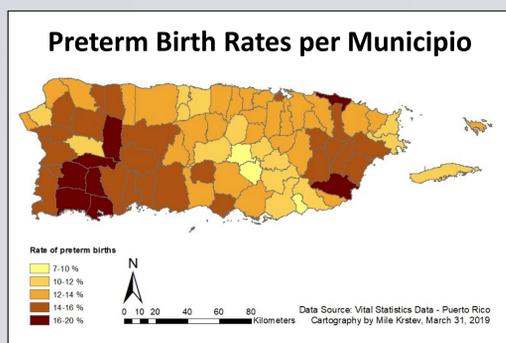


A POISONED ISLAND?

The Impact of Exposure to Environmental Hazards on Preterm Birth Rates in Puerto Rico

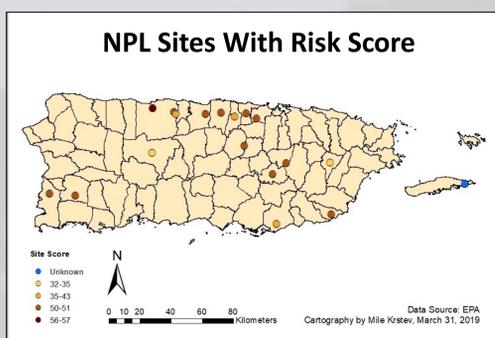
Introduction

Puerto Rico, along with some of the southern U.S. states, has one of the highest preterm birth rates in the country and in all of the Americas too. The preterm birth rate on the island has dropped from 19.6 percent in 2008 to 11.5 percent in 2016, still exceeding the U.S. national average by 1.6 percent. Several studies have pointed out the discrepancy between preterm birth rates among Hispanics living on the U.S. mainland and those living in Puerto Rico, thereby indicating that a combination of social and environmental circumstances could be responsible for the preterm birth epidemic.



The Center for Disease Control has conducted a cohort study encompassing all pregnant women in Puerto Rico between 1999 and 2014 that showed up at a health center at least once. The average preterm birth rates per municipality over the course of the study show significant spatial variability. Large spatial variability in health indicators is usually explained with social and environmental indicators that also vary spatially.

The island is the site of several U.S. military bases and test sites, several of which are still in use. Moreover, the chemical and pharmaceutical industries arrived on the island at a time when no stringent environmental regulation existed to control the toxic emissions of these industries. As a result, Puerto Rico has over 200 hazardous waste sites, including 16 active sites on the National Priority List under EPA's "Superfund" program (shown on the map below). That makes it



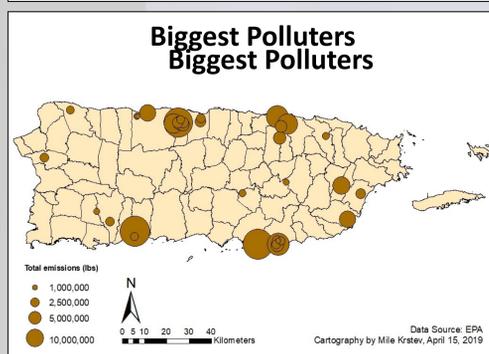
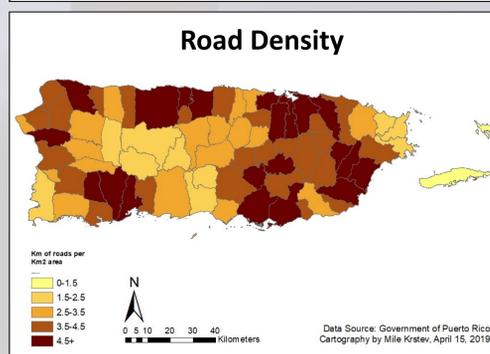
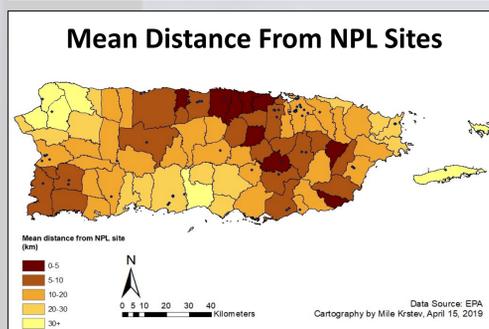
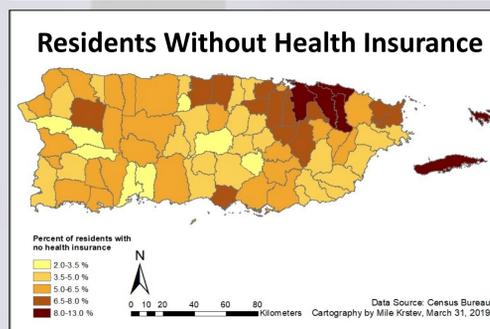
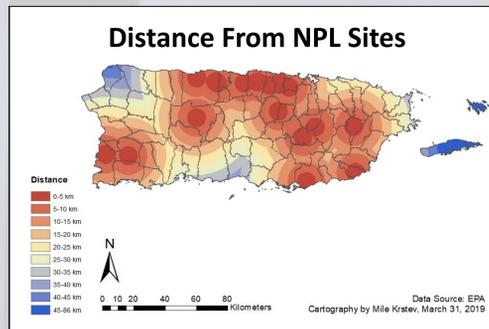
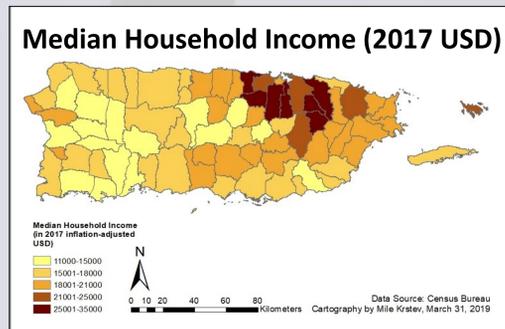
the U.S. territory with the highest density of NPL sites.

The NPL sites, along with the ongoing emissions from the energy and chemical

Methodology

Because of the observed variability in preterm birth rates and concentration of NPL sites between municipalities, a geospatial analysis was deemed appropriate for investigating the claim that the differential exposure to environmental hazards could explain the variability in preterm birth rates. The original Vital Stat dataset with records of over 600,000 births was processed in R and then used to create all the layers in ArcMap. The 78 'municipios' were used as the unit for spatial analysis because those were the smallest territorial units for which data on environmental and social indicators could be obtained. Two EPA datasets for environmental hazards were used: 1) the NPL site locations and the associated risk scores and 2) the Toxics Release Inventory for all chemical releases into the environment between 1987 and 2015. The following municipal socioeconomic indicators were obtained from the U.S. Census Bureau and Government of Puerto Rico—median household income, hospital locations, health insurance coverage, and road network.

Using the road network map, a road density (km roads per km² area) was calculated for each municipality. For the point data, i.e. the hospitals, NPL sites, and 35 biggest polluters (with total emissions of more than 1,000,000 pounds between 1987 and 2015), distance rasters were created and average municipal distances to each of these were calculated. For the chemical releases, the net emissions per area were calculated and categorized for each municipality. Both the distance to polluters and the emissions density were used as indicators because of the differential impact that different exposure routes can cause. Using the individual, socioeconomic, and environmental indicators, logistic regression models were developed in R to test the statistical significance of the environmental indicators as determinants of the likelihood of preterm birth.



Socioeconomic indicators

Environmental indicators

Logistic Regression

The logistic regression was set up to predict the odds of having preterm birth given a set of individual, environmental, and socioeconomic conditions. The individual indicators considered were: baby's sex and mother's age, race, and health insurance type. Father's age and race were also considered; however, no statistically significant coefficients were obtained. From the socioeconomic indicators, median household income, road density, and distance from hospital were considered. Out of these, only road density showed statistically significant results. From the environmental indicators, distance from NPL sites, distance from big polluters, and chemical release per unit area were considered. The last two yielded statistically significant coefficients.

Results

The results from the logistic regression model for each type of indicator are listed below. In order to contextualize the association between exposure to environmental hazards and preterm birth rates, the individual and socioeconomic indicators were considered constant.

Individual indicators

- The probability of preterm birth decreases for each year the mother is older. (Explicable by the low average mother's age)
- Black women have a higher likelihood of giving birth prematurely as opposed to White and Hispanic mothers.
- Giving birth to a male baby is associated with reduced probability of preterm birth.
- Using public health insurance (Medicaid) increases the probability of preterm birth.

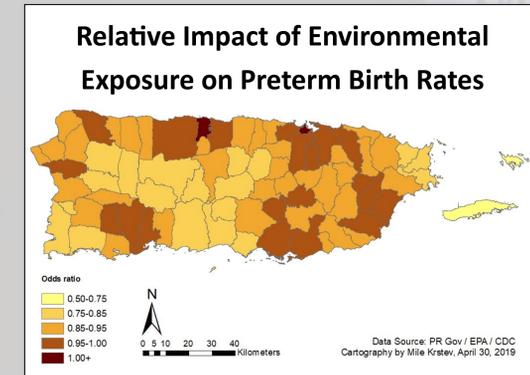
Socioeconomic indicators

From the socioeconomic factors, road density was found to be positively correlated with preterm birth. While the opposite was expected, since road density is an indicator of economic development, the outcome is most likely due to the connection between economic development and environmental emissions in the absence of strong environmental regulation enforcement.

Environmental indicators

- A one-kilometer increase in the mean municipal distance from a big polluter was found to reduce the odds of giving birth prematurely by 1.1 percent.
- An increase of one order of magnitude in the total chemicals released per unit area was found to increase the odds of giving birth prematurely by 1.2 percent.

The following map shows the predicted relative impact of exposure to environmental hazards on the likelihood of giving birth prematurely provided all socioeconomic and individual indicators are held constant.



Online sources: EPA, CDC, ESRI, Government of Puerto Rico, WHO, March of Dimes.

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