Determining the Relationship between Household Income and Household Proximity to Tsunami Inundation Zones in Humboldt County, CA

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Abstract

The purpose of this project was to identify if there is a relationship between household income level and house locality within tsunami inundation zones in Humboldt County, CA. In order to accomplish this task we needed to download multiple sets of data, most importantly income census data blocks and a tsunami inundation zone boundaries shapefile. We defined low and high income and symbolized accordingly. This showed no relationship between income level and house locality within tsunami inundation zones. As we used our GIS skills to attempt this task, we began to recognize that there were many variables that needed to be considered. We did not anticipate complexities that would arise when testing our hypothesis. Despite the fact that we were unable to find a consistent trend, through our analysis we were able to identify specific blocks that will be less resilient if a tsunami were to occur.

Introduction

Vulnerability to extreme events (more commonly referred to as natural disasters) is truly a matter of resilience. Those with the socio-economic means to cope with the effects of a disaster will in the end be less affected by it. In Hurricane Katrina for example, "lack of access to a vehicle or other means of transportation was an unexpected factor in the overall human impacts [of the disaster]" (Cooley 248). Therefore, vulnerability should be measured not only by the environmental characteristics of an extreme event, but also by the socio-economic standing of those affected by it. An individual's socio-economic standing influences their resilience, or rather, their ability to bounce back from an extreme event. This called to question the effects a natural disaster would have on our home, Humboldt County, CA. For this project we set out to see if there is a correlation between household income level and house proximity to tsunami inundation zones in Humboldt County. This involved downloading data sets and creating new ones. With the combination of census data which we used to identify where 'low income' families live in relation to tsunami inundation zones, we tested the hypothesis that low income families are subjected to live in these hazard zones.

Figure 1: This map shows our area of interest, Humboldt County, in relation to the West Coast of the United States.

Methods

Materials:

To complete this project, we utilized the internet for acquiring data and ArcMap for data integration and analysis.

Digital Data Collection:

Our first task was to acquire data from two separate online GIS data portals. Our first source, the Humboldt County GIS data portal (http://humboldtgov.org/276/GIS-Data-Download), is where we downloaded a county outline shapefile and a tsunami inundation line shapefile. The county outline shapefile delineates the

boundary of Humboldt County. The tsunami shapefile delineates the areas within Humboldt County which county officials has estimated will be inundated if a tsunami occurs. Our second source was the Census GIS data portal (https://www.census.gov/geo/maps-data/data/tiger-data.html). This is where we acquired 2007-11 Block Group Data for the entire state of California as a geodatabase file.

Data Integration:

Our spatial reference system of choice was NAD 1983 UTM Zone 10 N, however none of our acquired data was projected to this system. For the shapefiles from the Humboldt County website, we simply used the "project" tool to adjust this. However, the census data was in geodatabase format and therefore an extremely large file. This made projecting it much less simple. To get around this obstacle, we had to "select by attribute" for all blocks that had Humboldt County's code (023) because the dataset included all of the counties in California. We made a new layer from this selection. In the new Humboldt County Census layer, we selected only the fields regarding total income for the last 12 months because there was a huge amount of other demographic fields (race, gender, age, etc.) wrapped up into the geodatabase file. Then we exported this data as a shapefile and made a new layer from it. Finally, we were able to convert the dataset to our preferred spatial reference system using the "project" tool.

Census data is divided up into polygons that they call "blocks." Because we wanted to see if people who would potentially be affected by a tsunami were generally lower income than people who wouldn't be affected, the next step was to determine what blocks could be inundated. We used "select by location" and selected for all blocks within the census data that intersect or are completely covered by the tsunami inundation line and made a new layer. The following layer we made was for the inverse, the layers *not* intersecting the inundation line. In both of these new layers, we added many fields to the attribute table. Each new field calculated different percentages of people who fell into different income levels per the total amount of people within a given census block. The census data already separated the income data into categories, for example: $0-$10,000; $10,000-$15,000; $15,000-$20,000; …….; $200,000-anything higher. We found the percentages for the low ends and then the high ends and made map layouts that displayed this. After inspecting those maps, we decided that the categories that the census provided was not inclusive enough for our purposes. To solve this, we simply combined a few of the fields in the lower income categories and added them together. Then we were able to calculate a percentage of those totals and did the same for the higher incomes. For our purposes, we define $0-$20,000 as "low income" and $100,000-$200,000 (and up) as "high income." For our symbology on each layer, we utilized the "quantities" feature to display the range of percentages which is what our map layouts in the results section represent.

Results

Our data showed no relationship between income level and house locality within tsunami inundation zones. The following figures show percentages of households that make $0-20,000/year per census block (Figure 2) and $100,000-200,000 (and up)/year per census block (Figure 3). The line that runs through both of these figures is the tsunami inundation line. As we can see from the figures, there is no common trend between income level and household locality within tsunami inundation zone. We recognize that there is a mixture of “low income” and “high income” families that live within the tsunami inundation zones and in other areas of the county. The reasons in which we may have not observed any trend is explained in the discussion section.

Despite coming up with inconclusive answers to our original question, these maps may help identify specific blocks that will be less resilient if a tsunami occurs (Figure 4). Zooming in on blocks in Arcata and Eureka that surround the Humboldt Bay reveals that there are “at risk” areas (in terms of socio-economic vulnerability). A few of the blocks show up red and orange meaning that they host high percentages of low income people.

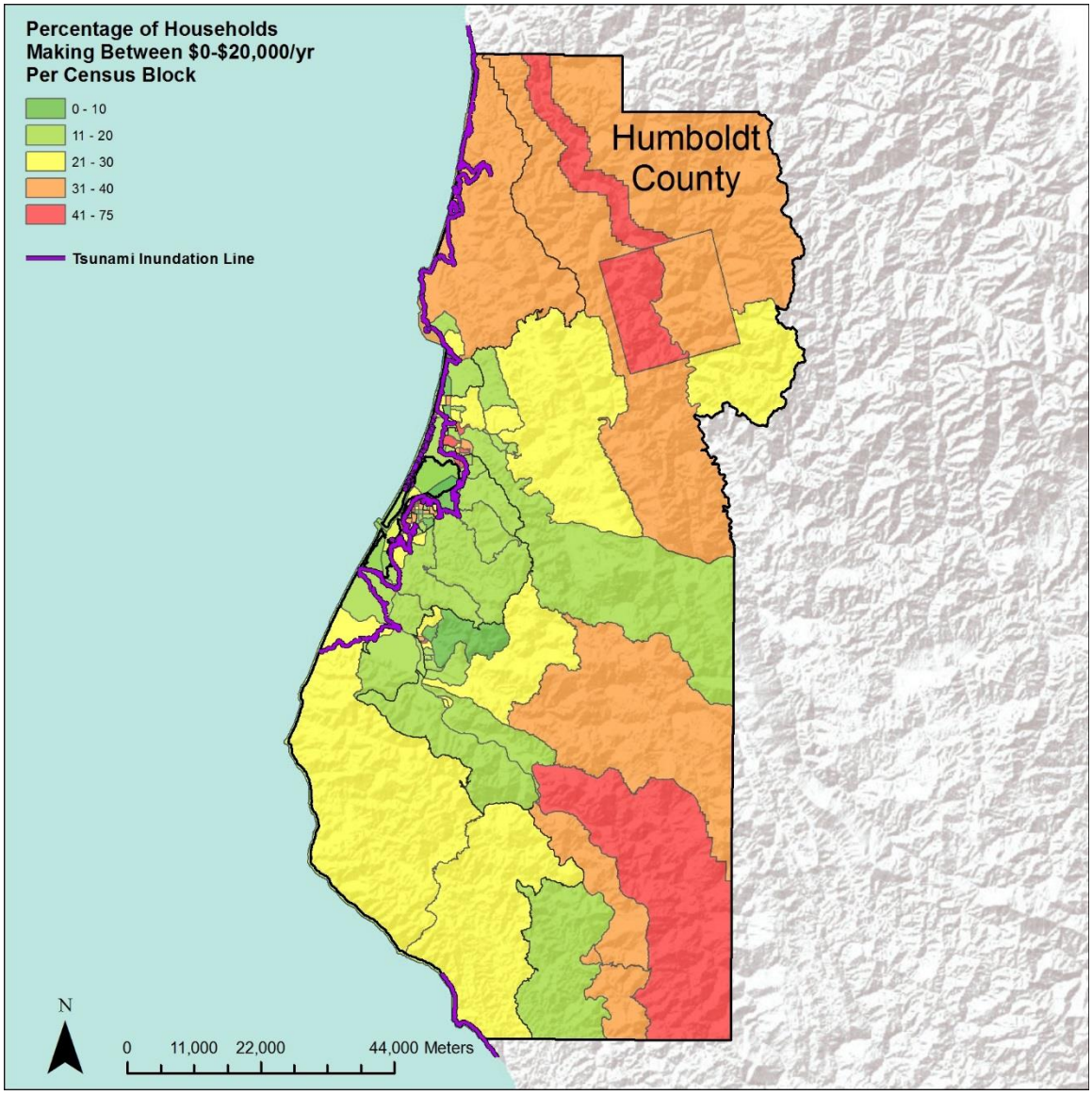

Figure 2: This map represents percentage of households that make a "low income" (per census block).

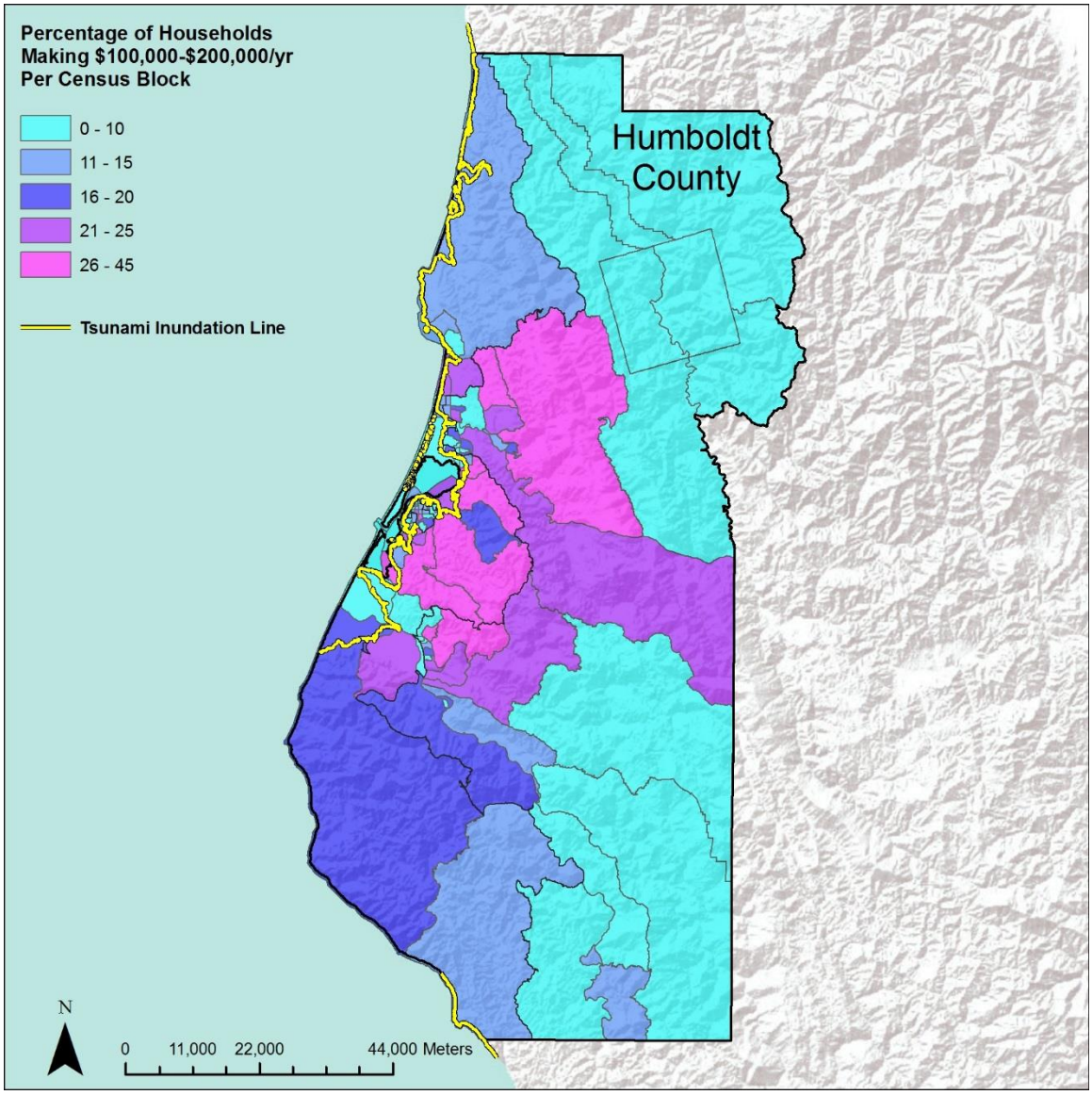

Figure 3: This map represents the percentage of households that make "high income" (per census block)

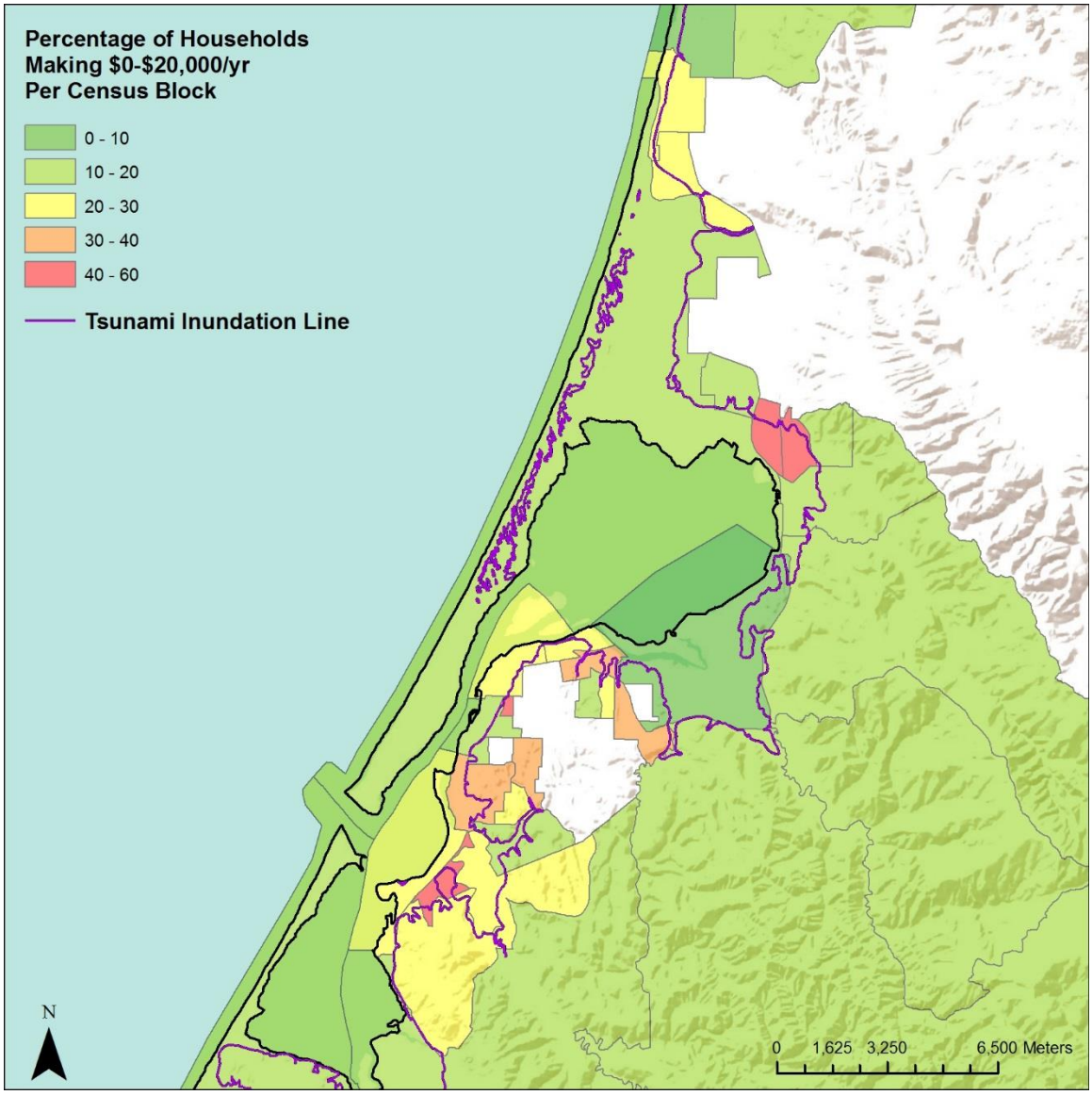

Figure 4: This map is focused on the areas that intersect the inundation line around Humboldt Bay. Red and orange areas are potentially high risk areas.

Discussion

As we were going through the steps of our analysis, we saw that there were a lot of unforeseen problems that we ran into. We did not see a consistent trend, and this is because testing our hypothesis involves analyzing and understanding multiple aspects. These are some of the following issues which we ran into:

Beaches are often sought for luxury reasons: Beaches are naturally within tsunami hazard zones (because all beaches are at sea level). We expected to see that poorer families would be pushed to tsunami inundation

zones, but did not consider that beaches and other low elevation locations near the ocean are often intentionally sought for luxury reasons.

Blocks intersecting tsunami inundation zones do not show specific location of houses: For this project, we created blocks of family level income that showed the percentage of families that make $10,000/year - $20,000/year and the percentage of families that make $100,000 - $200,000/year. Some blocks intersect tsunami inundation zone (that is, some areas within a given block are in tsunami inundation zones while the rest of the block is not within the tsunami inundation zone). The problem with this is that the blocks only reveal the percentage of family incomes within the given block, and does not reveal the distribution of these family incomes within the blocks. The reason that the distribution is not revealed is for privacy reasons.

Not all income is represented: The census data that we worked with is income that was reported, therefore these households are not accurately represented. What about families that make decent money, but do not report it? As a consequence, they may show up as "poor", when really we have no idea what their financial standing is.

We do not know the reason why a family may choose to live in their current location: The variables for this issue can be endless. Perhaps a family lives within the tsunami inundation zone in order to stay with their family that has lived there for generations. Maybe the family has inherited land in these locations. These variables make it difficult to find a trend, as they arise regardless of a family's income status.

We did not display household income data for a whole range of households: In our data analysis, we only made census block data for families that make $0 - 20,000/year and households that make $100,000 - 200,000/year. These excludes a whole range of households (households that make between $20,000 - 99,999/year), and so we are missing a lot of data.

Conclusion

In conclusion, we did not find a relationship between household income and house location within tsunami inundation zones. We downloaded the appropriate data and sifted through this data the best that we could. However, due to all of the interacting variables and the complexity of tackling a task like this, we did not find a trend. Primarily, we believe that our analysis would have been more accurate if the Census data was more specific. However, for privacy purposes, this may never be an option for everyday GIS analysts, like us. There may be a relationship between family income and house locality in relation to tsunami inundation zones in reality, however, we were not able to observe this with our limitations.

This analysis may still be useful for identifying locations in Humboldt County hosting less resilient households/families. If a tsunami were to occur, our maps could help identify locations to direct resources first. They could also be useful for implementing preventative/adaptation measures and methods. In blocks that host a high

percentage of “low income” people could be given priority for improving/building infrastructure that would buffer the block from a tsunami.

Acknowledgements

Census Data from: https://www.census.gov/geo/maps-data/data/tiger-data.html

Humboldt County GIS download http://humboldtgov.org/276/GIS-Data-Download

Base maps:

1. World Topographic Map
2. World Terrain Base

Bibliography

Cooley, Heather. "Water and Climate." *A Twenty First Century U.S. Water Policy*. Oxford: Oxford UP, 2012. 244-62. Print.