SEA LEVEL RISE EFFECTS ON THE SALEM SOUND REGION OF MASSACHUSETTS:

1, 3 & 4 METER RISE IN SALEM, DANVERS, PEABODY, MARBLEHEAD, BEVERLY & MANCHESTER

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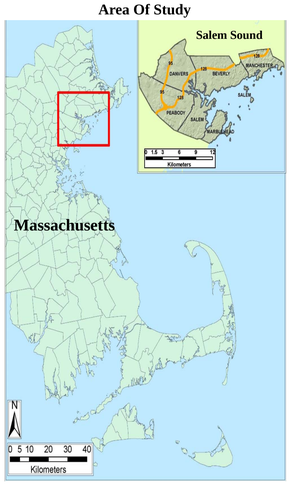
For Dr. Marcos Luna's GGR903, Salem State College, Fall Semester 2009

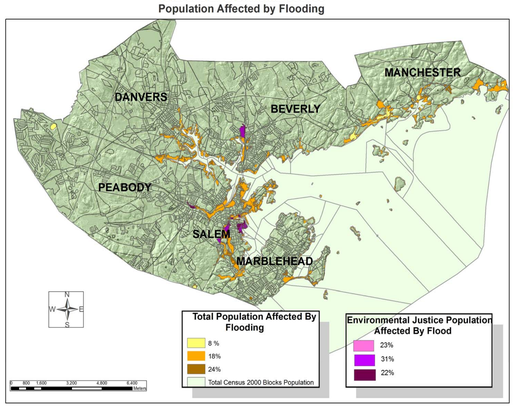
Introduction

As the threat of sea level rise associated with climate change becomes more important and better understood, the need to determine it's effects also increases. Studies conducted are typically done at the global, national or state level. The need to assess the threat that sea level rise poses to communities is important because local governments and private citizens are likely to be the first to deal with this potential problem. The purpose of this study was to determine the effects of a 1, 3 and 4 meter sea level rise would have on the Salem Sound region of Massachusetts. These levels of rise correspond to the minimum , maximum, and the worst case storm flooding that have been projected to affect the area by the end of the century. This area is Northeast of Boston on the Atlantic Coast. The towns in the region include Beverly, Danvers, Manchester, Marblehead, Peabody and Salem. The population of these towns ranges from around 5,000 in Manchester to just under 50,000 in Peabody. The focus was the potential effects of sea level rise on critical infrastructure, population, and land use.

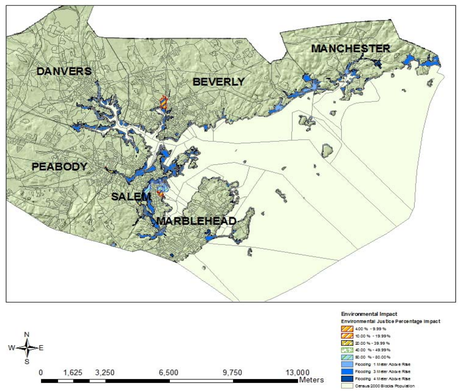
Area Of Study



Total and Environmental Justice Population Affected by Flooding



Environmental Justice Population Affected by Flooding



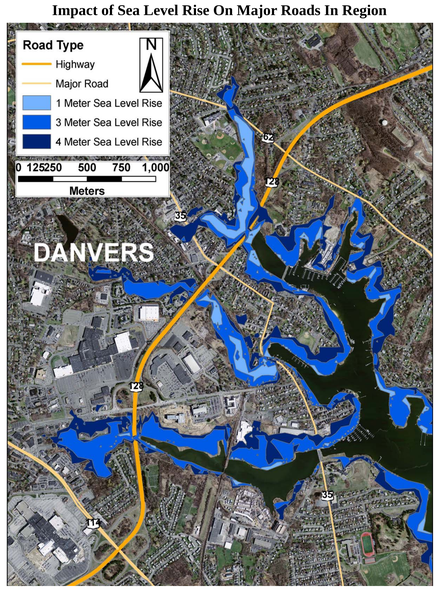
METHODOLOGY

To produce these maps, Digital Terrain Models (DTM) for the area were downloaded from MassGIS. The DTM data was converted to X, Y, & Z coordinates for each point in Microsoft Excel. The Excel data was then imported into ArcMap. Arcmap was used to plot points from the Excel data, which provided Northing, Easting, and elevation coordinates for points all over the towns. These points were then used to interpolate a Digital Elevation Model (DEM) of the area. Areas 1, 3 & 4 Meters above sea level were then calculated from the DEM using the raster calculator in ArcMap's spatial analyst. The areas affected by the different amounts of sea level rise were then analyzed to see how they affected different aspects of the region. Layers used included Massachusetts Roads, Land Use, Police Stations, Fire Stations Hospitals, Lighthouses and U.S. Census data for population. Total population impacted was calculated by dividing the residential area affected by each sea level rise by the total area of the Census Block it was in which gave a percentage. This percentage was then multiplied by the total population of each Census Block.

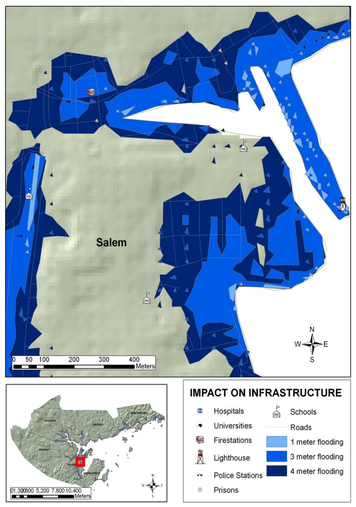
Critical Concentrations of increased risk populations		
Increased-risk Population	Category	Critical concentration percentage
Over 65 years of age	Elderly	>=40
Living below poverty level	Poor	>=49
Non-English speakers	Non-English speakers	>=24

Residential Area Flooded (Square Meters)	Population Impacted
1 Meter Flood	
37,870.45	11
3 Meter Flood	
938,272.82	1,719
4 Meter Flood	
1,951,740.58	4,924

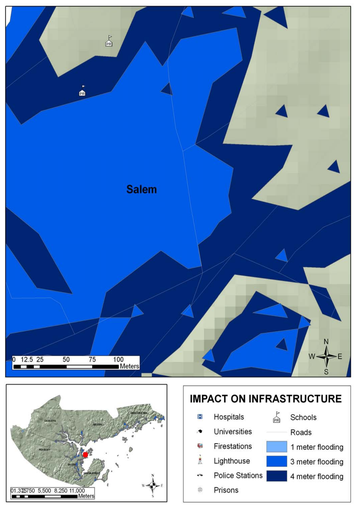
Impact of Sea Level Rise On Major Roads In Region



3 METER IMPACT ON INFRASTRUCTURE



4 METER IMPACT ON INFRASTRUCTURE



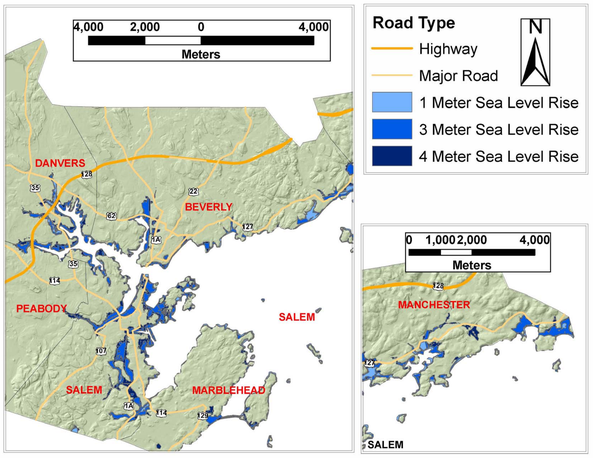
Results

Severe flooding will affect vulnerable populations in the response phase and during evacuation. Most environmental justice population depends on public transportation, lacking alternatives. Pre-existing socio-economic conditions play a significant role in a particular economic class' ability to respond to such flooding as well as its aftermath.

Major roads such as Route 128, connecting Northeastern Massachusetts to interstate 95 and the rest of the state could be flooded in up to 3 places in Danvers by the 3 and 4 meter flood. Other major roads such as Route 35 and 129 could also be flooded. In addition Ocean Avenue, which connects Marblehead Neck to the main part of Marblehead could be flooded by the 1, 3 and 4 meter sea level rise.

Important infrastructure that we considered include hospitals, fire stations, police stations, schools, universities, prisons and lighthouses. Fortunately most of these buildings would be unaffected by flooding. No critical infrastructure was affected by 1 meter flooding. Three schools, one fire station and one lighthouse would be in the 3 meter flood zone. A 4 meter flood would affect the aforementioned buildings along with one more school.

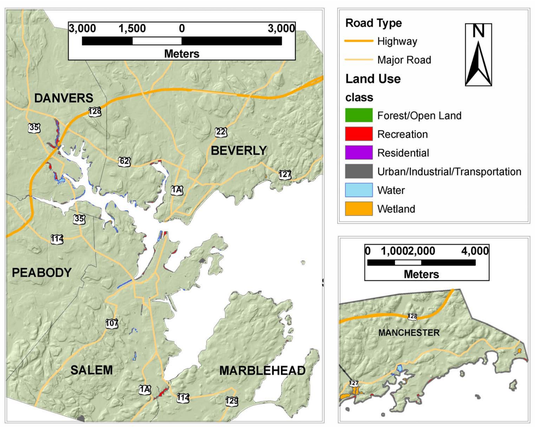
Flooded Areas of Salem Sound



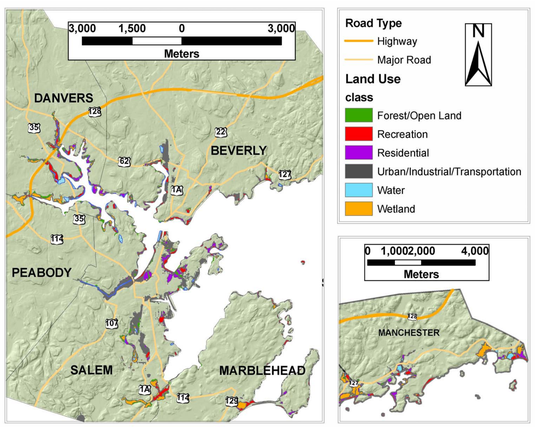
Discussion

This study is really just a starting point for the Salem Sound Area to become prepared for sea level rise. The main purpose was to point out what the potential effects of such a rise would be. However, there are many other facets of the problem that have not been examined. Perhaps the most important to everyone is the financial implications. The cost of preparing Rt. 128 to avoid flooding have not been investigated. Nor has the effect of a major disruption of traffic. The cost of the amount of land that could be lost should also be calculated. Another factor to be further researched is where the displaced populations would be evacuated to. The possible disruption of power due to flooding around main transmission lines would could also be a major inconvenience to people in the region. The length of time and economic impact of a major power disruption should also be studied.

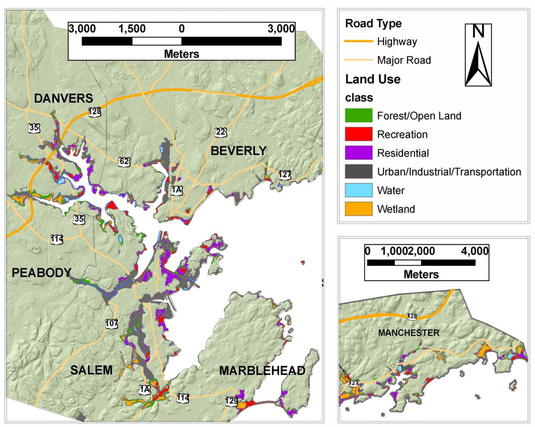
1 Meter Sea Level Rise Land Use Impacts



3 Meter Sea Level Rise Land Use Impacts



4 Meter Sea Level Rise Land Use Im-



1 Meter Sea Level Rise LandUse Impact

Land Use Class	Total Area Inundated (Square Meters)
Forest/Open Land	68,093.5117
Recreation	443,255.1324
Residential	40,542.4911
Urban/ Industrial/ Transportation	113,829.4343
Water	155,972.8648
Wetland	303,323.842

3 Meter Sea Level Rise Land Use Impact

Forest/Open Land	648,599.3423
Recreation	1,303,804.601
Residential	961,778.7802
Urban/ Industrial/ Transportation	1,195,739.061
Water	375,032.496
Wetland	1,187,678.585

4 Meter Sea Level Rise Land Use Impact

Forest/Open Land	1,246,429.223
Recreation	1,710,431.432
Residential	1,988,475.891
Urban/ Industrial/ Transportation	2,245,487.387
Water	407,487.8516
Wetland	1,484,165.485

ALL DATA TAKEN FROM MASSGIS DATABASE
WWW.MASS.GOV/MGIS

ALL MAPS IN MASSACHUSETTS MAINLAND STATE PLANE PROJECTION