A Research and Decision Support Framework to Evaluate Sea-Level Rise Impacts in the Northeastern U.S.

Erika Lentz, Rob Thieler, Nathaniel Plant, and Sawyer Stippa
U.S. Geological Survey Woods Hole, MA

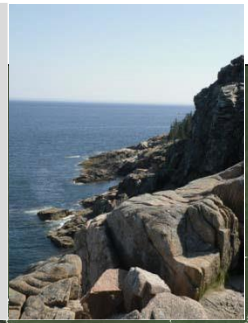
Collaborators: Dean Gesch (USGS), Radley Horton (Columbia University)

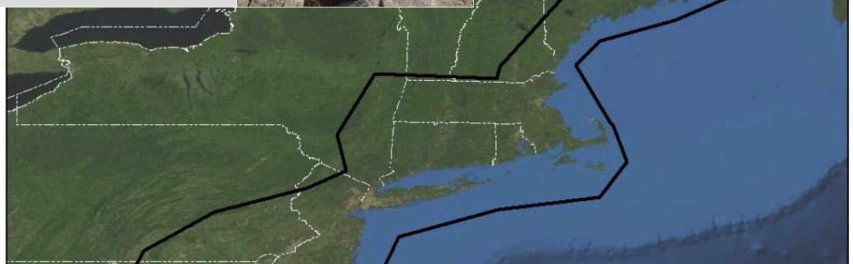
Defining decision-support needs with DOI agencies

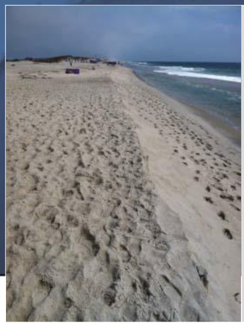
Structured Decision Making Workshop, September 2012
Landscape Conservation for Sea Level Rise Adaptation –
A Regional Framework

Objective: **Predict potential sea level increases and distinguish the corresponding coastal response type for several time steps throughout the Northeast region**

Inundate: bedrock coasts, highly developed or engineered shorelines







Dynamic: beaches, unconsolidated cliffs, barrier islands, and wetlands

What we set out to do:

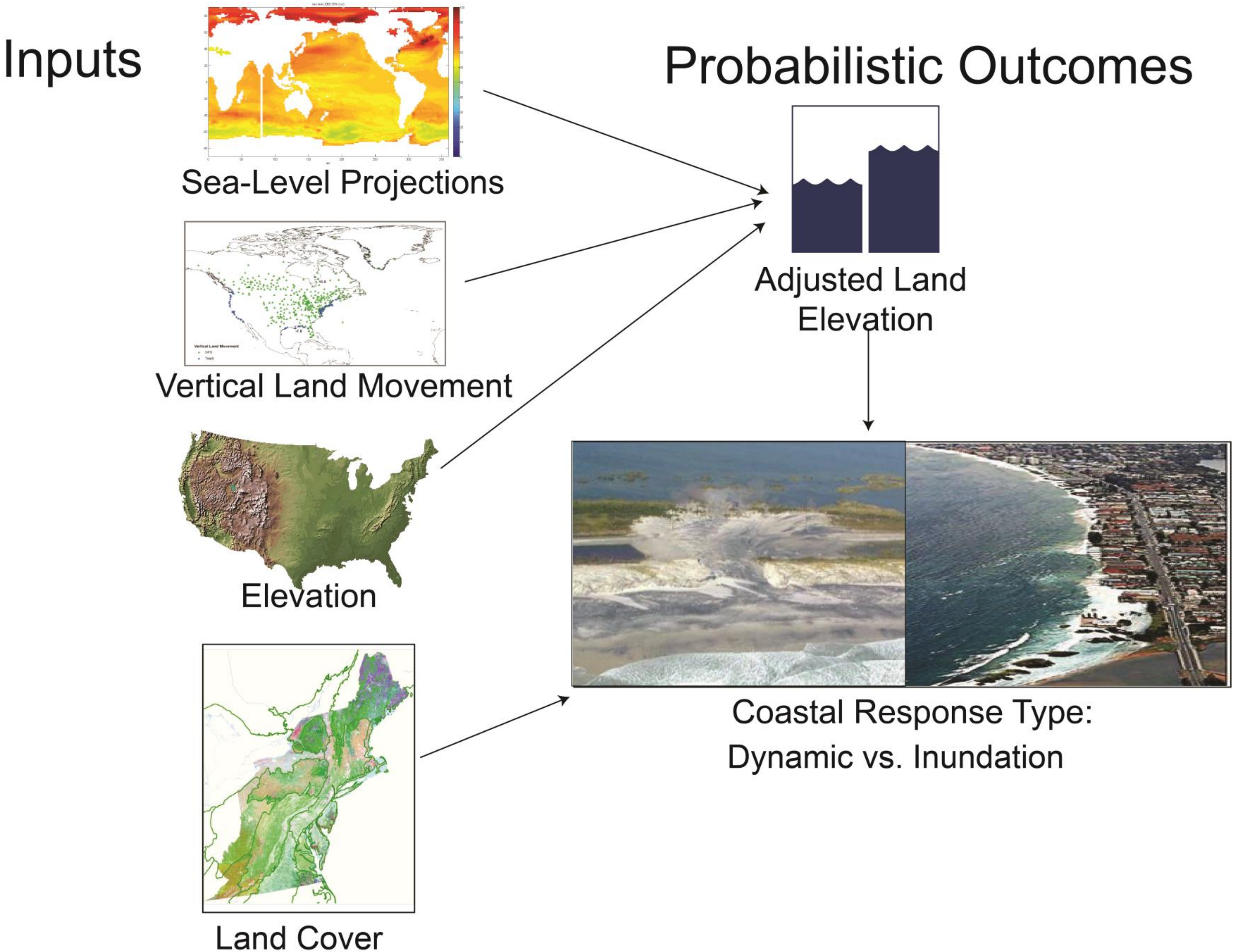
1. Produce results for full region at resolutions commensurate with habitat models

2. Build on existing inundation model structure by adding:
   - Vertical land movement
   - Robust and intuitive integration of uncertainty
   - Associate a time horizon with SL projections

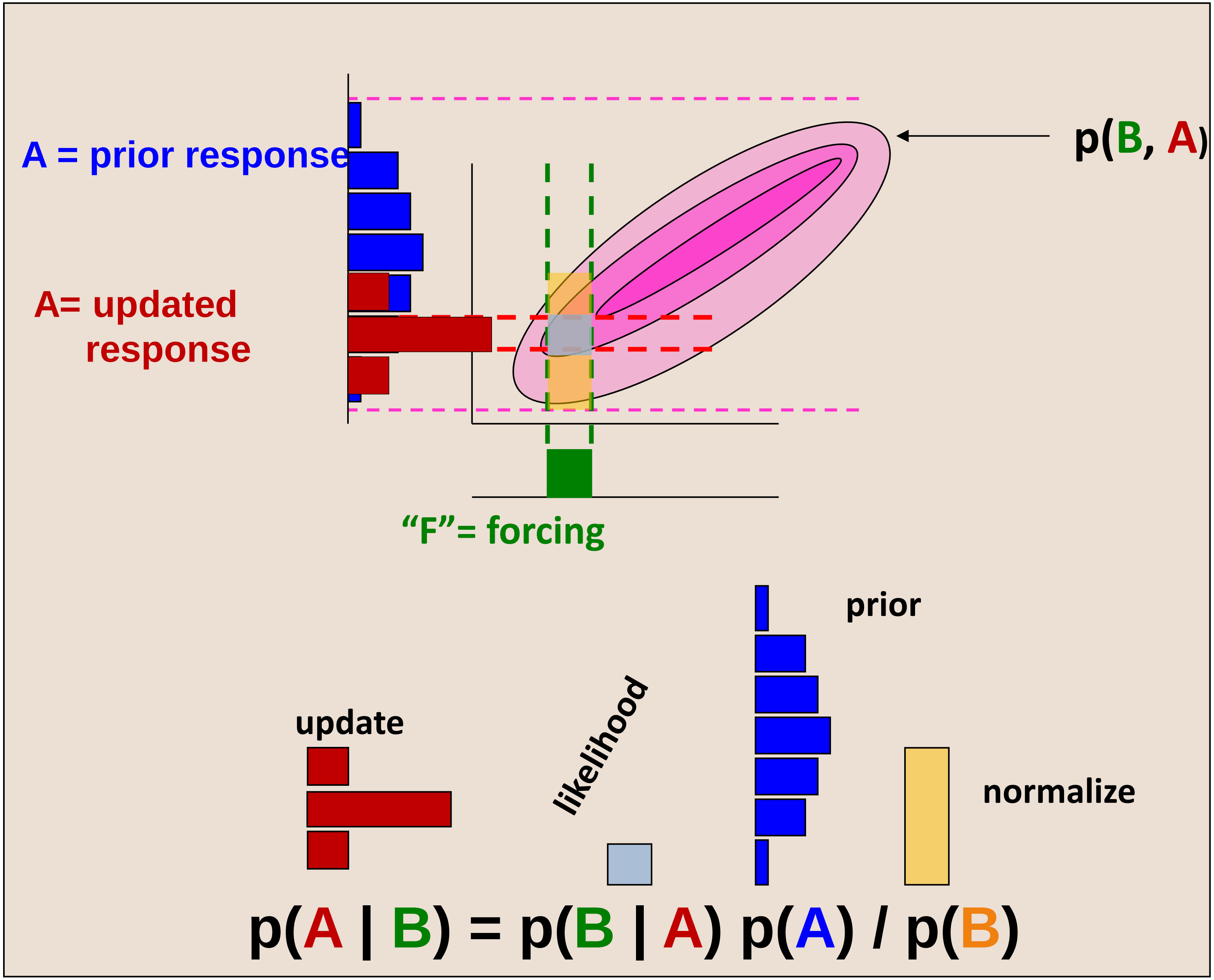
3. Add dynamic response information
   - By incorporating land cover to differentiate coastal response

4. Make it possible to update the model by adding new/better data as they become available

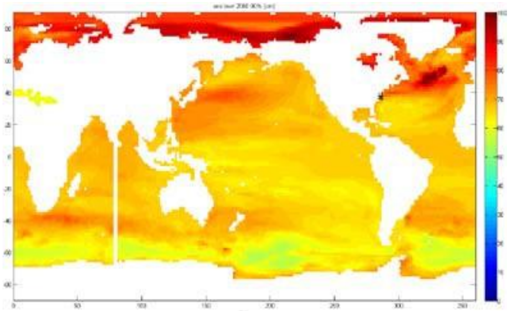
Use regional datasets and their uncertainties to generate predictions



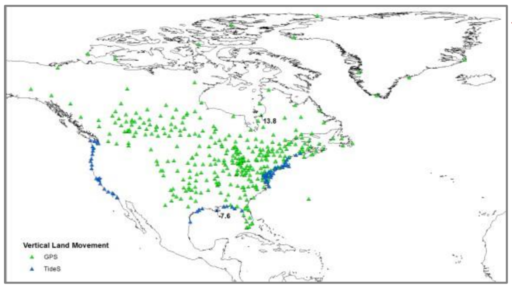
How a Bayes net works:



Determine probabilities of adjusted land elevation and response type given a range of sea level scenarios:

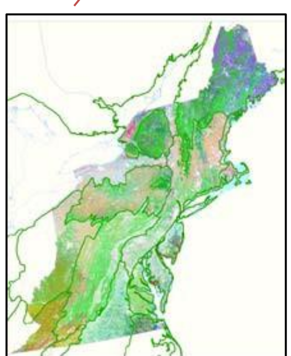


Latest GCM Projections



Tide Gauge and GPS Velocities

National Elevation Dataset



DSL as derived
From TNC et al.

Projected Sea Level (m)	
0 to 0.25	25.0
0.25 to 0.5	25.0
0.5 to 0.75	25.0
0.75 to 2	25.0

Vertical Land Movement (m)	
-0.3 to 0	33.3
0 to 0.1	33.3
0.1 to 0.3	33.3

Elevation (m, MHW)	
-10 to -1	39.8
-1 to 0	18.7
0 to 1	17.4
1 to 5	23.5
5 to 10	0.55

Adjusted Elevation (m)	
-11.7381 to -1	40.2
-1 to 0	18.1
0 to 1	15.2
1 to 5	19.5
5 to 10.0478	6.99

Land Cover Type	
Water	57.0
Marsh	14.5
Beach	4.02
Cliff	0.24
Forest	13.5
Developed	10.7

Coastal Response Likelihood	
Dynamic	71.0
Inundate	29.0

Adjusted Elevation (range)

Dynamic Response vs. Inundation

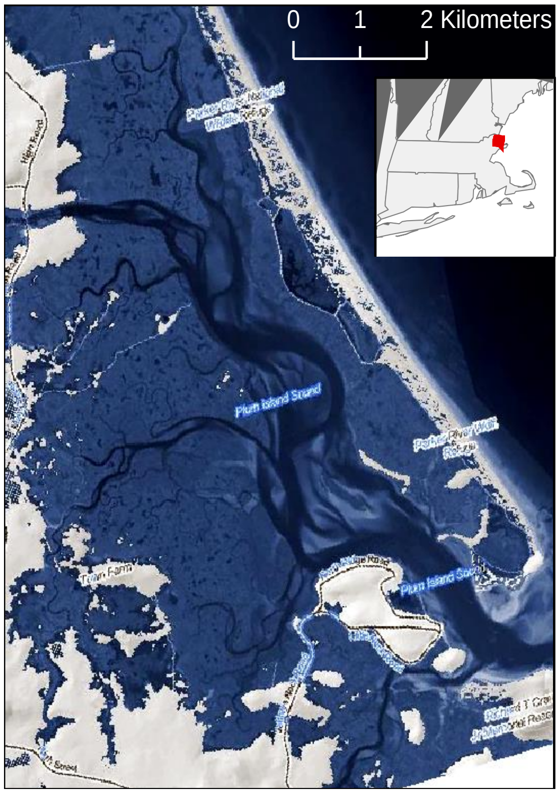
Photo Credit:
Sydney Coastal Councils Group

How we inundate

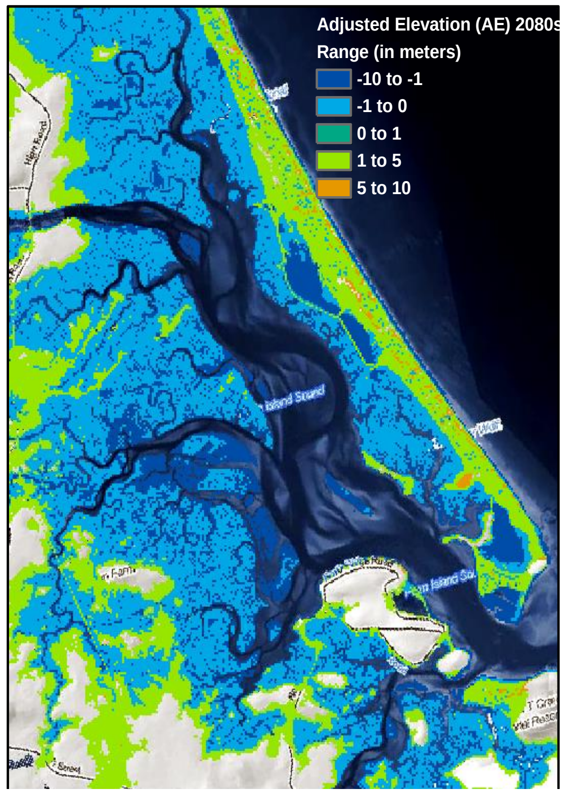
Adjusted Elevation (range)

AE (x, t) = E (x) – SL (x, t) + VLM + uncertainties

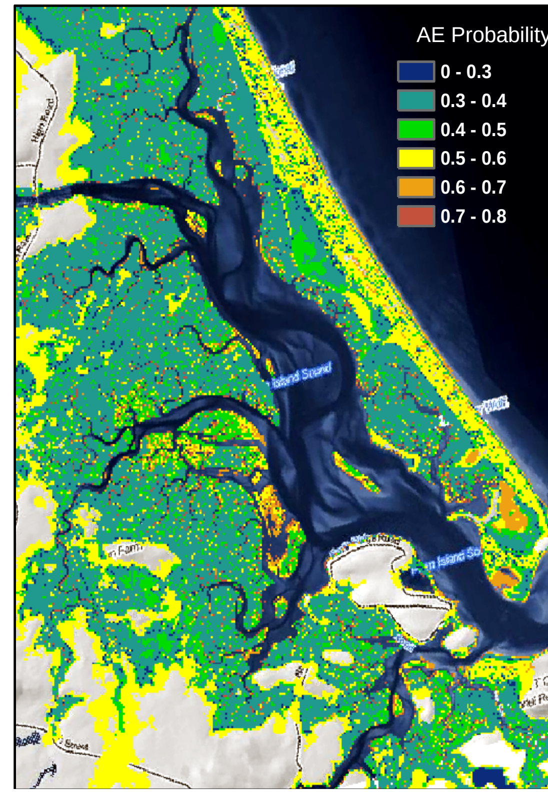
Source: Surging Seas at http://ss2.climatecentral.org



Standard Inundation Model



Our Predictions

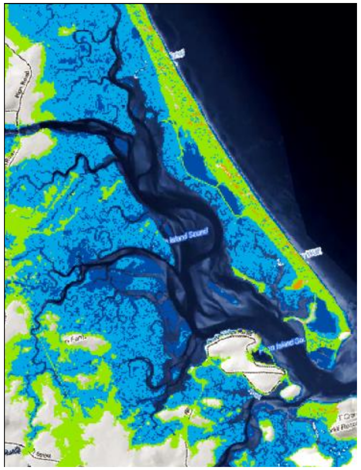


Prediction Probabilities

Adding the dynamic response

AE Ranges

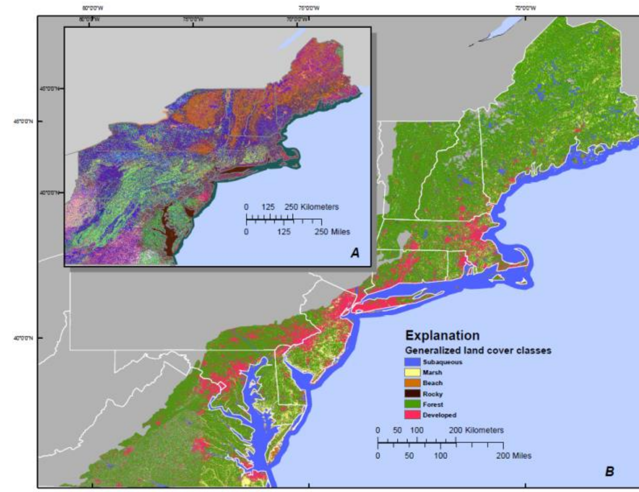
<-10 to -1 m
-1 to 0 m
0 to 1 m
1 to 5 m
5 to 10 m



Adjusted Elevation

Land Cover Type

Subaqueous
Marsh
Beach
Forest
Rocky
Developed



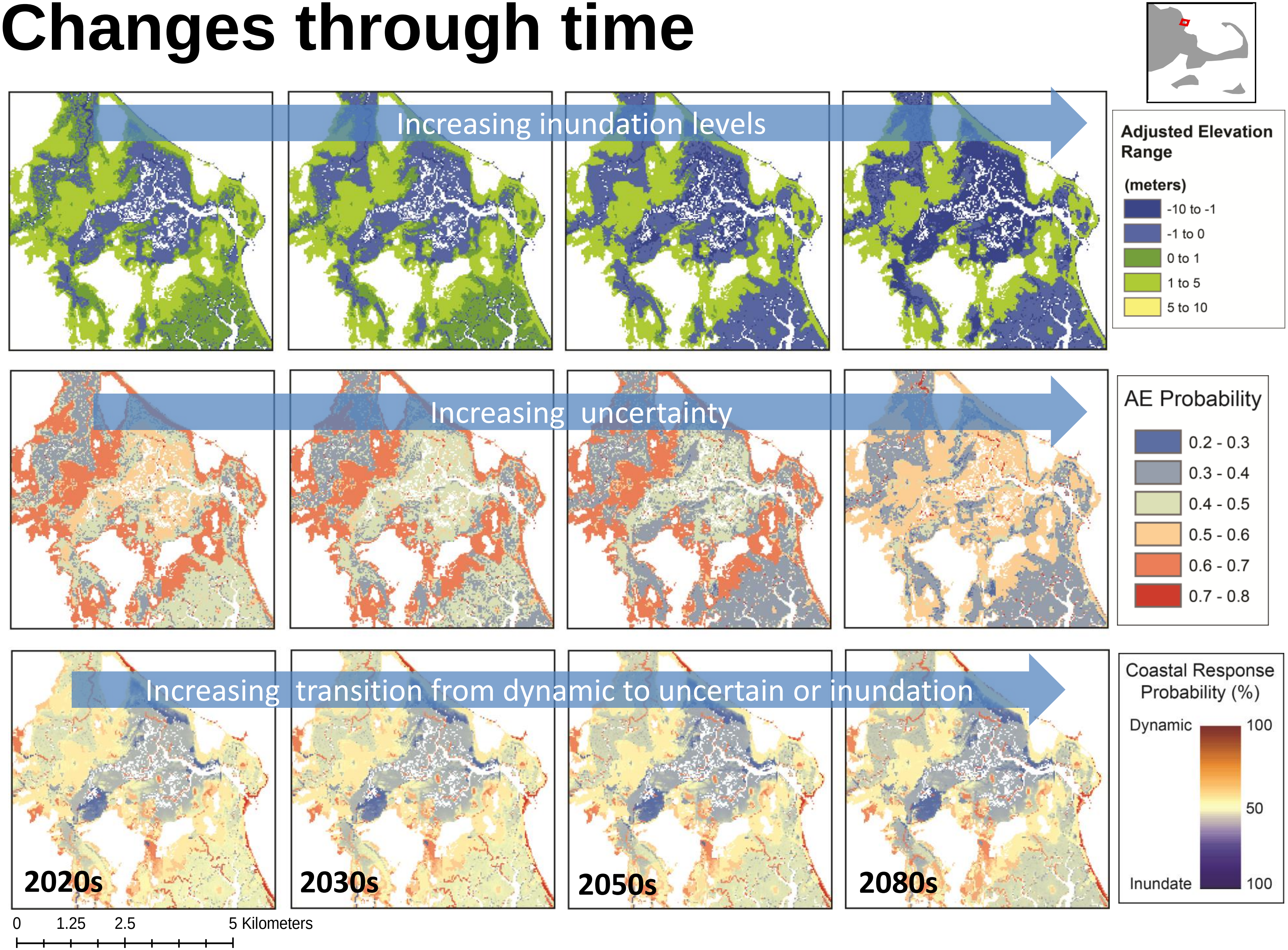
General Land Cover Type

Coastal Response Likelihood

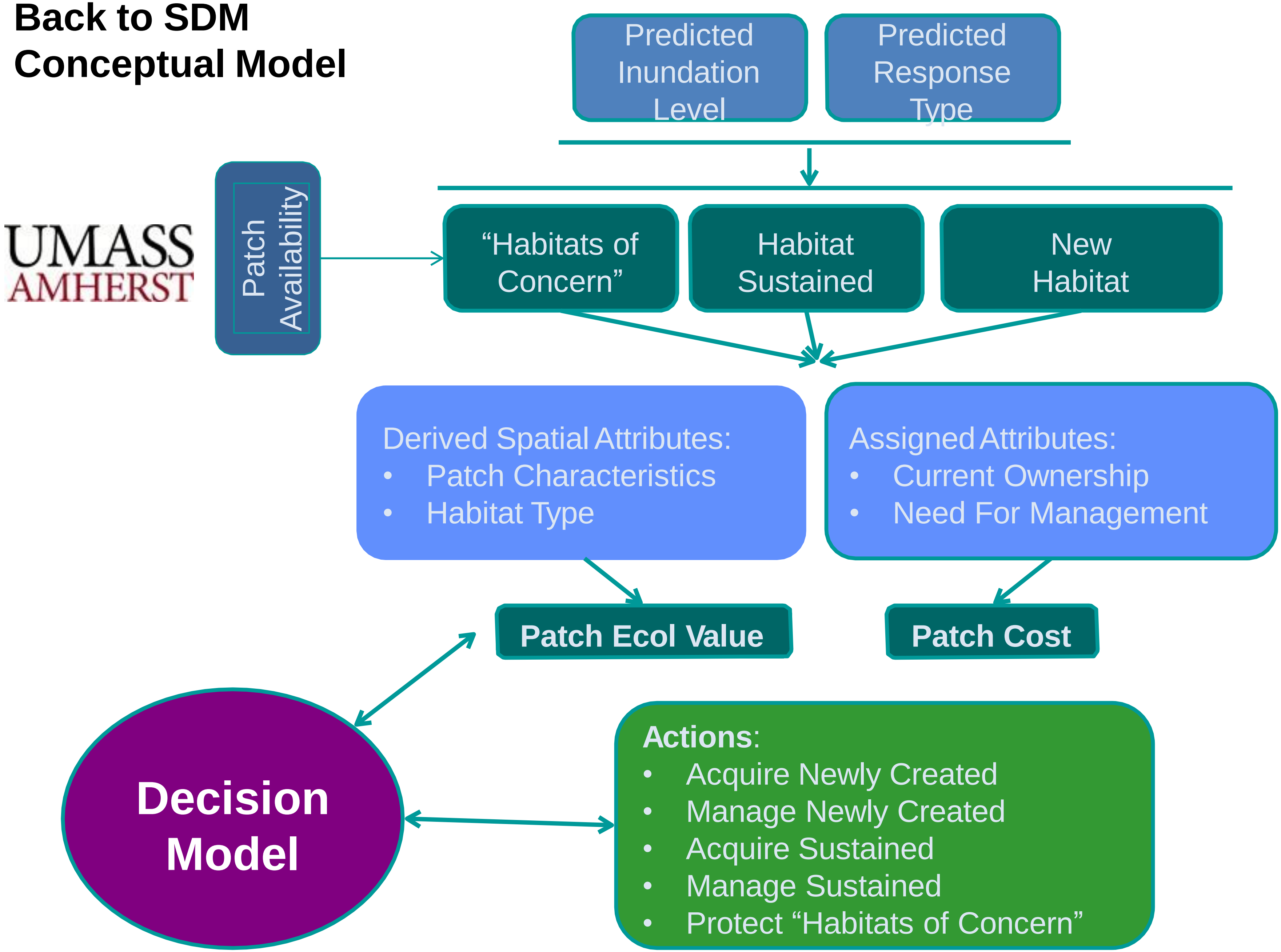
Sydney Coastal Councils Group

Based on published SLR threshold rates; and expert knowledge

Changes through time



Back to SDM Conceptual Model



Slide credit: Kevin Kalasz, SDM '12 workshop

Products

Report (Open-File Report) describing approach, methods, and datasets

Geospatial data (ArcGIS rasters) that describe which processes/models are necessary to resolve coastal response

- Resolution useful to inform habitat and landscape change models (30 m resolution, -10 to 5 m coastal coverage) for 2020s, 2030s, 2050s, and 2080s
- Will be available through USGS Coastal Change Hazards Portal

Scientific Papers: Change the conversation beyond the bathtub

Next steps

Decision-support tool development

Incorporating marsh-specific updates

Can easily update:

- Elevation data
- Sea-level rise thresholds (as probabilities)

Next model iteration:

- Explore storms/storm impacts, possibly using USGS storm-induced coastal change

More challenging (but possible in future model iterations):

- Integration of marsh specific variables (e.g. accretion rates, sedimentation)

Acknowledgments

- SDM-SLR 2012 Workshop Team (Andrew Milliken, Tim Jones, Dorina Frizerra, Bill Hulslander, Kevin Kalasz, Adam Whelchel, and Matt Whitbeck; coaches: Brady Matteson, Erin Rivenbark, Krishna Pacifici)
- North Atlantic Landscape Conservation Cooperative
- Northeast Climate Science Center
- USACE Climate Program