



Think Evolve Consultancy
Building for the Next Billion Users

Impact of Natural Disaster on the Economy



WHITEPAPER

Introduction



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Hurricanes, tornadoes, earthquakes, floods, avalanches, and wildfires are all examples of catastrophes that have occurred for millennia and impacted mankind in every region of the world. Natural disasters are defined by the International Journal of Disaster Risk and Reduction External as "...catastrophic events with atmospheric, geological, or hydrological origins (e.g., droughts, earthquakes, floods, hurricanes, and landslides) that can result in fatalities, property damage, and social and environmental disruption."

Historical Perspective

Possibly the most famous earthquake in United States history occurred in 1906 in San Francisco. It happened on April 18 and was estimated to be 7.9 in magnitude (estimated because the Richter Scale, which is used to measure the magnitude of earthquakes, was not invented until 1935 by Charles F. Richter) (Nathan, 2020). Though it lasted less than a minute, the resulting devastation was immense, and the death toll was estimated to be as high as 3,000.

The earthquake and ensuing fire triggered by broken gas mains destroyed almost 80% of the city during a four-day period.

The earthquake, one of several that have occurred in this region, was caused by tectonic activity along the San Andreas Fault, which separates the Pacific and North American plates.

A storm made landfall near Galveston, Texas, in 1900. Not only was it the deadliest storm in United States history, but it was also the deadliest natural calamity! This hurricane made landfall on September 8 and was believed to be a category 4 storm with a storm surge of more than 15 feet, wreaking havoc on the city. There has been debate over the total number of casualties, although the most frequently quoted figure is 8,000, which is a sizable proportion of the roughly 38,000 total population at the time (Nathan, 2020).

Australia's 2019-2020 bushfire season was the deadliest on record, with 46 million acres scorched by hundreds of flames that claimed dozens of lives.

The fires' impact on air quality was proven when the Air Quality Index classified various portions of the country, including areas around Sydney, as dangerous. The flames also took a toll on wildlife populations. Over a billion creatures are thought to have perished in the fires, including some endangered species (Smriti, 2021).

Impact of Natural Disasters on the Economy



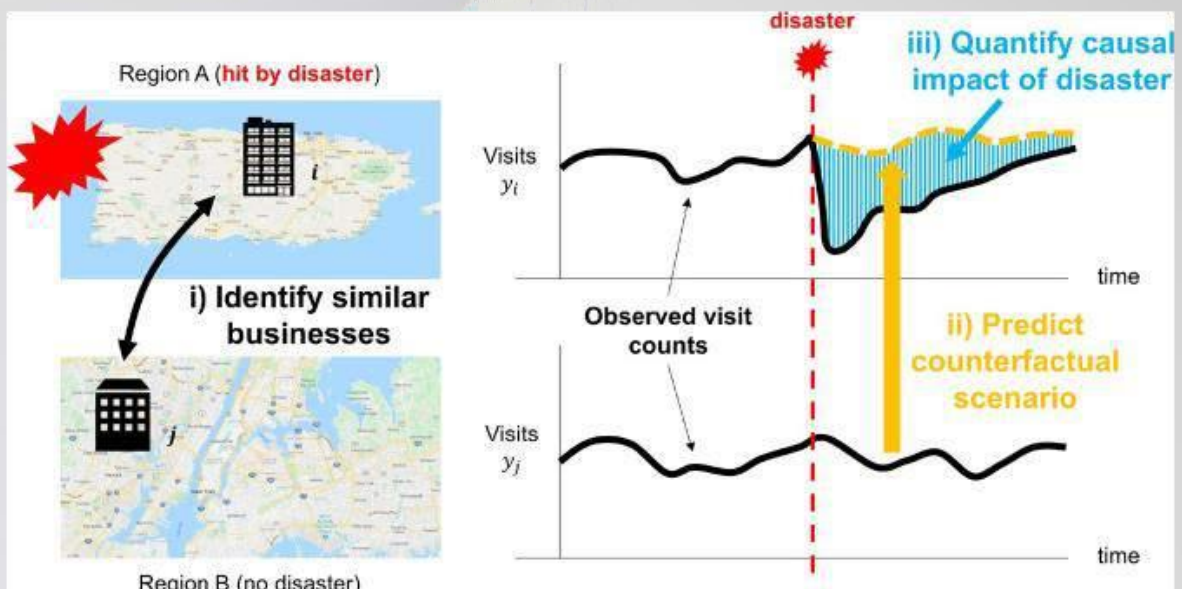
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Botzen, Deschenes, & Sanders (2019) reported that since the 1990s, a series of natural disasters have caused economic losses in the tens of billions of U.S. dollars. Citing the following examples of the Northridge (United States) earthquake in 1994, the Kobe (Japan) earthquake in 1995, the 2004 Indian Ocean earthquake that caused the Asian tsunami, Hurricane Katrina (United States) in 2005, the 2011 earthquake and tsunami in Japan, and Hurricane Harvey (United States) in 2017.

Yabe, Zhang, & Ukkusuri (2020) in their paper titled “Quantifying the economic impact of disasters on

businesses using human mobility data” reported that since 2000, the economic losses incurred by such natural catastrophes have exceeded \$2.5 trillion globally, and are increasing each year as a result of increased urbanization in many places.

Yabe et al (2020) used business visit data from mobile phone trajectories in Puerto Rico and New York to quantify the causal impact of Hurricane Maria on businesses in Puerto Rico. To establish the impact of disaster on businesses, they further made several observations from the visualizations of their experiment.

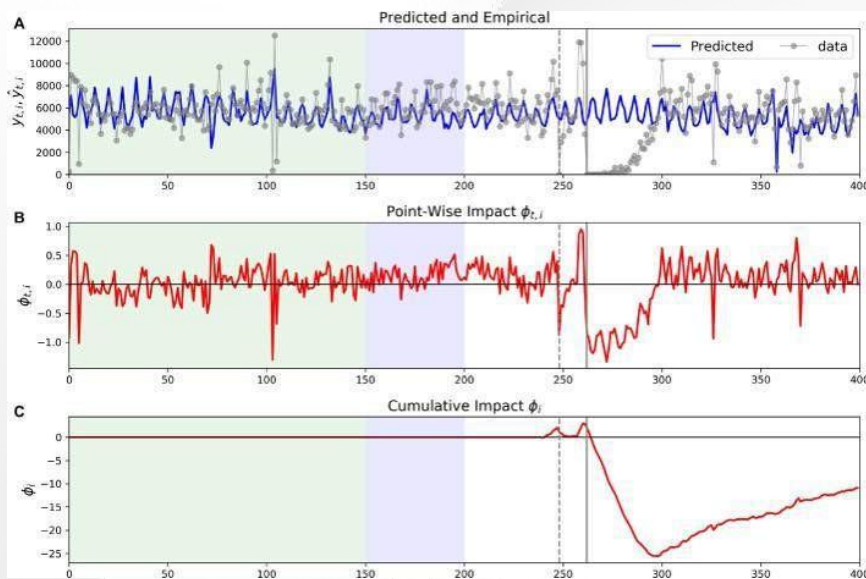


Yabe et al (2020) The image above shows the prediction of what if a disaster never happens and what happens after a disaster.



First, they observe common trend across several business categories, where all three regions (San Juan Municipio, Metropolitan Area and Outside Metro Area) experience negative impact right after Hurricane Maria, and then the businesses in the urban areas recover quicker compared to those in rural areas. They also observed intuitive trend in various business categories including building materials, supermarkets, restaurants, telecommunications, and grocery stores where they see a significant increase in gasoline stations in metropolitan areas after Hurricane Maria. This reflects the

high travel demand from the rural areas towards the metropolitan areas in the island due to evacuation mobility. Third, in some business categories such as hospitals and hotels, they observed an increase in visits after the hurricanes compared to before, especially in the San Juan region. An increase in hospital visits reflect the large number of injuries and casualties caused by the flooding and severe winds caused by the hurricane. Significant increase in visits to hotels in San Juan reflect the large number of residents who evacuated from the rural areas in Puerto Rico to the capital city.



The chart above shows example of how the disaster impact is quantified. (A) Predicted and actual observed daily visit patterns for a randomly selected business. (B) Point-wise impact $\phi_{t,i}$, and (C) cumulative impact ϕ_i of the disaster (Yabe et al., 2020)

Importance of Human Mobility Data in Disaster Studies



Human mobility pertains to how people move across space and plays a crucial role in understanding human movement for shelter after a disaster. With the emergence of novel and often large-scale data collected from mobile sensors and online social platforms, researchers are now capable of observing and analyzing the dynamics of people, goods, and information at an unprecedented spatio-temporal granularity. In particular, location data collected from mobile phones (e.g. call detail records, GPS trajectories) have enabled researchers to observe individual mobility patterns at an unprecedented high spatio-temporal granularity. These new datasets are becoming new standards for population level studies, and are used to understand the population distribution in cities. Such datasets are now utilized for a wide range of applications to solve urban challenges including population density estimation, estimation of dynamic traffic flows Yabe et al. (2020), predicting poverty in developing counties, and modeling the impact of human mobility patterns on the spread of epidemics. In the context of extreme events and disasters, Yabe et al (2020) reported that several studies have used mobile phone data to analyze the mobility patterns during and after disasters. Studies using such large scale data has revealed important insights on the evacuation and migration patterns of the affected people. Yabe et al (2020) leverage on the available large scale mobility data to quantify economic impact of disasters on businesses while estimating the visiting behavior of people to stores and businesses using mobile phone GPS data.

Conclusively, natural disasters cause significant damage and thus appear to be detrimental to the economy. Natural disasters wreak havoc on businesses' tangible assets – such as buildings and equipment – as well as human capital, eroding their production capacity. These negative consequences can be fatal for businesses, forcing them to shut down. However, with a thorough understanding of how people behave following a disaster, policy maker can leverage on such data to decide on allocation of appropriate relief materials to locations with high needs, similarly, data from this type of research can help businesses to expedite recovery after a disaster.



References

Botzen, W. J. W., Deschenes, O., & Sanders, M. (2019). The Economic Impacts of Natural Disasters: A Review of Models and Empirical Studies. *Review of Environmental Economics and Policy*, 13(2), 167–188. <https://doi.org/10.1093/reep/rez004>

Nathan, S. (2020). *Natural Disasters: A Resource Guide*. Library of Congress. <https://guides.loc.gov/natural-disasters>

Smriti, M. (2021). *Australian bush fires belched out immense quantity of carbon*. Nature. https://www.nature.com/articles/d41586-021-02509-3?error=cookies_not_supported&code=40d611f3-ff59-4ccc-8801-447c1e7a2753

Yabe, T., Zhang, Y., & Ukkusuri, S. V. (2020). Quantifying the economic impact of disasters on businesses using human mobility data: a Bayesian causal inference approach. *EPJ Data Science*, 9(1). <https://doi.org/10.1140/epjds/s13688-020-00255-6>

