Description of Predictive Models of SLR Impact and Coastal Vulnerability by USGS:	In this section, we describe a host of simulation models, decision-support tools, and analytical techniques that have been applied to predict potential impacts of sea-level rise on coastal ecosystems and species, or related changes in the physical environment. We categorize the suite of data, methods, and models from a broad spectrum of disciplines involving different designs and scales of spatial and temporal complexity for predicting environmental change and ecosystem response. Model descriptions are given to highlight design type and features, functional attributes of input parameters and predictive variables, and characteristics of model utility or limitations. Criteria were established to distinguish the source, scale, and quality of information input and geographic datasets; physical and biological constraints and relations; datum characteristics of water and land components; utility options for setting sea-level rise and climate change scenarios; and ease or difficulty of storing, displaying, or interpreting model output.

Downloadable Excel version: http://masgc.org/assets/uploads/documents/List_of_SLR_Models_All.xlsx

Description of SLR Simulation and Inundation Models by USGS:	Some hydrological models have been developed to generate future sea-level projections for predicting inundation of shorelines or for use in other field and modeling studies. Model types range from arbitrary scenarios to derived projections based on tide gage records, glacial melt calculations, or climate change models designed to forecast probable increase of future sea level. Uncertainty in the extent of inundation for a particular sea-level rise scenario (such as 50 cm by 2100) is related to both the uncertainty in transformation of water-level datums (for example, orthometric to tidal) and the uncertainty in coastal elevation data. The combined amount of uncertainty from datum transformation and elevation sources can present critical limitations to sea-level rise applications. We exclude from this discussion tide simulation models or more sophisticated hydrodynamic models used for wave analyses, storm surge, or extreme flood forcing because these models are primarily used for engineering bridges and other coastal infrastructure.

Tool Name	Description	Geographic Scope	Scale of Application	Provide	Link/URL

SLR with Vertical Land Movement	App that runs on most devices (Android, iOS, most browsers) that allows the quick assessment of sea level rise with the vertical land movement component included. Zoom in to take a closer look and click (or tap) any location to add a pin and see a graph of projected values for the years 2020, 2040, 2060, 2080 and 2100. In the Menu you can choose to display results in feet, inches or centimeters (default).	National		CLIMsystems	http://slr.climsystems.com/
USGS Coastal Change Hazards Portal	The Coastal Change Hazards portal organizes products and information into discrete items within three specific coastal hazard themes: 1) severe storms, 2) shoreline change, and 3) sea-level rise. Each data item represents an individual research product. Items with a common topic area are grouped into aggregations within a theme, to show the breadth of that topic and make it easy to explore related information. Items and aggregations can be added to a bucket that saves this information for download or sharing.	National		USGS	http://marine.usgs.gov/coastalchangehazardsportal/
CoastCLIM Sea-Level Simulator	CoastCLIM (Warrick, 2006; Warrick and Cox, 2007) is a database tool for generating predicted sea-level curves for any global coastal location. CoastCLIM uses a global database of regional grid cells to generate localized rates of sea-level change associated with downscaled GCM projections of future sea-level rise and CO2 emission scenarios under climate change. A total of six emission scenarios are included in the package, and they can be queried for their associated changes in temperature, icemelt effects, and CO2 concentration as produced for IPCC projections. CoastCLIM employs a user-friendly interface that allows users to select the region or coastal reach of interest from a global map. CoastCLIM displays the predicted outcome in relative sea-level rise above zero in tabular and graphical format on an annual basis to 2100. CoastClim sea-level simulations show that sea-level rise can vary with both the selected model and scenario.	Global	Local, regional, global	CLIMsystems	http://slr.climsystems.com/

NOAA innundation frequency analysis program	An inundation freqency analysis program was developed by the NOAA National Ocean Service as a utility tool for ocastal planners. The program uses observed 6-min water-level recrds of tide gages relating observed times and heights of high-water tides for a desired period of record as data input. The data ouput of this program is n an Excel spreadsheet that takes each of the tabulated high tides in a specified time period relative to the user-specified reference datum or threshold elevations and calculates the elvations and durations of inundation above the reference datum. This inundation frequency analysis generates graphs and historgrams of freqency occurences by elevation and duration. For each threshold evelation, statistical summaries of flooding frequencies are generated for total number of high tides, hours inundated and number of days inundated, and the percentage of time inundated. For application of analyzing various sea-level rise scenarios, the reference datum is adjusted by the estimated amount of the elevation change for a given sea-level rise scenario, and the aforementioned statistics are recalculated.	National	Local	NOAA	https://tidesandcurrents.noaa.gov/inundation/

Sea-Level Rise Rectification Program (SLRRP)	The Sea-Level Rise Rectification Program (SLRRP) (Keim and others, 2008) was developed by the USGS to generate future sea-level rise projections based on historical tide gage records and user-specified inputs or selections of IPCC (2001) GCMs and emission scenarios. SLRRP was designed to provide other USGS coastal ecosystem models with corresponding sea levels rectified to NAVD 88. SLRRP uses the mean monthly tide records of NOAA tide gages projected into the 21st century with the addition of curvilinear rates of eustatic sea level expected from climate change. SLRRP utilizes a graphic user interface of sequential pop-up windows to facilitate user selection of a desired tide station, GCM, emission scenario, or alternative customized inputs (fig. 10). The SLRRP customized mode allows users to manually enter a local subsidence rate and eustasy rate or elevation over a given time frame instead of using model defaults. The program gives the user options for saving graphical and digital formats of generated sea-level projections. SLRRP prompts the user to execute a seawater inundation option that builds a supplemental graph of the timing and rate of flooding for an elevation entry of a land surface or other feature (fig. 10). In effect, the model shows the prospective date and time period for which sea level may likely overtop and permanently submerge a given landscape feature under a future sea-level projection. Flooding potential is the percentage of months within a year when there is inundation by seawater for a given elevation determined by the user, assuming hydrological connectivity. SLRRP is used to generate projected sea-level rise curves for other USGS ecological models, such as SELVA-MANGRO, SLOPE, and WETLANDS, developed for assessing tidal wetland migration under sea-level changes for either a rise or a fall.	National	Local, regional	USGS

Temperature-based sea-level rise model	A semi-empirical model of future sea-level rise was developed (Rahmstorf, 2007) to project possible changes in global sea-surface height from global near-surface air temperature. The model is based on the assumption that the rate of sea-level change is roughly proportional to the magnitude of relative warming above pre-industrial temperatures. A semi-empirical approach is a reasonable alternative to process-based GCMs given their accuracy limitations to reproduce historical sea-level trends of the 20th century. Modern climate records show a highly significant correlation of global temperature with sea-level change by rate and direction. It is expected that, with every 1 °C change in global air temperature, sea levels will rise or fall by 10–30 m. The linear approximation of sea-level change with this semi-empirical approach provides reproducible results of modern sea-level trends within centimeters. Future projections are based on the range of predicted temperature changes that will vary according to greenhouse gas controls and conservation measures. Projected rates for the 21st century from this model fall within the range of other global lows and highs from more complex models.	Global	Global	Potsdam Intitute for Climate Impact Research	http://science.sciencemag.org/content/315/5810/368.short

Description of GIS Sea-Level Rise Mapping Tools by USGS:	Geographic information system (GIS) sea-level rise mapping tools are abundant and popular for ease of construction and interactive graphical display. These tools allow Internet browsers to visualize the potential impact of future sea-level rise scenarios on land maps at local, regional, and global scales as determined by tool design and capability. Tool developers include Federal, State, university, and nongovernmental organizations utilizing GIS data, software, and graphic user interfaces to display developer-specified images or user-specified choices of geospatial extent and sea-level rise options. As a rule, these are non-expert tools lacking scientific credibility that display maps of potential coastal inundation based on public-domain digital elevation models (DEMs) and arbitrary sea-level projections. These mapping tools are often referred to as “bathtub” models for the overly simplified approach of water-over-land relations, an approach that disregards important biological, hydrological, physiographic, and geodetic considerations.At best, these mapping tools provide only a visualization of the future extent of tidal wetlands and shorelines suitable for facilitating discussion of coastal issues and, more importantly, highlighting the need for expert model application and accuracy. For more go to USGS SLR Modeling Handbook pg22.

Tool Name	Description	Geographic Scope	Scale of Application	Provider	Link/URL
Coastal Resilience 2.0	Ecological, social, and economic information can be viewed alongside sea level rise and storm surge scenarios in specific geographies. This tool uses custom, dynamic high--resolution sea level rise and flood data. In addition, geographies have plug--in tools ("apps") that address specific coastal issues and help users visualize potential nature--based adaptation solutions. As such, this tool is less about data availability and download, and more about providing social, economic, and ecological assessments for decision makers in specific geographic areas. These detailed analyses results help communities identify nature--based solutions for reducing vulnerabilities and disaster risk.	Gulf of Mexico	Regional	The Nature Conservancy	http://maps.coastalresilience.org/gulfmex/
NOAA SLR Viewer	Provides a first look at a community's potential exposure to inundation from coastal flooding and sea level rise and provides nationally consistent data for download or consumption via map services. The digital elevation models (DEMs) that form the base maps are conditioned specifically for mapping inundation and have been used in selected coastal resilience efforts and for storm surge modeling and mapping by the National Hurricane Center. These DEMs are available for download. NOAA's primary objectives for this tool are to provide a consistent, national viewer and open access to the data that local communities need to address their needs.	National	Local, regional, national	NOAA Office for Coastal Management	http://coast.noaa.gov/digitalcoast/tools/slr Viewer

Surging Seas	Public web tool to help communities, planners, and leaders better understand sea level rise and coastal flood risks. The multi---part tool provides local sea level rise and flood risk projections, searchable interactive maps, "fast look" community reports, data downloads, and exposure tabulations by zip codes, municipalities, counties. Exposure assessments cover over 100 demographic, economic, infrastructure and environmental variables using data drawn mainly from federal sources, including NOAA, USGS, FEMA, DOT, DOE, DOI, EPA, FCC and the Census. Maps are based primarily on elevation data supplied by NOAA and used in NOAA's Sea Level Rise Viewer.	Multi-state	City, county, state	Climate Central	http://sealevel.climatecentral.org/
MIRA	The MIRA tool is an interactive map that explores the effects of sea level rise on the Mississippi coast. Using Hurricane Katrina as a backdrop, it simulates what could have happened if it struck in the year 2050 when sea level was 6, 12, or 18 inches higher than it was in 2005. Additionally, the tool goes back in time to 1960 when sea level was 5 inches lower.	Mississippi & Alabama	Regional	University of Central Florida	http://champs.cecs.ucf.edu/CDSLR/
Coastal Flood Exposure Mapper	This product supports community discussions about coastal hazard vulnerabilities and assets with maps that show people, places, and natural resources exposed to coastal flooding. Based on the Roadmap for Adapting to Coastal Risk training, the tool supports users undertaking a community-based approach to assessing coastal hazard risks and vulnerabilities. Users can select their geography and create a collection of maps that can be downloaded or shared online. Also included are tips for using these maps in a community workshop, case studies, and resources for continuing risk and vulnerability conversations.	Gulf of Mexico & Atlantic Coast	City, county, state	NOAA Office for Coastal Management	http://coast.noaa.gov/digitalcoast/tools/flood-exposure
Sea Level Scenario Sketch Planning Tool	The purpose of the tool is to facilitate the identification of transportation infrastructure potentially at risk from projected sea level changes. The tool visualizes various sea level scenarios at future time periods in an effort to inform transportation planners and highlight infrastructure for potential avoidance, minimization, or mitigation.	Florida		University of Florida GeoPlan Center/Florida Department of Transportation	http://sls.geoplan.ufl.edu/#intro

Florida SLR Viewer	The tool helps local planners identify the most vulnerable infrastructures and places using the inundation data provided by the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer. Using the online visualization tool (University of Florida sea level rise viewer), the users can easily view the estimated vulnerability under 1-foot, 2-foot, and 5-foot scenarios. Detailed information regarding the vulnerable infrastructure and the vulnerable census block groups can also be viewed.	Florida	University of Florida	http://plaza.ufl.edu/dengyujun11/SLR7.0.html
Sea Level Trends	The mean sea level (MSL) trends measured by tide gauges that are presented on this web site are local relative MSL trends as opposed to the global sea level trend. Tide gauge measurements are made with respect to a local fixed reference level on land; therefore, if there is some long-term vertical land motion occurring at that location, the relative MSL trend measured there is a combination of the global sea level rate and the local vertical land motion. The global sea level trend has been recorded by satellite altimeters since 1992 and the latest calculation of the trend can be obtained from NOAA's Laboratory for Satellite Altimetry, along with maps of the regional variation in the trend. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and provides detailed explanations about the issues involved.	National	NOAA Tides and Currents	http://tidesandcurrents.noaa.gov/sltrends/sltrends.html
Community Health and Resources Model (CHARM)	The Coastal CHARM Program is a Texas A&M University program that seeks to bring the power of scenario planning and mapping to communities around the Gulf dealing with hazards, sustainability, and resilience.	Multi-state	Texas Sea Grant	http://tcwp.tamu.edu/charm/
Sea-Level Rise Visualization for Alabama, Mississippi, and Florida	This pilot project is a collaborative effort of the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, Mississippi-Alabama Sea Grant Consortium, and U.S. Geological Survey.	Gulf of Mexico	NOAA/MS-AL Sea Grant, USGS	http://gom.usgs.gov/slr/slr.aspx

Geohazard Mapping - Texas Barrier Islands	Barrier islands are highly vulnerable to relative sea-level rise, erosion, and tropical storms, but simply categorizing their entire extent as a risky place to live would not help guide ongoing urban development. These interactive maps show areas that vary in their susceptibility to, and function for, mitigating the effects of geological processes. These processes include relative sea-level rise, erosion, and storm-surge flooding and washover. Information about geoenvironments, terrain elevation, historical and projected shoreline positions, and parcels is also included. These interactive maps have been created by the Coastal and Marine Geospatial Lab of the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University-Corpus Christi. Content displayed on the map viewers has been developed using information and funding from various sources.	Texas	Harte Research Institute	http://geohazards.tamucc.edu/
Coastal Flood Exposure Mapper	This product supports community discussions about coastal hazard vulnerabilities and assets with maps that show people, places, and natural resources exposed to coastal flooding. Based on the Roadmap for Adapting to Coastal Risk training, the tool supports users undertaking a community-based approach to assessing coastal hazard risks and vulnerabilities. Users can select their geography and create a collection of maps that can be downloaded or shared online. Also included are tips for using these maps in a community workshop, case studies, and resources for continuing risk and vulnerability conversations.	National	NOAA Office for Coastal Management	http://coast.noaa.gov/floodexposure/#/map
Louisiana Coastal Protection and Restoration Authority (CPRA) Flood Risk & Resilience Viewer	This viewer integrates and displays the results from CPRA's 2012 Coastal Master Plan, along with additional coast-wide data that allow for a broad examination of how flood risk impacts communities. It is not appropriate for site-specific decision making. Users can look at projected land changes, flood risk, and impacts to communities based on the implementation of Coastal Master Plan projects.	Louisiana	CPRA	http://cims.coastal.louisiana.gov/floodrisk/

SURGEDAT: The World's Storm Surge Data Center	SURGEDAT includes maps that show storm surge and storm tide heights (i.e., high water marks) from high-profile hurricanes. The maps also contain hourly position and hurricane intensity information. Under the Interactive Surge Maps tab, users can select a storm name and year to see the locations and values of high water marks. Under the Historical Surge Maps tab, users can see the position and intensity for the top 10 storms to hit the Gulf Coast and Atlantic Coast.	Gulf of Mexico and East Coast		Louisiana State University, Southern Climate Impacts Planning Program	http://surge.srcc.lsu.edu
USGS Sea Level Rise Animation	The online USGS Sea-Level Rise Animation (Usery and others, 2010) creates visualizations of seawater over land, illustrating vulnerability of low-elevation areas (rather than predictions of sea-level rise). The animated graphics are created by using raster elevation, land cover, and population data at 1-km (global), 90-m (regional), and 30-m (regional, specifically the U.S. areas) resolutions. Colors reflect land cover categories, and the counts are numbers of people living or impacted below specific elevations. The animated graphics are not meant to be site specific. They are based exclusively on elevation and do not attempt to account for tidal action, shoreline configuration, and other characteristics that might affect how the water would rise in a specific coastal zone. Data resolution and accuracy limit the ability to access a particular location and get an accurate measure of the exact inundation area and number of people. Any errors in the data affect the accuracy of the simulations. The limits of the rise in the global animated graphics are set to 80 m, the theoretical limit of sea-level rise if all glaciers and icecaps melt. For regional animated graphics, a limit of 30 m is used because this was the greatest rise resulting from the Indian Ocean tsunami in 2004.	Global	local, regional, national, global	USGS	http://cegis.usgs.gov/sea_level_rise.html

Description of Wetland Change Models by USGS:	Ecological simulation models used for sea-level rise impact assessment vary fundamentally in design and function on the basis of the organizational unit, whether at ecosystem, species, or organism level. In this section, we describe the class of wetland change models designed to predict changes in land cover at the ecosystem (habitat) level in terms of presence or absence (table 5). In these models, there are no quantitative features or attributes applied to the cover type other than a descriptive classification. The wetland type or habitat cover descriptions vary in detail and discrimination from generic classification of terrestrial or aquatic forms to surficial qualifiers of tidal flat, beach, low marsh, high marsh, swamp, upland, or other cover type. These models predict change on the basis of the relation between land and water and assign a vegetative cover or habitat change effect. Further, wetland change models generally have a simple rule set that assigns a given habitat type by degree of submergence. As the land grid cell becomes more inundated over time, these models account for the loss or gain of the different habitat types as a measure of impact from sea-level rise. Wetland change models differ largely on the delineation of habitat types or classification scheme used and the degree of inundation at which a habitat switches from one type to another. Predicted loss of habitat is generally a matter of erosion or submergence by surface inundation when a marsh, swamp, or mudflat eventually transitions to open water.

Tool Name	Description	Geographic Scope	Scale of Application	Provider	Link/URL

Barataria-TerreA4:A24bonne Ecosystem Landscape Spatial Simulation (BTELSS)	The Barataria-Terrebonne Ecological Landscape Spatial Simulation (BTELSS) (Voinov and others, 1999, 2007; Martin and others, 2000; Reyes and others, 2000, 2004; Binder and others, 2003) and its predecessor, the Coastal Ecological Landscape Spatial Simulation (CELSS) (Constanza and others, 1990; Sklar and others, 1991), represent a process-based ecological model design of coastal wetland change and water constituents within a watershed context for evaluating potential impacts of restoration projects, river diversions, saltwater intrusion, climate change, and sea-level rise. Time-series data of Atchafalaya River and Mississippi River discharges, Gulf of Mexico salinity, river sediments and nutrients, rainfall, sea level, runoff, temperature, and winds are inputs to the model affecting water and constituent movement through the watershed. The location, dredging date, and characteristics of waterways, canals, and levees are also supplied as model inputs affecting historical conditions and effects on watershed hydrological dynamics. Land elevation in relation to flooding pattern determines succession of one habitat type to another by way of a simple switching algorithm. The model has been validated by hindcasting historical conditions and matching vegetation type and conversion with more contemporary vegetation maps.	Barataria and Terrebonne basins of Louisiana	local, regional	Louisiana State University	http://ecobas.org/www-server/rem/mdb/btelss.html

Sea Level Affecting Marshes Model (SLAMM 1- 5)	The Sea Level Affecting Marshes Model (SLAMM) (Park and others, 1989; Galbraith and others, 2002, 2003; National Wildlife Federation, 2006; Craft and others, 2009; Clough and others, 2010; Geselbracht and others, 2011) is a menu-driven, map-based simulation model using discrete time steps of 5–25 years. The different model versions reflect upgrades in software, data sources, and spatial resolution of subsequent site applications more than they reflect any substantial changes of functionality or design. Spatial resolution ranges from 500-m pixel size, for map areas confined to 7.5-min quadrangles prior to the advent of DEMs, to 10-m pixel dimensions of more recent versions. Orthometric land elevations are converted to tidal datum equivalents for selected regional tide gages. Sea-level rise is simulated as a static increase of projected eustatic sea-level rise for the proportion of years matching model time step. Model output consists of graphical displays of habitat change by color scheme and tabular export files for calculating summary statistics of land loss and marsh migration with rising sea level. Model execution allows non-expert utility accomplished by command line and batch mode inputs of discrete user options for sea-level scenarios and map view based on a data matrix structure. Habitat data are based on classification of multispectral Landsat data of early versionsof SLAMM and U.S. Fish and Wildlife Service (FWS) National Wetland Inventory (NWI) habitat delineations of later versions of SLAMM, including aquatic systems, urban developed, terrestrial wetland, and upland forest classes. Elevations of the grid cells in SLAMM are based on interpolated topographic contour lines and slopes in early versions to DEMs based on USGS NED and supplementary lidar coverage in later versions. Model predictions are based on rule sets of land loss/conversion relative to water-table inundation of the land surface and wave erosion on the edge of large water bodies, excepting protected	National	local, regional	Warren Pinnacle Consulting, Inc.	http://warrenpinnacle.com/prof/SLAMM/

Sea Level Affecting Marshes Model (SLAMM 6)	See SLAMM 1-5. Earlier SLAMM versions did not account for marsh accretion, whereas version 6, the most updated version, assigns habitat-specific accretion rates that, if not exceeded by sea-level rise, allow for habitat migration or conversion.	National	local, regional	Warren Pinnacle Consulting, Inc.	http://warrenpinnacle.com/prof/SLAMM/
Sea Level Over Proportional Elevation (SLOPE)	The Sea Level Over Proportional Elevation (SLOPE) model (Doyle and others, 2010) is a USGS product that predicts coastal forest retreat and saltmarsh/mangrove migration from projected sea-level rise on the basis of a proxy relation of saltmarsh/mangrove area and tidal range.The model as applied to the Gulf Coast is subdivided into separate reaches defined by each of the 60 coastal counties from Texas to Florida. Summaries of saltmarsh/mangrove area for each coastal county were obtained from published sources on the basis of detailed grid sampling of the NWI database and habitat classification scheme. Tidal ranges were obtained from NOAA tide stations for more than 300 locations and filtered to assign corresponding maximum tide range for each coastal county. The SLOPE model assumes that the sum area of saltmarsh/mangrove habitat along any given coastal reach is determined by the slope of the landform and vertical tide forcing. The model assumes that area and boundary characteristics of saltmarsh/mangrove ecosystems have been defined by the local tidal prism in relation to ambient salinity concentrations and circulation suitable to support saltwater habitats in a given coastal reach.	Gulf of Mexico	regional, national	USGS	

Hydro Marsh Model

LSU

Description of Surface Elevation and Shoreline Erosion Models by USGS:	In this section, we describe process-based studies and models of marsh-elevation change, substrate biogeochemical state, and shoreline erosion that are complementary to predictive sea-level rise models, particularly species- and ecosystem-based simulation models to be discussed in later sections. There are a number of empirical studies and observation systems for monitoring the process and rate of surface elevation change, substrate biogeochemical state, and shoreline erosion that are important to highlight. Geographic position of barrier island and mainland shorelines from maps dating to the European discovery of North America has been compared with more recent map sources to demonstrate shifts, erosion, and aggradation of coastal features linked to longshore currents and riverine influences. New observational tools and techniques to monitor surface elevation and soil salinity change within coastal wetlands have improved understanding of the dynamic nature of subsidence, accretion, sedimentation, eutrophication, and saltwater intrusion with changing hydrological forcing connected with hurricanes, sea level, streamflow, climate, and biotic factors. In this section, we describe different tools and techniques for monitoring and modeling surface elevation, shoreline change, and storm influences of coastal systems.

Tool Name	Description	Geographic Scope	Scale of Application	Provider	Link/URL
Coastal Vulnerability Index (CVI)	The Coastal Vulnerability Index (CVI) (Gutierrez and others, 2011) represents an objective (observed) measure of shoreline erodibility for the coastlines of the United States on the basis of historical shoreline maps and geological studies. The CVI is a probability index designed to assign relative risk and future threat of shoreline change under rising sea level. The index is based primarily on empirical measures of physical changes determined from comparative shoreline surveys or maps related to physical forces and features of tidal range, wave height, coastal slope, geomorphology, and relative sea-level trend by coastal reach. This approach, using combinations of measured change, coastal attributes, and physical forcings, provides a relative vulnerability, or erodibility, measure for guiding coastal planning and research. CVI provides a useful construct and decision-support tool on a national and regional basis for assessing economic risk and threats of coastal erosion, flooding, and storm damage. A Bayesian Network (BN) analysis has been developed to complement the historical perspective of the CVI to predict long-term shoreline change for the different projections of sea-level rise. The BN analysis links the relations between driving forces, geological constraints, and coastal response for the U.S. Atlantic Coast that include observations of local rates of relative sea-level rise, wave height, tide range, geomorphic classification, coastal slope, and shoreline change rate. Probabilistic predictions of shoreline retreat can be generated in response to different sea-level rise projections, mostly demonstrating that shoreline retreat increases with higher rates of sea-level rise.	National	national, regional	USGS	

Marsh Equilibrium Model (MEM)			
Tidal Channel Network Models (TIGER)	Various numerical models have recently been developed to describe the morphogenesis and long-term dynamics of saltmarsh channels and tidal creek networks during periods of rising sea levels (Fagherazzi and Sun, 2004; D'Alpaos and others, 2005; Kirwan and Murray, 2007). Current understanding of coastal landform evolution is still more conceptual than certain in ability to validate quantitative predictions of how, when, where, and whether saltwater and freshwater systems can or will keep pace with different rates of sea-level rise.	local	http://people.bu.edu/sergio/CV/papers%20pdf/2008%20WRR-TIGER.pdf

Description of Niche-Based Species Distribution Models by USGS:	Niche-based species distribution models describe the interrelation of environmental factors or conditions thought to define or limit species range on the basis of geographic extent. These models assume that modern distribution of species is controlled by associated climate and edaphic factors that can be quantified and expressed as favored and adapted ecological space. Fundamental niche space is theoretically all sets of factors controlling species presence, colonization, and persistence, whereas realized niche space (actual species range) is a limited expression of full ecological potential. Commonly, the overlap of precipitation and temperature datasets coincident with species range is used to construct niche space and project potential spread with changing climate. This approach assumes that environment solely controls species spread and success apart from event-driven causes or other physiographic, hydrological, or biotic factors. Find more in USGS SLR Modeling Handbook pg 40.

Tool Name	**Description**	**Geographic Scope**	**Scale of Application**	**Provider**	**Link/URL**
none					

Description of Leaf to Landscape (L2L) Ecosystem Models by USGS:	Leaf to landscape (L2L) ecosystem models are the most sophisticated ecological models developed for sea-level rise application. These models predict ecosystem change at the species and organism level on the basis of the physiological tolerances and ecological requirements of a species and specific environmental conditions of an organism or individual plant (table 6). L2L ecosystem models incorporate a hierarchical integration of ecological processes and response from the leaf level, where photosynthesis, water exchange, and carbon allocation take place on an individual tree or plant basis, to the stand level, where interplant competition, biomass, and diversity are measured, to the landscape level, where physical factors of soil, watershed, climate, and disturbance differences affect system-level response.

Tool Name	Description	Geographic Scope	Scale of Application	Provider	Link/URL
Coupled Saltmarsh Biogeochemical and Demographic Model	A coupled biogeochemical and demographic model (Simas and others, 2001) was developed for saltmarsh in the Tagus estuary in Portugal to predict potential effects of sea-level rise on distribution of C3 and C4 plant species (plants that use a carbon fixation pathway with 3- and 4-carbon molecules, respectively, in the first stable photosynthetic product). Saltmarsh processes are simulated as a function of C3 and C4 species carbon production from light- and temperature-dependent functions of growth, respiration, and leaf mortality. A class transition model simulated the demographics of plant population density per unit area. A GIS tool was used to track changes in elevation with constant sedimentation inputs over time and the various production attributes of lower marsh (C4) and upper marsh (C3) with sea-level rise of 95 cm by 2100. The model does not simulate marsh migration upslope but rather simulates the loss of marsh habitat cover and production over time.	Tagus Estuary Portugal	local	Universidade Nova de Lisboa-Quinta Da Torre, Portugal	

Hammock-Mangrove Vadose Zone Model	The Hammock-Mangrove Vadose Zone Model (Teh and others, 2008) was developed by the USGS to investigate the process of species distribution and productivity response of changing salinity concentrations with sea-level rise. The simulation model is of hypothetical design for a 1-hectare landscape (made of 100-by-100 1-m grid cells) at the ecotone of hardwood hammock and mangrove vegetation with an assumed elevation gradient of 10 cm/km.The Hammock-Mangrove Vadose Zone Model simulates daily changes and diffusion of saltwater intrusion on the basis of difference calculations or infiltration rates of precipitation, evaporation, and transpiration distinguished by wetland type. Daily tide values are compared with cell elevation to determine flux additions of salinity that is subsequently diffused among neighboring cells and with soil depth based on salinity concentrations. A single 1-m grid cell can contain both hammock and mangrove species. Physiological parameters are species specific to account for species growth rates and litter production. The model was developed principally to evaluate the process of self-organization under chronic sea-level changes and acute impacts of storm surge synoptics. The model predicts species biomass and distribution spatially and temporally for exploring the process of regime shifts of species dominance.	Imaginary	hypothetical landscape 100 x 100 m	USGS

Spatially Explicit Landscape Vegetation Analysis Model (SELVA)	An L2L ecosystem model known as SELVA-MANGRO (Doyle and Girod, 1997; Doyle and others, 2003b; Berger and others, 2008) was developed for Neotropical mangrove forests by the USGS to investigate the potential impacts of climate change on the quality and distribution of future coastal wetland habitat of The Everglades. SELVA-MANGRO predicts mangrove displacement of freshwater marsh and swamp habitat with increasing tidal inundation in proportion to the rate of sea-level rise. SELVA-MANGRO represents a hierarchically integrated landscape-scale vegetation model (SELVA) spatially linked to an individual-based stand simulation model (MANGRO) for predicting change in the structure and distribution of mangrove forests at a park, a refuge, or regional scale. Both models are spatially explicit, thereby accounting for arrangement of trees within a forest stand and stand distribution within a landscape. SELVA-MANGRO comprises multiple linked hierarchical relations at the leaf, tree, species, stand, ecosystem, and landscape level. The location of each individual tree and stand is explicitly mapped within the same coordinate system, akin to a GIS. SELVA and MANGRO represent trees and space in three-dimensional architecture of horizontal and vertical articulation. SELVA contains a regionally interpolated DEM of south Florida based on a 1-ft contour survey conducted in the 1950s. For more see USGS SLR Model Handbook pg 47.	Florida	local	USGS, National Wetlands Research Center

Mangrove Forest Growth and Succession Model (MANGRO)	See SELVA description		tree and stand level, local	USGS, National Wetlands Research Center

Spatial Relative Elevation Model	The Spatial Relative Elevation Model (SREM) (Kairis and Rybczyk, 2010) was developed for Padilla Bay, Washington, to predict changes in bathymetry on the basis of distribution an dproductivity of seagrass meadows dominated by *Zostera marina* (eelgrass). SREM is a modified version of amarsh soils cohort model for coastal Louisiana adapted to consider the processes of sediment deposition affecting bathymetry of an aquatic bay sysetm. SREM is aspatial model of Padilla Bay at a 50 m grid resolution with no interaction between neighboring cells. Each cell simulates processes of seagrass productivity, aboveground and belowground, and standing stock resulting in net changes in bay-bottom elevation. Survival is determined by discrete depth ranges, taking into account that water can be too shallow or too deep. A number of sea-level rise scenarios were applied to forecast bathymetric changes of Padilla Bay and the threat to eelgrass communities.	Padilla Bay, Washington	local	Skagit River System cooperative, Western Washington Univeristy

WETLANDS	The WETLANDS L2L ecosystem mdoel (Doyle and others, 2003) predicts plant-species distribution and migration with changing land-water relations. The WETLANDS model is a USGS product that uses empirical relations of species occurrence by elevation within the tidal plane to project marsh regression or transgression with sea-level fall or rise, respectively. The model uses data from a field study that was conducted to relate plant-species distribution and ecotones to suface elevation and tidal inundation by using differential leveling surveys. The WETLANDS model contains functional probabilities of species tolorance to flooding conditions that dictate the rate and process of ecological succession and coastal retreat with SLR. For more go to USGS SLR Modeling Handbook pg 52.	local, regional, national	USGS