RISK ANALYSIS OF FLOOD IN RUTLAND, VERMONT

INTRODUCTION

In comparison to the traditional flood maps, flood risk maps generate more information about the flooding event because they bring into account of the effects of flooding. Risk maps are usually generated as a mathematical combination of damage maps of different return periods. In this project, the study area is the Rutland City, Vermont. The hurricane Irene hit the city on Aug 31 and Sept 1, 2011, and caused a huge flood in the Otter Creek which is a river located at the southwest to the central city. Traditional flood map, land use map, water depth map and population density map are introduced as parameters of the algorithm for estimating flood risk. These results of flood risk analysis can be useful to evaluate policy alternatives and they are important inputs for social cost benefit analysis.

Tianyi Luo, Master Candidate of Environmental & Water Resources Engineering, Tufts University
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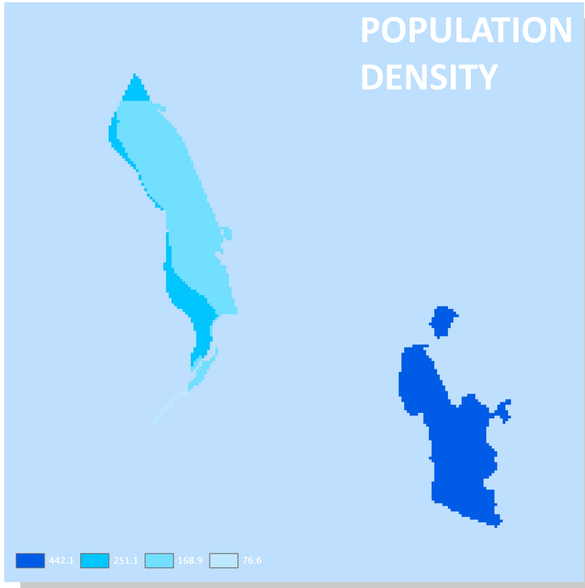
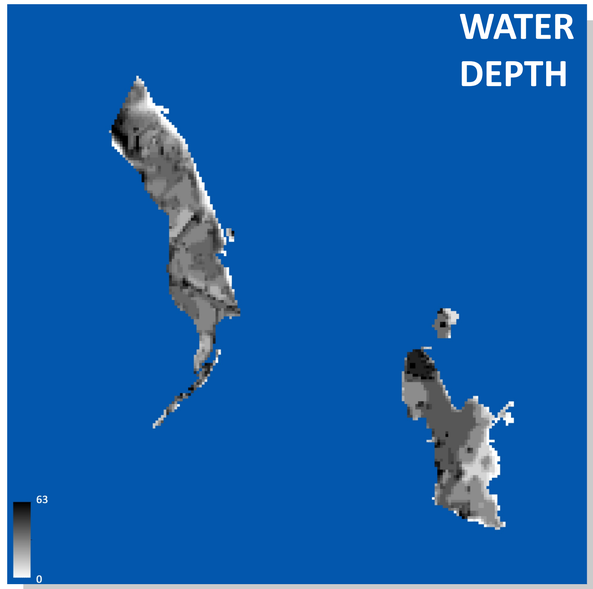


POPULATION DENSITY MAP

Population density data is from the US Population by Zip Code 2010 Dataset which was obtained directly from ArcGIS Online. This raster layer presents the 2010 estimated population density distribution of the flood areas, which shows the population per square miles that has been effected by the flood damage caused by the Hurricane Irene, which is an important part of risk analysis.

WATER DEPTH MAP

The water depth layer is estimated from the Digital Elevation Map (DEM) which is provided by USGS National Elevation Dataset. There are 5 pieces of flood areas which are completely isolated from each other. The water depth of each cell was computed by taking the largest elevation value in that piece of area and then subtracting by the elevation value of its own cell.



CONCLUSION

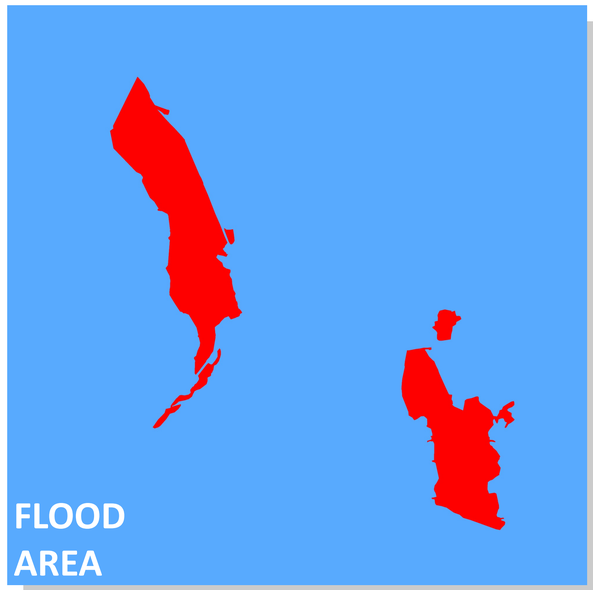
Overall, by looking at the land use ratio of the flood area, the city of Rutland has a fairly good urban planning design. Most of the flood plains were covering by water when the flood came, and they reduced the flood damage by storing and releasing the water. However, there are still some highly developed areas, some of them are even far away from the Otter Creek, suffering the damages caused by the flood. The results of the risk analysis could be used by, the insurance companies for risk assessments and land evaluation, and the department of urban planning for damage control and stormwater management. The scientific base for the calculation allows spending financial resources in a more effective and objective way.

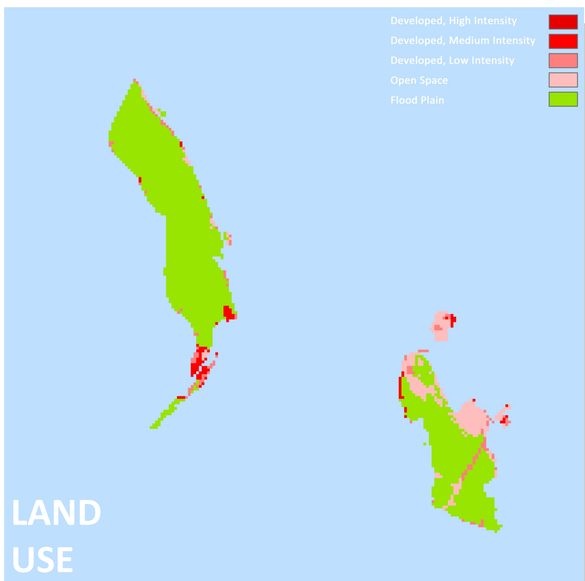
FLOOD AREA MAP

The flood area data was provided by the Vermont GIS Center, and it records the flooding condition around Rutland City on the days of August 31, 2011 when Hurricane Irene hit the state of Vermont. The flood areas have 5 isolated pieces of water bodies, a combined area of 1.149 square miles in total, and they are located to the southwest of the central Rutland.

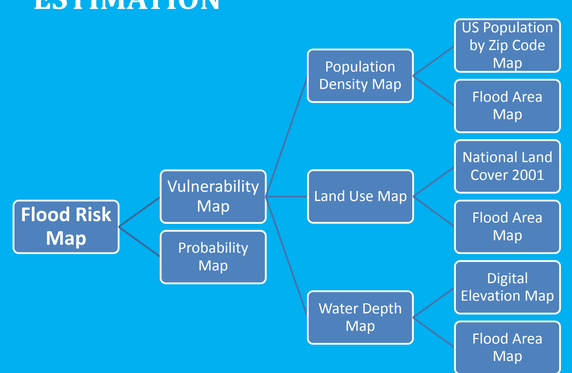
LAND USE MAP

The land use layer was obtained from 2001 USGS National Land Cover Dataset. Developed areas are more vulnerable to natural disasters like flood, so areas other than the developed ones, mostly of different vegetations and wetlands, are all been considered as flood plains. The developed areas is 7.84% of the entire flood areas.





FLOW CHART OF FLOOD RISK ESTIMATION



FLOOD RISK MAP

The flood risk is estimated and calculated on the basis of

$$Risk = Probability \times Vunerability$$

However, the probability of this flood cannot be determined in this project, since there is no flood area images of other flood events available, and the USGS National Water Information System did not have the record of the peak flow of this flood. Therefore, probability will be assumed as 1 in this study, which means the flood area is fixed if there was a flood event. In order to estimate the vulnerability, three major components of it, land use, population density and water depth of the flood, must be determined. Combining with these three layers of rasters, and using the algorithm of

$$Vulnerability = Land\ Use \times Population\ Density \times exp(Water\ Depth)$$

Then, by introducing the estimated vulnerability to the previous risk equation, a risk map of the flood areas can be produced.