

# HURRICANE IAN

An in-depth analysis of evacuation rates and methodologies



Spectus' [Social Impact](#) program provides access to privacy-preserving geospatial data for academic research and humanitarian initiatives related to human mobility. Since 2018, our team has developed natural disaster evacuation analyses following events such as hurricanes, wildfires, and earthquakes.

More recently, Spectus has developed interactive maps that provide information on inter-county evacuation patterns during natural disasters, such as [Hurricane Irma](#), which hit the state of Florida in 2017. While these maps serve as a visual heuristic for understanding high-level evacuation behaviors, Spectus also provides access to [differentially-private data](#) at a more granular census-area level. This enables researchers and humanitarian organizations to gain deeper situational awareness into evacuation behaviors, and to model variables such as the effect of [evacuation orders](#), elevation, and [income](#) on evacuation behaviors.

The following analysis provides insight into inter-county evacuation patterns during Hurricane Ian, which made landfall in Southwest Florida as a category 4 hurricane on September 28th, 2022.

**Our analysis indicates that there were high evacuation rates at the census tract level within severely affected areas, such as Fort Myers Beach, and relatively lower inter-county evacuation rates as compared to previous Florida hurricanes, such as Hurricane Irma.**

Finally, in the Discussion section we describe limitations of the analysis and offer important guidelines on interpreting the results.



# Methodology

## Evacuee data

The Evacuation Rates dashboard measures the percentage of residents within a given county who do not spend the night within their primary county of residence on each day of the period of interest. For all users who are considered to be evacuated, the maximum distance traveled from home each day is measured, and the median distance in miles is reported per county.

## Destinations

In order to determine destinations of evacuees, for each pair of the evacuated county and visited county, we report the percentage of evacuees who have migrated to the new county. Every destination is shown on the map, and you'll find the top 5 destinations connected to the evacuated county through arcs.

## Income segmentation

In order to compute the evacuation rate by income group, we calculate the evacuation rate for residents of the bottom 10%, middle 10% – 90%, and top 90% census block groups by income for a given Core Based Statistical Area.

## Tract level insight

While not displayed on the public-facing map for privacy reasons, we also conduct several census tract level analyses on Evacuee Data among the worst-hit census tracts in order to provide a more nuanced view that captures intra-county evacuation behaviors.

## Differential Privacy

Spectus has applied Differential Privacy to the computation of all evacuation metrics to improve the utility of evacuation analyses without sacrificing user privacy. Differential Privacy is the application of statistical noise to processes, in order to obfuscate user-level data points while maintaining the overall utility of the aggregate insights.

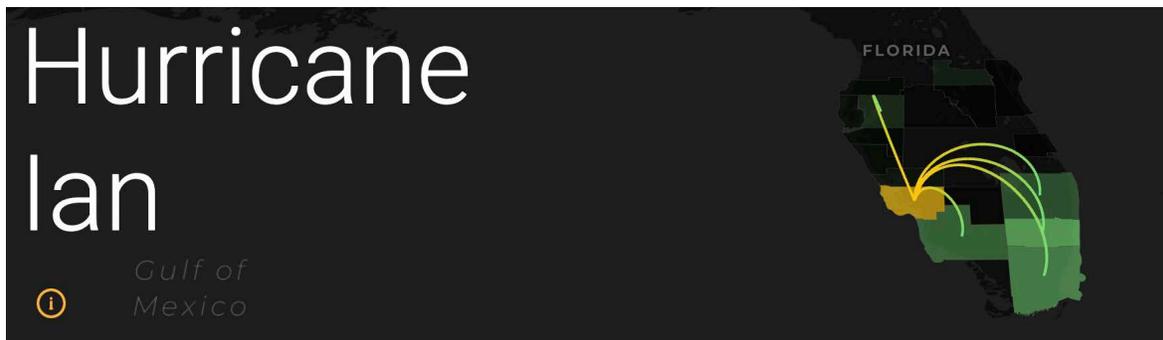
Our datasets are generated using the SmartNoise differential privacy toolkit, which is developed by Microsoft and Harvard University and is part of the OpenDP open-source software project. You can learn more about SmartNoise and OpenDP at the [OpenDP SmartNoise repository](#).



# County Level Analysis

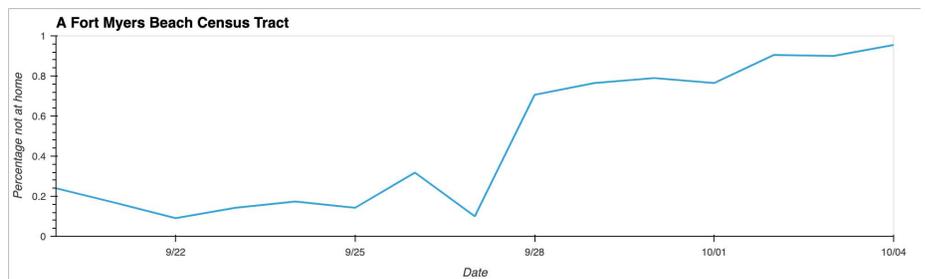
## Lee County

Hurricane Ian made landfall in Lee County as a Category 4 Hurricane on September 28th. Affected communities within Lee County include Cape Coral and Fort Myers. According to our analysis, 11.32% of Lee County residents evacuated to another county on September 28th, and a total of 13.6% of residents evacuated to another county on September 29th. On September 29th, 16% of the highest decile income bracket evacuated to another county, as compared to 10.77% of the lowest decile income bracket. Broward County was the most visited place among the destinations for inter-county evacuees, with 21.49% of evacuees ending up in Broward County.



Evacuation rates in Lee County

As discussed in the Tract Level Analysis (right), certain census tracts within Lee County, such as those in the Fort Myers beach area, experienced total evacuation rates of up to 70% on September 28th, with up to 95% of residents evacuated in the aftermath of Hurricane Ian on October 3rd.

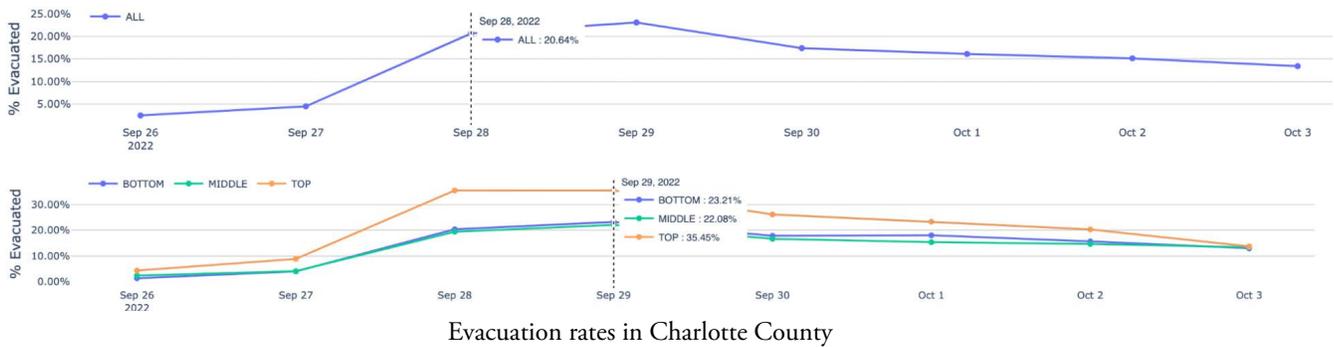


Evacuation rates for a census tract in Fort Myers Beach



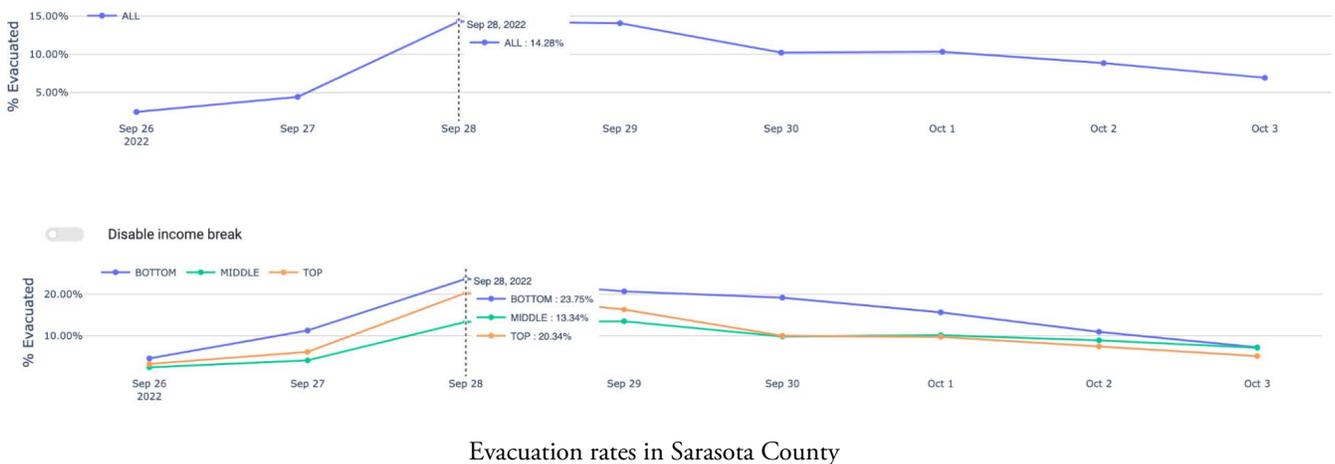
## Charlotte County

Charlotte County directly north of Lee County, and includes the city of Punta Gorda. According to our analysis, 20.64% of Charlotte County residents evacuated to another county on September 28th, and a total of 23.08% of residents evacuated to another county on September 29th. On September 29th, 35.45% of the highest decile income bracket evacuated to another county, as compared to 23.21% of the lowest decile income bracket. Sarasota County was the most visited place among the destinations for inter-county evacuees, with 26.45% of evacuees ending up in Sarasota County.



## Sarasota County

Sarasota County sits directly north of Charlotte County, and includes the city of Sarasota. According to our analysis, 14.28% of Charlotte County residents evacuated to another county on September 28th. On September 28th, 20.34% of the highest decile income bracket evacuated to another county, as compared to 23.75% of the lowest decile income bracket. Manatee County was the most visited place among the destinations for inter-county evacuees, with 24.9% of evacuees ending up in Manatee County.



## Tract Level Analysis

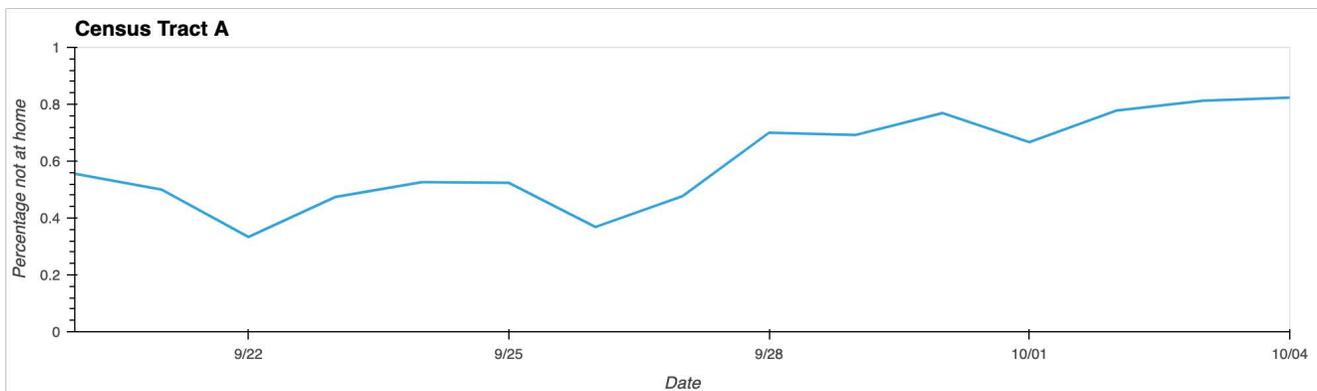
In order to overcome the reporting limitations inherent in an inter-county only analysis, we calculated evacuation rates among census tracts within one of communities most severely affected by Hurricane Ian—Fort Myers Beach.

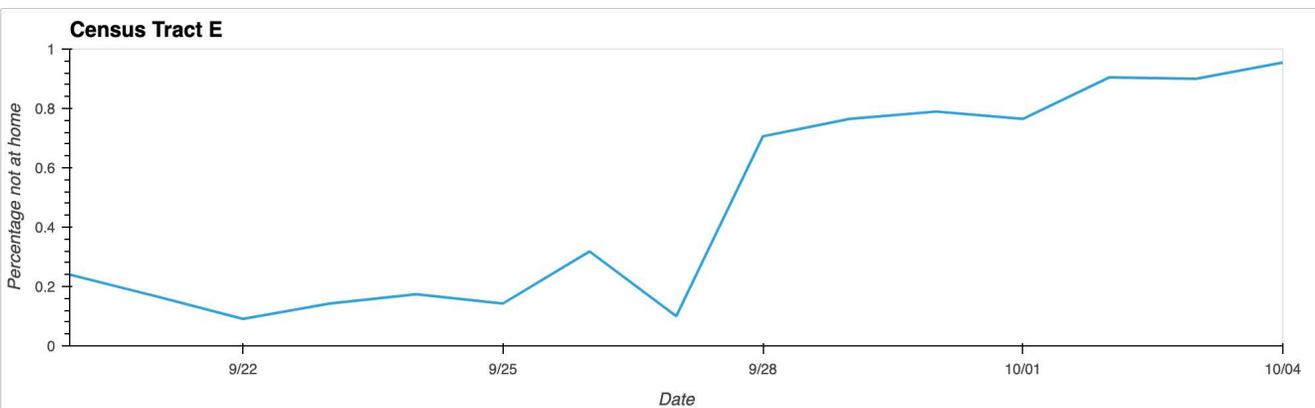
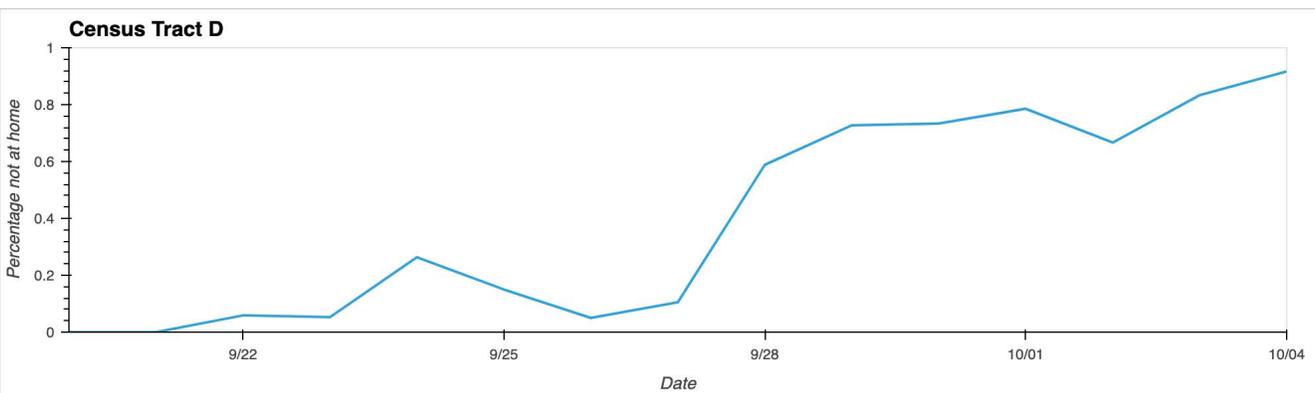
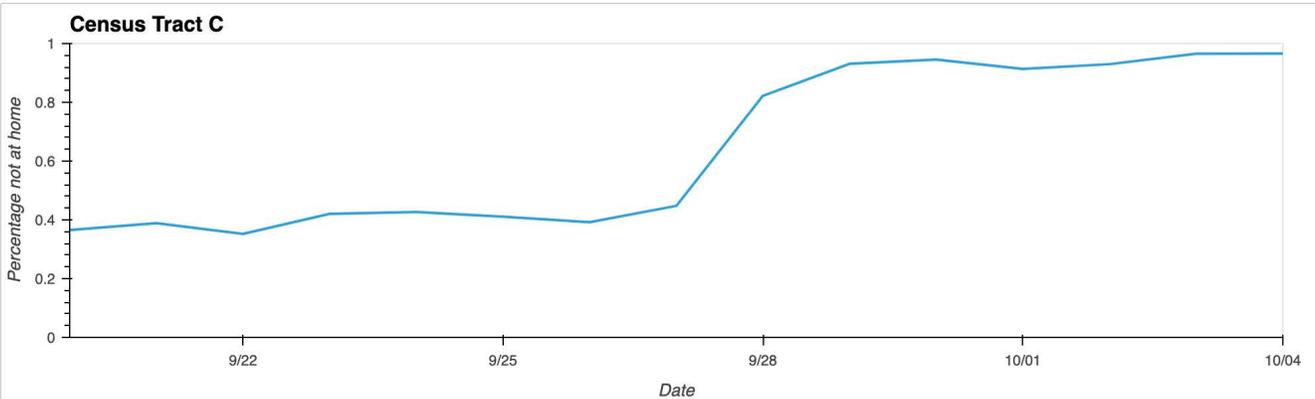
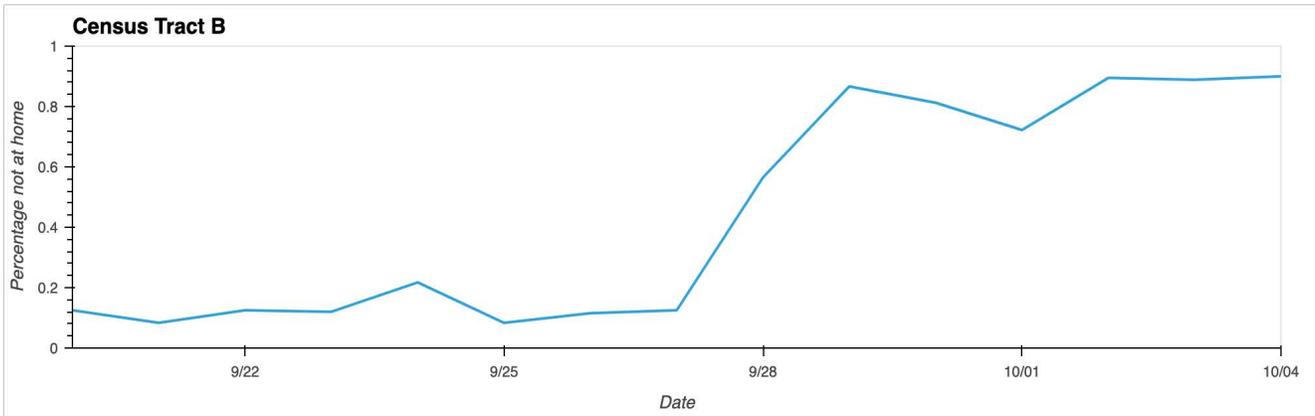


Satellite imagery of Fort Myers Beach, before and after Hurricane Ian. Source: New York Times

Across five census tracts (below) within Fort Myers beach, we observe evacuation rates on September 28th ranging from 56% to 70%.

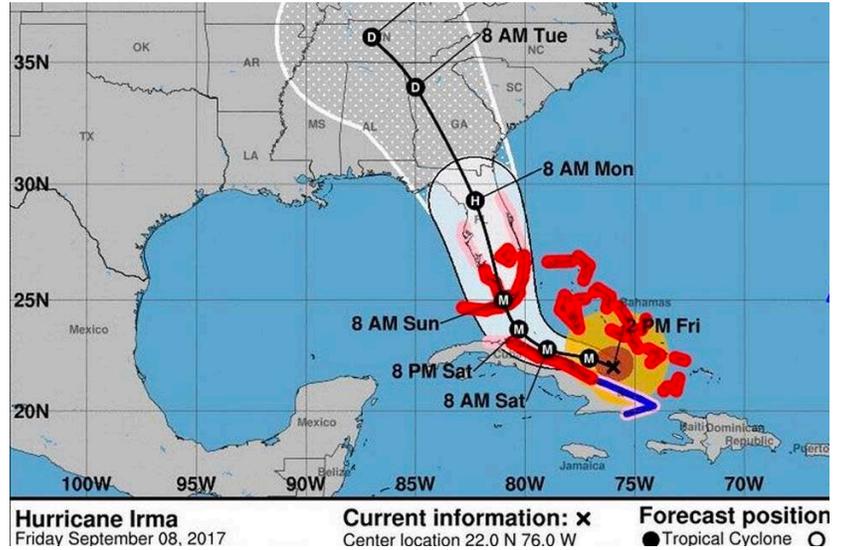
In the following days, evacuation rates increased, potentially due to homes—and the general area—becoming uninhabitable. By October 3rd, we observe evacuation rates ranging from 80% all the way up to 95%.





# Discussion

Hurricane Ian was the deadliest Hurricane to hit the Florida Coast in the 21st century. However, we observe lower inter-county evacuation rates during Hurricane Ian as compared to Hurricane Irma, which hit Southwestern Florida as a Category 4 hurricane in 2017.



Hurricane Irma Cone of Uncertainty. Source: NOAA

In several cases, inter-county evacuation rates during Hurricane Irma were more than double the evacuation rates during Hurricane Ian. For example, Lee county had a 30.7% maximum inter-county evacuation rate during Hurricane Irma, compared to a 13.6% maximum evacuation rate during Hurricane Ian. Similarly, Charlotte county had a maximum evacuation rate of 41.85% during Hurricane Irma, compared to a maximum evacuation rate of 23.08% during Hurricane Ian.



Hurricane Ian Cone of Uncertainty. Source: NOAA

The stark difference in inter-county evacuation rates may be due to the delay in mandatory evacuation orders issues during Hurricane Ian. Additionally, the Cone of Uncertainty for Hurricane Irma covered nearly the entire state of Florida, vs Hurricane Ian's Cone of Uncertainty which was positioned farther west, indicating in early forecasts a likely landfall of Mid to Northwest Florida.

Finally, during extreme weather events, residents of coastal and low-elevation communities may evacuate to homes, shelters, or hotels that are both inland and of a higher elevation. Often, these places may be located within the same county as an evacuee's primary county of residence. While inter-county evacuation analyses help provide a high-level picture of comparative evacuation behavior, it is recommended that researchers and humanitarian organizations rely on more granular evacuation analyses at the census tract or block group level.

**For more information on how to access pro-bono, differentially private evacuation datasets from Spectus, please contact us at [socialimpact@spectus.ai](mailto:socialimpact@spectus.ai).**



Data. In sight.

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