**Post-Disaster Private Construction and Permit Distribution**

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## Introduction

Our group was tasked with understanding the role of the private construction industry in Puerto Rico's post-disaster recovery process. We aimed to build upon preexisting scholarship and the work of the 2023 Studio by updating the construction permits dataset they gathered, analyzing trends in the data, and crafting a narrative describing patterns and challenges faced by construction industry. We analyzed the spatial distribution of construction permits and chronological trends in permit issuance following Hurricanes Irma, Maria, and Fiona, as well seriously damaged. Our findings indicate that despite flaws in the permitting process, uneven permit distribution, and serious challenges to reconstruction, the amount of formal construction occurring in Puerto Rico has been growing.

*Regulatory Context and Construction in Puerto Rico*

The practice of issuing construction permits is intended to ensure that changes to the built environment comply with land use and structural regulations. Land use regulations are one of the key mechanisms that planning entities use to guide and control development and construction. The laws establishing land use patterns in Puerto Rico are called the Reglamento Conjunto. This joint regulation was established in 2010 by the Junta de Planificación the Planning Board of Puerto Rico.

There have been a series of unsuccessful attempts to modify this code. During the development of the 2019-2020 Reglamento Conjunto, the required public involvement actions were modified or conducted improperly, and the Supreme Court of Puerto Rico annulled it (Microjuris). The permit offices have been enforcing an outdated code while keeping track of changes to code with uncertain legal standing. In June of 2023, the government issued an emergency order to implement the 2023 Reglamento Conjunto. The outdated legislation and uncertainty mean that the changes the Planning Board has made intending to increase sustainable development are not being implemented. The Reglamento Conjunto exists alongside special area zoning codes administered by some municipalities.

In addition to ensuring land use compliance, permits ensure that construction projects are structurally sound and meet safety and design standards. The current building code on the island was enacted in 2018 and was developed with input from FEMA so that new construction would be less likely to flood, more resistant to wind in the event of a hurricane and have more structural features that respond to liquefaction in the event of an earthquake.

Construction permitting in Puerto Rico is done by two offices. At the commonwealth level, there is the Oficina de Gerencia de Permisos (OGPe) or the Permit Management Office responsible for permits in municipalities that do not have the means to support their own offices. Then, there are municipal-level offices. These offices work in tandem to review and approve permits submitted through the Single Business Portal (SBP), which handles construction and usage permits. The Single Business Portal is the online portal that OGPe and the municipal offices use to review and approve permits. Usage permits include fire occupancy certifications, electrical permits, or plumbing permits that are an extension of the building code. All construction projects must submit blueprints signed by a licensed architect or engineer. Projects that comply with the Reglamento Conjunto are issued ministerial permits. Projects that do not

align with the existing zoning are classified as discretionary permits. These permit applications are required to undergo an environmental impact assessment and are subject to public input and judicial review. Ministerial permits are often exempted from environmental review and are generally approved quicker. The 2023 studio report concluded that the permitting process in Puerto Rico was

Before the natural disasters, Puerto Rico experienced *la crisis Boricua*, a period marked by labor market deterioration. The number of public-
Puerto Rico fell by about 33 percent [...] between 2006 and 2014, and those employed by local

PROMESA and the creation of the Junta de Supervisión Fiscal financial oversight board added

functions (Mora, 2017). The firms on the island that are involved in the formal construction sector are at a disadvantage, competing with mainland contract
expenditures for both relief and recovery efforts [...] not flowing into Puerto Rico-based

2022).

To understand the role of the private construction industry in Puerto Rico's post-disaster recovery process, we sought to answer key questions. How have permit issuances changed between 2017 and 2023? How are permitted construction projects distributed geographically? What kinds of issues are causing the problems in permitting identified by the 2023 studio? What patterns have people involved in construction and construction permitting noticed following natural disasters? What issues have people in the private sector identified as barriers in reconstruction efforts?

## Methodology

*Quantitative Methods*

I. Data Overview and Preprocessing

Two primary datasets were utilized in the quantitative portion of our research. The first is a construction permit dataset, which contains records of construction permits filed with the Oficina de Gerencia de Permisos (OGPe), or Permitting Office of Puerto Rico, from December 2014 through November 2023. The 2023 Puerto Rico Studio used previous version of the same dataset with data through September 2022. The second dataset, Selected Statistics of the Construction Industry, was compiled by the Junta de Planificación, or Planning Board of Puerto Rico. While this dataset includes many categories of statistics, we focused on the total value of private construction activity in Puerto Rico. According to the Junta de Planificación, this is estimated by summing investments in the construction of housing, commercial and industrial buildings, and privately funded infrastructure. Property insurance is another factor in the valuation (Ruiz et al., 2023). The data is broken down by fiscal semester, ranging from 2012 to 2022.

We took steps to clean both datasets (See Appendix F
Dataset - Data
using the R programming language. The raw OGPe construction permits dataset contained 33,505 rows and 20 variables. First, we translated the dataset from Spanish into English. Next, we removed duplicate rows. A small subset of rows were missing cost (2.95 percent), and we denoted these missing costs with the value 0. Next, Federal Information Processing Standards

cartesian coordinates. Notably, 0.53 percent of rows were missing latitude and longitude

coordinates; thus, we relied on cartesian coordinates when mapping instead, which were provided for every permit. Additionally, we created a duration variable that represents each

permit may belong to, such as residential, construction, or corporate owner. We created 28 categories, each represented by a binary-encoded variable.

The Junta de Planificación dataset was cleaned similarly by formatting the Excel dataset to be workable, removing missing values, renaming variables, and converting columns to numeric data types. We filtered the data to include private construction statistics only.

II. Spatial Mapping of Permits

We used ArcGIS software to map the permits geographically. The data was first preprocessed and filtered using RStudio, as described earlier. We filtered the data to include permits that were filed within a given reconstruction period. We also removed all publicly funded permits. Private, public-private alliance, and public with private contracting permit types were included while mapping. It is important to note that all the permits in the dataset were either approved or pre-approved, so there was no need to filter for approval status. All the permits included in the maps represent real, on-the-ground construction projects.

We analyzed four distinct reconstruction periods. The first spans one year after Hurricane Irma struck. Since Hurricane Maria struck shortly after Hurricane Irma, we included it in the same reconstruction period. The next period spans one year after the 2020 Earthquakes. We chose the day after the most powerful earthquake in the series hit, January 8$^{th}$, as the beginning of this reconstruction period. Next, we analyzed the one-year period following Hurricane Fiona. Finally, we analyzed an overall reconstruction period which spans from Hurricane Irma landfall to November of 2023.

Once the data for each reconstruction period was gathered, the spatial coordinates

function in ArcGIS. It is important to note that while the Census data is formatted according to spatial code EPSG:4269, the permit coordinates are in EPSG:4437 format. TIGER/Line shapefiles provided by the United States Census Bureau were used to gather 2020 census data at the Census Block and Census Tract level. For all maps, populations corresponding to the Census

Within" function. We chose to map permits at the Census Tract level because they are digestible yet granular. Next, the following steps were repeated for each distinct reconstruction period. First, the construction permits were binned into their respectiv

Then, the raw permit counts were normalized by dividing them by each respective Census Tract population. This ratio was multiplied by 100,000 to obtain the permit count per 100 thousand capita for each Census Tract. Finally, the permit counts were divided into equal-

added to capture outliers which included counts greater than a threshold, such as 1,000 permits.

*Qualitative Methods*

We conducted a series of semi-structured interviews with individuals in the public sector and the private sector. In the public sector, we interviewed employees at OGPe, the San Juan Municipal Permitting Office, and the Caguas Municipal Permitting Office. In the private sector, we interviewed engineers with Venegas Construction, employees at the Puerto Rico Builders Association, and a gestor (a person who can be hired by people trying to go through the permit process). These interviews were conducted over the phone, through Zoom, online video conferencing, and in person. Interviews were conducted in English or Spanish, based on the

. The interview questions covered the permitting process, the impacts of the hurricanes, earthquakes, the COVID-19 pandemic, informal construction, changes to the building code and the Reglamento Conjunto, and economic development strategies (See Appendix E: Group 3 Interview Question List).

*Overview of Deliverables*

Our final deliverables included both quantitative and qualitative components. On the quantitative side, raw and clean data and the code used to clean the data were provided. A data dictionary that describes the OGPe dataset and its variables and records of the correspondence with organization staff to obtain the dataset was prepared as well. For mapping, the ArcGIS project itself and a description of the mapping procedure were included. Lastly, the generated figures, tables, and maps were provided.

On the qualitative side, a comprehensive narrative of the permitting process in Puerto Rico, including regulatory context, the permitting process itself, and obstacles to permitting was created. Information gained from interviews with construction companies and organizations was also discussed within this narrative. Copies of our interview questionnaires, fieldwork agenda, and pictures of site visits were also provided in the deliverables.

**Findings**

Overall, our findings seek to understand the role that the private construction industry has played in Puerto Rico's post-disaster recovery process. To answer this, we have relied heavily on both quantitative and qualitative methods, including various interviews. On the quantitative side, the geographic mapping and analysis of construction permit data over time have proved crucial to our research. However, before this process began, we sought to better understand the data by calculating descriptive statistics and visualizations. The results of this preliminary analysis are highlighted below.

**Table 1:** Construction Permits Summary

| Variable | Statistic/Category | Value/Count |
|---|---|---|
| **Approval Time (days)** | Mean | 108.951 |
| | Standard Deviation | 162.307 |
| | Range | 0 - 2480 |
| **Estimated Cost (US$)** | Mean | 275,299.203 |
| | Standard Deviation | 1,689,750.323 |
| | Range | 0.210 - 179,675,453 |
| **Project Type** | Private | 29,423 (90.5%) |

| | | |
|---|---|---|
| | Public | 879 (2.7%) |
| | Public with Private Contracting | 2155 (6.6%) |
| | Public-Private Alliance | 53 (0.2%) |
| **Rural/Urban** | Rural | 14,494 (44.6%) |
| | Urban | 18,016 (55.4%) |
| **Filed by PA (Permitting Assistant)** | Yes | 6,076 (18.7%) |
| | No | 26,434 (81.3%) |
| **Corporate Owner** | Yes | 4,506 (13.9%) |
| | No | 28,004 (86.1%) |
| **Total Rows** | | 33,441 |

Table 1 gives an overview of the construction permits dataset with descriptive statistics such as mean, standard deviation, and range, along with the distributions of different permit types.

Table 1: Construction Permits Summary highlights the mean, standard deviation, and range for continuous variables in the dataset such as approval time and estimated cost. It also includes counts and percentages of the total dataset for categorical variables like project type and corporate owner. Note that the filed by PA variable denotes whether a permit was filed by an authorized permitting assistant or not. Table 1 reveals that the mean approval time for a permit filed in Puerto Rico is roughly 109 days. Also, the standard deviation of estimated cost is extremely high, which means the dataset is representative of construction projects of vastly different scales. Lastly, while the dataset contains a fairly even split of rural and urban permits, most are private.

**Figure 1:** Approval Time Vs. Estimated Cost of Construction Permits by Project Type

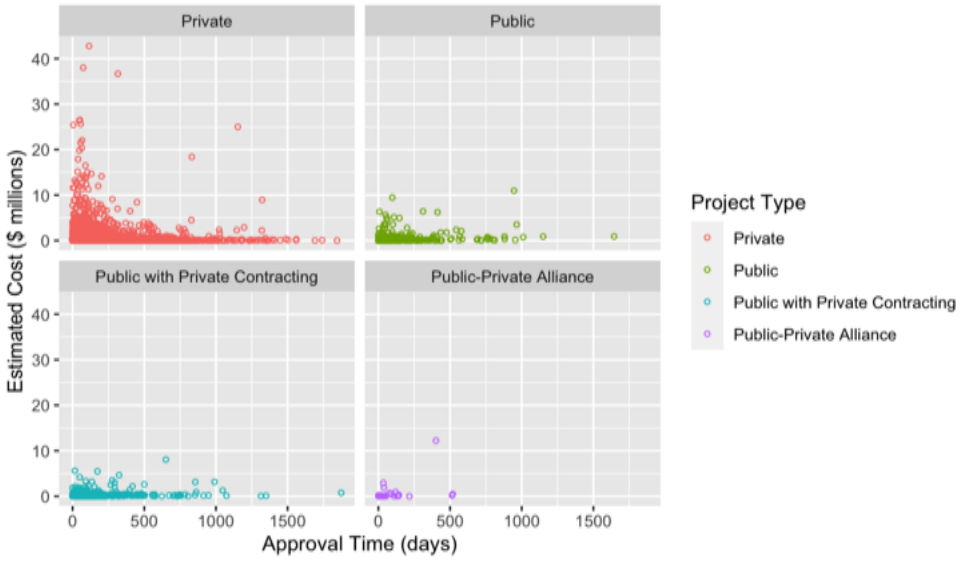



Figure 1 contains four scatterplots for private, public, public with private contracting, and public-private alliance permit types which show the relationship between approval time and estimated cost in US dollars.

**Figure 2:** Approval Time Vs. Estimated Cost of Construction Permits by Rural/Urban Classification

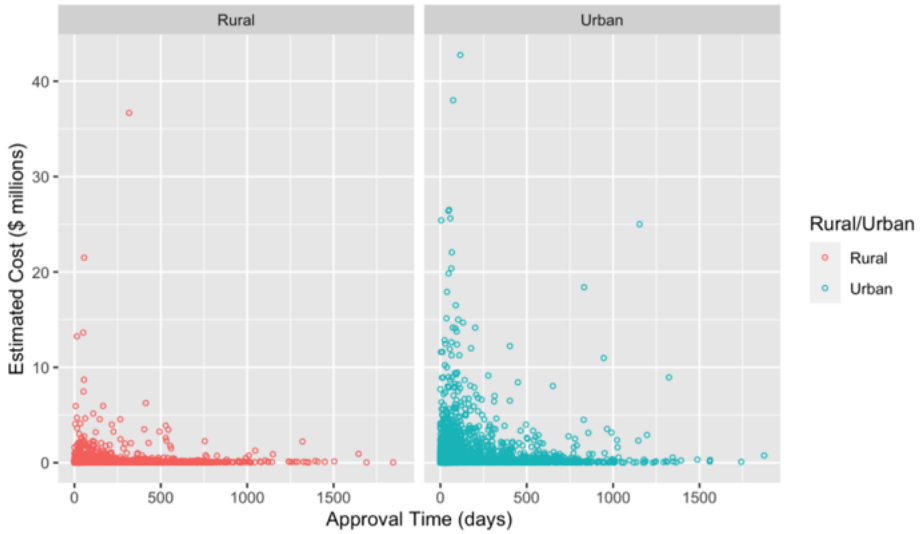
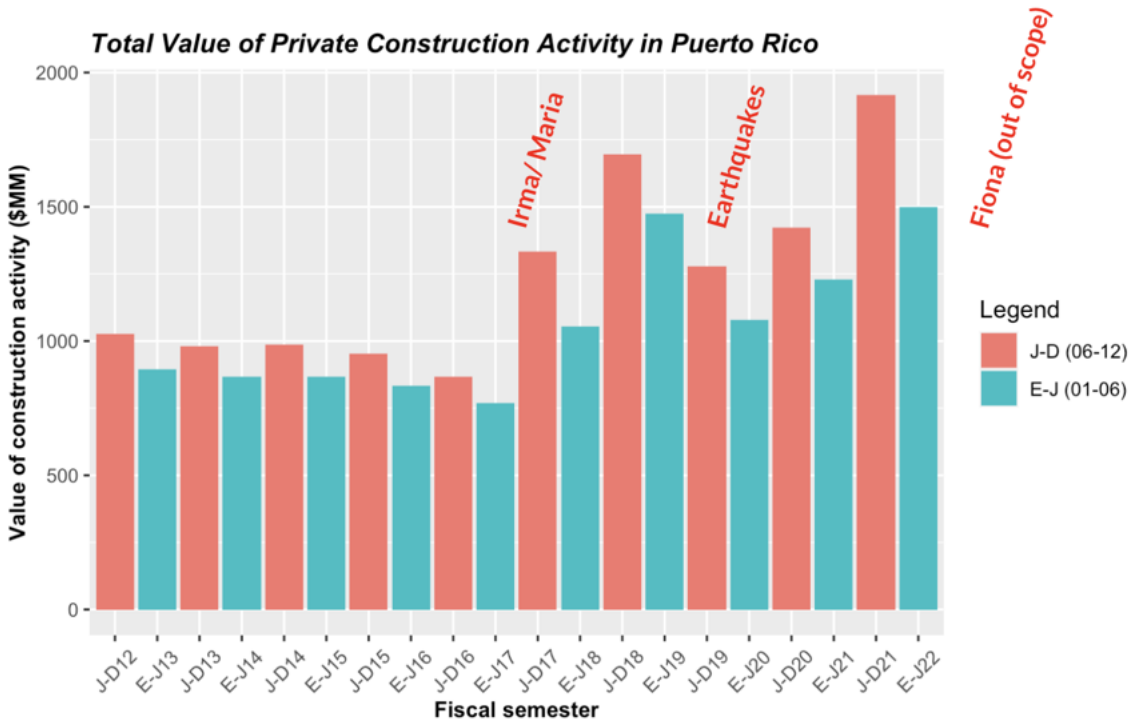



Figure 2 contains two scatterplots for rural and urban permit types which show the relationship between approval time and estimated cost in US dollars.

Figures 1 and 2 (see above) plot the permits based on two variables: approval time and estimated cost. Additionally, the data points are color-coded to represent different categories or types, which differ across the plots. In general, the plots highlight that approval time and estimated cost are inversely related (this is especially true in the rural and private categories). Therefore, the more expensive a construction project is, the quicker its permit will be approved, on average.

To illustrate how private reconstruction trends in Puerto Rico have changed over time, the following figures in this section are organized chronologically from Hurricanes Irma and Maria until the present day.

**Figure 3:** Total Value of Private Construction Activity in Puerto Rico




*Source: Junta de Planificación de Puerto Rico. Chart created using RStudio.*

Figure 3 is a bar chart showing the total value of private construction activity in Puerto Rico broken down by fiscal semester from 2012 to 2022.

Figure 3 (see above) was generated from the Selected Statistics of the Construction Industry dataset provided by the Junta de Planificación (Ruiz et al., 2023). To understand trends and patterns in reconstruction following recent natural disasters, we analyzed construction patterns during the individual time periods following each disaster and comprehensively analyzed them from Hurricane Irma to the present day.

As shown in Figure 3, private construction activity dipped in the six months immediately following recent disasters but rose one year later. We chose to map permits filed at the year mark following each of the natural disasters to reflect real-life reconstruction patterns.

Our qualitative research indicates that construction picked up more at the annual mark than the 6-month mark because of the delayed permitting process. In interviews, OGPe and certain municipal permit offices reported staffing problems and technological issues with the SBP since its introduction in 2018.

individual permit management offices to teach them how to operate the SBP. Our interviews also found that the SBP may not appropriately filter permits to the correct office based on the cadastre or location information. Additionally, information available in the GIS data provided by the planning board can slow down the permitting process if it ever goes down. These issues with the SBP learning curves, technological problems, and the COVID-19 pandemic could explain the dip from 2018 to 2020 in Figure.

In interviews with the private sector, we learned that COVID-19 significantly impacted the construction industry, with restrictions limiting the amount of work they could take on and the health risks to the workforce. There has been a steady increase in construction and permitting since Hurricanes Irma and Maria. There are several contributing factors to this including increased damage and changes in the permitting process.

**Figure 4:** Distribution of Private Construction Permits in Puerto Rico 1-Year Following Hurricanes Irma/Maria by Census Tract

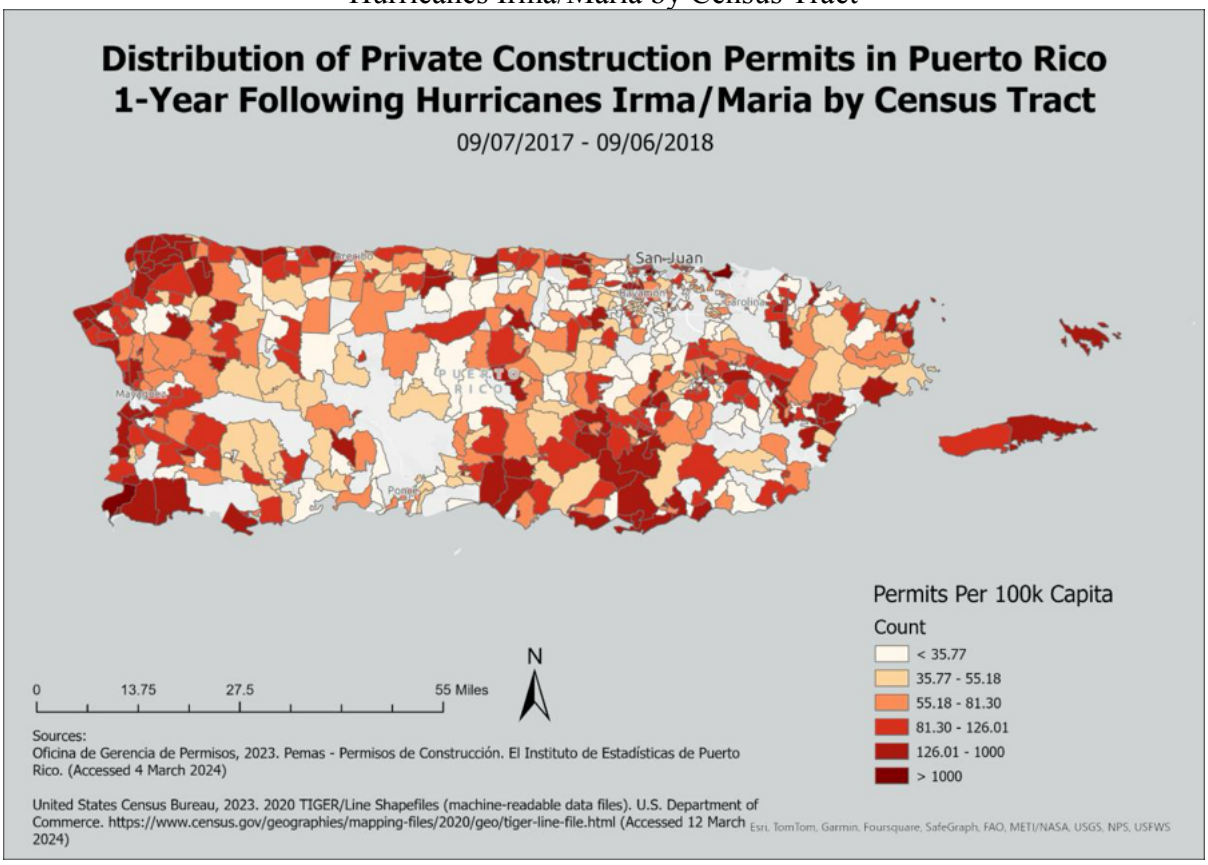



Figure 4 is an aggregate map showing the distribution of private construction permits in Puerto Rico during the one-year period following Hurricanes Irma and Maria, broken down by Census Tract.

Figure 4 (see above) shows the distribution of private construction permits per capita in the one-year interval following Hurricane Irma. Since Hurricane Maria struck only two weeks later, causing even more damage, we combined these two disasters into one reconstruction period in our analysis. The darker areas on the map correspond to denser concentrations of permits. The gray areas indicate places where zero permits were recorded or where data was unavailable. The permit counts are adjusted by population so permit distribution can be compared in a standardized way.

Large cultural acceptance of informal construction was emphasized during several of our interviews. This idea showed up, particularly in our interview with employees from the Caguas Municipal Permitting Office. They said many families in Puerto Rico build new homes as their family grows, leading to many homes on one parcel of land. For this very reason, many households in

Puerto Rico lack official land titles for their property. However, proof of ownership is an integral part of the permitting process. A lack of a title precludes permit issuance, so those without paperwork to prove their land ownership choose to build without the permit instead. As people choose to build informally without a permit, they also inevitably end up without a title or proof of ownership, which leads to a self-perpetuating cycle of informal construction and lack of land titles.

**Figure 5:** Distribution of Private Construction Permits in Puerto Rico 1-Year Following Earthquakes by Census Tract

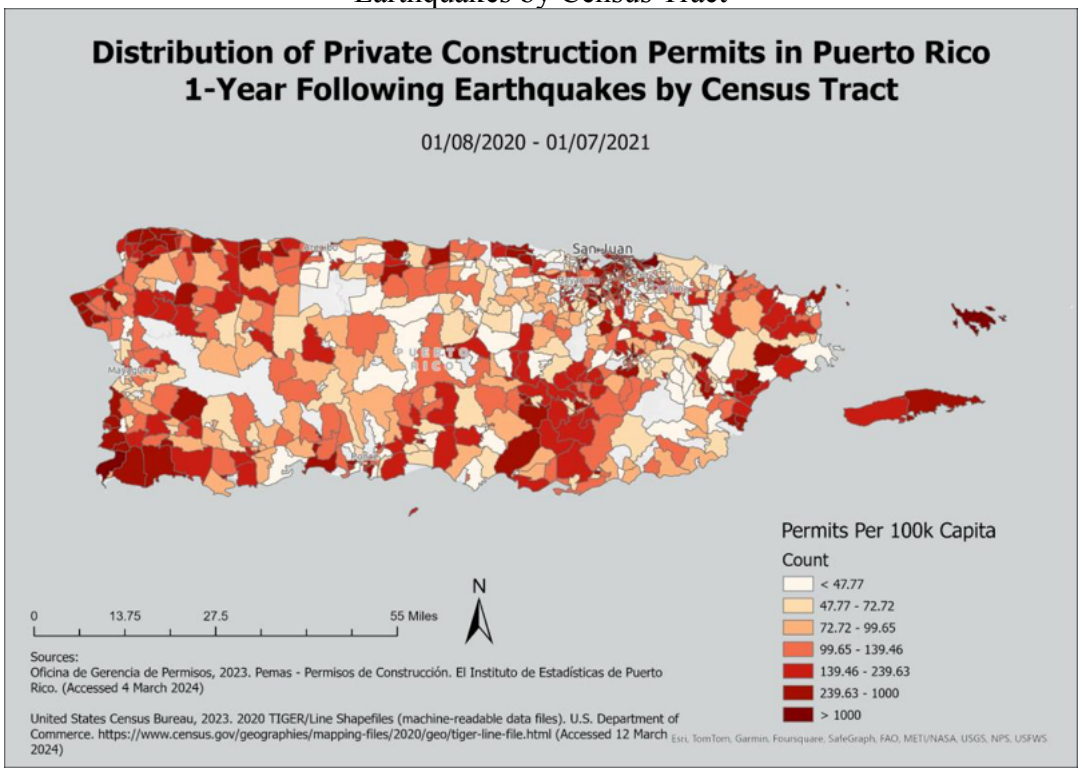



Figure 5 is an aggregate map showing the distribution of private construction permits in Puerto Rico during the one-year period following the 2020 Earthquakes, broken down by Census Tract.

**Figure 6:** Distribution of Private Construction Permits in Puerto Rico 1-Year Following Earthquakes by Census Tract in Ponce

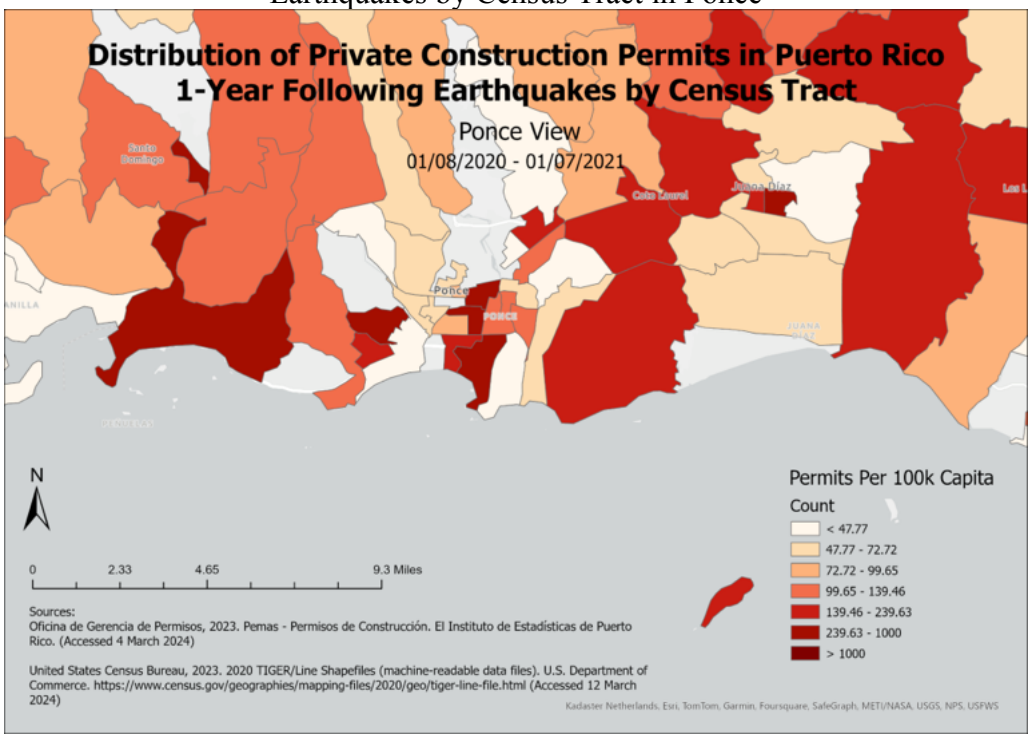



Figure 6 is an aggregate map showing the distribution of private construction permits in the city of Ponce during the one-year period following the 2020 Earthquakes, broken down by Census Tract.

Figures 5 and 6 (see above) highlight permit distribution in the one-year interval following the earthquakes. Since the impact of the earthquakes was fairly concentrated around the city of Ponce, we have provided a municipality-level map as well (see Figure 6). Here, we see fewer areas of the island that lacked any formal construction in the year following the earthquakes than after Hurricanes Irma and Maria. Interviewees from the Caguas Municipal Permitting Office indicated people realized after Hurricanes Irma and Maria that without proper land titles and permits, they would be denied essential FEMA aid. They also mentioned that many homes destroyed by Hurricane Maria were informally constructed, and the challenges

value of building safety codes. Increased population awareness does not change that the permitting process takes a long time. Even in a concentrated region like Ponce, there are still areas without formal construction.

**Figure 7:** Distribution of Private Construction Permits in Puerto Rico 1-Year Following Hurricane Fiona by Census Tract

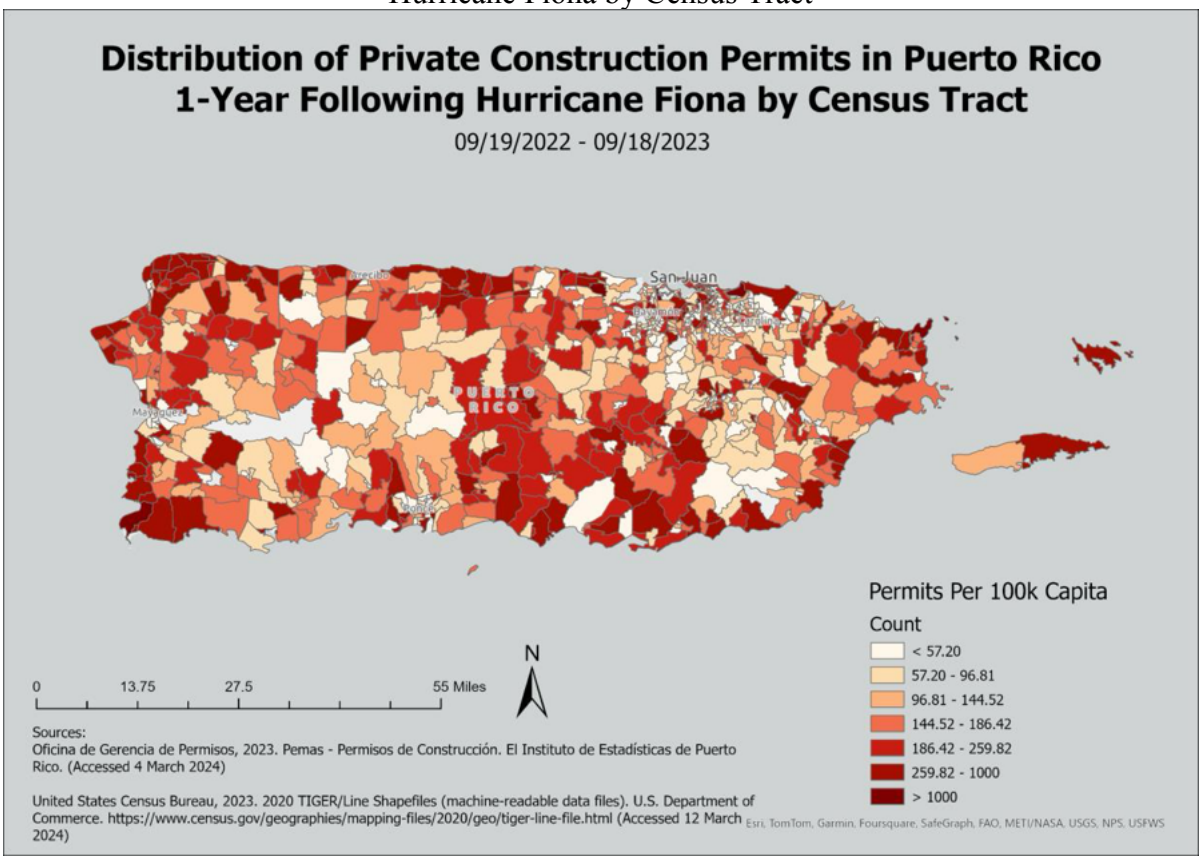



Figure 7 is an aggregate map showing the distribution of private construction permits in Puerto Rico during the one-year period following Hurricane Fiona, broken down by Census Tract.

Figure 7 (see above) shows the distribution of private construction permits one year after Hurricane Fiona's landfall. This map is clearly darker and more populated than the map showing permit distribution after Hurricanes Irma and Maria (see Figure 4) five years earlier. The maps we created show an increase in formal construction over time, consistent with the construction activity shown in Figure 1.

**Figure 8:** Distribution of Private Construction Permits in Puerto Rico Since Hurricanes Irma/Maria by Census Tract

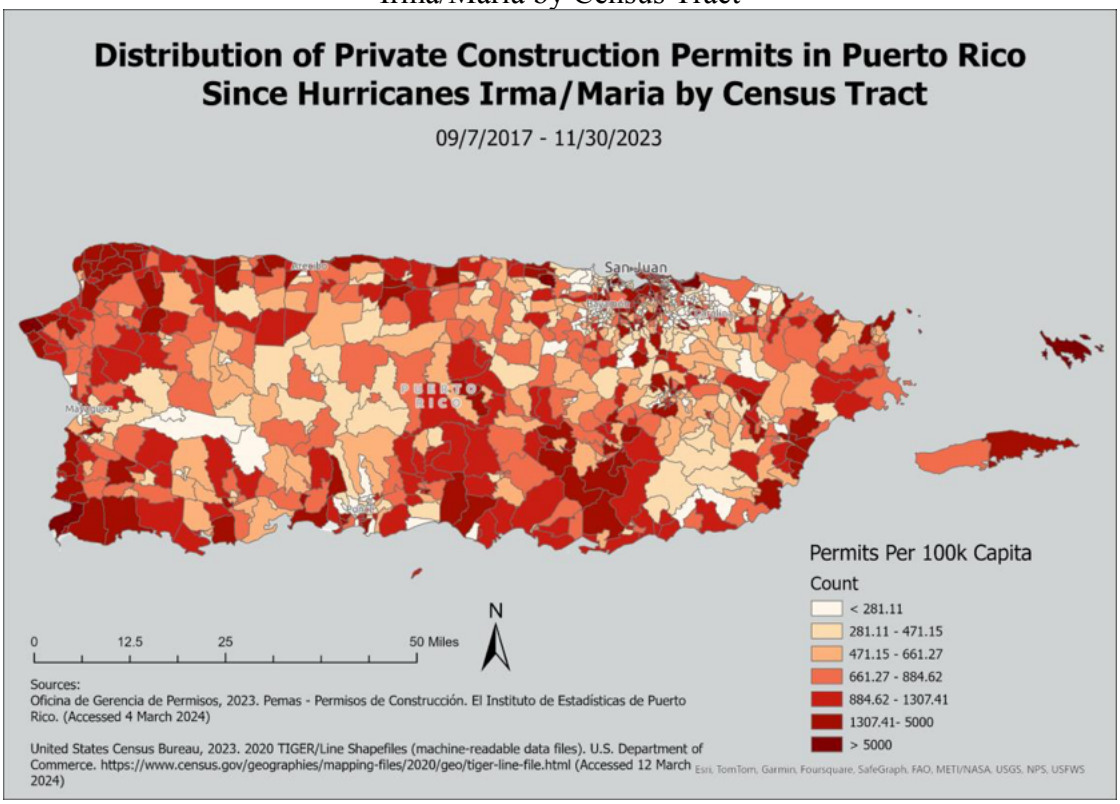



Figure 8 is an aggregate map showing the distribution of private construction permits in Puerto

Census Tract.

Figure 8 (see above) shows the overall distribution of construction permits filed per capita from September 2017 through November 2023. This map indicates that formal construction is distributed unevenly but generally concentrated along the coast. The island's central-southern region has experienced high permit counts relative to other rural or mountainous areas. This area also experienced high levels of housing damage relative to others, as shown by the housing damages maps created by Group 1 and Group 2.

**Figure 9:** Administrative Regions of OGPe


Figure 9 is a photo of a map of the regional, administrative OGPe offices which was taken at the OGPe office in the municipality of San Juan.

Figure 9 (see above) is a map of the regional OGPe offices that reveals an additional explanatory factor as to why there are more permits in the central-southern region. These offices provide permitting assistance, and the darker region described earlier loosely corresponds to the Consorcio CCVS, a group of four municipalities that share a well-organized and autonomous permitting office. The distinction may be due to more accessible, higher quality permitting assistance available in the Consorcio CCVS than in other regions.

**Figure 10:** Distribution of Private Construction Permits in Puerto Rico Since Hurricanes Irma/Maria by Census Tract in San Juan

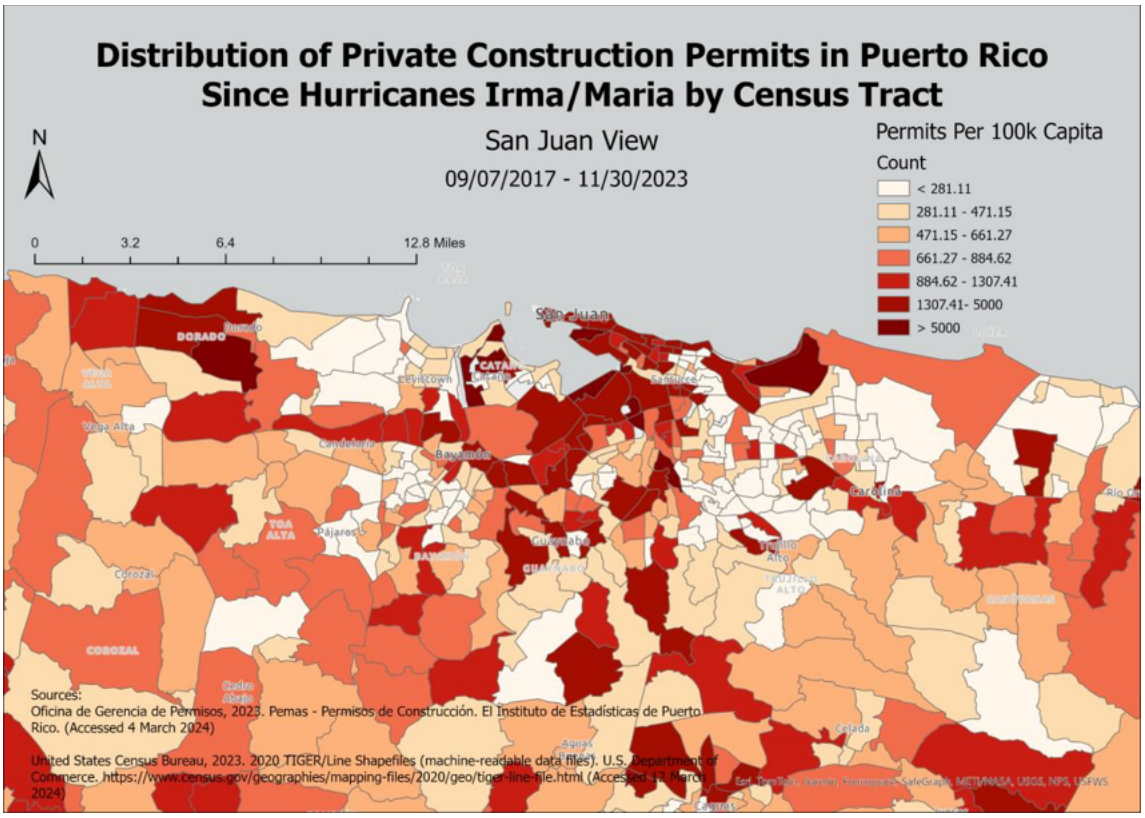



Figure 10 is an aggregate map showing the distribution of private construction permits in San Juan

Census Tract.

Figure 10 (see above) provides a closer look at the overall construction distribution in The lack of gray areas indicates that every census tract in this area has experienced at least some level of recorded permitting and construction since 2017. It also makes it clear that even in the capital city, permit issuance is unevenly distributed.

disproportionately higher amounts of permitting. This trend is mirrored throughout the island.

**Figure 11:** Frequency of Permit Categories

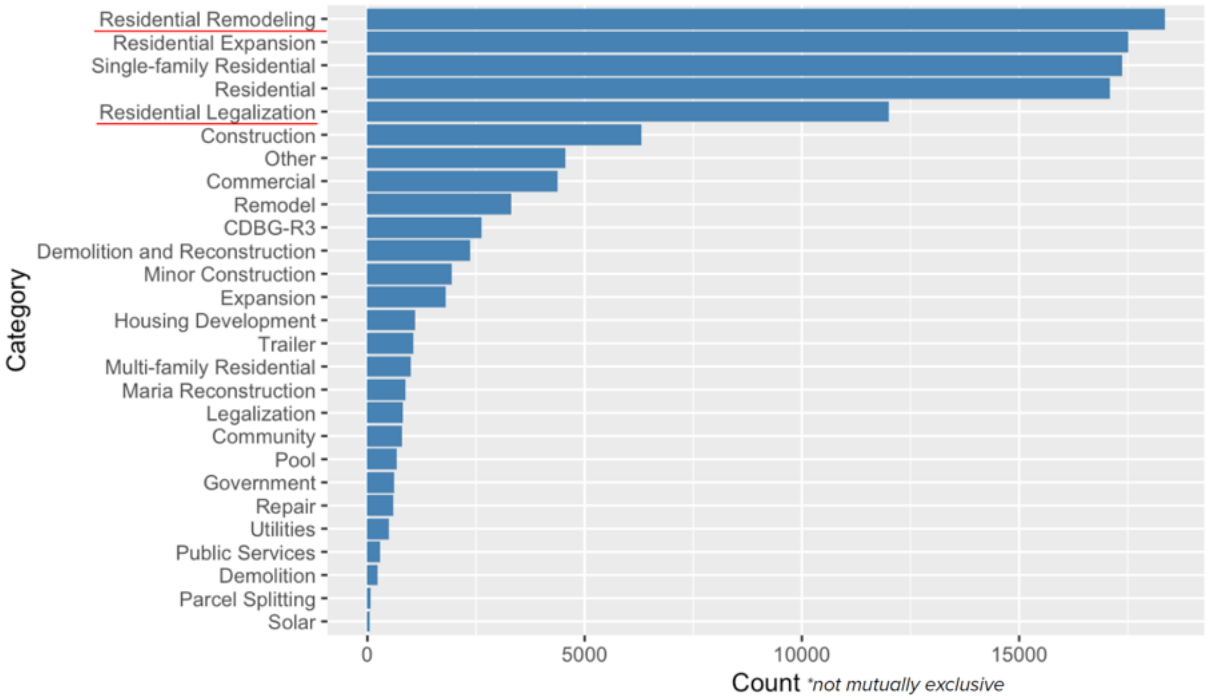



Figure 11 is a bar chart displaying the counts of different categories that permits in the construction permits dataset belong to, ranked in descending order from the top.

Figure 11 (see above) highlights the frequencies of the different permit categories captured in the dataset. Note that permits may belong to more than one category. This chart reveals that residential permits or residential-related permits are the most commonly filed permits. The largest category of permits was residential remodeling projects. This was corroborated by our interviewees in the private sector, who said that.... The other category we have highlighted is residential legalization, which refers to permits filed to help bring informal construction into compliance with the law. Our interviews suggest that this increase in legalization might represent a shift in awareness of the vulnerability that results from unclear property titles and informal construction practices. Our qualitative research also revealed that Puerto Rican companies are disadvantaged in the competition for bids against mainland firms looking to capitalize on Community Block Grant investments. Industry professionals expressed

organizations we spoke with have not seen increased profits as real estate prices rise. The main concern for public and private sector actors is the lack of skilled and unskilled labor. Our Puerto posed H-2B work visas as a potential strategy to bolster the workforce. A professional organization of developers told us that they were working to convince the government to change social security benefits benchmarks to draw people into the labor force.

**Conclusion**

Reconstruction in Puerto Rico is a complex task. There are barriers in the public sector impeding the ability of the employees tasked with enforcing the laws governing construction and preventing them from operating effectively. Attempts to update those laws have been stifled on a constitutional level. There is a serious weakness in the labor force, in both public and private sectors as they compete with the mainland for both skilled and unskilled labor. Puerto Rican-

based firms are at a disadvantage in competition with large mainland companies due to reconstruction financing requirements. High costs, cultural norms, and a lack of clear land titles drive informal construction. Additionally, technological issues within the SBP increase the time it takes to receive a construction permit. Despite this, our findings indicate some growth in formal construction projects between September 2017 and November 2023. The next steps in this research would be to compare our maps with the vulnerability, damage, and public funding distribution maps produced in the other parts of this report. We also hope that the clearer picture we offer of formal construction on the island provides a foundation for additional research into the informal construction that our data does not capture.

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