CURRENT STATE OF THE SHARING ECONOMY AND EVACUATIONS:
LESSONS FROM CALIFORNIA

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16. Abstract

In many evacuations including wildfire evacuations, public agencies often do not have enough resources to evacuate and shelter all citizens. Consequently, we propose that the sharing economy, through private companies and/or private citizens, could be leveraged in disasters for transportation and sheltering resources. To assess this feasibility, we distributed surveys to individuals impacted by three major wildfires in California: 1) the 2017 October Northern California Wildfires (n=79), 2) the 2017 December Southern California Wildfires (n=226), and 3) the 2018 Carr Wildfire (n=284). Using these data, we find that private citizens are moderately to highly likely to share transportation and sheltering resources in future disasters, but numerous reservations persist about sharing. We also find significant spare capacity in evacuating vehicles and potential homes. To supplement this work, we also conducted four focus groups (n=37) of vulnerable populations to determine the benefits and limitations of a sharing economy strategy in terms of equity. Groups included low-income (2017 December Southern California Wildfires), older adult (2017 October Northern California Wildfires), individuals with disabilities (2017 October Northern California Wildfires), and Spanish-speaking (2018 Mendocino Complex Wildfire). We find that while severe equity limitations exist, groups were able to develop several recommendations for successfully leveraging sharing economy resources for the general population and their specific vulnerable group. We conclude with several local agency and statewide recommendations for building a sharing economy framework for California to prepare for future evacuations.

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Executive Summary

Since Hurricane Floyd in 1999, there has been an increasing focus on transportation issues in disaster response in the United States (U.S.). In many disasters, evacuations remain the primary strategy to ensure safety, including the recent wildfires in California in 2017 and 2018. Despite increasing involvement of transportation and public transit agencies in evacuations, many local agencies do not have enough resources to transport or subsequently shelter all citizens in a disaster. At the same time, improvements in technology and communication have led to the rise of the sharing economy, a collection of Internet-based transactions where goods and services are shared and obtained. With the growth of private companies in transportation and sheltering (e.g., Airbnb, Lyft, Uber), the sharing economy could be leveraged in disasters and evacuations by mobilizing the unused capacity and resources of individuals through mobile and Internet platforms.

The sharing economy is a collection of transactions where goods and services are shared via the Internet. Recently, the sharing economy has grown rapidly in the transportation and hospitality industries with the proliferation of transportation network companies (TNCs), carsharing, and homesharing companies. TNCs (also known as ridesourcing and ridehailing), such as Lyft and Uber, allow users to request car rides through a smartphone application and charge riders based on distance and travel time. Carsharing companies (e.g., Zipcar, Car2Go, Turo) provide short-term access to automobiles, allowing users to gain the benefits of a private automobile while forgoing auto ownership costs. Homesharing companies (e.g., Airbnb, VRBO) organize marketplaces of homes and rooms where people have the opportunity to rent out their space or rent another's space. These shared transportation and housing resources are often perceived as less expensive, more economically efficient, more sustainable, and even enjoyable to use.

The recent wildfires in California in 2017 and 2018 are a stark reminder of the need for adequate and fast-acting transportation and sheltering resources. With the increasing need to evacuate citizens in these wildfires, we focus our attention on the feasibility of supplementing public resources through the sharing economy in wildfire evacuations. We first present recent actions of sharing economy companies in California during disasters (including non-wildfires). We next employed an online survey that was distributed to individuals impacted by three California Wildfires: the 2017 October Northern California Wildfires (n=79), the 2017 December Southern California Wildfires (n=226), and the 2018 Carr Wildfire (n=284). Through these surveys, we present quantitative results on the willingness of individuals to share their own private resources in a future disaster, along with the current capacity of these shared resources, and individual reservations and concerns about sharing. To supplement this survey work, we conducted four focus groups (n=37) of vulnerable populations – older adult (n=10), individuals with disabilities (n=10), low-income (n=8), and Spanish-speaking (n=9) – to assess the equity potential of a shared resource strategy. The focus groups were held with individuals impacted by the 2017 October Northern California Wildfires, the 2017 December Southern California Wildfires, and the 2018 Mendocino Complex Wildfire. The groups were held in Rohnert Park in August 2018, Ventura in August 2018, and Lakeport in April 2019, respectively for the wildfires. Further description of the focus groups is provided in Table ES1.

Summary of Wildfire Survey Results

Below we present several key findings from the three different surveys of California wildfires in 2017 and 2018. We found that there was:

- Little to no TNC or carsharing use in the evacuations;
- Small usage of homesharing, ranging from 4.0% to 5.4% during the evacuations;

- Extreme likelihood to share personal shelter at a cost, ranging from 9% to 14%;
- Extreme likelihood to share personal shelter for free, ranging from 19% to 30%;
- Extreme likelihood to share personal transportation before evacuating, ranging from 37% to 62%;
- Extreme likelihood to share personal transportation while evacuating, ranging from 59% to 72%;
- High resource availability ranging from 84% to 90% of households with one or more extra beds;
- Moderate resource availability among households with two or more open seats in their vehicle, ranging from 54% to 69%;
- Significant sharing economy concerns related to sheltering due to personal safety and security considerations, responsibility for a house guest, disruption of daily tasks, and interacting with strangers;
- Significant sharing economy concerns for transportation related to personal safety and security, responsibility for a passenger, not having enough space in the vehicle, and adding extra time to the evacuation;
- Moderate willingness to deviate from the evacuation route to pick up extra passenger; and
- Willingness to carry passengers in vehicle at least 10 miles during an evacuation, ranging from 56.8% to 76.7%.

Summary of Focus Group Results

Next, we found several key results from the four focus groups (Table ES1) of vulnerable populations:

- Groups had a split or somewhat negative opinion of employing TNCs in disasters.
- Opinions of TNCs improved with further discussion among participants who offered potential improvements and strategies.
- Groups had a split or somewhat positive opinion of leveraging homesharing in disasters.
- Opinions did not change with further discussion of homesharing, however, as some groups did not extensively discuss the benefits or limitations in disasters.

Table ES1: Summary of Focus Groups

	Older Adult	Individuals with Disabilities	Low-Income	Spanish-Speaking
Focus Group Eligibility	65 years or older	Have a disability or family member with a disability	Have a 2017 household income below $40,000	Speak Spanish in the household*
Wildfire	2017 Northern California Wildfires	2017 Northern California Wildfires	2017 Southern California Wildfires	2018 Mendocino Complex Wildfire
Focus Group Location (Month + Year)	Rohnert Park, CA (Aug. 2018)	Rohnert Park, CA (Aug. 2018)	Ventura, CA (Aug. 2018)	Lakeport, CA (Apr. 2019)
Number of Participants	10	10	8	9
Evacuated from Wildfire	9	10	6	8
Received Mandatory Evacuation Order	3	4	4	6
Lost Home in Wildfires	4	4	3	0

Through the four focus group discussions, we also found several primary limitations for both TNCs and homesharing:

TNCs

- All vulnerable groups expressed strong concern about driver availability and reliability.
- All vulnerable groups expressed low trust in drivers and private companies.
- All vulnerable groups explained that vehicles would have little access to areas near the fire line.
- Older adults were highly concerned about personal safety.
- Individuals with disabilities stated that companies would be unfriendly and unaccommodating regarding disabilities.
- Low-income individuals were concerned about the lack of money to pay for services.
- Spanish-speaking individuals expressed that they would not have knowledge of available services due to language barriers.

Homesharing

- Two groups – older adult and low-income – did not mention any limitations.
- Individuals with disabilities expressed that some housing would not be able to accommodate a variety of disabilities and that hosts would need additional training.
- Spanish-speaking individuals expressed low trust of hosts/strangers and were worried about the lack of other resources such as food and water.

Despite these limitations, the focus group participants offered ideas for improving sharing economy strategies for evacuations. These ideas are presented in Table ES2.

Table ES2: Recommendations Provided by Focus Groups for Developing a Sharing Economy Strategy

	Older Adult	Individuals with Disabilities	Low-Income	Spanish-Speaking
General TNC Strategies	• Plan in advance using well-established protocols and disseminating resource information • Build a community-driven approach (neighbors helping neighbors) • Focus on the recovery period following the evacuation • Train drivers to assist all people in disaster situations			
Group Specific TNC Strategies	• Partner with local governments • Use drivers who live in unimpacted zones • Ensure that costs remain low (no surge)	• Create partnerships with paratransit that could identify and assist individuals with disabilities • Include an option in the application to denote disability or if pet owner	• Create coordination between emergency services and companies to send drivers • Develop multi-modal system that prioritizes public transit with private companies fulfilling first-mile, last-mile	• Provide information on available resources in Spanish • Include credentialing information for drivers to increase trust • Increase emergency education to encourage sharing across the community
Group Specific Strategies for Homesharing	• Offer a tax deduction for providing home to evacuees	• Distribute information about available resources across multiple platforms • Leverage pre-existing senior care and homeless shelter options and expertise	• Reform short-term rental laws to increase supply of homes	• Provide information on available resources in Spanish • Include credentialing information for hosts to increase trust

Summary of Recommendations

We conclude this report with several policy and research recommendations that could help public agencies to leverage the sharing economy for a variety of disaster use cases, some of which are also mentioned in Wong and Shaheen (2019). Several actionable steps that agencies should take to build sharing economy partnerships include:

- Reaching out to private companies to establish basic contacts and meeting opportunities to begin the planning process and create a working relationship;
- Adding private companies to emergency management stakeholder meetings and training exercises to explain emergency roles;
- Relaying the mission, goals, and challenges that agencies face in emergency situations to private companies. The same process should occur for private companies wherein they explain their mission, goals, and challenges in disaster situations;
- Researching price gouging laws in the relevant jurisdiction(s) to prevent surge pricing and other abuses;
- Working with neighborhood associations to develop localized community-based plans to ensure transportation for neighbors and build community capacity of resources;
- Beginning sharing economy partnerships with information sharing and situational awareness (e.g., sharing information on the location of hazards);
- Amending current evacuation plans (e.g., ESF 1 - Transportation Functional Annex) to add private companies as resource partners and designate the appropriate communication flow with other agencies such as law enforcement (ESF 13) and community-based organizations (ESF 17).
- Discussing appropriate policy mechanisms (e.g., surge flagging), beginning with memorandums of understanding (or MOUs). These mechanisms may differ by disaster and by use case, even within the same jurisdiction(s); and
- Focusing on small-scale disasters and emergency situations and supplementing public assets through private resources to pilot the sharing economy strategies.

California should also consider reviewing several disaster policies to bolster the amount of sharing economy resources and improve partnerships, specifically:

- Amend the California Office of Emergency Services (CalOES) Emergency Plan to require disaster councils to add a multi-hazard evacuation plan with clearly outlined transportation assets (both public and private) as a part of their Emergency Operations Plan (EOP);
- Consider the addition of sharing economy companies into the Business Operations Center (BOC) pursuant of SB 546 (Disaster Public-Private Partnerships Act of 2006); and
- Require disaster councils to identify all available resources, whether public or private, for vulnerable groups to meet the requirement of AB 2311 (Emergency Services: Access and Functional Needs in Emergencies Act of 2016), which requires cities and counties to integrate access and functional needs into emergency plans upon its next update.

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About the UC Institute of Transportation Studies

The University of California Institute of Transportation Studies (UC ITS) is a network of faculty, research and administrative staff, and students dedicated to advancing the state of the art in transportation engineering, planning, and policy for the people of California. Established by the Legislature in 1947, ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

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Background

In the past 20 years, transportation has grown to become an integral part of emergency management, an essential support function in many multi-hazard emergency plans. The elevation of transportation to a more prominent position has been largely out of necessity. For a variety of hazardous events, evacuations are the primary method to ensure the safety of large populations in the United States (U.S.). While large-scale hurricane evacuations draw the most attention, smaller, more local disasters (such as wildfires) and related evacuations also adversely impact communities. At the same time, officials continue to struggle with transportation management when preparing for, responding to, and recovering from disasters.

The lack of equitable evacuation and emergency planning was most acutely clear during Hurricane Katrina in 2005. The New Orleans evacuation plans did not include a process for evacuating the estimated 200,000 to 300,000 people without reliable personal transportation (Wolshon, 2002), and the city failed to provide adequate assistance for them during the evacuations (Renne, 2006). Lessons learned from this devastating event included the need to build overcapacity and redundancy into any transportation vehicle plans and to create a multi-modal system with a variety of evacuation options (Litman 2006). Hurricane Katrina also exposed the lack of transportation and sheltering assets available to evacuees. Consequently, New Orleans now offers transportation through its city-assisted evacuation plan, which maps out pickup points and develops a process to use city assets, such as buses (The City of New Orleans, 2019). However, New Orleans remains an outlier. Indeed, research has found that one-third of the 50 largest cities in the U.S. do not have evacuation plans (Renne and Mayorga, 2018). In addition, less than half of cities with evacuation plans mention carless or vulnerable populations (Renne and Mayorga, 2018). Research has attempted to solve evacuation resource challenges to build more robust public transit evacuation plans (Bish, 2011), develop strategies for older adults (Gibson and Hayunga, 2006), and construct a toolkit for carless and special needs populations (Renne et al., 2011). However, implementation of these ideas in practice remains ongoing and slow.

Other disasters have exposed critical transportation and sheltering resource deficiencies, as well. In 2017 and 2018, a series of wildfires in California led to mass evacuations, devastating damage, and tragic loss of life. While the size of the population to evacuate in a wildfire is typically less than for a hurricane, the speed of wildfires can quickly overcome evacuees and overwhelm local governments. In some cases, wildfires spread so quickly that governments have difficulty deciding where and when to issue evacuation orders and how to manage transportation systems during the evacuation (Watkins et al., 2017; Lewis et al., 2018; Nicas et al., 2018). These wildfires also impact areas along the urban-wildland interface, regions with generally fewer transportation assets than larger cities. Indeed, most citizens must rely on their personal vehicle to evacuate. In some cases, smaller public transit agencies, including SMART, VINE Transit, and the Santa Rosa CityBus, assisted in evacuating citizens (several hundred) in the 2017 October Northern California Wildfires (SMART Train, 2017; Napa Valley Register, 2017; ABC7 San Francisco, 2018). In the 2017 December Southern California Wildfires, Gold Coast Transit and Santa Barbara MTD also assisted in the evacuation of citizens (Gold Coast Transit, 2017; Brugger, 2017). However, for most evacuees of these fires, personal vehicles were the only option available. In addition, individuals impacted by the Carr Fire, Mendocino Complex Fire, and the Camp Fire (all in 2018) had little to no access to public transportation in their area, leaving behind those without vehicles (Nicas et al., 2018). Given these critical resource deficiencies for evacuations, especially for wildfires in California, alternative strategies should be explored to provide an adequate number of flexible and adaptive options for evacuees.

One key advance has been the development of the sharing economy, an Internet-based collection of company-to-peer and peer-to-peer transactions where goods and services are shared and obtained. Companies including Airbnb, Lyft, Uber, and Zipcar have disrupted traditional economic and service structures, gaining immense popularity, especially among young Americans. This online "collaborative consumption" has grown with the help of information and communications technology (ICT) as well as consumer awareness and the development of sharing economy companies, rather than just online communities (Hamari et al., 2016). With the proliferation of smartphone technology, consumers are now able to access resources through the sharing economy rapidly and efficiently. In the cases of mobility and sheltering, shared resources are often perceived as less expensive, more economically efficient, more sustainable, and even enjoyable to use (Hamari et al., 2016).

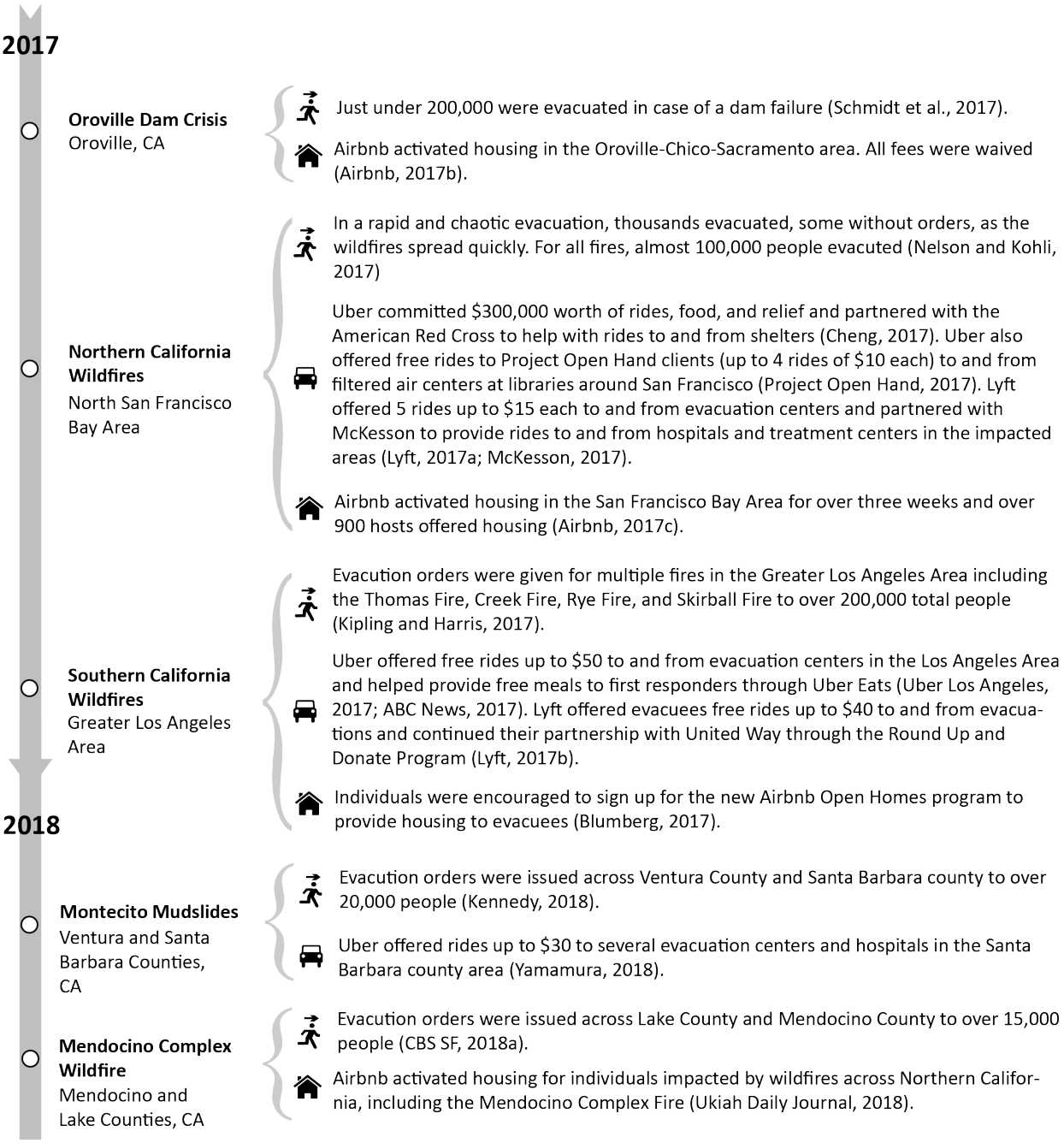
The explosive growth of sharing economy services has also exposed them to external forces in the marketplace, including disasters and emergencies. The size and reach of some sharing economy companies suggest that their presence (or lack thereof) in disasters could greatly impact transportation and sheltering operations in communities (Wong et al., 2019). Two primary sharing economy markets have been active in disasters: transportation network companies (TNCs) (also known as ridesourcing and ridehailing) and homesharing. TNCs, such as Lyft and Uber, allow users to request car rides through a smartphone application and charge riders based on distance and travel time (Rayle et al., 2016). To encourage market equilibrium when demand is high and driver availability is low, TNCs raise prices through a mechanism called Prime Time or surge pricing. Homesharing companies, Airbnb and VRBO, allow users to participate in a marketplace of homes and rooms where people have the opportunity to rent out their space or rent another's space. Another sharing economy market that has not yet actively participated in disasters is carsharing. Carsharing companies, Zipcar and car2Go, provide short-term access to vehicles, giving individuals the benefits of auto ownership without the costs of ownership (Shaheen and Cohen, 2013). Other sharing economy mobility options, such as bikesharing and scooter sharing, have also not actively participated in disasters.

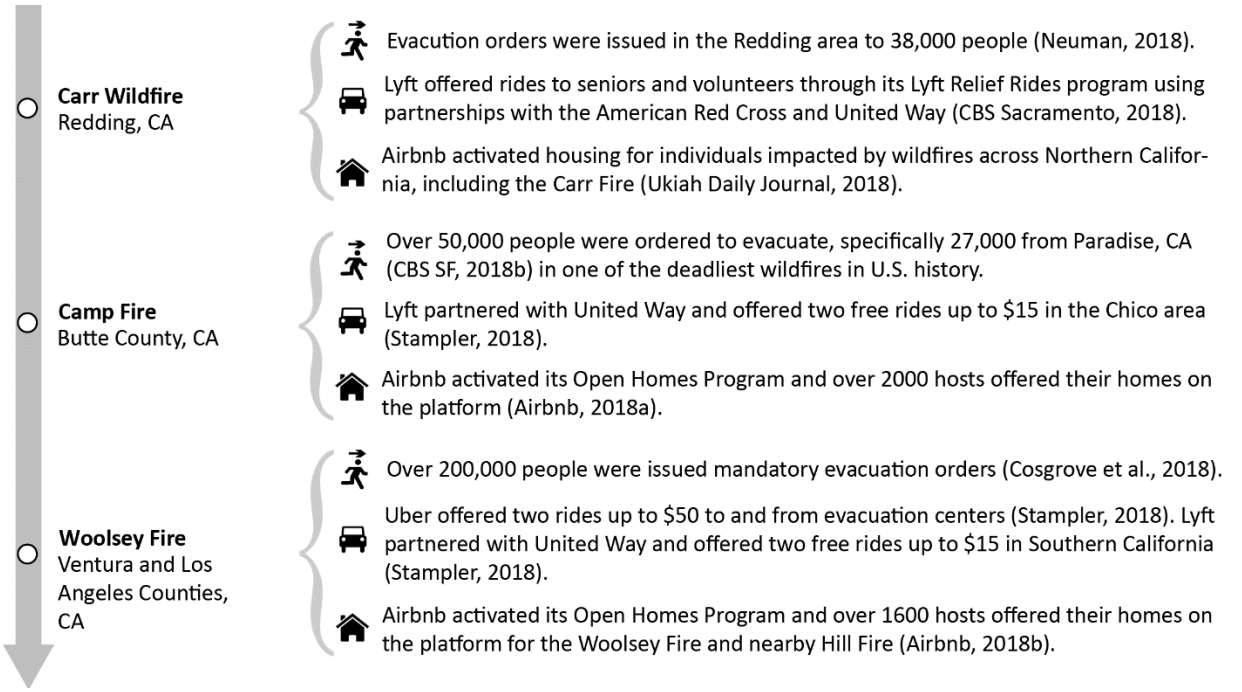
The first example of TNC and homesharing actions in a disaster was Hurricane Sandy in 2012. Immediately following Hurricane Sandy, Uber instituted a surge of twice the base price to meet the increase in demand. However, the company received intense criticism on social media by users who viewed the move as unethical and exploitive (Walk, 2012; Weiner, 2014). This led Uber to give 100% of proceeds from rides during the disaster directly to the drivers. For homesharing, about 400 Airbnb hosts offered their apartments and houses free of charge to anyone in need of housing after Hurricane Sandy (Airbnb, 2017a). With positive press coverage, Airbnb decided to formalize the idea into the Disaster Response Program (now called Open Homes). This program, which waives all company fees, provides alerts to hosts near disaster areas, encouraging them to offer their houses for free to victims of the disaster (Airbnb, 2017b; Airbnb, 2018a). Despite several key limitations, sharing economy companies have been active in 25 disasters in the United States and received mostly positive opinions from experts since Hurricane Sandy (Wong et al., 2019).

In California alone, sharing economy companies have been active in eight large-scale disasters. Figure 1 provides a summary of the actions of three private companies – Airbnb, Lyft, and Uber – in California disasters. In most of these situations, companies have offered resources for the disaster relief period. Lyft and Uber focused their attention on providing rides to and from evacuation centers and partnering with non-governmental organizations, such as the American Red Cross and United Way. For most disasters, Airbnb activated its Open Homes Program, and thousands of hosts offered their homes for evacuees.

These well-structured actions from private companies indicate a potential pathway forward for building redundancy and flexibility into evacuations. With the spread of technological advances, emergency management and transportation agencies have an opportunity to leverage the sharing economy to increase evacuation compliance rates, reduce congestion, support vulnerable populations, and ensure public safety (Wong et al., 2018; Li et al., 2018).

Figure 1: Summary of Key Sharing Economy Actions in California





Given the potential for the sharing economy in disasters as an evacuation strategy, the goal of this report is to provide evidence of this potential through a mixed-method approach. In this report, we present quantitative results from three surveys of individuals impacted by California wildfires in 2017 and 2018 and a qualitative discussion of four focus groups representing different vulnerable populations. To guide the study, we developed three key research questions:

1. What was the usage of the sharing economy during the evacuations from California wildfires?
2. What is the willingness of individuals to offer their own private shelter or transportation to assist others? What reservations might individuals have?
3. How might vulnerable populations use the sharing economy in disasters? What are the potential use cases, benefits, and limitations for different vulnerable groups?

We first describe the methods used for developing the report and answering the research questions. Next, we present the results from three California wildfire surveys: 1) 2017 October Northern California Wildfires, 2) 2017 December Southern California Wildfires, and 3) 2018 Carr Wildfire – on the feasibility of a sharing economy strategy. We then offer insights from our discussions with four vulnerable population focus groups on the applicability, potential, and challenges of sharing economy platform use in evacuations from a social equity perspective. Finally, we conclude with several policy recommendations, focused on early action, and future research recommendations.

Methodology

California Wildfires Surveys

This report employs a mixed-method research approach to bring together the research fields of evacuation and the sharing economy. For the quantitative approach, we distributed three surveys to individuals impacted by the California wildfires in 2017 and 2018 as seen in Table 1. All individuals were allowed to participate in the survey, even those who did not evacuate or receive a mandatory evacuation

order. In the surveys, we asked respondents a range of questions related to their evacuation behavior along with their willingness to participate in the sharing economy in a future evacuation. To distribute the survey, we first compiled a list of local agencies, community-based organizations (CBOs), non-governmental organizations (NGOs), and news media in the same geographic region as each wildfire. Local agencies included transportation, public transit, emergency management, social service, and health agencies. We also employed a snowball technique, allowing agencies to contact other agencies, news networks, and officials who might be interested in distributing the survey. All partnering agencies were allowed to post the survey to various online outlets including but not limited to Facebook, Twitter, agency websites, news websites, and alert subscription services. The goal of this wide distribution was to increase the coverage of the survey across the general population and increase the likelihood of reaching individuals unconnected to emergency management agencies. An online survey was chosen as a cost-effective and efficient method to gather responses quickly within a complex survey structure. To increase survey response and reduce selection bias, we incentivized each survey through a drawing of gift cards. Once surveys were collected, responses were thoroughly cleaned to prepare the data for descriptive statistics and future behavioral modeling. A summary of the demographic characteristics of each survey is provided in Table A1 and Table A2 of the Appendix.

Table 1: California Wildfire Case Studies and Surveys

	Northern California Wildfires	Southern California Wildfires	Carr Wildfire
Month/Year	Oct. 2017	Dec. 2017	July 2018
Primary Impacted Area	Sonoma, Napa, and Mendocino Counties	Los Angeles, Ventura, and Santa Barbara Counties	Shasta and Trinity Counties
Primary Fires	Atlas; Nuns; Tubbs; Redwood Valley Complex	Creek; Rye; Skirball; Thomas	Carr
Evacuation (# of people)	~100,000	~200,000	~40,000
Survey Timeline	March to April 2018	March to July 2018	March to April 2019
Incentive	Drawing of five $200 gift cards	Drawing of five $200 gift cards	Drawing of ten $250 gift cards
Responses	284	552	647
Finished Responses	92	303	338
Finish Rate	32%	55%	52%
Sample Size (*after cleaning*)	79	226	284
Distribution Method	Online via transportation agencies, emergency management agencies, community-based organizations, non-governmental organizations, and local media		

Vulnerable Population Focus Groups

Given the limitations of an online survey, we also conducted four focus groups composed of individuals who evacuated or received an evacuation order from one of three wildfires (Table 2). We specifically developed these groups to collect information from vulnerable populations who experience additional challenges and barriers in an evacuation. In addition, we defined each focus group population to broadly reflect the vulnerable groups most impacted by the chosen wildfires (2017 Northern California Wildfires, 2017 Southern California Wildfires, 2018 Mendocino Complex Wildfire). Individuals in three of the focus groups were first contacted through their participation in the 2017 Northern California and 2017 Southern California Wildfire surveys. The groups (each with a maximum of ten people) were filled first using the survey participants and then with additional participants found through partnering agencies. We formed the Spanish-speaking focus group for the Mendocino Complex Wildfire solely through partnering agencies, since we did not distribute a prior survey. Similar to the surveys, multiple types of partners (i.e., local agencies, CBOs, NGOs, news media) advertised the focus groups across online platforms. Participants could also ask to be part of the focus group by calling a phone number. All participants had to meet the eligibility requirements for the group. Participants were also incentivized with a $100 gift card. In addition, the Spanish-speaking focus group was conducted only in Spanish.

Table 2: Vulnerable Population Focus Group Design

Focus Group Population	Focus Group Eligibility	Wildfire	Number of Participants	Focus Group Location & Date
Older Adult	65 years or older	2017 Northern California Wildfires	10	Rohnert Park, California (Aug. 2018)
Individuals with Disabilities	Disability or family member with a disability	2017 Northern California Wildfires	10	Rohnert Park, California (Aug. 2018)
Low-Income	2017 household income below $40,000	2017 Southern California Wildfires	8	Ventura, California (Aug. 2018)
Spanish-Speaking	Speak Spanish in the household*	2018 Mendocino Complex Wildfire	9	Lakeport, California (Apr. 2019)

* Focus group conducted solely in Spanish

Study Limitations

This research has several limitations, specifically related to the wildfire surveys. First, the surveys exhibit a self-selection bias since individuals opt into the study. Further, our surveys were not randomly distributed across impacted areas in California. To address these limitations, we attempted to distribute the surveys through multiple partnering agencies and news agencies to increase the geographic coverage. Moreover, we incentivized the surveys with the chance to win gift cards. The online survey method is also

a key limitation that leads to skewed demographic characteristics. The respondents in all three surveys are generally more wealthy, well-educated, white, and female than the population of the impacted areas. Naturally, an online survey is difficult to complete for individuals without access to the Internet and knowledge of how to use electronics (i.e., digital divide). Consequently, an online survey fails to reach many vulnerable populations. However, we do note that age and household characteristics (e.g., household size, homeownership, length of residency) show more variation. We also address the equity limitations by augmenting the survey through focus groups of vulnerable populations. While the focus groups were small and spread throughout several wildfires, discussions related to evacuation behavior and the sharing economy offer a strong supplement to the online survey method.

California Wildfire Case Studies

To assess the feasibility of the sharing economy in evacuations, we distributed a survey to individuals impacted by three wildfires: 1) 2017 October Northern California Wildfires (n=79), 2) 2017 December Southern California Wildfires (n=226), and 3) 2018 Carr Wildfire (n=284). We first asked individuals about their willingness to provide transportation and sheltering resources in a future evacuation under four scenarios (Table 3). We also asked participants about their current availability of shared resources and their reservations related to sharing transportation and sheltering resources in an evacuation. Finally, several scenario-specific questions were posed including the distance participants would be willing to transport an evacuee and the maximum time the participant would be willing to deviate from their evacuation route.

Table 3: Description of Sharing Scenarios for a Future Disaster

Scenario	1	2	3	4
Resource Type	Sheltering	Sheltering	Transportation	Transportation
Label	S1-Shelter-Cost	S2-Shelter-Free	S3-Transport-Before	S4-Transport-During
Wildfire Respondents	All	All	Evacuees only	Evacuees only
Explanation of Scenario	Individual's willingness to offer shelter to other evacuees at a **cost per night**	Individual's willingness to offer shelter to other evacuees **for free**	Individual's willingness to offer a ride to other evacuees **before the evacuation process begins**	Individual's willingness to offer a ride to other evacuees **during the evacuation**, enroute to the destination
Additional Information to Survey Taker	Shared home is safe and has not been ordered to evacuate		No additional information	
Recipient Description	The individual(s) receiving assistance is not specified beyond "individual(s)"			
Question Design	Likert scale from 5 (extremely likely) to 1 (extremely unlikely)			

Summary of Demographic Characteristics

A full summary of the demographic characteristics of the wildfire survey samples is located in the Appendix in Table A1 and Table A2. We briefly summarize the characteristics by wildfire below to provide context for the sharing economy survey results.

For the 2017 October Northern California Wildfires, respondents were predominately female (77.2%), highly educated (72.1% with a four-year degree or higher), and white (83.5%). Ages were highly varied and a significant proportion of respondents were 65 or older (21.5%). The survey undersampled young adults between the ages of 18 and 24 (2.5%). Just under half of respondents were employed full time (49.4%), and a significant proportion were retired (21.5%). Most respondents used private vehicles to commute to work (81.0%), while some worked from home (7.6%). While most respondents had previously experienced a wildfire (77.2%), just 20.3% had previously evacuated. The sample was also tech-savvy as 91.1% owned a smartphone and 100% had access to the Internet at home. A significant number of respondents were long-time residents (48.1% living in their residence for more than 10 years). Despite long-term residence, 41.8% of respondents said they did not know if they lived in a Cal Fire high risk area. The majority of respondents were homeowners (78.5%) and lived in single-family homes (79.7%). While household income skewed toward higher incomes (49.4% at $100,000 or more), some respondents did have incomes below $50,000 (12.8%). Most households had pets (75.9%), some households had children (27.8%), and some had at least one member with a disability (19.0%). Respondents were split between three counties: Sonoma (64.6%), Napa (24.1%), and Solano (11.4%).

For the 2017 Southern Northern California Wildfires, respondents were predominately female (73.9%), highly educated (77.5% with a four-year degree or higher), and white (81.5%). The sample had a higher proportion of Hispanics (11.1%) than the other survey samples. Age was highly varied including a sampling of 19.0% for adults 65 and over but an undersampling of people between ages of 18 and 24 (2.7%). The majority of respondents were employed full time (57.1%), with a significant number of retirees (22.1%). Almost all respondents drove alone to work in a personal vehicle (87.6%). For disaster experience, 93.4% of respondents had experienced a wildfire previously. Yet, only 35.3% had evacuated previously. While most respondents owned a smartphone (92.0%) and had Internet at home (98.7%), only 79.6% had either in-vehicle or smartphone navigation for driving. For household characteristics, 45.1% of respondents had lived in their residence for more than 10 years. While most respondents lived in a single-family home (73.9%), a significant proportion lived in an apartment (19.5%). The homeownership rate was 67.3%. For living in a Cal Fire high risk area, 38.1% said that they did, but 33.2% did not know. While household income skewed toward higher incomes (48.7% at $100,000 or more), some respondents had incomes below $50,000 (12.3%). Most households owned a pet (63.7%), and some households had children (25.2%). Households with a member with a disability represented 14.2% of the sample. Respondents were largely split between three counties: Ventura (43.8%), Santa Barbara (41.6%), and Los Angeles (13.3%).

For the 2018 Carr Wildfires, the demographic characteristics follow a similar trend as the other wildfire surveys with several key differences. Respondents were predominately female (69.7%), highly educated (59.2% with a four-year degree or higher), and white (90.8%). The sample was not as highly educated as the other wildfire samples. Ages were highly varied, but the survey still undersampled young adults (just 2.8% between 18 and 24). Just under half of respondents were employed full time (47.9%), while a significant proportion was retired (26.1%). Almost all respondents drove alone to work (92.6%). Most had experienced a wildfire (89.1%), but just 31.0% had previously evacuated. Respondents had considerable

access to technology with 93.0% owning a smartphone and 97.2% having access to Internet at home. However, in-vehicle or smartphone navigation access for driving was lower at 78.2%. For household characteristics, just under half of respondents lived in their residence for more than ten years (49.3%). Compared to the other wildfire samples, single-family home residences were significantly higher at 91.2%. The homeownership rate was 81.3%. Respondents had a moderate knowledge of Cal Fire high-risk areas (37.7% lived in one), but 27.1% of respondents did not know. Income overall was lower than the other two wildfires samples as 33.4% of respondents had a household income of $100,000 or higher. Households with income below $50,000 was 22.5% of the sample. Most households had pets at 81.7%. A significant proportion of households had a member with a disability (18.7%) and a significant proportion had children (35.2%). Almost all respondents resided in Shasta County (94.0%).

Current Use of Shared Resources in Evacuations

We first asked individuals if they used sharing economy resources during the wildfire evacuations (Table 4). No individuals in the 2017 Northern California Wildfires used TNCs or carsharing, while only a very small fraction did for the 2017 Southern California Wildfires and the 2018 Carr Wildfire. TNCs and carsharing services via private companies are fairly limited in several of the wildfire locations, contributing to these results. However, reflecting the wider geographical reach of homesharing companies such as Airbnb, VRBO, and Homeaway, homesharing was more prevalent in evacuations than shared transportation services. These results indicate that even without targeted policy mechanisms or marketing, homesharing composes a small but viable percentage of sheltering options in evacuations.

Table 4: Sharing Economy Use in Evacuations (Evacuees Only)

2017 Northern California Wildfires (n=37)	TNCs	Carsharing	Homesharing
Yes, used resource for evacuation	0.0%	0.0%	5.4%
No, did not use resource for evacuation	100.0%	100.0%	94.6%
2017 Southern California Wildfires (n=175)	TNCs	Carsharing	Homesharing
Yes, used resource for evacuation	1.1%	0.6%	4.0%
No, did not use resource for evacuation	98.9%	99.4%	96.0%
2018 Carr Wildfire (n=254)	TNCs	Carsharing	Homesharing
Yes, used resource for evacuation	0.8%	0.8%	5.1%
No, did not use resource for evacuation	99.2%	99.2%	94.9%

Willingness to Share Resources in Future Evacuations

We next asked participants about their willingness to share their own private resources in a future evacuation (Figures 2 - 4). We found that participants were more willing to share transportation resources than housing resources. This finding holds across all three wildfire case studies but is most prominent for the 2017 Northern California Wildfires. Sharing transportation requires a lower level of commitment (i.e., a few hours) compared to the higher requirements for providing shelter (i.e., several days to several weeks). In all three cases, more individuals were extremely likely to share housing for free than share

housing at a cost. This result may indicate community compassion expressed in the form of free relief. In addition, more individuals were extremely likely to share transportation during the evacuation process than before the evacuation. This intuitive result stems from the often-chaotic preparation time between risk recognition of the wildfire and the evacuation. With little lead time, all preparation time is valuable in loading luggage and beginning the evacuation. For both housing scenarios across wildfires, we found a strong floor of unwillingness based on those who were somewhat unlikely or extremely unlikely to share. The floor was not as strong for transportation but was higher for sharing transportation before evacuating than sharing during the evacuation. The results indicate that some individuals will not share resources under any circumstance.

Figure 2: 2017 Northern California Wildfires - Willingness to Share Resources

Shelter: n = 79; Transportation: n = 37

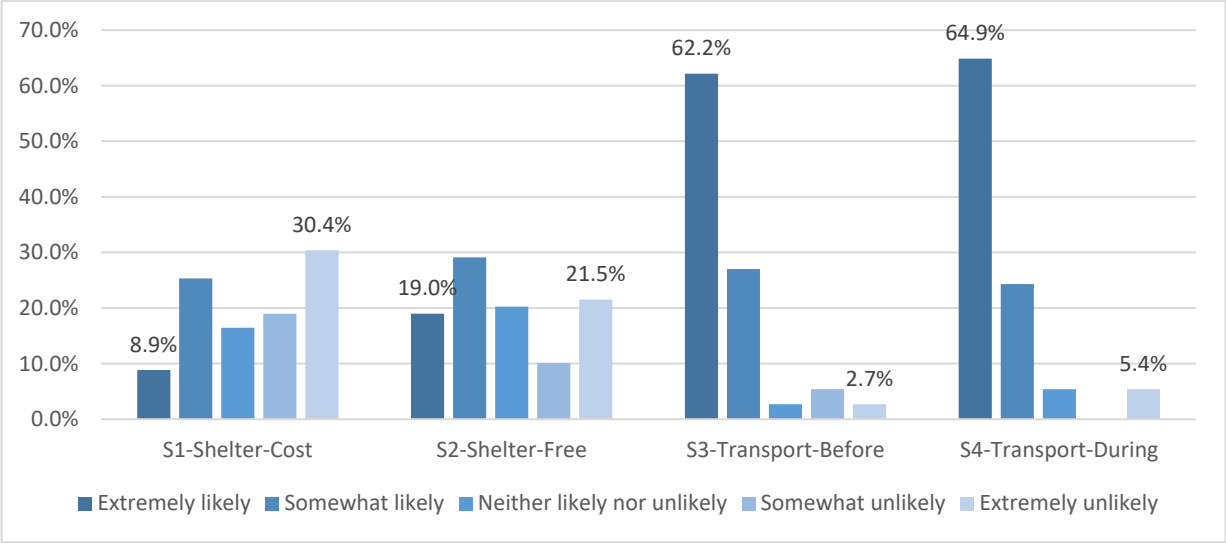


Figure 3: 2017 Southern California Wildfires - Willingness to Share Resources

Shelter: n = 226; Transportation: n = 175

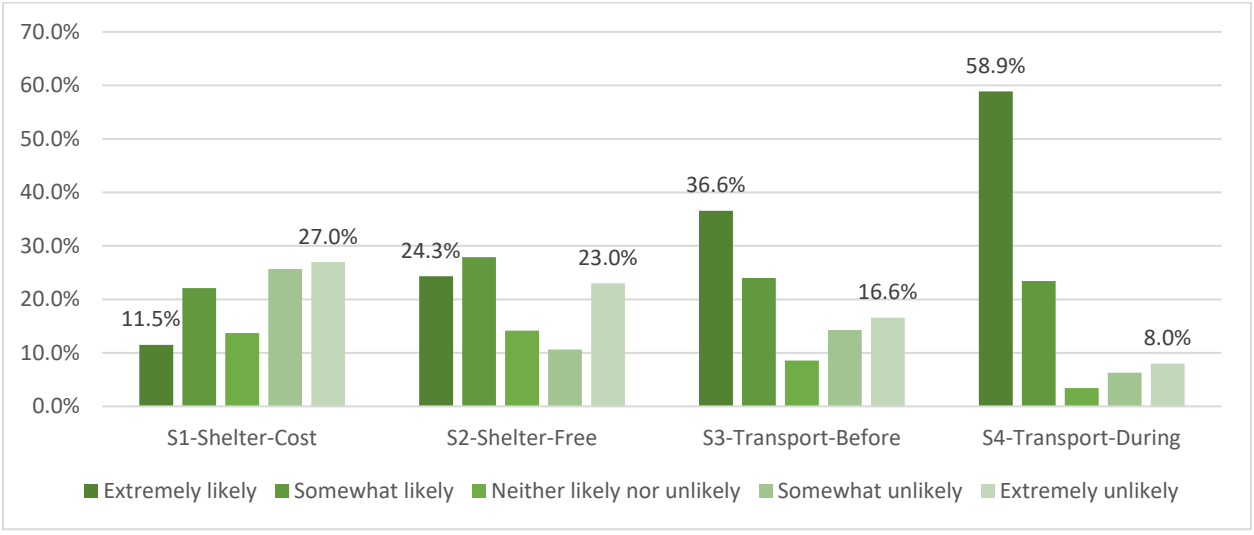
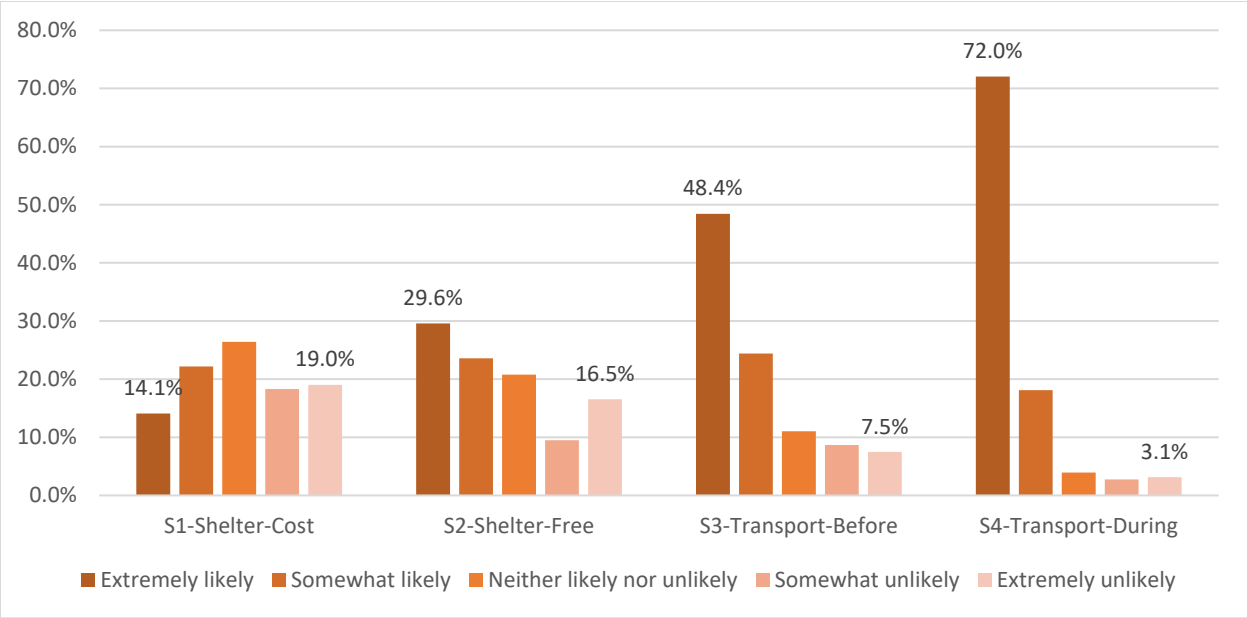


Figure 4: 2018 Carr Wildfire - Willingness to Share Resources

Shelter: n = 284; Transportation: n = 254



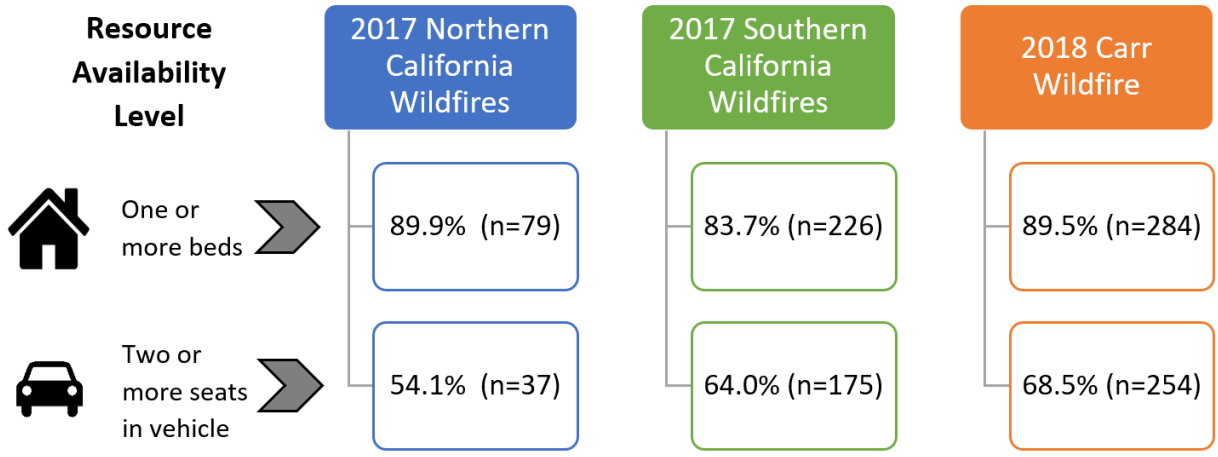
Capacity of Shared Resources

Even if an individual is willing to share their own resources, the amount of those resources plays a critical role in the feasibility of meeting the demand of evacuees (Figure 5). We first asked all respondents the number of available beds and mattresses that they had in their home. Almost all respondents stated that they had at least one or more beds available for all three wildfire cases, indicating substantial capacity. For transportation, we asked only evacuees about the number of open seats across *all evacuating vehicles*. We found a substantial number of evacuees had two or more seats in their vehicle, but this was far below the levels of sheltering. Consequently, a mismatch problem arises. While respondents have a large number of sheltering resources, they are less willing to share. On the other hand, respondents are much more willing to share transportation during an evacuation, but many lack the capacity to transport individual evacuees, let alone households.

Sharing Economy Reservations and Additional Constraints

Despite these somewhat promising results of both willingness to share resources and the capacity to do so, respondents also indicated that they had numerous sharing economy reservations in the context of evacuations (Table 5). For sheltering, uncertainty about one's own safety or security was the most common reservation with over 50% for all wildfire cases. Close behind, respondents were concerned about feeling responsible for additional house guests, disruptions to everyday tasks, and having to interact with a stranger. Concerns about interacting with a stranger, as well as uncertainty about one's own safety or security, points to a lack of trust. A matching system that links unknown evacuees to providers of shared sheltering resources may not be robust enough, as it would fail to bolster trust. Indeed, some personal connection between the evacuee and shared shelter provider may be required to bridge the primary reservations (e.g., shared employer, neighborhood, school district, social/community group).

Figure 5: Current Capacity for Sharing Sheltering and Transportation



Respondents again cited uncertainty about one's own safety or security as a primary reservation for transporting evacuees (Table 5). Feeling responsible for the passenger was also prominently cited, indicating that liability concerns might be a barrier in willingness to share resources. Two other key reservations were not having enough space to carry additional luggage and adding extra time to the evacuation trip to pick up passengers. Many potential shared transportation providers would be evacuating with their own belongings, making space a key concern, especially when larger households need transportation. Sharing transportation may also add time to the evacuation if the provider needs to deviate from their evacuation route or travel longer distances to drop off their passenger. With the rapid spread of wildfires, time is a precious commodity that can impact survival. Consequently, the routing of the transportation matching system (or app) would require little to no deviation away from the provider's chosen route.

Table 5: Reservations for Sharing Sheltering and Transportation

Reservations of the Sharing Economy ***(Top Four Reservations Highlighted)***	**2017 Northern California Wildfires**	**2017 Southern California Wildfires**	**2018 Carr Wildfire**
Reservations About Sheltering an Evacuee	*n = 79*	*n = 226*	*n = 284*
Uncertainty about one's own safety or security	58.2%	55.3%	57.4%
Feeling responsible for the additional house guest(s)	49.4%	48.7%	45.1%
Disruption of everyday tasks	43.0%	42.0%	37.3%
Having to interact with a stranger	41.8%	40.7%	35.9%
Not enough space for the additional guest(s)' belongings	27.8%	29.6%	29.6%
General dislike of hosting	17.7%	21.2%	20.4%
Having to drive the individuals around	12.7%	12.8%	16.5%
Not having enough water and/or food	8.9%	24.8%	24.3%
No government oversight	5.1%	5.3%	3.9%
I do not have reservations	2.5%	4.0%	9.5%

Reservations About Transporting an Evacuee	*n = 37*	*n = 175*	*n = 254*
Uncertainty about one's own safety or security	54.1%	44.6%	48.4%
Feeling responsible for the additional passenger(s)	48.6%	44.6%	25.6%
Not enough space for the additional passenger(s)' belongings	45.9%	53.7%	42.9%
Adding extra time to the evacuation	43.2%	56.6%	45.7%
Having to deviate from evacuation route	32.4%	39.4%	31.9%
Having to interact with a stranger	24.3%	25.7%	16.9%
Having to drive the individuals for a long period of time	16.2%	22.3%	13.0%
Not having enough fuel	10.8%	18.3%	16.1%
Not having enough water and/or food	10.8%	8.0%	6.3%
I do not have any reservations	10.8%	6.9%	13.0%
No government oversight	5.4%	6.3%	1.2%

This conclusion is further supported by what respondents chose as the: 1) maximum time deviation from the evacuation route to pick up a passenger and 2) maximum miles to carry a passenger in an evacuation (Figures 6 and 7). We found that individuals prefer a maximum deviation of under 30 minutes with a sizable proportion stating they would only be willing to deviate less than ten minutes. These results are similar for all wildfire cases. The low willingness to deviate is likely related to both the hazards and the stressful evacuation process. Wildfires tend to spread quickly, and evacuees often have limited time to begin the process. The risks associated with spending an extra ten minutes picking up another evacuee are substantially higher than for evacuations with a longer lead time, such as hurricanes. Time also impacts the viability of certain routes, which can become overrun by fire quickly.

We also found that respondents were generally willing to carry a passenger for only a small distance (Figure 7). Responses were concentrated under the 20-mile mark for all three wildfire cases. However, some participants were willing to carry individuals much further distances, even as far as 30 miles or more. For purposes of wildfire evacuations, a 10- to 20-mile trip might provide enough distance to reach a safe location, such as a public shelter. The distance to safety will depend on the wildfire, as passengers might need to be transported more than once. It should be noted, however, that almost all respondents were willing to carry a passenger some distance. This result suggests that route deviation presents a more significant barrier to sharing transportation. Absent route deviation, a provider might even be willing to transport an evacuee to their final destination.

Figure 6: Maximum Time Deviation from Evacuation Route to Pick Up Passenger

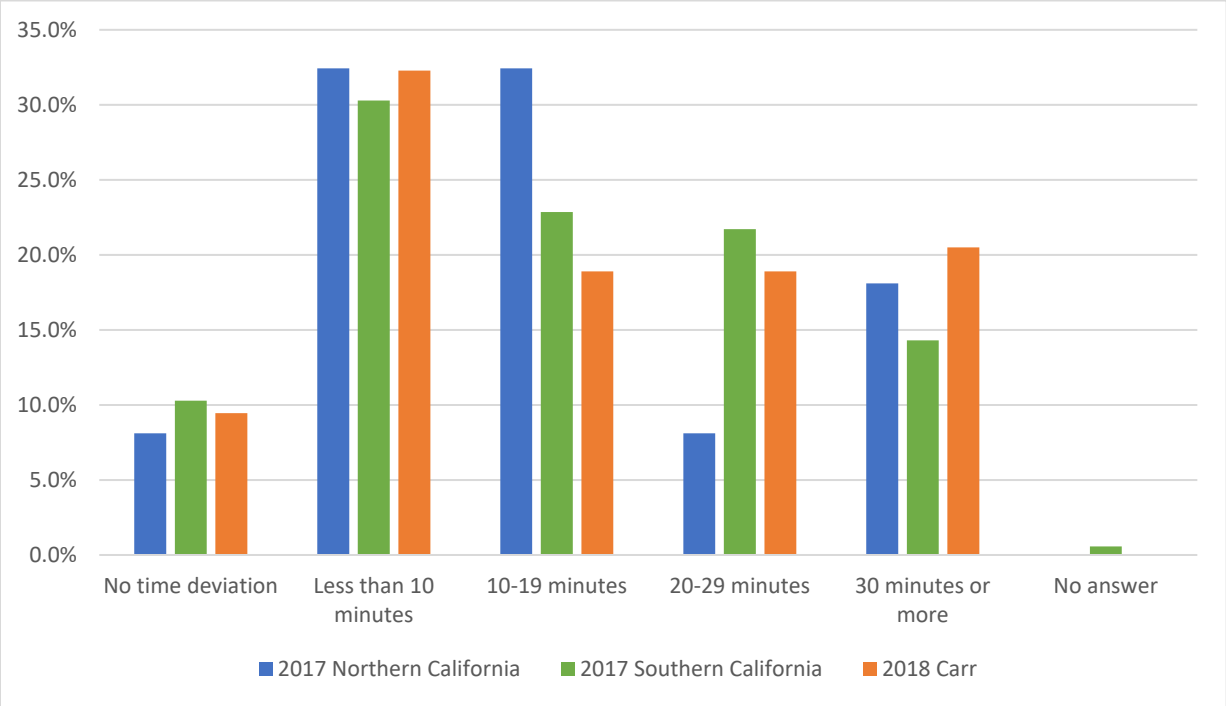
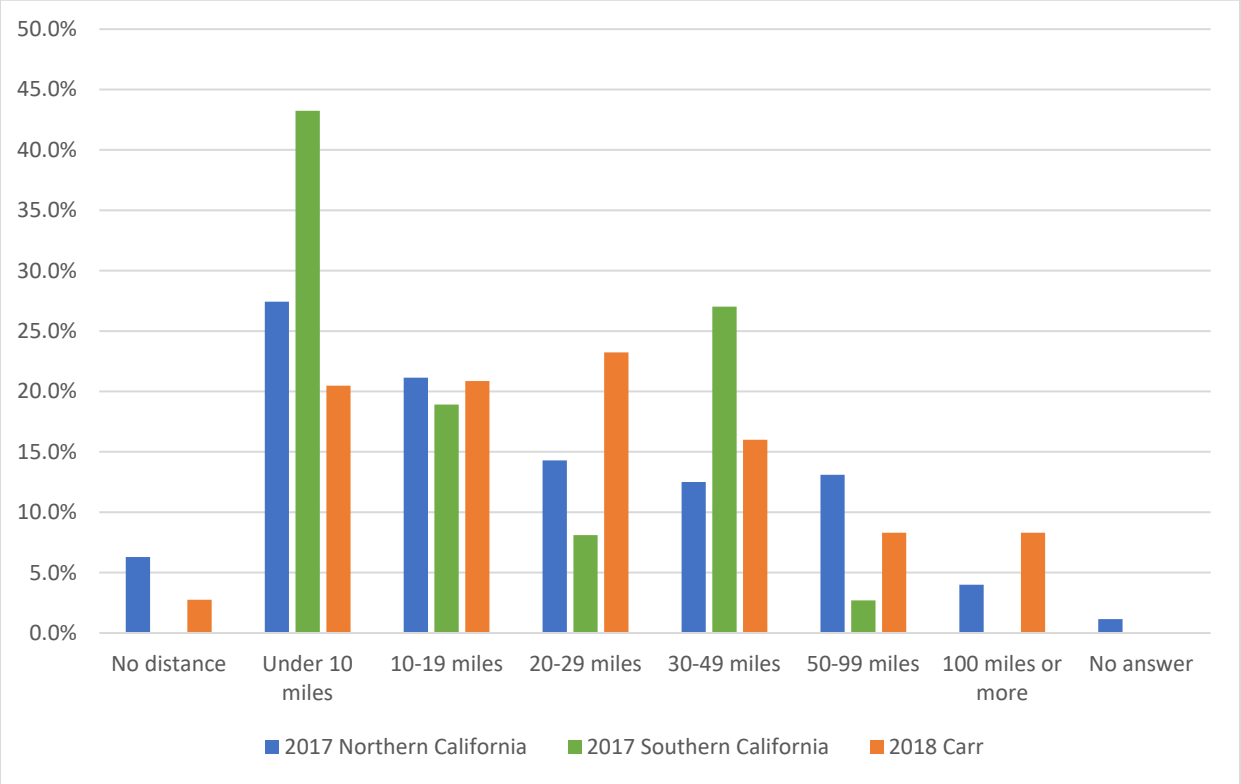


Figure 7: Maximum Miles to Carry Passenger



Key Takeaways

Using data from three surveys of individuals impacted by California wildfires, we provided a brief l analysis of the feasibility of leveraging shared resources in evacuations. Key takeaways include:

- TNCs and carsharing were rarely used in the three wildfire case studies.
- Homesharing constituted a small but viable sheltering option in the three wildfire case studies.
- A moderate number of individuals are extremely willing to share their own resources in a future evacuation.
- Individuals are more willing to share transportation than housing.
- Individuals are more willing to share transportation during the evacuation than before the evacuation.
- Space capacity exists for seats in vehicles and beds in homes, with a higher capacity of beds than seats.
- Potential home providers are predominately concerned about their own safety, feeling responsible for an additional guest, disruption to life, and interacting with a stranger.
- Potential transportation providers are predominately concerned about their own safety, feeling responsible for an additional passenger, having enough space in their vehicle, and adding extra time to their evacuation.
- Most potential transportation providers are unwilling to deviate far from their evacuation route.
- Most potential transportation providers are willing to carry evacuees some distance to safety in their vehicle.
- Sharing economy capacity, stated willingness, and reservations are fairly consistent across wildfire cases, indicating moderate generalizability.

Based on these results, a citizen-oriented approach to sharing resources may ensure that highly willing sharers have the means and mechanism to offer their services to evacuees. The type of policy levers will differ by geography as well as hazard. We also note that shared resources may not be fully accessible to all individuals, and some people may find these services hard to find and difficult to use. Next, we transition our discussion to the possibility of the sharing economy being used as an equitable strategy in evacuations. This work using data collected from vulnerable population focus groups offers a critical perspective on the opinions of potential users of shared resources in evacuations.

California Case Study Focus Groups

A key limitation of our online surveys is that certain populations did not have the opportunity to respond. These surveys missed individuals unable to access the Internet, knowledge of how to use computers, or the ability to read English. At the same time, the sharing economy has been considered a possible strategy to assist both the general population and vulnerable populations, resulting in more equitable evacuations (Wong et al., 2018). Given the survey constraints and the potential of the sharing economy to address equity issues, we conducted four focus groups composed of vulnerable individuals. The groups were defined as: 1) older adult, 2) individuals with disabilities, 3) low-income, and 4) Spanish-speaking. During each focus group, we asked participants about their general evacuation experience, how they received evacuation orders and information, and the processes for evacuating and returning after the wildfires. We also included a section of questions geared toward assessing the feasibility of the sharing economy as an equitable response strategy in evacuations. Participants were asked about their current use of the sharing economy and their opinions regarding the benefits and limitations of shared resources in an

evacuation. We encouraged participants to draw upon their recent evacuation experience, including the challenges they faced, in offering their opinions. In this section, we present characteristics of the focus groups and results from the sharing economy discussions (Table 6).

Table 6: Vulnerable Population Focus Group Characteristics

Focus Group Population	Older Adult	Individuals with Disabilities	Low-Income	Spanish-Speaking
Sample Size	**10**	**10**	**8**	**9**
Participant Characteristics				
Evacuated from Wildfire	9	10	6	8
Received Mandatory Evacuation Order	3	4	4	6
Lost Home in Wildfires	4	4	3	0
Sharing Economy Characteristics	N=10	N=10	N=8	N=8*
Used TNCs Before	50%	30%	63%	0%
Used Homesharing Before	60%	50%	50%	38%
Knowledge of Airbnb Open Homes Program	20%	30%	63%	38%
Used TNCs for Wildfire	0%	10%	0%	0%
Used Homesharing for Wildfire	10%	0%	13%	0%

** One respondent had to leave before the sharing economy discussion*

Focus Group: Older Adults

Opinions of the Sharing Economy: Older Adults

The older adult focus group was held for the 2017 October Northern California Wildfires in Rohnert Park in August 2018. For the group, a participant was eligible if they were 65 years or older. The group was composed of ten participants, of which nine evacuated from the wildfires and four lost their homes. Participants had moderate experience with the sharing economy as five had used TNCs before and six had used homesharing before.

Overall, the older adult focus group was mostly split on whether TNCs were beneficial or a problem for transportation (Table 7). Participants who use TNCs noted that it was cheap, easy to use, and still had a layer of security provided by the company. However, about half of the participants had a number of criticisms mostly directed to the lack of financial security and personal safety. A few others stated they had no need for TNCs since they already owned a vehicle, and they enjoyed the independence of their car.

Homesharing drew a similar split reaction from the participants (Table 8). Even for those who previously used homesharing, the opinions were mixed. While participants viewed homesharing as convenient, cheaper than hotels, and beneficial in exploring different neighborhoods, they also noted that the quality of the homes and rooms can be somewhat random. Moreover, they found the feedback and rental history

systems to be burdensome. For example, one participant said that they did not want to give negative feedback because then the host would also give a negative review. In addition, two participants expressed that they experienced poor customer service about issues with poor rentals.

Table 7: Older Adults: TNC Opinions

TNC Advantages	TNC Disadvantages
• Cheaper than owning a car	• Already own vehicle
• Cheaper than paying for parking, tolls, and gas	• Live far away from the city and where service is unavailable
• Easy to use	• Enjoy the independence of owning a private vehicle
• Complementary to public transit	• Vehicles cause problems with public transit
• Allows for greater freedom for those unable to drive for medical reasons	• Lack of financial security since account is linked to finances
• Gives flexibility in travel for those of an older age	• Feel vulnerable as an older adult
• Companies add security by tracking vehicles	• Preference for taxi drivers that live locally and know the area
• Companies ensure safety and use insured vehicles	• Drivers are not safe since there are no background checks
• Preferable in a number of use cases including: going to a large city, airport, medical appointment, traveling abroad, and out for a drink	• Drivers do not know local traffic laws, sometimes do not speak English, stop in random places on the road, and come from outside areas

Table 8: Older Adults: Opinion of Homesharing

Homesharing Advantages	Homesharing Disadvantages
• Hotels are too similar (prefer a change)	• Feedback system is unfair
• Often located in better places where hotels do not exist	• Randomness in the quality of the home/room
• Costs less than hotels, especially in cities	• Often need a rental history to find a place
• Simple and convenient	• Home/room can be dirty
• Enjoy exploring different neighborhoods	• Hosts can be difficult to work with
• Good customer service	• Poor customer service
• Useful for visiting friends and family, vacations, or making money	• Shared spaces, especially bathrooms, are not preferred
• Useful for a final evacuation destination	• Owns own RV

Sharing Economy in Disasters: Older Adults

When asked to consider the idea of using shared resources in an evacuation, participants in the older adult focus group did not have a positive outlook on using private companies as a strategy, particularly for sharing rides. Participants were most concerned about the drivers and their availability/reliability. Indeed, the group quickly noted that drivers may also be impacted by the wildfires and may need to evacuate their own families.[1] Drivers may also be unable to pick up passengers in the evacuation zone or may be unwilling to help assist in the evacuation process. Several participants also stated that they did not trust TNC drivers, and they had concerns about their personal safety. Several participants noted that the increase in resources would not make much of a difference in the evacuation process. Indeed, additional drivers may only lead to more confusion. Despite these many stated drawbacks, a few participants did view the use of TNCs in an evacuation more favorably. One key benefit they described is the ability of such mobility platforms to provide vehicle arrival times via their "apps." In general, participants warmed to the idea if this shared mobility strategy:

1) Received support and approval by the government in some capacity;
2) Included only drivers from the surrounding county (not impacted by the wildfires);
3) Ensured that costs would remain low (no surge pricing);
4) Focused on the recovery period following the evacuation (as well as the initial evacuation period); and/or
5) Leveraged a neighborhood network of volunteer drivers similar to carpooling.

Participants favored a community-driven approach for shared rides provided by volunteers over a strategy that used pre-existing private companies. One key advantage is that a neighborhood network would make participants feel more comfortable. Moreover, they viewed the creation of a neighborhood network as a mechanism that would encourage neighbors to meet each other and get to know one another. Participants noted that this network would allow them to know who they could rely on in an evacuation and who they could assist in an evacuation (as a driver or as part of a phone tree). One participant explained that neighborhoods are more readily able to form these networks. Despite this enthusiasm, several key limitations were also discussed. First, these networks would need to be coordinated well in advance, especially with regard to phone trees and driver allocation. Second, these drivers, especially in the neighborhood, would still need to evacuate their own families. Third, participants pushed the idea that drivers should be trained in some way to assist in the evacuation. The group generally presented a mistrust for coordinating evacuations with strangers and preferred to work with neighbors. Finally, the group was unable to determine the best form of communication. While most of the conversation focused on transportation, participants also expressed their thoughts on sharing houses in evacuations. In general, participants were more open to this idea, and they believed that Airbnb was a viable mechanism to offer these resources. Airbnb would allow people who were not impacted by the fire to help in some way. Finally, one participant said that people might be more willing to host if a tax deduction was available for assisting. Limitations and drawbacks were not mentioned during the focus group, indicating the more favorable view of homesharing over carpooling and TNCs in a disaster.

[1] This limitation somewhat contradicts earlier statements made by the group that Lyft and Uber drivers come from outside the area and do not know local conditions.

Focus Group: Individuals with Disabilities

Opinions of the Sharing Economy: Individuals with Disabilities

The individuals with disabilities focus group was held for the 2017 October Northern California Wildfires in Rohnert Park in August 2018. For the group, a participant was eligible if they had a disability (visible or invisible) or a family member with a disability. The group was composed of ten participants, of which all ten evacuated from the wildfires and four lost their homes. Participants had some experience with the sharing economy as three had used TNCs before and five had used homesharing before.

Participants from the focus group of individuals with disabilities held mostly negative views of TNCs, particularly related to accessibility (Table 9). They noted that the vehicles from these companies are often not wheelchair accessible nor spacious enough to store a wheelchair. Without knowing the accessibility features of the arriving vehicle, some felt they could not trust the service. One participant noted that their friend often experiences cancellations when the driver realizes they have a disability. Still, the individuals who had used TNCs explained that the service was convenient in certain situations, including overcoming medical limitations related to driving, traveling when their car was under repair, and going out for an evening. Participants offered fewer opinions for and against homesharing (Table 10). They were in agreement that Airbnb was most useful for vacationing. However, accessibility for individuals with disabilities remains a key reason not to use homesharing.

Table 9: Individuals with Disabilities: TNC Opinions

TNC Advantages	TNC Disadvantages
• Only option when vehicle is being repaired	• Expensive
• Preferable when going out for a drink or to a concert	• Not disability-friendly (vehicles) and possible discrimination toward individuals with disabilities
• Allows for greater freedom for those unable to drive for medical reasons	• Poor perception of TNCs and leaders within the companies
• Convenient without inconveniencing friends/family	• More useful to the younger generation that goes out
• Helps pick up children from school	• Lack of knowledge of arrival time
• Useful for certain evacuation situations	• Poor vetting process for drivers
	• Safer TNC options (e.g., Women Driving Women)
	• No incentive to use if people own their own vehicle
	• Companies are not paying their share for roads and impact on airport facilities

Table 10: Individuals with Disabilities: Opinion of Homesharing

Homesharing Advantages	Homesharing Disadvantages
• Spending time in the city • Vacationing • More comfortable than a hotel • Evacuation purposes	• Poor accessibility for disabilities • Imposing as a guest in another's home

Sharing Economy in Disasters: Individuals with Disabilities

When asked about the benefits and limitations of the sharing economy in disasters, most participants gave a negative opinion of the usefulness of TNCs. Specifically, participants noted that sharing economy companies are not disabled-friendly, and the service would be cost prohibitive in an evacuation. Another concern was related to reliability – the driver may not show up in a chaotic evacuation. One participant explained that with so many people trying to leave a neighborhood in an evacuation, it would have been impossible for drivers to enter and pick up passengers. Another crucial issue is that the driver may not possess the knowledge to assist an individual with a disability. As a result, the driver may refuse to take someone, even in a critical situation. Unlike government emergency workers, TNC drivers are not trained to save people in a disaster.

Despite these drawbacks, several participants noted possible opportunities where TNCs could be applicable and useful. Participants were more willing to back leveraging shared resources if companies:

1) Created partnerships with paratransit that could identify and assist individuals with disabilities;
2) Assisted carless individuals by providing rides between shelters or to stores;
3) Transported evacuees only after the evacuation was over;
4) Included an option in the application to note their disability type or if they had pets; and
5) Trained drivers to identify and assist individuals with disabilities.

For homesharing, participants noted similar limitations including concerns about the accessibility of homes for individuals with disabilities. In addition, hosts may not have the knowledge to successfully provide assistance for them. Indeed, one participant explained that they required oxygen, which was readily available at many shelters. However, an individual's home would most likely not have that available. Others stated that they would not want to impose on other citizens for assistance and would not want to be a guest in someone's home. Despite these limitations, participants noted several benefits including:

1) A more pleasant environment to stay instead of a crowded shelter;
2) Easier access to food, which would only come at specific times in shelters;
3) A location to bring pets with adequate caregiving resources; and
4) A way for people to volunteer and more efficiently distribute resources.

One participant stated that one local city operated a small program of 50 to 60 homeowners who would assist in an evacuation. They also noted that a senior citizen residence took in some evacuees, and independent organizations helped facilitate homesharing. Another participant thought that homeless shelters should be tapped given their experience in providing housing. Many participants were also willing to assist, if not forced to evacuate and still had a home. Participants noted the challenge of obtaining shared resources without smartphones. One participant stated that a local radio station was effective in its dissemination of information about resources. Other programs, such as homeless shelters and evacuation centers, also tried to mitigate this problem by providing mobile phones and chargers.

Participants were also more open to shared resources, if a supporting system was developed within neighborhoods. One participant explained that each neighborhood needs to have their own evacuation plan, and shared resources could be a part of it. Several participants explained that neighborhoods had attempted to organize through a program called "COPE" and through Community Emergency Response Teams (CERT). These programs could organize neighborhoods, provide information in a disaster, and train residents in CPR and rescue scenarios. Information could also be passed through NextDoor (a neighborhood-based communication platform) to neighbors. Participants were strongly against involving the government in distributing or controlling shared resources or in public-private partnerships (with the exception of paratransit and private companies). This was due to the participants' poor experience with governmental communication. They explained that private citizens were often the ones fighting the fires and transporting people out of danger. Participants stated that they were more willing to work with and for community members rather than people from outside organizations, like private companies and government agencies. Yet, several participants stated that the government, although not playing a role, should still pay for the operations.

Focus Group: Low-Income

Opinions of the Sharing Economy: Low-Income

The low-income focus group was held for the 2017 December Southern California Wildfires in Ventura in August 2018. For the group, a participant was eligible if their 2017 household income was below $40,000. The group was composed of eight participants of which six evacuated from the wildfires and three lost their homes. Participants had moderate experience with the sharing economy as five had used TNCs before and four had used homesharing before.

Overall, the low-income focus group had strong opinions about TNCs that leaned more negative than positive (Table 11). Participants explained that TNCs are beneficial in certain cases but also stated reasons they do not use them, do not know how to use the service, and high costs. Furthermore, participants owned personal vehicles. The primary concerns of the group centered around the role of the driver. Multiple participants explained that they do not feel safe with the drivers, and they do not trust them. Moreover, some stated that they had witnessed erratic driving that posed a danger to both passengers and pedestrians. One participant noted that drivers may not be familiar with the area, and another said that drivers are often not punctual.

Table 11: Low Income: TNC Opinions

TNC Advantages	TNC Disadvantages
• Do not feel comfortable driving at night	• Already own vehicle
• Preferable for going out for a drink, especially given the high cost of a DUI	• Transportation in small, compact areas is already easy to use (public transit, cycling)
• First-mile, last-mile connection to public transit while traveling	• Do not know how to use the service
• Useful for going to volunteer activities	• Hard to use with disability, as there are few wheelchair accessible vehicles
• Convenient	• Cost prohibitive
• Easy to use especially where parking is difficult	• Security, erratic driving behavior, and trust concerns with the driver
• Helpful when personal vehicle is being repaired	• Drivers are not familiar with the area
• Used to commute to work	• Drivers are not punctual
	• Do not want to ride with strangers

The discussion related to homesharing was shorter and less contentious than that for TNCs. Most participants had positive experiences with homesharing and used it to travel (Table 12). Three of the participants are hosts through a homesharing platform, offering their homes to both strangers and visiting friends. During the conversation, a participant also noted that Airbnb hosts were offering their rooms for free during the wildfire evacuations. Five of the eight participants had heard about the Airbnb Open Homes Program. However, one participant also noted that they had heard of scams and did not know what to trust. Another participant explained that the program was not well promoted and only learned about it through a conversation at a local coffee shop.

Table 12: Low-Income: Opinion of Homesharing

Homesharing Advantages	Homesharing Disadvantages
• Vacation and travel	• Cost prohibitive
• Escape smoke from the wildfires	• Lack of availability
• Space for friends and family visiting from out of town	
• Means of connecting with people	

Sharing Economy in Disasters: Low-Income

Participants in general did not use sharing economy resources during the wildfires, with the exception of one participant who rented an Airbnb to escape the smoke from the fires. However, participants were quick to explain that while they did not use private company services, they had multiple friends who did. While much of the discussion focused on current use of Airbnb, some participants noted they were generally positive about further leveraging homesharing in a disaster. Moreover, one participant expressed the need for reforming short-term rental laws, which would allow people to help in an emergency without fear of breaking the law.

When specifically asked for opinions about using TNCs and shared transportation in a disaster, most participants were at first skeptical. Participants explained that there would be no incentive for a driver to enter a danger zone to pick up a passenger. In addition, some roads had been switched to flow completely outbound, making access a major issue. Participants also did not think that drivers should be forced to transport evacuees wherever they wanted to go. Another concern was having the money available to pay at that exact moment. Participants also talked extensively about the need to conduct more public transit-based evacuations, stating that bolstering the bus system might be a stronger option than using private company sharing platforms. There was considerable disagreement as to whether private companies should operate on their own or in partnership with the government. Several participants also noted that many members of the community were offering free rides and free housing for neighborhoods independent of sharing economy companies. Another individual noted that private companies did not act until after the primary evacuation, severely diminishing their usefulness during the disaster.

Despite these concerns, participants were open to the idea of shared transportation resources, and six of the eight held a positive opinion. If the resources were free, participants were collectively more open to shared resources. They also described frameworks that could be beneficial including:

1) Coordination from emergency services to send safe drivers who could provide rides to evacuation centers;
2) Operation by emergency services using their own vehicle fleet but with trained Lyft/Uber drivers that would be part of the emergency response initiative;
3) Well-established private company system and protocols without government involvement;
4) Contract to train drivers for both day-to-day and emergency operations;
5) Multi-modal system that prioritizes public transit and rights-of-way, with private companies helping when evacuees reach a safer location, such as shelters.

For these potential frameworks, participants were adamant about planning and preparation before a disaster. Specifically, participants wanted to be informed about the availability of resources prior to a wildfire, so they could be better prepared. One participant also explained that there would need to be a guarantee of services, especially from private companies. However, if drivers were willing to stay and the companies paid for it, one participant was very open to the idea. Finally, a participant mentioned that carpooling could be a method to evacuate and take vehicles off the road.

Participants talked extensively about the need to build a more comprehensive strategy using public transit services. This discussion occurred within the context of shared mobility. One participant explained that protocols need to be established in advance, especially to help individuals with disabilities and low-income individuals, if they do not have enough resources. One participant noted that marking normal bus stops

as evacuation bus stops could help in congregating people for transportation to shelters. Another participant explained that buses should also be handicap accessible. Shared resources or public resources could also be beneficial for other underserved populations, including the Hispanic community in the area. Finally, participants explained that text messaging would be the best method to communicate available shared resources. However, several pointed out the necessity for information long before the evacuation, as well as pre-planned routes and pickup points, especially given that communication may be unavailable.

Participants also expressed great interest in connecting the shared resource strategy to community organizations. Multiple participants mentioned the important work of numerous groups in providing funding, food, shelter, and transportation following the wildfires. However, a more prepared strategy employing public transit is a high priority, including a shuttle system to and from the evacuation centers.

Focus Group: Spanish-Speaking

Opinions of the Sharing Economy: Spanish-Speaking

The Spanish-speaking focus group was held for the 2018 Mendocino Complex Wildfires in Lakeport in April 2019. For the group, a participant was eligible if they spoke Spanish in the household. The group was conducted solely in Spanish. The group was composed of nine participants, of which eight evacuated from the wildfires but no one lost their homes. Participants little to no experience with the sharing economy as none had used TNCs before and three had used homesharing before.

We first asked the Spanish-speaking focus group participants about their current usage of TNCs and homesharing (Table 13). From the group, no one had used TNCs before, mostly because they are not available in the Lakeport or Lake County area. One participant mentioned that the area has a service available known as Maria's Midnight Ride, a local taxi that can be booked by calling. Since participants had not experienced TNCs, they did not have any reasons to use (or not use) it, beyond the lack of availability. When asked about homesharing, several participants noted that they had used Airbnb before, mostly to travel or go on vacation. However, participants who were not traveling did not use homesharing. Others said they stayed with friends, family, or at hotels when traveling. One participant noted that Airbnb costs fluctuate and can sometimes be high. Several participants also noted that their children often use homesharing.

Table 13: Opinion of Homesharing: Spanish-Speaking

Homesharing Advantages	Homesharing Disadvantages
• Traveling • Going on vacation	• No need to use it since not traveling • Stay with friends and family instead • High costs • Lack of availability • Discomfort with living in other people's space

Sharing Economy in Disasters: Spanish-Speaking

Given that many participants had little experience with TNCs and homesharing – especially through private companies – the discussion on the sharing economy in disasters was more ad hoc and free formed compared to other focus groups. When asked if they were providers or users of shared resources during the wildfires, several said that they found shelter at a friend's or family member's home. Several other participants offered housing to friends or family members during the evacuations. One participant noted that they could not offer space in their home because it was in an evacuation zone. That same participant also stated that they began to run out of food and were worried about electricity and water. In addition, several explained that they shared transportation with family members, which also saved on fuel costs. Another participant offered to transport several friends from church to ensure their safety. Finally, multiple participants mentioned that they offered to share other resources beyond transportation and sheltering, including food and power generators.

When asked about potential benefits and limitations of sharing resources, participants had mixed opinions about the prospect of sharing in disasters. Primary benefits that arose from the discussion related to sharing transportation included:

1) Providing transportation to people without vehicles, such as those who had to walk to evacuate;
2) Reducing the cost of fuel and increasing the number of evacuations before fuel shortages; and
3) Increasing the amount of resources for vulnerable populations, including older adults and those with disabilities.

Within the context of these benefits, participants noted that the resources would first need to be available and then communicated effectively to the community. Indeed, several participants explained that information about trustworthy programs was not available to many communities, especially Hispanic communities that relied on English to Spanish translations. Other participants explained that if they had space, they might be willing to pick up a neighbor, but only if they were located away from the wildfire.

Participants also discussed limitations of TNCs and shared transportation. These included:

1) People taking advantage of the situation and harming others;
2) Lack of trust in private companies and drivers;
3) No knowledge of companies and how to use potential services;
4) Poor communication of information in Spanish (written and spoken) to evacuees; and
5) High risk of entering a hazard zone to help others.

Participants noted that many people in Hispanic communities have no experience with shared services and would not trust any resources from private companies. At the same time, some are unable to read Spanish, making even written translations a poor mechanism for describing services and providing transportation information. One participant also explained that if they had to deviate even just a few blocks toward the fire, they would not share transportation due to the high-risk potential. Moreover, they noted that they would only share with a neighbor not a stranger. Indeed, the issue of trust was a consistent theme. Participants explained that they would much rather share resources with people they trusted rather than consider resources from other sources. Despite these limitations, some were generally

positive about shared resources, especially if the communication and trust barriers could be resolved. Moreover, participants noted that most people have good intentions, and they should try to receive these resources in good faith.

Regarding housing, most respondents held more negative views related to homesharing. Issues of trust surfaced, including a lack of trust of hosts and other people at the shared shelter location. The issue of burdening other people was mentioned, with one participant explaining that sharing housing with strangers would not be well accepted. People would much rather stay with people they highly trust. A discussion also arose about the potential amenities of shelters – including public shelters – which tied into the homesharing idea. Participants explained that people at public shelters often do not speak Spanish, shelters may not have enough food or common household items, and some shelters may not accept pets. One participant stated that they would feel uncertain about taking their kids to a public shelter. Despite this discussion on public shelters, participants were not generally positive about using homesharing instead. Only three participants had heard of the Airbnb Open Homes program. One explained that if people had heard about the program, more may have used it during the evacuation.

Finally, much of the discussion related to shared resources revolved around communication and information challenges. On the homesharing side, a participant explained that the community was not informed about possible housing resources—both homesharing and public shelters. In other cases, resources were described but only in English, making it difficult for Spanish-speakers to find the resources. One participant noted that if Uber and Airbnb conducted background checks and this was relayed to the public, more people would use these services. Communicating the credentialing process to increase trust was mentioned in several other instances. Naturally, if people do not trust a potential shelter or source of resources, they are generally unwilling to leverage it. Participants were also unwilling to share personal information or resource availability across wider platforms or channels, even if they had spare space in homes or vehicles. Finally, several participants stated that education around sharing resources in an emergency would be needed to increase sharing.

Focus Groups: Key Takeaways

The four vulnerable population focus groups offer a foundation for developing a sharing economy framework that benefits all people. Specifically, TNCs – despite some major concerns and limitations – could be feasible in a future evacuation using some of the recommendations offered by focus group participants (Table 14). Participants were generally positive about homesharing (with the exception of the Spanish-speaking group), but they did not explore it as much as they did TNCs in the discussion. To summarize, Table 15 includes several limitations and potential strategies noted by focus group participants for shared mobility and sheltering.

Table 14: TNC Key Takeaways

	Older Adult	Individuals with Disabilities	Low-Income	Spanish-Speaking
View of TNCs in Disasters	Mostly negative	Mostly negative	Largely split	Largely split
General TNC Limitations	• High concern about driver availability and reliability • Low trust of drivers and private companies • Low access in hazardous zones			
Group Specific TNC Limitations	• Personal safety concerns • Little to no impact in amount of resources	• Companies are not disability friendly • Low knowledge of assisting those with disabilities	• No money available to pay for services	• Not knowing about companies and how to use potential services • Poor communication of information in Spanish
General Strategies for TNCs	• Plan in advance using well-established protocols and disseminating resource information • Build a community-driven approach (neighbors helping neighbors) • Focus on the recovery period following the evacuation • Train drivers to assist all people in disaster situations			
Group Specific Strategies for TNCs	• Partner with local governments • Use drivers who live in unimpacted zones • Ensure that costs remain low (no surge)	• Create partnerships with paratransit that could identify and assist individuals with disabilities • Include an option in the application to denote disability and/or if pet owner	• Foster coordination between emergency services and companies to send drivers • Develop multi-modal system that prioritizes public transit with private companies fulfilling first-mile, last-mile	• Provide information on available resources in Spanish • Include credentialing information for drivers to increase trust • Increase emergency education to encourage sharing across the community

Table 15: Homesharing Key Takeaways

	Older Adult	Individuals with Disabilities	Low-Income	Spanish-Speaking
View of Homesharing in Disasters	Somewhat positive	Largely split	Somewhat positive	Somewhat negative
Group Specific Homesharing Limitations	• Limitations not mentioned	• Low accessibility for disability • Hosts may need additional training • Do not want to impose on other people	• Limitations not mentioned	• Low trust of hosts and strangers • Sheltering with friends or family is more attractive • Homes may not have enough food/water
Group Specific Strategies for Homesharing	• Offer a tax deduction for providing home to evacuees	• Distribute information about available resources across multiple platforms • Leverage pre-existing senior care and homeless shelter options and expertise	• Reform short-term rental laws to increase supply of homes	• Provide information on available resources in Spanish • Include credentialing information for hosts to increase trust

Recommendations and Conclusions

To consolidate the results and discussion, we offer several actionable policy recommendations for public officials at emergency management and transportation agencies in all levels of government. These recommendations include simple first steps for policy directors and emergency planners to establish improved partnerships with sharing economy companies.

Partnerships

While numerous challenges remain, the recommendations act as a launching point to encourage agencies to consider adding shared resources into strategies for evacuation and sheltering response.

- Reach out to private companies to establish basic contacts and meeting opportunities;
- Add private companies to emergency management stakeholder meetings;
- Relay the mission, goals, and challenges that agencies face in emergency situations to private companies. The same process should occur for private companies wherein they explain their mission, goals, and challenges in disaster situations;
- Discuss appropriate policy mechanisms, beginning with memorandums of understanding (or MOUs). These mechanisms may differ by disaster and by use case, even within the same jurisdiction(s);
- Begin partnerships with information sharing and situational awareness;
- Research price gouging laws in the relevant jurisdiction(s);

- Focus on small-scale disasters and emergency situations and on supplementing (not supplanting) public assets by using private resources;
- Work with neighborhood associations to develop localized community-based plans to ensure transportation for neighbors; and
- Amend current evacuation plans (e.g., ESF 1 - Transportation Functional Annex) to add private companies as resource partners and designate the appropriate communication flow with other agencies, such as law enforcement (ESF 13) and community-based organizations (ESF 17)

We also recommend that several California disaster policies should change to bolster the amount of sharing economy resources and improve partnerships.

- Amend the California Office of Emergency Services (CalOES) Emergency Plan to require disaster councils to add a multi-hazard evacuation plan with clearly outlined transportation assets (both public and private) as a part of their Emergency Operations Plan (EOP);
- Consider the addition of sharing economy companies into the Business Operations Center (BOC) pursuant of SB 546 (Disaster Public-Private Partnerships Act of 2006); and
- Require disaster councils to identify all available resources, whether public or private, for vulnerable groups to meet the requirement of AB 2311 (Emergency Services: Access and Functional Needs in Emergencies Act of 2016), which requires cities and counties to integrate access and functional needs into emergency plans upon next update.

It should be noted that different partnerships may be applicable for different emergency management and transportation agencies across the U.S., depending on the availability and size of the sharing economy services. While an obvious start would be in large and vulnerable cities (e.g., San Francisco, New York City, New Orleans, Houston), small cities could benefit from the increase in resources and any enhancement to response and recovery capabilities. With the global reach of many sharing economy companies, opportunities also exist internationally, particularly for typhoons and earthquakes in the Pacific Rim and terrorist attacks in city centers. However, given the more tenuous relationships between sharing economy companies and cities outside the U.S., the applications abroad may be more limited.

We also note that multiple public agencies and community organizations will need to develop partnerships (or at least working relationships) with sharing economy companies. Several items need to be considered in the planning process. First, local areas need to determine if resources from sharing economy companies are even available. Sharing economy companies often do not operate in rural areas of California. Consequently, a community-based strategy that leverages neighbors and private citizens will be most effective (e.g., carpooling networks, homesharing networks, phone trees, CERT integration). We note that these community-based strategies should not be restricted to rural areas but are also crucial for disaster preparedness in larger cities and suburban communities. Second, several entities need to be consulted in developing a shared resource strategy. Specifically, law enforcement agencies, such as the California Highway Patrol, are responsible for on-the-ground evacuation response and can restrict access to areas where sharing economy vehicles may attempt to go. Other agencies also should be consulted as noted in Table 16 below. Other entities, including city governments and neighborhood associations should also be part of the conversation. Finally, the relationships developed with the various agencies in Table 16 may differ by jurisdiction and even by hazard. Flexibility within these relationships is crucial, which is why we recommend beginning with situational awareness and working relationships before developing more structured shared resource partnerships.

Table 16: Implementing a Sharing Economy Strategy through Partnership Development

Agency Type	Emergency Support Function	Examples	Connection to the Sharing Economy
Transportation Agencies	ESF-1 (Transportation)	▪ California Department of Transportation ▪ Los Angeles Department of Transportation ▪ San Francisco Municipal Transportation Agency	Transportation agencies typically have relationships with sharing economy companies. These relationships can act as starting points for building further partnerships. Agencies also have a broad understanding of the transportation network and where resources may be needed.
Public Transit Agencies	ESF-1 (Transportation)	▪ Gold Coast Transit ▪ VINE Transit ▪ Santa Rosa CityBus ▪ Redding Area Bus Authority	Public transit agencies often provide additional, high-capacity assets to transport evacuees. Sharing economy companies should work in tandem with public transit agencies not in competition. For example, shared transportation could be effective in transporting evacuees from a central drop off point to other locations around the area. This would require substantial organization in advance.
Regional Metropolitan Planning Organizations (MPOs)	ESF-1 (Transportation)	▪ Santa Barbara County Association of Governments ▪ Shasta Regional Transportation Agency ▪ Metropolitan Transportation Commission	In some cases, the regional MPO is the clearinghouse for all transportation-related information in an evacuation in regions with population of 50,000 people or more. Partnerships are needed with MPOs such that information about the actions of sharing economy companies can be efficiently disseminated. Moreover, MPOs have a broad understanding of the transportation needs of the region and may be able to direct sharing economy companies to provide resources in specific areas.
Firefighting Agencies	ESF-4 (Fire and Rescue)	▪ Cal Fire ▪ Local fire departments ▪ Local first responders	Firefighting agencies play multiple roles in wildfire events, including evacuating citizens and restricting access to hazardous areas. Agencies should be aware of sharing economy companies and that the companies may be operating in areas near the hazard.
Emergency Management Agencies	ESF-5 (Management)	▪ California Office of Emergency Services ▪ Ventura County Office of Emergency Services ▪ Sonoma County Fire and Emergency Services Department ▪ Lake County Office of Emergency Services	Emergency management agencies are typically the lead agency in disasters. Agencies also often issue evacuation orders and communicate directly with the public. This messaging could include information about shared transportation and sheltering options. A working relationship would be most appropriate for these agencies.

Housing and Health Agencies	ESF-6 (Care and Shelter)	▪ California Health and Human Services ▪ Shasta County Housing and Community Action Programs ▪ Ventura County Human Services Agency	Housing and health agencies are responsible for ensuring that evacuees find both short-term and long-term shelter. While most sheltering management is given over to the American Red Cross and other community-based organizations (CBOs), agencies retain some oversight ability. Consequently, they can help disseminate information about shared resources, especially housing, to evacuees.
Law Enforcement	ESF-1 (Transportation) ESF-13 (Law Enforcement)	▪ California Highway Patrol ▪ California National Guard ▪ Local police departments	Law enforcement, especially the California Highway Patrol, play a critical role in directing and managing evacuations. First, law enforcement officials should be consulted about developing cordons and procedures for permitting or restricting sharing economy transportation companies. Second, information from law enforcement can assist in developing situational awareness for where resources are needed. The same information can be used for public transit agencies, if the resource needs are high.
Community-Based Organizations	ESF-1 (Transportation) ESF-6 (Care and Shelter) ESF-17 (Volunteer and Donations Management)	▪ American Red Cross ▪ Volunteer Organizations Active in Disasters ▪ Community Organizations Active in Disaster ▪ The Salvation Army ▪ Catholic Charities ▪ United Way	CBOs are vital for developing and implementing shared resources, especially those from private citizens. Since these CBOs have extensive volunteer networks, leveraging these connections may boost the amount of resources for evacuees. Since partnerships already exist between some of these organizations and sharing economy companies, strengthening these relationships will produce a more structured and planned response.

Future Research Directions

Finally, several research directions are offered that would advance the framework of the sharing economy in disasters and fill key gaps in the current evacuation literature. These research recommendations are not meant to encompass the entire field of evacuations, but serve as a primer for future work that could build off of this report.

- Measure the number of current sharing economy assets and the availability of assets during emergency conditions;
- Determine the risk perception of individual providers and users in the sharing economy in cases of disasters;
- Study the capacity of other sharing economy assets such as:
  - Carpooling – grouping of travelers into a private automobile for trips between home and work locations or for trips that would have otherwise occurred;
  - Bikesharing – on-demand access to bicycles at a variety of pick-up and drop-off locations for one-way or roundtrip travel;

    - Scooter Sharing – on-demand access to electric scooters at a variety of pick-up and drop-off locations for one-way or roundtrip travel; and
    - Carsharing – short-term access to automobiles, allowing users to gain the benefits of a private automobile while forgoing auto ownership costs;
- Add an equity consideration to both the benefits and limitations of the sharing economy in evacuations;
- Focus additional research on the sharing economy to cover small-scale evacuations, non-hurricane evacuations, and rural evacuations; and
- Consider the role of innovative mobility beyond the sharing economy, including electric vehicles, driverless vehicles, and urban air mobility (e.g., flying cars).

As transportation expands its foothold in emergency management, agencies and local governments are now required to think more holistically about mitigation, preparedness, response, and recovery. Despite some of the legal battles between sharing economy companies and local governments, emergency management offers a unique opportunity for cooperation. This report contends that the sharing economy could be a strategy to offer moderate to substantial benefits in emergency management. Despite clear limitations for specific vulnerable groups, a number of strategies could be implemented within a sharing economy framework to increase the supply and demand for shared resources. This report argues that the sharing economy could address some pressing problems related to resource deficiency, slow responsiveness, poor communication, and low support for vulnerable groups. However, a focus on serving the needs of vulnerable populations is needed (embracing both obstacles and opportunities to use). Partnerships between emergency management and transportation agencies could further explore and foster a more formalized framework that leverages sharing economy platforms, including carpooling apps, and benefits emergency preparedness, response, and recovery while embracing social equity objectives.

Appendix

Table A1: Individual and Household Characteristics of Survey Respondents

	2017 Northern California Wildfires	2017 Southern California Wildfires	2018 Carr Wildfire
Individual Characteristics			
Gender			
Male	22.8%	26.1%	30.3%
Female	77.2%	73.9%	69.7%
Age			
18-24	2.5%	2.7%	2.8%
25-34	15.2%	17.7%	12.7%
35-44	12.7%	15.0%	19.0%
45-54	21.5%	19.0%	22.9%
55-64	26.6%	26.5%	19.7%
65+	21.5%	19.0%	22.9%
Race			
Asian	2.5%	2.7%	1.1%
Black or African-American	0.0%	0.4%	0.0%
Mixed	6.3%	7.5%	3.5%
Native American/Alaska Native	1.3%	0.4%	1.4%
Pacific Islander	1.3%	0.9%	0.0%
White	83.5%	81.4%	90.8%
Other	1.3%	4.0%	0.0%
Prefer not to answer	3.8%	2.7%	3.2%
Ethnicity			
Hispanic	5.1%	11.1%	5.3%
Not Hispanic	82.3%	76.1%	87.3%
Prefer not to answer	12.7%	8.8%	7.4%
Education			
Less than high school	0.0%	0.0%	0.7%
High school graduate	5.1%	0.9%	4.9%
Some college	12.7%	15.9%	23.2%
2-year degree	7.6%	5.8%	12.0%
4-year degree	32.9%	41.2%	27.8%
Professional degree	29.1%	28.3%	27.5%
Doctorate	10.1%	8.0%	3.9%
Prefer not to answer	2.5%	0.0%	0.0%
Employment			
Employed full time	49.4%	57.1%	47.9%
Employed part time	13.9%	11.9%	10.9%
Unemployed looking for work	5.1%	2.2%	2.8%
Unemployed not looking for work	5.1%	2.7%	4.2%

Retired	21.5%	22.1%	26.1%
Student	0.0%	2.2%	1.8%
Disabled	2.5%	1.3%	2.8%
Prefer not to answer	2.5%	0.4%	3.5%
Primary Mode of Transportation			
Drive alone using a car, SUV, pickup, or van	81.0%	87.6%	92.6%
Carpool/vanpool	0.0%	2.2%	1.4%
Rail (e.g., light/heavy, subway/metro, trolley)	0.0%	0.9%	0.0%
Bus	1.3%	1.8%	0.0%
Motorcycle/scooter	0.0%	0.9%	0.4%
Bicycle	1.3%	0.9%	0.7%
Walk	3.8%	0.4%	0.0%
Shuttle service	0.0%	0.0%	0.4%
Work from home	7.6%	1.8%	1.4%
Other	5.1%	0.9%	2.8%
Prefer not to answer/No answer	0.0%	2.7%	0.4%
Decision Making Role			
I am the sole decision maker	24.1%	25.2%	18.3%
I am the primary decision maker with input from another household member	12.7%	19.9%	19.4%
I share equally in making decisions with another household member(s)	58.2%	51.3%	57.4%
I provide input into the decisions, but I am not the primary decision maker	5.1%	2.2%	3.2%
Another person is the sole decision maker	0.0%	0.4%	1.4%
Prefer not to answer	0.0%	0.9%	0.4%
Previous Evacuee			
Yes	20.3%	35.3%	31.0%
No	79.7%	64.7%	69.0%
Previous Wildfire Experience			
Yes	77.2%	93.4%	89.1%
No	22.8%	6.6%	10.9%
Mobile Phone Type			
Do not own a mobile phone	1.3%	2.7%	3.2%
Own a typical mobile phone (non-smartphone)	7.6%	5.3%	3.9%
Own a smartphone	91.1%	92.0%	93.0%
Access to Internet at Home			
Yes	100.0%	98.7%	97.2%
No	0.0%	1.3%	2.8%
In-Vehicle or Smartphone Navigation			
Yes	87.3%	79.6%	78.2%
No	12.7%	20.4%	21.8%

Household Characteristics			
Displacement after Wildfire			
Same Residence	93.7%	88.9%	87.0%
Displaced	6.3%	10.6%	13.0%
No answer	0.0%	0.4%	0.0%
Length of Residence			
Less than 6 months	2.5%	5.8%	3.2%
6 to 11 months	2.5%	4.9%	5.3%
1 to 2 years	11.4%	12.4%	13.7%
3 to 4 years	13.9%	14.6%	9.5%
5 to 6 years	10.1%	7.1%	7.7%
7 to 8 years	8.9%	5.3%	5.3%
9 to 10 years	2.5%	4.9%	6.0%
More than 10 years	48.1%	45.1%	49.3%
Residence Structure			
Site build (single home)	79.7%	73.9%	91.2%
Site build (apartment)	12.7%	19.5%	4.2%
Mobile/manufactured home	6.3%	6.2%	4.6%
Prefer not to answer	1.3%	0.4%	0.0%
Homeownership			
Yes	78.5%	67.3%	81.3%
No	21.5%	29.6%	17.3%
Prefer not to answer	0.0%	3.1%	1.4%
Live in Cal Fire High Risk Area			
Yes	10.1%	38.1%	37.7%
No	48.1%	28.8%	35.2%
I don't know	41.8%	33.2%	27.1%
Household Characteristics			
Household with Disabled	19.0%	14.2%	18.7%
Household with Children	27.8%	25.2%	35.2%
Household with Elderly	29.1%	28.3%	31.3%
Households with Pets	75.9%	63.7%	81.7%
Household Income			
Less than $10,000	1.3%	0.4%	0.7%
$10,000 - $14,999	1.3%	1.3%	3.9%
$15,000 - $24,999	1.3%	2.2%	2.8%
$25,000 - $34,999	0.0%	2.2%	5.6%
$35,000 - $49,999	8.9%	6.2%	9.5%
$50,000 - $74,999	19.0%	14.6%	17.6%
$75,000 - $99,999	7.6%	11.5%	14.8%
$100,000 - $149,999	21.5%	21.2%	19.7%
$150,000 - $199,999	8.9%	13.3%	5.6%
More than $200,000	19.0%	14.2%	8.1%
Prefer not to answer	11.4%	12.8%	11.6%

Table A2: County of Residence of Survey Respondents

2017 Northern California Wildfires		2017 Southern California Wildfires		2018 Carr Wildfire	
Sonoma	64.6%	Ventura	43.8%	Shasta	94.0%
Napa	24.1%	Santa Barbara	41.6%	Other California	2.5%
Solano	11.4%	Los Angeles	13.3%	Non-California	3.5%
		Other California	1.3%		

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