NORTHERN GULF OF MEXICO

KEEPING PACE

A short guide to navigating sea-level rise models

Why Does it Matter?

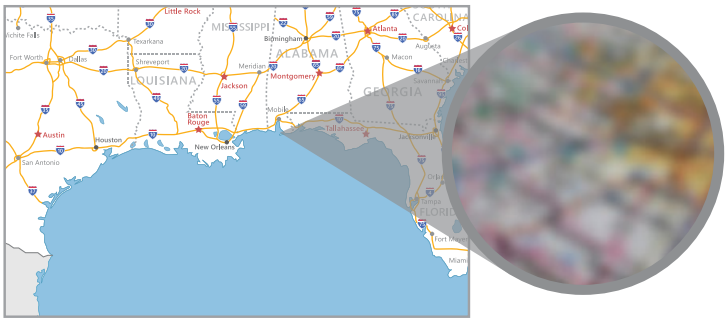
The Importance of Sea-Level Rise Model Selection

There are many models, tools, experts, and maps available that provide decision support for local decision makers to address potential impacts of rising sea-levels. In a world with increasing climate pressures and diminishing resources it is critical to utilize the right tool for the right job. On the surface it may appear easy to utilize one model for all needs and questions. However, models are not developed for the same purposes and it can be difficult to determine which is the best choice for a given need. Therefore, we've found the experts and synthesized their knowledge to give you a model selection "cheat sheet". This guide will walk you through some "need to know" concepts, a few model categories, and how to select which category of model is appropriate for your specific coastal issue. Throughout the guide we also have references and lists to jump start your next steps!

HELPFUL CONCEPTS

Scale

Depending on how you need to apply a model, scale is important. As the spatial scale is increased from local to regional to national to global perspective, some data (such as elevation) are averaged and spatial resolution is lost. For example, much like trying to use a national map for details on a coastal community, a model designed for a national or regional application will not have the correct resolution for a city or county. This makes applying the results a challenge.



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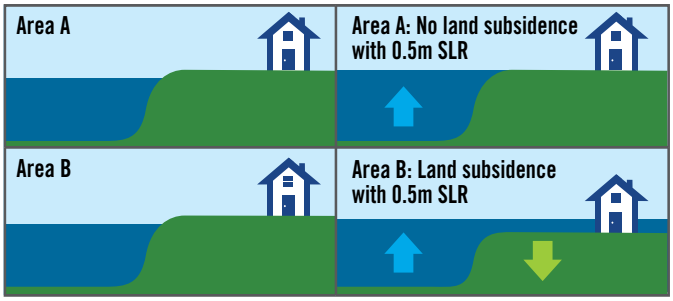
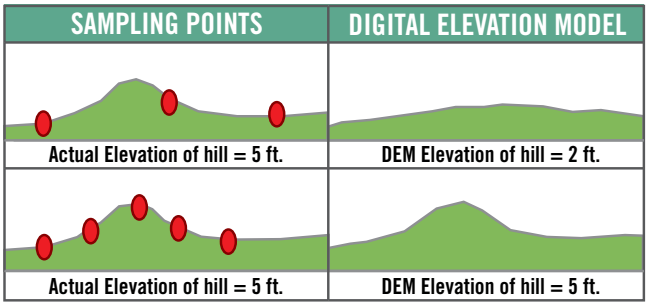
Relative Sea-Level Rise (SLR)

Global SLR scenarios, such as those released by the Intergovernmental Panel on Climate Change (IPCC), are just that – global. Ideally these scenarios are used as a starting point for coastal communities. Global sea-level change looks different in mangitude and timing at the local scale depending on a wide variety of factors. For example, a community that experiences subsidence (the sinking of land) combined with SLR will result in a greater realized SLR than a community that is not experiencing subsidence. Th s difference is known as relative SLR. How SLR will impact a local area is based on hydrologic, biologic, and geologic processes. Some models do not take these local processes into account and apply the global change. These less accurate models are dubbed "bathtub models" because they portray SLR as a simple rise in water, much like when you add water to a bathtub.



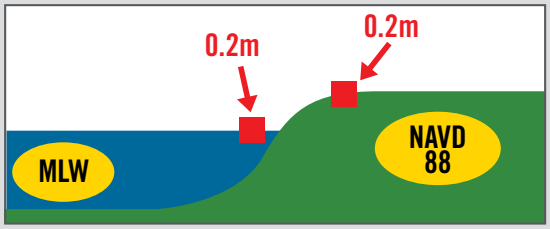
Digital Elevation Models

Land elevation is the backbone of SLR projection models that allow you to predict if an area will be underwater in the future. Because it is impractical to measure elevation by hand at every single point, a network of elevation sampling points are measured to develop a digital elevation model, or DEM. Several factors contribute to the accuracy of DEMs and often publicly available datasets are sampled via remote sensing. For this reason they often lack the spatial resolution or technology to accurately measure local scale elevation. Supplementing public DEMs with local, high resolution DEMs will improve the accuracy of SLR prediction models.



Datum Conversion

There is not one single reference network that all elevations are measured to. There are several datums, or reference points, that water level and land elevation can be measured against. In the example on the right both red boxes are at 0.2 m elevation; however, one is against MLW and the other against NAVD 88. It is important to recitfy, or convert measurements to the same datum, because it can dramatically change the accuracy of SLR predictions.



How to Use These Concepts

The concepts above are important to consider when selecting a model for predictions of SLR and its effects. These concepts can be applied by considering the following:

- **Scale of application: Is the model designed for the scale you want? Ex: National, regional, local?**
- **Data Inputs: Is the elevation data accurate? Were the tidal datums rectified? Are local features included?**
- **Are biological, hydrographic, and geological processes that impact relative sea-level rise included?**
- **How are different habitats and land use classifications defined?**

MODEL CATEGORIES

Sea-level Rise Simulation and Inundation Models

These models output future sea-level projections to estimate inundation. They can be based on randomly selected scenarios to observations and climate models. This category of models can often generate high levels of uncertainty because of the multiple data sources and data transformation.

Uses: Community awareness and discussion; early stages of planning

These models are not for: Detailed planning

More info: USGS Sea-level Rise Handbook pg 15

Geographic Information System (GIS) Sea-level Rise Mapping Tools

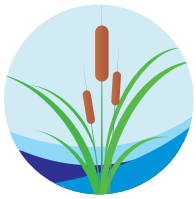
GIS mapping tools and output maps help users visualize a variety of SLR scenarios and impacts on multiple temporal and spatial scales. Relatively easy to develop, they are abundant on the Internet and come from a wide range of developers. These are not expert tools and frequently do not take into account important processes (e.g. marsh accretion, hydrologic flow, or subsidence) or local features (e.g. levees or dikes) diminishing their accuracy.

Uses: Discussion of coastal issues, community engagement, identification of locations where expert model application and data collection are needed

These models are not for: Planning purposes

More info: USGS SLR Handbook pg 22

Wetland Change Models



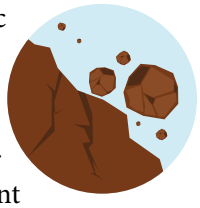
The output from wetland change models demonstrates change in habitat or land cover classification. The models typically determine habitat classification based on water height at each sea-level scenario.

Uses: Discussion of coastal issues, prioritizing areas for study and expert model application

These models are not for: Infrastructure planning purposes

More info: USGS pg 29

Surface Elevation and Shoreline Erosion Models



These models consider biological, hydrologic and geologic processes on local and regional scales to complement predictive SLR models.

Uses: Identifying vulnerable coastal areas for further study and assessment for management options and application.

These models are not for: Community engagement

More info: USGS SLR Handbook pg 33

Niche-Based Distribution Models

These models output future potential locations of species based on projected environmental conditions.

Uses: Demonstrating how SLR will interact with other climate change impacts to affect distribution of species and habitats; identifying potential areas to prioritize for conservation and management

These models are not for: Community engagement, non-technical application

More info: USGS Sea-level Rise Handbook pg 40

Leaf to Landscape Models

These models generate ecosystem change at the species and organism level in response to SLR. The most sophisticated of the SLR models, they consider physiological needs and processes from the leaf (e.g. photosynthesis, water uptake, etc.) to landscape processes (e.g. competition, inundation, etc.)

Uses: Detailed management and planning of natural resources

These models are not for: Community engagement, non-technical application

More info: USGS SLR Handbook pg 43

Comprehensive, categorized list of models: http://tinyurl.com/hnjdh2q

Doyle, T.W., Chivoiu, Bogdan, and Enwright, N.M., 2015, Sea-level rise modeling handbook—Resource guide for coastal land managers, engineers, and scientists: U.S. Geological Survey Professional Paper 1815, 76 p., http://dx.doi.org/10.3133/pp1815.

QUESTIONS & ANSWERS

This section presents example questions and coastal issues that have been discussed at public meetings, community planning events, and other local workshops. T he answers that follow reflect the category of model that could be utilized to answer the proposed question. Affiliated with each category is a list of models with a variety of attributes that could potentially meet your needs.

Q: How do I identify critical infrastructure such as roads, storm water systems, or emergency services, that could be at risk under various SLR scenarios?

A: Sea-level Rise Simulation and Inundation Models

Q: I need to manage local natural resources such as critical habitat or species. What would be the best models to consider?

A: Wetland Change Model (beginning stages); Niche-Based Distribution Models (Land Acquisition/Conservation); Leaf to Landscape Models (detailed questions about specific distribution of plant species/habitat)

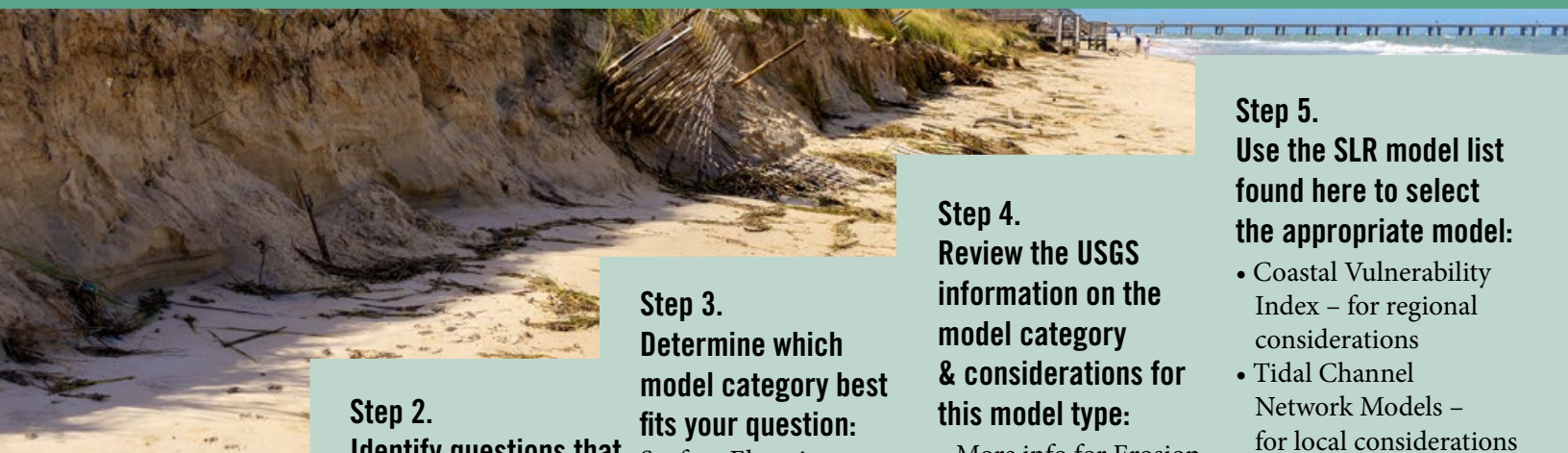
Q: How do I raise awareness and spark discussion about potential impacts from SLR and coastal inundation?

A: Geographic Information Systems (GIS) Sea-Level Rise Mapping Tools

Q: How do I determine what studies or observations are necessary to better answer questions regarding local SLR impacts?

A: Surface Elevation and Shoreline Erosion Models

EXAMPLE



Step 1.
Identify the issue:
My community is having a hard time managing erosion.

Step 2.
Identify questions that need to be answered to address the issue:
What will erosion look like in my area with sea-level rise?

Step 3.
Determine which model category best fits your question:
Surface Elevation and Shoreline Erosion Models

Step 4.
Review the USGS information on the model category & considerations for this model type:

- More info for Erosion Models on pg 33 of the USGS Handbook
- Comprehensive model list: http://tinyurl.com/hnjdh2q

Step 5.
Use the SLR model list found here to select the appropriate model:

- Coastal Vulnerability Index – for regional considerations
- Tidal Channel Network Models – for local considerations

Funding for the USGS handbook:

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