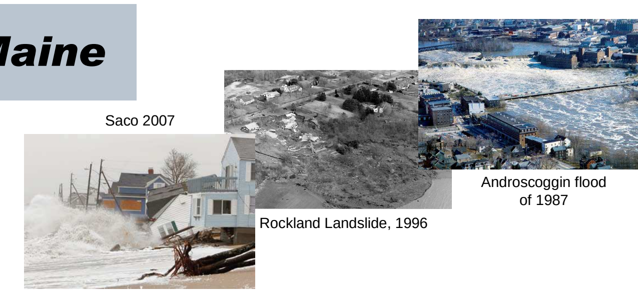
Flooding of York downtown May, 2006

Demographics of Natural Disaster Hotspots in Maine

Lindsay Dreiss and Caitlin Dufraine
Colby College Environmental Studies Program
ES 212: Introduction to GIS and Remote Sensing



Saco 2007

Rockland Landslide, 1996

Androscoggin flood of 1987

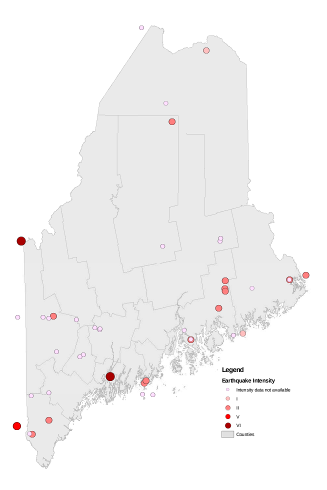
Abstract

Natural disasters can cause extensive damage to communities and infrastructure. The state of Maine is fairly lucky, because natural disasters are relatively infrequent. Maine does, however, experience earthquakes, floods, hurricanes and landslides. Certain areas of the state are more prone to experience natural disasters than others. Using GIS analysis, we have determined natural disaster hotspots in Maine to explore the possibility of a statistically significant relationship between natural disaster susceptibility and socioeconomic variables. We chose to look at median family income and population in the context of disaster hotspots. We hypothesized that lower income communities would be disproportionately exposed to natural disasters. These concerns originated from concepts of environmental justice. We found that Maine's coastline, an area of industrial growth and wealth, is an important factor that determines the location of disasters. Maine's population that experiences high risk of disasters is disproportionate in relation to the land area (in square miles) exposed to the same risks.

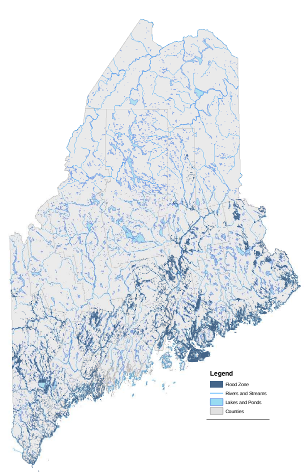
Introduction

The study of environmental social justice often finds that marginalized communities frequently inhabit areas that are exposed to disproportionate environmental risks (Clinton 1994). The concept of environmental justice assures "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income…" (EPA 2008). In this project, we used this definition to examine the relationship between natural hazards and community demographics. We modeled our study after research conducted by the Center for Hazards and Risk Research at Columbia University that focused on mortality and economic losses in global disaster hotspots (Dilley 2005). We created an index of risk susceptibility to identify Maine's disaster hotspots. We assessed the relationship between total town population, median income and susceptibility/history of natural disasters.

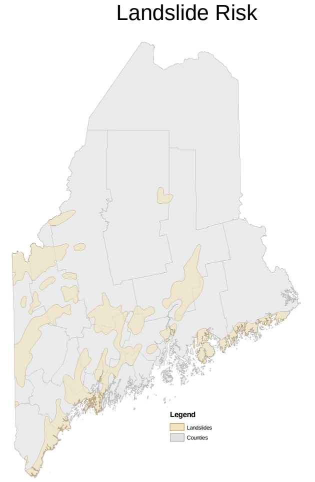
Earthquakes (1973-2005)



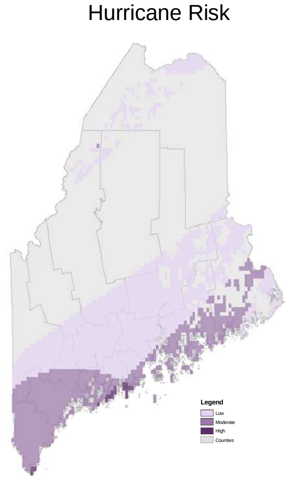
Flood Risk



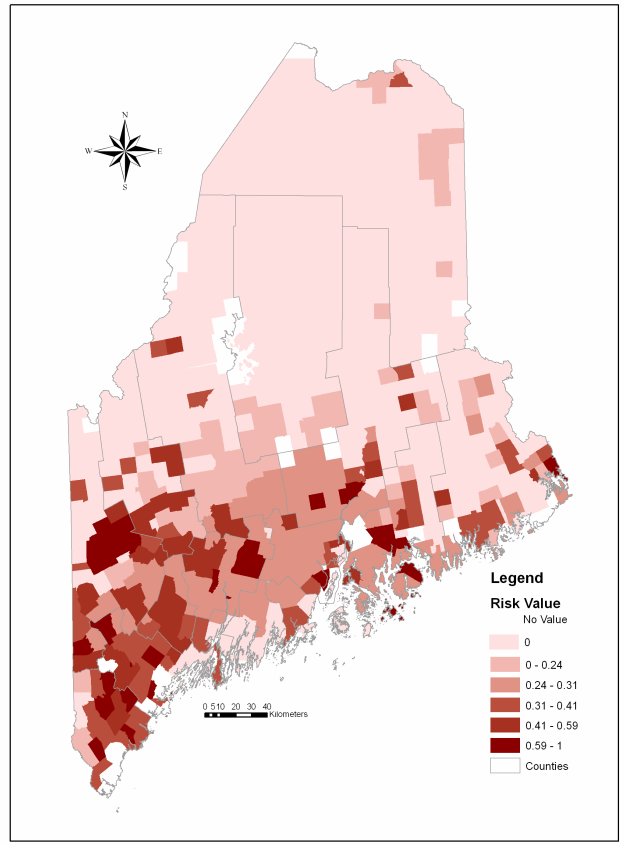
Landslide Risk



Hurricane Risk



Natural Disaster Impact Zones of Maine



Methods

The Geographic Information System we used was ArcGIS. We compiled layers of data representing earthquakes since 1973, hurricanes, landslides (data from 1997) and floods to create maps of natural disasters (Boston College, Center for International Earth Information Network, USGS and Maine office of GIS). Tables of population and median family income from Maine office of GIS were used to map demographics. Our data were projected to NAD 83, UTM zone 19.

Tabular data were joined to vector shapefile attribute tables to create map layers. Using the dissolve tool we compiled and simplified data in order to export and import it into ArcGIS. We associated (using a union) these vector polygon features (landslides and floods) with the township polygons they intersected. We converted the hurricane layer from raster to vector. By selecting disaster attribute that occurred within a three mile buffer zone we determined the susceptibility index for townships.

Using a coefficient for each disaster (variable) we weighted the importance based on intensity and frequency to better represent our data. (Table 1). The equation for risk value is: $R = 0.25*E + 0.5*L + 0.75*H + F$; where R= Risk, E= earthquakes occurring multiple times, once, and not at all (1, 0.5, 0), L= Landslide susceptibility and incidence of high, moderate, or low (1, 0.5, 0), H= Hurricanes based on intensity values of <5,5,7, or 8 (0,0.3, 0.6, 0.8,) and F= Flood occurrence in 100 year flood zone or not (1 or 0).

Value	Hazard Risk
0	Rare
0-0.24	Very Low
0.24-0.31	Low
0.31-0.41	Moderate
0.41-0.59	High
0.59-1	Very High

Table 1: Susceptibility values calculated to describe six categories of hazard risk.

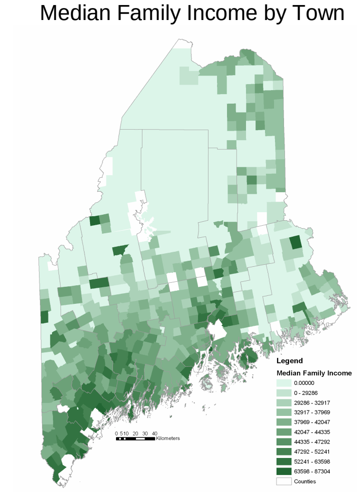
To create a 0-1 risk value scale, we normalized the data by dividing all the risk values by the highest. We depicted this index by mapping natural disaster susceptibility zones. We also gathered socioeconomic data including median household income and population by township. Using townships, our data on risk, median family income, and population, we conducted a preliminary statistical analysis in Excel which produced figures and an initial representation of our results. Our null hypothesis states that data values of high risk (above 0.5) show little variance from low risk (below 0.5) values. To test this hypothesis, secondary statistical analysis was conducted using SPSS (a statistics program). After dividing datasets into risk values above and below 0.5, we used a non-parametric, two-independent samples (Mann-Whitney) T-test to test our null hypothesis.

Results

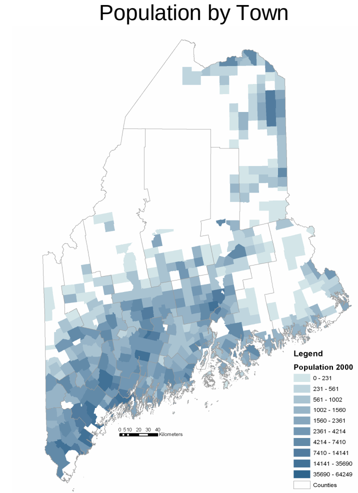
A significant relationship exists between household median income and the susceptibility to natural disasters (Figure 1). While the lowest income class does exhibit high susceptibility, we saw an increase in risk value in higher income classes. Our T-test rejected the null hypothesis showing that the mean rank for income for high risk areas (299.54) is significantly greater than those at low risk (232.08). The significance value was $p = 0.00017$ (for our purposes significance was $p < .05$).

A relationship between population and likelihood of natural disasters was not clear in our preliminary analysis (Figure 2). However, following our SPSS analysis we found the distinction between populations in high and low risk areas to be significant ($p = 0.006$). Townships at a higher risk tend to be larger in population. By using the population and land area (in square miles) of Maine counties we made approximate calculations that support this idea (Maine Government). From our estimates, only 8% of Maine is in an area of high risk (>0.5 risk) while 25% of Maine's population is similarly effected.

Median Family Income by Town



Population by Town



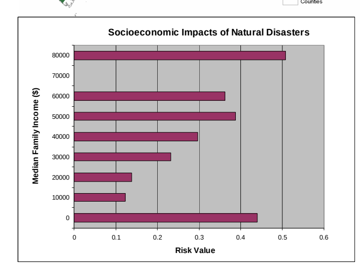


Figure 1. The relationship between the average risk value for median family income ranges ($10,000 increments).

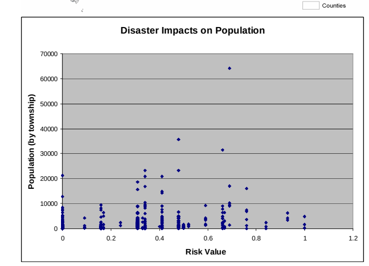


Figure 2. The relationship between risk value and the population for each township.

Discussion

Families with lower incomes, contrary to environmental justice theory, are not disproportionately impacted by environmental variation. Wealthier residents may live along the coast by choice or because their livelihoods rely on the marine environment and coastal attractions. Maine's economy is dependent on its coastal tourism, aquaculture, and agriculture among other things. These areas along the coast are considered to be hotspots. Therefore, these industries are susceptible to natural hazards that may be detrimental to the state's economy.

Our initial analysis involving population was inconclusive because the dataset was skewed. The majority of Maine townships have populations under 10,000 people, while 15 townships with higher populations are outliers. As a result there is clustering of data points in Figure 2 that obscures any noticeable correlation. SPSS analysis indicated that despite our figures, the relationship between variables was indeed significant. A large portion of Maine's population resides on the coast which supports our finding that heavily populated townships are more susceptible to risk. The population that is at risk is disproportionately large compared to the area; while 8% of Maine's land area is at high risk, 25% of the state's population resides there.

We conclude that proximity to the coast is a determinant of townships' income, population and risk susceptibility. Further study in this area should include a thorough assessment of the risk along the coast, and consideration of additional natural disasters (ie. ice storms, forest fires) and the amount of economic loss due to these events.

Acknowledgements

Manny Gimond
Philip Nyhus
The Oak Foundation

Literature Cited

Boston College, Northeast Earthquake Catalogs, http://www.bc.edu/research/westonobservatory/
Center for International Earth Information Network, Columbia University http://www.ciesin.org/download_data.html
Clinton, Bill. 1994. *Executive Order 12898* "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"
Dilley, M *et al*. 2005, Natural Disaster Hotspots:A Global Risk Analysis Synthesis Report. http://www.ldeo.columbia.edu/chrr/index.html.
EPA. 2008. Environmental Justice Webpage http://www.epa.gov/compliance/environmentaljustice/
Maine office of GIS hhttp://www.apollo.ogis.state.me.us
Maine Government County Facts http://www.maine.gov/local/
USGS Report Series Data http://www.lib.ncsu.edu/gis/usgspubs.html

2006 Earthquakes in Acadia National Park