A Coast Imperiled: Mangroves in Belize

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Introduction

Mangroves form pan-tropical coastal forests that are one of the world's most well known and widely studied ecosystems. Mangrove forests are both ecologically and economically important: they support rich biodiversity and provide global ecosystem services estimated at $1.6 billion per year (Krauss et al. 2014). Since 1980, however, an alarming 35% of global mangrove forests have been lost (Polidoro et al. 2010). Deforestation, development, agriculture and aquaculture, and sea level rise are just some of the major threats to mangroves. Caribbean mangrove forests are especially imperiled as tourism companies develop coastlines and climate change increases the risk of storms and fires.

In Belize, mangroves line the Caribbean Sea and many barrier islands; in doing so, they contribute $200 million per year to the economy in the form of shoreline protection, tourism, and fisheries (Bood et al. 2012). In 1993, mangroves covered 3.15% of the nation, the most in Central America, but in just four years, that ratio dropped to 3.03% (Spalding et al. 1997). Coastal development and unbridled resource extraction are undeniably the biggest pressures against the long-term persistence of these mangrove forests (Rodriguez and Feller 2004). A recent revision legislation has attempted to curb further destruction of mangrove trees. Whether or not Belize's mangrove forests are currently threatened is unclear. In this project, I explore this question.

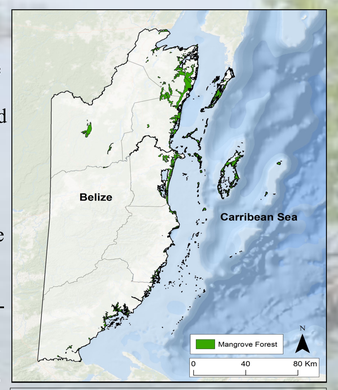


Figure 1. Current distribution of mangrove forests in Belize.

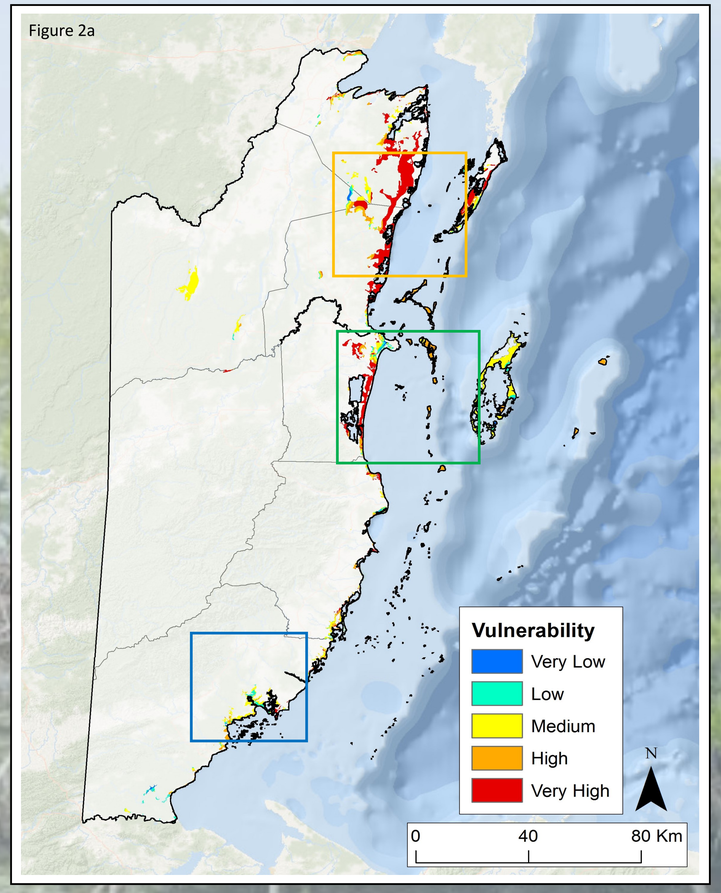
Methods

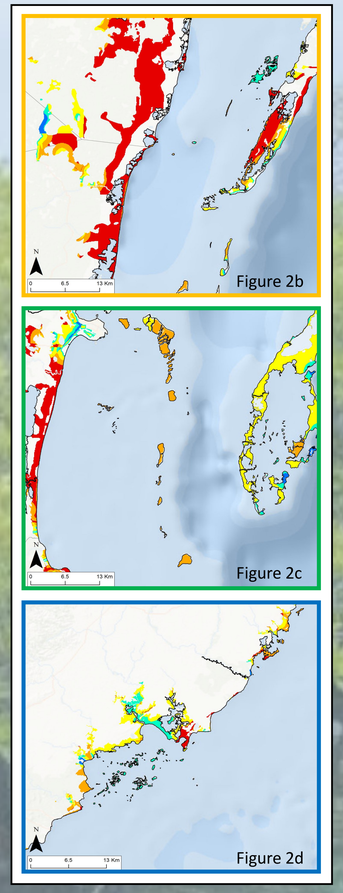
In order to perform a vulnerability analysis on Belize's mangroves, I identified four factors that threaten their distribution: proximity to development (2011), fire risk (2004), proximity to roads (2010), and exclusion from a preserve (2014). All shapefiles were retrieved from Biodiversity & Environmental Resource Data System of Belize (BERDS) and processed into rasters with a grid size of 90m x 90m.

The ecosystem shapefile provided the extent of mangrove habitat, which was used as a proxy for current distribution. Development includes the selection of both urban and agricultural land. The roads factor was split into three road classes—major, paved, and minor—to account for differences in the edge effect of each road class (e.g., the impact of major roads penetrates farther than that of minor roads). Proximity to development (both urban and agricultural) and roads each used a Euclidean distance raster processing step.

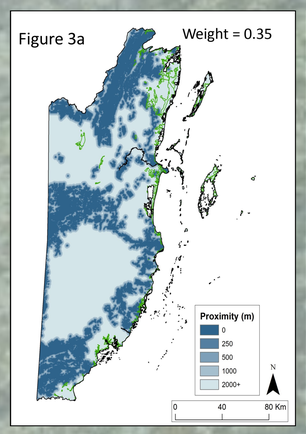
Each factor was reclassed into 5 categories, with 1 being the least vulnerable and 5 being the most, then weighted according to its relevance (Figure 3a-d).The final vulnerability map is a product of a binary mangrove distribution raster and the sum of these factor maps (Figure 2a-d).

Mangrove Vulnerability Analysis

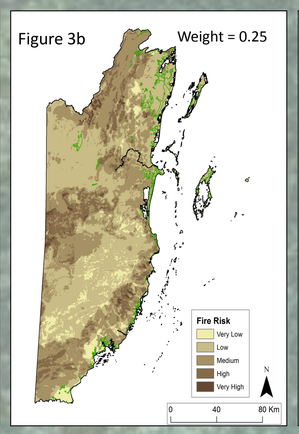




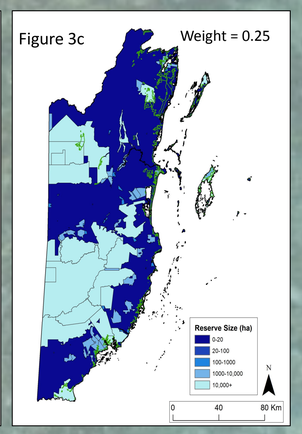
Development



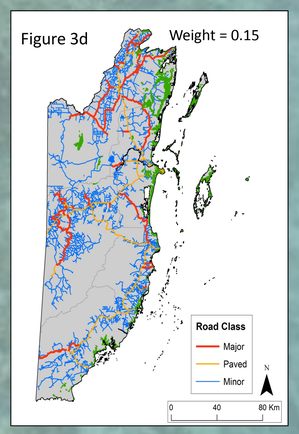
Fire Risk



Preserve Size



Roads



Discussion

Based on this analysis, 58% of Belize's mangrove forests are threatened (scored high/very high). The majority of these forests occur on the northern coast, where large parks are not as prevalent, but development is, and on a few of the smaller barrier islands (Figure 2b). UNESCO's only site in Belize is the over the barrier reef system (Figure 2c), yet since only some islands are protected, many mangrove patches are in danger. This suggests, counter-intuitively, that park presence is not always an indicator of protected forest. These results reveal that large-scale mangrove loss is likely to occur if no action is taken.

Despite this, Belize's mangrove forests are in much better shape than other places in Latin America; Honduras has lost 18% and Mexico has lost 65% of their mangroves over the last 30 years. By comparison, Belize has lost just 5% (Bood et al. 2012). Conservation efforts should focus on northeastern mangrove forests; by combining active reforestation with repeated field studies to continually monitor mangrove cover, it ensures updated and reliable records are kept for future studies.

Future Analyses

Future analyses should use finer resolution data and consider other threats to mangroves in order to adequately map vulnerability, such as the following:

1) Mangrove *habitat* used here does not necessarily represent the true distribution of mangroves. This discrepancy might mean imperiled forests are not appropriately described in this study or that actually protected forests are erroneously shown to be vulnerable. Indeed, the WWF reports that 3% of Belize is mangrove forest whereas this map shows that 8% is (Bood et al. 2012).

2) One factor driving mangrove loss is repeated damage from an increasing frequency of hurricanes. This analysis did not incorporate any climate factors —such as sea level rise, storm surge probability, or even temperature—but consideration and inclusion of at least one in a future analyses is essential.

3) Mangrove forests are dynamic ecosystems; they rely on their resident organisms just as much as those organisms rely on them. Without rich biodiversity to foster cycling of nutrients and maintain the interactions that support mangrove forests, intact walls of mangroves are actually at-risk of collapse. A future analysis should include this ecological dilemma, even if just a coarse quantification of species diversity.

Figure 4. Mangrove forests support life both above and below

References

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Drude de Lacerda, L. 2001. *Mangrove Ecosystems: Function and Management.* p. 8-10. New York: Springer

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Rodriguez, W. and Feller, I.C. 2004. Mangrove landscape characterization and change in Twin Cays, Belize using aerial photography and Ikonos satellite data. *Atoll Res. Bull.* 513.

Poster Design and Cartography: Nick Dorian, GIS 1010, December 2015
Data: ESRI Basemaps, BERDS |**Photos:** Tim Laman, Universal Image Group
Projection: NAD 27, UTM Zone 16N

"If there are no mangroves, then the sea will have no meaning. It is like having a tree without roots, for the mangroves are the roots of the sea" -Words of a Thai Fisherman