International Journal of Building Pathology and Adaptation

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Retrofitting for bushfire resilience: a scalable approach to addressing housing vulnerability among ageing populations in Australia

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Received 9 May 2025
Revised 24 June 2025
21 July 2025
23 July 2025
Accepted 26 July 2025

Abstract

Purpose – This study investigates the barriers older Australians face when retrofitting their homes for bushfire resilience. Many retirees rely on the Age Pension or limited superannuation, restricting their capacity to fund upgrades. Physical constraints reduce their ability to undertake or manage retrofit tasks. Complex building codes and bushfire regulations add to the challenges, especially without access to technical advice. These financial, physical and regulatory barriers delay or prevent effective retrofitting, increasing risk for older people in bushfire-prone areas.

Design/methodology/approach – The research adopts a case study approach centered on the Bega Valley region in New South Wales an area severely impacted by the 2019–20 Black Summer bushfires. Data were collected in two phases during 2023: first, focus groups with older adults to elicit lived experiences, challenges and perceptions regarding bushfire retrofitting; second, site visits and structured property assessments using a bespoke Property Assessment Protocol and aerial drone imagery to evaluate vulnerabilities.

Findings – Key challenges include the cost of upgrades, a lack of clear guidance on bushfire attack level requirements and limited access to qualified tradespeople. Many older residents struggle with maintenance tasks due to physical limitations. Emotional attachment to homes and fear of relocation also influenced decisions. The findings highlight the need for clear, simple retrofitting guidance tailored to older adults and stronger community networks that connect homeowners with skilled professionals.

Originality/value – This research develops a scalable framework to address a gap in bushfire preparedness for older Australians. It combines resident interviews, site assessments and compliance checks to identify barriers to retrofitting and define actions based on risk, effort and cost. The framework offers a structured method for prioritizing retrofit tasks according to user capability and property-specific risk. Its originality lies in presenting a practical approach that enables staged retrofitting tailored to the needs of ageing populations in bushfire-prone areas.

Keywords Bushfire resilience, Retrofitting, Ageing population, Climate-adaptation

Paper type Research article

Introduction

The increasing frequency and severity of bushfires in Australia, driven by climate change and environmental conditions, pose significant challenges for communities living in fire-prone

Funding: This research was funded in 2022 under the Black Summer Bushfire Recovery Grants Program.

International Journal of Building Pathology and Adaptation
Vol. 43 No. 8, 2025
pp. 75-88
Emerald Publishing Limited
e-ISSN: 2398-4716
p-ISSN: 2398-4708
DOI 10.1108/IJBPA-05-2025-0100

areas (Douglas and He, 2019). Rising temperatures, prolonged droughts and the accumulation of dry vegetation have intensified fire risks, leading to longer and more destructive fire seasons, particularly in southern and eastern Australia (Jalaludin and Morgan, 2021). The accumulation of dry vegetation and other combustible materials, exacerbated by these conditions, provides ample fuel for fires, allowing them to grow in intensity and spread rapidly once ignited (Cramp and Scott, 2019), often triggered by human activities such as fire management practices and accidental ignitions (Keith *et al.*, 2022). The Black Summer bushfires in 2019–2020 resulted in the loss of at least 33 lives, the destruction of over 3,000 homes, the burning of approximately 18 million hectares of land and significant adverse impacts on wildlife, with nearly three billon animals affected, alongside severe air quality deterioration that contributed to widespread health issues (Cramp and Scott, 2019; Parsons *et al.*, 2021; Halcomb *et al.*, 2022). The destruction led to a surge in insurance claims, raising concerns about coverage affordability in fire-prone areas, highlighting the long-term socio-economic consequences and community displacement (Jalaludin and Morgan, 2021).

The ageing of Australian's population has led to a significant number of vulnerable older adults living in fire-prone regions, heightening their risk during bushfire events (Fountain *et al.*, 2019; Tannous *et al.*, 2017). Older adults often face unique challenges in disaster management, necessitating an increased focus on their hazard awareness, evacuation preparedness, post-disaster recovery needs and the pivotal role of community engagement and support networks (Fountain *et al.*, 2019; McCall *et al.*, 2023). Older adults' decision to remain in bushfire-prone areas are shaped by a complex interplay of emotional, practical and situational factors (Adedokun *et al.*, 2024). A primary influence is a desire to protect their properties, valuables and pets, with concerns about looting promoting residents to stay and defend their homes (Jones and Walker, 2023).

Emotional ties to home and community often outweigh perceived risks from bushfires, especially for long-term residents (Jones and Walker, 2023). Confusing or delayed evacuation messages further complicate decisions (Adedokun *et al.*, 2024). Financial barriers related to unaffordable retrofitting, rising cost, limited insurance and bureaucratic delays, can trap older adults in high risk homes (Penman *et al.*, 2017). These challenges demand targeted communication and support. This study investigates the barriers to bushfire retrofitting for older Australians and proposes practical solutions based on case studies from the Bega Valley. The research assesses existing retrofitting measures, identifies key constraints and align proposed actions with the Construction of buildings in Bushfire-prone Areas AS3959:2018 (Standards, 2018). The goal is to inform policy and community responses that improve preparedness among older adults in at-risk areas.

Bushfires risk in NSW and the impact on planning and buildings

Bushfire risks in southern and eastern Australia are shaped by the environmental and climatic factors. These areas typically experience a hot and dry climate during the summer months, which when coupled with prolonged droughts and elevated temperatures create optimal conditions for bushfires to ignite and spread quickly (Cramp and Scott, 2019). The abundance of flammable vegetation, particularly eucalyptus forests, intensifies this risk, as these forests possess high fuel loads that can lead to severe fire upon ignition (Godfree *et al.*, 2021). Changes in vegetation types and ecosystems due to climate change significantly influence the fire dynamics by allowing certain plant species to adapt and thrive in warmer conditions, leading to increasing fuel loads that elevate wildfire fire risk (Roberts *et al.*, 2021). Furthermore, the expansion into peri-urban regions has resulted in an increased number of homes situated in bushfire-prone areas, many of which were constructed prior to the establishment of the AS3959:2018 (Standards, 2018), rendering them more susceptible to fire damage (Costin, 2021).

Bushfire-prone lands are documented in maps, which local councils produce, and Rural Fire Service (RFS) Commissioner certifies (McCormack *et al.*, 2022). Effective bushfire protection necessitates a comprehensive approach encompassing fire prevention, strategic suppression, hazard reduction, planning and development control and recovery efforts

(Bandara *et al.*, 2023). An Asset Protection Zone (APZ) is an essential element of bushfire management, serving as a buffer between bushfire-prone land and homes to reduce bushfire damage by managing vegetation to lower fuel loads (Douglas and He, 2019). Fuel loads play a crucial role in bushfire dynamics by increasing the rate of spread, fire intensity, flame height and spotting potential (Khan *et al.*, 2019). A key factor in this process is fuel moisture content, with a significant rise in fire spread occurring when moisture levels drop to 6–8%, as drier fuels ignite more easily and combust faster (Tayari *et al.*, 2023). To mitigate these risks, effective vegetation management within APZ is vital, which includes clearing combustible materials, creating gaps between tree clusters, pruning low branches to reduce ladder fuels and removing wind-vulnerable trees or limbs (Weber *et al.*, 2019). Additionally, using less flammable plant species for landscaping, such as those with high moisture content and minimal debris, can further enhance fire safety (Bandara *et al.*, 2023).

The Environmental Planning and Assessment Act (1979), Government (1979) is a critical legal framework in NSW for integrating bushfire risk management into development assessments. For example, section 4.14 of the Act mandates that developments on land designated as bushfire-prone adhere to the guidelines stipulated in the *Planning for Bush Fire Protection* (PBP*)* (2019). These guidelines address critical elements, including APZs, access routes, water supply, construction methods, landscaping and emergency planning to ensure development proposals consider and mitigate potential bushfire risks. The PBP outlines a five-step process involves identifying the Forest Danger Index (FFDI) for the council area, assessing vegetation types, determining the effective slope beneath the impacting vegetation, measuring the horizontal distance from unmanaged vegetation to the building and aligning these factors to the corresponding bushfire attack level (BAL). The BAL guides APZ dimensions to ensure adequate protection. For example, the PBP (2019), recommends designing residential subdivisions to ensure the most vulnerable structures comply with BAL-29 and specifies non-combustible fencing and retaining walls for higher-risk categories, such as BAL-40 and BAL-FZ.

The building envelope type of single dwellings in Australia plays an important role in protecting homes against ember and smoke incursion in fire-prone areas. Several studies highlighted that ember attacks significantly impacted homes damaged in bushfires (Costin, 2021; Shahparvari *et al.*, 2019; Ullah *et al.*, 2021; Whittaker *et al.*, 2020). In high winds, ember penetration can affect houses even before the fire flames arrive (Honey and Rollo, 2011). While research mentioned that ember penetration into urban areas is harmful at a distance of 700 m from the fire flames, the 2003 Canberra fire records show that houses located 2 km away were severely affected by fire-generated wind even before the flames arrived (Ghaderi *et al.*, 2020). Wind driven wildfires interact dynamically with structures in the wildland-urban interface, as buildings alter the fire plume dynamics, leading to premature buoyant instabilities. This increases plume intermittency, defined as the irregular pulsed emission of smoke and heat, creating risky zones that may generate new fire sources (Ghaderi *et al.*, 2020).

Older homes often use nailed metal sheet roof cladding, while newer homes typically utilize pop rivets for capping and flashing; however, gaps at the ends and overlaps can still occur, allowing embers to infiltrate the roof even if the sheeting or capping is intact (Costin, 2021). Additionally, the shape and design of the house significantly affects the ember accumulation on rooftops during bushfire storms, with embers mainly gathering in the internal corners of roofs, trapping burning debris and increasing the risk of ignition (Nguyen and Kaye, 2021, 2022). Fascias, eaves and guttering areas are susceptible to ember attacks when wind angles are between 45 and 65°, due to the risk of ember ingress from deformed galvanized or painted steel gutters, which can dislodge non-combustible cement soffits under high temperatures (Honey and Rollo, 2011). Similarly, the external wall cladding in older homes without sarking, may have gaps in the overlaps of weatherboards, in the eaves-to-wall junctions and wall corners, making these areas susceptible to ember entry (Honey and Rollo, 2011). Additionally, the pull-through capacity of the commonly used cold-formed steel cladding systems decreased, as elevated temperatures can alter the failure mode of material (Pieper and Mahendran, 2022). As such, routine maintenance of rooftops is essential, particularly in fire-prone areas, which are likely to demand extra effort for older people, who may be less capable of performing regular inspections and repairs on their own due to physical limitations (Fountain *et al.*, 2019).

BAL ratings significantly increase retrofitting costs after a bushfire event due to additional construction requirements. The complexity of the BAL system leads to confusion among homeowners, many of whom are unaware of their property's BAL rating, resulting in unexpected financial burdens (Adedokun *et al.*, 2024; McCormack *et al.*, 2022). For example, after 2013 Blue Mountains bushfires, 82% of affected homeowners were uninsured, with some facing extra cost of up to $150,000 due to BAL requirements (de Vet and Eriksen, 2020). These challenges highlight the need to understand how embers interact with various building elements to develop effective retrofitting guidance for older adults in fire-prone regions. However, retrofitting remains difficult due to homeowners' willingness and financial capability.

Challenges faced by older adults in fire prone regions

Recovery after the 2019 Australian Black Summer bushfires involved significant stressors, including trauma, rebuilding challenges, financial hardship and concerns for family well-being (Harms *et al.*, 2021). Fire damage, both properties and symbolic, can retraumatize affected individuals (Tannous *et al.*, 2017). Older adults face heightened risk due to health issues, limited mobility and communication barriers that hinder evacuation and access to emergency information (Adedokun *et al.*, 2024). Bushfire stress can worsen chronic conditions and increase injury risk during evacuation (Fazeli *et al.*, 2024). These factors underscore the need for targeted strategies to protect older adults in emergencies.

After the Black Summer bushfires, several retrofitting guides were disseminated, such as guidelines for complying with the AS3959:2018 (Standards, 2018) requirements using visual aids and practical steps for constructing new homes and retrofitting older ones. Educational workshops were also offered to provide practical training, case studies showcase successful design strategies and videos and tutorials offering guidance for construction, enabling homeowners to make informed choices regarding bushfire resilience (McCormack *et al.*, 2022). However, in Australia, one in six people is aged 65 or older, with 34% of this demographic residing in rural and remote areas that are at higher risk of bushfire exposure (Fountain *et al.*, 2019; Australian Institute of Health and Welfare (AIHW), 2024). Recent changes to Australian Building regulations, particularly regarding the BAL ratings, has introduced unforeseen retrofitting costs that many homeowners are not prepared for (de Vet and Eriksen, 2020; Wain *et al.*, 2024). Current retrofitting guides and toolkits often lack adequate guidance for this demographic, complicating effective home modifications (Salam *et al.*, 2024; Harvison *et al.*, 2011; Unver *et al.*, 2022; Wu *et al.*, 2025). This research seeks to address the gap in understanding challenges faced by older Australians in retrofitting their homes for improved bushfire resilience and to develop tailored resources to support them in undertaking necessary home retrofitting and preparedness measures.

Method and data collection

The research adopted the case study design (Yin, 2017) to collect multiple data sources to produce a reliable understanding of the challenges facing older adults to retrofit their properties. The data collection took place in Bega Valley local government area (LGA) in New South Wales (NSW). This area has a Fire Danger Index (FDI) value of 100, indicating catastrophic fire conditions where fires are completely uncontrollable, spread rapidly and evacuation is the only safe option (Standards, 2018). This LGA area was impacted by the 2019 Black Summer bushfires in NSW that affected northern, central and coastal regions (Cramp and Scott, 2019). The eligibility criteria included the older local demographic (65+ years) and individuals in the pre-retirement phase who anticipated ageing in place within bushfire-prone communities. The data collection included two phases. The first phase was the focus groups with older adults to introduce the research and gather insights about their retrofitting knowledge and challenges and to get approvals for their participation in the second phase. The second phase included site visits to homeowners who were planning to enhance the bushfire resilience of their property and to get them to participate in interviews to gather insights about their existing retrofitting and future plans to guide the development of the scalable framework for prioritising bushfire retrofit actions. This step involved experts' consultation to validate the scalable framework, including bushfire specialists, building practitioners and ageing-population advocates to assess its technical accuracy and practical applicability.

The focus group was conducted at a community center in Bega Valley in April 2023, followed by the site visits in May 2023. A property assessment protocol was developed to help research team in recording the current conditions of the property during the site visits. The protocol consisted of a key information page and nine sections that address various aspects of the property, including roof and walls, windows and doors, subfloor, external features, outdoor area, garage, storage and garden. The key information collected for each case study included: the age group of the occupants, the year of construction, the type of house, the external cladding material, the internal framing material, the type of surrounding vegetation and its proximity to the structure as well as the overall condition of the property. The nine sections of the protocol were designed to document the condition of the house, as each section is accompanied by a reference page containing photographic examples of various roof types, cladding materials and vegetation. These visual aids were added to facilitate accurate and consistent documentation.

For the assessment of roofing construction and condition, a DJI Mavic Mini 3 Pro drone was piloted around each property. Aerial imagery of the roof and the surrounding landscape was captured for each site and subsequently utilized to evaluate the vulnerability of both the home and its garden areas. The following features of the property were assessed using the drone footage: vegetation and landscaping, roof condition and material, skylights, external cladding materials, outdoor area (e.g. sheds), water tanks and the condition of driveways and escape routes. In addition to drone footage, an Insta 360 X3 camera was employed to capture 360° images of the outdoor area. These images were compiled into a walk-through tour of each property using H5P software for the analysis process. Exterior images were detailed enough to evaluate the condition and materials of walls and roofing and garden areas to assess the density of plant vegetation, particularly in locations where the drone footage lacked clarity.

Each two-hours site visit included a participant-led property followed by a semi structured interview exploring retrofit decisions. Interviews used open-ended interview questions covering personal experiences, retrofit motivations, disaster plans and community support. This method built on focus group insights and allowed a systemic comparison across cases. Topics included future lifestyle and housing preferences, drivers for retrofitting (climate readiness, sustainability or livability) and local support for bushfire resilience. The analysis combined focus group, interview and site data to develop strategies for older Australians. Thematic analysis identified key factors: risk perception, retrofit barriers, decision-making, information needs, ageing-in-place factors, community support and trust in technical advice. The resulting framework, developed by the first author, prioritizes retrofit actions by risk, effort and cost, aligning measures with older adults' capacities. It supports bushfire resilience assessment and planning, using triangulated narrative, visual and site data.

Results and discussion

Focus group discussions revealed participants' vulnerabilities and highlighted their interest in strengthening bushfire resilience. Many valued non-monetary items such as pets, ID documents and heirloom artifacts. Evacuation strategies prioritized essential documents, while sentimental possessions were secondary and protected through defensive structures (sheds/bunkers). Companion animals were included in evacuation plans, livestock relied on community coordination. Participants with prior bushfire experience reported shifting priorities, focusing less on possessions and more on safe evacuation. This reflects a post-trauma reprioritization where survival outweighs property preservation.

Retrofitting concerns

Participants emphasized the importance of proactive bushfires measures, including defensible spaces, fire-resistant materials and landscapes maintenance. However, many felt ill-equipped to make informed decisions due to complexity of materials choices and fire safety regulations. Ensuring compliance with current building standards is particularly difficult when existing structures do not meet these requirements. Concerns about non-compliance, such as fines or needing to redo work add further pressure. Council and Rural Fire Brigade (RFS) assessments are required before retrofitting, but the multi-step process often delays and increases administrative burden. Older adults face additional barriers, including physical capacity, cognitive load and financial stress (Fountain *et al.*, 2019; Tannous *et al.*, 2017) and trauma from past bushfires (Harms *et al.*, 2021; Penman *et al.*, 2017). A shortage of qualified tradespeople in rural areas further complicates retrofitting. This scarcity raises costs, discourages upgrades and increases stress for homeowners seeking to protect their properties.

Participants highlighted various landscaping challenges, particularly in managing vegetation to reduce fire risk, which requires significant labor and planning for bushfire safety compliance. Ongoing maintenance demands continuous effort and resources, while environmental sustainability is also a consideration, necessitating the choice of fire-resistant plants suitable for the local ecosystem. Additionally, engaging with the community on fire safety landscaping practices adds complexity, as coordination with neighbors is essential for a cohesive safety approach in the area. The group acknowledged the essential role of local knowledge, particularly from Aboriginal communities, in enhancing land management and fire practices. Indigenous people's traditional ecological knowledge can significantly improve fire management strategies, especially following the Black Summer bushfires, which spurred discussions on integrating these insights into current practices (Nikolakis *et al.*, 2020, 2024).

The community members underlined that existing retrofitting resources and toolkits were inadequate, particularly regarding accessibility for older adults. The lack of tailored resources leaves individuals feeling overwhelmed and unsure of how to begin, complicating the retrofitting process and fostering feelings of isolation as they struggle to connect with service providers. This situation eventually affects the safety and resilience of their homes and the wider community (Jones and Walker, 2023).

Overview of the case studies

Three homeowners from the Bega LGA focus group participants agreed to participate as case studies for the research. The three case studies were situated approximately 60 kilometers apart, spanning locations from Brogo (case study A) to Tura Beach (case study B) and Eden (case study C), as shown in Figure 1 below. This geographical diversity highlights the different environments and community contexts within the region. The varying distances suggest that each household may encounter unique challenges and opportunities for retrofitting for climate resilience, influenced by land use, level of bushfire risk, infrastructure and community resources. For example, a rural household in Brogo may have different needs compared to one in the coastal area of Tura Beach or the town of Eden. This variation enabled the researchers to collect a wide range of data, essential for investigating retrofitting measures of different communities.

Case study A. It is in Brogo, NSW 2550, spans 120 hectares and features a detached house built in 2000. The building's external wall cladding is brick on the lower level and weatherboard on the top floor, with a timber frame. The house is surrounded by vegetation on the southwest side, consisting of a mix of open forest, scrub or heath trees, and grassland, all within 100 meters of the structure. The house and a small shed are situated at the end of the driveway offering a view over the rest of the property, where cattle are located, adding to the rural landscape of the property. The house is insured and in good condition, requiring some minor repairs, and includes accessible features such as no-step entry, grab rails and wide corridors for ease of movement. However, the property is only accessed via a driveway lined with trees on both sides, which the owner described as "*acting like a magnet to fire*", as shown in Figure 2 (a and b).

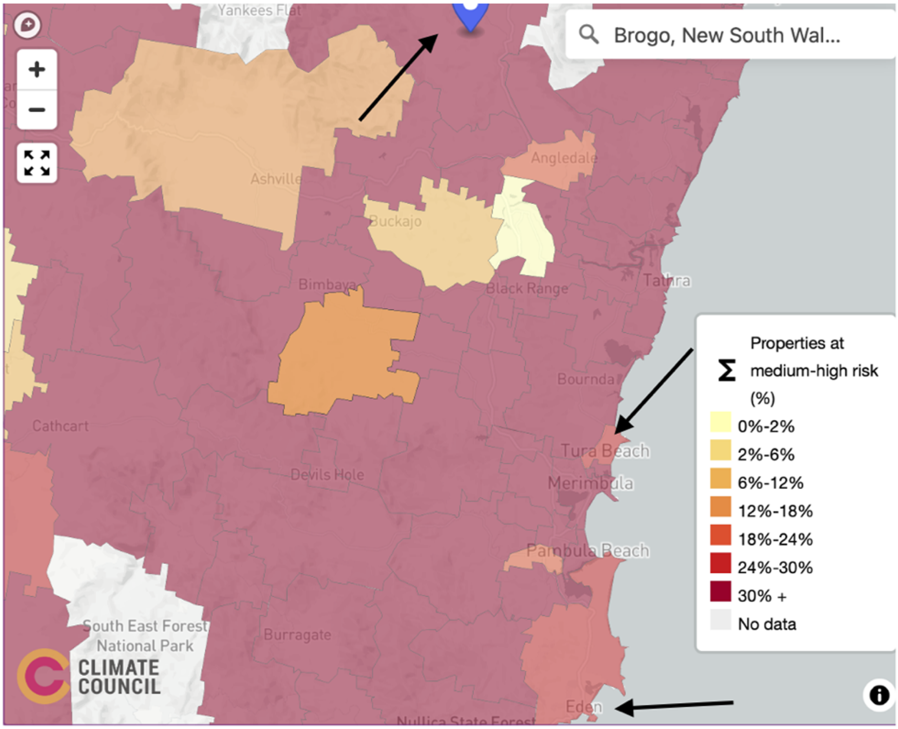

Figure 1. Climate risk map of the Bega region, illustrating the proximity of the case study locations. The case study sites, arranged from North to South, include Brogo (case A), Tura Beach (case B), and Eden (case C). Image source (Council, 2025)

Case study B. It is in Tura Beach, NSW 2548 and spans 1.4 hectares. It consists of a detached house with a guest house and has two caravans on the site. Originally built in 1960s, the house was extended in 2007 to include a larger living area and a deck. The building's external cladding is weatherboard and the frame is timber. The general condition of the house is good, requiring only minor repairs and it features accessibility modifications, including ramps and an additional driveway that is approximately 250 meters long. The property is insured. However, the house is located near dense vegetation, including tall trees and scrub. One tall tree stands particularly close to the entrance, prompting the owner to state, "*we will leave immediately because of this tree*", as shown in Figure 2 (c and d).

Case study C. It is located in Eden, NSW 2551 and involves a 1950s house purchased in 2022. The roof has been upgraded, but the house remains uninsured and is in suboptimal condition. A deteriorated shed with a dry timber frame and damaged roof sits near the house, as shown in Figure 2 (e and d). Asbestos has been removed from the shed's interior walls. The house has timber-framed windows and doors without shutters, a gap in the exterior cladding above the main entrance and a flower bed under the windows. An extension serves as the living room and a winter garden, clad in plastic corrugated sheets without internal walls. A tall tree in the backyard has been flagged by the neighbor as a fire hazard. The owner is aware of the need for retrofitting the property but is unsure how to proceed and reports no strong attachment to the property.

Physical limitations and living arrangements

The respondents expressed uncertainty about their physical limitations and their impact on future living arrangements. Case Study A stated, "*I'm reasonably fit but would not be able to*

Figure 2. Site overview of case studies A, B and C: environmental context and surrounding vegetation (Source: images captured by the authors; used with permission)

perform all the tasks required in the event of a catastrophic fire". Similarly, Case Study B noted: "*I can do the regular maintenance tasks, but I don't know if I will fit enough next year to do these task*". Respondents expressed a strong desire to remain in their current homes as long as possible, indicting a focus on maintaining their independence and continuity in family living arrangements. In context of bushfire preparedness, mobility challenges significantly impact respondents' ability to evacuate quickly. They indicate that, in the event of a catastrophic fire, they would not remain to defend their properties due to their age and physical limitations. This raises concerns about their capacity to evacuate safely and efficiently, particularly if they are alone or face mobility issues during an emergency. The uncertainty surrounding these arrangements increase their stress and necessitates careful consideration of their preferences.

Existing maintenance and retrofitting measures

Homeowners in Cases A and B actively managed vegetation around their properties as part of their landscaping and fire safety strategies. They removed flammable vegetation, including shrubs and trees located near exterior walls, to create a defensible space, reduce the risk of fire and prevent it reaching the homes. They also planted fire-retardant trees with low ignition to slow down the spread of fire and enhance fire protection. Additionally, these homeowners equipped their properties with multiple water tanks to ensure a reliable water supply, curial for firefighting during a bushfire. Implementing sprinkler systems, including remote-controlled options enables them to activate the system in response to fire threats, adding a further layer of protection. These measures reflect a proactive approach to effective fire mitigation.

Community support and communication were key theme among the three cases. Case A households joined a community phone tree network for rapid messaging during emergencies. Neighbors also shared resources, such as fuel for evacuation, which enhanced individual preparedness and fostered a sense of solidarity within the community. Case B homeowners highlighted the importance of proximity to essential services and neighbors, maintaining direct communication with Fire/Rescue services to receive critical information promptly. They planned to evacuate immediately if fire threatened, given the specific risk from nearby tall trees. Case C, as a new owner, engaged differently, relying on support from a nearby friend for advice in bushfire season.

All case studies showed structural upgrades to improve bushfire resilience. Homeowners used non-combustible materials for eaves and roofing and maintained windows and doors to reduce ember entry, a key ignition source (Honey and Rollo, 2011). While aware that retrofitting is still needed, many were confused by the inconsistent guidance from councils and online sources. This research responds with a scalable framework that prioritizes retrofit actions by risk, effort and feasibility. Grounded in resilience as an adaptive capacity (Abramson *et al.*, 2015), this framework supports staged, practical interventions aligned with varying skills, resources and exposure. It enables older homeowners to reduce risk incrementally within existing constraints, building long-term resilience through targeted actions.

Development of a scalable framework for prioritizing bushfire retrofit actions

The scalable framework provides a structured method for prioritizing bushfire retrofit actions by risk, effort and cost. It supports older homeowners with varying capacity, resources and exposure by aligning actions with their specific constraints. It organizes retrofitting actions into three priority levels based on structural vulnerability and urgency of risk, the work and cost involved. These levels are high, medium and low. High-priority actions address major vulnerabilities and reduce immediate bushfire risk. These actions range from sealing a 2 mm gap in cladding or joinery, which require a handyman (moderate effort), to higher-cost upgrades such as replacing non-compliant roofing. These actions are urgent and often necessary to protect against ember entry and structural failure during a bushfire. Prioritizing them supports older homeowners who may not have the skills or capacity to undertake even minor repairs without assistance. Medium-priority actions reduce risk but can be scheduled later. These include installing external shutters or upgrading to fire-resistance doors. They require moderate effort and a manageable level of cost, making them suitable for staged implementation. Low-priority actions support long-term resilience and can be scheduled over time. These include high-cost upgrades such as replacing windows with double glazing, which improve performance but are not immediately essential if shutters are installed. In contrast, regular maintenance tasks, such as clearing gutters or maintaining seals are low-cost but remain a high priority due to their role in reducing ember entry and maintaining protection around the property. Fieldwork and expert review validated the actions and confirmed their suitability for older homeowners. The scalable framework supports decision-making by aligning actions with available time, labor and funds. It enables users to begin with manageable tasks and progress toward broader retrofitting to improve bushfire readiness. Validated through fieldwork and expert review, the framework applies to diverse setting beyond the Bega LGA, provided building type, age and maintenance practices are considered.

Table 1 summarizes the site assessment of existing retrofitting measures and recommends actions aligned with AS3959:2018 (Standards, 2018), along with maintenance tasks to complete before the bushfire season. Recommendations are categorized by priority, effort and cost, with consideration for the needs of older Australians. The table presents a scalable approach: low-effort tasks can be done by homeowners, moderate-effort tasks may require a handyman or tradesperson and high-effort tasks should be carried out by a specialized builder.

Table 1. Bushfire retrofitting measures: existing and recommended solutions with priority, effort and cost rankings

Building element	Existing retrofitting measures (case study)	Recommended retrofitting measures based on AS3959:2018 and ongoing maintenance recommendations	Retrofit measures ranking categories		
			Priority	Effort	Cost
Roof vulnerability	Non-combustible roofing *(cases A and B)*	Repair or replace damaged gutters, gutter shielding, and sarking materials *(cases A and B)*	High	Moderate	Moderate
	Replaced the old roof with a new corrugated steel roof *(case C)*	Consider using additional sprinkler heads in the roof cavity, especially if they contain or are composed of, combustible materials (cases A and B)	High	Moderate	Low
		Clean debris accumulated on roof *(all cases)*	High	Low	Low
Gutter maintenance	Closed gutters *(cases A, B, and C)*	Clean debris accumulated around gutters *(all cases)*	High	Low	Low
Eaves	Sealed eaves *(cases A, B, and C)*	Seal any gaps *(all cases)*	High	Low	Low
External wall integrity	The extension part constructed using fire resistance timber species comply with AS 3959–2009 *(case B)*	Seal all gaps larger than 2 mm, protect vents and weepholes using metal mesh	High High	Moderate Moderate	Low Moderate
		Repaint and reapply any fire-retardant treatments to damaged painted external areas *(all cases)*			
		Sand and paint any rough sawn timber finishes to prevent embers from igniting the textured surface *(all cases)*	High	Moderate	Low
		Protect all re-entrant corners (for at least 500 mm in all directions) and bottom of all ground level (at a minimum of 500 mm) using non-combustible materials or class 1 durability timber, with additional flame resisting sarking *(cases A and C)*	Moderate	High	High
Window protection	Upgraded dining area windows to double glazing *(case A)*	Fill gaps in windows frame using draught seals or close-fitting construction methods *(all cases)*	High	Moderate	Low
	New windows were installed in 2013 to comply with AS 3959–2009 *(case B)*	Install window shutters	High	Moderate	Moderate
		Repair and repaint damaged surfaces and reapply fire-retardant treatments *(case C)*	High	Moderate	Moderate
		Install tight steel mesh and heat-resistant fiberglass fabric with a heat-reflective outer layer on windows for effective ember and heat protection during bushfire season *(all cases)*	High	Moderate	Low
		Upgrade windows to double glazing *(all cases)*	Low	High	High

(*continued*)

Table 1. Continued

Building element	Existing retrofitting measures (case study)	Recommended retrofitting measures based on AS3959:2018 and ongoing maintenance recommendations	Retrofit measures ranking categories		
			Priority	Effort	Cost
Door safety		Upgrade to fire-resistance doors *(all cases)*	Moderate	Moderate	Moderate
		Remove any obstacles in the doorway and slippery mats *(all cases)*	High	Low	Low
		Install tight steel mesh and heat-resistant fiberglass fabric with a heat-reflective outer layer on doors for effective ember and heat protection during bushfire season *(all cases)*	High	Moderate	Low
Subfloor protection	Underground area is enclosed (concrete) and has fire-resistant curtain protecting the door *(case B)*- (Cases A and C have no subfloor area)	No further action is required			
Deck and outdoor area	Constructed using fire resistance timber species comply with AS 3959–2009 *(case B)*	Use non-combustible materials for deck and outdoor furniture *(case C)*	High	Moderate	High
	Eucalyptus trees near the shed were also removed *(case A)*	Remove eucalyptus and overhanging trees close to the house *(cases B and C)*	High	Moderate	Low
Sprinkler systems and cameras	Installed an outdoor camera, upgraded Internet, larger water tank with diesel pump, and solar batteries for emergency power, and installed a remote-controlled sprinkler system. *(case A)* Installed a remote-controlled sprinkler system on the roof *(case B)*	Consider using additional sprinkler heads to cool down external walls in fire season *(all cases)*	Moderate	Moderate	Moderate
Defensible space and Asset management zone	Gravel added on west side of the house, flammable plants near house were removed, fire-retardant trees planted, and lawn maintained for safety *(case A)* Constructed a secondary road at the back of the property for emergency access They have six water tanks as a backup plan for emergency use *(case B)*	Replace trees along driveway with fire-retardant trees or trim for safety during evacuation (case A) Trim tall trees near the house (cases B and C)	High	High	Moderate

Source(s): Authors' own work

Conclusion

The study examines the barriers older Australians face in retrofitting homes for bushfire resilience and offers practical solutions. Older adults living in fire-prone areas face heightened risk due to climate change, ageing and limited resources. Their decisions to remain are shaped by emotional ties, financial constraints and responsibilities such as caring for pets. Key barriers include high retrofit cost, physical limitations, regulatory complexity and lack of clear guidance. Many homes predated the AS3959:2018 standards, and homeowners often do not know their BAL, leading to unexpected expenses. Ageing related limitations and shortage of skilled tradespeople further hinder retrofitting. Complex regulations and compliance requirements add to community concerns.

This research provides a scalable framework to guide older homeowners in prioritizing bushfire retrofitting actions based on risk, effort and cost. By aligning retrofitting tasks with user capacity and property-specific vulnerabilities, the framework supports staged implementation tailored to ageing populations. It offers a practical tool for homeowners, local councils, and community organizations to facilitate decision-making and resource allocation. The study underscores the need for simplified guidance, accessible technical support and targeted financial assistance. Integrating these insights into policy and community programs can enhance bushfire preparedness, reduce housing vulnerability and support ageing in place for Australians in fire-prone areas. Future research could focus on investigating the role of local councils and community networks in facilitating retrofitting initiatives could provide insights into collaborative solutions that enhance bushfire preparedness. Finally, longitudinal studies assessing the effectiveness of retrofitting interventions over time would contribute to evidence-based policy recommendations, ensuring that older Australians in fire-prone regions receive the necessary support to safeguard their homes and well-being.

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