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Mapping and modelling bushfire exposure at the wildland–urban interface in Australia

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Abstract: The wildland-urban interface (WUI) is increasingly recognised as a zone of high exposure to bushfire risks, yet national-scale assessments of its extent and vulnerability in Australia is still unexplored. In this study, we have attempted to mitigate the gap by mapping the WUI in Australia using a consistent method, enabling robust comparisons of spatial and temporal changes in the WUI across the continent. The WUI was characterized as developed areas containing residential, commercial, educational and medical structures in major or semi-urban areas that are located within 1 km of wildland vegetation larger than 2 km^2. The WUI was broadly classified into forested and grassland WUIs depending on the vegetation type. This enabled a nuanced understanding of fire interactions with different WUI environments.

Although the mapping approach identifies the WUI areas, it does not directly assess the bushfire risk. To identify the risk zones, we further investigated the potential exposure of WUI area to ignitions under varying fire weather conditions represented by the Forest Fire Danger Index (FFDI). We generated random ignition points at multiple distance bands from the WUI (250-500 m, 500-1000 m, 1000-5000 m and 5000-10000 m). The fire spread was simulated using the SPARK platform. The ignitions were spatially indexed into 50 m grids in a GIS environment. The ignitions that resulted in fire spread into the WUI under different FFDI conditions (mild, moderate, severe and extreme) were identified.

We derived a grid-based impact scoring system expressed as a matrix of ignition distance versus FFDI from the obtained results. Higher FFDI values and shorter ignition distances to the WUI correspond to greater impact scores, reflecting the likelihood of fire spread into the WUI under extreme weather conditions. This approach provides a quantitative assessment of WUI exposure, facilitating targeted analysis of areas that are most susceptible to fire under varying atmospheric scenarios.

This study demonstrates the utility of coupling a nationally consistent WUI map with fire spread simulations to evaluate the influence of ignition location and fire weather on bushfire exposure. The outcomes have direct implications for prioritising bushfire risk reduction strategies, land-use planning, and emergency management across Australia.

Keywords: *Bushfire, wildland-urban interface, risk assessment*

