Graphic Detail

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What Do Visualizations of Administrative Address Data Show About the Camp Fire in Paradise, California?

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Abstract

The Camp Fire destroyed most structures and displaced most of the population in Paradise, California. Since the wildfire, Paradise has returned to approximately one-fourth of its pre-wildfire population. This article visualizes administrative address data before and after the wildfire to measure population displacement and return. Administrative address data is likely underutilized for that purpose.

Camp Fire

On November 8, 2018, electrical transmission lines owned and operated by Pacific Gas and Electric Company (PG&E) sparked the fire that would become the Camp Fire near Pulga, California (Mohler, 2019). The Camp Fire resulted in 85 fatalities, three injuries, nearly 19,000 structures destroyed, and more than 153,000 acres burned (CAL FIRE, 2019). The Camp Fire was the most destructive wildfire to date in California's history (CAL FIRE, 2022), destroyed nearly 90 percent of the housing stock of Paradise and displaced approximately 83 percent of its residents (Kuczynski and Sharygin, 2019). The Camp Fire was estimated to have caused at least $16.5 billion in damages (Munich RE, 2019).

This article examines administrative address data from the United States Postal Service (USPS) to analyze households by mail delivery status in Paradise before, immediately after, and most recently since the Camp Fire. Administrative data offer unique insights into social problems and societal issues that may not otherwise be available to study from traditional social science data sources (Connelly et al., 2016). Substantial work in modeling fire risk has been done using structure data that had to be created, such as the vector building dataset by Microsoft (Ager et al., 2021), and by estimating population migration following a wildfire (Sharygin, 2021). Using existing administrative data may be useful when creating new datasets is expensive, unreasonable, or otherwise not possible.

The purpose of this analysis is to examine what happened to the mail delivery status of residential addresses in the area destroyed by the Camp Fire as a proxy for occupied housing before and after an extreme weather event that destroyed most structures in a community. Developing knowledge and furthering data resources in this domain are particularly important because parts of the United States, including California, have nearly one-half of their housing stock in the wildland-urban interface (WUI) (Hammer, Stewart, and Radeloff, 2007); housing growth inside the WUI outpaces housing growth outside the WUI (Radeloff et al., 2018); and extreme autumn wildfire conditions have increased (Goss et al., 2020). Address data have been used to evaluate population displacement and return following Hurricane Katrina in and around New Orleans, Louisiana (Finch, Emrich, and Cutter, 2010). The USPS may be a good proxy for disaster recovery analysis. Although the USPS has experience reestablishing mail delivery service following an extreme weather event (Stevens, 2005), a lag in the data collection may be present as the USPS works to reestablish service (Plyer, Bonaguro, and Hodges, 2009). USPS address data are likely underutilized and underresearched as a means to analyze population displacement and recovery.

Data

The primary data source for this analysis was administrative address data from the USPS's Address Management System (AMS). Address data are extracted from the AMS at the end of each quarter and aggregated to points at the ZIP+4 geographic level, a highly granular unit of geography.[1] The power of those data is that they are collected daily from letter carriers that visit each address, are promptly made available, are available at the near-address level, and can be aggregated to any level

[1] In Paradise, California, a single ZIP+4 point contained 1–24 residential addresses.

of administrative geography or used as points. The USPS categorizes residential addresses where mail is not being collected into two categories:

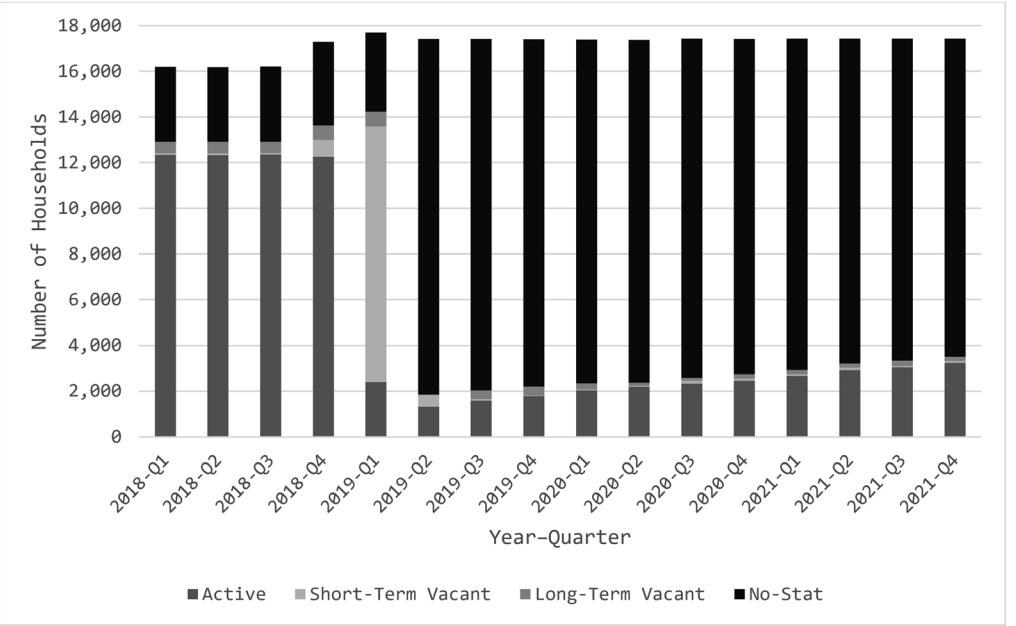
1. Vacant: Mail has not been retrieved for at least 90 days. This category is typically further separated into two levels of vacancy (Harrison and Immergluck, 2021):
    a. Short-term vacant (6 months or less): Potential healthy levels of vacancy, such as unit turnover.
    b. Long-term vacant (6 months or more): An indicator of abandoned housing and an unhealthy housing market.
2. Not-a-statistic (no-stat): Mail has not been retrieved for at least 90 days, the address has been demolished, the address has been merged with another address, the address is under construction and not yet receiving mail, or unlisted other possibilities (HUD, 2010).

Active residential addresses are calculated as addresses that are neither vacant (for any term) nor no-stat. These addresses are a proxy for occupied housing.

Household mail delivery status for Paradise, California, is shown in exhibit 1. In the three quarters before the Camp Fire, Paradise had approximately 12,300 active residential addresses, fewer than 100 short-term vacant residential addresses, about 500 long-term vacant residential addresses, and nearly 3,300 no-stat residential addresses. The Camp Fire occurred during the fourth quarter of 2018.

Exhibit 1

Residential Addresses by Mail Delivery Status in Paradise, California (2018–2021)



Source: HUD Aggregated USPS Administrative Data on Address Vacancies; 2018–2021; analysis by author

The data extract for that quarter was pulled more than a month after the wildfire was contained, but the number of active, long-term, and no-stat residential addresses remained roughly the same. The number of short-term vacant addresses increased by nearly ten-fold, to 662; however, that number is far short of the nearly 19,000 structures that were destroyed by wildfire.

Data for the first quarter of 2019 were extracted from the AMS on March 31, 2019, more than 4 months after the Camp Fire was contained. The number of long-term vacant (662) and no-stat (3,460) residential addresses remained similar to previous quarters. Short-term residential vacancies grew to more than 11,000, and the number of active residential addresses fell to roughly 2,400, suggesting that occupied housing fell to 19.4 percent of homes that were occupied at the end of the third quarter of 2018, immediately before the fire; that percentage is consistent with the estimate that 83 percent of Paradise's population was displaced (Kuczynski and Sharygin, 2019).

Most non-active residential addresses were listed as no-stat addresses in the second quarter of 2019. Residential addresses actively receiving mail declined to its lowest count—slightly more than 1,300, a decrease of 89.2 percent from before the fire. The number of short-term vacant and long-term vacant homes decreased significantly.

From the second quarter of 2019 to the first quarter of 2021, active residential addresses increased from slightly more than 1,300 to more than 3,200, an increase of more than 144.7 percent since the lowest point of active residential housing units in the second quarter of 2019. This count of active residential addresses represents roughly one-fourth (26.2 percent) of active residential residences before the Camp Fire. The numbers of short-term vacant and long-term vacant residential addresses remained roughly stable throughout this period. No-stat residential addresses decreased at roughly the same rate as active residential addresses increased, and the number of total residential addresses remained around 17,400.

Maps

The maps shown were produced using dot densities instead of the ZIP+4 points. Dot density maps are a common method for showing counts of data, particularly population location and density (Gomes, 2016). Because ZIP+4 points are relatively close together and represent relatively few residential addresses, breaking up a ZIP+4 point into multiple, smaller dots to visualize the location of residential addresses allows for a close approximation of residential addresses at the scale of viewing all of Paradise together. Dot density maps were created to visualize the density of occupied housing units before, immediately after, and most recently since the Camp Fire. Several steps were taken to produce the maps:

- Because ZIP+4 points can have the same latitude and longitude coordinates as other ZIP+4 points, ZIP+4 points that were stacked on other ZIP+4 points were collapsed into a single point[2] (a collapsed ZIP+4 point).

[2] For the third quarter of 2018, this activity reduced the number of ZIP+4 points from 3,433 to 2,926 unique points. The number of residential addresses—of a mail delivery status—stayed the same.

- To represent the developed outline of Paradise and contain the area in which dot density points could be created, a convex hull[3] of the collapsed ZIP+4 points was created. A convex hull is the smallest shape that contains a set of features—in this case, collapsed ZIP+4 points. Edits to the polygon were made to remove sections without housing to restrict possible dot density placement further.
- Thiessen Polygons[4] were created from each collapsed ZIP+4 point; the attributes of each collapsed ZIP+4 point persisted to each respective Thiessen Polygon.
- The Thiessen Polygons were clipped by the edited convex hull.
- The dot density of each Thiessen Polygon after the clip was mapped.

The resulting clipped Thiessen Polygons for each collapsed ZIP+4 point had a median area of 2.5 acres, or approximately 0.64 acres per residential address of any mail delivery status. Finally, each clipped Thiessen Polygon was mapped by dot density by the number of occupied residential addresses, which is defined as any household actively receiving mail (not vacant or no-stat). The dots do not draw in the exact location of any particular address, but the area on which each set of dots can be generated is very small and thus reflects near-location placement.

Exhibit 2 visualizes the presence of active residential addresses in Paradise as of September 30, 2018, about a month and a half before the fire. Each dot represents one active residential address, and the exhibit shows more than 12,200 such addresses. Housing is generally dispersed throughout the community except at some of the city limits and in the far southern area. This map serves as the benchmark for active residential addresses before the Camp Fire.

[3] The tool Minimum Bounding Geometry in ArcGIS Pro was used to create the convex hull, see https://pro.arcgis.com/en/pro-app/2.8/tool-reference/data-management/minimum-bounding-geometry.htm for further information on the tool.

[4] The tool Create Thiessen Polygons in ArcGIS Pro was used to create the Thiessen Polygons; see https://pro.arcgis.com/en/pro-app/2.8/tool-reference/analysis/create-thiessen-polygons.htm for more information on the tool.

Exhibit 2

Active Residential Addresses in Paradise, California (September 30, 2018)

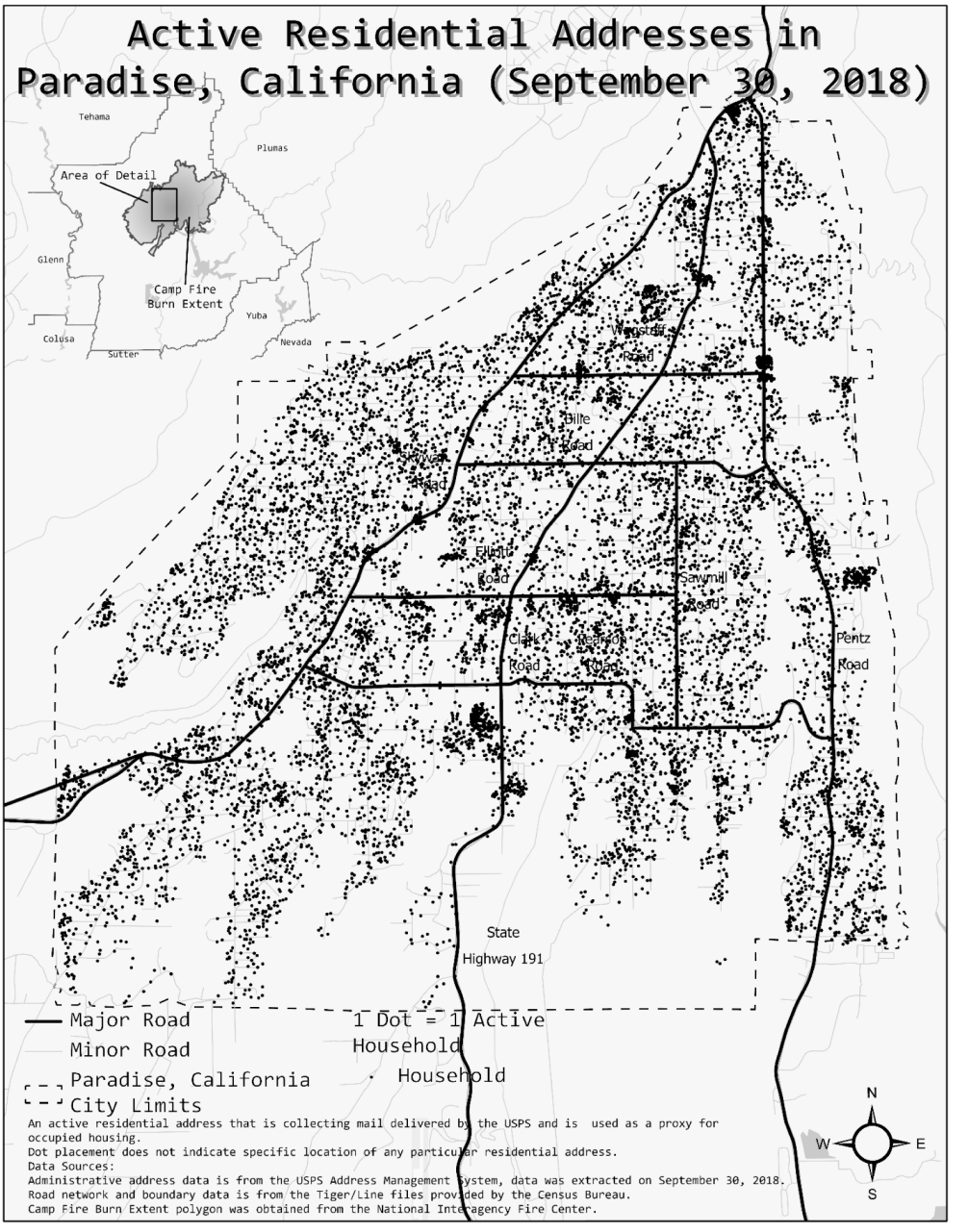


Exhibit 3 shows the presence of active residential addresses in Paradise on June 30, 2019, about seven months after the wildfire. Active residential addresses have been reduced from more than 12,200 to slightly more than 1,300—an 89.2-percent reduction. Housing has been reduced in all

sections of Paradise. Few clusters of dense housing remain, particularly along Clark Road to the northwest of the intersection with Peterson Road and near the intersection with Wagstaff Road. A visual inspection of the map shows such a drastic reduction in active residential addresses throughout Paradise that it is difficult to pick any particular section to describe.

Exhibit 3

Active Residential Addresses in Paradise, California (June 30, 2019)

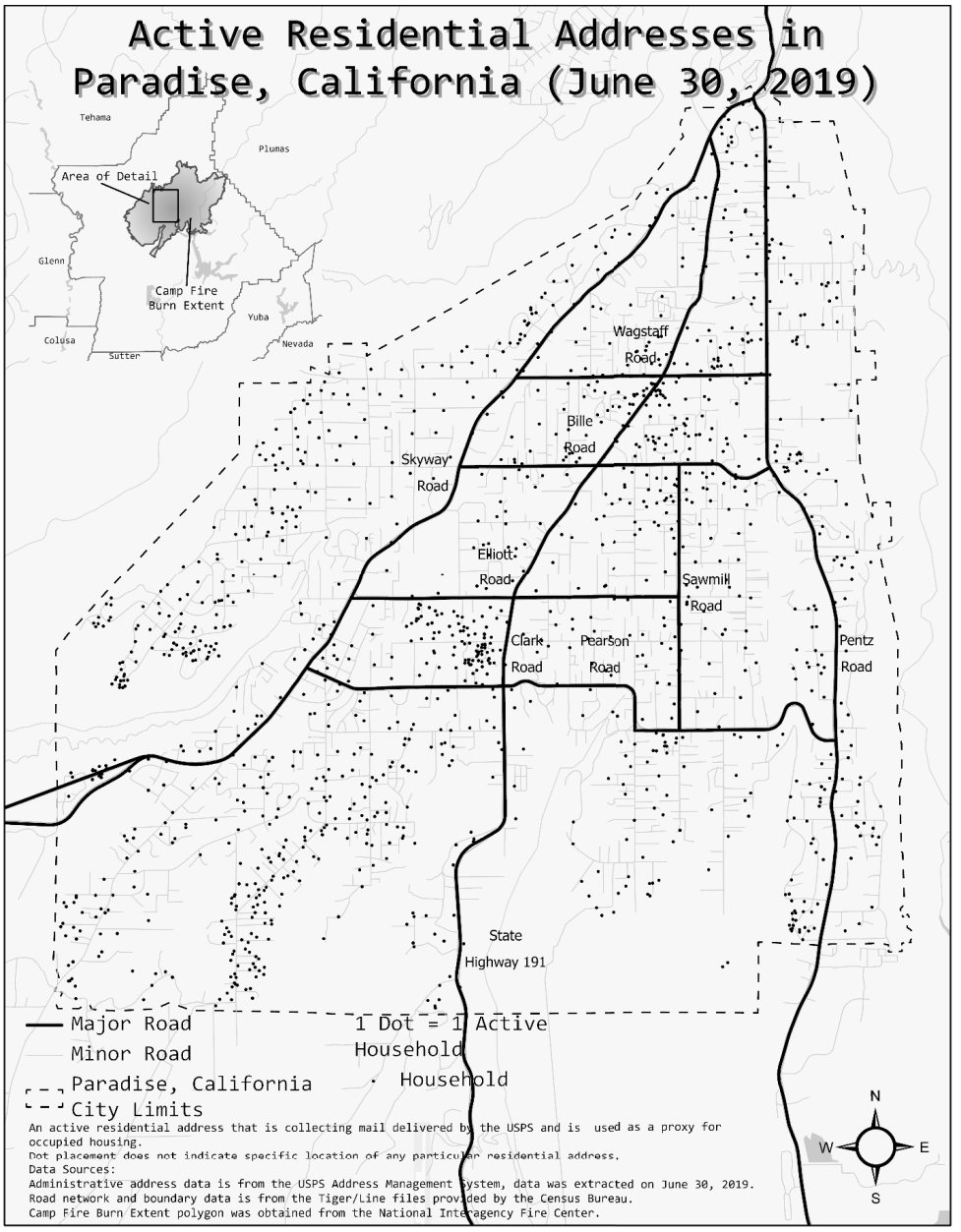
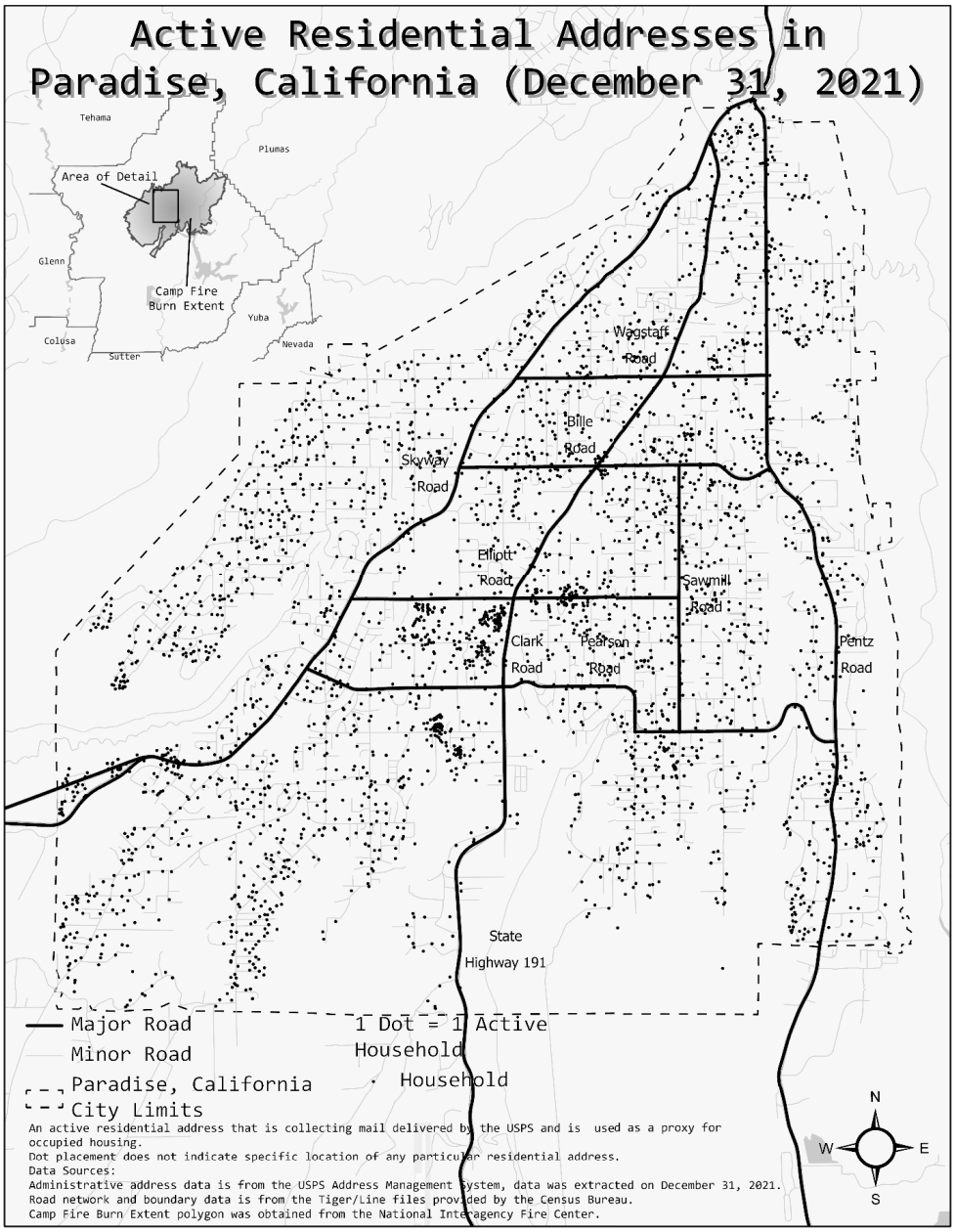


Exhibit 4 displays a dot density map for active residential addresses as of December 31, 2021, the date of the most recently available data at the time this article was written. Active residential addresses have grown to more than 3,200, an increase of 144.7 percent since the lowest count at

Exhibit 4

Active Residential Addresses in Paradise, California (December 31, 2021)



the close of the second quarter of 2019. This increase represents slightly more than one-fourth (26.2 percent) of homes that were assumed to be occupied before the Camp Fire. Growth in active housing appears to have occurred throughout Paradise. Clusters of active housing are present to the east and west of Clark Road, particularly along Elliott Road. Even with the high rate of return of active housing, the density of dots is far less than before the Camp Fire.

Conclusion

This article is a high-level overview of the potential for analyzing administrative address data before and after an extreme weather event has destroyed the majority of a community's housing stock. Numerous possibilities exist for researchers, analysts, and policymakers to further the use of these data for monitoring and evaluating population displacement and recovery in the wake of extreme weather events, particularly as such events are predicted to increase (Keyser and Westerling, 2017). Researchers, planners, policymakers, and other interested parties should take note of administrative address data as a data source to evaluate population displacement and return, particularly when other data sources may not be available or when other data sources are slower to capture population mobility trends (Sharygin, 2021).

Topics for further research might include, but are not limited to, the following:

- More in-depth and sophisticated spatial analysis of population displacement and recovery in Paradise, California, or other communities affected by wildfires and other extreme weather events to further understand the geography of population return.
- Spatial analysis of the growth of housing in the Wildland Urban Interface.
- Data linkage with destroyed structure survey data or construction permit data to further understand how to best monitor and evaluate administrative address data following a disaster, such as a wildfire, for population displacement and return.
- Data linkage with other datasets, such as NASA's Nighttime Lights dataset, which has served as a proxy for human development (Bruederle and Hodler, 2018).
- Analysis of administrative address data across multiple extreme weather events that result in population displacement but not necessarily the destruction of housing.
- Spatial analysis of administrative address data following disaster events, such as tornadoes, poses unique challenges due to the highly localized destruction.
- Comparison of population mobility trends, such as school enrollment or other administrative data that capture record-of-home changes.

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