IMPACT OF HOUSE, PARCEL, AND NEIGHBORHOOD CHARACTERISTICS ON STRUCTURE SURVIVAL

AMY METZ, ERICA FISCHER, ABBIE LIEL

SANTA CLARA COUNTY FIRESAFE COUNCIL
PRESENTATION 12-17-2024

Oregon State University

University of Colorado Boulder

Role of Housing in Wildfire

Role of Housing in Wildfire

https://wildfiretoday.com/2022/01/05/photos-before-and-after-the-marshall-fire-in-boulder-county-colorado/

https://www.denverpost.com/2021/12/31/marshall-fire-explained-firestorm-colorado-weather/

<u>During the Fire</u>

- Fuel for the fire
- Assets to be protected

A. J. Metz, E. C. Fischer, and A. B. Liel, “The Influence of Housing, Parcel, and Neighborhood Characteristics on Housing Survival in the Marshall Fire,” *Fire Technol.*, vol. 60, no. 6, pp. 4065–4097, Nov. 2024, doi: 10.1007/s10694-024-01616-7.

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<u>During the Fire</u>

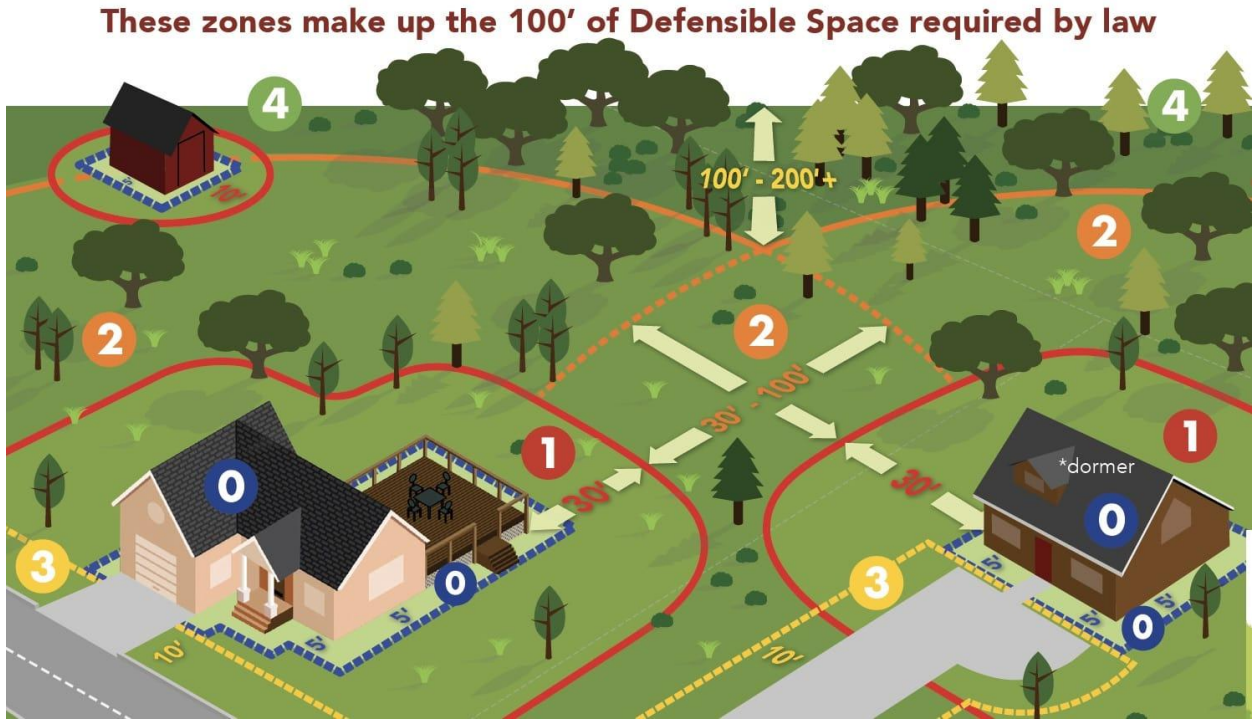
- Fuel for the fire
- Assets to be protected

<u>After the Fire</u>

- Cost to rebuild
- Business closures
- Job losses
- Population migration

A. J. Metz, E. C. Fischer, and A. B. Liel, “The Influence of Housing, Parcel, and Neighborhood Characteristics on Housing Survival in the Marshall Fire,” *Fire Technol.*, vol. 60, no. 6, pp. 4065–4097, Nov. 2024, doi: 10.1007/s10694-024-01616-7.

Role of Housing in Wildfire



https://www.landworks.co/defensible-space/

Wildfire Mitigation

- Focus on individual homeowner action
  - Defensible space
  - Home hardening

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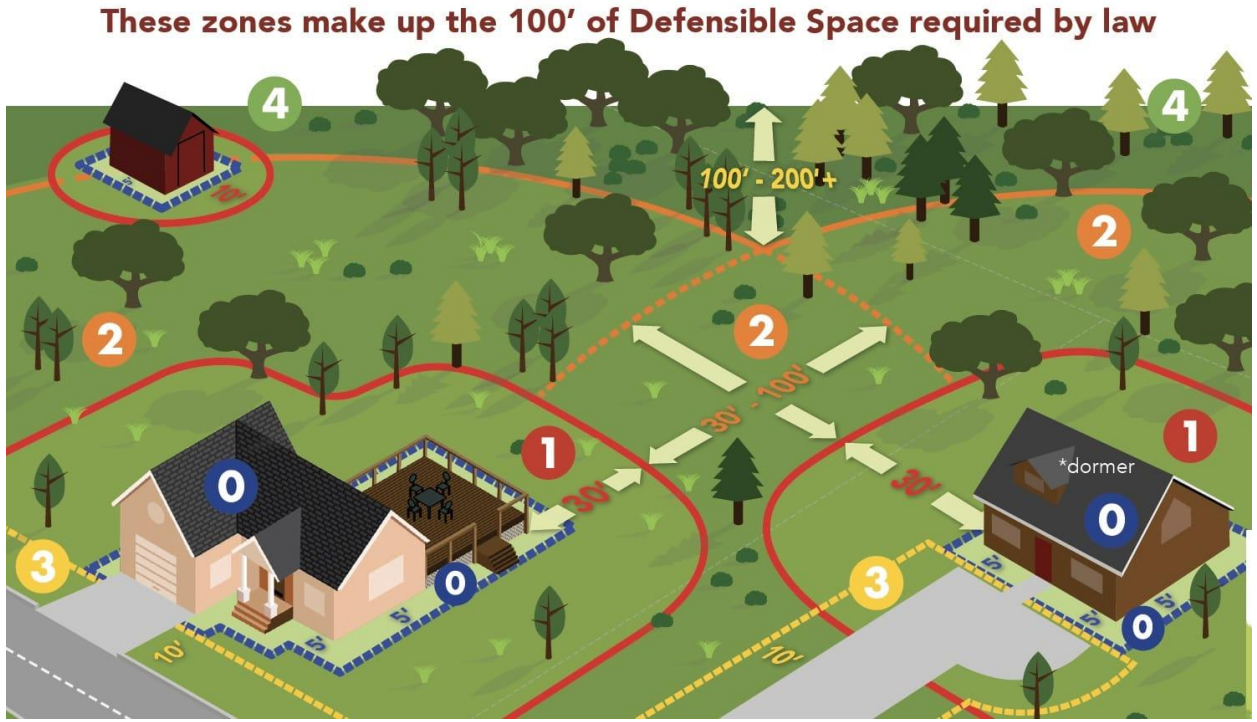

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Wildfire Mitigation

- Focus on individual homeowner action
  - Defensible space
  - Home hardening
- Most areas, such as Colorado, have no building code requirements
  - IWUI provides guidelines for fire-resistant construction
  - CA's Chapter 7a

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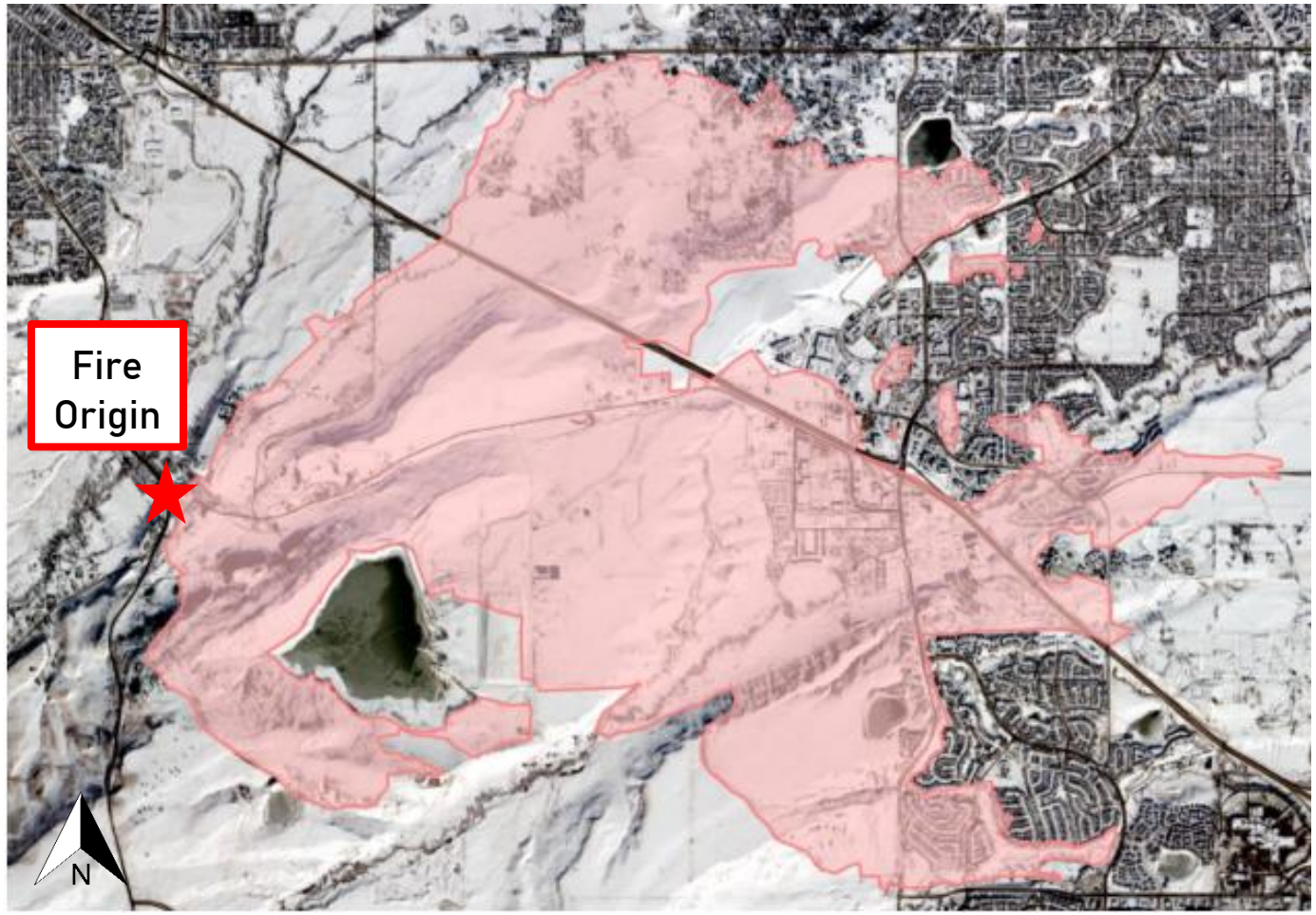
Marshall Fire: Context and Data

Marshall Fire Overview



adapted from Fischer, E., Wham, B., Dashti, S., Javernick-Will, A., Liel, A., Whelton, A., Berty, N., Klingaman, J., Metz, A., Ramos, J., Rose, H.-R., Collins, A., de la Cruz, A., Ellery, M., Gonzalez, J., Isaacson, K., Jankowski, C., Kun Kang, D., Ley, C., … Wartman, J. (2022). *The 2021 Marshall Fire, Boulder County, Colorado*. https://doi.org/10.18118/G6KT04

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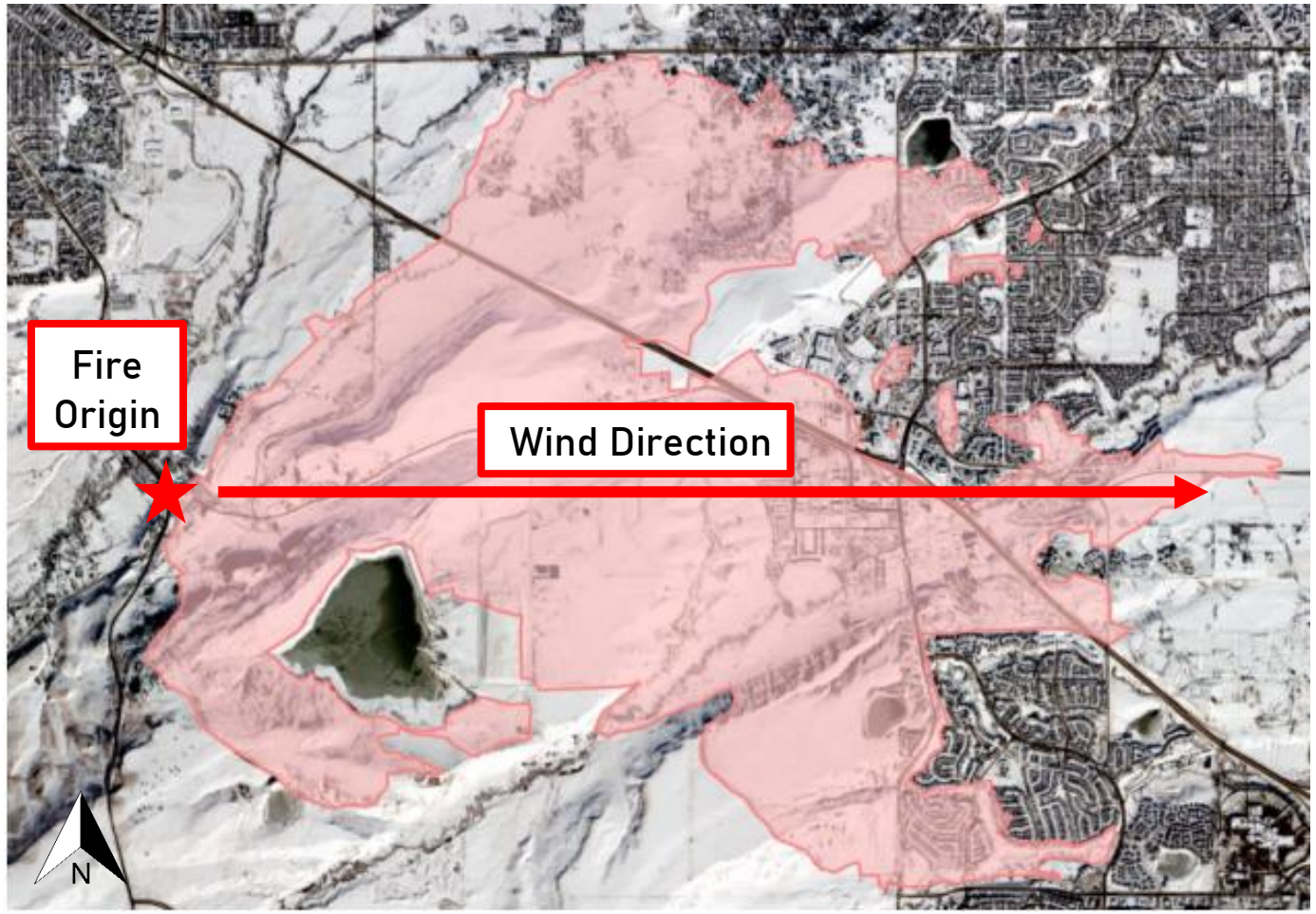

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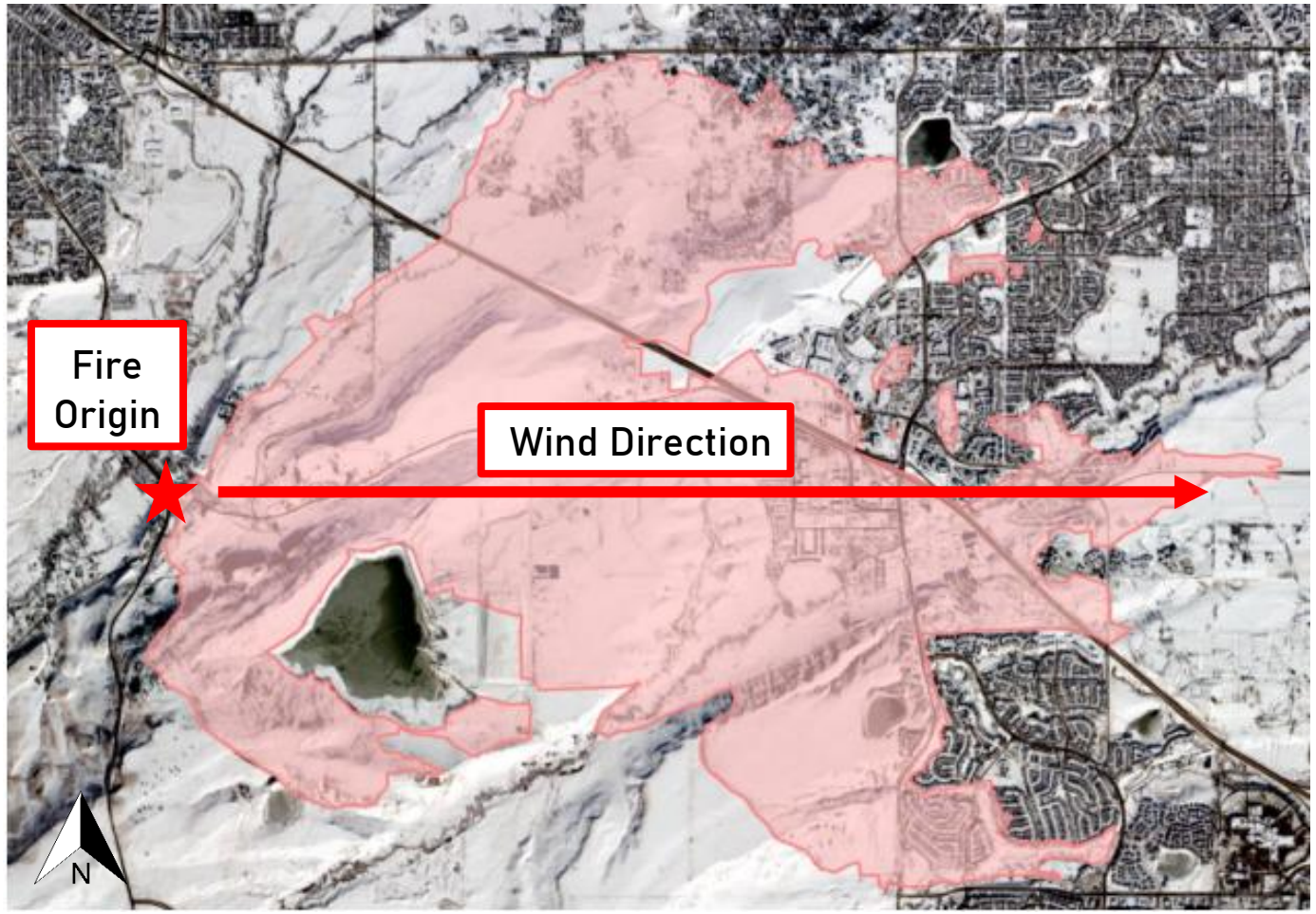

Weather Conditions

Hurricane force winds
- Gusts 80-100 mph
- Sustained 50-60 mph

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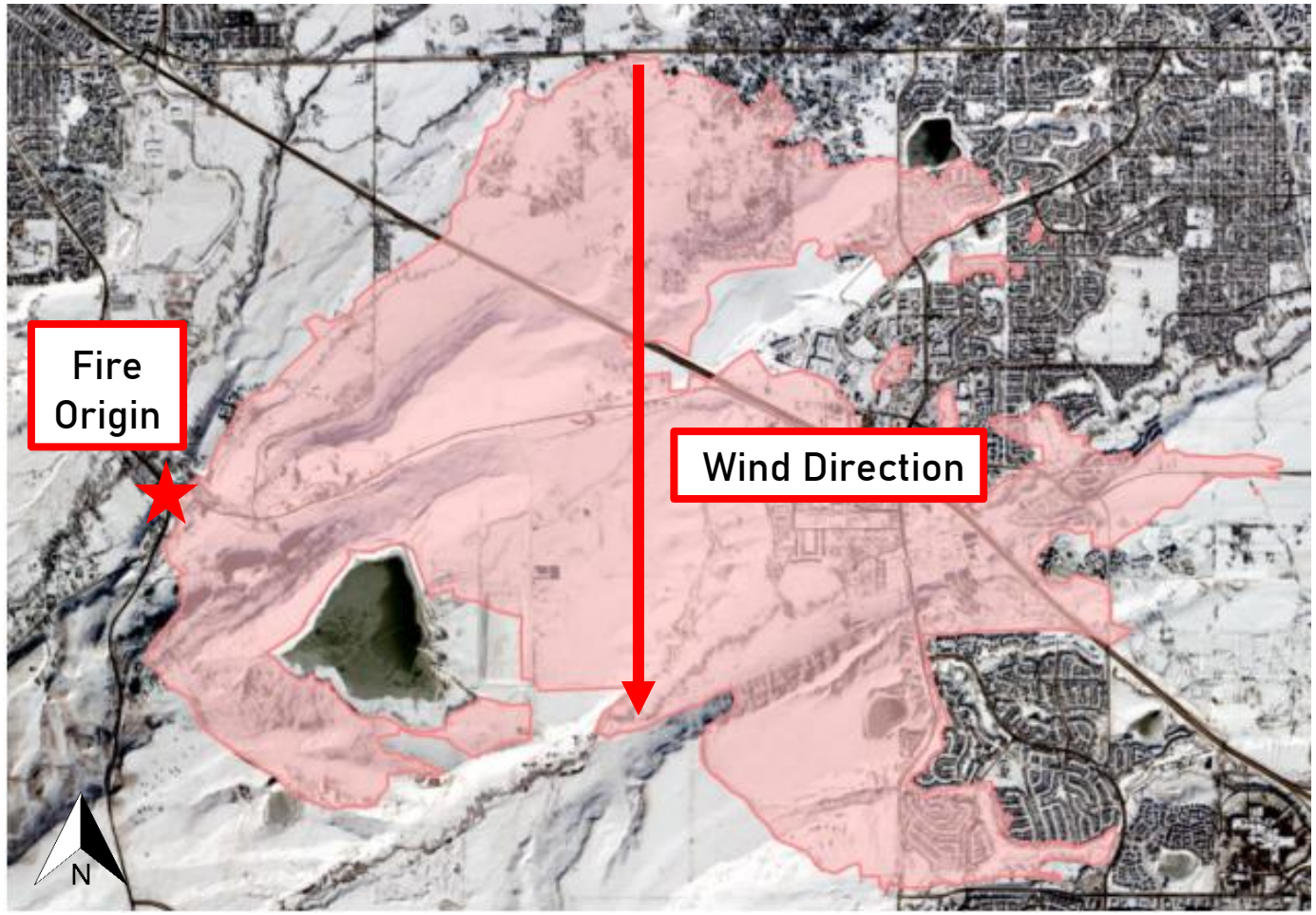

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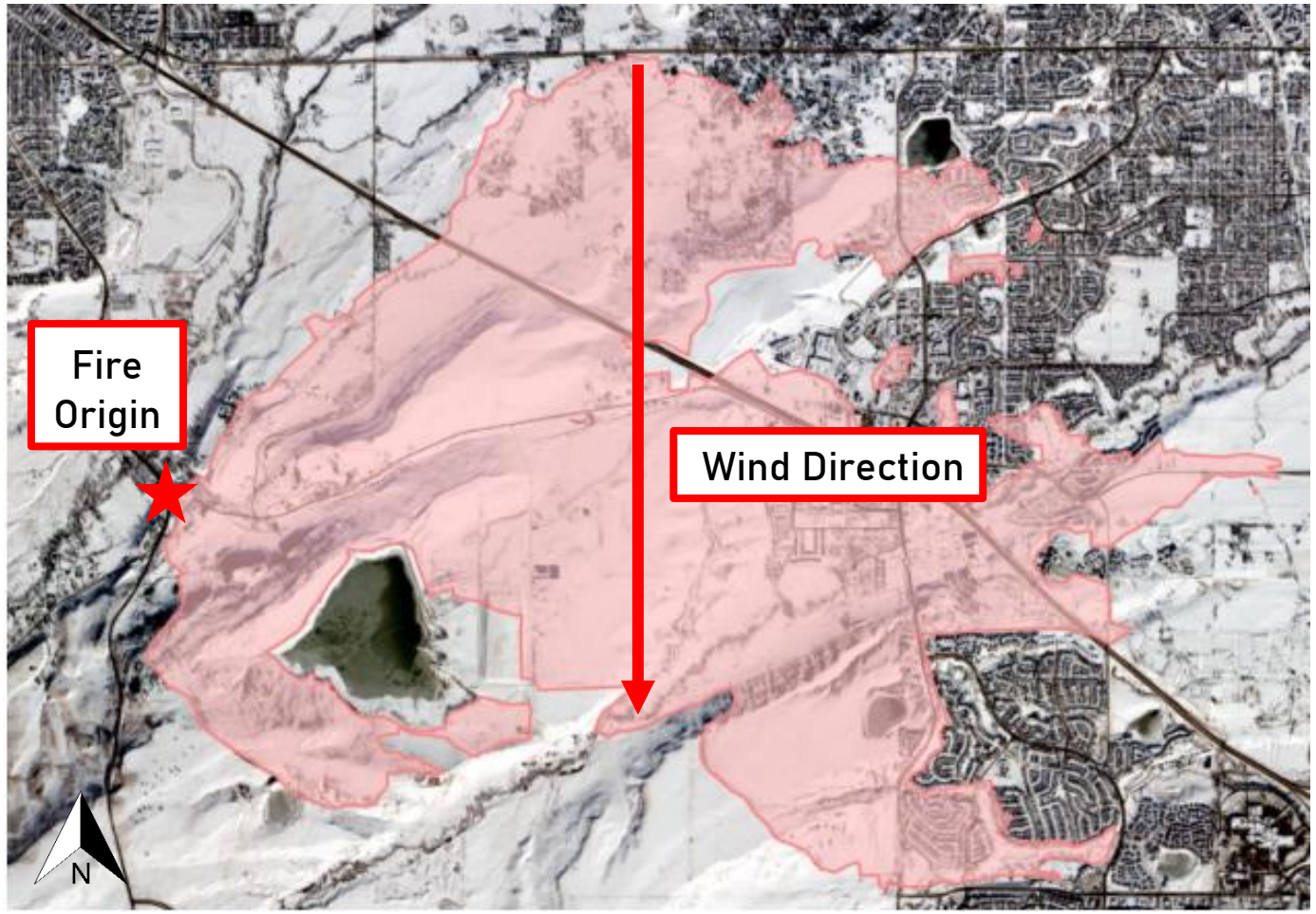

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Snowfall on 12/31/2021

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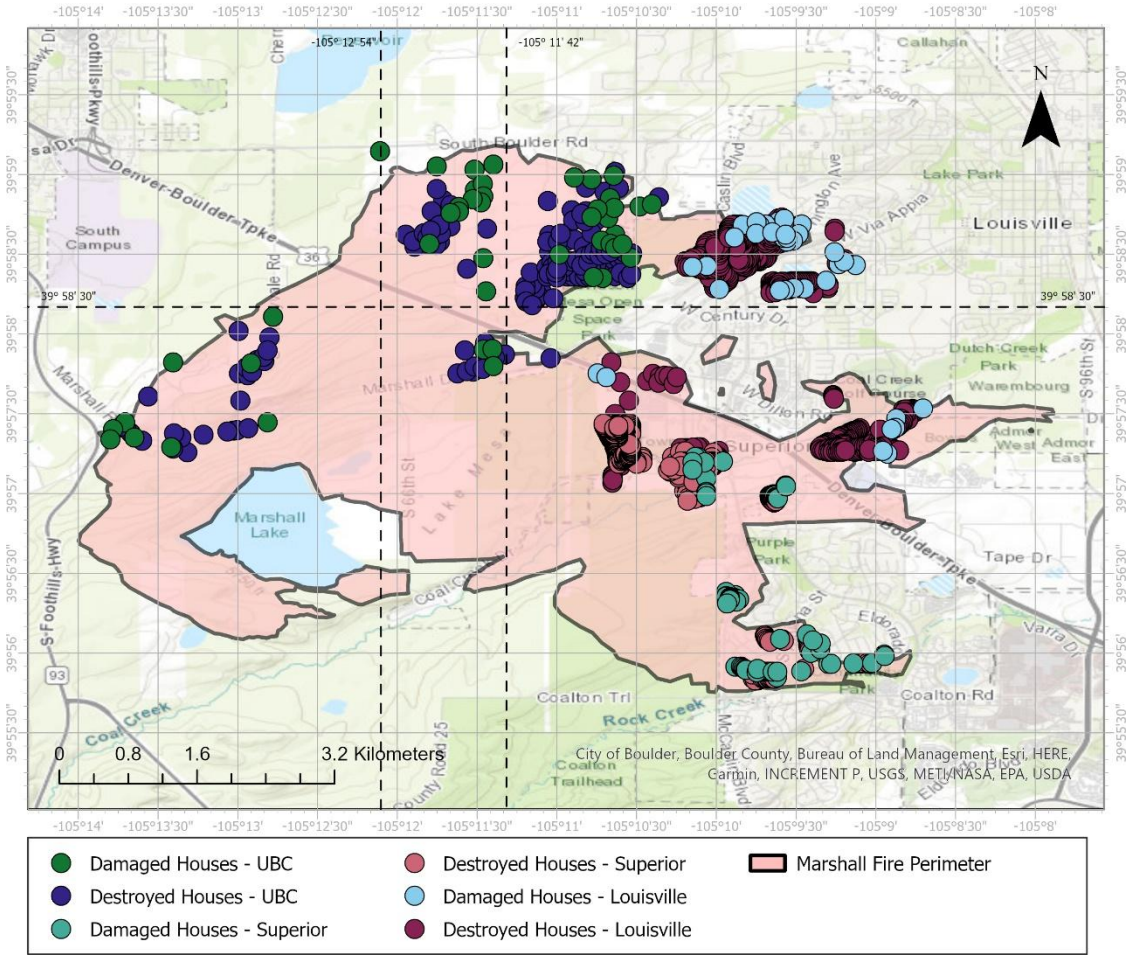


Community Damage

<u>Impacted Houses</u>

1085 reported as damaged or destroyed

Boulder Office of Disaster Management, “Boulder County releases updated list of structures damaged and destroyed in the Marshall Fire,” bouldercounty.gov.

Housing Characteristics for Analysis

A Review of Pathways for Building Fire Spread in the Wildland Urban Interface Part II: Response of Components and Systems and Mitigation Strategies in the United States

Raquel S. P. Hakes, Sara E. Caton and Michael J. Gollner, Department of Fire Protection Engineering, University of Maryland, 3106 J.M. Patterson Building, College Park, MD 20742-3031, USA*

Sara E. Caton, Engineering Laboratory, Fire Research Division, National Institute of Standards and Technology, 100 Bureau Dr., Gaithersburg, MD 20899, USA

Daniel J. Gorham, Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02169-7471, USA

Where wildfires destroy buildings in the US relative to the wildland–urban interface and national fire outreach programs

H. Anu Kramer[A,D], Miranda H. Mockrin[B], Patricia M. Alexandre[C], Susan I. Stewart[A] and Volker C. Radeloff[A]

[A]SILVIS Lab, Department of Forest and Wildlife Ecology, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI 53706, USA.
[B]Northern Research Station, USDA Forest Service, 5523 Research Park Dr Suite 350, Baltimore, MD 21228, USA.
[C]Forest Research Centre, School of Agriculture, University of Lisbon, Tapada da Ajuda, PT-1349-017 Lisboa, Portugal.
[D]Corresponding author. Email: hakramer@wisc.edu

United States Department of Agriculture
R5-TP-026b
June 2008

USDA
Home Destruction Examination
Grass Valley Fire
Lake Arrowhead, CA

NIST Technical Note 2205

WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology

Relationships between building features and wildfire damage in California, USA and Pedrógão Grande, Portugal

Simona Dossi[A], Birgitte Messerschmidt[B], Luís Mário Ribeiro[C], Miguel Almeida[C] and Guillermo Rein[A,*]

WUI fire risk mitigation in Europe: A performance-based design approach at home-owner level

Pascale Vacca[a], David Caballero[b], Elsa Pastor[a,*], Eulàlia Planas[a]

[a]*Centre for Technological Risk Studies, Department of Chemical Engineering, Universitat Politècnica de Catalunya•BarcelonaTech, Eduard Maristany 10-14, Barcelona, Catalonia E-08019, Spain*
[b]*Pau Costa Foundation, c. Castell 11, Tivissa, Tarragona, Spain*

Factors related to building loss due to wildfires in the conterminous United States

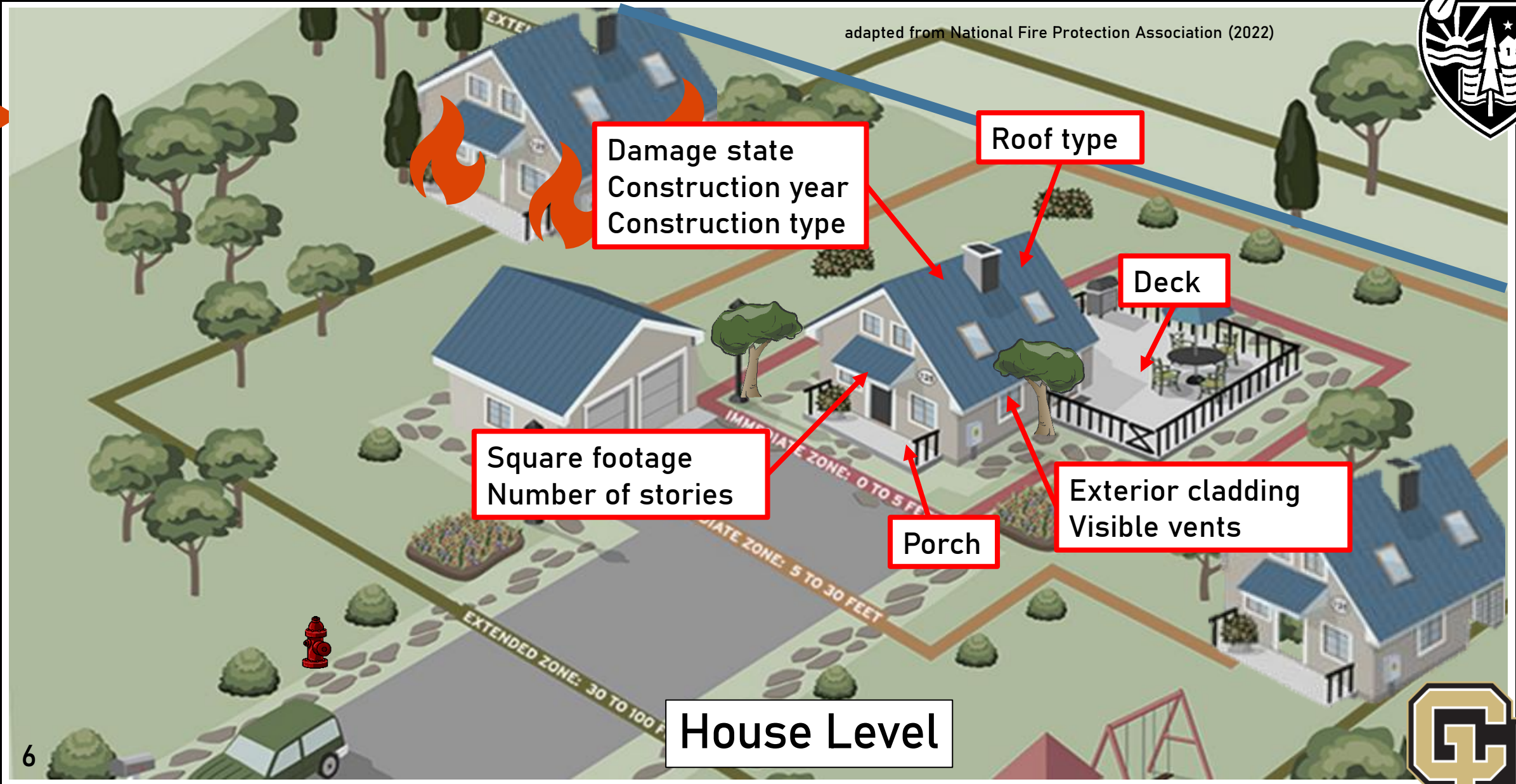
Patricia M. Alexandre,[1,6] Susan I. Stewart,[1] Nicholas S. Keuler,[2] Murray K. Clayton,[2] Miranda H. Mockrin,[3] Avi Bar-Massada,[4] Alexandra D. Syphard,[5] and Volker C. Radeloff[1]

[1]*SILVIS Lab, Department of Forest and Wildlife Ecology, University of Wisconsin Madison, 1630 Linden Drive, Madison, Wisconsin 53706 USA*
[2]*Department of Statistics, University of Wisconsin Madison, 1300 University Avenue, Madison, Wisconsin 53706 USA*
[3]*Rocky Mountain Research Station, USDA Forest Service, 2253 Research Park Boulevard, Suite 350, Baltimore, Maryland 21228 USA*
[4]*Department of Biology and Environment, University of Haifa, Haifa, Israel*
[5]*Conservation Biology Institute, 10423 Sierra Vista Avenue, La Mesa, California 91941 USA*

Article

Parcel-Level Risk Affects Wildfire Outcomes: Insights from Pre-Fire Rapid Assessment Data for Homes Destroyed in 2020 East Troublesome Fire

James R. Meldrum [1,*], Christopher M. Barth [2], Julia B. Goolsby [1], Schelly K. Olson [3], Adam C. Gosey [3], James (Brad) White [3], Hannah Brenkert-Smith [4], Patricia A. Champ [5] and Jamie Gomez [6]



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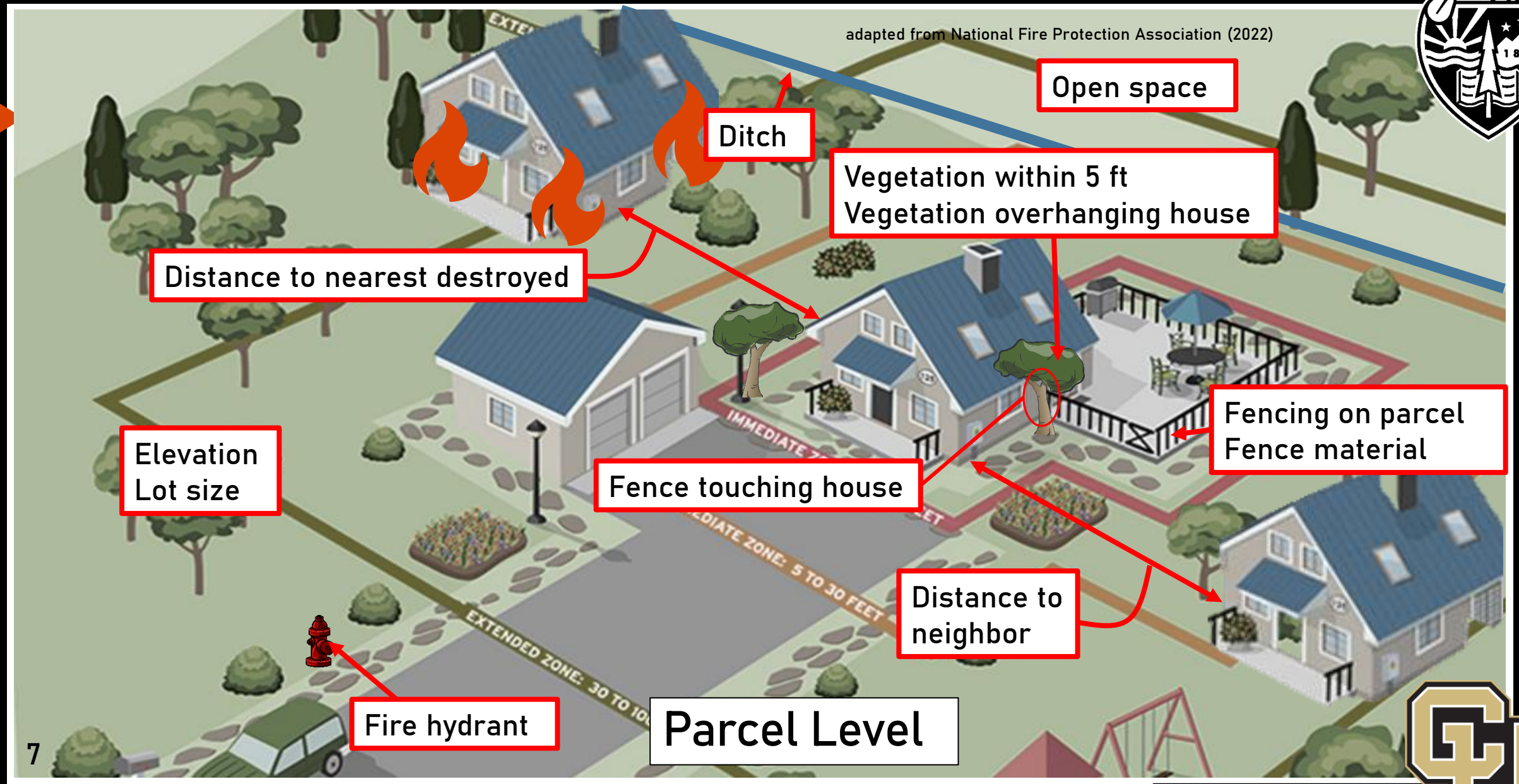

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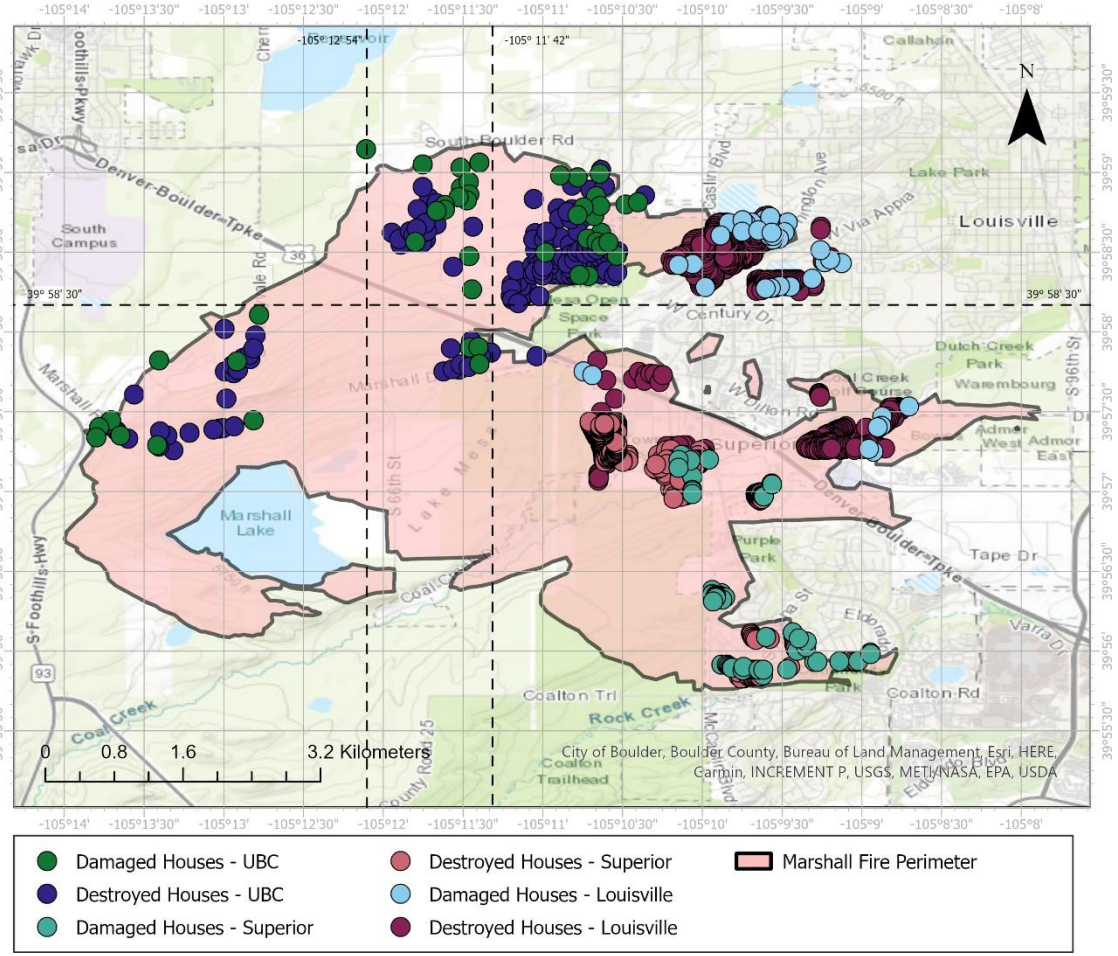

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<u>Analysis Data Sets</u>
1,055 houses included in the aggregated dataset

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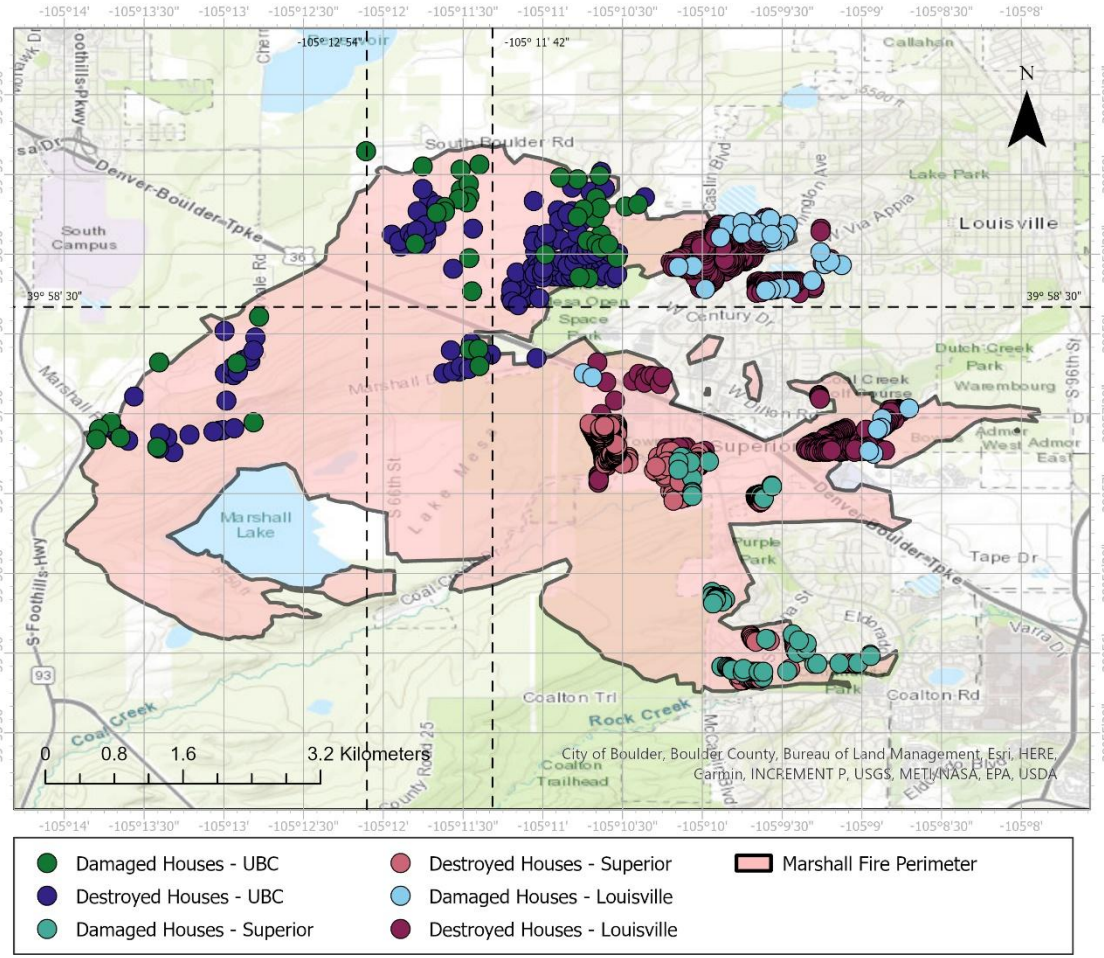

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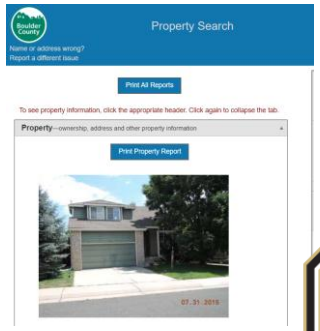

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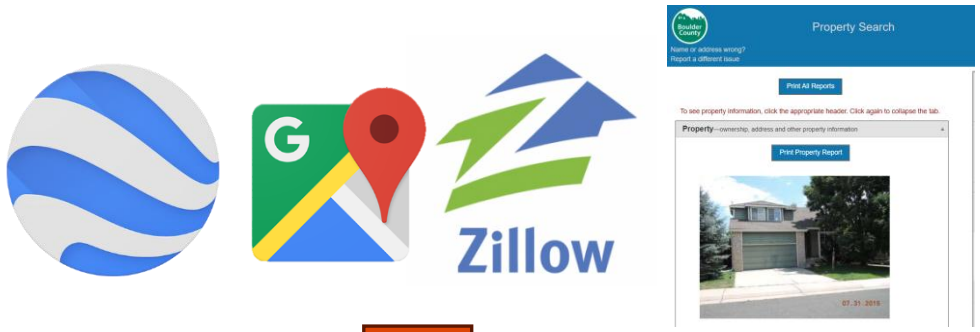

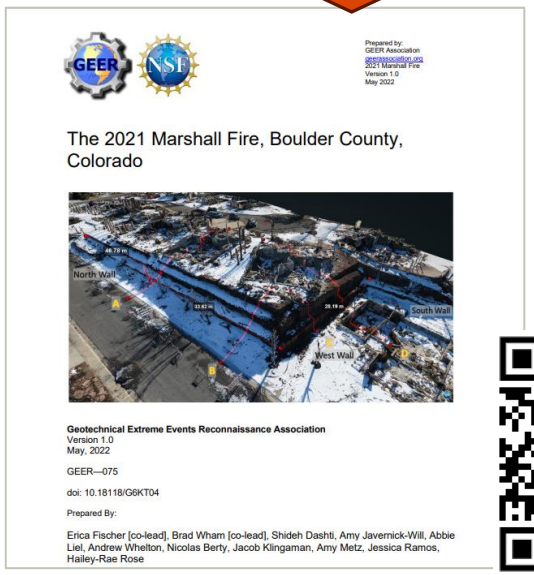

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Data Trends

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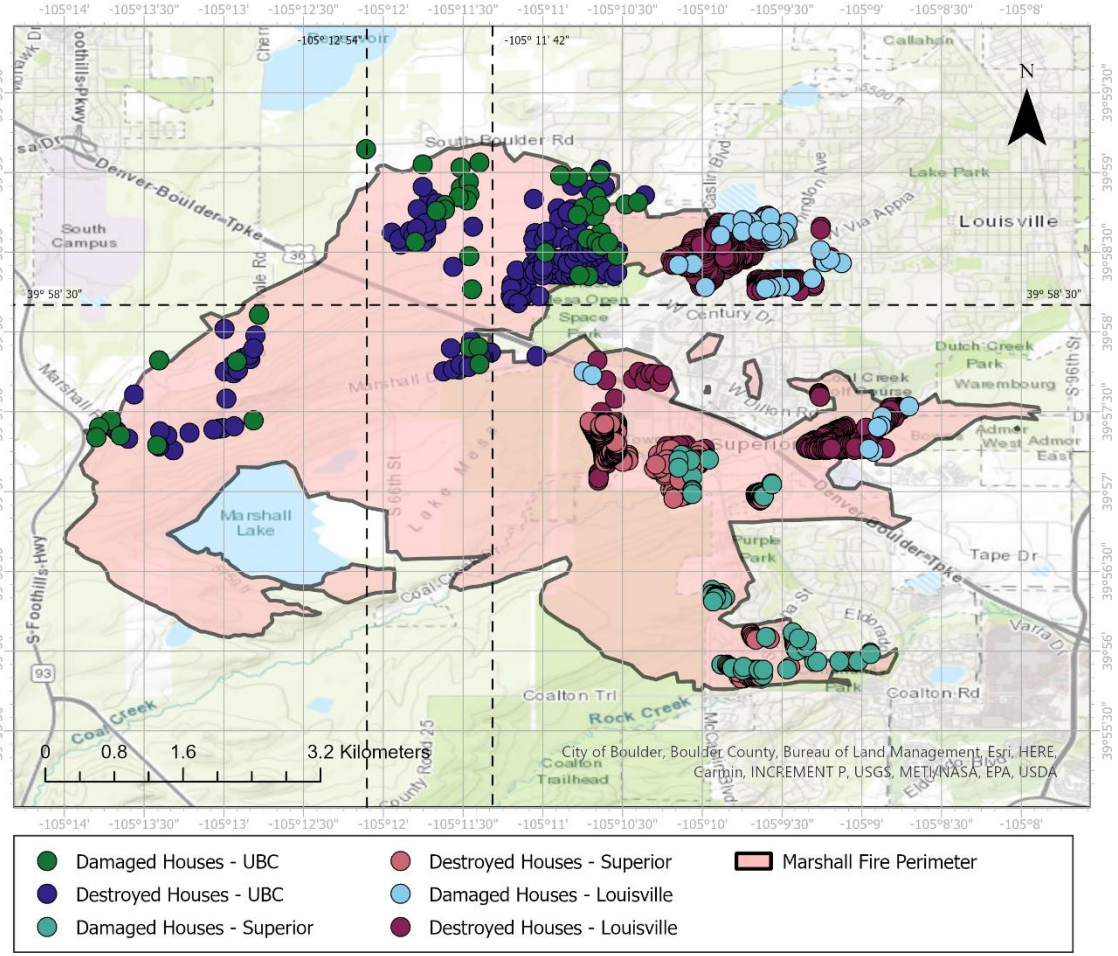

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85% of the houses in the data collected were considered destroyed.

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Raw Data Trends – House Level

Construction Type

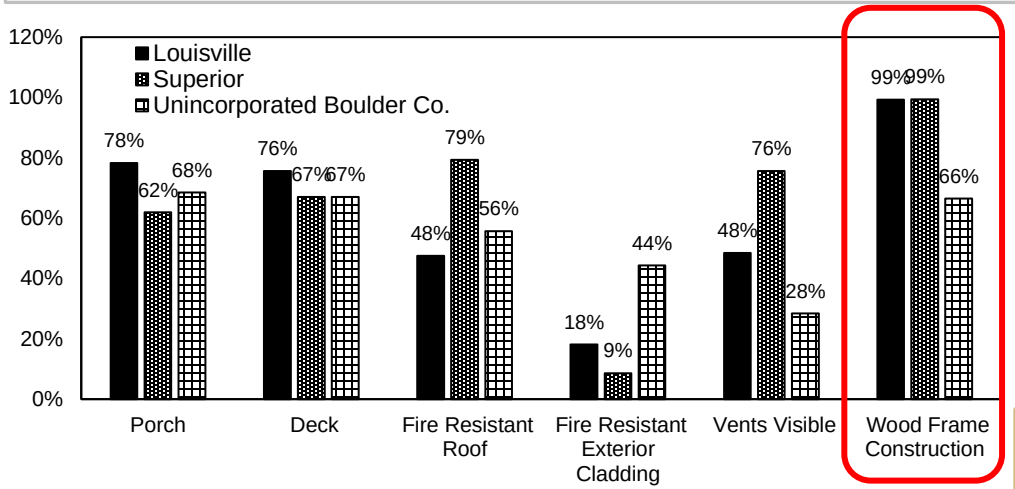
- Impacted houses predominantly wood frame construction
- Larger variation in construction type in Unincorporated Boulder County

Housing Characteristics – Attachments

- Consistent across all three jurisdictions
- Louisville had the highest occurrence of both porches and decks

Housing Characteristics – Building Envelope

- Less than 50% of impacted houses had fire resistant exterior cladding
- Fire resistant roofing (Class A) more common than cladding



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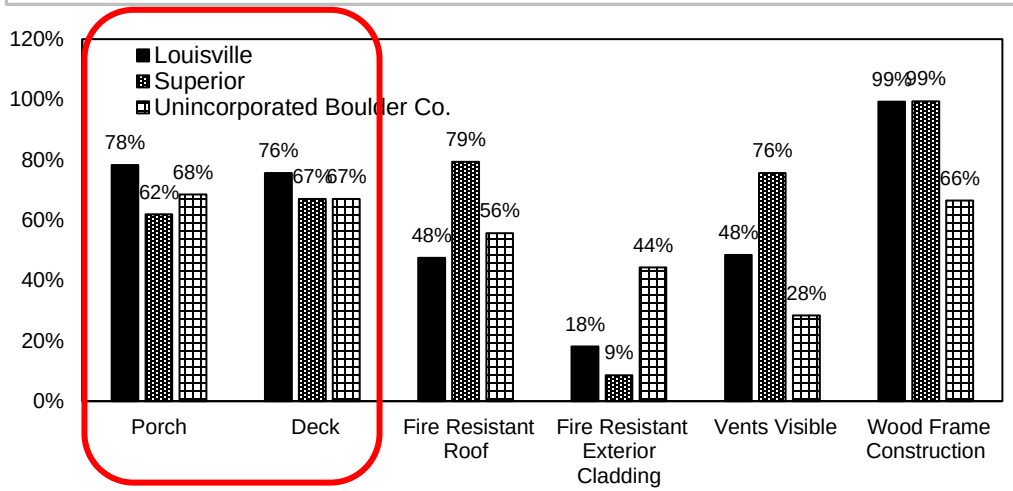

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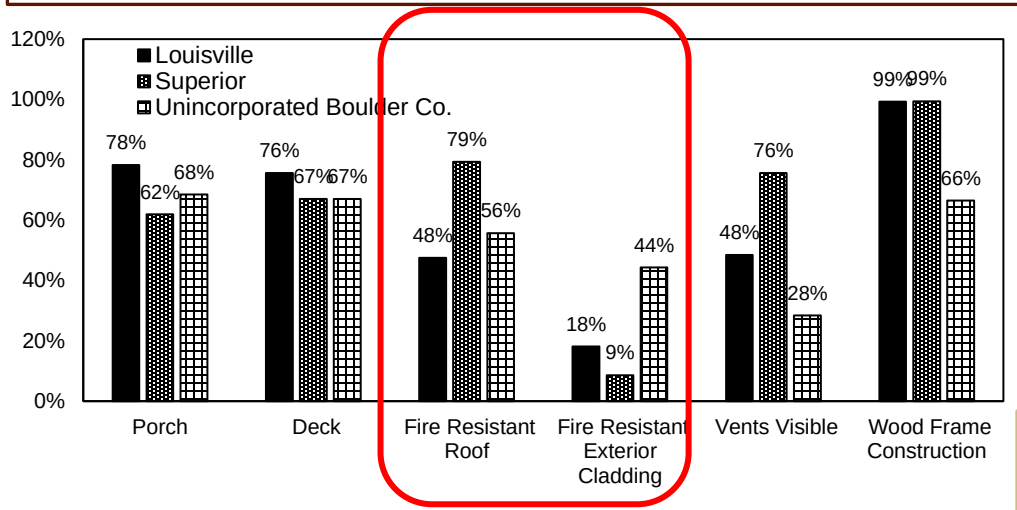

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Raw Data Trends – Parcel Level

Neighboring Characteristics

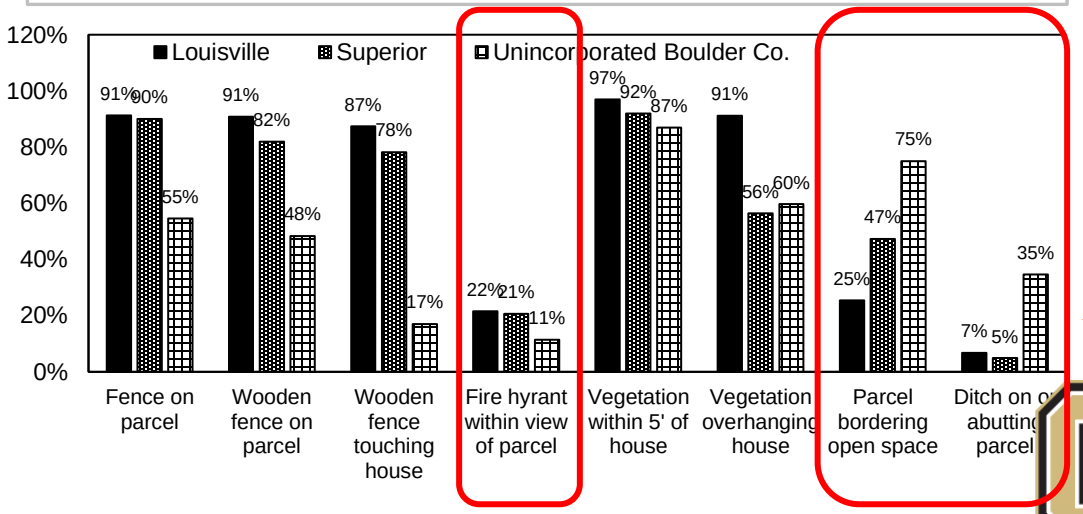
- 75% of houses in UBC abutted open space
- 35% of houses in UBC near drainage ditches
- UBC's access to firefighting resources was approximately 50% less than other jurisdictions

Vegetation

- Greater than 85% percent of houses had vegetation within 5ft of their exterior walls
- 91% of houses in Louisville had vegetation overhanging the house, ~35% greater than Superior and UBC

Fencing

- Wooden fences were most prevalent
- 96% and 95% of wooden fences touching home in Louisville and Superior
- 35% of wooden fences were touching the house in UBC



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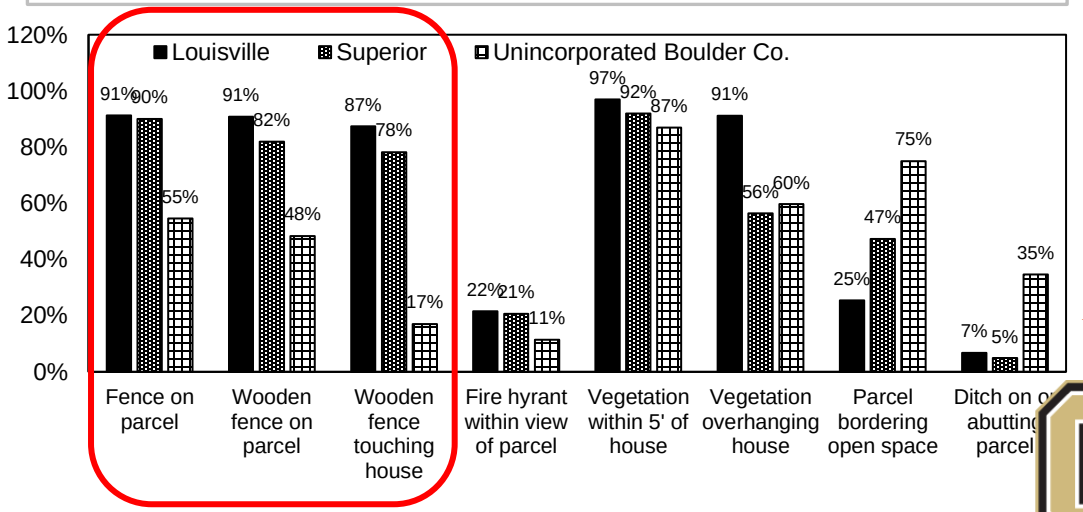

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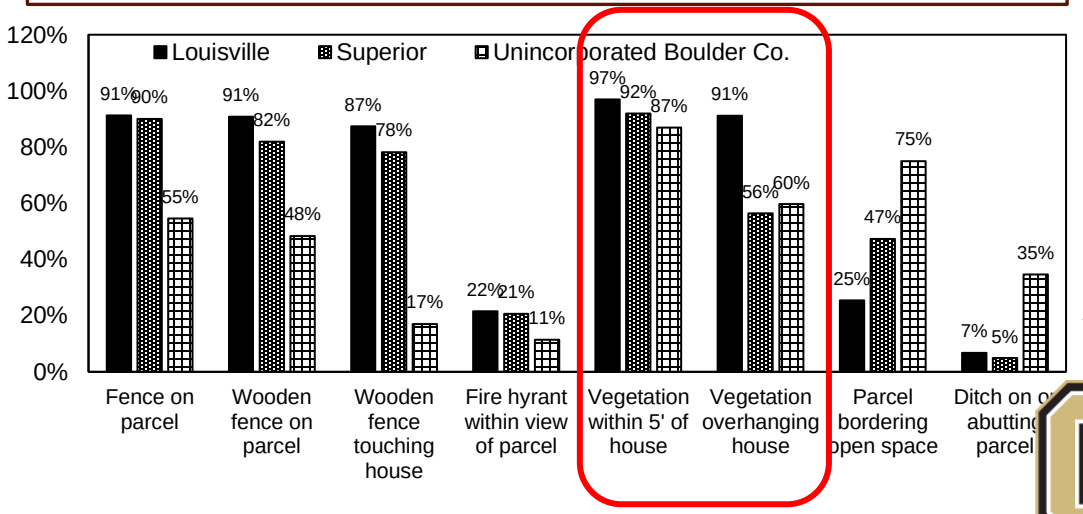

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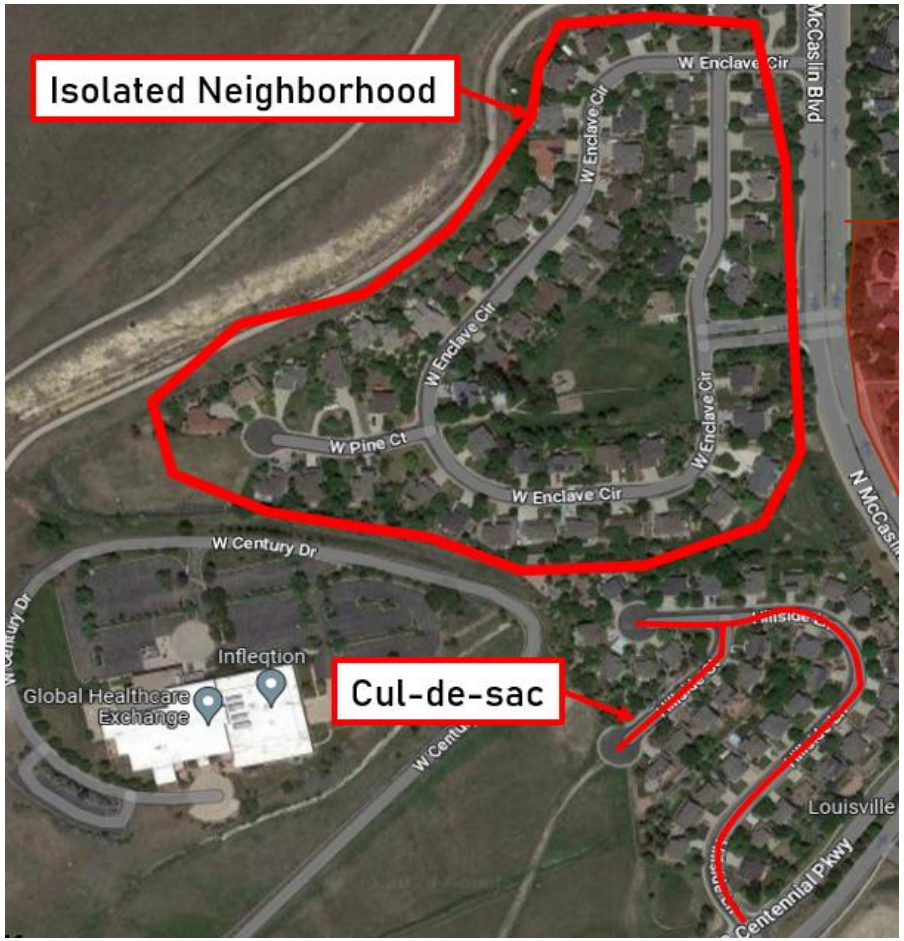

Neighborhood Characteristics

Houses on cul-de-sacs or in isolated neighborhoods

- Louisville – 91%
- Superior – 63%
- UBC – 88%

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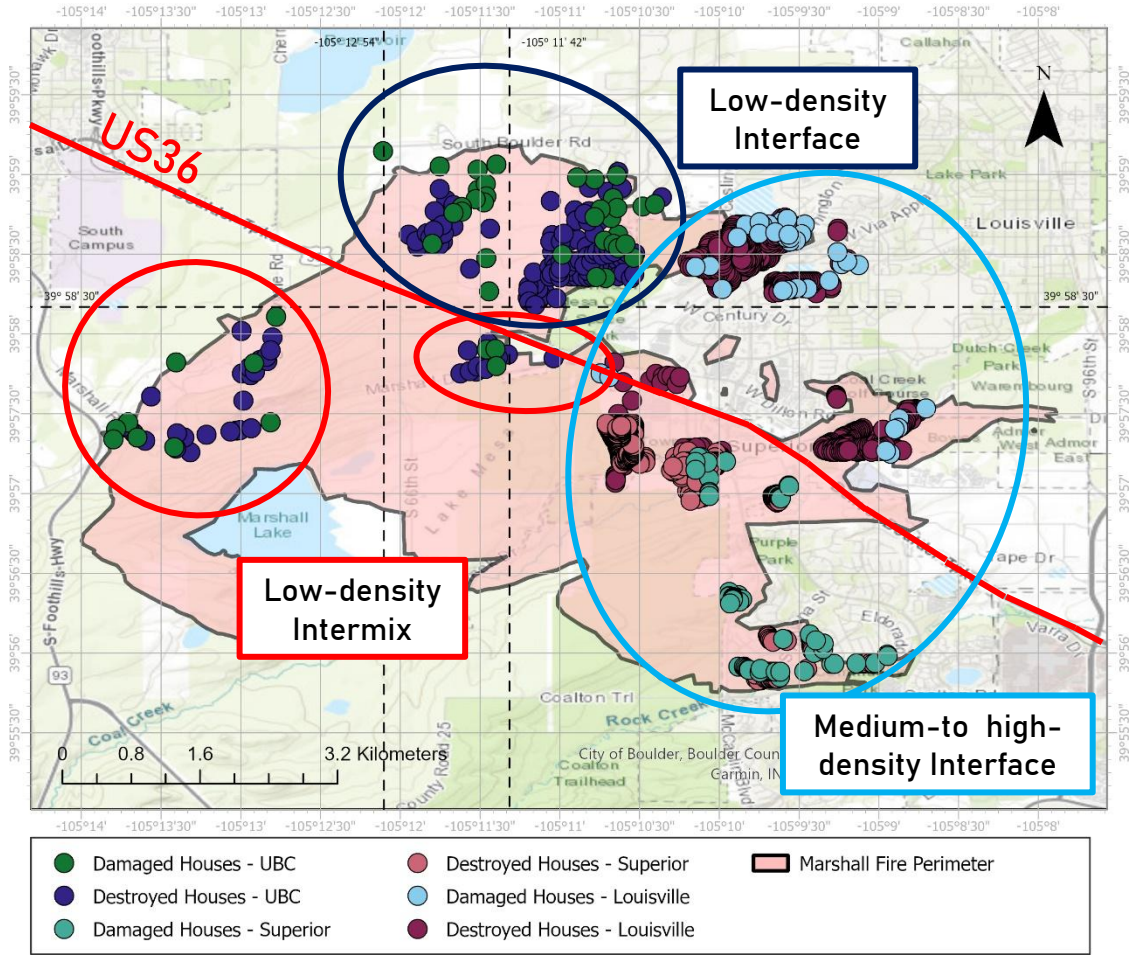
Raw Data Trends – Neighborhood Level



Neighborhood Characteristics

Houses on cul-de-sacs or in isolated neighborhoods

- Louisville – 91%
- Superior – 63%
- UBC – 88%

WUI type varied by jurisdiction

- Medium to high density interface in Louisville and Superior
- Low-density interface N of HW36 in UBC
- Low-density intermix S of HW36 in UBC

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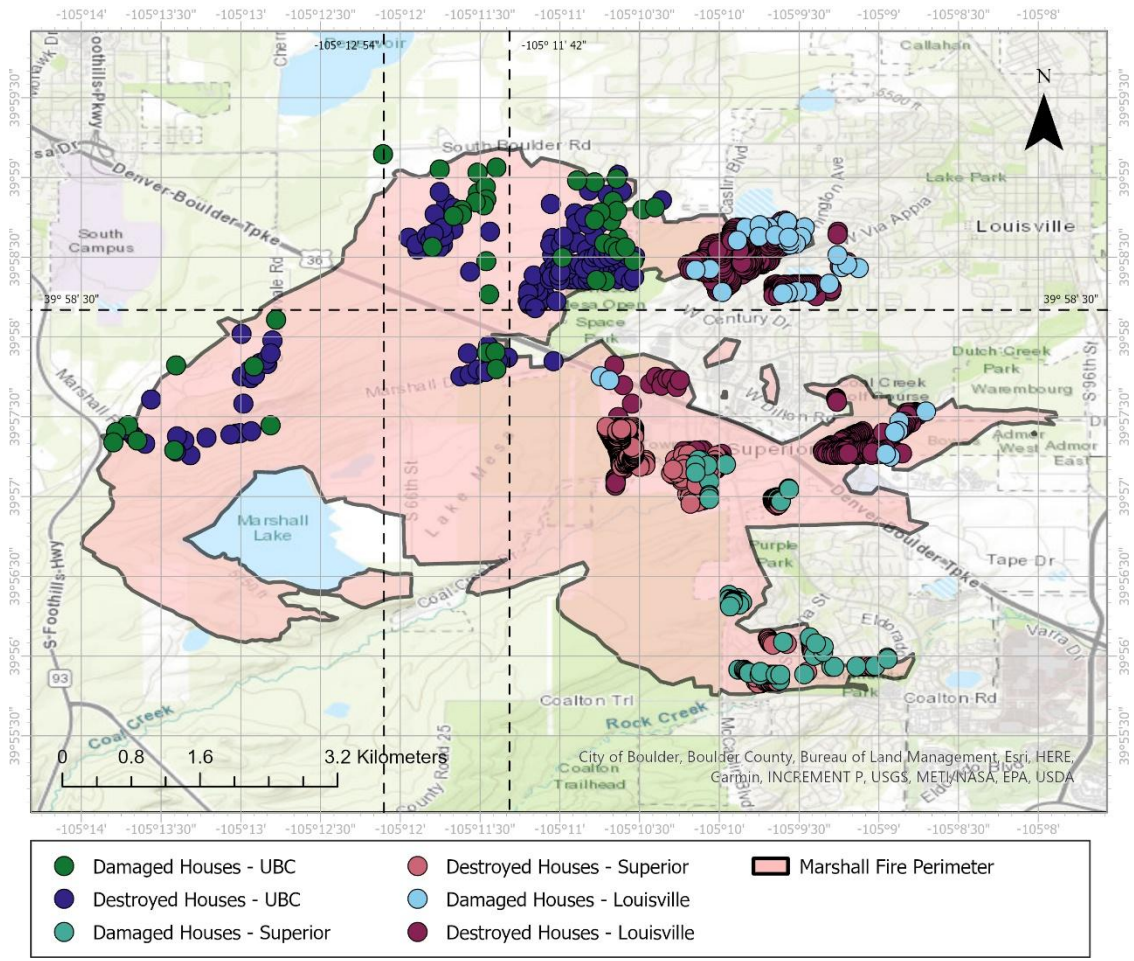
Random Forest Model: Prediction of House Loss

Random Forest Model

Model Development

- Four binary classification random forest models
  - Louisville
  - Superior
  - Unincorporated Boulder County
  - All data



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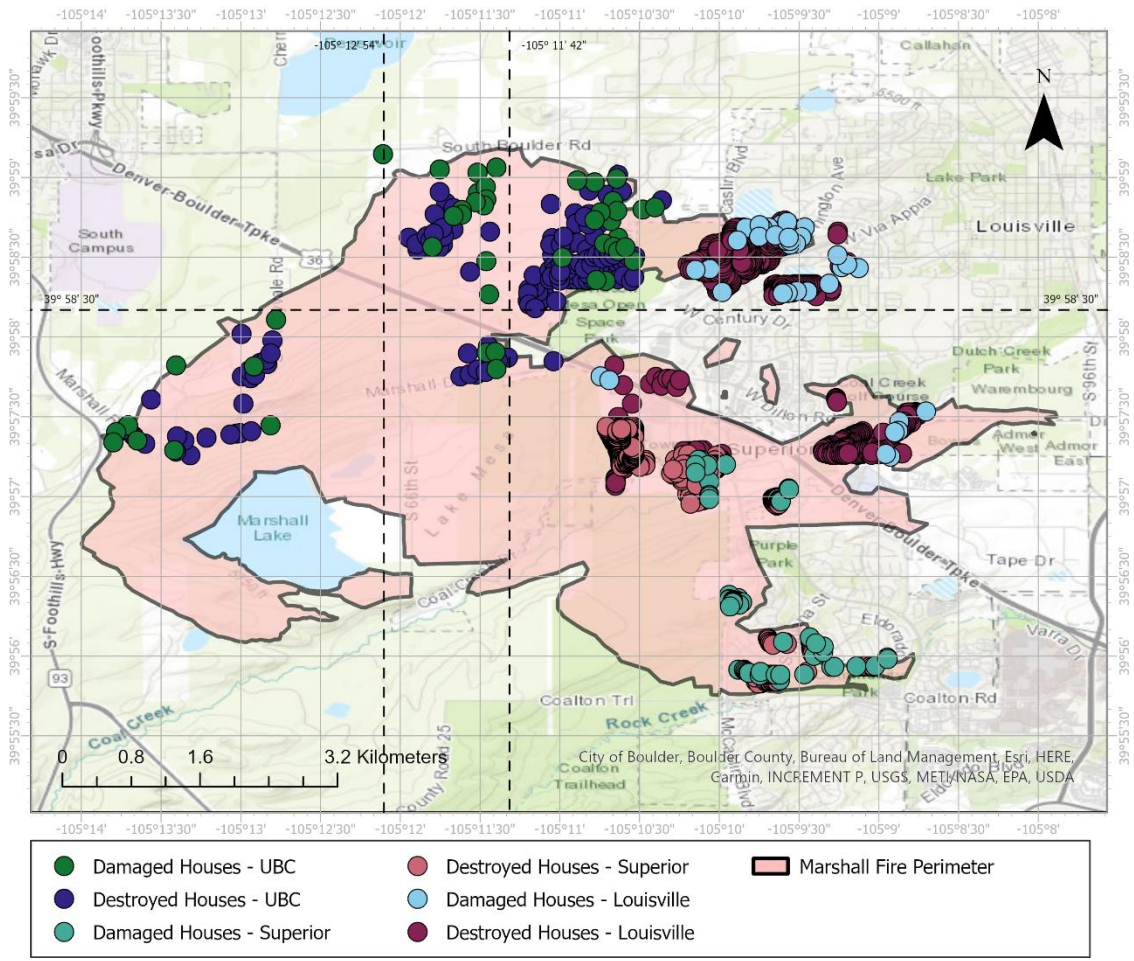
Random Forest Model

Model Development

- Four binary classification random forest models
  - Louisville
  - Superior
  - Unincorporated Boulder County
  - All data
- Information available pre-fire and post-fire were considered



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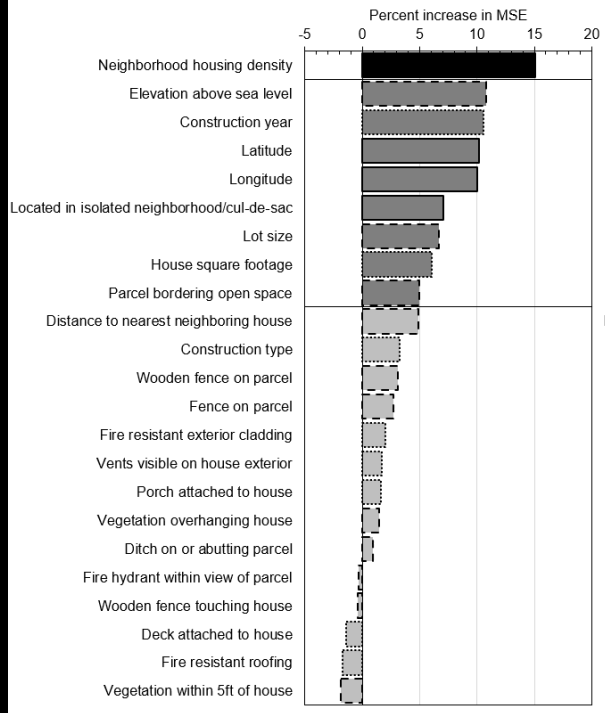
Random Forest Model - Results

Neighborhood level Parcel level House level



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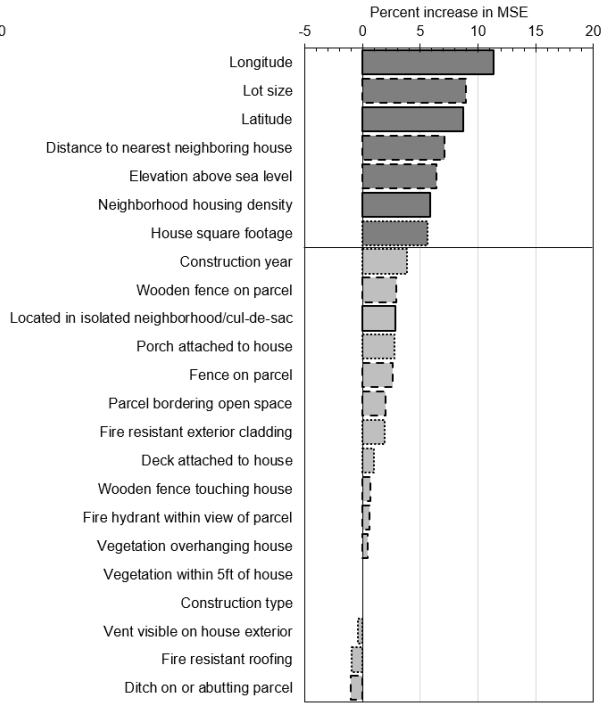
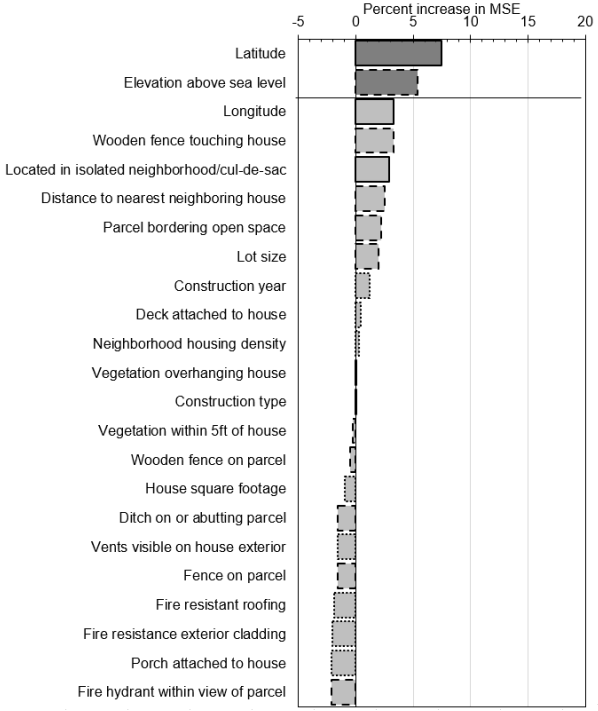


Superior



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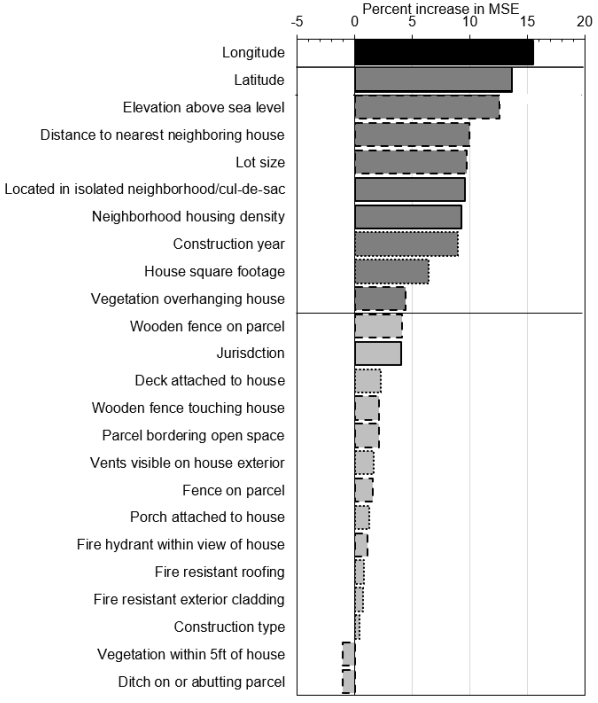

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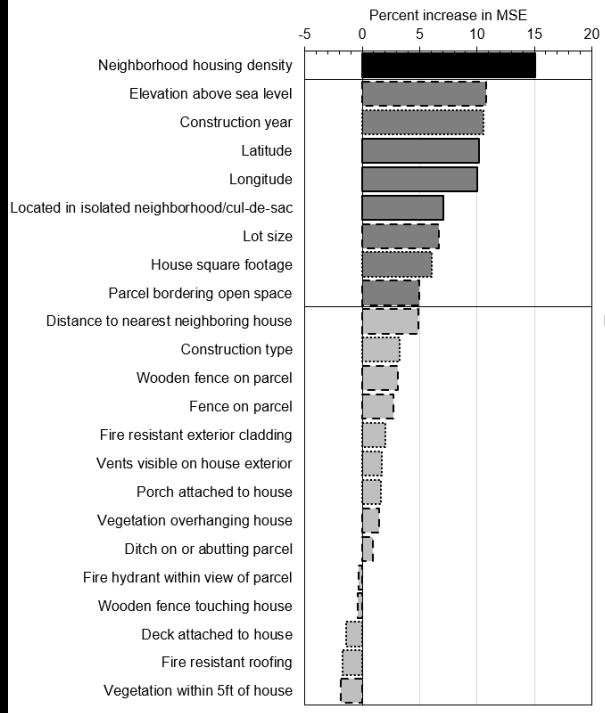
Random Forest Model - Results

Neighborhood level | Parcel level | House level



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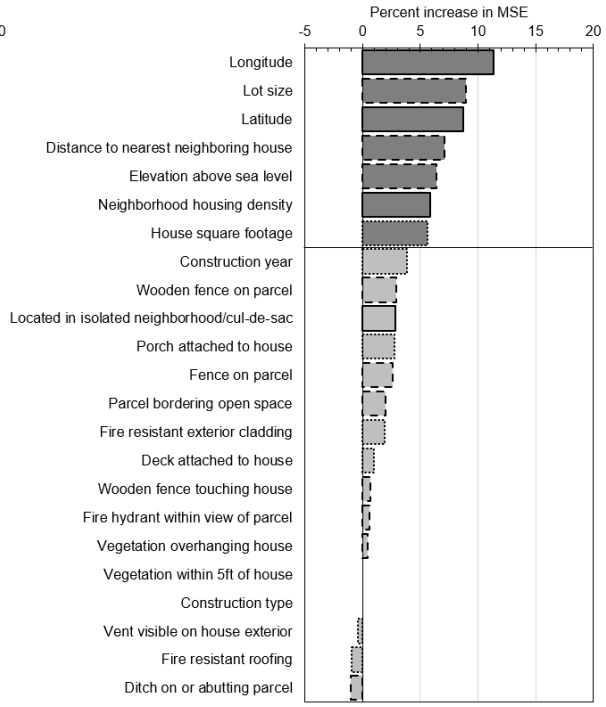

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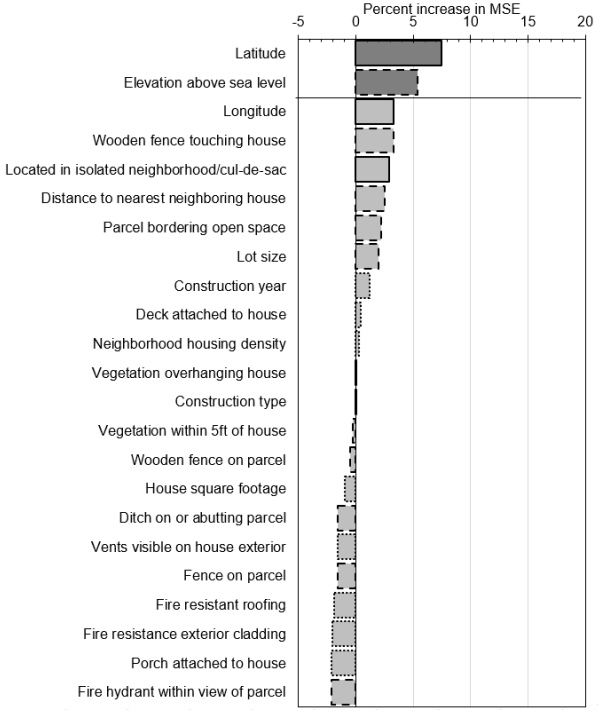

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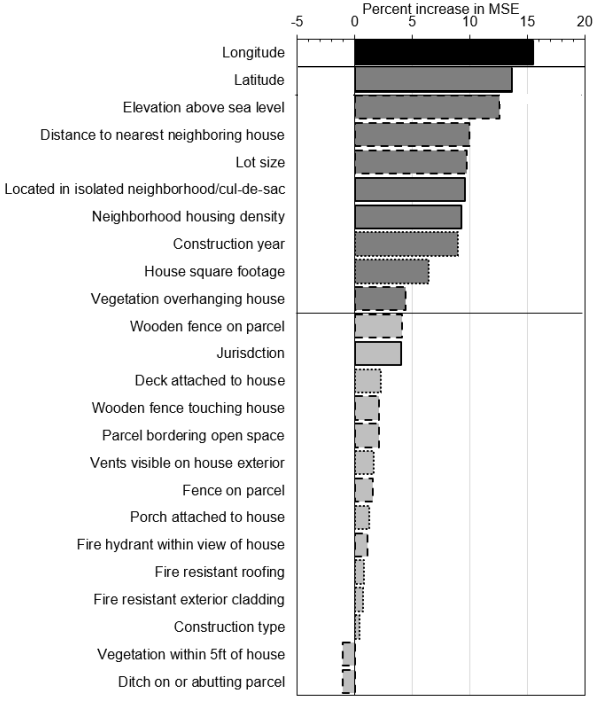

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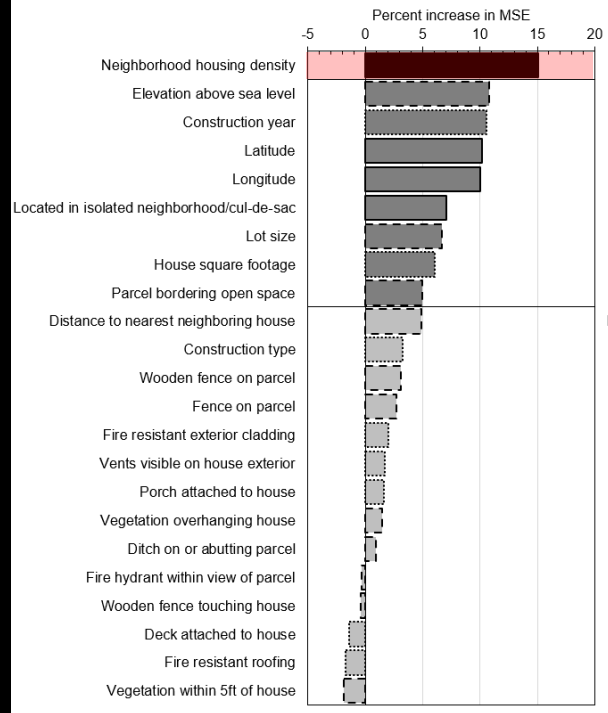
Random Forest Model - Results

Neighborhood level Parcel level House level



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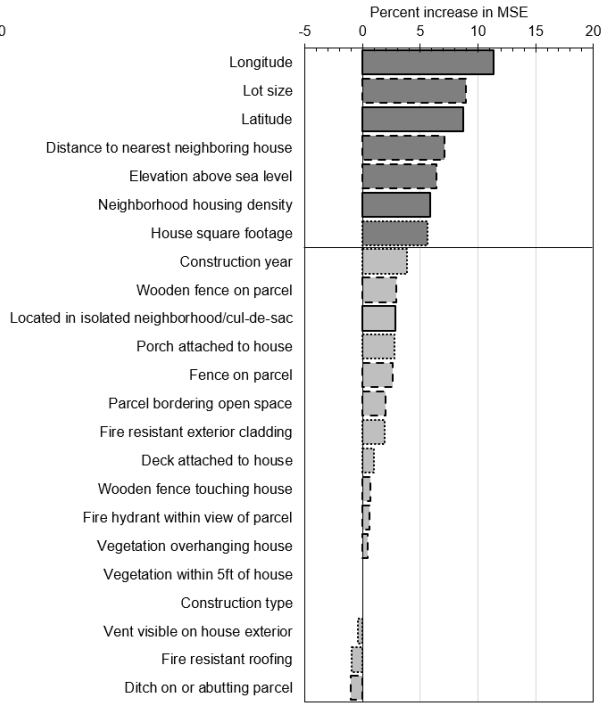

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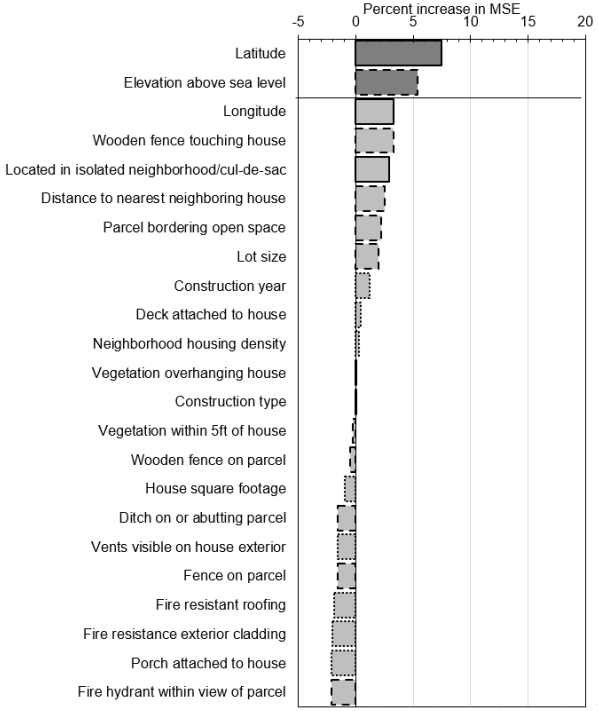

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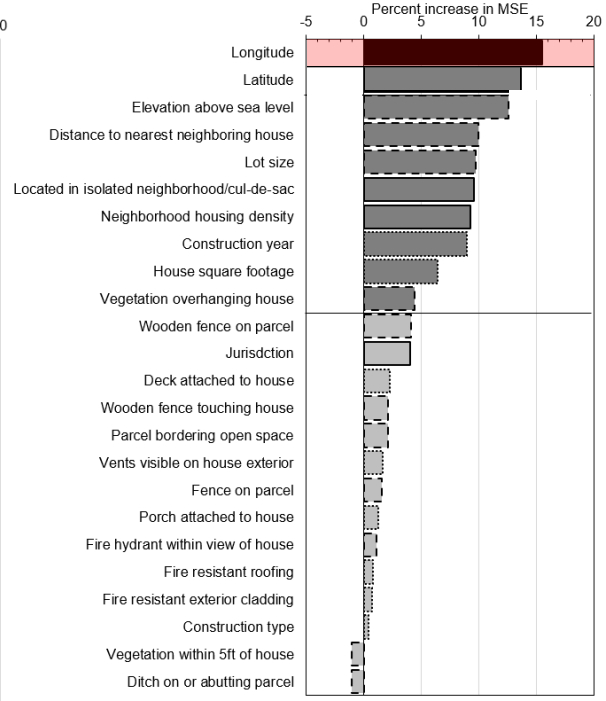

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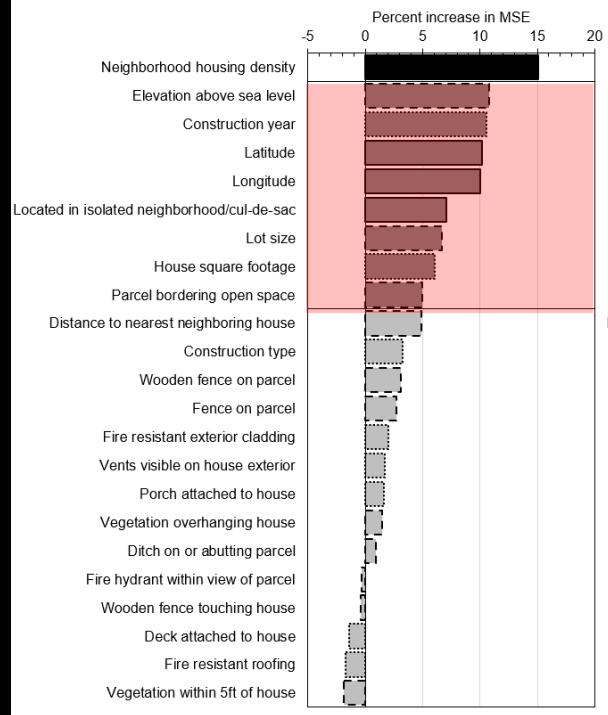
Random Forest Model - Results

Neighborhood level | Parcel level | House level



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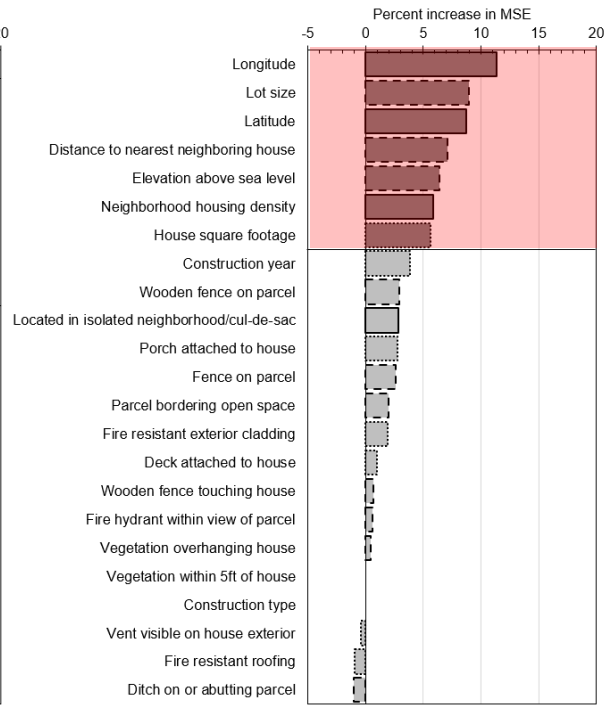

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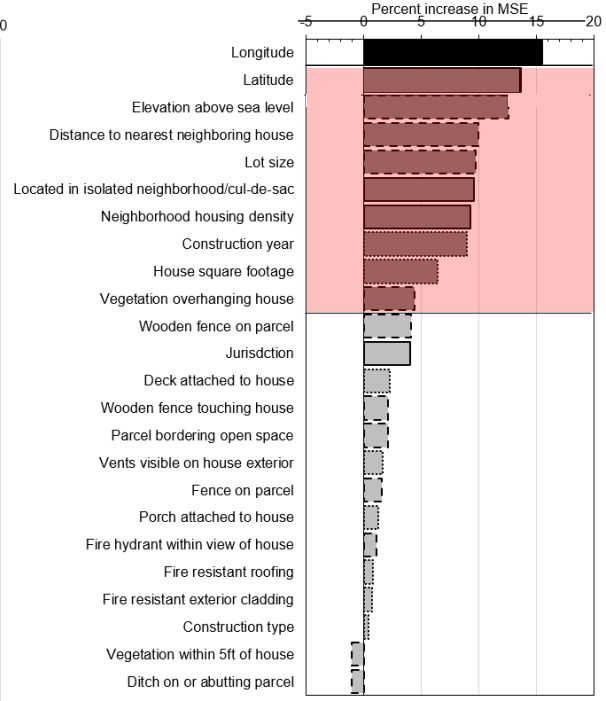

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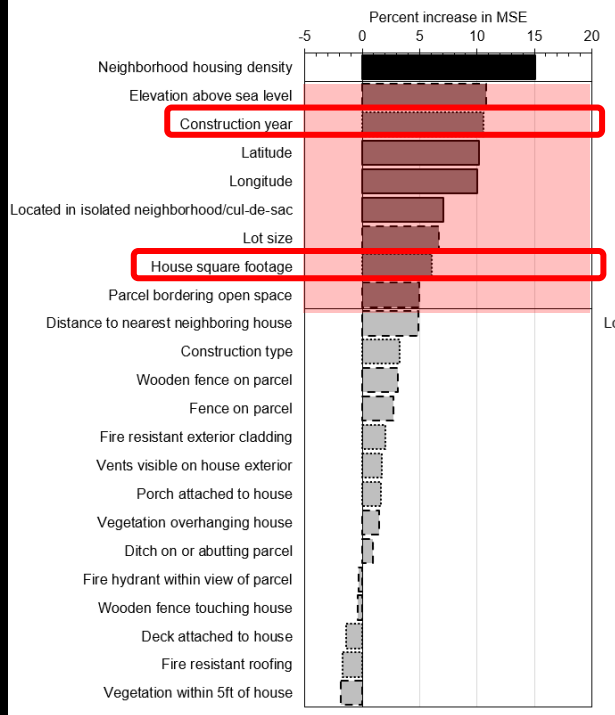
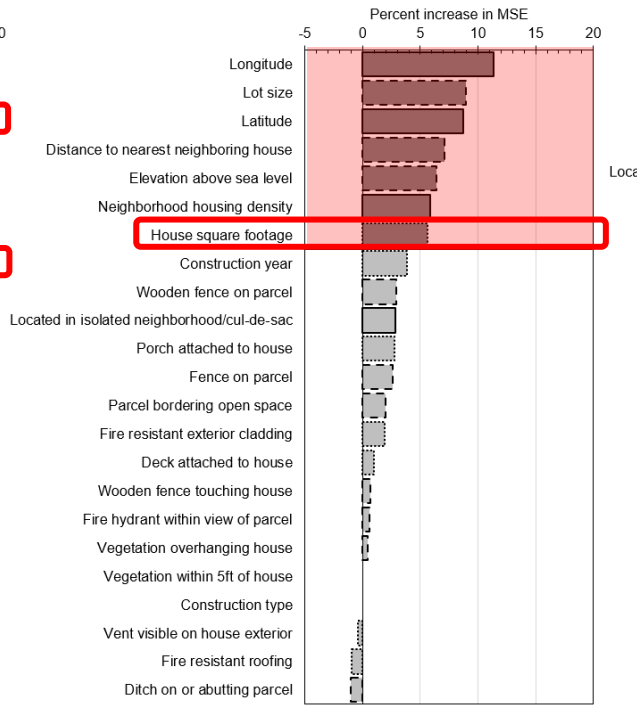


Louisville



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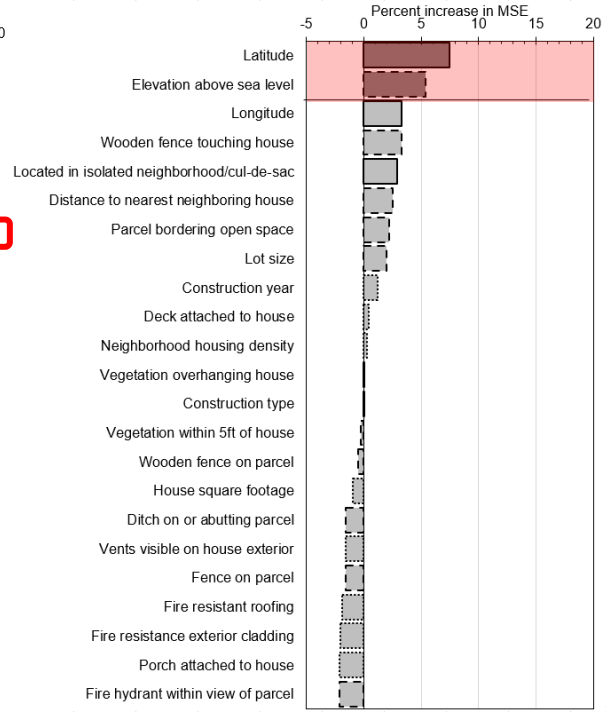

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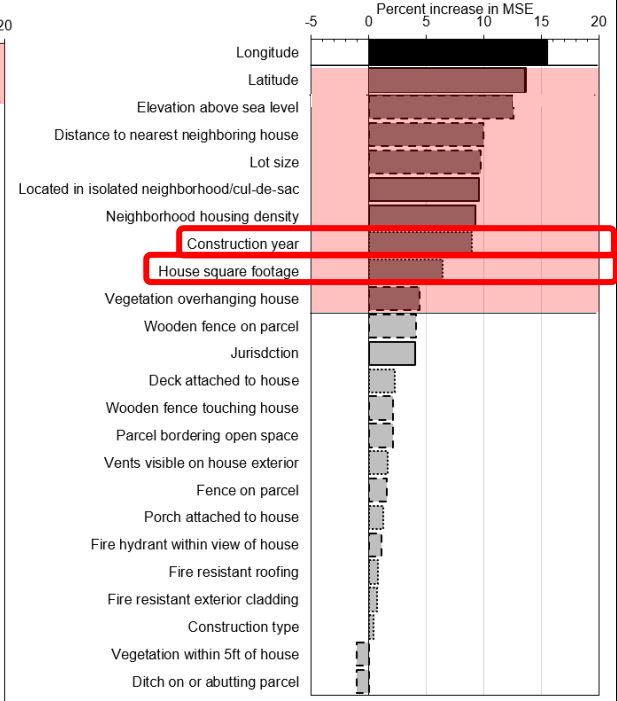

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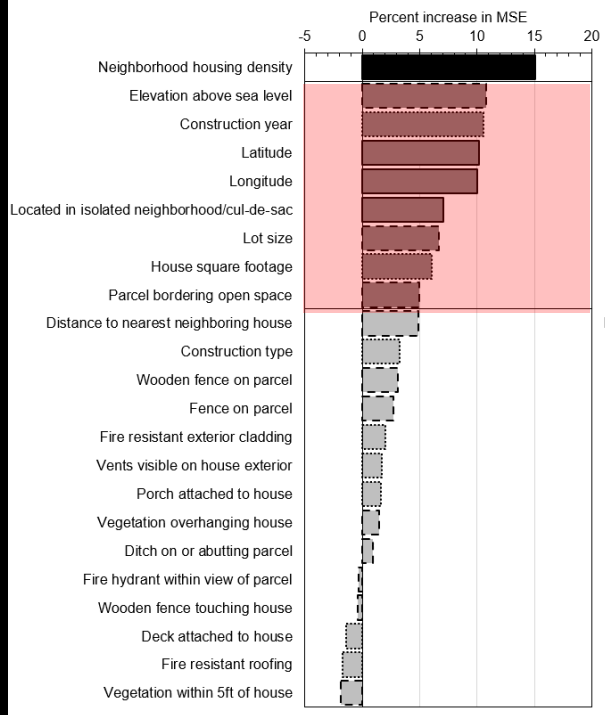
Random Forest Model - Results

Neighborhood level Parcel level House level



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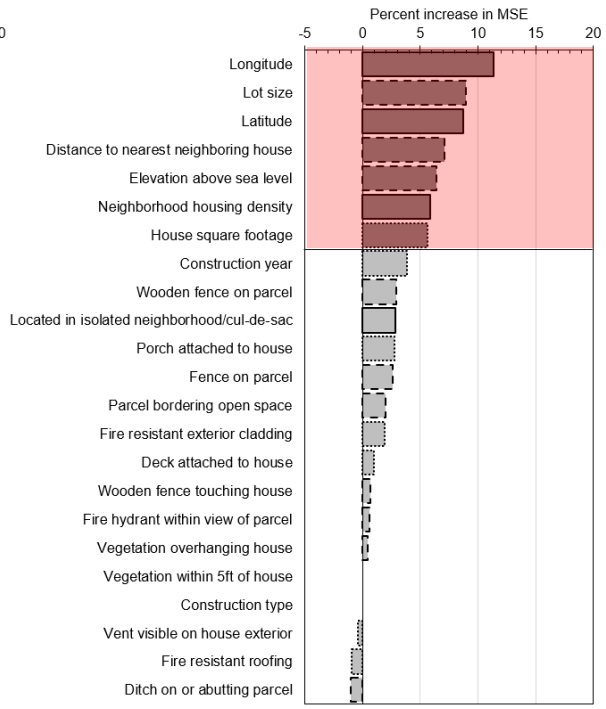

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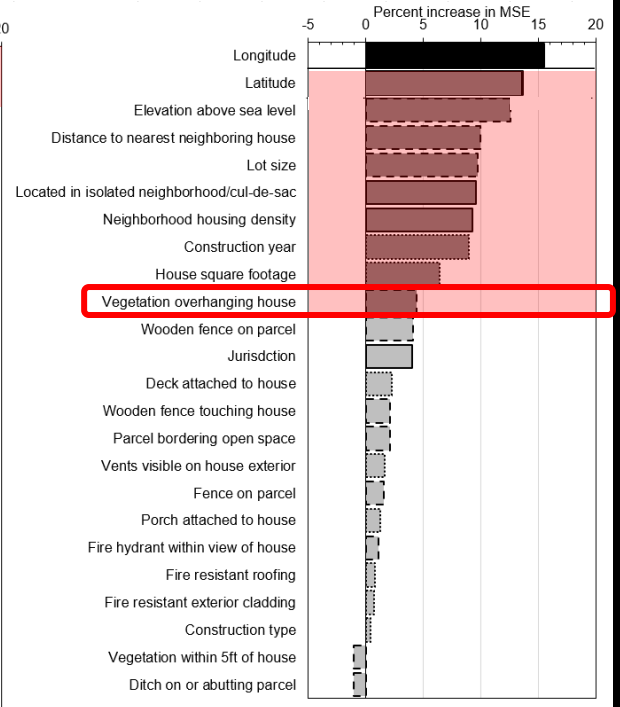

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Random Forest Model - Results

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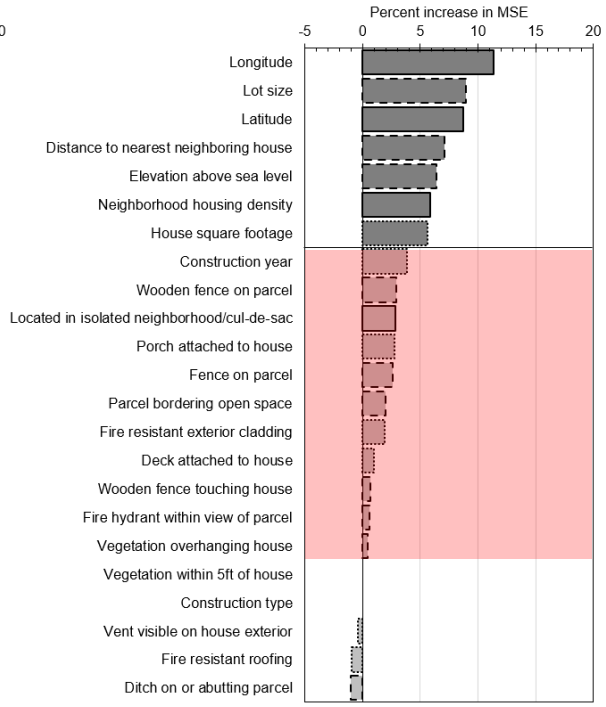

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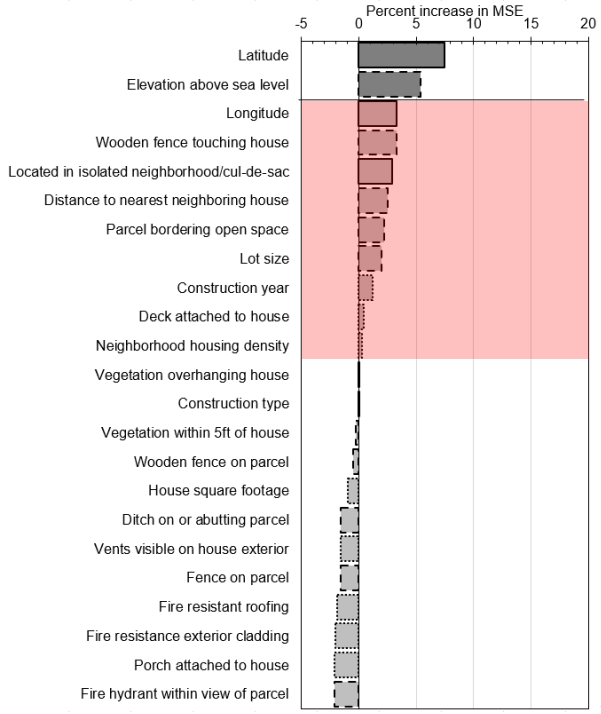

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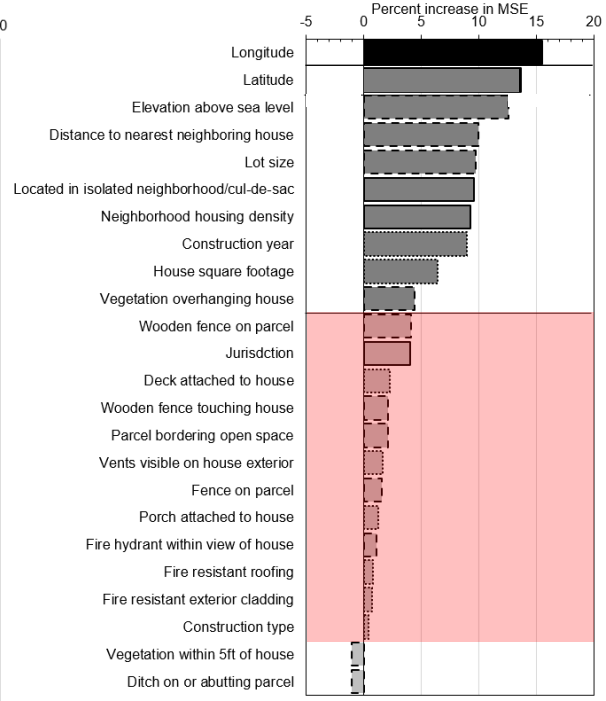

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Random Forest Model - Results

Louisville	Superior	UCB	Aggregated Data
Neighborhood housing density (15.1%)	Longitude (11.4%)	Latitude (7.4%)	Longitude (15.5%)
Elevation above sea level (10.7%)	Lot size (9.1%)	Elevation above sea level (5.3%)	Latitude (13.7%)
Construction year (10.6%)	Latitude (8.8%)	Longitude (3.2%)	Elevation above sea level (12.6%)
Latitude (10.1%)	Distance to nearest neighboring house (7.1%)	Wooden fence touching house (3.2%)	Distance to nearest neighboring house (9.9%)
Longitude (9.9%)	Elevation above sea level (6.5%)	Located in an isolated neighborhood or on cul-de-sac (2.9%)	Lot size (9.7%)

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- Data aggregation can result in study areas being improperly represented when aggregating across different WUI community types or jurisdictions within the Marshall Fire perimeter.
- The lack of impact of the characteristics under an individual homeowner's control for the Marshall Fire indicates the importance of community-wide mitigation

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Acknowledgements

Principle Investigators: Erica Fischer, Oregon State University
Abbie Liel, University of Colorado, Boulder

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Chloe Hoepfinger, Oregon State University
Walter Lewandowski, Oregon State University
Jocelyn Gonzalez-Franco, University of Colorado, Boulder

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Geotechnical Extreme Events Reconnaissance (GEER)

Thank You!

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