fire earth

Social Vulnerability to Wildfire

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Key Findings

- Private parcel characteristics (e.g., size, age, value), and not demographic characteristics, provide the most significant explanation of variability in wildfire exposure, sensitivity and overall risk of damages from wildfire. Higher income correlated with increased sensitivity and overall risk.
- Residents' perception of risk often deviated from the quantitative scientific measure of risk and exposure used in this study. The most at-risk residents may not perceive themselves as being so.
- Part-time or full-time residency, age, perceived property risk, and year of development were among the few significant determinants of residents' performance of fuel reduction. Older populations and part-time residents, for example, are often more sensitive to wildfire-related losses but still less likely to perform heavy fuel reduction.
- Recent home development and future development are exacerbating the challenges of wildfire management by exposing additional populations to higher wildfire risk and damages.
- Although part-time residents and owners of newer properties are performing some level of fuel reduction, it is not enough to reduce the exposure, sensitivity, or risk of significant property damage in the places where they live.

Keywords. Wildfire, social vulnerability; Wildfire, adaptive capacity; Risk communication; Wildland-urban interface; wildfire, evacuation

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Fuel treatments can be effective at reducing the spread and impact of wildfires, creating defensible space around communities. Photo: USDA Forest Service under CC BY 2.0.

Wildfires present an increasing threat to communities through impacts that include destruction of homes or outbuildings, evacuations, damage to public infrastructure, and economic disruption. Effective fire management entails identifying and understanding behavioral patterns of communities most at risk from such disturbances, and how actions taken by individual residents and communities can help mitigate risks and alleviate the need for federal resources for wildfire suppression. A common way of analysing human susceptibility to wildfire is through the concept of social vulnerability, which describes a population's potential exposure and sensitivity to wildfire-related risks, and their ability to reduce the negative impacts from the hazard through mitigation actions—for example, fuel suppression carried out on private property by homeowners or landowners. Addressing and reducing such vulnerability to the effects of wildfire first entails a sufficient understanding of the factors that determine who is vulnerable and why.

Researchers at the University of Idaho conducted two studies in an effort to assess the potential factors of social vulnerability. As part of a long-term effort to explore adaptation to wildfire, risk and vulnerability in the area surrounding McCall, Idaho, researchers analysed (a) self-reported survey data from at-risk residents, (b) computer-based wildfire risk simulations, and (c) geospatial data. McCall provides a useful setting for studying wildfire vulnerability because fires typically occur in the surrounding region on an annual basis, and because the area is considered to be at high risk for future wildfire impacts. Employing a similar methodology, researchers analysed the characteristics contributing to increasing social vulnerability to wildfire in Flathead County, Montana, a fire-prone region that includes a growing population of residents living in the wildland-urban interface. In both locations, researchers measured social vulnerability using calculations of expected residential losses from

Three Determinants of Social Vulnerability to Wildfire

Exposure	The likelihood a wildfire hazard impacts populations and the resources they rely upon.
Sensitivity	The severity or magnitude of wildfire impacts that could occur to a range of values, ecological processes or assets valued by a target population.
Adaptive Capacity	The ability of populations to adapt in ways that reduce their exposure or sensitivity to wildfire, thus alleviating future wildfire impacts

Performing fuel reduction treatments on their properties is one option that contributes to adaptive capacity of communities. Property owners may vary in terms of their willingness, capacity and perception of the need to perform fuel reduction treatments. Photo: Tracy Robillard/NRCS under CC BY-ND 2.0.

wildfire (E(RLW)), a probabilistic, monetary metric calculated for every residential parcel in the sample area.

Exposure to Wildfire Risk

Researchers found that perceived vegetation risk (e.g. residents' perceived likelihood that wildfire would burn the vegetation around their property during the next 10 years), building value, parcel value and location all play a significant role in predicting wildfire exposure in both McCall and Flathead County. Newer properties were associated with a higher risk of wildfire exposure, as were smaller properties, part-time residences, and residents' perceived likelihood that wildfire burns vegetation around their property during the next decade. Meanwhile, demographic characteristics and residents' perception of wildfire risk on their properties were generally insignificant indicators of exposure and overall risk.

Sensitivity to Wildfire Impacts

In McCall, according to E(RLW) calculations, those most sensitive to potential wildfire losses were found to be higher income households, older residents, those with children, and part-time residents. Those most sensitive to wildfire losses also displayed less opposition to additional taxation for wildfire management, but expressed less agreement that federal agencies should devote more efforts to fuels reduction, and less support for property regulations such as prohibiting development in high risk areas.

Expected Residential Losses from Wildfire [E(RLW)] Calculation

$$E(RLW) = pb_j\left[\left(\sum_{h=1}^{nj} pS_{hj}\, VS_{hj}\right) + \beta_j\, TV_j\right]$$

pb_j = Probability that parcel j burns, derived from outputs of vegetation and wildfire behavior simulation models.

nj = Number of existing residential properties in parcel j, determined using the 2010 Montana Cadastral data.

pS_{hj} = Probability that structures on property h in parcel j burns, given parcel j burns, based on the level of fuel reduction reported by the survey respondent.

VS_{hj} = Total value of existing structure(s) on residential property h in parcel j.

β_j = Average percentage loss in aesthetic value of residential properties in parcel j given parcel j burns, based on prior empirical research concerning loss of property value following wildfires.

TV_j = Total value of residential property (land + structure) in parcel j, determined using the 2010 Montana Cadastral data.

Meanwhile, in Flathead County, newer properties had higher levels of sensitivity to wildfire losses, as did properties with higher land value. In contrast to McCall, those most sensitive to potential wildfire losses in Flathead County were full-time, not part-time residents. Significantly, residents' perceived wildfire risk to their property did not often match their simulated risk or exposure using the latest scientific means. For example, as residents' reported likelihood of property damage decreased, the sensitivity of their property to wildfire damages increased. Similarly, as perceptions of wildfire risk decreased, overall sensitivity increased.

Adaptive Capacity

Around 40% of survey participants in McCall had performed little or no fuel reduction in the past decade. Those more likely to perform light fuel reduction were older residents and those who considered wildfire risk in their decision to buy a property in the first place. Full-time residents, owners of newer properties, and those who oppose additional taxation for fire suppression and fuel reduction were more likely to perform heavy fuel reduction when compared with no fuel reduction at all. Meanwhile, in Flathead County, those most likely to perform light fuel reduction were part-time residents, younger residents, and residents of newer properties.

Combined, these results illuminate some key factors that influence social vulnerability to wildfire. Managers might consider utilizing this research to identify and target vulnerable populations with campaigns aimed at encouraging fuel reduction among these populations and sub-populations. For example, these studies suggest diversity and differences among residents in terms of factors like land ownership, residency and perceived risk could predict significantly different responses to the threat of wildfire. Such diversity implies that land managers could tailor effective communication strategies to specific groups of residents (e.g., full-time homeowners versus part-time renters) as well as enacting broad risk communication strategies aimed at all residents of an at-risk community.

Foundational Publications

Paveglio, T. B., Prato, T., Edgeley, C., & Nalle, D. (2016). *Evaluating the characteristics of social vulnerability to wildfire: demographics, perceptions, and parcel characteristics.* Environmental Management, 58(3), 534-548. https://doi.org/10.1007/s00267-016-0719-x

Paveglio, T. B., Edgeley, C. M., & Stasiewicz, A. M. (2018). *Assessing influences on social vulnerability to wildfire using surveys, spatial data and wildfire simulations.* Journal of Environmental Management, 213, 425-439. https://doi.org/10.1016/j.jenvman.2018.02.068