

# How UFTI Used Location Analytics to Enhance Natural Disaster Emergency Response Planning and Management

# Overview: Examining Wildfire Evacuation Data to Help Vulnerable Communities Reduce Risk and Enhance Safety

## THE CLIENT

The University of Florida is a public research university based in Gainesville, FL. As of September 2021, UF is ranked #5 among public universities in the latest U.S. News & World Report Best Colleges rankings. It is the state's oldest, largest, and most comprehensive university and among the nation's most academically diverse public universities. One of its academic divisions, the University of Florida Transportation Institute (UFTI) brings together faculty, staff, and students from many diverse backgrounds to provide solutions to a variety of transportation problems. UFTI is located within the Herbert Wertheim College of Engineering, which houses one of the largest and most dynamic engineering programs in the nation and produces leaders and problem-solvers who take a multidisciplinary approach to innovative and human-centered solutions.

## THE PROBLEM

Researchers from UFTI recognized that wildfires have become a growing threat to communities across the globe, especially in recent years as the frequency and intensity of wildfires have increased due to climate change. In addition, researchers noted that urban and suburban growth has led to the expansion of the wildland-urban interface (WUI), areas where houses and other development

intermingle with the undeveloped natural environment. This has resulted in an increase in the number of communities vulnerable to wildfire risks due to their proximity to flammable vegetation.

To reduce wildfire risks and strengthen the resilience of WUI communities, researchers from UFTI sought to enhance the understanding of wildfire evacuation behaviors by studying the movements of local residents during the 2019 Kincade Fire in Sonoma County, CA. Researchers hoped the study's findings could help emergency managers develop appropriate response measures and make effective decisions during a wildfire event while enhancing emergency planning strategies to prepare WUI households for wildfires in the future.

Although there had been previous research studies on wildfire evacuation behaviors, these studies typically relied on data collection methods such as surveys, interviews, and focus groups, which have various limitations:



### **Small sample sizes.**

Past studies were conducted utilizing relatively small sample sizes, so researchers were only able to collect and analyze a limited amount of data. Because of this, the results of these studies may have been more easily impacted by bias and outliers.



### **Narrow timeframe.**

In previous studies, researchers were primarily focused on examining evacuation behaviors that took place in the span of a few hours.

Because a household's evacuation decisions could take place over the span of several days, the results of past studies may have been limited by analyzing data from short timeframes.



### **Self-report bias.**

Since past studies utilized self-report research methods to gather data, such as surveys and interviews, the data analyzed in these studies could have been affected by self-report bias. For example, it may have been difficult or nearly impossible for some study participants to remember the actions they took when evacuating a fire, especially if they were asked to provide their exact location at specific times during the evacuation.





**“To better understand human behavior during wildfire events, we wanted to implement a different data collection method than those used in past studies. We hypothesized that mobility data would provide us with new insights into human movement during a catastrophic event, which could help facilitate emergency planning and management.”**

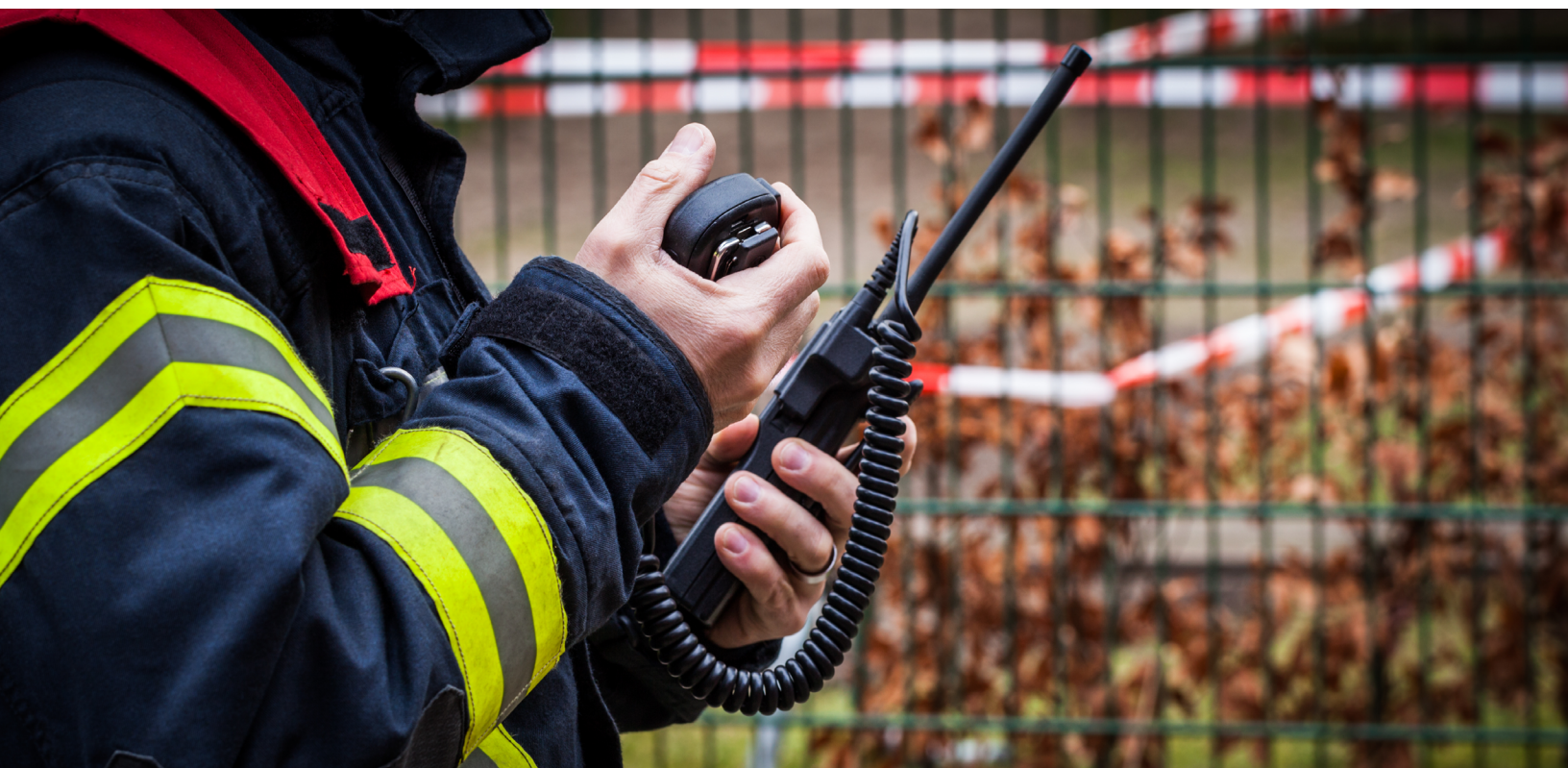
**Xilei Zhao, Ph.D., Assistant Professor  
Department of Civil and Coastal Engineering, University of Florida**

## THE SOLUTION

To gain insight into the evacuation behaviors of those impacted by the 2019 Kincade Fire, UFTI researchers worked with Gravy Analytics to secure trusted human mobility data for their study.

Gravy Analytics provided UFTI researchers with its Observations Data-as-a-Service (DaaS) product for mobile devices seen in the evacuation zone and surrounding area of the wildfire. Researchers selected Gravy's data for its quality, precision, and additional Forensic Flags which enabled them to filter and use only the data they needed for this particular analysis.

With Gravy Observations data, UFTI researchers were able to isolate the human mobility data in which they were most interested and then determine and apply their own modeling parameters. This data fueled their analysis to gain insight into the movement of local residents before, during, and after the fire in order to better understand evacuation behaviors.



By analyzing a global, mobile location-based data set, researchers were able to categorize residents as either non-evacuees or evacuees. For those who were identified as evacuees, researchers further classified them into four different groups:



**Self-Evacuee:** Located in or near the evacuation zone and left after the fire started but before any evacuation warning/order was issued



**Shadow Evacuee:** Located outside but near the evacuation zone and left after an evacuation warning/order was issued



**Evacuee Under Warning:** Located in the evacuation warning zone and evacuated after the warning was issued and before an order was issued (if any)



**Ordered Evacuee:** Located in the evacuation order zone and evacuated after the order was issued

## AT A GLANCE, THE STUDY REVEALED:



Among all residents inside of the evacuation warning/order zones who were categorized as either a non-evacuee or an evacuee, **46%** of residents evacuated and **54%** did not evacuate during the 2019 Kincade Fire.



Out of the four groups, **Self-Evacuees** and **Shadow Evacuees** accounted for more than half of the evacuees (55%). UFTI inferred that residents in these two groups may have proactively evacuated due to prior experiences with wildfires.



Classified as Evacuees Under Warning, **7%** of evacuees left home as soon as they received an evacuation warning. Among Ordered Evacuees, **38%** of evacuees left home once they received mandatory evacuation orders.

UFTI's complete research study can be found here:

<https://arxiv.org/pdf/2109.07745.pdf>

*Note: The research findings are preliminary and have not gone through the peer-review process.*

## THE RESULTS

The resulting data and analysis helped UFTI researchers to:



### **Better understand wildfire evacuation behaviors.**

By examining the movements of local residents before, during, and after the 2019 Kincade Fire, researchers gained a deeper understanding of how people behave during wildfire evacuations.



### **Support more effective emergency management.**

Emergency managers can use the results and insights of UFTI's study to develop and improve their response measures during wildfires as well as other natural hazards (e.g., executing traffic management strategies, issuing evacuation orders, providing support for travelers in need, undertaking rescues, etc.). The study can also help enable decision-makers to customize emergency management processes based on time of year, day of week, or even time of day based on understanding the regular behaviors of local populations at those times.





### **Help vulnerable communities prepare and mitigate risks.**

The findings of the study can be used by emergency managers and planners in the development of targeted public outreach campaigns, training protocols, and emergency communication strategies to prepare WUI households for future wildfires. With enhanced strategies, at-risk communities may be able to reduce the impact of a natural hazard.



## IMPROVED DISASTER RESPONSE RESEARCH WITH GRAVY ANALYTICS' SERVICES

With Gravy Analytics, UFTI researchers were able to gain deeper insight into human behaviors during wildfires, which can help emergency managers develop and enhance disaster preparedness and emergency response strategies. By using Gravy Observations data, UFTI researchers improved their understanding of evacuation behaviors by complementing the existing studies that used surveys, interviews, and focus groups.



**“Through the use of location intelligence, we were able to develop a new methodology to analyze human behavior during wildfires and gain insight into residents’ evacuation decisions. The results of our study can help to advance the research of modeling and analyzing evacuation behaviors during natural hazards.”**

**Xilei Zhao, Ph.D., Assistant Professor  
Department of Civil and Coastal Engineering, University of Florida**

## ABOUT THE UNIVERSITY OF FLORIDA TRANSPORTATION INSTITUTE

The University of Florida Transportation Institute (UFTI) located in the Herbert Wertheim College of Engineering aims to advance state-of-the-art transportation, disseminate research results, and provide educational opportunities related to transportation. UFTI brings together faculty, staff, and students from many diverse backgrounds to provide solutions to a variety of transportation problems. Faculty affiliates conduct innovative and transdisciplinary research across several research areas: Artificial Intelligence and Big Data; Autonomous and Connected Vehicles; Human Factors; Materials and Infrastructure; Resilience and Sustainability; Safety, Transit, and Micromobility; and Transportation Equity. The Institute is an umbrella organization housing several transportation-related centers within the University of Florida. It houses McTrans, which distributes and supports traffic engineering and transportation planning applications, and the Florida Transportation Technology Transfer Center, which provides training and technical assistance to professionals around the country and internationally to transportation, public works, and safety professionals as well as the general public. UFTI is home to the Southeastern Transportation Research, Innovation, Development, and Education (STRIDE) Center, one of ten Regional University Transportation Centers (UTCs) funded by the U.S. Department of Transportation (USDOT). One of UFTI's signature initiatives known as I-STREET (Implementing Solutions from Transportation Research and Evaluating Emerging Technologies) is a living lab on the UF campus and surrounding roadway network where advanced technologies such as autonomous vehicles, smart devices, and sensors are tested and deployed to enhance mobility and safety. For more information on UFTI, visit [www.transportation.institute.ufl.edu](http://www.transportation.institute.ufl.edu).

## ABOUT THE STUDY

The research project is an international collaboration led by Xilei Zhao, Ph.D., from the University of Florida. Additional researchers include Yiming Xu, M.S., Alex Wu, B.S., and Xiang Yan, Ph.D., from the University of Florida; Ruggiero Lovreglio, Ph.D., from Massey University; Erica Kuligowski, Ph.D., from RMIT University; Daniel Nilsson, Ph.D., from the University of Canterbury; and Thomas Cova, Ph.D., from the University of Utah. The project was funded by the National Institute of Science and Technology (NIST).

## ABOUT GRAVY ANALYTICS AND LOCATION DATA

Where people go and why tells the story of our world. Founded in 2011, Gravy Analytics is the enterprise location technology company providing actionable intelligence to businesses. Using its patented technology, the company brings data about people, places, and events together to understand human mobility, helping companies enhance their sales and marketing strategies and optimize business operations. Today, the company's intelligence powers leading-edge solutions for a wide range of industries—from advertising to market research, financial services to supply chain risk management—that rely on knowing how people, products, and materials move throughout the world. For more information, please visit [unacast.com](https://unacast.com).

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