8TH INTERNATIONAL WILDLAND FIRE CONFERENCE
GOVERNANCE PRINCIPLES: Towards an International Framework

Identifying Traffic Strategies for Wildfire Evacuations using Past Behaviour of Evacuees

UNIVERSITY OF ALBERTA

RESUME Group

RESILIENT AND SUSTAINABLE MOBILITY & EVACUATION GROUP

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

rimi California Resilient and Innovative Mobility Initiative

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tsrc Berkeley Transportation Sustainability RESEARCH CENTER

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Outline

Context

Transportation Choices in Wildfires

Traffic Strategies

CONTEXT

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Large-Scale Evacuations

- One of the primary methods to safeguard human life
- Consistently large wildfire evacuations in the U.S. and Australia
- Medium-sized evacuations in Canada, Portugal, Spain, Greece, Chile, etc.

Fort McMurray Wildfire, Alberta (2016)

Source: Greg Halinda/AP

Wildfires in California (Cal Fire, 2021)

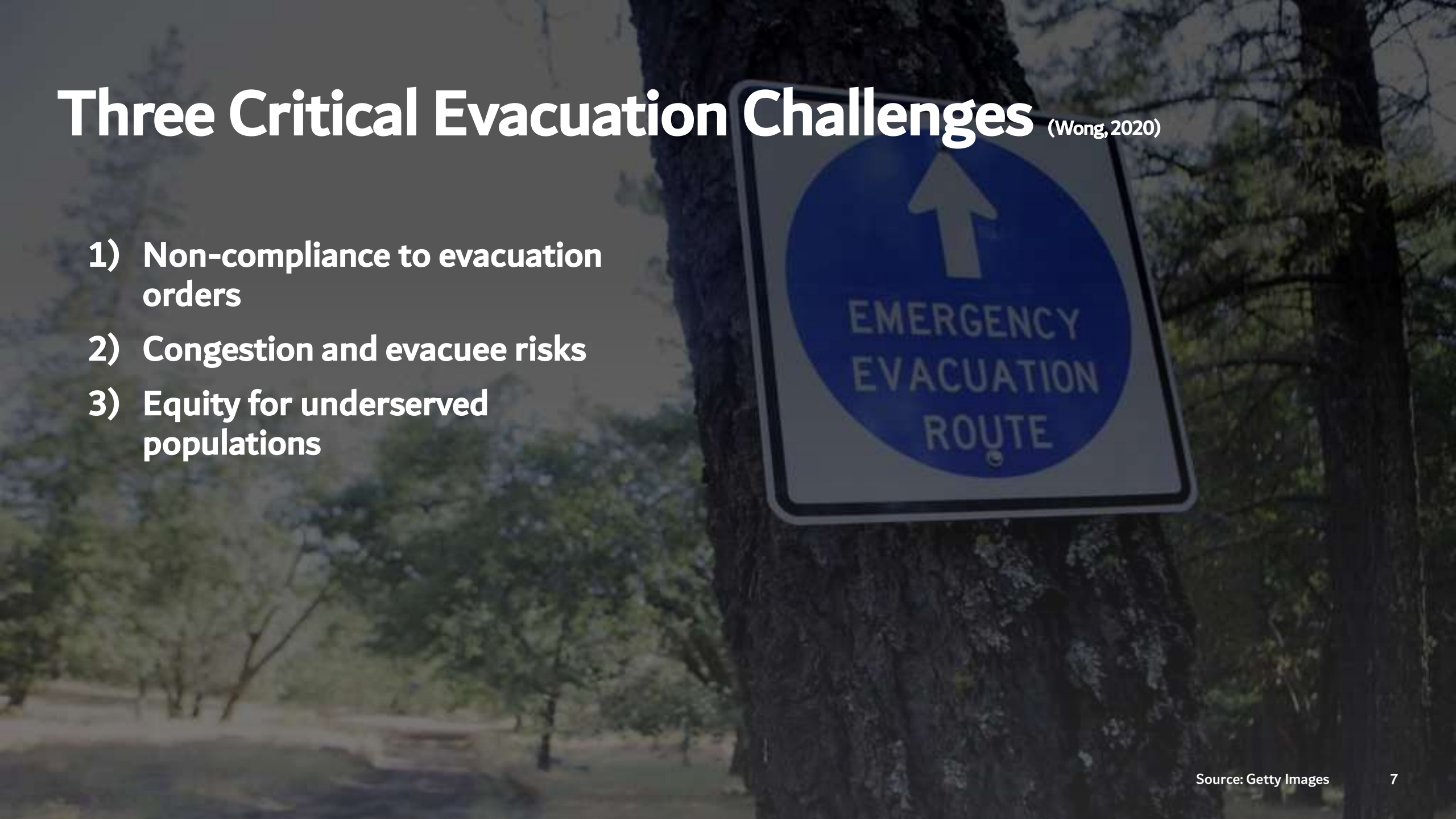
Year	Incidents	Acres Burned	Structures Destroyed	Fatalities	Evacuation Orders
2017	9,270	1.55 million	10,280	47	1.1 million people (Wong et al., 2020a)
2018	7,948	1.98 million	24,336	100	
2019	7,860	0.26 million	732	3	
2020	9,917	4.26 million	10,488	33	+350,000 people (research in progress)
2021	7,396	2.57 million	3,846	3	
TOTAL	**42,391**	**10.62 million**	**49,682**	**186**	**+1.45 million people**

Woolsey Fire, CA (2018)

Source: Grant Denham

Three Critical Evacuation Challenges (Wong, 2020)

1) Non-compliance to evacuation orders
2) Congestion and evacuee risks
3) Equity for underserved populations



Source: Getty Images

Focus of Presentation

1) Evacuee behaviour for guiding strategies

2) Traffic and transportation response strategies

LNU Complex Fire, California (2020)

Source: Noah Berger/AP

TRANSPORTATION CHOICES IN WILDFIRES

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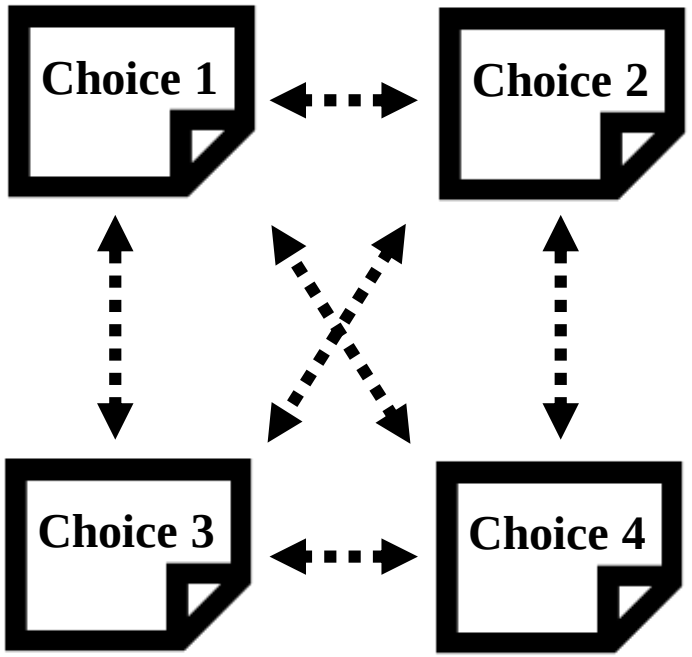
Latent Classes and Joint Evacuation Behavior

- **Wong, S.,** Broader, J., Shaheen, S. Walker, J. (2022). Understanding California Wildfire Evacuee Behavior and Joint Choice-Making. *Transportation, Springer*

Joint Correlation and Decisions

- Complex decisions in hazards that impact the transportation system
- Work has been done on joint choices in evacuations but only considering two choices at a time (Fu and Wilmot, 2004; Fu et al., 2006; Gudishala and Wilmot, 2012; Bian, 2017; Bian et al., 2019; Sarwar et al., 2019; Gehlot et al., 2019)
- Joint: Modeling more than two choice variables within the same model (Wong et al., 2020)
- **Portfolio choice model (PCM)** - originally developed for tourism choice (Dellaert et al., 1997; Van Cranenburgh et al. 2014)



Data in Summary

- Online survey to survivors of wildfires in California

Wildfire	Survey Sample
2017 Southern California Wildfires	226
2018 Carr Wildfire (Redding, California)	310

2017 December Southern California Wildfires

Source: New York Times

Portfolio Choice Model

Source: Daniel Sebler | Unsplash

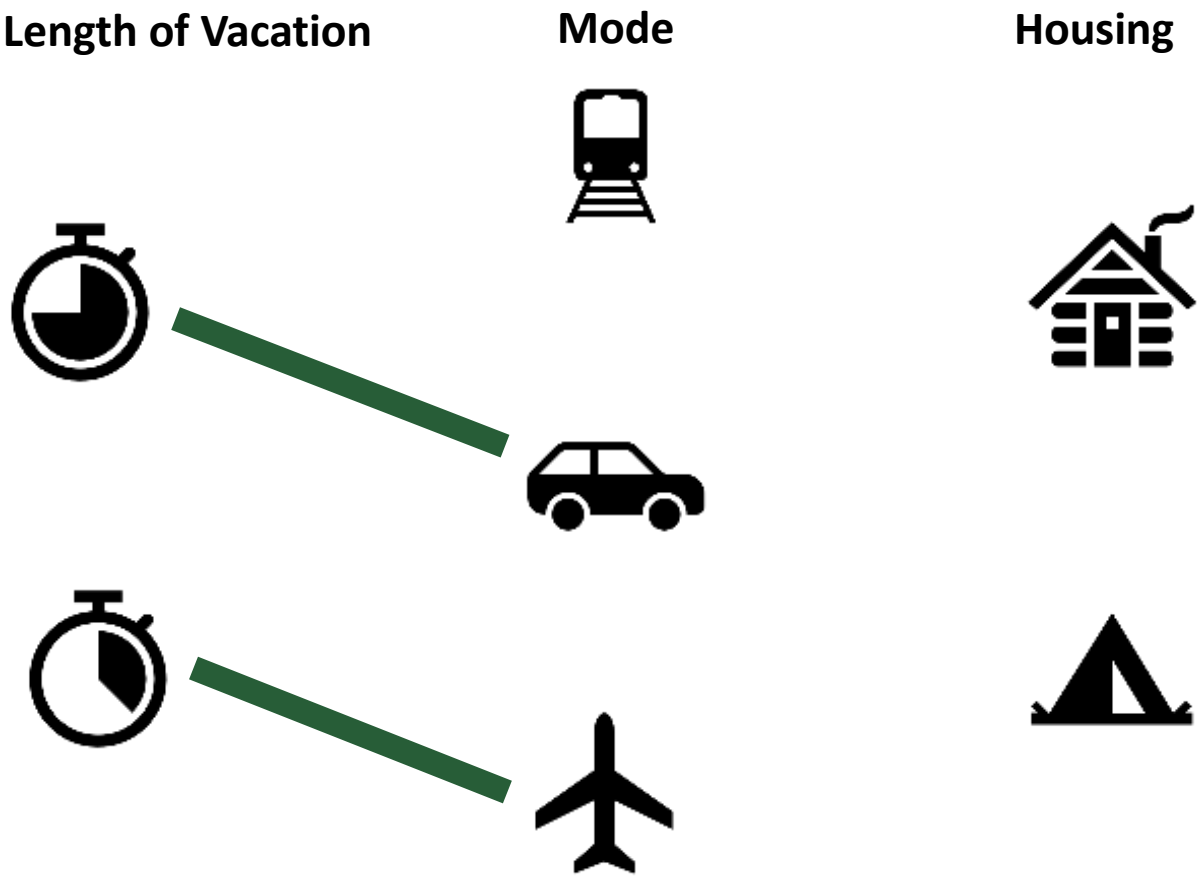
Length of Vacation

Mode

Housing

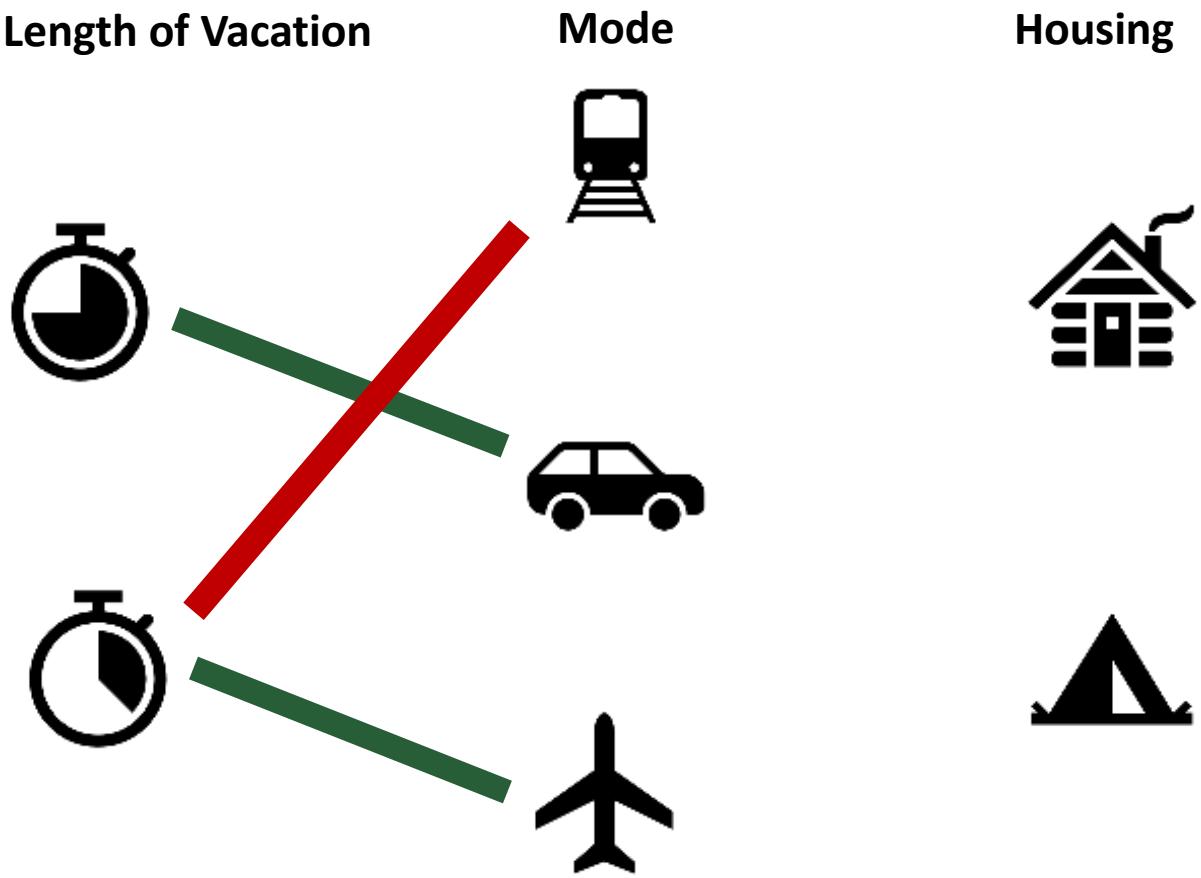
Portfolio Choice Model

Source: Daniel Sebler | Unsplash



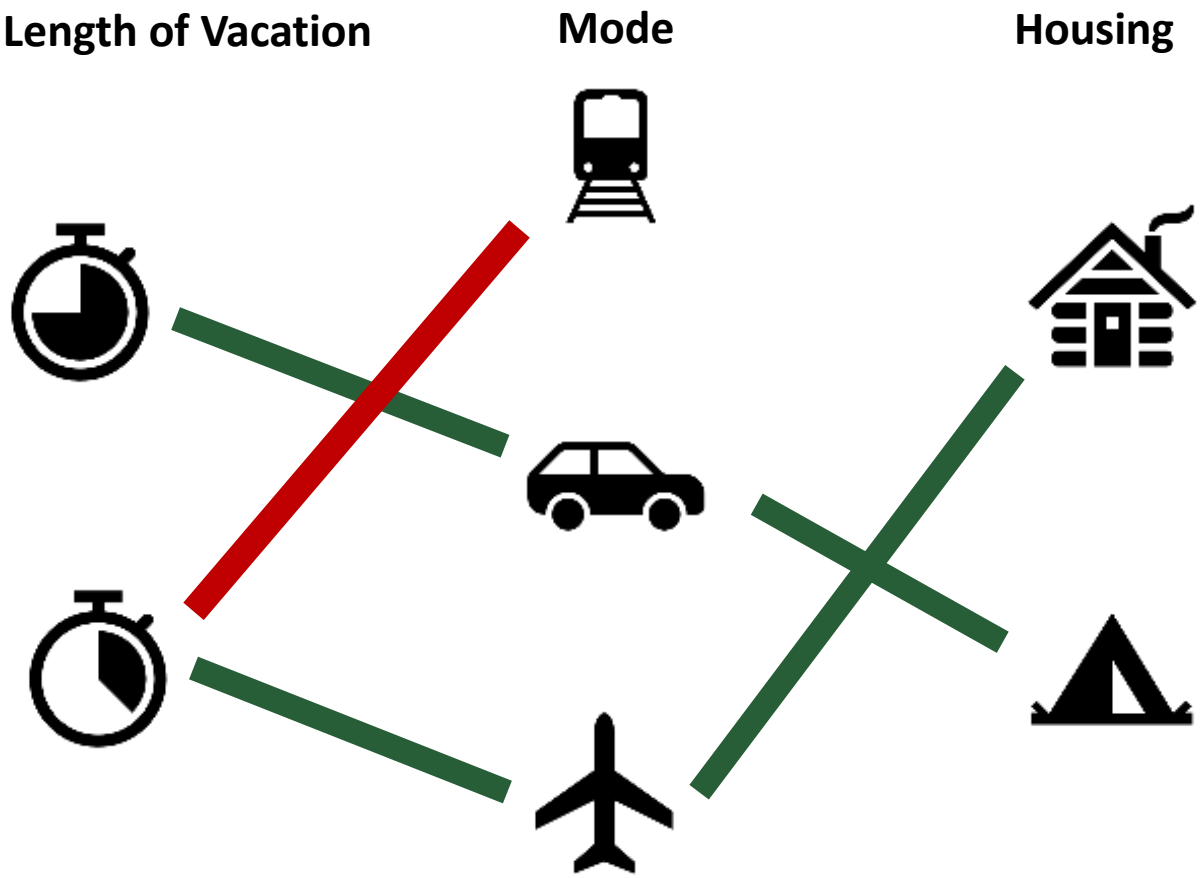
Portfolio Choice Model

Source: Daniel Sebler | Unsplash



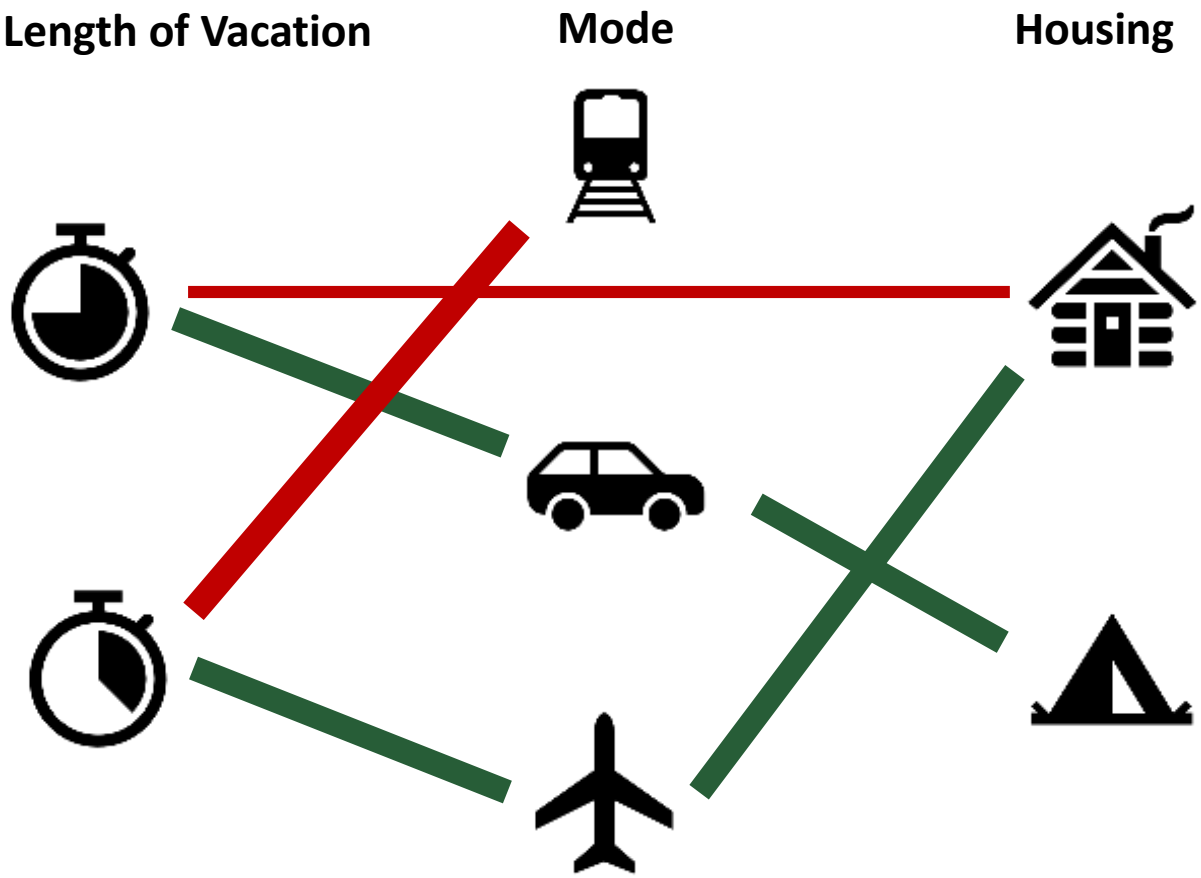
Portfolio Choice Model

Source: Daniel Sebler | Unsplash



Portfolio Choice Model

Source: Daniel Sebler | Unsplash



Portfolio Bundles

Departure Day
Immediate
Not immediate

Departure Timing by Hour
Night
Day

Destination Choice
Within county
Outside of county

Mode Choice
2+ vehicles
Other

Shelter Type
Public
Private

Primary Route by Road Type
Highway
Non-highway

PCM Within County – Interactions (Selected)

Interactions	Southern California Wildfires			Carr Wildfire		
	Est. Coef.	Std. Error	p-value	Est. Coef.	Std. Error	p-value
Within County x Night	1.12	0.35	0.001***	0.73	0.30	0.014*
Within County x Private	0.58	0.38	0.120	0.87	0.36	0.016*
Within County x Highway	-0.99	0.52	0.057	-1.22	0.29	<0.001***

Positive: Within County x Night

- Wanting to stay close during a higher risk time

Positive: Within County x Private

- Strong social networks within the county (e.g., friends/family)

Negative: Within County x Highway

- No need to travel on highways if staying close (can take local roads)

PCM Within County – Demographics (Selected)

	Southern California Wildfires				Carr Wildfire			
Variable	Est. Coef.	Std. Error	p-value		Est. Coef.	Std. Error	p-value	
Higher Level Degree (Master's, Professional, Doc.)	-0.63	0.39	0.101		-0.68	0.29	0.018	*
Living in Residence for More than 10 Years	1.38	0.41	0.001	**				
Impacted by Thomas Fire	-2.97	1.09	0.007	**				

Negative: Within x Higher Edu

- More resources and connections in other places

Positive: Within x 10+ Years

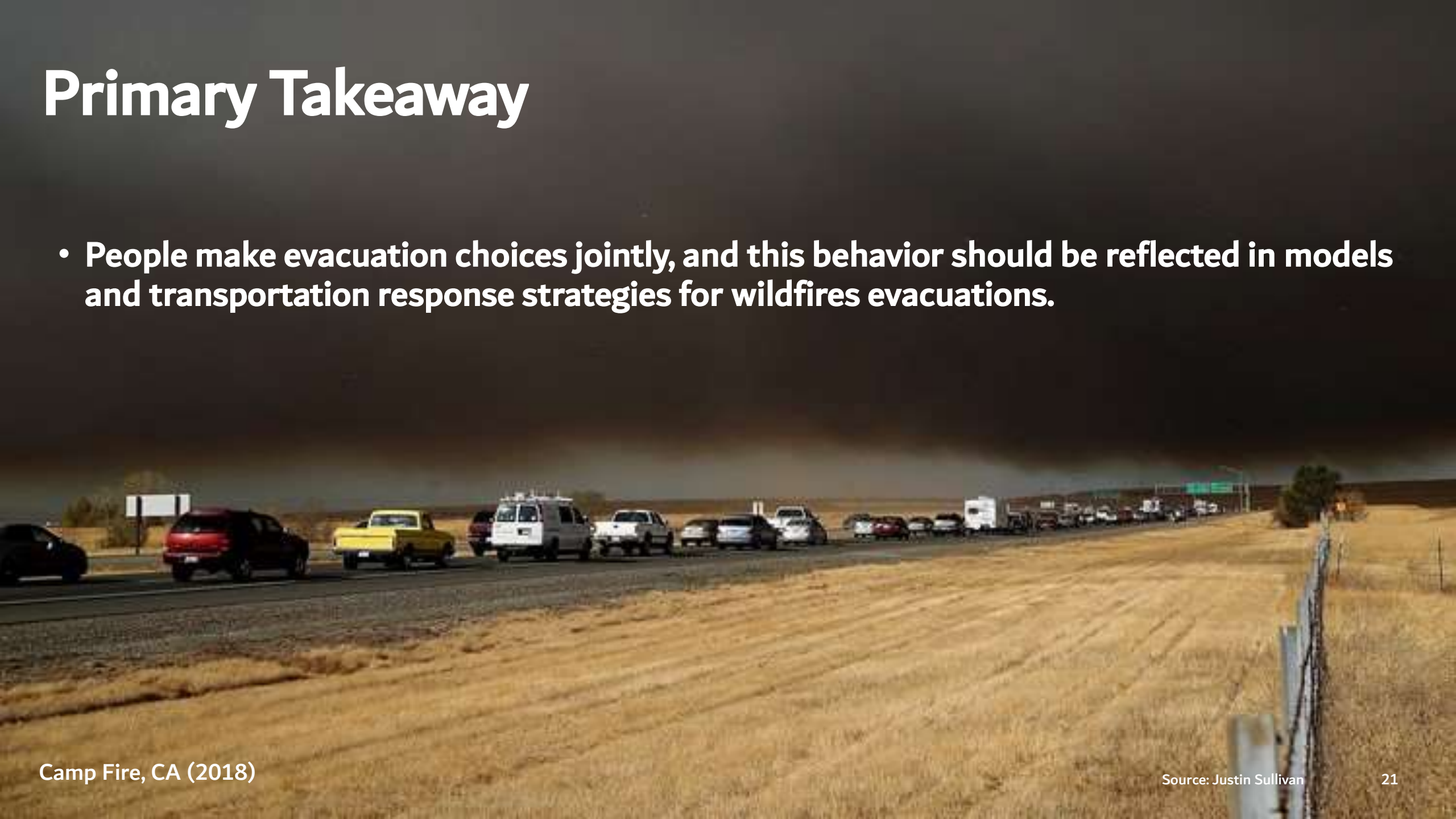
- Stronger connections to community and/or desire to defend/protect

Negative: Within x Thomas Fire

- Very large fire that significantly impacted two different counties

Primary Takeaway

- **People make evacuation choices jointly, and this behavior should be reflected in models and transportation response strategies for wildfires evacuations.**



Camp Fire, CA (2018)

Source: Justin Sullivan

TRAFFIC STRATEGIES

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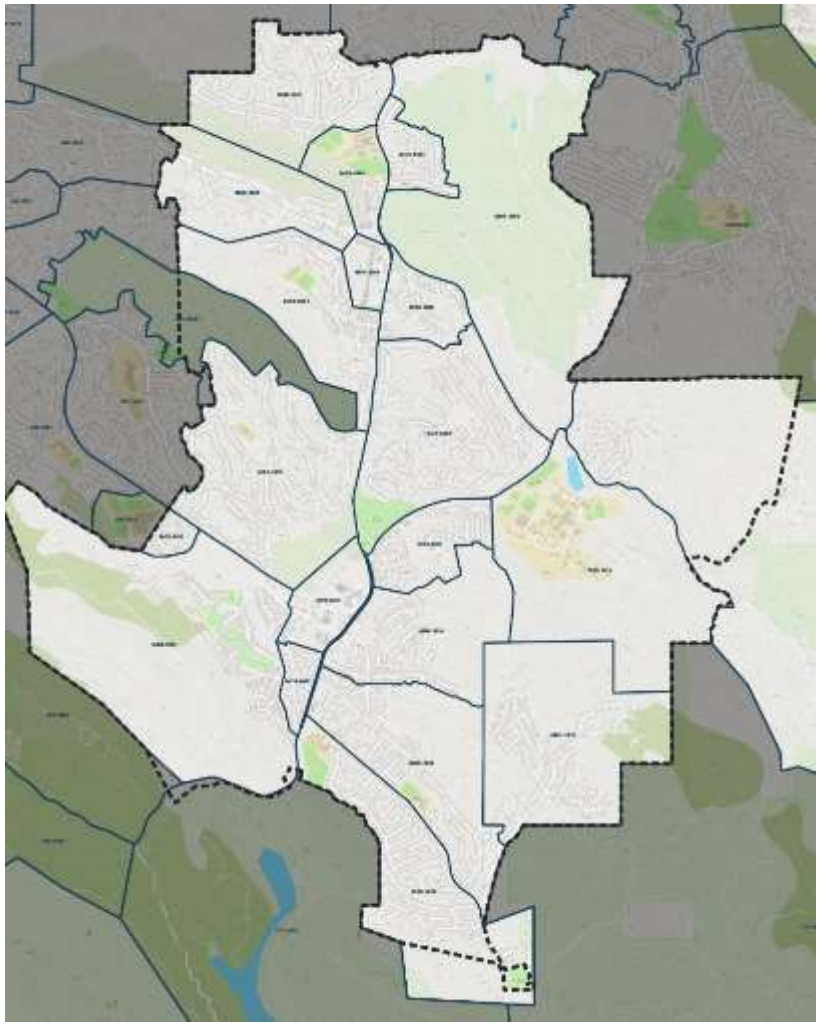
Demand-Side (Adapted from Lindell et al., 2019 and Wong, 2020)

Strategies
Timely departures
Phased evacuation
Triggered evacuations
Vehicle reduction



Credit: City of Moraga

Supply-Side (Adapted from Lindell et al., 2019 and Wong, 2020)

Strategies
Contraflow
Shoulder usage
Ramp closures
Route closures
Turn restrictions
Signal priority
Manual traffic control
Public transit
Mode shift
Parking restrictions

Credit: Andrew Heneen

Information-Side (Adapted from Lindell et al., 2019 and Wong, 2020)

Strategies
Rapid information delivery
Evacuation preparation
Route preparation
Dynamic route guidance
System monitoring
Travel information

Credit: Stephen Wong

Credit: Stephen Wong

Policy Implications for Portfolio Choice

Immediate x Night (Pos.)

- **Demand-side:** Phased evacuations can spread out demand during this peak period.
- **Supply-side:** Quick and low-resource responses should be used
- **Information-side:** Travel information and dynamic route guidance can help evacuees navigate.

Carr Fire, CA (2018)

Credit: Hung T. Vu

Policy Implications for Portfolio Choice

Within County x Night & Within County x Private (Pos.)

- **Demand-side:** Vehicle reductions may be feasible including the prepositioning of vehicles.
- **Supply-side:** Transportation responses should be highly localized.
- **Information-side:** Evacuation preparation should encourage identifying a shelter.

Camp Fire, CA (2018)

Source: Josh Edelson / Getty Images

Policy Implications for Portfolio Choice

Within County x Highway (Neg.)

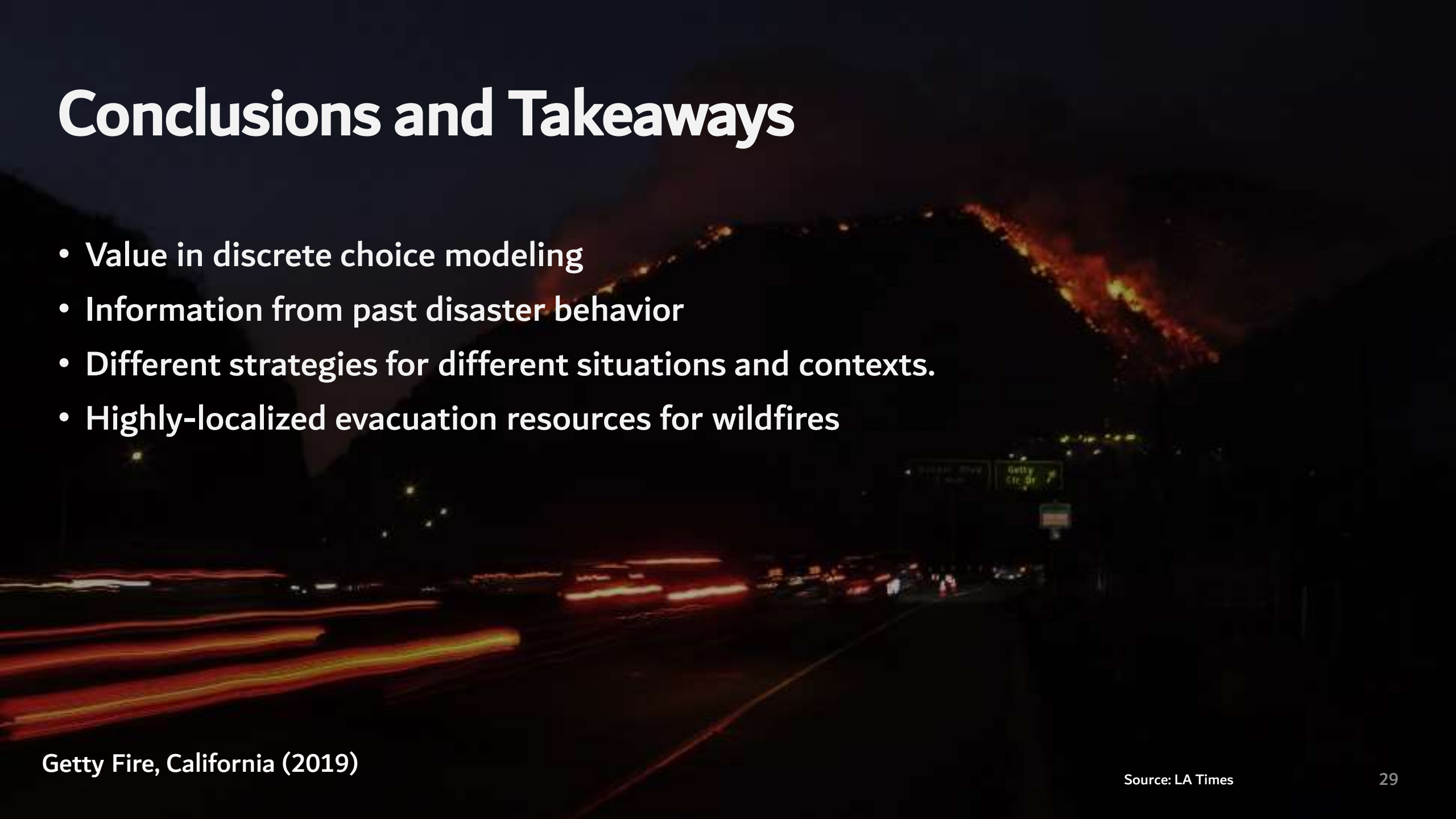
- **Demand-side:** Phased evacuation plans should assume less highway travel.
- **Supply-side:** Contraflow will not be effective unless it is used at a local bottleneck.
- **Information-side:** Route preparation should focus on arterial roadways and main streets.

Blue Ridge Fire, CA (2020)

Source: David McNew/Getty Images

Conclusions and Takeaways

- Value in discrete choice modeling
- Information from past disaster behavior
- Different strategies for different situations and contexts.
- Highly-localized evacuation resources for wildfires



Getty Fire, California (2019)

Source: LA Times

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Leading with Purpose.

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