The Nature Conservancy www.maps.coastalresilience.org/gulfmex

Gulf of Mexico Risk Explorer: Assessing Risk and Identifying Solutions

The Risk Explorer allows decision makers (i) **to assess risk and vulnerability** to waves, storms and sea level rise and (ii) **identify habitat restoration and management priorities** that may be most useful for risk reduction. The Explorer provides both Answers (i.e., a static map) and a dynamic exploration tool.

The Risk Explorer is organized by state and permits users to easily visualize coastal hazards risk as a function of both coastal exposure and social vulnerability. In the "Show Me" section of the Risk Explorer, the user can quickly view where habitat loss may have the greatest impacts on risk and thus where management (including for example restoration to enhance the condition of existing marshes and reefs) is most important for risk reduction (and thus should be proactively managed and protected to reduce risk). The "Show Me" section also includes maps showing where oyster restoration is most likely to reduce risk and maps showing the variation in median owner-occupied housing values across each state.

Methods

The Risk Explorer features two main components:

Risk Score

Risk= Exposure X Vulnerability

The Risk Score for each 1km coastline segment depends on both the coastal exposure of the segment and the vulnerability of the people within and adjacent to that segment of the coastline. In the Risk Explorer, the Exposure and Vulnerability scores for each segment both range from 1-5. The Exposure and Vulnerability scores for each coastline segment are calculated and then multiplied. Therefore, the Risk Score for each 1km coastline segment ranges from 1-25 with higher scores indicating areas of higher risk. Thus the assessment of exposure and in particular the role of habitats in reducing exposure is purely qualitative, but at this regional scale that is still a major first. We have ongoing work with a variety of partners to quantify the spatially-explicit assessment of the role of habitats in risk reduction.

The exposure score is calculated using the equation and methods developed by The Natural Capital Project/InVEST and described both in the draft National Climate Assessment (2013) and Arkema et al. (in

press, Nature *Climate Change*). The coastal exposure score is based on seven physical and biological variables: geomorphology, habitats, relief, SLR, wind exposure, wave exposure and surge potential.

Table 1 outlines the variables and ranking system used to develop the exposure score. Each coastline segment is scored 1-5 for each variable relative to the other segments within the state. The scores for each variable are then averaged to provide an overall exposure score that ranges from 105. The user can choose to include current exposure to SLR in their exposure calculation or include a projection for future SLR in 2100 (based on the A2 Emission Scenario). Under the A2 scenario, the global rise predicted by the National Climate Assessment is 1.2m. This value was multiplied by a scaling factor to account for local differences. The scaling factor was the ratio of the historical local rate to the historical global rate (1.8mm/yr) (see Arkema et al).

Table 1. Coastal exposure index values and ranking system (adapted from Arkema et al). Ranks for relief, sea level rise, wind exposure, wave exposure and surge potential were calculated relative to each Gulf coast state.

Rank Variable	Very low 1	Low 2	Moderate 3	High 4	Very high 5
Natural habitats	coral reef; coastal forest	high dune; emergent marsh	low dune	seagrass bed; canopy kelp forest; aquatic vegetation	No habitat
Geomorphology	Rocky; high cliffs; fiord; fiard; seawalls	Medium cliff; indented coast; bulkheads; small seawalls	Low cliff; glacial drift; alluvial plain; revetments; rip-rap walls	Cobble beach; estuary; lagoon; bluff	Barrier beach; sand beach; mud flat; delta
Relief	1st quantile	2nd quantile	3rd quantile	4th quantile	5th quantile
Sea-level change	1st quantile	2nd quantile	3rd quantile	4th quantile	5th quantile
Wind exposure	1st quantile	2nd quantile	3rd quantile	4th quantile	5th quantile
Wave exposure	1st quantile	2nd quantile	3rd quantile	4th quantile	5th quantile
Surge potential	1st quantile	2nd quantile	3rd quantile	4th quantile	5th quantile

The vulnerability score is calculated using social vulnerability indicators from the American Community Survey's 2006-2010 5 year summary file. The user has the ability to choose which of the three social vulnerability variables will be included in the vulnerability score: total population, number of people older than 65, number of families with total income below the poverty line. Each coastline segment has a score ranging from 1-5 for each of these variables. For example, coastline segments with the most population will be scored a 5 while the segments with little or no population are scored a 1. If all social vulnerability variables are included in the vulnerability score, the resulting vulnerability score will be an average score based on the three variables. The vulnerability score varies from 1-5.

The Risk Score is then calculated by multiplying the exposure score (1-5) by the vulnerability score (1-5). The Risk Score ranges from 1-25.

Identifying Priorities for Habitat Management and Restoration: Static "Show Me" Maps

The bottom half of the Risk Explorer features three static maps that help the user to explore the potential role of habitat conservation and restoration in risk reduction.

The first map shows **where habitat loss will likely increase risk** (and habitat management may help most). These areas were identified by calculating a Risk Score (Exposure X Vulnerability) for each coastline segment both with and without habitats. As noted above, exposure is based on seven variables including coastal habitats and Risk can easily be calculated by removing habitat effects from the exposure equation. The difference between the Risk scores "with habitats" and "without habitats" is mapped for each coastline segment. The resulting map shows where risk likely increases the most if you remove or degrade habitats. These areas are priority areas for habitat management, restoration and risk mitigation activities.

The second map shows **where oyster reef restoration will likely reduce risk the most**. To generate this map we calculated a new Risk score for each coastline segment based on a statewide oyster restoration scenario. The oyster restoration scenario was generated using the Gulf DS Restoration Explorer. Ecological criteria including salinity, water depth and the historic and/or current footprint of oyster reefs were used to identify areas within each state that are likely ecologically suitable for oyster reef restoration. Oyster restoration scenarios were exported from the Restoration Explorer for each state and the resulting polygons of potential oyster reef habitat were added into the habitat maps used to calculate the exposure score. We used this restoration scenario to calculate an oyster restoration scenario Risk Score and compare it to the default Risk Score that reflects the current distribution of habitats. The difference between the two Risk Scores (current habitats versus an Oyster Restoration Scenario) is then mapped to show where new oyster reef projects will likely reduce risk the most.

The third map shows the **median owner occupied property values** per census block group. This map is helpful for identifying areas with high residential property values (and likely high replacement costs) that may benefit from the risk reduction provided by habitats. This layer can be explored simultaneously with other layers within the Risk Explorer and overlayed with habitat data from the map layers.