Analyzing Potential Undeveloped Land Loss from Hydrologically-Connected Inundation by 2070

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Introduction

Coastal wetland change has been and will be primarily caused by natural and anthropogenic drivers of environmental change; including sea-level rise (SLR). Loss of coastal wetlands could be caused by hydrologically-connected (HC) inundation outpacing soil accretion rates and /or urban development occupying their potential migration areas. These effects will make coastal urbanized communities more vulnerable to SLR-enhanced flooding and storm surge. Within the Indian River Lagoon (IRL) system, the undeveloped areas (including coastal wetlands and their potential migration areas) were noted as areas that would most likely not be protected from HC inundation. Due to relative SLR differences throughout the IRL system, the study area was the northern portion of the IRL system. The project answered the following questions:

1) **Which drainage basins will be considered as potential undeveloped land loss (ULL) hotspots?**
2) **Within the potential ULL hotspots, how much future urban development areas and vegetation communities will be threatened by hydrologically-connected inundation by 2070?**

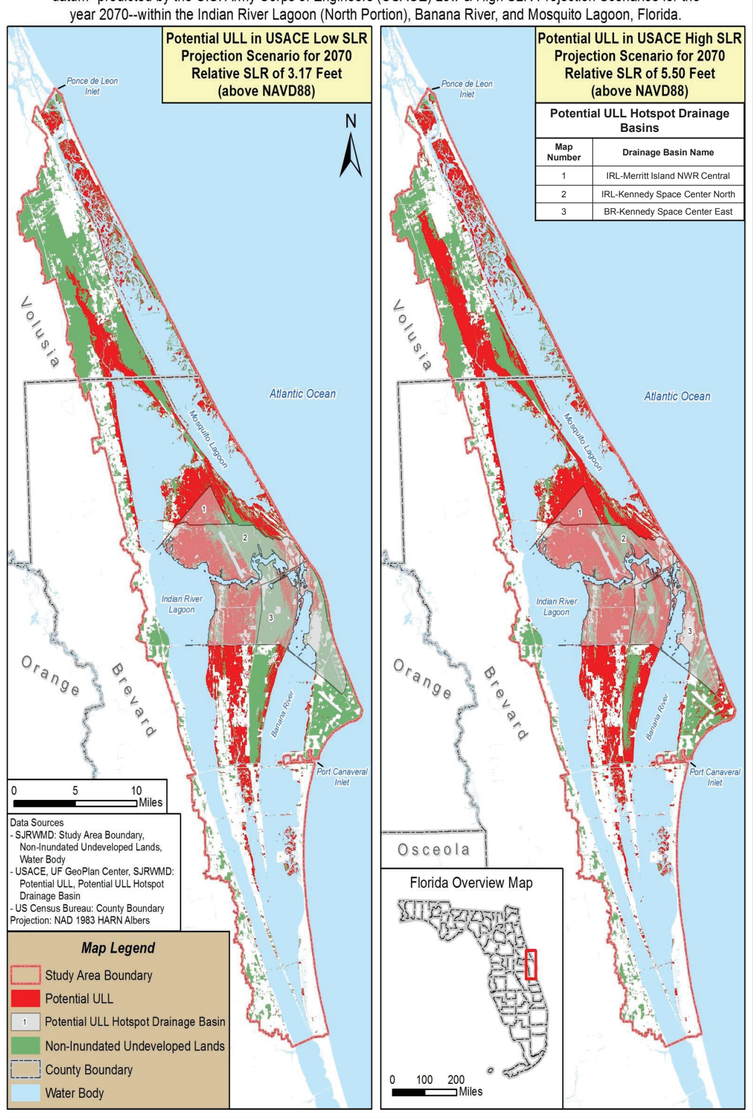
Methodology

The project utilized HC Inundation Surface Geographic Information Systems (GIS) layers that were obtained from the University of Florida GeoPlan Center and based on the United States Army Corps of Engineers (USACE) Low and High SLR projection scenarios for the year 2070. The features of the original drainage basin GIS layer—obtained from the St. John's River Water Management District (SJRWMD)—extended across major water bodies (such as the IRL, Banana River, and Mosquito Lagoon) and contained generic names. To avoid a misleading representation of ULL, the majority of the drainage basin features were divided along the major water bodies and subsequently renamed to reflect its corresponding major water body and local features. This resulted in 44 drainage basins throughout the study area.

The potential ULL areas were identified as the intersecting regions between undeveloped lands and the HC Inundation Surface GIS layers and split among the 44 drainage basins. The potential ULL for each drainage basin was subsequently calculated. The Getis-Ord Gi* test was used to statistically determine the locations of potential ULL hotspots by analyzing each drainage basin within the context of neighboring drainage basins. To be considered as a statistically significant hotspot (z-score equal to or greater than [≥] 1.96, 95% confidence level), a drainage basin would have to contain a high ULL value and be surrounded by drainage basins with high ULL values. The drainage basins that had a z-score ≥ 1.96 in both scenarios were identified as a potential ULL hotspot. Within the potential ULL hotspots, the future urban development and threatened vegetation community areas were calculated. The top six threatened vegetation communities (by area) were noted and mapped.

Figure 1 - Potential Undeveloped Land Loss (ULL) & Hotspots Map

This map displays the potential ULL from Relative Sea-Level Rise (SLR) with the Mean Higher High Water (MHHW) tidal datum--predicted by the U.S. Army Corps of Engineers (USACE) Low & High SLR Projection Scenarios for the year 2070--within the Indian River Lagoon (North Portion), Banana River, and Mosquito Lagoon, Florida.



Possible Implications

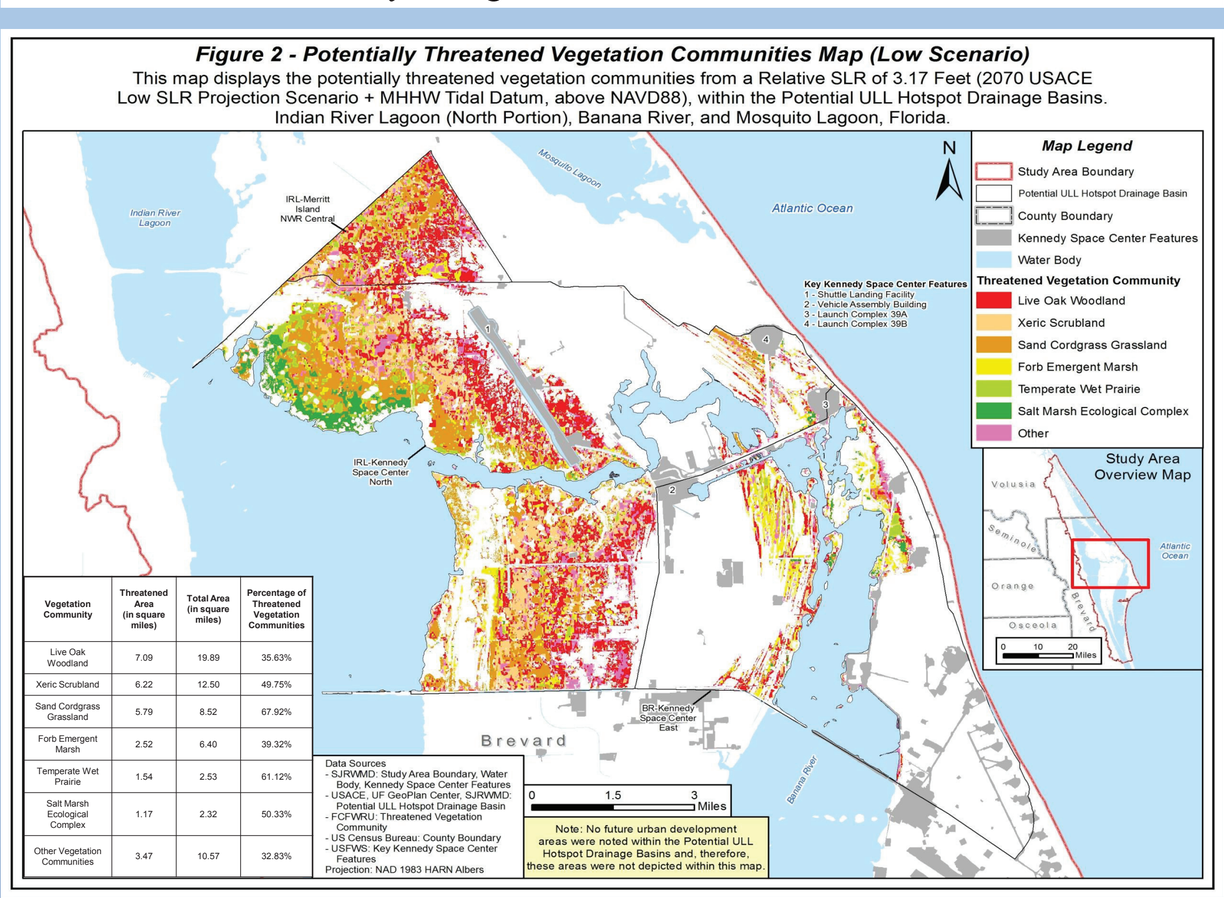
The potential inundation of undeveloped lands, within the potential ULL hotspot, could make some Kennedy Space Center features more vulnerable to other SLR impacts, due to a reduced buffer area between these features and open water bodies. This was reinforced by a New York Times article that stated how the National Aeronautics and Space Administration (NASA) has been considering the possible effects of SLR on its coastal structures and facilities. Protection of undeveloped lands should be considered and/or incorporated into future SLR protection strategies.

Results & Discussion

One potential ULL hotspot was found to contain three drainage basins within the Merritt Island National Wildlife Refuge (NWR) and Kennedy Space Center (shown in Figures 1 to 3). No future urban development areas were noted in the potential ULL hotspot. Within the potential ULL hotspot, the top six threatened vegetation communities consisted of Live Oak Woodland, Xeric Scrubland, Sand Cordgrass Grassland, Forb Emergent Marsh, Temperate Wet Prairie, and Salt Marsh Ecological Complex (shown in Figures 2 and 3). These six communities consisted of 24.32 mi^2 and 36.11 mi^2 of the hotspot's overall threatened vegetation communities in the Low and High SLR scenarios, respectively. The most threatened vegetation community was found to be Live Oak Woodland as 7.09 mi^2 (35.63%) and 12.79 mi^2 (64.30%) of hotspot's Live Oak Woodland community was found to be potentially threatened in the Low and High SLR scenarios, respectively. Compared to the Low SLR scenario, the High SLR scenario potential ULL hotspot drainage basins' threatened vegetation communities increased by a range between 19 and 212%.

Figure 2 - Potentially Threatened Vegetation Communities Map (Low Scenario)

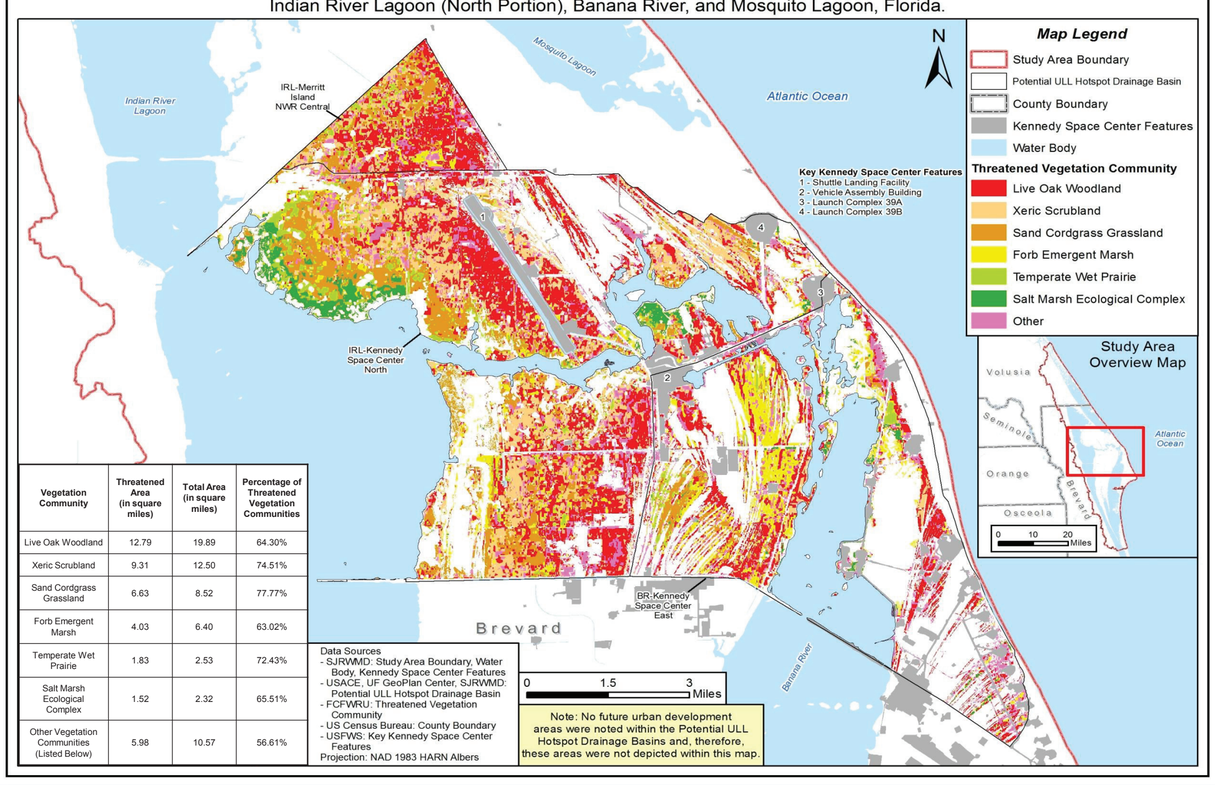
This map displays the potentially threatened vegetation communities from a Relative SLR of 3.17 Feet (2070 USACE Low SLR Projection Scenario + MHHW Tidal Datum, above NAVD88), within the Potential ULL Hotspot Drainage Basins. Indian River Lagoon (North Portion), Banana River, and Mosquito Lagoon, Florida.



Vegetation Community	Threatened Area (in square miles)	Total Area (in square miles)	Percentage of Threatened Vegetation Communities
Live Oak Woodland	7.09	19.89	35.63%
Xeric Scrubland	6.22	12.50	49.75%
Sand Cordgrass Grassland	5.79	8.52	67.92%
Forb Emergent Marsh	2.52	6.40	39.32%
Temperate Wet Prairie	1.54	2.53	61.12%
Salt Marsh Ecological Complex	1.17	2.32	50.33%
Other Vegetation Communities	3.47	10.57	32.83%

Figure 3 - Potentially Threatened Vegetation Communities Map (High Scenario)

This map displays the potentially threatened vegetation communities from a Relative SLR of 5.50 Feet (2070 USACE High SLR Projection Scenario + MHHW Tidal Datum, above NAVD88), within the Potential ULL Hotspot Drainage Basins. Indian River Lagoon (North Portion), Banana River, and Mosquito Lagoon, Florida.



Vegetation Community	Threatened Area (in square miles)	Total Area (in square miles)	Percentage of Threatened Vegetation Communities
Live Oak Woodland	12.79	19.89	64.30%
Xeric Scrubland	9.31	12.50	74.51%
Sand Cordgrass Grassland	6.63	8.52	77.77%
Forb Emergent Marsh	4.03	6.40	63.02%
Temperate Wet Prairie	1.83	2.53	72.43%
Salt Marsh Ecological Complex	1.52	2.32	65.51%
Other Vegetation Communities (Listed Below)	5.98	10.57	56.61%

Future Research

One suggestion for future research is to conduct ground-truthing operations within the potential ULL hotspot, which can consist of interviewing United States Fish and Wildlife Service and NASA employees about past flooding events or confirming the locations of threatened vegetation communities. These methods can validate or annul the accuracy of project results.

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