



project ≡ blue tarp

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April 15, 2021

Introduction



Natural Disasters: Hurricanes Irma, Harvey, and Maria severely impacted Florida, Texas, and Puerto Rico in 2017.



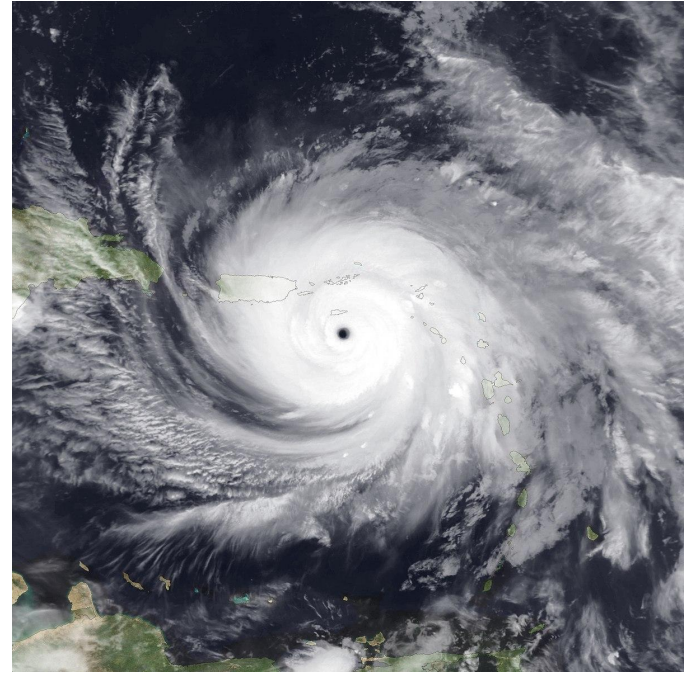
Federal Emergency Management Agency (FEMA): The Individuals and Households Program (IHP) provides financial assistance to eligible individuals and households who have uninsured or underinsured necessary expenses and serious needs.



Puerto Rico: The island has faced some of the worst socioeconomic decline in recent years including a 20% decrease of its economy since 2006, and lost almost 16% of its population exacerbated by Hurricane Maria.

Research Goal

Project BlueTarp **uses supervised machine learning to evaluate the extent to which Puerto Rico received an equitable allocation of aid**, through a comparison with Florida and Texas, also impacted by hurricanes that year.



Category 5 Hurricane Maria impacting Puerto Rico (2017)

Users

Field experts and academics who can expand and further build upon our analysis to advocate for an effective and a more equitable disaster recovery process.



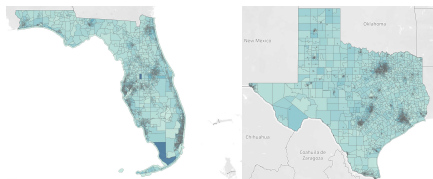
Deepak Lamba-Nieves is the research director & Churchill G. Carey, Jr. Chair in Economic Development Research at the Center for a New Economy (CNE). He also teaches at the University of Puerto Rico's Graduate School of Planning.



Raúl Santiago-Bartolomei is a Research Associate at Center for a New Economy (CNE). He is also an adjunct professor at the Graduate School of Planning in the University of Puerto Rico, where he teaches courses on housing policy, economic and community development and econometrics.

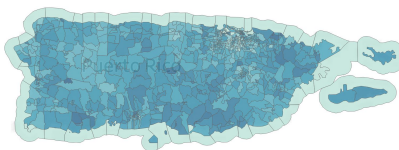
TRAINING DATASET

Florida & Texas



TEST DATASET

Puerto Rico

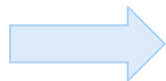


GOAL

Assess extent to which FEMA allocated housing assistance aid consistently

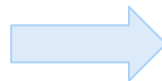
SAMPLE FEATURES

- Eligibility status
- Inspections
- Insurance status
- FEMA estimate of property damages
- Fair Market Rates



OUTCOME

Housing
Assistance
Amount



GAP DETECTION

Predicted Housing
Assistance
Amount

vs.

Actual Housing
Assistance
Amount

Data Sources

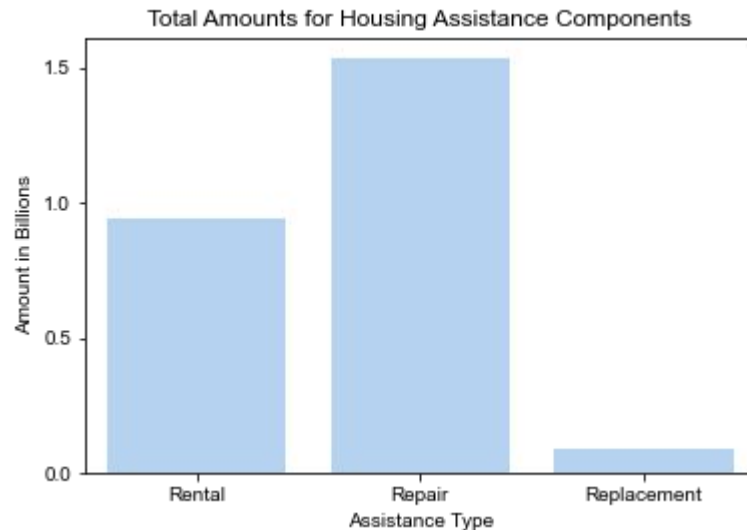
OpenFEMA's Individual and Households Program

4.6 million

anonymized applications to the Individuals and Households Program between the three hurricanes

\$2.5 billion

paid out by FEMA in Housing Assistance

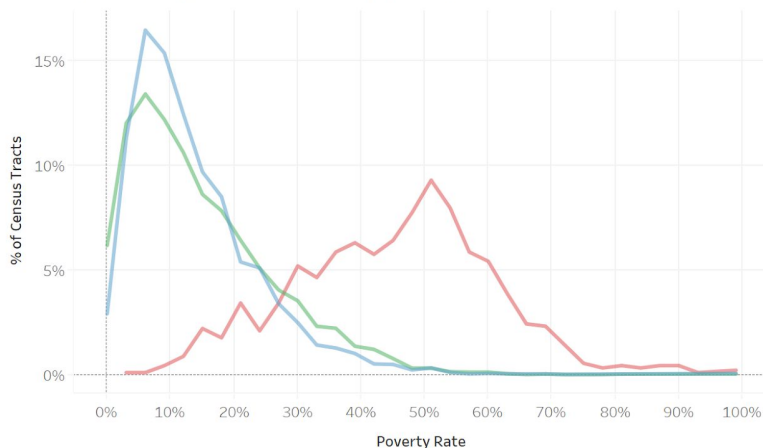


US Census Bureau's American Community Survey

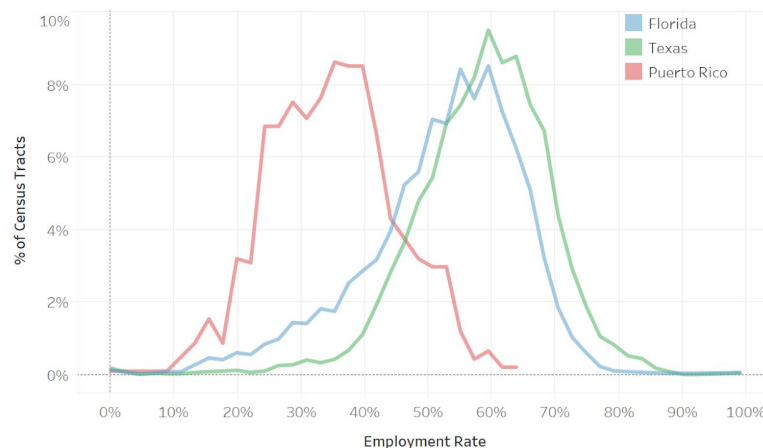
300+ demographic attributes at the census tract level including:

- Socioeconomic factors
- Housing characteristics

Poverty Rates by State/Territory (2017)



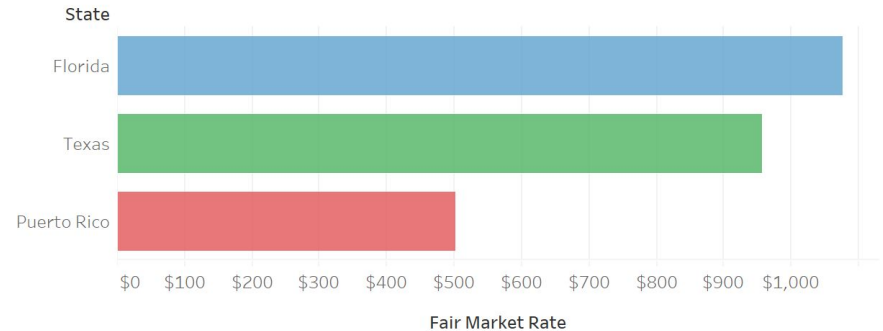
Employment Rates by State/Territory (2017)



HUD's Fair Market Rates

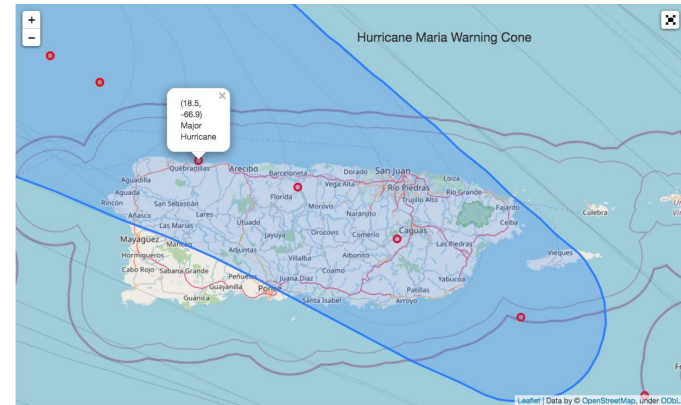
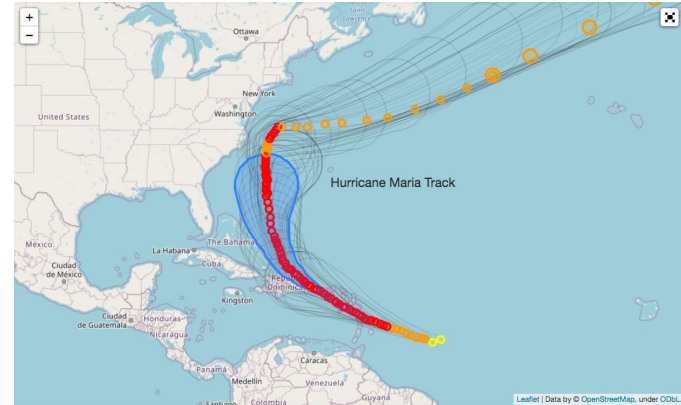
- Fair market rates: gross rent estimates established by the U.S. Department of Housing and Urban Development.
- Key component of calculating rental assistance rates for communities in the wake of a disaster

Fair Market Rate - 2 Bedrooms (2017)



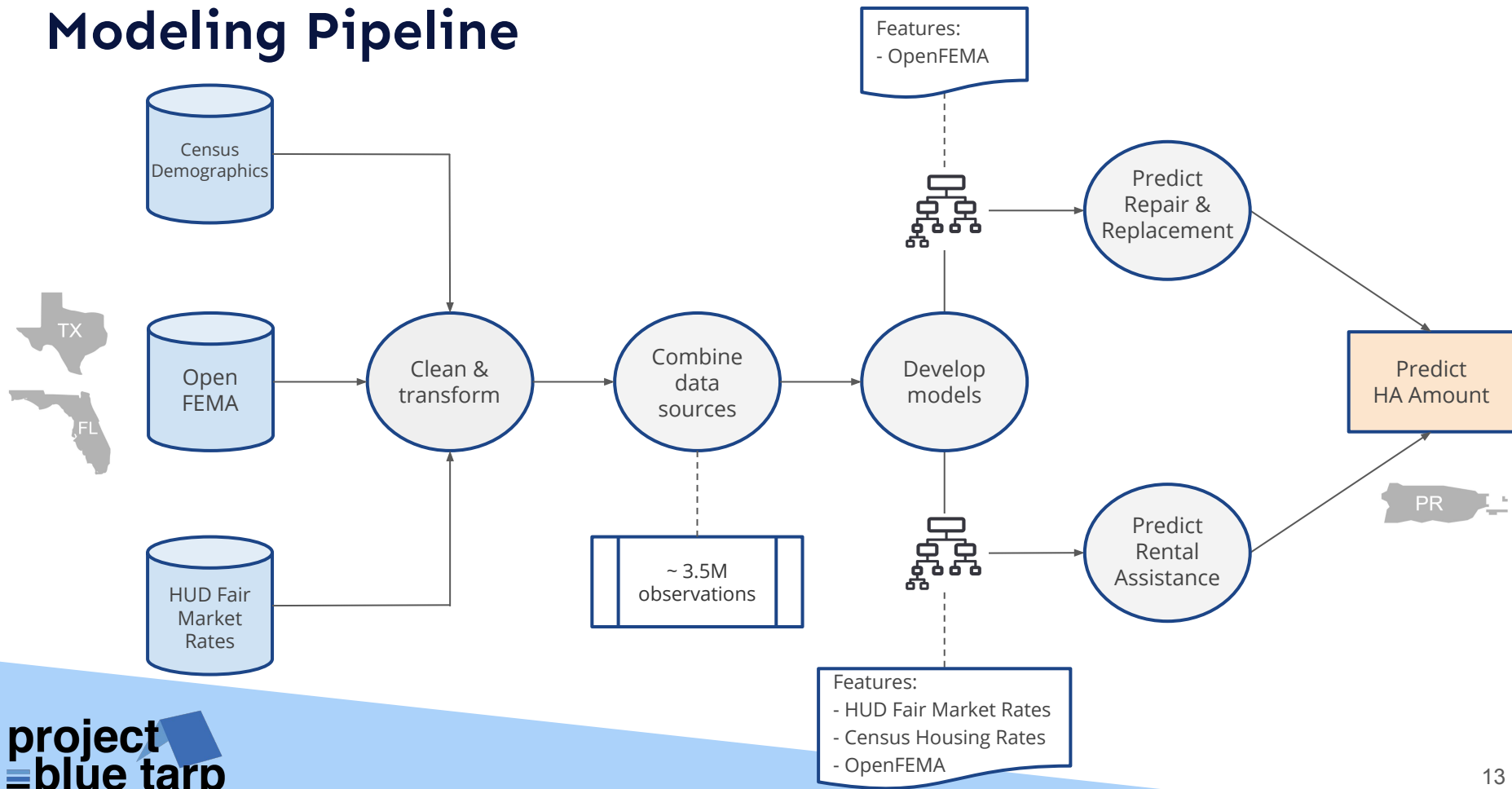
NHC's Hurricane Track Data

- Hurricane path and warning cones in GIS shapefiles from National Hurricane Center's archives
- Key in allowing for visualization of the storms' most highly impacted areas



Approach

Modeling Pipeline

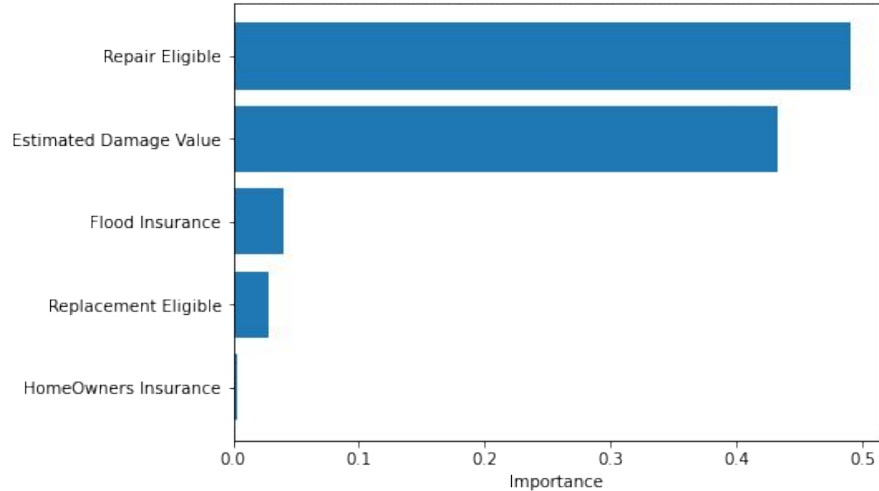


Model Selection

Model	RMSE	MAE	Performance	Interpretability	Regularization	Predictions within bounds
Lasso	1414.0	371.8	✗			
AdaBoost	846.5	171.4	✗			
MultiLayer Perceptron	565.1	79.6	✓	✗		
Gradient Boosting	544.1	75.7	✓	✓	✗	
XGBoost	540.2	72.0	✓	✓	✓	✗
Random Forest	545.9	73.1	✓	✓	✓	✓

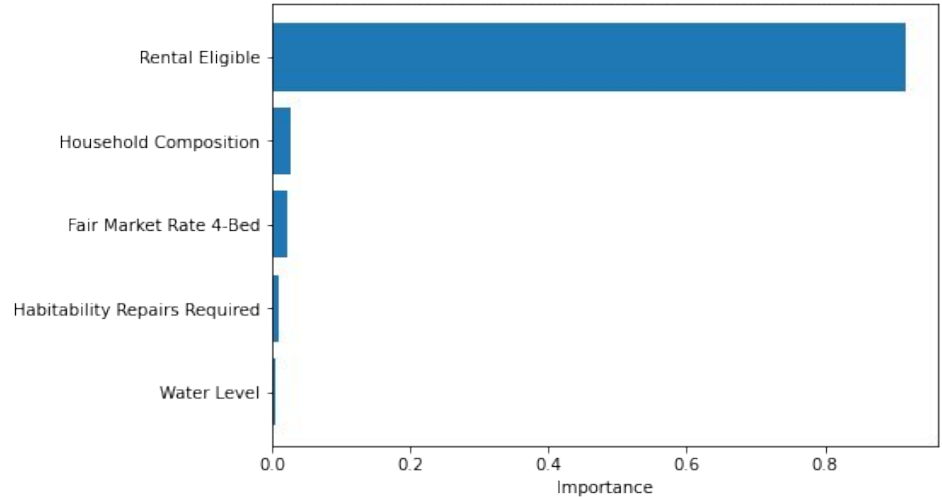
Model Interpretability

Repair-Replace Pipeline: Feature Importance (n-estimators=125)



Training/Dev input shape
(2549828, 33) (2549828,)
(637457, 33) (637457,)

Rental Pipeline: Feature Importance (n-estimators=125)



Training/Dev input shape
(2549828, 23) (2549828,)
(637457, 23) (637457,)

Model Performance

Dataset	Housing Assistance Type	RMSE	MAE	Actual	Predicted
In-Sample (FL/TX)	Repair/Replacement	453.6	29.0	\$217.3M	\$217.0M
	Rental	341.8	30.5	\$89.6M	\$89.2M
Out-of-Sample (NC)	Repair/Replacement	777.29	77.0	\$55.0M	\$62.1M
	Rental	170.53	47.16	\$29.9M	\$31.2M



Hyperparameters

'bootstrap': True,
'max_depth': 9,
'max_samples': 0.8,
'min_samples_leaf': 5,
'n_estimators': 125

Modeling Results

Results - Puerto Rico

Repair/Replacement:

- Actual similar to predicted
- Consistent allocation for damages

Rental Assistance:

- Estimated shortfall of **\$49M**
- Reflects contextual factors limiting access to aid

Repair/Replacement Assistance

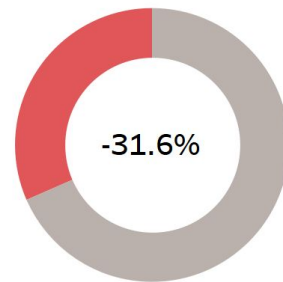
Actual	Predicted
\$529.3M	\$530.2M



■ Actual Amount

Rental Assistance

Actual	Predicted
\$105.9M	\$154.8M



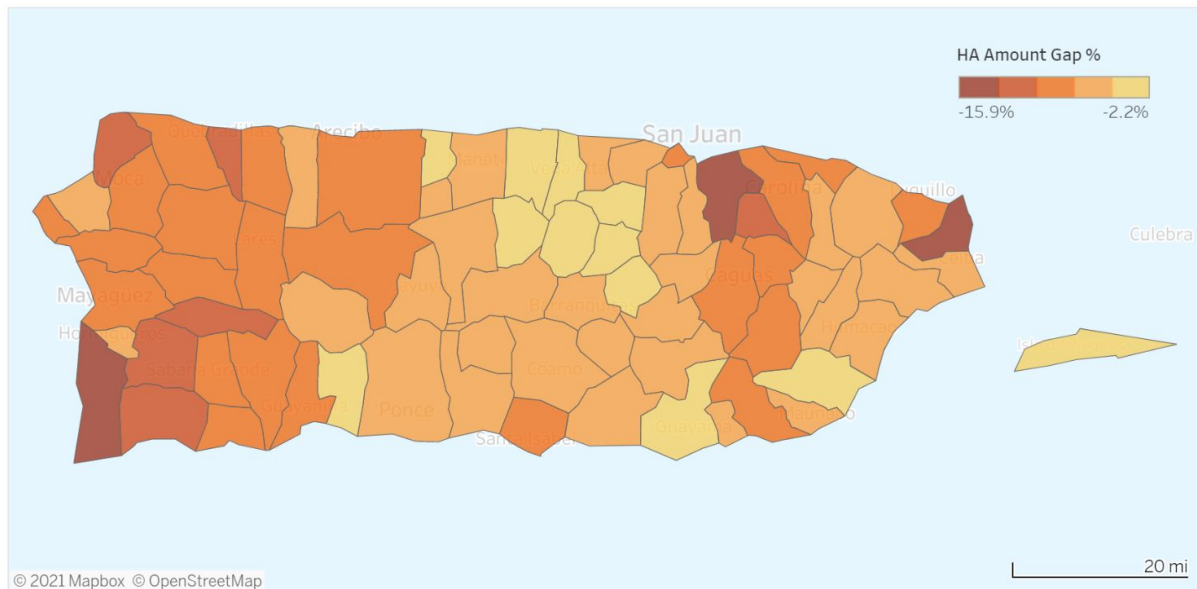
■ Estimated Shortfall

Housing Assistance - Puerto Rico

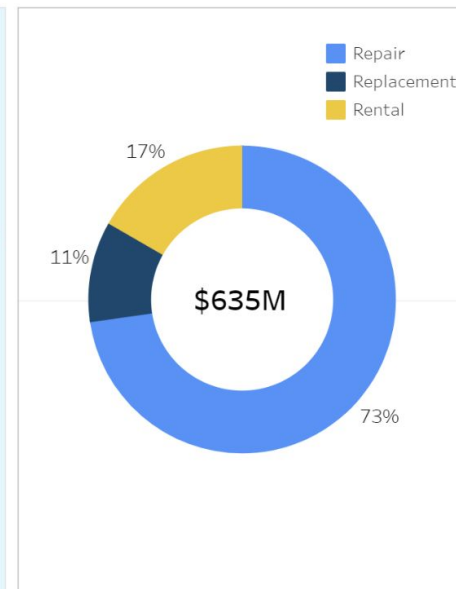
Claims	Inspection Rate	HA Amount	Estimated Gap
1,041,742	68.6%	\$635,216,471	-7.3%

HA Amount - Estimated Gap by County

Gap = Actual less Predicted



HA Amounts Allocated

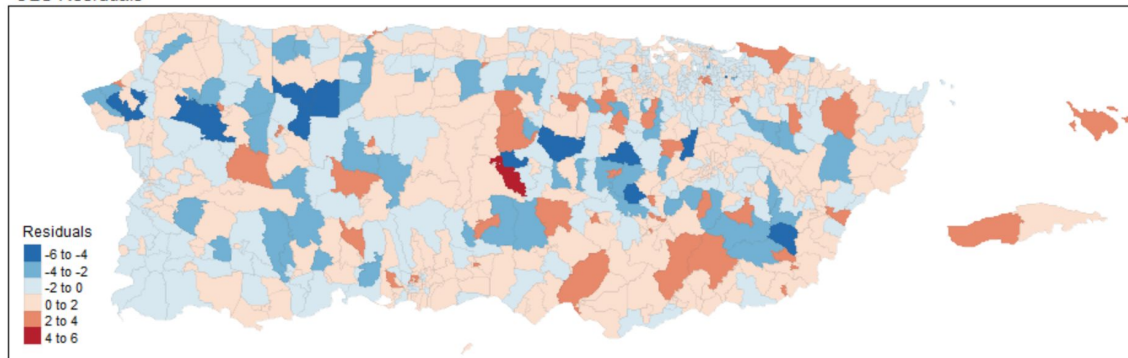




Post Analysis and Findings

Social Vulnerability & Damages

OLS Residuals



Results:

- Below Poverty Rate significant indicator of damages
- Rate of older homes was weakly significant

Table 1: Social Vulnerability and Susceptibility to Damages

	<i>Dependent variable:</i>	
	Damage Amount per Capita (Log)	
	OLS	Spatial Error
	(1)	(2)
Peak Wind Gusts	0.152*** (0.048)	0.121* (0.063)
Water Level (log)	0.830*** (0.114)	0.800*** (0.124)
Below Poverty Rate	1.765*** (0.626)	1.513** (0.640)
Bachelor Degree Rate	0.517 (0.988)	0.738 (0.992)
Unemployed Labor Rate	-1.764 (1.160)	-1.496 (1.238)
Homes built 1979 or Earlier Rate	0.279 (0.269)	0.469* (0.282)
Owner Occupied Rate	0.638 (0.454)	0.527 (0.475)
Constant	3.333*** (0.751)	3.463*** (0.765)
Observations	884	884
Akaike Inf. Crit.	3,159.605	3,126.455

Note:

*p<0.1; **p<0.05; ***p<0.01

Findings & Recommendations



- Puerto Rico did not receive an equitable allocation of housing aid
- Rental Assistance gap due to lack of alternative housing



- Anticipate surplus in Rental Assistance aid
- Reallocate funds to support an expedited recovery process
- Focus on communities with higher poverty rates

Limitations & Future Research

Limitations in scope:



- Focused on aid allocation for inspected applications
- Policy recommendations may not generalize

Future Research:



- Evaluate inspection selection process



Thank you!

Any questions?

Individual Contributions

Dani – Field experts contact and follow-up meetings, feature engineering, outlier search and detection, EDA and Tableau visualizations

Kai – Website development, Tableau dashboards, linear modelling, feature engineering pipeline, search for and identify demographic data, EDA

Ross – Modeling and hyperparameter tuning, post-analysis modeling, creation of Census demographic dataset, EDA on demographics

Sonali – Modeling and hyperparameter tuning, post-analysis modeling, hurricane data analysis, openFEMA EDA