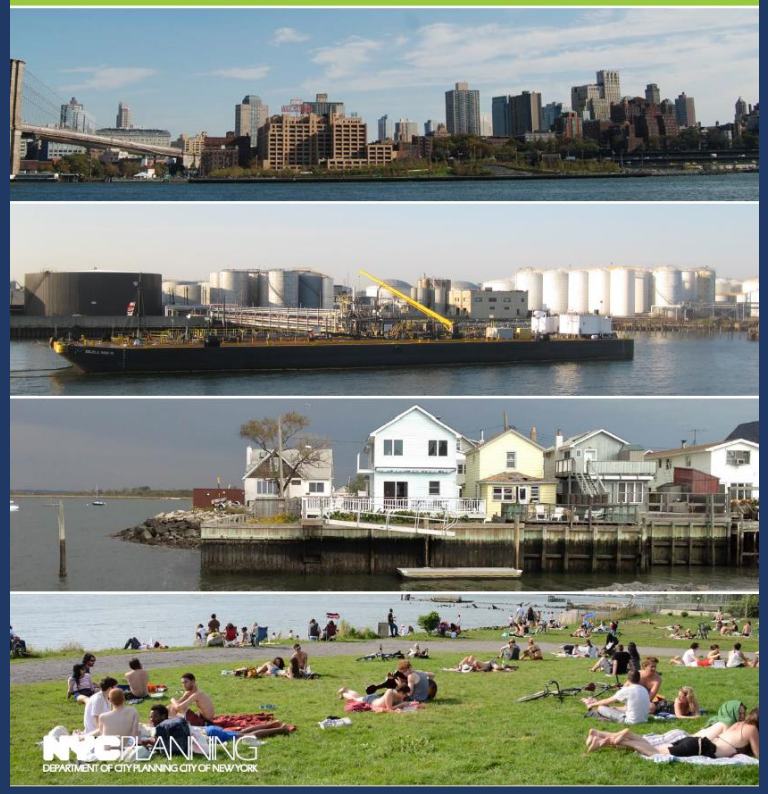
How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy

Florida Adaptation Planning Guidebook

COASTAL CLIMATE RESILIENCE

Urban Waterfront Adaptive Strategies



RISC-KIT

Resilience-Increasing Strategies for Coasts – Toolkit
www.risckit.eu

e (2019) 153:491–507
0.1007/s10584-018-2200-8

CrossMark

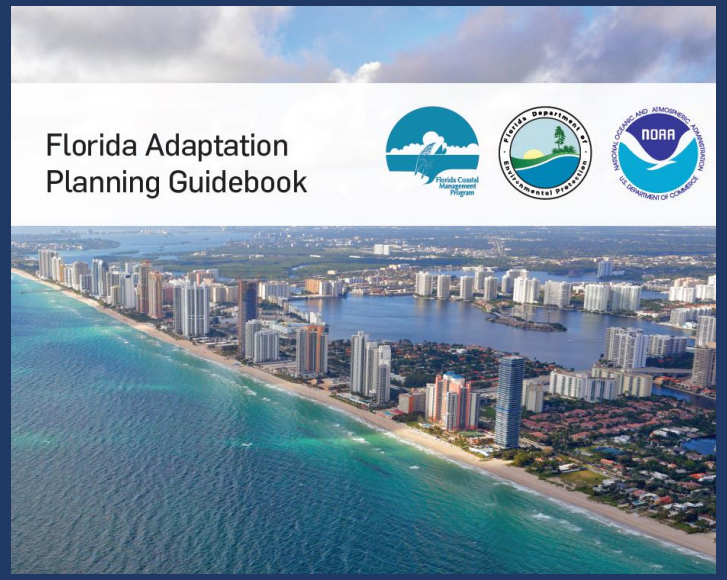
CoastAdapt: an adaptation decision support framework for Australia's coastal managers

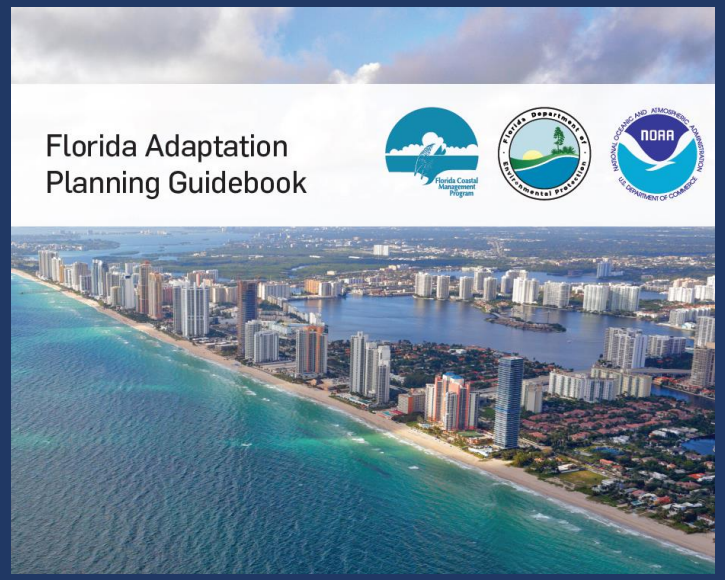
J. P. Palutikof[1] · D. Rissik[1] · S. Webb[1] ·
Fahim N. Tonmoy[1,2] · S. L. Boulter[1] · Anne M. Leitch[1] ·
A. C. Perez Vidaurre[1] · M. J. Campbell[1]

There are LOTS of strategic planning guidelines and examples to choose from

- Regardless of which framework is followed, data from field observations and/or modeling are required to implement a decision support framework

- Some tools/models that generate inputs into a decision-making framework:
  - NOAA sea-level rise viewer
  - Nature Conservancy Coastal Resiliency Mapping Portal
  - ADCIRC Models (SLR + storm surge)
  - USACE Sea Level Change Curve Calculator
  - Wave Watch III
  - Lidar-derived digital elevation models
  - USGS Historical shoreline change rates
  - FEMA HAZUS





Designing adaptive strategies that can react to new information from Earth science observations can drastically improve future outcomes in the event of potentially damaging flood events.

Srikrishnan, Alley, and Keller (2019)

Steps to Create Adaptation Plans

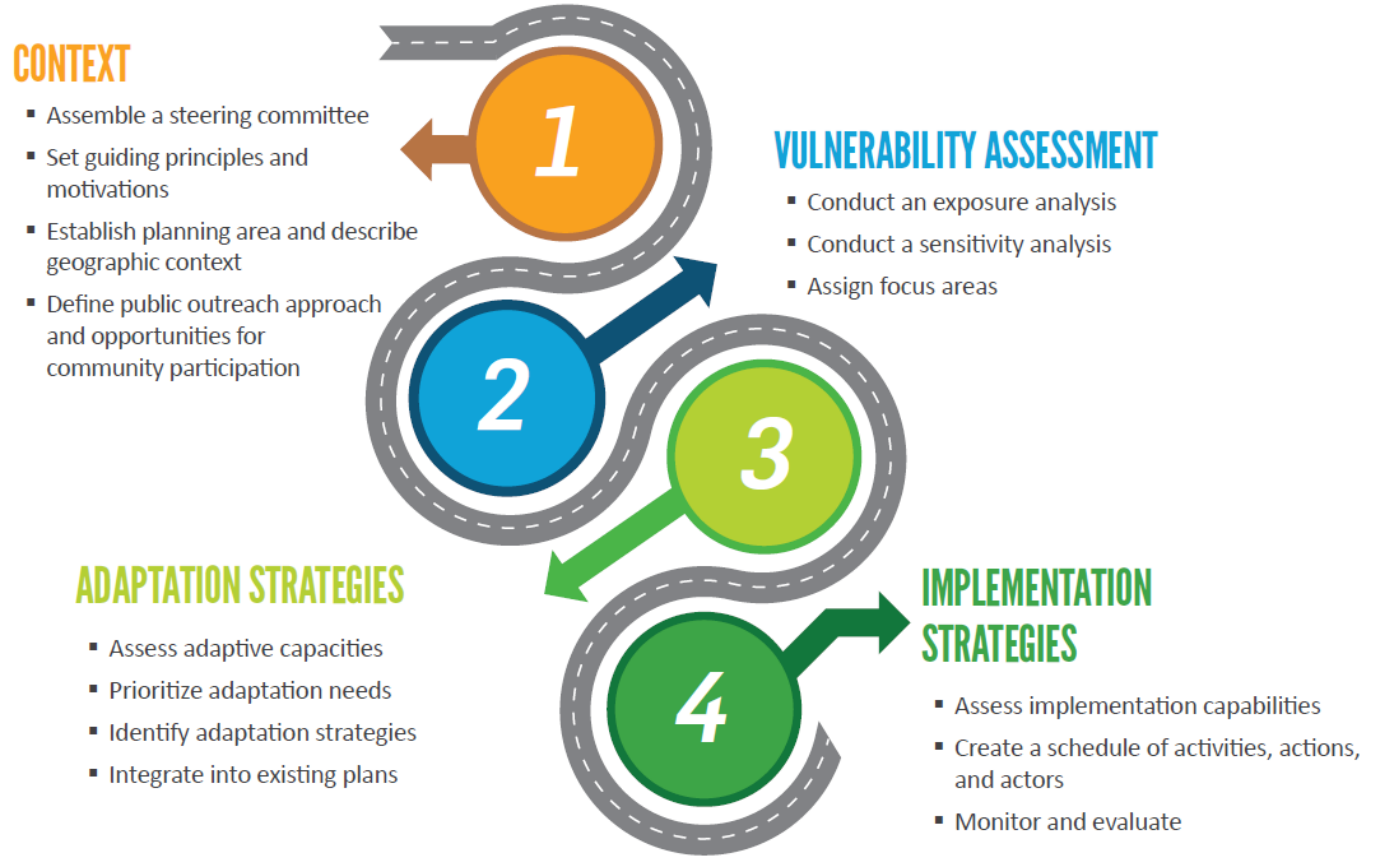
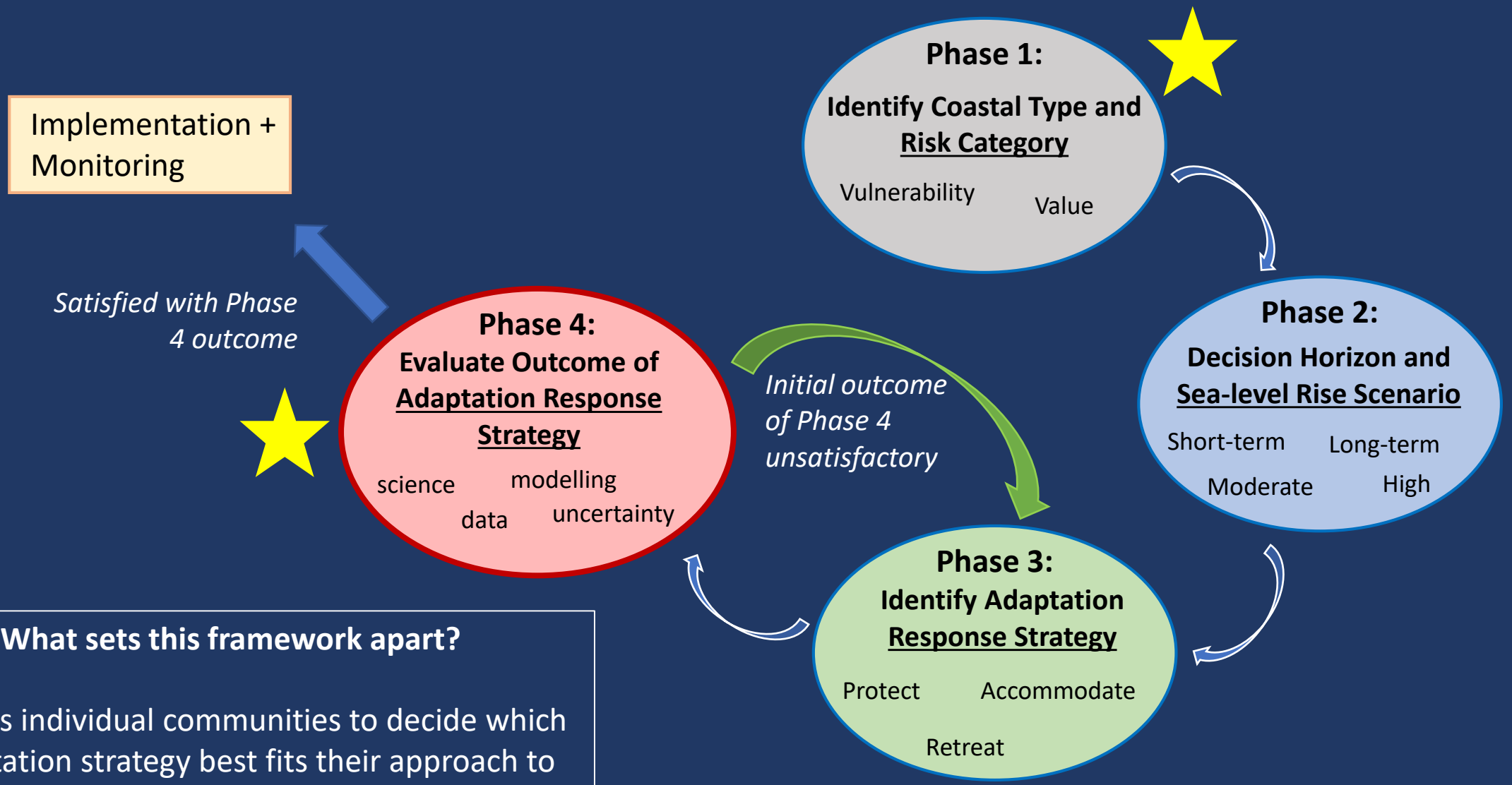


Figure 1. Communities can follow this roadmap of steps to create an adaptation plan.

Coastal Community Model-based Decision Support Tool



What sets this framework apart?

- Allows individual communities to decide which adaptation strategy best fits their approach to uncertainty and risk tolerance

Phase 1: Coastal Typology Analysis – define Vulnerability and assign Value

- Characterize coastal geomorphology, exposure to hazards (waves, flooding, erosion), shoreline type
- Characterize land-use and density

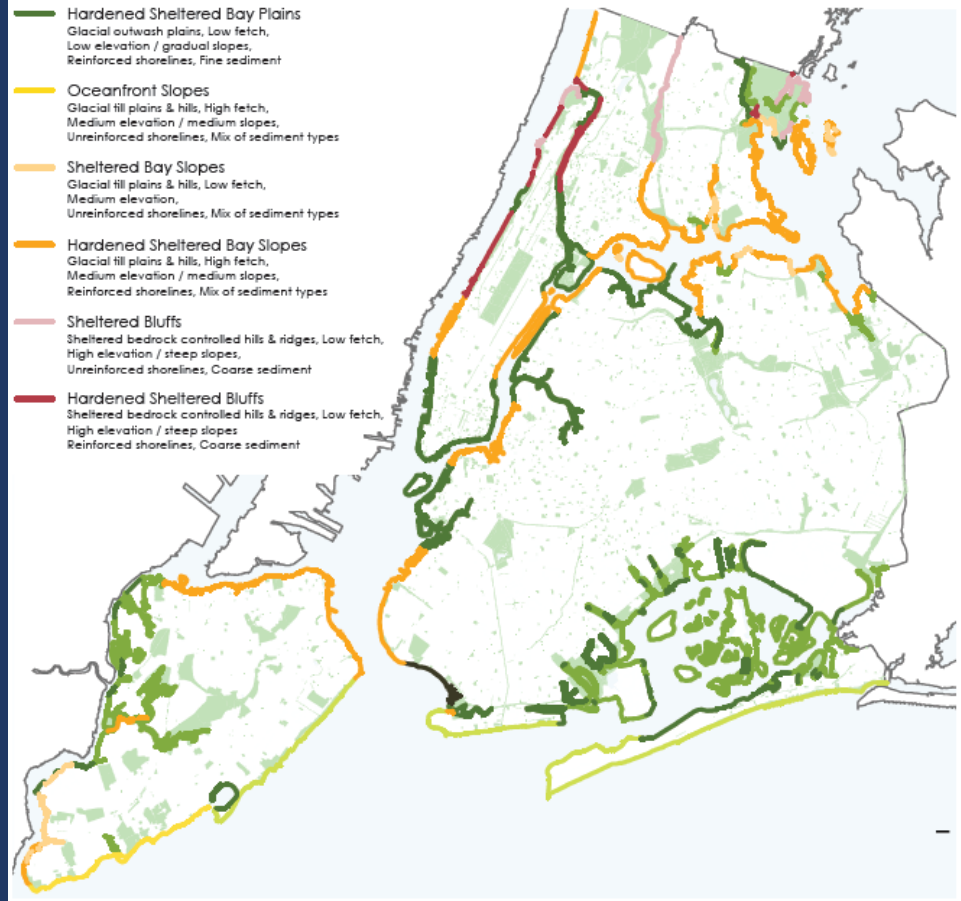
Generate index and reference maps

Open-ocean beach Marsh coast Mangrove coast Bayside beach Commercial Residential

COASTAL GEOMORPHOLOGY CATEGORIES

Based on the mapping of geologic landforms, shoreline condition, and wave exposure, nine geomorphology types emerged as representative of the range of factors present in New York City. Each type is a composite of these three factors. These types can be analyzed for their degree of exposure to sudden and gradual coastal hazards.

- **Oceanfront Beaches**
  Glacial outwash plains, High fetch, Low elevation / gradual slopes, Unreinforced shorelines, Fine sediment
- **Hardened Oceanfront Plains**
  Glacial outwash plains, High fetch, Low elevation / gradual slopes, Reinforced shorelines, Fine sediment
- **Coastal Marshes**
  Glacial outwash plains, Low fetch, Low elevation / gradual slopes, Unreinforced shorelines, Fine sediment
- **Hardened Sheltered Bay Plains**
  Glacial outwash plains, Low fetch, Low elevation / gradual slopes, Reinforced shorelines, Fine sediment
- **Oceanfront Slopes**
  Glacial till plains & hills, High fetch, Medium elevation / medium slopes, Unreinforced shorelines, Mix of sediment types
- **Sheltered Bay Slopes**
  Glacial till plains & hills, Low fetch, Medium elevation, Unreinforced shorelines, Mix of sediment types
- **Hardened Sheltered Bay Slopes**
  Glacial till plains & hills, High fetch, Medium elevation / medium slopes, Reinforced shorelines, Mix of sediment types
- **Sheltered Bluffs**
  Sheltered bedrock controlled hills & ridges, Low fetch, High elevation / steep slopes, Unreinforced shorelines, Coarse sediment
- **Hardened Sheltered Bluffs**
  Sheltered bedrock controlled hills & ridges, Low fetch, High elevation / steep slopes Reinforced shorelines, Coarse sediment



GEOMORPHOLOGY CATEGORIES

HIGH ◐ MEDIUM ○ LOW

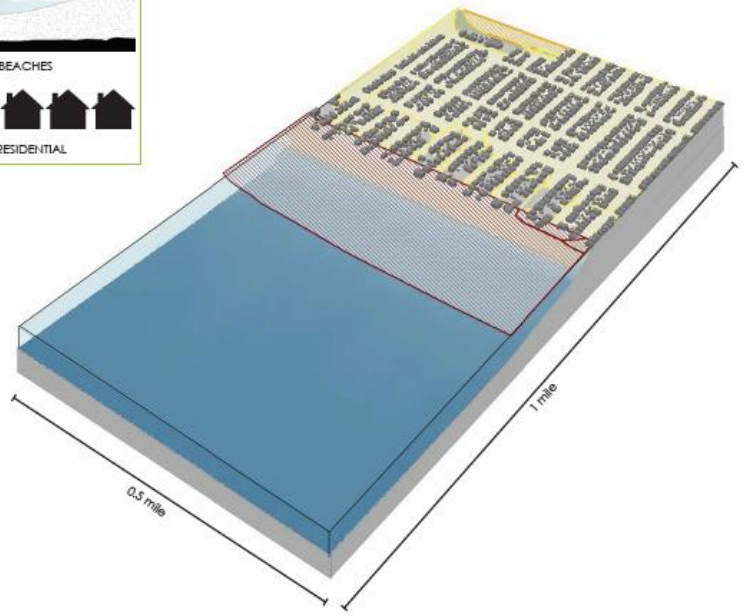
DEGREE OF EXPOSURE TO COASTAL HAZARDS

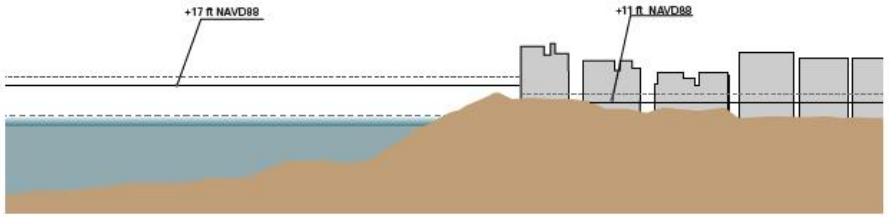
		EVENT BASED			GRADUAL	
		Storm Surge	Wave Action	Sudden Erosion	Sea Level Rise	Erosion
1	Oceanfront Beaches	●	●	●	●	●
2	Hardened Oceanfront Plains	●	●	◐	●	○
3	Coastal Marshes	●	○	○	●	●
4	Hardened Sheltered Bay Plains	●	○	○	●	○
5	Oceanfront Slopes	◐	●	●	◐	●
6	Sheltered Bay Slopes	◐	○	○	◐	◐
7	Hardened Sheltered Bay Slopes	◐	○	○	◐	○
8	Sheltered Bluffs	○	○	○	○	◐
9	Hardened Sheltered Bluffs	○	○	○	○	○

Till plains / Hills · Outwash plains / Post glacial deposits · Bedrock

From NYC Urban Waterrfront Adaptive Strategies, 2013

OCEANFRONT BEACHES / LOW DENSITY RESIDENTIAL





LAND USE / DENSITY FACTORS

Building Types	1-2 story Detached Homes 1-2 story Semi-detached Homes Community Facilities
Open Space	Beach Neighborhood Park
Infrastructure	Roads
Built Area	1.7 M ft² Floor Area 1 M ft² Ground Floor Area
Land Area	7 M ft² Total Land Area 3.9 M ft² Total Lot Area (excluding water)
Density	0.5 Dwelling Units Per Acre 0.45 FAR[1]

HAZARD EXPOSURE

EVENT-BASED	Storm Surge (High)	●
	Storm Surge (Low)	●
	Wave Force	●
	Sudden Erosion	●
GRADUAL	Frequent Flooding due to Sea Level Rise	◐[2]
	Gradual Erosion	◐

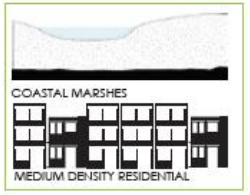
FLOOD ZONES[3]
V Zone
Coastal A Zone
A Zone

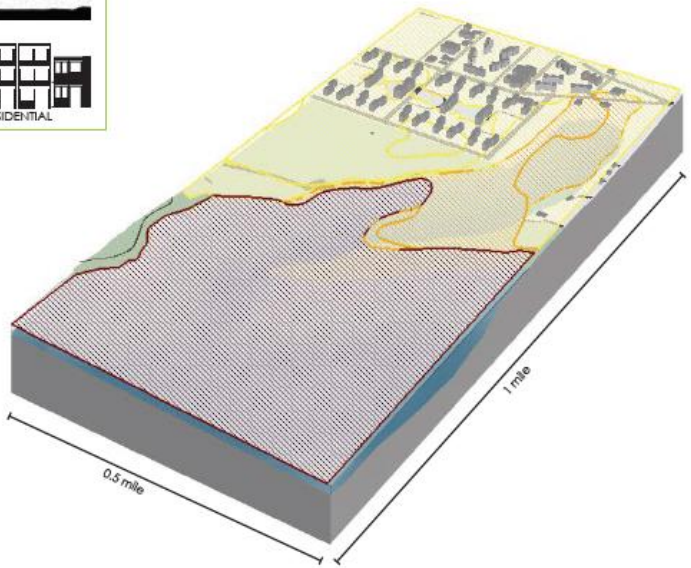
FLOOD LEVELS[3]
Future Base Flood Elevation
Current Base Flood Elevation

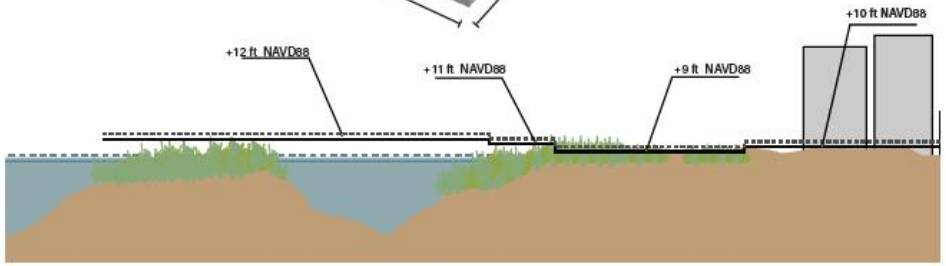
SEA LEVELS[4]
Future High Tide
High Tide

[1] FAR based on total floor area over total lot area, excluding open space, vacant, and unknown land uses.
[2] The beach may be regularly inundated due to increasing sea level rise, but developed areas are on ground above the expected heights of sea level rise.
[3] Source: FEMA Preliminary Work Maps, June 2013
[4] Source: NPCC, 90th Percentile Projections, 2013
* Vertical exaggeration in sections

COASTAL MARSHES / MEDIUM DENSITY RESIDENTIAL







LAND USE / DENSITY FACTORS

Building Types	High-Rise Residential Buildings Low-Rise Commercial Buildings Community Facilities Marinas
Open Space	Wetlands Active Recreation parkland Unimproved parkland
Infrastructure	Roads
Built Area	2 M ft² Floor Area 400,000 ft² Ground Floor Area
Land Area	7.5 M ft² Total Land Area 2.8 M ft² Total Lot Area (excluding water)
Density	13 Dwelling Units Per Acre 0.75 FAR[1]

HAZARD EXPOSURE

EVENT-BASED	Storm Surge (High)	●
	Storm Surge (Low)	●
	Wave Force	○
	Sudden Erosion	◐
GRADUAL	Frequent Flooding due to Sea Level Rise	◐
	Gradual Erosion	●

FLOOD ZONES[2]
V Zone
Coastal A Zone
A Zone

FLOOD LEVELS[2]
Future Base Flood Elevation
Current Base Flood Elevation

SEA LEVELS[2]
Future High Tide
High Tide

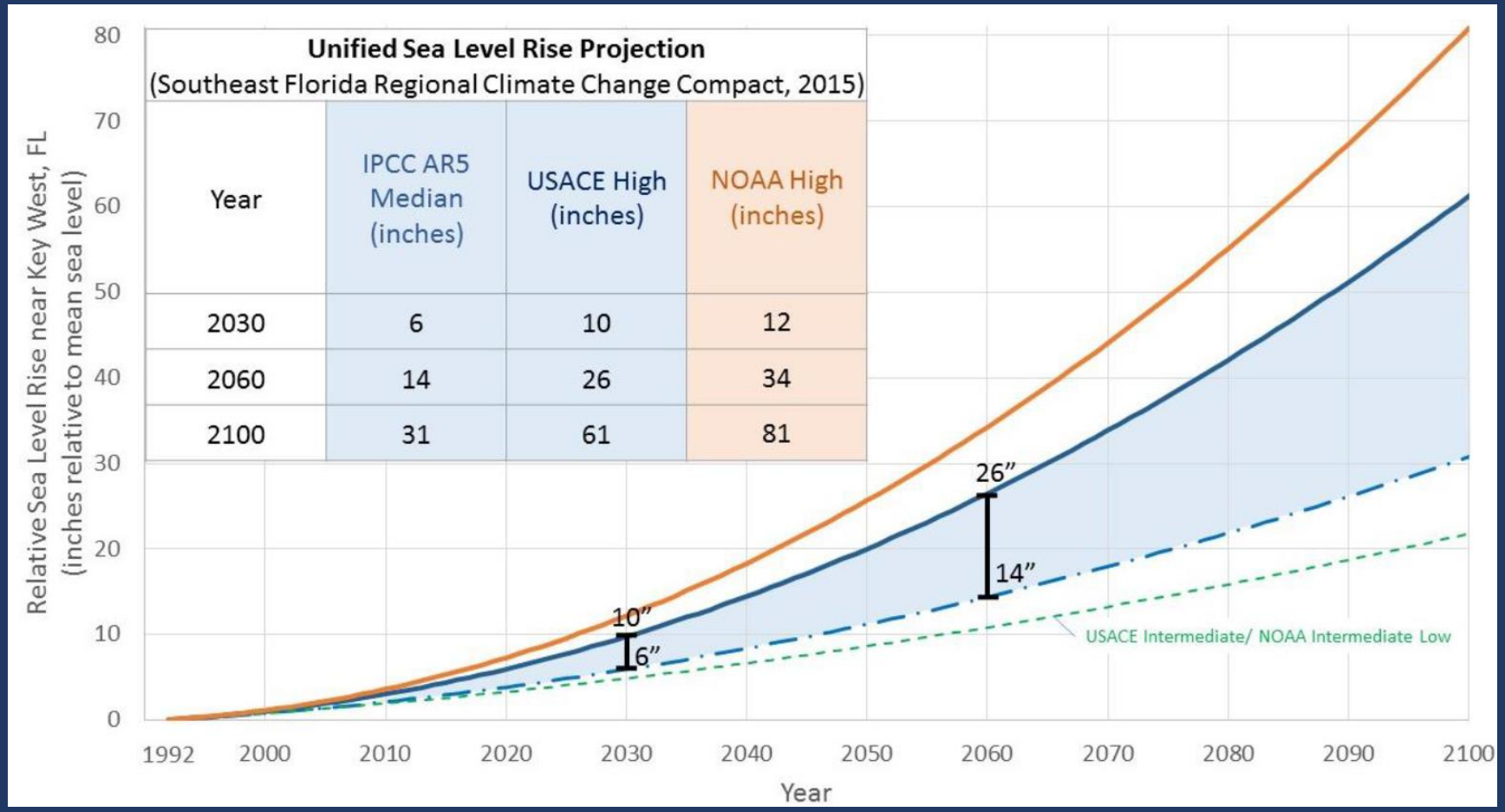
[1] FAR based on total floor area over total lot area, excluding open space, vacant, and unknown land uses.
[2] Source: FEMA Preliminary Work Maps, June 2013
[3] Source: NPCC, 90th Percentile Projections, 2013

From NYC Urban Waterrfront Adaptive Strategies, 2013

Phase 2: Decision Horizon and Sea-level Rise Scenario

- Identify time horizons for adaptive management and decision making
  → 10, 20, 30 years

- Choose sea-level rise scenario: which curve to use?



Phase 3: Adaptation Response Strategy

Do nothing

Protect

- Nourishment
- Berm-building
- Living shorelines
- Marsh/mangrove restoration
- Sandbags
- Oyster restoration

- Seawalls
- Bulkheads
- Revetment

Accommodate

- Elevate buildings
- Flood-proof buildings
- Elevate land & roads
- Increase setbacks for new construction
- Replacing vegetation with salt-tolerant

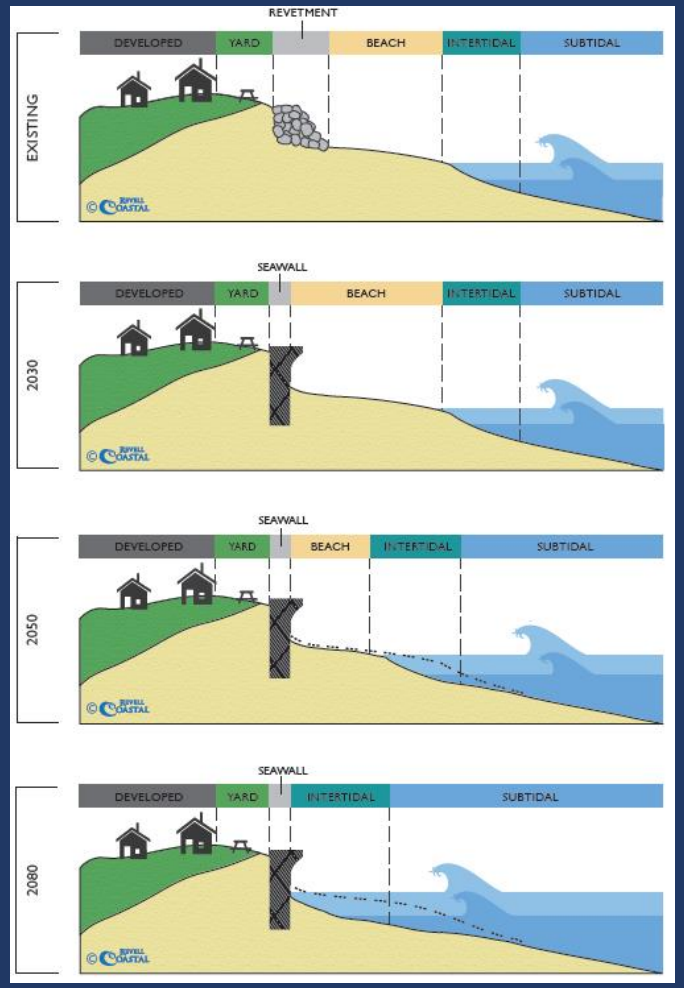
Retreat

- Limit expansion of development
- No rebuilding after storms
- Rebuilding restrictions after storms
- Buy-outs

Phase 4: Modelling to Assess Outcome of Response Strategy

- Explore effectiveness of alternative adaptation response measures
- Determine likely timeframe in which a decision or a new decision will need to be made (i.e. trigger point)

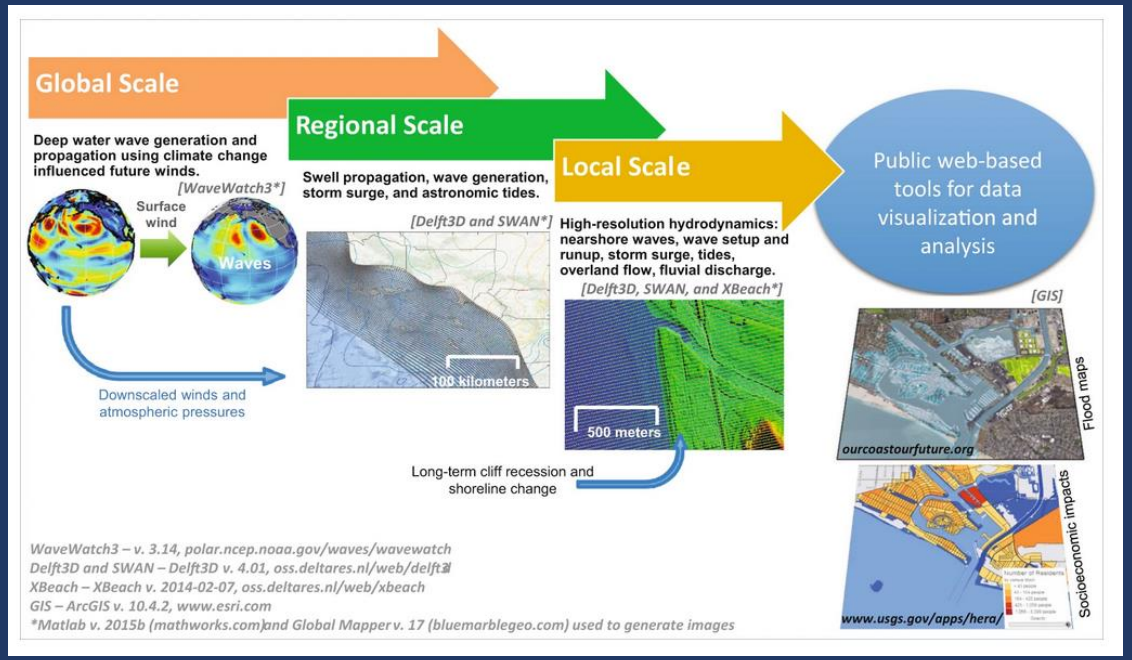
Conceptual models to gauge time, effectiveness, and consequences



Broad range of models that vary in complexity

Statistical Output

Complex models for forecasting sea level rise on vegetated coasts (SLAMM) and storm + sea-level rise on open-ocean coasts (CoSMoS)



Coastal ADAPT Toolkit