

Appendix D – Decision Support Tools - Predictive Models

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1.0 Foreword

These technical documents were drafted in various stages of master plan development to support modeling that occurred in late 2010 – early 2012. Although the team tracked technical developments and updates in the literature since that time, documentation was not updated during this analysis. It is envisioned that any developments not captured herein will be captured in future updates to the master plan.

Also, this appendix refers to a number of appendices, including individual technical model reports. Several of these documents are currently undergoing review and revision and will be posted in the upcoming weeks. Please check the website or contact Alaina Owens (aowens@brwncaid.com) for the status of any appendix.

1.1 Background and Context

The goal of the approach described here is to predict the ways in which restoration and risk reduction projects support the overall objectives of the 2012 Coastal Master Plan. Broadly, master plan objectives include support for flood protection, natural processes, coastal habitats, cultural heritage, and a working coast. The approach includes a number of linked models (Figure 1) that predict change in the conditions of the Louisiana coastal system under both a future without additional restoration and risk reduction projects and the conditions which would result from project implementation. The concept of linked models in Louisiana coastal planning is not new, as linked models were applied to aid restoration planning for the 2004 Louisiana Coastal Area (LCA) large-scale planning effort (USACE 2004) and several linked models were used to inform the 2007 Coastal Master Plan (CPRA 2007: Appendix G). However, the yellow arrows in Figure 1 indicate substantially improved or entirely new feedbacks and linkages among models that were developed and utilized to support the 2012 Coastal Master Plan process. In addition to new linkages, several entirely new models were created to support this effort (detailed below in the Summary of Models section).

Figure 1 shows the models both provide inputs to other models and/or produce outputs which themselves are used to estimate how much projects contribute toward achieving master plan objectives. Each model also considers important but uncertain factors which influence the dynamics of that aspect of the system. A number of environmental and risk reduction uncertainties were used to develop scenarios reflecting the potential range of future conditions (Appendix C - Environmental Scenarios). The uncertainties associated with developing scenarios are not to be confused with the uncertainty within the models themselves, as was assessed through a Model Uncertainty Analysis (Appendix D27).

Model output is ultimately used as input to a Planning Tool. The Planning Tool is a user friendly tool used to sort and view model results and compare projects to one another. In addition to model outputs, it also sorts projects based on costs, funding constraints, and stakeholder preferences. For more information on the Planning Tool, see Appendix E – Planning Tool.

This document provides a general description of:

- Each model and how the models work together to predict project effects
- Environmental uncertainties and scenarios that were used to evaluate a variety of potential future conditions
- Methods that were used to conduct internal quality review of the model files
- Post-processing of model outputs for use as input to the Planning Tool
- The model Uncertainty Analysis that was performed to gauge uncertainty within the models
- The Technical Advisory Committee that was called upon to assist with model development and application

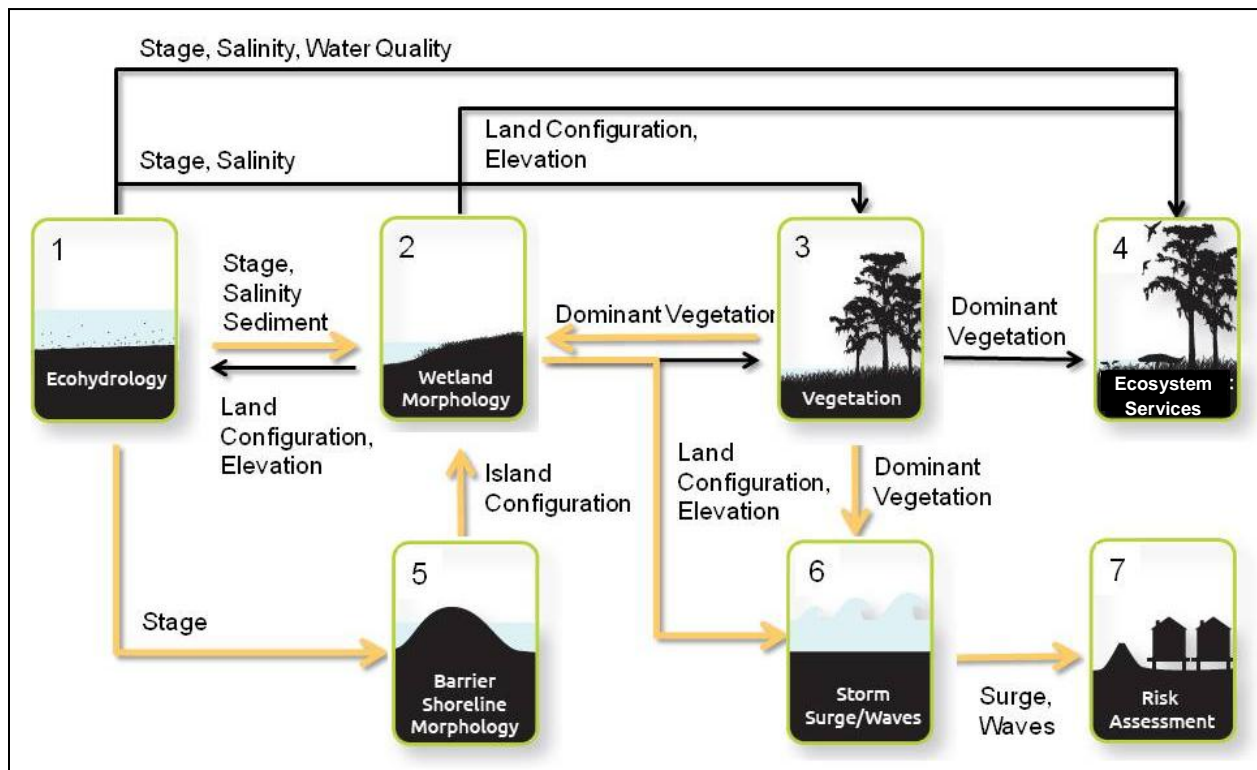


Figure 1. Linkages and Feedbacks among Models (Inputs and Outputs). New linkages are indicated in yellow.

1.2 Summary of Models

1.2.1 Eco-Hydrology

Detailed Model Report: Appendix D1

The Eco-Hydrology model consists of three individual models (Chenier Plain region, Atchafalaya-Terrebonne region, and the Pontchartrain-Barataria region) that connect to one another to provide coast wide outputs. Each model predicts the salinity, stage, and other selected water quality constituents of the open water bodies (including channels) within estuaries. For each region, a mass balance approach is used to estimate the exchanges of solids and chemicals due to advection and dispersion processes. These models use conveyance links and storage cells or boxes

(ranging in size from 0.05 – 5844 km²) to allow multi-year simulations in a few hours on a desktop computer. This approach was used previously to support restoration planning in the Pontchartrain Basin. It has been extended to the entire coast and modified to estimate salinity, stage, and other water quality parameters needed by the ecosystem services models and to assess nutrient uptake dynamics.

Inputs: Wind Speed and Direction, Land Area, Gulf Stage, Gulf Salinity, Gulf Nutrient Concentrations, Air Temperature, River Discharge, River Sediment, River Nutrient Concentrations, Diversion Flows, Atmospheric Deposition Rates, Rainfall and Evapotranspiration.

Outputs: Stage, Salinity, Water Temperature, Total Suspended Solids, Accretion, Total Kjeldahl Nitrogen, Tidal Range, Nitrate + Nitrite Nitrogen, Ammonium Nitrogen, Dissolved Organic Nitrogen, Total Phosphorus, Soluble Phosphorus, Phytoplankton as Chlorophyll-a, Detritus, Residence Time and Nitrogen Removal Rate.

1.2.2 Wetland Morphology

Detailed Model Report: Appendix D₂

This model tracks the changes in wetland-dominated landscapes over time including the loss of existing wetlands, the creation of wetlands by both natural and artificial process, and the fate of those newly created wetlands. Whereas previous modeling efforts have simply projected past trends, this model represents an effort to consider more characteristics of the landscape as predictors of change. This model operates on a spatially explicit platform and utilizes spatially explicit input data sets, an improvement from past modeling efforts.

Inputs: Land/Water, Land Change Rates, Elevation (topography and bathymetric data), Average Band 5 Reflectance (from Landsat TM), Eustatic Sea Level Rise (ESLR), Local Subsidence, Freshwater Input, Sediment Supply, Sediment Bulk Density, Sediment % Organic Matter, % Organic Carbon, % Mineral, Vertical Accretion, Salinity, Water Level, Marsh Type and Dominant Plant Species.

Outputs: Land/Water Fragmentation, Edge Density, Surface Elevation, Percent Land, and Soil Organic Carbon (used to estimate potential carbon sequestration).

1.2.3 Barrier Shoreline Morphology

Detailed Model Report: Appendix D₃

The Barrier Shoreline Morphology model is a new model that was created for the 2012 Coastal Master Plan. Changes in barrier shorelines and headlands are based on a simple shoreline change model driven by analysis of historical shorelines that are a part of the Barrier Island Comprehensive Monitoring project (BICM). The model tracks changes in both Gulf side and bay side of islands along shoreline segments to allow changes in island shape and migration to be estimated. The character of tidal inlets is determined by both barrier configuration and tidal prism, which is dependent on wetland loss/gain (determined by the wetland morphology model) within the estuarine basin.

Inputs: Current Barrier Shoreline Location and Bathymetry, Location of Tidal Inlets, Terminal Groins, Sediment Character, Dune/Berm Elevation, Offshore Wave Climate, Mean Daily Tidal Range, Bay Area and Location and Magnitude of Sediment Bypassing.

Outputs: Tidal Prism, Shoreline Position, Barrier Position, Inlet Cross-sectional Area and Position of Major Inlets.

1.2.4 Vegetation

Detailed Model Report: Appendix D4

The Vegetation model is a new model that was created for the 2012 Coastal Master Plan. It predicts the extent of 19 emergent vegetative types/communities and submerged aquatic vegetation (SAV). It estimates spatial and temporal changes in vegetation types/communities based on environmental drivers, such as salinity and water level change. Coastwide Reference Monitoring System (CRMS) data were used to establish relationships between physical conditions and plant distributions, and these relationships were used to predict change in dominant species.

Productivity is based on general estimates for each vegetation type.

Inputs: Initial Vegetation Distribution, Land Area Distribution, Elevation, Water level and Salinity.

Outputs: Percent of each Vegetation Type in Each Cell at 1 Year Intervals.

1.2.5 Ecosystem Services

Detailed Model Reports: Appendix D5 – D23

These models are used to predict how well Louisiana's future coast will provide habitat for commercially and recreationally important coastal species and habitats for other key species. This group of models uses inputs from the Eco-hydrology, Wetland Morphology, Barrier Shoreline Morphology, Vegetation and Storm Surge/Wave models. It includes habitat suitability indices for American alligator (*Alligator mississippiensis*), muskrat (*Ondatra zibethicus*), river otter (*Lontra canadensis*), spotted sea trout (*Cynoscion nebulosus*), brown shrimp (*Penaeus aztecus*), white shrimp (*Litopenaeus setiferus*), largemouth bass (*Micropterus salmoides*), gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), mottled duck (*Anas fulvigula*), neotropical migrants (varied species), roseate spoonbill (*Platalea ajaja*), wild-caught crawfish (*Procambarus clarkii*), and eastern oyster (*Crassostrea virginica*). These species were selected for one or more of the following reasons: they are thriving in coastal Louisiana, they are of commercial or recreational importance, and/or their habitat would likely be either increased or decreased by protection and restoration projects. Besides the habitat models, many of which were based on existing habitat suitability indices, new ecosystem services models were developed to reflect potential for surge/wave attenuation, nature-based tourism, freshwater availability, agriculture/aquaculture, nitrogen uptake and carbon sequestration (see Appendix D2 Wetland Morphology Model).

Inputs: Salinity, Water Temperature, Water Depth, Water Level, Water Level Fluctuation, Chlorophyll-a, Marsh Type, Vegetation Type, Index Value of Primary Productivity, Edge, Percent Land/Open Water, Percent of Cell near Undeveloped Island, Percent Submerged Substrate Covered by Emergent Vegetation, Percent Cultch Cover on Bottom, Distance to Population Centers, Distance to Barrier Islands, Distance to Strategic Assets Requiring Fresh Water

Outputs: Habitat Suitability Indices for 13 species (Crawfish, Alligator, Largemouth Bass, Mottled Duck, Gadwall, Green-Wing Teal, River Otter, Muskrat, White Shrimp, Brown Shrimp, Oyster, Spotted Sea Trout, Roseate Spoonbill) and 1 functional group (Neotropical Migrants) and non-species Ecosystem Services including Surge/Wave Attenuation Potential, Nature Based Tourism Potential, Potential for Freshwater Availability, Potential for Agriculture/Aquaculture, Nitrogen Uptake Potential and Carbon Sequestration Potential.

1.2.6 Storm Surge/Waves

Detailed Model Report: Appendix D24

This model uses the widely-used ADCIRC large domain storm surge model coupled with the unstructured SWAN wave model. ADCIRC uses an unstructured mesh, which allows for variation of resolution from coarse in the open ocean to very fine near islands, channels, levees, and areas where flow gradients are large (such as in channels and wave breaking zones). The unstructured mesh allows a very precise representation of the topographic and bathymetric features and accurate representation of the flow conditions.

The Storm Surge/Waves model requires output from the Wetland and Barrier Shoreline Morphology models to determine landscape configuration and output from the Vegetation model to set roughness parameters. This model provides flood stage and wave time series at select locations for use by the Storm Damage (Risk Assessment) model.

Inputs: Land Area Distribution and Elevation, Percent of Each Vegetation Class (Land Use/Land Cover), Barrier Island Geometry, Inlet Configuration and Shoreline Position.

Outputs: Surge Hydrographs and Waves at Damage Model points.

1.2.7 Risk Assessment (Storm Damage)

Detailed Model Report: Appendix D25

The Risk Assessment model is a new model that was created for the 2012 Coastal Master Plan. It calculates residual economic damage from storm surge flooding by calculating overtopping of flood risk reduction structures due to surge and waves, probabilistically assessing flooding due to breaching of hurricane risk reduction systems, estimating flood elevations, and determining economic consequences. For unprotected areas, the flood height is the sum of the maximum surge height and significant wave height. For protected areas, the model calculates a distribution of flood elevations that result from overtopping and breaching of the risk reduction system. A simplified interior drainage model, including pump system performance, is used to equalize flood elevations among adjacent basins. It uses an asset inventory based on the 2010 Census estimates. Direct damage calculations and other flood cost relationships are derived from the HAZUS model.

Inputs: Storm Surge and Related Data (Hydrographs and Wave Characteristics), Risk Reduction System Data (Locations and Characteristics), Data Regarding Assets and Values of Assets in Protected and Unprotected Areas.

Outputs: Flood Depths and (Economic) Risk/Damage Estimates at Different Recurrence Intervals

1.3 Scale of the Analysis

The models provide full coast wide coverage; however, some of the models operate at different spatial scales, e.g., the Eco-Hydrology output is provided for approximately 500 compartments across the coast, and Wetland Morphology, Vegetation and Ecosystem Services models make calculations for over 340,000 500m x 500m cells within the analytical boundary. Model scales were considered when determining the spatial resolution of the coastal regions for which model output was processed and transferred to the Planning Tool.

The temporal scale of the analysis is 50 years with predictions of individual model outputs at daily to 5 year intervals; however, this combined modeling approach is designed to produce long-term assessments of project effects and thus inter-annual or sub-decadal scale variations in outputs may not provide a meaningful basis for assessing project performance. Morphological change is predicted at 5 year intervals and other models ‘update’ morphological inputs at 25-year intervals. Thus, there may be ‘step’ changes in some outputs every 25 years which are associated with the way in which predictions are derived rather than any specific change in project effects.

1.4 Environmental Scenarios

Appendix C – Environmental Scenarios

To address uncertainties in the coastal Louisiana landscape and inform the 2012 Coastal Master Plan, project performance was evaluated across several possible future scenarios. The uncertainties referred to below and in Appendix C – Environmental Scenarios are different than the uncertainties described in the Model Uncertainty Analysis (Appendix D27 - Model Uncertainty Analysis). In the case of scenarios, ‘uncertainties’ refer to key environmental and risk reduction conditions that may change and should be considered when planning 50 years into the future, as a means of capturing a variety of potential future conditions. Environmental uncertainties are those that could affect how the natural system could change over time (e.g., sea level rise, subsidence), where as risk reduction uncertainties include conditions that could change into the future specifically in relation to storm projection features (e.g., fragility of a levee system, participation rate in nonstructural protection programs).

In the Model Uncertainty Analysis, uncertainties within the models themselves were tested and described. Table 1 provides an overview of the environmental uncertainties that were used to formulate scenarios and considered by the various models. Values for each uncertainty were selected to model moderate and less optimistic future conditions.

Table 1. Nine environmental uncertainties were considered in the modeling effort, used to evaluate project performance 50-years into the future under two plausible future conditions			
Environmental Uncertainty	Plausible Range	Moderate Value	Less Optimistic Value
Sea Level Rise	0.12 to 0.65 m over 50 years <i>(see Appendix D1 Eco-Hydrology)</i>	0.27 m / 50 yr	0.45 m / 50 yr
Subsidence	0 to 35 mm/yr; varies spatially <i>(see Appendix D2 Wetland Morphology)</i>	0 to 19 mm / yr (values vary spatially)	0 to 25 mm / yr (values vary spatially)
Storm Intensity	Current storm intensities to +30% of current intensities <i>(see Appendix D25 Risk Assessment)</i>	+ 10% of current intensities	+ 20% of current intensities
Storm Frequency	-20% to +10% of current storm frequency <i>(see Appendix D25 Risk Assessment)</i>	Current storm frequency; (One Category 3 or greater storm every 19 yr)	+ 2.5% of current storm frequency; (One Category 3 or greater storm every 18 yr)
Mississippi River Discharge	-7% to + 14% of annual mean discharge; adjusted for seasonality <i>(see Appendix D1 Eco-Hydrology)</i>	Mean annual discharge (534,000 cfs)	-5% of mean annual discharge (509,000 cfs)
Rainfall	Historical monthly range (+/-1 SD); varies spatially <i>(see Appendix D1 Eco-Hydrology)</i>	Historical monthly mean (values vary spatially)	-0.4 SD from historical monthly mean (values vary spatially)
Evapo-transpiration	Historical monthly range (+/-1 SD); varies spatially <i>(see Appendix D1 Eco-Hydrology)</i>	Historical monthly mean (values vary spatially)	+0.4 SD from historical mean monthly (values vary spatially)
Mississippi River Nutrient Concentration	- 45% to +20% of current N & P concentrations <i>(see Appendix D1 Eco-Hydrology)</i>	-12% of current concentrations (mg/L) Phosphorus = 0.19 Nitrite + Nitrate = 1.1 Ammonium = 0.038 Org. Nitrogen = 0.67	Current concentrations (mg/L) Phosphorus = 0.22 Nitrite + Nitrate = 1.3 Ammonium = 0.044 Org. Nitrogen = 0.77
Marsh Collapse Threshold	<i>(see Appendix D2 Wetland Morphology)</i> Salinity (ppt) Swamp: 4-7 Fresh Marsh: 6-8 Inundation (water depth, cm) Intermediate Marsh: 31-38 Brackish Marsh: 20-26 Saline Marsh: 16-23	Mid-range values of salinity and inundation result in collapse Salinity Swamp: 6 Fresh Marsh: 7 Inundation Intermediate Marsh: 34 Brackish Marsh: 23 Saline Marsh: 21	Lower 25 th percentile values of salinity and/or inundation ranges result in collapse Salinity Swamp: 5 Fresh Marsh: 7 Inundation Intermediate Marsh: 33 Brackish Marsh: 21 Saline Marsh: 18

The risk reduction uncertainties are handled differently than the environmental uncertainties, as they are not built around the moderate and less optimistic scenarios, per se; rather, the Risk Assessment model adds additional iterations of future uncertainty *within* each of those

environmental scenarios. Therefore, if the Risk Assessment model applied all possible risk scenarios for two environmental scenarios to help understand potential variations in future conditions, the experimental designs would yield in the tens to hundreds of combinations / scenarios.

Additional information regarding the risk reduction uncertainties and their ranges is provided in Table 2; however, given the complexity of this set of uncertainties, detailed information regarding scenario generation is provided directly in the Risk Assessment Model Technical Report (Appendix D25).

Risk Reduction Uncertainties	Ranges
Protection System Fragility	None / Low / Medium / High
Pumping Effectiveness	0/50/100% of rated capacity
Coast Wide Growth Rate	-1.0% to +1.5% / yr ; Current: 0.67%
Fraction of Population Growth in Urban Versus Rural Areas	76% to 86% ; Current = 81%
Effectiveness of Non-Structural Programs (Participation Rate)	Low 10-40%, Medium 40-60%, Medium-High 70-80%, and Full 100%

1.5 Internal Quality Review of Model Files

With thousands of model input and output files generated during the modeling process, internal quality review (QR) of model files was a necessity. Two primary types of internal CPRA review were conducted on the model output: mechanical review and technical review. Mechanical review is a way to ensure files were copied, loaded, and converted properly from one format to another. Technical review is a way to assure technical soundness of the outputs (validation based on expert opinion, in a sense). Essentially, it is a way to consider the inputs for a particular model run and then make judgments regarding the reasonableness of the corresponding output. During the technical review phase, CPRA also solicited input from the Framework Development Team Technical Subgroup (Jim Tripp - EDF, John Ettinger - EPA, Michael Massimi - BTNEP, Paul Kemp - Audubon, Quin Kinler - NRCS, Darryl Clark - USFWS, David Muth - NWF, Rick Hartman - NMFS, and John Lopez - LPBF). This group of technical stakeholders delved into model output and provided comments on patterns and relationships between inputs and outputs. In some cases, feedback from this group was used to modify models during the project-level modeling phase.

The inputs and outputs for both Future Without Action (FWOA) and Project Groups (i.e., model runs containing projects for evaluation) were reviewed for the two environmental scenarios applied during project-level analysis (moderate and less optimistic) – Appendix C – Environmental Scenarios. A systematic sampling of outputs was selected to reflect the range of project types, sizes and locations. In this way, outputs from the Eco-Hydrology, Wetland Morphology, Barrier Shoreline Morphology, Vegetation, and Ecosystem Services models were

reviewed for both mechanical and technical soundness. Files were checked at both the year 25 and year 50 time periods for consistency. The EverVIEW Data Viewer (Conzelmann and Romañach, 2010) was used to view model output.

CPRA personnel also performed quality reviews of the model algorithms for Ecosystem Services models. During this review, all algorithms, variables, and associated equations were reviewed and model edits were made where necessary. Due to the complexity of the input files associated with the Storm Surge/Waves and Risk Assessment modeling effort, CPRA was only able to conduct reviews of the output files for technical soundness. Comments were provided to these teams, and in some cases model edits were made. It should also be noted that the Wetland Morphology, Vegetation, Storm Surge/Waves, and Risk Assessment models underwent additional reviews by subject matter experts not involved in the modeling. For additional information on individual modeling team reviews, please refer to the individual model technical reports (Appendixes D1-D25).

The internal QR process for “stitched” model output (described in Barrier Island “Stitcher” section, below) also required the review team to examine input and output files at multiple time periods using EverVIEW to ensure that the appropriate files had been stitched together. EverVIEW is user friendly software designed for easy viewing of spatial inputs and outputs.

EverVIEW

The EverVIEW Data Viewer software (EverVIEW), created by the U.S. Geological Survey for the Everglades Joint Ecosystem Modeling group for use in viewing Everglades ecosystem modeling data (Conzelmann and Romañach, 2010) was used for both Mechanical and Technical Review of master plan model inputs and outputs. EverVIEW allows a user to load a Network Common Data Form (netCDF) file and visually inspect and compare the graphical data outputs both spatially and temporally (Figure 2). Users can select points within the graphical data to identify model output values at that location, and model output values can also be viewed in tabular format within EverVIEW.

Eco-Hydrology and Wetland Morphology model output files (.txt and .img, respectively) were converted to (netCDF) format and reviewed using EverVIEW. These model output files serve as input files for Ecosystem Services models which themselves produce netCDF output files. Lastly, outputs from the Ecosystem Services models were reviewed using EverVIEW.

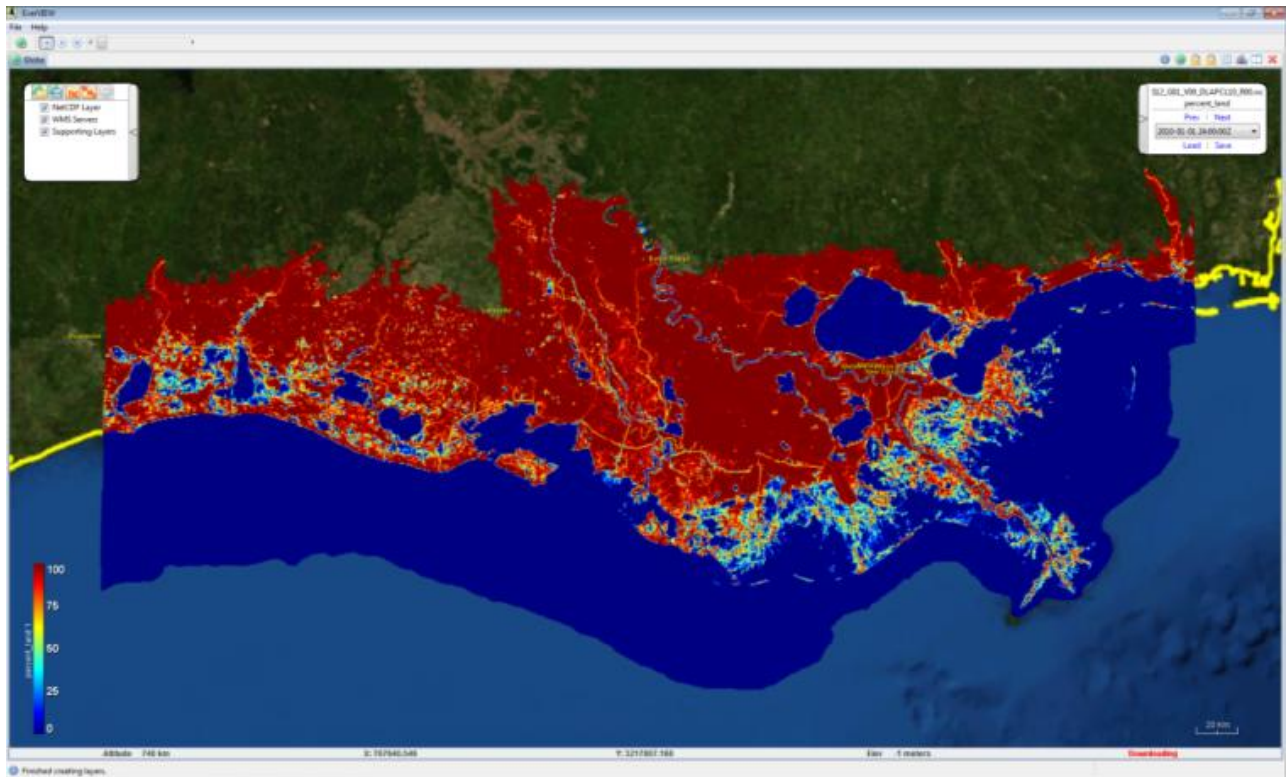


Figure 2. Example Output in the EverVIEW Data Viewer

1.5.1 Barrier Island “Stitcher”

Because output from the Barrier Shoreline Morphology and Wetland Morphology models is provided separately, a special application was created by collaborators at USGS to insert the barrier islands from the Barrier Shoreline Morphology model into the coastal landscape from the Wetland Morphology model. This was done to support a number of other models. The Ecosystem Services models require coast wide Percent Land (PCL), Percent Edge (EDG), and Elevation Data (ELV) at 500m resolution, the Vegetation model requires coast wide PCL at 500m resolution, and the Storm Surge/Wave model requires a coast wide Digital Elevation Model (DEM) at 30m resolution (which is ELV output).

The Barrier Island Stitcher can complete the following processes:

- Merge the 30m Barrier Morphology ELV with the 30m Wetland Morphology ELV
- Merge the 500m Barrier Morphology ELV with the 500m Wetland Morphology ELV
- Merge the 500m Barrier Morphology PCL with the 500m Wetland Morphology PCL
- Merge the 500m Barrier Morphology EDG with the 500m Wetland Morphology EDG

The internal QR process for stitched files required the review team to examine each PCL file for multiple time periods using EverVIEW to ensure that the appropriate files were stitched together. To confirm that the appropriate files were stitched together, the review team selected multiple points within each PCL file to determine whether the PCL value was increasing (e.g., land gain; area of diversion influence) or decreasing (e.g., land loss; due to sea level rise or subsidence) as

appropriate for that location. The same process was completed for ELV files. Because PCL, EDG, and ELV files are generated simultaneously using the same input files, the EDG files were assumed to be accurate if the PCL and ELV files were determined to be accurate.

1.5.2 Land Use Land Cover (LULC) Converter

The LULC Raster to NetCDF Converter is used to convert the land use/land classification static initialization dataset into NetCDF files. The program outputs a number of NetCDF files based on user provided "Value" and "Class" attribution. The "Value" entry describes the data value in the LULC file, and the "Class" entry defines in which class you would like that data value to be classified. One NetCDF file is output for each "Class" type. If multiple "Value" entries are assigned the same entry for "Class", then those types will be added and the result will be output into one NetCDF file for that class.

1.5.3 Eco-Hydrology Output Processor

The Eco-Hydrology Output Processor tool is used for calculating summary information on hydrologic model output and providing data in the DBF format for other models to easily utilize. The type of summary data includes summation and averaging, depending on the input data type which includes accretion, salinity, and stage represented by one of the three hydrologic regions or as a coast-wide dataset.

1.5.4 FTP File Watcher

The need to notify modeling teams when model outputs become available resulted in the construction of a polling/monitoring application. This application inventories the data storage site (FTP) at regular intervals and notifies users once files are available for use in other models. The application is setup such that automatic notifications are sent to team members when a new data file is posted or when an existing files has been updated or deleted. This software automated a process which otherwise would have been very difficult to manage considering the volume of data produced by this effort.

1.6 Model Output Post-Processing

Detailed Report: Appendix D26

Once model output was reviewed and deemed appropriate, an additional step of processing the output was necessary so it could be utilized by the Planning Tool. The Model Output Post-Processing Appendix (Appendix D26) provides a detailed account of how files were converted and how output was summarized or averaged both temporally and spatially to allow for transfer to and evaluation in the Planning Tool.

Not every output of every model was used directly in the Planning Tool; rather, output from the following models were processed for direct use in the tool for project analysis: American alligator, crawfish (wild caught)¹, eastern oyster, largemouth bass, spotted sea trout, other characteristic

¹ Crawfish output was post processed, though the model is currently undergoing further refinement.

fauna (muskrat, river otter, and roseate spoonbill), shrimp (brown and white), waterfowl (mottled duck, green-wing teal, and gadwall), potential for fresh water availability, potential for surge/wave attenuation², nature based tourism potential, carbon sequestration potential, nitrogen uptake potential, and percent land.

Output from the Risk Assessment model was also used in the Planning Tool. For information regarding post-processing of these outputs, see Appendix D25 Risk Assessment (CLARA) Model.

1.7 Model Uncertainty Analysis

Detailed Report: Appendix D27

In modeling context, uncertainty can be defined as the deviation of model prediction from the actual ecosystem response to a certain proposed project. As such, uncertainty is attributed to two main aspects: (1) uncertainty due to inherent natural variability in the external model drivers that control the dynamics of the ecosystem response, and (2) uncertainties associated with the models utilized within the project-effects analysis of the 2012 Coastal Master Plan. The first aspect of uncertainty is currently being addressed through a set of scenarios that capture a range of plausible future conditions as it relates to external forces (see Environmental Scenarios section, above and Appendix C – Environmental Scenarios). The second aspect of uncertainty (internal model-related uncertainties) is the focus of the model uncertainty analysis as detailed in Appendix D27 – Model Uncertainty Analysis.

Because the master plan included the development and utilization of a new set of predictive models and a Planning Tool, it was necessary to assess uncertainty associated with the models. In addition to identifying the uncertainties, the uncertainties needed to be assessed for the extent to which they may affect model accuracy. The uncertainty analysis began by identifying a set of model outputs that were used to evaluate the changes in the landscape (both with and without projects). The analysis then back-tracked the uncertainties in the predictive models that were perceived to be most critical for assessing these outputs. This approach, despite not being comprehensive in assessing all sources of uncertainties, focused on a narrower set of model parameters that were perceived to be most critical for the end result of the predictive modeling effort in its entirety.

The current uncertainty analysis concentrated on the following ecosystem services:

- American Alligator Habitat Suitability
- Juvenile Brown Shrimp Habitat Suitability
- Largemouth Bass Habitat Suitability
- Eastern Oyster Habitat Suitability

² Surge/wave attenuation potential output was post processed, though the model is currently undergoing further refinement.

- Surge/Wave Attenuation Potential
- Land Area

1.8 Technical Advisory Committee

Technical Advisory Committees (TAC) are three to five member groups of nationally known experts who are responsible for advising CPRA on how to conduct analyses in the most technically sound manner. TACs assisted with the modeling analysis, the structure and use of the Planning Tool, as well as incorporation of cultural heritage. Each of these committees met multiple times with the master plan team to provide feedback during plan formulation, and the committees will continue to provide guidance as the 2012 Coastal Master Plan is finalized.

The Predictive Modeling Technical Advisory Committee (PM-TAC) was convened soon after the launch of the modeling effort to provide ongoing technical advice and guidance on critical components of predictive modeling task. Individuals were requested by CPRA to serve on this committee not only because of the experience they bring from other large national restoration programs, but also for the knowledge they have of coastal Louisiana ecology.

The CPRA Predictive Modeling Decision Team met with the committee approximately once per month between July 2010 and March 2012, typically via conference call or webinar. The committee served primarily as a sounding board, providing guidance and advice. Formal reporting was not considered part of their role.

Members of the PM- TAC include Dr. Steve Ashby, Dr. John Callaway, Prof. Charles Simenstad, and Dr. Fred Sklar. Their bios are included herein:

Steve Ashby, Ph.D.

Dr. Ashby is the Associate Director of the Geosystems Research Institute of Mississippi State University and the Northern Gulf Institute, a NOAA Cooperative Institute, both located at the Stennis Space Center in Mississippi. He received a Ph.D. in Wetland Biogeochemistry from Louisiana State University in 2000. Dr. Ashby retired from the USACE – Engineer Research and Development Center (ERDC) in 2011, following thirty-three years experience as a Physical Scientist and Research Hydrologist in the Environmental Laboratory. His recent research has focused on the design and conduct of water quality studies in freshwater and coastal ecosystems, watershed assessments, and planning and implementation of ecosystem restoration projects. He is also involved in watershed initiatives that involve state and local agencies and he served as the Program Manager for the System-wide Water Resources Program.

John Callaway, Ph.D.

Dr. Callaway is a Professor of Environmental Science at the University of San Francisco. He received a Ph.D. in Oceanography and Coastal Sciences from Louisiana State University in 1994. He has served as the Associate Director of the Pacific Estuarine Research Laboratory (PERL) at San Diego State University prior to his position at USF and currently teaches undergraduate and

graduate courses in introductory environmental science, applied ecology, wetlands, and restoration ecology. His research expertise is in wetland restoration, specifically wetland plant ecology and sediment dynamics, and his recent research projects focus on the development of restored wetlands, including evaluations of carbon sequestration rates in tidal wetlands of San Francisco Bay.

Charles (“Si”) Simenstad, M.S.

Mr. Simenstad is a Research Professor in the School of Fishery Sciences at the University of Washington. He received a M.S. in Fisheries from the University of Washington in 1971. Having conducted research on estuarine and coastal marine ecosystems throughout Puget Sound, the Washington coast, and Alaska for over twenty-three years, most of his studies have focused on the functional role of estuarine and coastal habitats to support fish (especially juvenile Pacific salmon) and wildlife, and the associated ecological interactions that are responsible for enhancing populations of economically and ecologically-important fisheries. His recent research emphasis has stressed integration of such basic interactions to applied issues such as restoration, creation and enhancement of estuarine and coastal wetlands and estuarine ecosystems, and ecological approaches to evaluating the success of anthropogenic stressors and alterations. His primary research focus relates to the association between habitat landscape structure and fundamental ecological processes that support both directly (e.g., foraging or rearing habitats) and indirectly (e.g., detritus sources) production of important organisms in the estuary.

Fred Sklar, Ph.D.

Dr. Sklar is the Director of the Everglades Division of the South Florida Water Management District. He received a Ph.D. in Wetlands Ecology from Louisiana State University in 1983. Dr. Sklar has over 15 years of experience at the South Florida Water Management District and focuses on research to facilitate Everglades restoration and to quantify the relationship between environmental stressors and ecological processes, particularly at the landscape scale. His research focus is on water quality thresholds, vegetation succession mapping and modeling, and the ecological dynamics of Everglades tree islands. Lastly, he is the Project Management and technical lead for keystone restoration projects including: decompartmentalization, adaptive management, and the large scale “Everglades Living Laboratory” macrocosms known as the Loxahatchee Impoundment Landscape Assessment (LILA).

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