Impact of Sea Level Rise- A Case Study on Cape Cod, Massachusetts

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Introduction– Sea Level Rise

Climate change has caused sea level rise, which will have profound impact on human survival in the next few centuries. The following is a summary of the current state of knowledge of sea level change:

- Based on the tide gauge data, the rate of global average sea level rise during the 20th century is in the range of 1.0 to 2.0 mm/yr, with a central value of 1.5 mm/yr.
- The average rate of sea level rise has been larger during the 20th century than the 19th century.
- Factors contribute to the observed sea level rise include thermal expansion of sea water and wide spread glacier retreat and loss of ice cap.
- A sea level rise of 0.09 to 0.88 m has been estimated by the IPCC for years 1990 to 2100.
- Even if greenhouse gas concentration were stabilized now, sea level would continue to rise for hundreds of years.

Impact Study of Sea Level Rise on Cape Cod

In order to demonstrate the impact of sea level rise to the communities living on the coast, a study using GIS was carried out for Barnstable County (Cape Cod), which is located in southeastern Massachusetts. Most of Cape Cod is surrounded by the ocean. Its topography is very flat, with a highest elevation of 95 m. Therefore, sea level rise will have many large effects on it. In this study, we will estimate the amount of area that would be inundated in three scenarios of sea level rise– rises of 1 m, 2m and 3 m, and look at the associated impacts on population and floodplain management of the county.

Figure 1. Overview of the Study Area

Findings

Area to be Inundated

The red, cantaloupe and blue areas shown Figure 2 are the areas that would be inundated by the ocean if sea level rises 1 m, 2 m and 3 m respectively. The green areas are those that would not be inundated in any of the three scenarios. Table 1 summarizes the area of inundation under each sea level rise scenario and its corresponding percentage of the total county area.

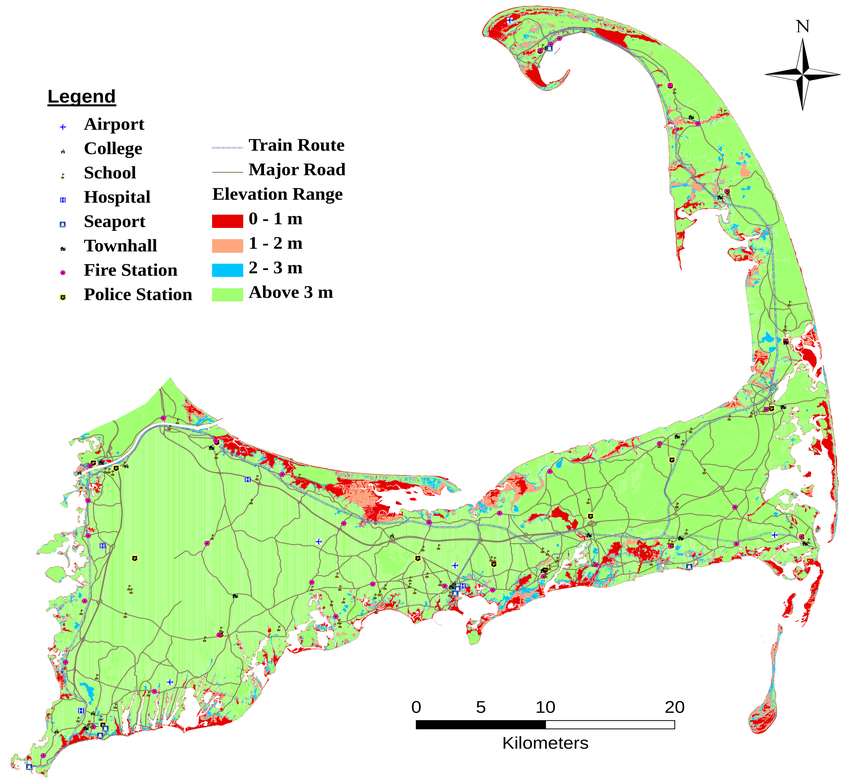

Figure 2. Area of Inundation & Major Infrastructure in the Area

Table 1. Area Inundated in Each Scenario

Sea Level Rise Scenario	Area Inundated (km^2)	% of Total County Area
1 m	63.5	6.0%
2 m	116.8	11.1%
3 m	159.4	15.2%

Population Relocation

Figure 3 shows the population distribution in Cape Cod in Year 2000. Assuming that the number of people that would be affected by the inundation is proportional to the area inundated, we obtain an estimate of the number of people that would need to be relocated in each scenario (see Table 2). If relocating one person and his associated property from the inundated area to inland costs $100,000, the total cost of relocation would be $7178 million for the entire county.

Impact on Floodplain Zoning

Sea level rise will increase flooding risk in a community. Figure 4 is a summary of the current floodplain zoning in Cape Cod. As sea level rises, the areas of the floodplains will be larger, putting the communities more prone to flooding. The cost of flood insurance will then be higher.

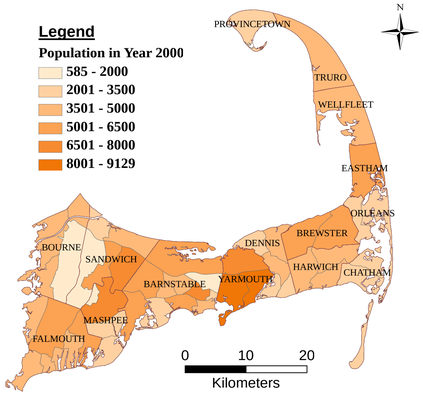

Figure 3. Population Distribution in Cape Cod

Table 2. Population Affected

Sea Level Rise Scenario	Population Affected
1 m	13334
2 m	24668
3 m	33779

NB: Total population in Cape Cod in Year 2000 is 222230.

Conclusion

Although existing models predict that globally on average sea level would rise in the range of 0.09 to 0.88 m by 2100, a peninsular like Cape Cod might experience higher and more dramatic rise. Many areas, as shown in Figure 2, would be inundated and inhabitable in the future.

If no policy is made to halt climate change, sea level rise might accelerate. Actions are needed to relocate the people and protect the communities against increased risk of flooding. It would be much more economically efficient to act now than later. Detailed impact studies are needed. Population relocation plans should be developed to move people to safer places, or more and higher sea walls should be built to protect the communities in Cape Cod.

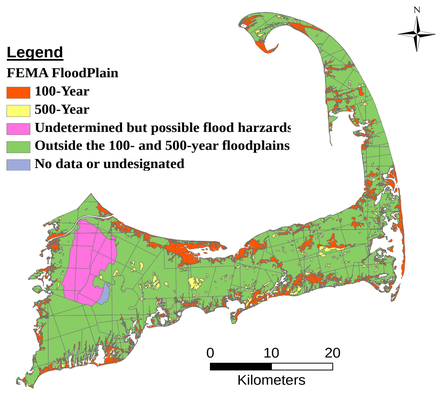

Figure 4. Current Floodplain Zoning

Methodology

1. Obtained DEM (Digital Elevation Model) data from MassGIS.

2. Reclassify the DEM data into the 4 elevation groups using Spatial Analyst and convert the raster file to a shapefile.

Elevation Range
0 - 1 m
1 - 2 m
2 - 3 m
Above 3 m

3. Overlay this shapefile with the political boundary, population, infrastructure and FEMA flood Q3 shapefiles, etc.

4. Edit the attribute data, make necessary selection and export the data to MS Excel and Access for further processing and analysis.

Reference:
Intergovernmental Panel on Climate Change. 2001. IPCC Third Assessment Report - Climate Change 2001: The Scientific Basis. Cambridge University Press

Resources of Data:
Massachusetts Geographic Information System (MassGIS)

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