Land Use Analysis: Sea Level Rise and Waterfront Inundation in Washington, DC

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for Intro to GIS

Introduction

As global temperatures rise, develop coastal areas are faced with the very dangerous and very expensive threat of land inundation and coastal erosion. Rising global temperatures have already begun to melt the polar ice sheets, and are expected to increase another 3 degrees Celsius in the next 150 years, resulting in coastal erosion occurring at a much faster rate along most waterfront. This is putting waterfront developments and populations, such as those along the US Atlantic coast, at a serious risk. The mid-Atlantic, in particular, is projected to have a faster rate of sea level rise than other areas due to glacial isostatic adjustment. Even if greenhouse gas concentrations were stabilized now, sea levels will continue to rise for hundreds of years. This has profound impacts on planning, development, and mitigation strategies for Washington, DC.

Data Sources

- Topographic (digital elevation map) data displayed is taken from the USGS.
- DC existing land use data is displayed courtesy of the DC Office of the Chief Technology Officer.
- Road data used was provided by the Tufts University M: drive, courtesy of ESRI.

Impact Study

In order to demonstrate the impact of sea level rise on mid-Atlantic waterfront communities, a study using GIS was carried out for the city of Washington, DC. While DC does not directly border the Atlantic Ocean, it is surrounded by the Potomac and Anacostia Rivers, which feed directly into it. Therefore, sea level rise will have many large effects on the area. In this study, I estimated the amount of land that would be inundated in three scenarios of sea level rise—1m, 2m, and 3m—and looked at the associated impacts on land use in the city.

Methodology

Pre-process → Process → Compare → Analyze

- Obtain DEM data from USGS (accuracy: 1/3 arc length). Add roads layer for visual reference.
- Reclassify DEM data into 4 elevation groups using Spatial Analyst. Convert raster file into a shapefile.
- Dissolve land use classes to generalize into new classification. Intersect both of the shapefiles and symbolize land use.
- Edit attribute data, make necessary selection and export the data to MS Excel for analysis.

Areas to be Inundated

The red, orange, and yellow areas depicted in Figure 1 is land that would be inundated by water if sea levels rose 1m, 2m, and 3m, respectively. The green area is land that would not be affected in any of the three scenarios. Table 1 summarizes the area of inundations under each sea level rise scenario, and its corresponding percentage of the total city land area.

Sea Level Rise Scenario	Area Inundated (miles^2)	% of Total Area
1m	1.3	1.9%
2m	8.1	11.8%
3m	15.7	22.9%

Table 1: Areas Inundated in Sea Level Rise Scenarios

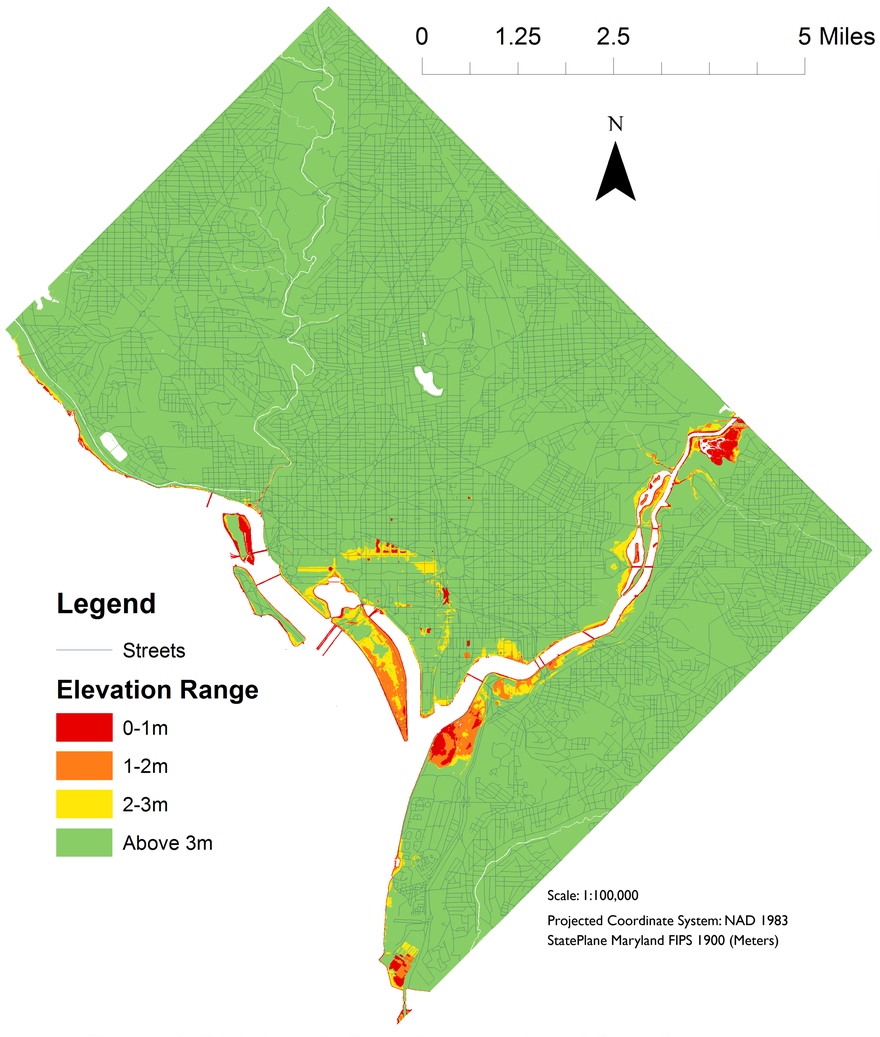

Figure 1: Risk Levels Based on Sea Level Rise Scenarios

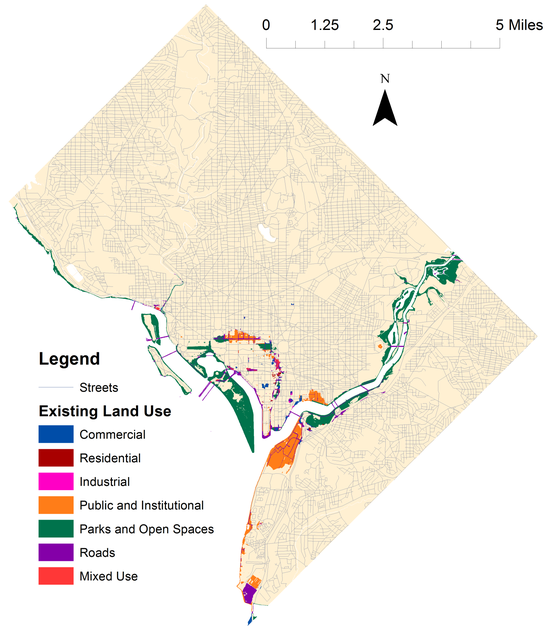

Figure 2: Land Use of Affected 3m Rise Areas

Land Use Analysis and Discussion

Land Use	Area Inundated (miles^2)	% Loss
Commercial	0.5	9%
Residential	0.2	1%
Industrial	0.0	1%
Public and Institutional	3.9	26%
Parks and Open Spaces	7.2	37%
Roads	3.4	12%
Mixed Use	0.4	13%

Table 2: Land Use Loss from 3m Rise Scenario

As shown in Table 2 and displayed in Figure 2, the majority of land uses (not including roads) in the affected areas are non-private ones. Under a 3m sea level rise scenario, the city will lose a quarter of its Public and Institutional lands, and over a third of its Parks and Open Spaces. These spaces include many national monuments and landmarks that shape the symbolic character of the nation's capital, such as the National Mall, the cherry blossoms, and federal and civil structures. Waterfront property in DC's NW and NE quadrants are especially attractive for tourists and locals alike. Additionally, DC has become one of the fastest growing areas in the country.; several neighborhoods targeted for rapid growth by the DC Office of Planning are waterfront areas. In light of these findings, proactive planning and mitigation measures need to be enacted to prevent damage to the city's form and function.