An Analysis on Flood Rik and Socio-Economic and Demographic Status in Wilmington, Delaware

SPPA667 Urban Evidence Based Policy
Project Final Presentation
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1. Introduction

Urban flood

Minority, Vulnerability, Justice

2. Background

Project Overview

Urban Evidence Based Policy Approach

- The Evidence Based Policy is to make more defensibly policy decisions based on conscientious, explicit, and judicious use of scientific evidence by **using science (Big Data and machine learning) as evidence in public policy** (Straf et al., 2012).

- In this way it is useful for policy makers by **providing insights into which policy interventions are most likely to lend desirable outcomes** (Androutsopoulou et al., 2018).

2. Background

Project Overview

Research Purpose

This research aims to find out the circumstances of the socioeconomic and demographic status is in the flood zone and suggest policy implications.

Research Question

Are vulnerable people living in the Wilmington city exposed to flood risk?

3. Data Description

Raw Data	Year	Type	Source
Census Block Groups	2016	Shapefile (.shp)	U.S. Census Bureau, Department of Commerce
Flood Depth Grid	2014	Raster	Federal Emergency Management Agency (FEMA)
Census data: Socioeconomic and Demographic Status (SED)	2014 (ACS5)	CSV	U.S. Census Bureau

3. Data Description

Census Block Groups - Delaware State

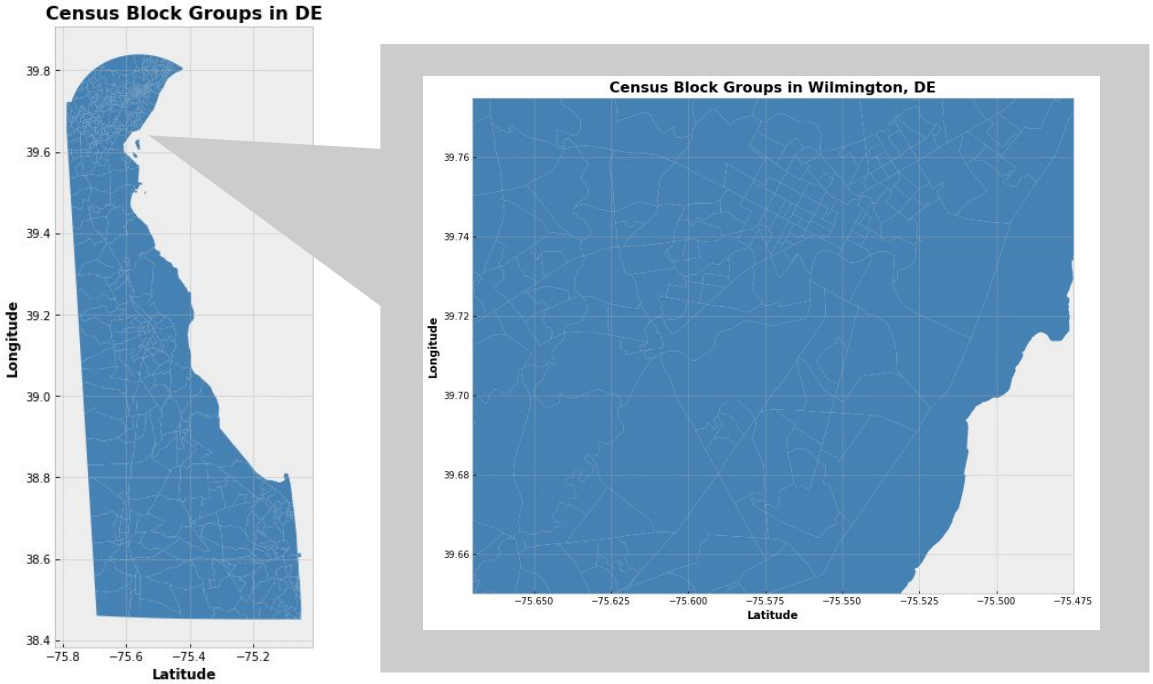


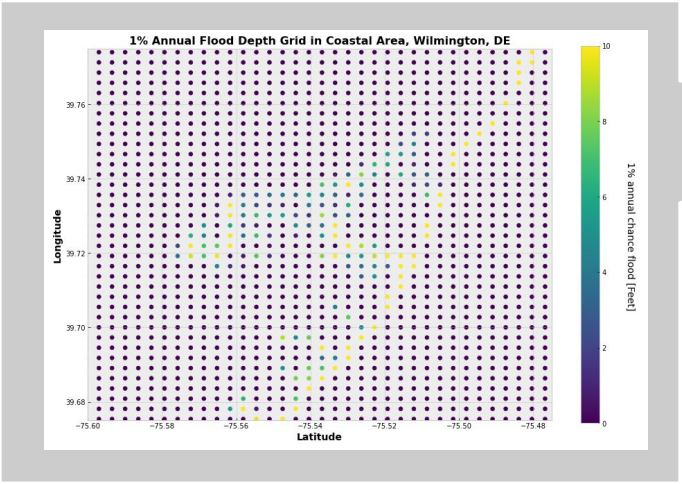
Fig 2. Census Block Groups in New Castle County. This figure is based on 2016 shapefile.The raw data shapefile includes water area, where they are generally in territorial seas, coastal water, and Great Lakes water areas.

3. Data Description

Flood Depth Grid (CstDpth_01pct) - New Castle County

* Flood hazard is defined by a relation between depth of flooding and the annual chance of inundation greater than that depth (FEMA, 2014).

* CstDpth_01pct [Unit: Feet]: Coastal flood depth for the 1 percent annual chance flood event.



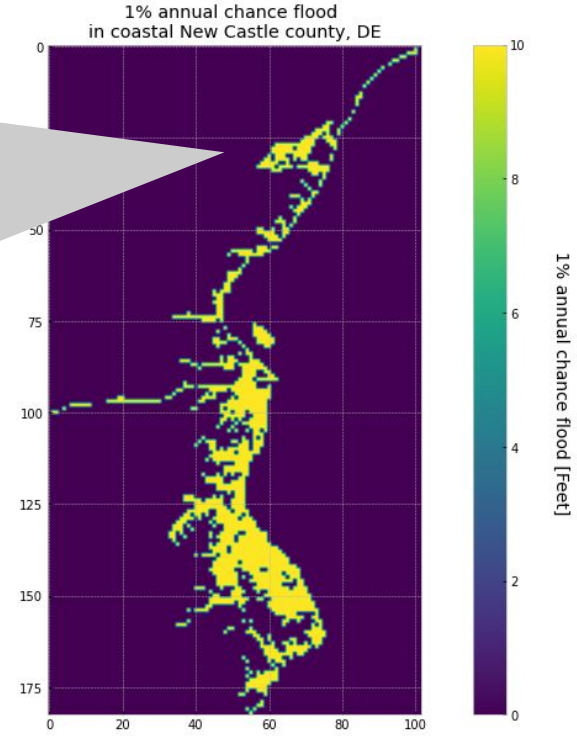


Fig 3. Flood Depth Grid with Latitude and Longitude
The raw data is based on the 2014 raster data from the FEMA. It shows that the local area surrounded by the Delaware River has the flood risk.

3. Data Description

Census Data: Socioeconomic and Demographic (SED) data

	mincome	per_nonwhite	per_below_povlev	population	no_school	under18	over65
count	368.000000	366.000000	365.000000	368.000000	368.000000	368.000000	368.00000
mean	67356.024457	33.694627	9.214050	1437.451087	1026.432065	338.307065	192.55163
std	33026.081728	27.510316	13.249521	905.320121	596.796311	291.806804	142.69507
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.00000
25%	45678.750000	11.243796	0.000000	858.750000	626.250000	156.000000	97.75000
50%	61144.000000	24.158250	3.773585	1152.000000	842.500000	256.500000	158.00000
75%	83391.000000	50.777329	12.932790	1835.750000	1263.750000	449.250000	254.25000
max	209250.000000	100.000000	82.666667	6553.000000	4066.000000	2217.000000	1147.00000

4. Method

4.1. Data summary

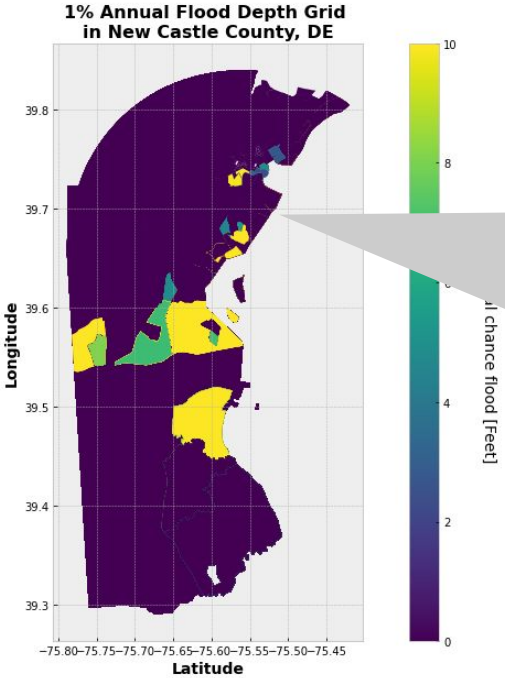
4.2. Geospatial analysis

4.3. Machine learning analysis

1) Random Forest Classifier
2) Logistic Regression Classification
3) Random Forest Regressor

4. Method

Geospatial Analysis



1) Spatial join

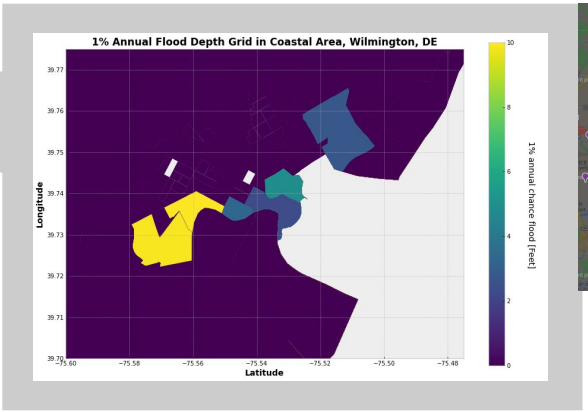
- Flood depth grid & Census block groups

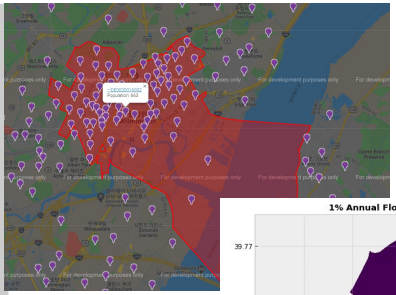
2) Merge

- Shapefile to the SED data

3) Subset

- New Castle county to Wilmington city





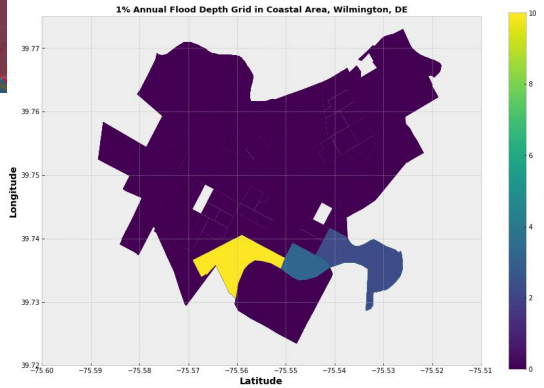
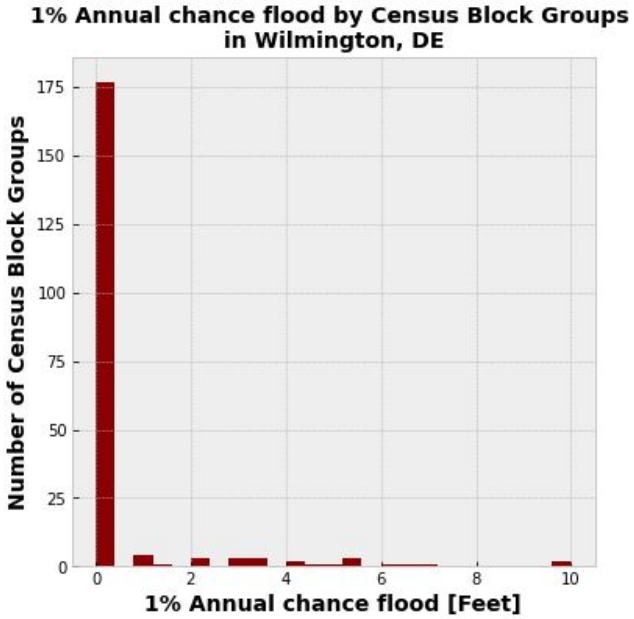


Fig 4. Flood risk in the Wilmington City

Flood depth grid based on census block groups shapefile

5. Analysis Results

5.1. Data summary



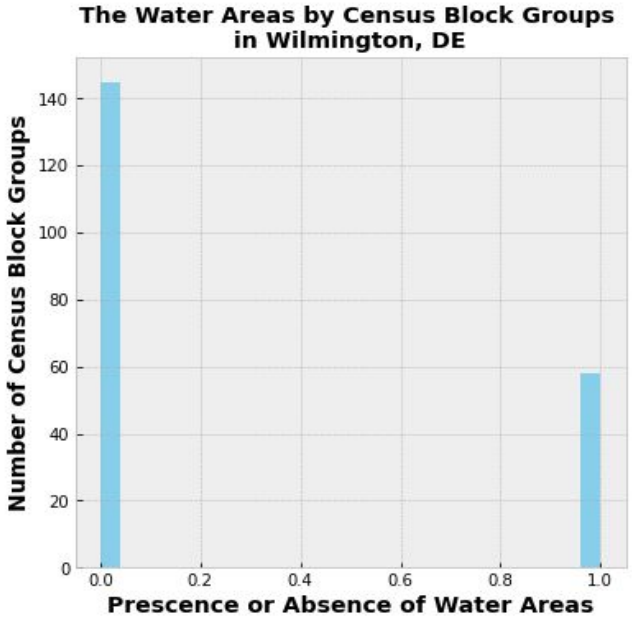


Fig 4. The Flood Depth & Water Areas

The flood risk status by census block groups in Wilmington, DE. The 1% annual chance flood is multilevel data set, while the water area is binary dataset.

5. Analysis Results

5.1. Data summary

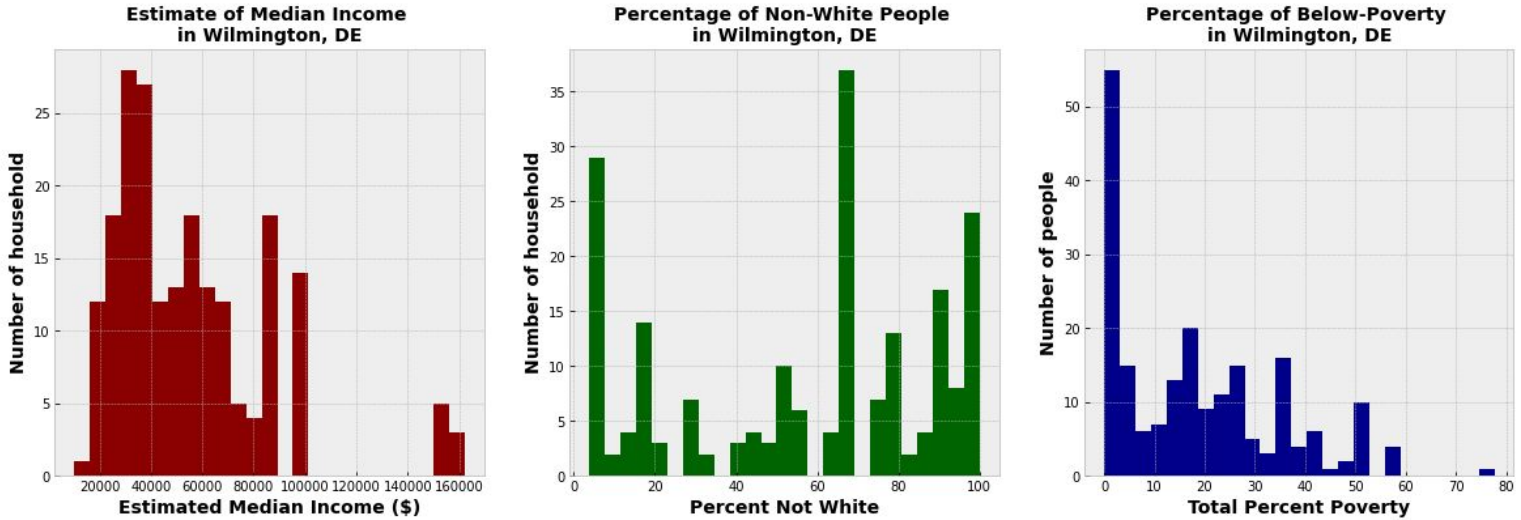


Fig 4. The socioeconomic demographic status in Wilmington, DE. The data is estimated from 2014 to 2018 and the data source is from the U.S. Census Bureau. Based on the census block groups, the mean of the median household income is $55,261, the percentage of not white people is 57.24%, and the rate of the total percentage of people under poverty line is 18.45%.

5. Analysis Results

5.1. Data summary

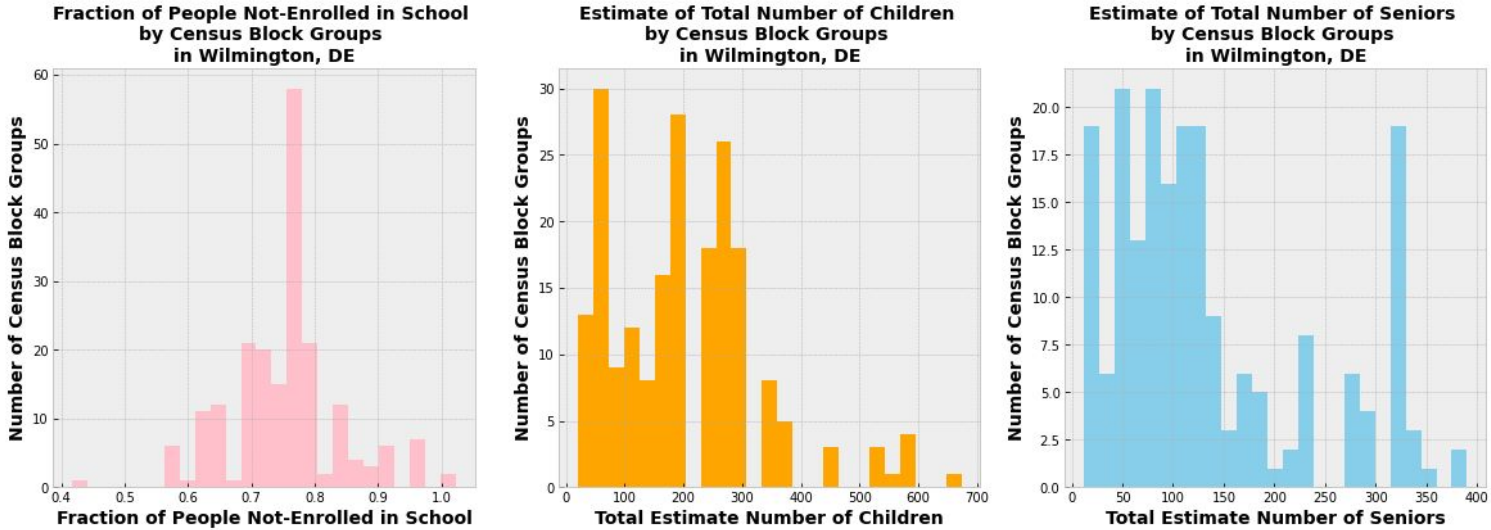


Fig 4. The socioeconomic demographic status in Wilmington, DE. The data is estimated from 2014 to 2018 and the data source is from the U.S. Census Bureau. Based on the census block groups, the mean of the fraction of people not enrolled in school is 0.76 (75.65%), the total estimate number of children (age under 18) is 201, and the total estimate number of seniors (age over 65) is 135.

5. Analysis Results

5.1. Data summary

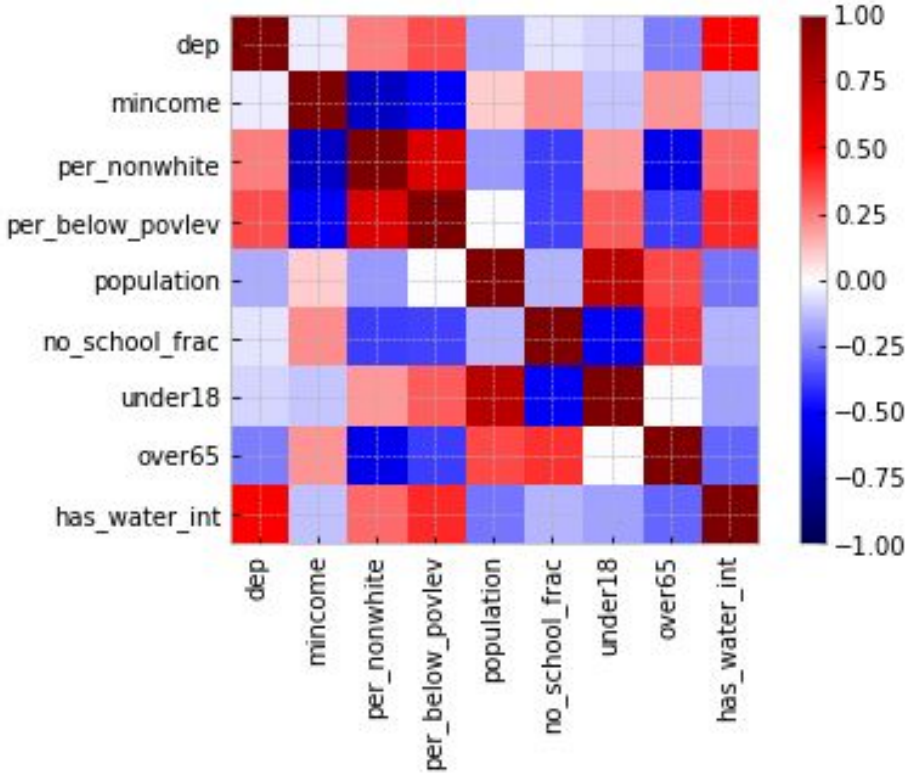


Fig 5. Correlation between features

The correlation between the 1% annual chance flood risk and percentage of people not white, and the percentage of the people below poverty line are highly correlated.

5. Analysis Results

5.2. Geospatial analysis result

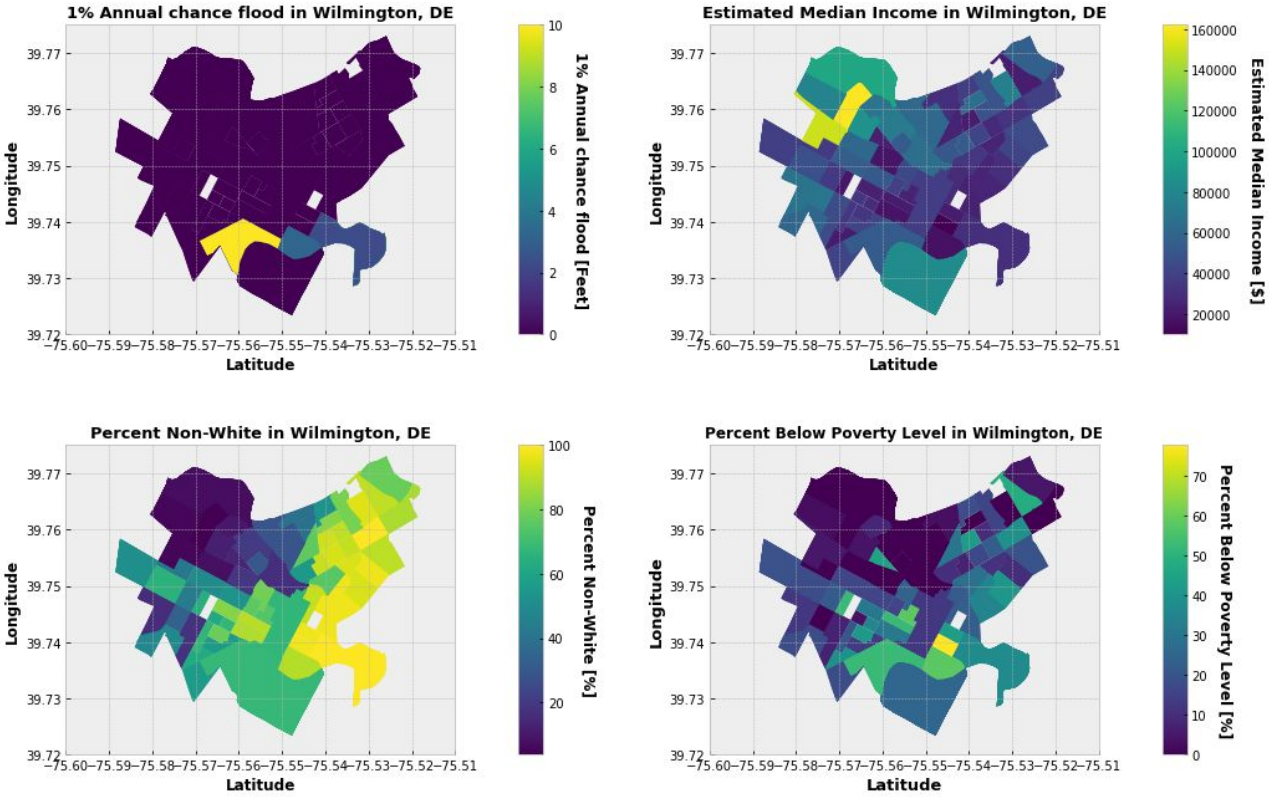


Fig 6-1. Geospatial comparison between flood risk and SED data

Based on the geospatial analysis, people living in the low median income household, people not white, and people under poverty line are living in the flood hazard zone in the City of Wilmington, DE.

5. Analysis Results

5.2. Geospatial analysis result

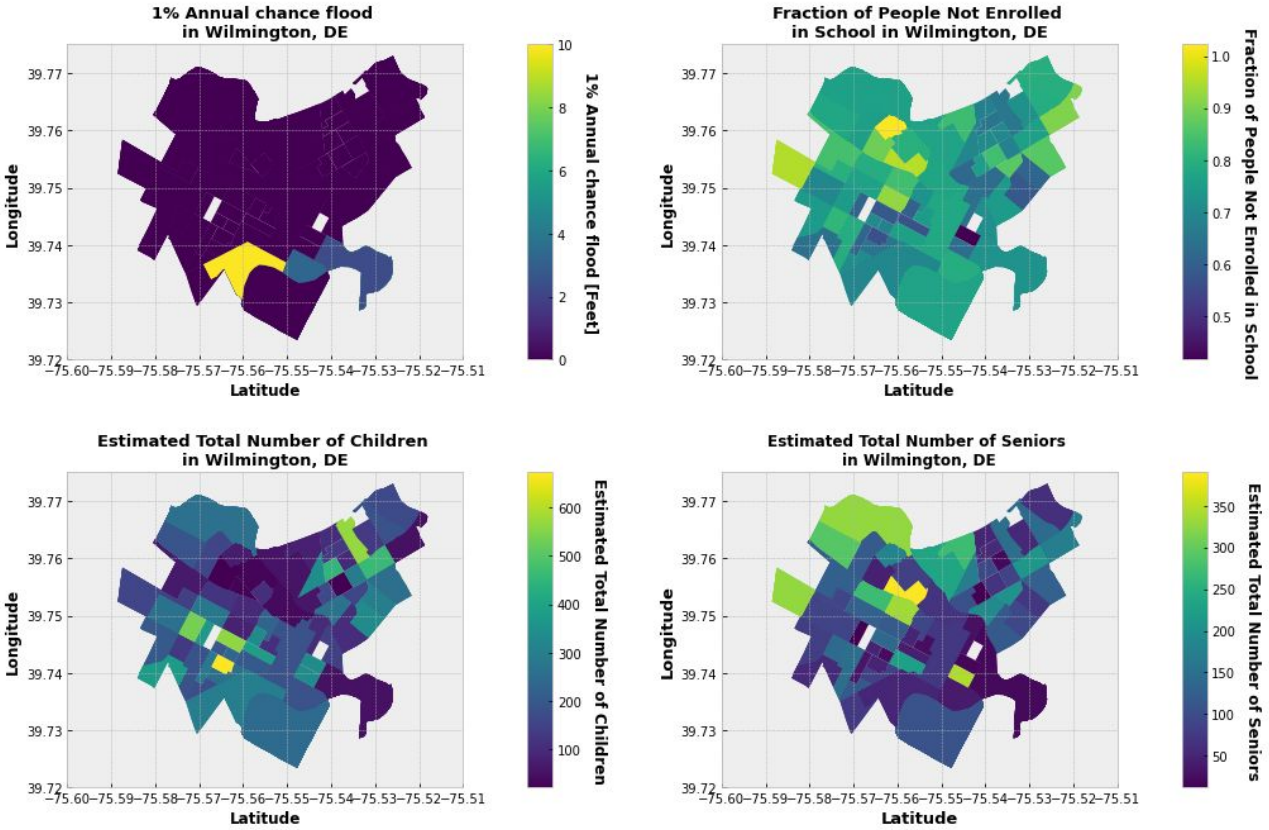


Fig 6-2. Geospatial comparison between flood risk and SED data

Based on the geospatial analysis, people not enrolled in school, children (people under 18 years old), and seniors (people over 65 years old) are not highly close to the flood hazard zone in the City of Wilmington, DE..

5. Analysis Results

5.3. Machine Learning

1) Random Forest Classifier

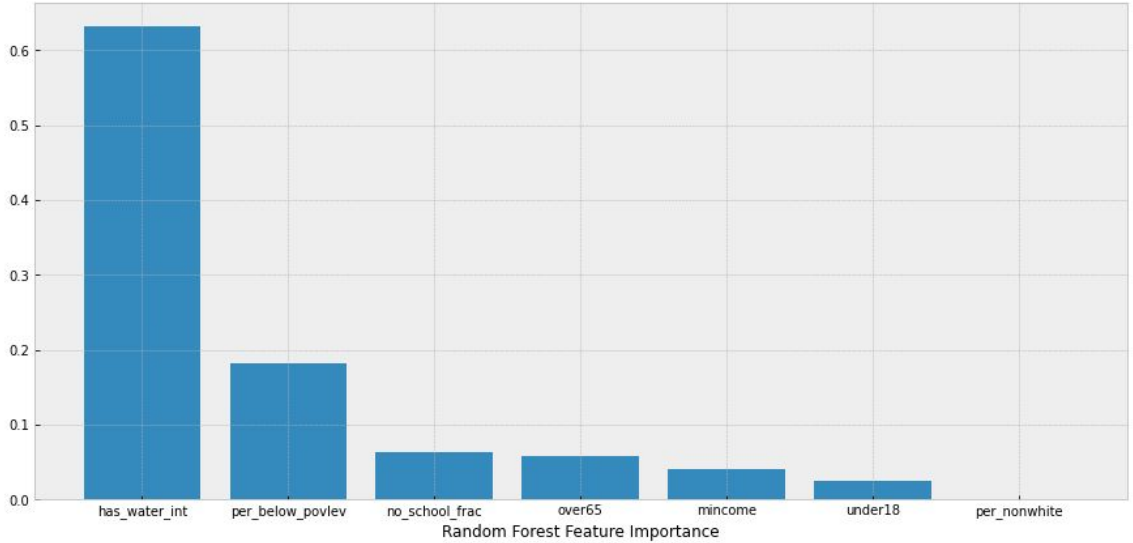
- Target: Presence or absence of flood risk (Binary)
- Objects: Census block groups
- Features:
  - Estimated median household income
  - Percent of population that is not white
  - Percent of people below the poverty line
  - Fraction of people not enrolled in school
  - Estimate number of children (Age under 18)
  - Estimate number of senior (Age 0ver 65)
  - Presence or absence of water areas (where the water areas is over 0.05%)

5. Analysis Results

5.3. Machine Learning

1) Random Forest Classifier - Result

	RFC Model (All features included)
Training accuracy	1.000
Testing accuracy	1.000



5. Analysis Results

5.3. Machine Learning

2) Logistic Regression Classification

- Target: Presence or absence of flood risk (Binary)
- Objects: Census block groups
- Features:
  - Estimated median household income
  - Percent of population that is not white
  - Percent of people below the poverty line
  - Fraction of people not enrolled in school
  - Estimate number of children (Age under 18)
  - Estimate number of senior (Age 0ver 65)
  - Presence or absence of water areas (where the water areas is over 0.05%)

5. Analysis Results

5.3. Machine Learning

2) Logistic Regression Classification - Result

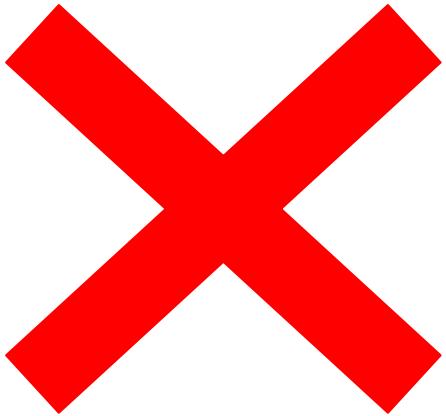
	LRC Model (All features included)
Training accuracy	1.000
Testing accuracy	1.000

Features	Coefficient
Percentage of people under poverty line	0.4707
Percentage of people not white	-0.1711
Estimated total number of seniors (Over 65)	-0.0925
Estimated total number of children (Under 18)	-0.046
Presence or absence of water areas (binary)	0.018
Fraction of people not enrolled in school	-0.028
Estimated household median income	0.003

5. Analysis Results

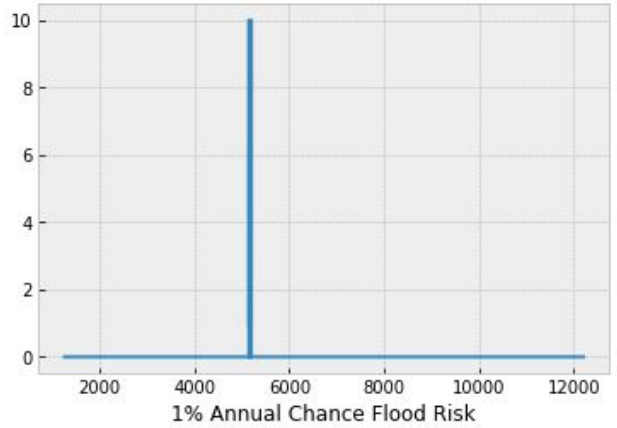
5.3. Machine Learning

1) Random Forest Classifier
2) Logistic Regression Classification



It is because….

target variable is too easy to be predicted!



What should I do next?

1) Increase feature variables (people not enrolled in school, children, seniors, etc.)
2) Add water areas as input variable
3) **Change the model**

5. Analysis Results

5.3. Machine Learning

3) Random Forest Regressor

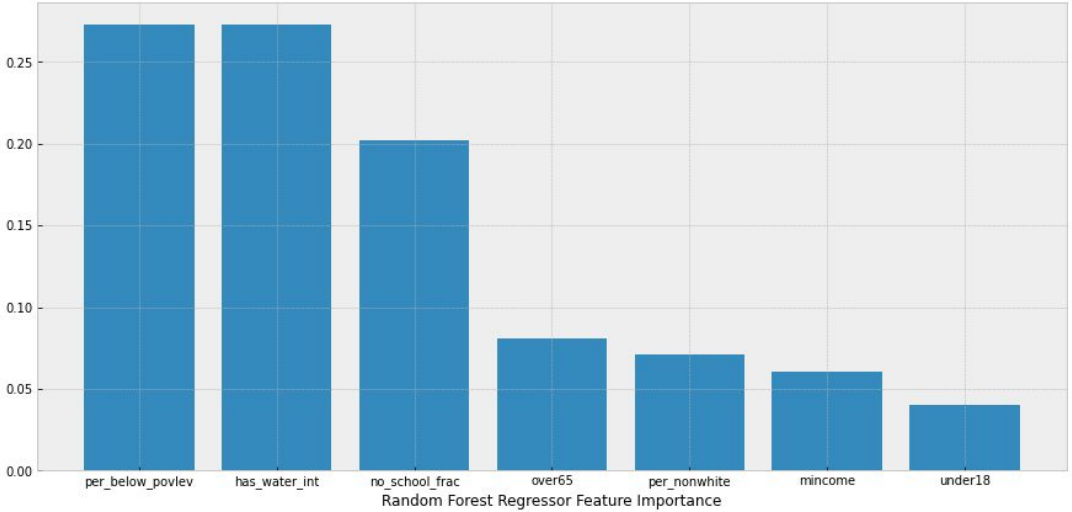
- Target (1): 1% Annual chance flood risk (Multilevel)
- Objects: Census block groups
- Features (7):
  - Estimated median household income
  - Percent of population that is not white
  - Percent of people below the poverty line
  - Fraction of people not enrolled in school
  - Estimate number of children (Age under 18)
  - Estimate number of senior (Age 0ver 65)
  - Presence or absence of water areas (where the water areas is over 0.05%)

5. Analysis Results

5.3. Machine Learning

3) Random Forest Regressor - Result

	MSE (All features included)	MSE/var (All features included)
Training accuracy	0.051	0.206
Testing accuracy	0.049	0.206



6. Discussion and Conclusion

- **The vulnerable people is exposed to the flood risk in the Wilmington, Delaware.**
  - According to the geospatial analysis result, people in the low median income household, people not-white, and people under poverty line are exposed to the flood risk.

- **During the policy-making decision process, policy makers can consider it as a factor for the policy intervention.**
  - The state government officers, policy makers, and researchers may have to consider the vulnerable people and flood risk in **the local climate adaptation policy.**

6. Discussion and Conclusion

- **Limitation**
  - In terms of the middle size of the urban city, it is limited to get diversified dataset of the flood depth grid from the open data source platform.
  - Since the accuracy of the RFR machine learning model is very low, the model should be more adjusted.
  - The flood risk depth raster data has limitation information of how it is collected.

- **Further study**
  - Adjust the machine learning model to increase model accuracy
  - (Expected) case study: New York City

Thank You

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