

2013

## Wildfire preparedness, community cohesion and social-ecological systems

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### Recommended Citation

Prior, Tim and Eriksen, Christine, "Wildfire preparedness, community cohesion and social-ecological systems" (2013). *Faculty of Social Sciences - Papers*. 616.  
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## Wildfire preparedness, community cohesion and social-ecological systems

### Abstract

The consequences of wildfires are felt in susceptible communities around the globe on an annual basis. Climate change predictions in places like the south-east of Australia and western United States suggest that wildfires may become more frequent and more intense with global climate change. Compounding this issue is progressive urban development at the peri-urban fringe (wildland-urban interface), where continued infrastructure development and demographic changes are likely to expose more people and property to this potentially disastrous natural hazard. Preparing well in advance of the wildfire season is seen as a fundamental behaviour that can both reduce community wildfire vulnerability and increase hazard resilience - it is an important element of adaptive capacity that allows people to coexist with the hazardous environment in which they live. We use household interviews and surveys to build and test a substantive model that illustrates how social cohesion influences the decision to prepare for wildfire. We demonstrate that social cohesion, particularly community characteristics like 'sense of community' and 'collective problem solving', are community-based resources that support both the adoption of mechanical preparations, and the development of cognitive abilities and capacities that reduce vulnerability and enhance resilience to wildfire. We use the results of this work to highlight opportunities to transfer techniques and approaches from natural hazards research to climate change adaptation research to explore how the impacts attributed to the social components of social-ecological systems can be mitigated more effectively.

### Keywords

social, ecological, systems, wildfire, preparedness, community, cohesion

### Disciplines

Education | Social and Behavioral Sciences

### Publication Details

Prior, T. & Eriksen, C. (2013). Wildfire preparedness, community cohesion and social-ecological systems. *Global Environmental Change*, 23 (6), 1575-1586.

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20 Word count: 8316

21 **1. Introduction**

22 Fire in the landscape is a natural phenomenon in many regions of the world, supporting both ecological  
23 processes and cultural practices. Yet the 'naturalness' of this phenomenon is simultaneously in a state of flux  
24 and controversial due to global climate change and population expansion into naturally vegetated landscapes.  
25 Global climate predictions suggest that wildfires will become more intense and more frequent, particularly in  
26 south-east Australia and in parts of the western United States (Bradstock *et al.*, 2009; Hennessy *et al.*, 2005;  
27 Lucas *et al.*, 2007; McKenzie *et al.*, 2004). Even if these predictions turn out to be inaccurate, the structural and  
28 demographic changes and developments at the 'peri-urban fringe' (interface landscapes characterised by a mix  
29 of urban, rural and wildland features: see Stewart *et al.*, 2007; Buxton *et al.*, 2006) will increase the  
30 consequence of wildfires in the future. 'Wildfire' has become an accepted moniker for danger, reflecting the  
31 growing hazardousness and potential for disaster of an endemic force in many ecosystems.

32 What makes wildfires disastrous is their social impact. Yet many wildfire studies have historically overlooked  
33 this social element, instead being framed within ecology or environmental research. More recent scholarship  
34 has focused on understanding the human dimensions of wildfire management and mitigation, demonstrating

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<http://dx.doi.org/10.1016/j.gloenvcha.2013.09.016>.

35 that the solutions are often social, not just engineered or environmental (Bihari and Ryan, 2012; Brenkert-  
36 Smith *et al.*, 2006; Collins, 2009; Cottrell, 2005; Eriksen and Gill, 2010; McCaffrey *et al.*, 2013; McCaffrey *et al.*,  
37 2011; Paveglio *et al.*, 2011; Sturtevant and McCaffrey, 2007). An important aspect of this human dimensions  
38 work has been an exploration of the role (and responsibility) of community members in mitigating their own  
39 wildfire risk. Here wildfire preparedness is advocated as an important means by which individuals and  
40 communities can reduce vulnerability and increase resilience to wildfire. While the relationship between  
41 preparation, vulnerability and resilience is yet to be fully understood (and may not be interchangeable as much  
42 of the disaster literature infers), results from preparation research across a range of natural hazards alludes to  
43 their strong connection and interaction, demonstrating that preparing minimises the consequences of the  
44 hazard and increases the ability of people to cope with, recover from and adapt to the hazard (Jonientz-Trisler  
45 *et al.*, 2005; Lindell and Perry, 2000; Paton *et al.*, 2008; Thomalla *et al.*, 2006; Whittaker *et al.*, 2012). Preparing  
46 enables at-risk people to coexist more sustainably with hazardous environments (Paton, 2006).

47 A central issue for wildfire managers is therefore the ability to understand the social processes that influence  
48 this complex social-ecological system. This paper uses qualitative and quantitative techniques to model the  
49 interactions between several key social factors that influence wildfire preparation. Many of these factors have  
50 been individually demonstrated as important determinants of disaster mitigation. Yet little systematic work has  
51 to date specifically identified how they relate to each other and what these relationships mean for wildfire  
52 vulnerability and resilience. That is, what social factors influence the ability of people to mitigate or adapt to  
53 the threat posed by natural hazards like wildfire, and how is the interaction between these factors important?  
54 Drawing on an Australian case study, the paper highlights the importance of social cohesion and social  
55 connections in preparation. It builds on advances in research on the human dimensions of natural hazards and  
56 disasters to illustrate how a focus on people in the environment may help to inform more effective responses  
57 to socially driven environmental issues associated with climate change. Like Adger (2003), we argue that  
58 community resilience springs from factors connected to the cohesive community. We explore causal  
59 relationships between social factors that influence individual and community-scale decision-making in relation  
60 to wildfire preparedness. People are shown to rely on this cohesion as a resource that supports both the  
61 adoption of mechanical preparations, and the development of cognitive abilities and capacities that can reduce  
62 vulnerability and contribute to resilience. We use the results of this work to examine the similarities and  
63 differences between natural hazards research and studies of climate change science. The paper suggests  
64 opportunities to transfer techniques and advances from natural hazards research to climate change science to  
65 explore how the impacts attributed to the social components of social-ecological systems can be mitigated  
66 more effectively.

## 67 **2. Background**

68 Natural hazards have long posed challenges for the communities that inhabit the places hazards affect. In all  
69 cases, the social impact can be gauged in lives, lifestyles and livelihoods lost or disrupted, not to mention the  
70 property and infrastructure destroyed. Indeed, what converts these naturally occurring hazards into disasters is  
71 their interaction with people. Equally important in this context is the makeup of society, and the ability of the

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72 members and components of society (individuals, neighbourhoods, communities, social structures and  
73 institutions) to mitigate and successfully adapt to impending risks.

74 Recent events such as the 'Black Saturday' wildfires in Victoria, Australia (2009), hurricane 'Katrina' in New  
75 Orleans, USA (2005), earthquakes in Haiti (2010) and New Zealand (2011), and the South East Asian and  
76 Japanese tsunamis (2004 and 2011 respectively) provide all-too-real indications of the ferocity and disastrous  
77 potential of the interaction between natural hazards and society. Such hazard activity also highlights the need  
78 for society to develop or refine the mechanisms that are used to confront these hazards – whether  
79 behavioural, cultural, structural or institutional.

80 In this paper we consider the way social cohesion influences knowledge about preparation, and the propensity  
81 to prepare for wildfire. We draw on this relationship to explore how preparation contributes to the adaptive  
82 capacity of people who are part of the wildfire social-ecological system, drawing on a broad base of disaster  
83 studies research to support the work. In the context of wildfire as a natural hazard, the concepts of  
84 vulnerability, resilience, and adaptive capacity are closely connected to wildfire preparation. Preparation can  
85 reduce vulnerability and increase resilience. Yet, the relationship between vulnerability and resilience is not  
86 always straightforward, and not always interchangeable. For example, undertaking wildfire preparations (with  
87 the aim of staying and defending a property or reducing hazardous fuels, *etc.*) can reduce vulnerability to a  
88 wildfire, but these actions may not automatically confer resilience. For instance, a person or community may  
89 be resilient because of their personal/collective abilities, not because of the structural modifications they make  
90 to their properties. We suggest that preparing for wildfire is part of an adaptation strategy that contributes to  
91 individual and collective hazard adaptive capacities.

## 92 **2.1. Wildfire as a social-ecological system**

93 The 'social-ecological system' (SES) concept has been used to represent the complex associations of people and  
94 nature. It connects people and their communities to the places they live and the impacts they have on those  
95 environments (Gallopín, 2006; Walker *et al.*, 2004; Westley *et al.*, 2002). SES has become a fundamental unit of  
96 focus in the climate change literature, where acknowledging an explicit connection between social and  
97 ecological systems is seen as imperative in generating effective solutions to intractable (even 'wicked')  
98 problems resulting from interactions between environment and society. However, connecting examinations of  
99 environment and society seamlessly remains a challenging research goal, but one that may be informed by a  
100 greater understanding of the specific social processes that influence peoples' interactions with the  
101 environment.

102 Environmental and ecological processes impact on people, just as human behaviour impacts on nature. Natural  
103 hazards like wildfire flip the focus in social-ecological systems from concern about the environment and the  
104 disruption of ecological processes wrought by human activity, to concern for the communities and the social  
105 disruption caused by natural processes. While this focus might be a mirror image of traditional SES research,  
106 communities at risk from or impacted by wildfire also represent the social dimension of a social-ecological  
107 system. Furthermore, the theoretical advances made in SES research in the climate change sciences in the last

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108 decade directly mirror human dimensions of natural hazards research. The synergies between these two  
109 research disciplines are close, and concepts like vulnerability, adaptive capacity and resilience are already  
110 imbued with significant cross-disciplinary relevance. Resilience and vulnerability, for example, have become  
111 key terms in the language of risk and environmental management. Both terms are used widely to denote  
112 general states of an entity – this community is 'resilient' to wildfire; that ecosystem is 'vulnerable' to climate  
113 change; the individual's 'resilience' has fallen, *etc.* Yet, while these terms have become part of both the SES and  
114 disaster studies vernaculars, their actual meanings often vary as much as the uses to which they are put and  
115 the sub-disciplinary contexts within which they are used.

116 Arguments for and against conceptual vagueness can easily be made (Strunz, 2012), but it is increasingly  
117 evident that the obscurity of these terms is linked to their inherent complexity as concepts and the uncertain  
118 linkages between them (Folke, 2006; Haimes, 2009; Ungar, 2012; Walker and Cooper, 2011). Norris and  
119 colleagues (2008, p127), for example, examined community resilience in the context of disasters, framing it as a  
120 "process linking a network of adaptive capacities" to adaptation, readiness and response. They suggest  
121 resilience decreases aspects of vulnerability, while Berkes (2007, p. 284) suggests that vulnerability "resides" in  
122 the resilience of a system. Contrarily, Gallopín (2006) considers resilience to be related to 'capacity of  
123 response', a component of vulnerability and an internal property of the system. Adger (2006, p 268) classifies  
124 vulnerability as "susceptibility to harm", which can be influenced by elements of resilience like autonomous  
125 self-organisation, shock absorption and pre- and post-shock reaction. The notion of 'resilience elements' is  
126 loosely reflected in Norris *et al.*'s assertion that resilience is determined by a "set of adaptive capacities" (2008,  
127 p 136), and Smit and Wandel (2006) point out that vulnerability decreases as adaptive capacity increases. Paton  
128 (2006) frames resilience as the ability to coexist with a natural hazard – not in the sense of being able to return  
129 to normal or 'bouncing back' – but to adapt to the new life and reality that the disaster's consequences  
130 present. That many authors, across a range of disciplines, have given extensive theoretical treatment to the  
131 relationships between these concepts without yielding real clarity arguably highlights the need for further  
132 empirical examinations of real systems where the relationships between these conceptual features can be  
133 observed in action.

## 134 **2.2. Preparedness: an element of adaptive capacity**

135 Natural hazard preparation is generally considered to be the preferred mechanism to encourage proactive  
136 actions (behavioural, cultural, structural or institutional) to mitigate the disastrous potential of these events  
137 (CDRSS, 2006; UN/ISDR, 2004). Preparation has dual objectives: to reduce vulnerability to a potential threat  
138 (CDRSS, 2006; Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2008; Thomalla *et al.*, 2006; Whittaker *et*  
139 *al.*, 2012), and to increase the resilience of the public exposed to a threat (Berkes, 2007; Cutter *et al.*, 2008;  
140 Norris *et al.*, 2008; Paton *et al.*, 2006a; Tobin and Whiteford, 2002; Vermaak and van Niekerk, 2004). Both  
141 objectives can be achieved independently by promoting practical and psychological hazard preparedness, and  
142 this has become one of the key hazard mitigation goals of natural hazard management agencies. In the context  
143 of wildfire, preparedness can involve behavioural plans, structural improvements, and vegetation management  
144 actions, all of which can mitigate the level of risk faced by a property and improve residents' capacity to

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145 respond to a wildfire event. Table 2 provides a detailed list of wildfire preparations that are advocated by fire  
146 management agencies in Australia.

147 By decreasing vulnerability and increasing resilience, preparation can be considered an element of the social  
148 system's adaptive capacity – an adaptation that permits the individual, household or community to coexist with  
149 the potential threat and consequences of environmental hazards like wildfire (Paton, 2006). Adaptive capacity  
150 allows the social system "to evolve in order to accommodate environmental hazards... and to expand the range  
151 of variability with which it can cope" (Adger, 2006, p.270). Preparation helps to precondition at-risk societies to  
152 the changes natural hazards potentially bring, thus contributing to their adaptive capacity. This permits them to  
153 respond both proactively and reactively through social learning (Gallopín, 2006), and by drawing on threat-  
154 (context) specific technical and cultural advances (Eriksen and Prior, 2011; Folke, 2006; Gallopín, 2006; Klein *et*  
155 *al.*, 2003; Smit and Wandel, 2006). As Smit and Wandel (2006, p. 282) point out "adaptation in the context of  
156 human dimensions of global change usually refers to a process, action, or outcome in a system ...in order for  
157 the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or  
158 opportunity". As an adaptation, and element of adaptive capacity, preparation clearly falls within this  
159 characterisation, but as Klein *et al.* (2003, p 38) highlight, the "existence of adaptation options does not mean  
160 that each vulnerable community, sector, or country has access to these options or is in a position to implement  
161 them." The failure to implement these adaptations is a central point of discussion in both the disaster risk  
162 reduction and climate change discourses.

163 Social contacts, cohesion, collaboration and trust have been proven to be key motivators in hazard  
164 preparedness (Carroll *et al.*, 2005; Lachapelle and McCool, 2012; Paton *et al.*, 2008; Paveglio *et al.*, 2011;  
165 Siegrist and Cvetkovich, 2000). Shinn and Toohey (2003, p. 427) even suggest that a failure to acknowledge the  
166 role of the community in forming the beliefs and attitudes of the individual "has adverse consequences for  
167 understanding psychological processes and efforts at social change". This view is broadly supported in the  
168 wider socio-psychological literature on resilience and vulnerability in trauma, risk and social responses to such  
169 processes (Bonanno, 2005; Norris *et al.*, 2008; Ungar, 2012). In acknowledging this, recent hazard preparedness  
170 research has highlighted the necessity of engaging people and communities in risk communication and  
171 mitigation activities, rather than simply expecting them to respond to passive information cues or sources  
172 (Eriksen and Prior, 2011). Overlooking the complexity of the social interplay between, for example, individual  
173 community members or between local communities and the civil structures that develop policies designed to  
174 assist society, can significantly obstruct the success of any given initiative aimed at mitigating the social  
175 consequences of natural hazards.

176 Wildfire poses a threat to individuals, neighbourhoods and communities alike. However, wildfire preparation is  
177 generally undertaken by the household for the household, despite communal responses having significant  
178 hazard mitigation benefits for the community collectively. One household's lack of preparation may influence  
179 the severity of the neighbourhoods' experience of wildfire, principally because an unprepared property may  
180 become fuel that increases the risk of the fire spreading to neighbouring properties (Gibbons *et al.*, 2012).  
181 Homeowners who share an interest in working together generally improve their overall level of preparedness

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182 and thus the likelihood of successfully defending their properties from wildfire. This community element of  
183 wildfire preparedness is represented by several key social factors that existing research has identified as  
184 important in wildfire preparation: information sharing and shared learning (Brenkert-Smith, 2010; Eriksen and  
185 Prior, 2011; McCaffrey *et al.*, 2011), trust (Lachapelle and McCool, 2012), collective efficacy, sense of  
186 community and social norms (Paton *et al.*, 2008), and responsibility (McCaffrey *et al.*, 2011; Paveglio *et al.*,  
187 2009; Winter and Fried, 2000). These social elements are broadly reflective of and determined by the context  
188 of individual communities.

189 Examining wildfire preparedness at the level of the community, through the lens of the individual and the social  
190 processes of influence, can provide important insights into how different community characteristics, dynamics  
191 and discourses influence the way wildfire risk is addressed in those communities (Brenkert-Smith *et al.*, 2006,  
192 2010). It also provides a lens through which individual decision making in response to unpredictable and  
193 uncertain environmental change can be observed and understood in the context of societal norms and  
194 traditions (Enarson 2012; Eriksen *et al.*, 2010; McCaffrey *et al.*, 2011; Paton *et al.*, 2008). These social structures  
195 and interrelationships contribute to an individual's mental model (or "sense-making": Westley *et al.*, 2002) as  
196 well as their local environmental knowledge of wildfire in the place where they live, both of which contribute  
197 to social learning and 'appropriate' responses to wildfire threat (Eriksen and Prior, 2011). However, it is equally  
198 plausible that the rapid turnover of property ownership in the peri-urban environment can erode local  
199 environmental knowledge. The effect of amenity migration can lead to an erosion of intra-community  
200 familiarity and trust, as well as the loss of local wildfire knowledge held by long-term residents, many of whom  
201 may be hesitant to interact with and share their knowledge with newcomers (Cocklin and Dibden, 2005;  
202 Eriksen and Gill, 2010; Forrest and Kearns, 2001; Morrison, 2003).

203 The focus of natural hazards research has slowly moved away from the 'command and control' actions that  
204 largely rely on technology to control nature and wildfire, to a social focus that emphasises the role of human  
205 behaviour, values, attitudes and decisions in managing wildfire. This shift has partly been driven by a realisation  
206 among wildfire management agencies of the important role community members can play in managing and  
207 mitigating wildfire (AFAC, 2010; McCaffrey and Rhodes, 2009; McCaffrey *et al.*, 2011; Steelman and Kunkel,  
208 2004). This highlights the capacity for self-organisation by the social components of the SES. Tapping into this  
209 capacity effectively could yield valuable social advances in addressing issues of vulnerability and resilience to  
210 natural hazards. Even so, encouraging people to prepare, as the most notable social response to natural  
211 hazards, is fraught with difficulty that has not been addressed by the techniques that have dominated natural  
212 hazard risk education and communication to date (Eriksen and Prior, 2011; Handmer and Haynes, 2008; Paton  
213 *et al.*, 2008).

214 In the following sections, we explore the notion of SES and the capacity for self-organisation by focusing on the  
215 social determinants that underpin decisions to prepare amongst communities members living at-risk from  
216 wildfire. We explicitly focus on the sub-components of social interactions (that may contribute to social capital  
217 like sense of community, belonging, trust, collective problem solving) and the interesting and pointed  
218 directions this may yield for innovative and effective solutions to social problems in social-ecological systems.



### 219 **3. Methodology and Results**

220 This paper presents the results of a mixed-methods research project, which utilised qualitative and quantitative  
221 techniques to explore and model factors that influenced the preparedness of householders living at-risk of  
222 wildfire in southeast Australia. Qualitative data were used to develop a substantive model that illustrated the  
223 influence of social processes or factors on wildfire preparedness behaviour role. Quantitative data was used to  
224 test (validate) this substantive model.

#### 225 **3.1. Qualitative data collection**

226 Qualitative data were collected using semi-structured interviews with adult household members from locations  
227 where the quantitative survey component of the research would be undertaken (see section 3.3). Interviews  
228 lasted between 30 and 90 minutes and were transcribed verbatim. The total number of interviews conducted  
229 was determined by data saturation. Interviewing continued as long as new ideas, themes, attitudes or beliefs  
230 were encountered. Interviews were based on a ten-question interview schedule that explored general cues for  
231 wildfire preparedness decision making and action, (including friends, family, and significant others; media; risk  
232 communication practices and content; and what preparations were undertaken, or not, and why). The  
233 interviews specifically focussed on elucidating the social drivers of preparedness decision making, and how  
234 these drivers compared to traditional forms of risk communication (pamphlets, advertisements, websites, etc.)  
235 as cues to hazard mitigation decisions. The semi-structured nature of the interviews permitted an in-depth  
236 discussion of the benefits of direct contact and interaction with neighbours, particularly those who were  
237 trusted, or with particular knowledge of, or experience with wildfire in the locality where the interviewee lived.

238 In total, 36 interviews were carried out over the phone with consenting individuals. Seventeen pilot interviews  
239 were conducted with purposively sampled consenting adults surveyed (but not interviewed) by Paton *et al.*  
240 (2006b) in March and April 2006 (who used a comparable survey instrument to the current study), and the data  
241 from these interviews was analysed and used to develop the survey instrument deployed in the quantitative  
242 component of this research. A further 19 interviews were conducted during the southern hemisphere winters  
243 of 2007 and 2008, following the distribution of the survey. Survey respondents could volunteer to take part in a  
244 follow-up telephone interview by providing their contact details with their survey response. Assenting  
245 respondents were sampled purposively based on their reported levels of preparedness in order to discuss the  
246 social influences on decision-making and preparation cues at all engagement levels of the preparedness  
247 spectrum. Narrative analysis of both sets of interviews (pre- and post-survey) using NVivo 7.0 illustrated strong  
248 similarities across the locations of interviewees and levels of wildfire risk, with no obvious influence from the  
249 survey. A decision was therefore made to combine these data sets for the development of the substantive  
250 model (section 3.2).

251 Once aggregated, all 36 interviews were systematically analysed using a four-step grounded theory technique  
252 (see Strauss and Corbin 1990, 1998). Data was coded in NVivo 7.0 using open, axial and selective coding  
253 techniques to highlight key themes in the data. Data was then analysed to identify relationships between

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254 themes and thereby build concepts that reflected these relationships. Concepts were aggregated based on  
255 broad similarities in order to generate a substantive model that explained the influence of social and individual  
256 drivers on preparedness. Grounded theory is a constant comparative method of systematic qualitative data  
257 analysis that allows the researcher to create networks among the concepts that emerge from the data (Strauss  
258 and Corbin, 1998). The grounded theory analyses focussed on exploring the causal relationships between key  
259 themes identified during coding of the interviews. This included an examination of how a given theme was  
260 influenced by or impacted on other themes. The identification of causal relationships permitted the  
261 development of a substantive (uni-directional) model representing the influence of social and individual  
262 processes on decision-making for wildfire preparedness.

### 263 **3.2. Effects of community and individual drivers on preparedness behaviour**

264 A mix of community-level and individual cues influenced preparedness for wildfire amongst the research  
265 participants. Interview analysis revealed the importance of 'sense of community' (McMillan and Chavis, 1986)  
266 and collective problem solving in overall levels of wildfire preparedness. At the individual level 'action coping'  
267 (Bishop *et al.*, 2000; Carver *et al.*, 1989), 'self-efficacy' (Bandura, 1977; 1986) and 'negative outcome  
268 expectancy' (Paton *et al.*, 2008), along with more operational and inhibitory issues like financial, time and  
269 emotional costs involved with preparing (Eriksen and Gill, 2010; Paton *et al.*, 2008), were important in  
270 determining preparation.

271 'Sense of community' emerged from the interview data as a key driver of preparedness, with direct and  
272 indirect influence on interviewees' preparation behaviour. The measure of 'sense of community' used in the  
273 survey included items associated with peoples' connections to the *place* they lived and the *people* who lived  
274 around them. The factor analysis conducted on this measure reduced the items into two groups that strongly  
275 represented place and people attachment. Both aspects (people and place) of 'sense of community' were  
276 important for interviewees. The social cohesion that comes with strong sense of community enabled people to  
277 share the anxiety that is associated with both the known threat of wildfire and the unknown consequences of  
278 the hazard, as captured by the reflections of one interviewee:

279 *Unless there's other people around me, I don't think I'd really want to necessarily [prepare, stay and*  
280 *defend] on my own. If there was more than one person helping me, then I would probably stay, but I*  
281 *don't know whether I'd want to do it on my own. (Female, Hobart)*

282 Interviewees worried less when they knew of other people in their community with whom they could share  
283 their concern. Sense of community contributed dramatically to individuals' willingness and ability to prepare  
284 for and act in a threat situation. Knowing that others were likely to help in an emergency was reassuring  
285 because fear, worry and responsibility could then be shared among the community members, easing the  
286 burdens presented by each of these aspects, which in turn increases 'self-efficacy'.

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287 *The fact that there was actually another human being on site made like about 90% difference to me. In*  
288 *fact if I had just one more person there I'd feel, I would have no qualms at all, I would stay and defend*  
289 *and know my preparations would work. (Female, Hobart)*

290 *You know everybody worries about [wildfires]; they want to pretend they don't, but they do ... so you*  
291 *discuss the equipment you could buy, or what you could do. Yeah [the community] is pretty good. (Male,*  
292 *Hobart)*

293 Sense of community also contributed to peoples' abilities to sift through risk information, identifying pertinent  
294 and contextual resources or advice. This increased individuals' ability to 'solve' (mitigate) the wildfire threat to  
295 communal and private property, increasing their 'action coping' ability. Conversely, people living in  
296 communities where there was little interaction between neighbourhood members were less likely to convert  
297 cohesiveness into preparation actions. This was largely attributable to lack of belief in effectiveness of  
298 preparedness behaviour ('negative outcome expectancy') – a belief reinforced by sense of isolation in terms of  
299 lack of help to carry out physical work and an inability to contextualise and localise information about  
300 preparing. Where there was extensive community knowledge of wildfire and the importance of preparing  
301 (which was often connected to personal wildfire experience) there existed not only greater levels of  
302 preparation in the community, but greater confidence in those preparations.

303 *Everyone in the street is really into fire awareness and we've got a telephone tree if there's a fire, and*  
304 *we've had a few meetings over the summer talking about how to be prepared and that sort of stuff. We*  
305 *get most information from our neighbours. (Female, Hobart)*

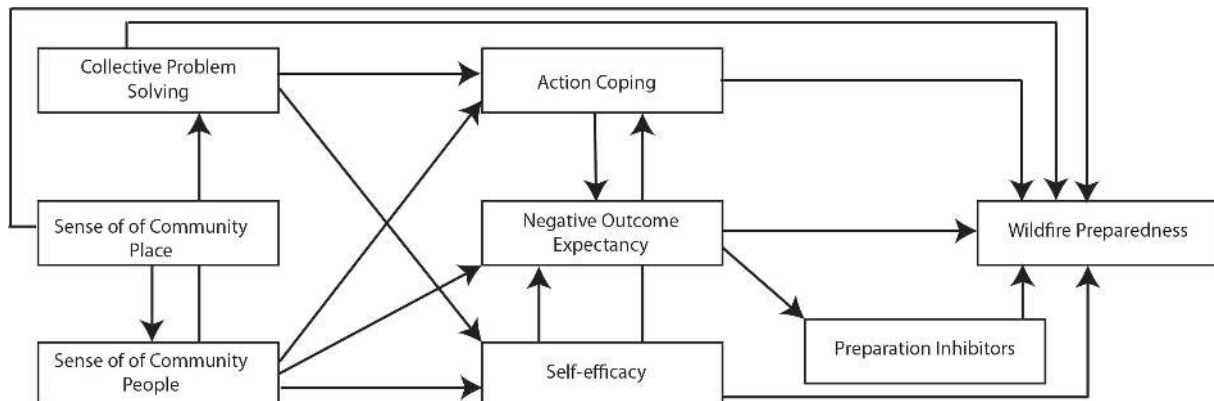
306 *I think I would at first sign [of fire], I think I'd be gone... simply because there isn't a gang of neighbours*  
307 *here who would all look after themselves, it doesn't happen in this day and age ... we don't even know*  
308 *our neighbours' names. We put ourselves out to try and speak to them, but people don't speak anymore.*  
309 *Even on the street here, people turn the other way. (Male, Hobart)*

310 Householders without personal wildfire experience expressed a need for affirmation from their peers of the  
311 value of preparedness behaviour, rather than from fire service representatives whose information was often  
312 viewed as theoretical and untested locally. Interview participants valued information from their peers who they  
313 knew had personal experience, which could be put to good use locally in a collective manner.

314 *[What made a difference] was basically a few guys in the street who are really enthusiastic about*  
315 *[preparing] and are ready to impart knowledge and have a look at our pumps and all that stuff. (Female,*  
316 *Hobart)*

317 *One guy in particular worries about [wildfires] all the time. Oh he's quite fretful about it but, you know,*  
318 *he's good with information and that's why he's formed the fire group so that everybody in [the] Lane is*  
319 *in it, and we have a meeting about once a month. (Male, Hobart)*

320 The relationship between these observed cues in the interview data formed the basis for the substantive  
321 (structural) model presented in Figure 1. This substantive model is consistent with the causal relationships of  
322 decision-making cues identified in the qualitative data, and illustrates householder cognition specifically  
323 relating to the social cues behind decisions about wildfire preparedness.



324 Figure 1. Substantive model of wildfire preparedness decision making derived from qualitative analysis of  
325 interviews conducted with householders living in peri-urban wildfire risk areas in Hobart.  
326

327 As a substantive representation of the qualitative data, figure 1 highlights the importance of both sense of  
328 community of *place* and *people*, suggesting that attachment to the place where householders live and the  
329 people they associate with are the most formative elements in preparing for wildfire. Attachment to other  
330 community members (cohesiveness) influences the ability of that group to solve problems, and the  
331 effectiveness of those solutions (collective problem solving). These community level drivers influence individual  
332 level drivers of preparedness, including 'self-efficacy', 'action coping' and 'negative outcome expectancy', but  
333 also have a direct influence on wildfire preparedness. Self-efficacy describes an individual's capacity to act  
334 when threatened, and is improved in situations where community cohesiveness is strong. Action coping is a  
335 measure of an individual's problem solving beliefs (how capable they feel they are when dealing with problems  
336 in their lives) and is also influenced by sense of community and the community's collective problem solving  
337 capacities. Lastly, 'negative outcome expectancy' has a direct influence on wildfire preparedness. This  
338 relationship may also be negatively mediated by preparation inhibitors.

### 339 3.3. Quantitative survey data collection

340 Quantitative data was collected using a longitudinal survey distributed to households within 100 metres of  
341 bushland at the peri-urban fringe of Hobart (Tasmania) and Sydney (New South Wales), Australia. Surveys were  
342 distributed by hand early in the wildfire seasons (October) of 2006/07 and 2007/08. In 2006/07 1500 surveys  
343 were distributed in Hobart with 499 returned (33.2% response rate). In 2007/08 1297 surveys were distributed  
344 in Hobart, and 1500 surveys were distributed in Sydney, with 399 returned in Hobart (30.7% response rate) and  
345 277 (18.5% response rate) returned from Sydney. In both Hobart and Sydney, surveys were distributed to every  
346 house in selected streets that were within close proximity to bushland. These streets (and suburbs) were  
347 systematically targeted in order to ensure sampling locations had broadly similar levels of wildfire risk based on  
348 local wildfire risk mapping by the Tasmania Fire Service (Hobart), the New South Wales Rural Fire Service and

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<http://dx.doi.org/10.1016/j.gloenvcha.2013.09.016>.

349 the New South Wales Fire Brigade (now Fire and Rescue NSW) (Sydney). 'Broadly similar' wildfire risk means  
350 areas have similar vegetation types, levels of on-ground fuel and wildfire history.

351 The survey consisted of 38 questions covering a wide variety of issues known to influence wildfire  
352 preparedness based on established measures from the hazard preparedness literature (for example, Paton *et al.*,  
353 2008). Additional measures surveyed were identified and developed during the 17 pilot interviews  
354 conducted with consenting householders from the Hobart sampling region in March and April 2006. Structural  
355 equation modelling was used for model validation. This analysis technique is sensitive to missing values, so  
356 survey responses with a large proportion of unanswered questions were removed from the analysis data set.  
357 All remaining missing values were replaced with a regression estimate calculated in SPSS 16.0, and checked  
358 against hand calculations of the mean of the available item scores within a single measure (a more accurate,  
359 but time consuming approach to missing value replacement).

360 Exploratory factor analysis (maximum likelihood, oblique rotation) was used to examine the underlying  
361 structure of the survey measures and to confirm that items in one measure fell together as one factor. The  
362 suitability of the data for factor analysis was determined before examining analysis results (subject to item  
363 ratio exceeded 10:1). Only measures that exhibited more than one factor (with factor loadings between 0.5 and  
364 0.9), and which could be explained as theoretically plausible with interpretable meanings were retained for  
365 possible analysis (Table 1). Following factor analysis the internal consistency (reliability) of possible factors to  
366 be included in the subsequent analyses were tested using the Chronbach's  $\alpha$  (alpha) statistic. The alpha score  
367 generally increases as the correlations between items increase. Higher alpha scores for a set of items suggest  
368 those items measure similar characteristics and are considered to exhibit good internal consistency. Only  
369 measures with an alpha score close to or greater than 0.7 were included in further analysis (Table 1), as high  
370 reliability indicates the measure is replicable.

371 <TABLE 1>

372 Table 1. Results of factor analysis and reliability testing of survey measures used in the structural equation  
373 modelling analysis. The measures for 'action coping' (Bishop, *et al.*, 2000; Carver, *et al.*, 1989), 'self efficacy'  
374 (Bandura, 1977; 1986) and 'preparation inhibitors' (Paton *et al.*, 2008) did not reduce to more than one factor.

375 The wildfire preparedness of the survey respondents was measured using a 54-item measure (Paton *et al.*,  
376 2006; Paton *et al.*, 2008). Factor analysis of the 54-item measure used in the survey reduced the set into three  
377 distinct factors (Table 2). One for preparation planning, which reflected individuals' deep thinking about  
378 wildfire threat, and the planning required to mitigate this threat. A second factor encompassed property-  
379 related preparations, which included operational actions like clearing space around the property. The last  
380 factor encompassed items necessary for a wildfire-specific emergency kit. The first factor, preparation  
381 planning, is used here as the measure of household preparedness as it best reflects the difficulty and necessary  
382 consideration that preparing requires. Preparedness measure items could be answered by survey respondents  
383 in three ways: 'I have done this' (assigned a value of 3), 'I will do this' (assigned a value of 2), 'I will not do this'  
384 (assigned a value of 1). Responses to the 'preparedness planning' factor (reduced from the 54-question

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385 preparation measure) were tallied for an overall preparedness value for each survey respondent. As such,  
386 survey respondents who consistently indicated they 'have done this' preparation action scored more highly  
387 than those reporting they 'would not'. Self-report surveys often suffer from reporting bias, but the mixed  
388 methodology and purposive sampling techniques used in this study allowed the researchers to cross-check  
389 survey responses during the post-survey interviews. The 19 post-survey interviews were conducted with the  
390 interviewee's survey at hand, and the cross-check was conducted on several random survey questions during  
391 the interview when the discussion touched on issues directly explored in the survey. Contradictions between  
392 the survey response and the interviews were rare, but were noted as memos in the NVivo analysis where they  
393 occurred and considered in the analysis of the interviewee's information.

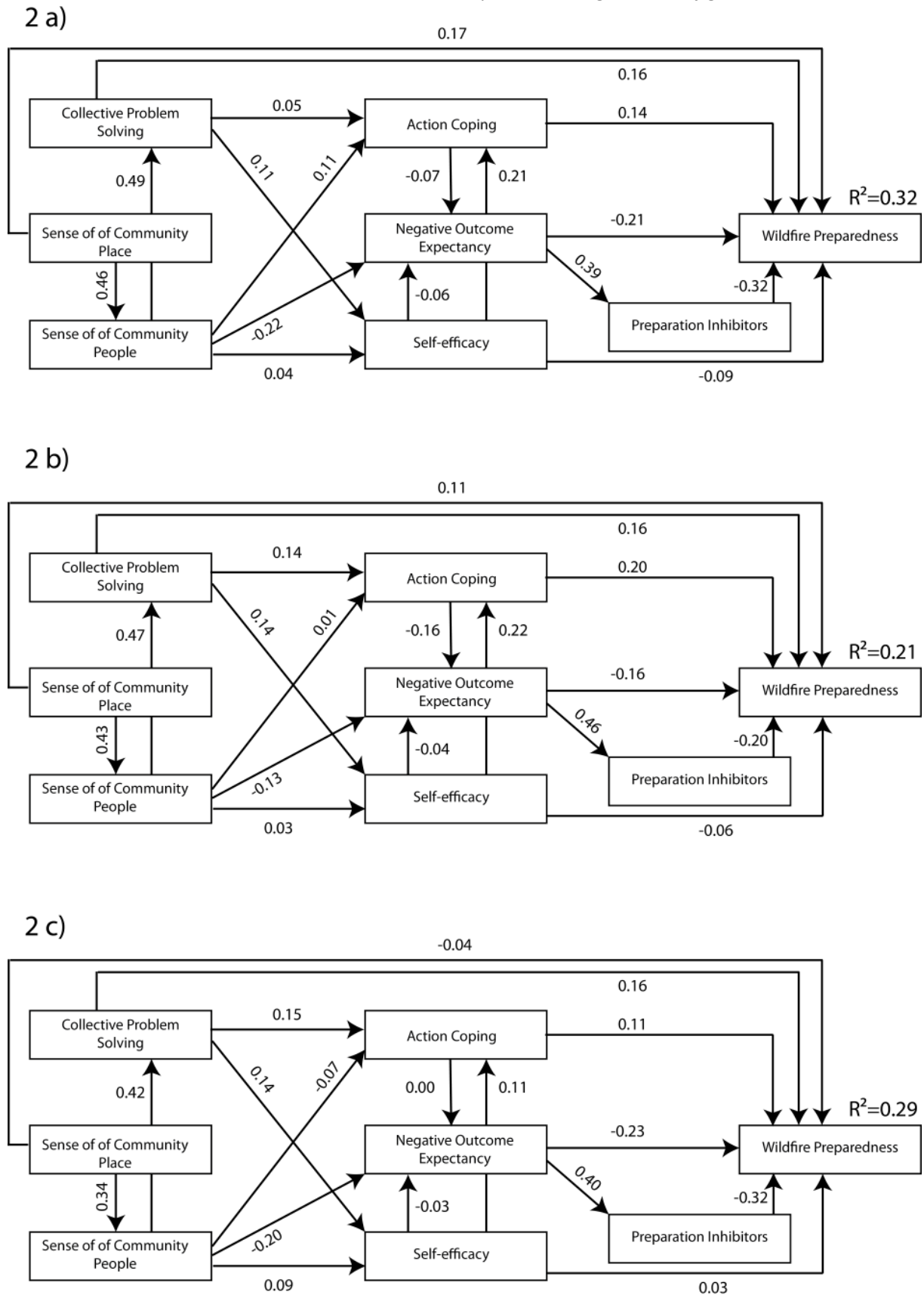
394 <TABLE 2>

395 Table 2. Factor analysis of the 54-item preparedness list used in the survey reduced to three factors:  
396 preparedness planning, property preparedness, and wildfire emergency kit. The items in each factor are listed,  
397 but only the preparedness planning factor was used in analyses conducted here.

### 398 **3.4. Model validation**

399 The model developed from the qualitative interviews was validated against data from the appropriate survey  
400 constructs using structural equation modelling (SEM). SEM is a multivariate data analysis technique that  
401 combines aspects of multiple regression (structural path analysis) and factor analysis (measurement of latent  
402 constructs with multiple items) to estimate a series of interrelated dependence relationships (Kline, 2011). The  
403 model was built and validated using IBM SPSS v.19 with AMOS extension. SEM is particularly suited to this task  
404 because of its utility in confirming theory and its functionality for assessing causal relationships between  
405 variables that are based on qualitative assumption and analysis (Anderson and Gerbing, 1988; Byrne, 2001;  
406 Nachtigall *et al.*, 2003). The benefit of using SEM lies in the ability to estimate multiple dependence  
407 relationships simultaneously and to identify how well empirical data fits with a hypothesised theory or  
408 substantive model (Goodness-of-fit).

409 Wildfire preparedness data collected from Hobart residents living at the peri-urban fringe in 2006/07 showed  
410 an excellent fit to the substantive model (N=482), with results summarised in Figure 2a. The model accounted  
411 for 32% of the variance in preparedness planning, a good effect size in intention-behaviour relationships  
412 (Sheeran, 2002). Data collected from Hobart (N=349, Figure 2b) and Sydney (N=221, Figure 2c) in 2007/08 did  
413 not fit the proposed model as well and explained less of the variance in preparedness behaviour: 21% and 29%  
414 respectively. More detailed discussion and possible reasons for this poorer fit are given in section 4.1.



415  
416 Figure 2. Measurement model (a –  $\chi^2=8.291$ ,  $df=11$ ,  $p=0.687$ ;  $RMSEA<0.001$ , 90% confidence 0.000-0.040) of  
417 social cohesion in wildfire preparedness decision making using data collected from Hobart householders in  
418 2007. Validation of measurement model using data collected in 2008 from households in Hobart (b –

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419  $\chi^2=26.795$ ,  $df=11$ ,  $p=0.005$ ; RMSEA=0.064, 90% confidence 0.034-0.096) and Sydney ( $c - \chi^2= 25.796$ ,  $df=11$ ,  $p=0$   
420 007; RMSEA=0.079, 90% confidence 0.039-0.119). Models show  $R^2$  values for planning preparedness and  
421 standardised regression weights of paths.

## 422 **4. Discussion**

423 The results from this empirical study demonstrate that social processes, and particularly cohesive communities,  
424 contribute substantially to individual preparation and the adaptive capacity of communities and community  
425 members who are threatened by wildfire. In this context adaptive capacity is reflected in the uptake of  
426 preparation behaviours, both at the individual and community levels. Individuals or communities that do not  
427 adopt protective measures have less capacity to adapt to wildfire threat and consequences. In the following  
428 sections, we discuss why membership in cohesive communities promotes preparation, and why individuals  
429 living in non-cohesive communities are less likely to respond in the same way. We explore how a cohesive  
430 community contributes to reduced vulnerability and the development of community and individual resilience.  
431 We extend the findings from this study to broader work on social-ecological systems. We suggest that paying  
432 greater attention to social attitudes, beliefs, values and emotions concerning the environment, and how these  
433 are influenced, could inform more effective and lasting solutions to intractable environmental problems that  
434 are socially derived.

### 435 **4.1. Why social cohesion helps people prepare**

436 From the results presented in section 3 it is clear that individuals facing wildfire threat draw on a supportive  
437 community to build their individual adaptive capacities and translate these into community-wide adaptations.  
438 Furthermore, under-prepared people or those with little knowledge about wildfire mitigation clearly benefit  
439 greatly from close community associations. Social connections permit faster and more risk-appropriate  
440 reorganisation, change and learning around the threat of wildfire. Whilst most natural hazards can be  
441 anticipated to a degree, their irregularity results in many people being taken by surprise when they do occur.  
442 Even wildfire, which can be expected with more certainty and regularity than many other natural hazards  
443 because of the seasonal nature and close connection to weather, is unfamiliar to many people. This is  
444 particularly the case for people relocating from the city to amenity-rich, but wildfire-prone, landscapes for  
445 lifestyle reasons. People who face uncertain threats often rely on their peers, family or neighbours who they  
446 believe, or perceive, have better or more complete knowledge about the threat, how to anticipate it and how  
447 to respond. Knowledge about wildfire, and where that knowledge comes from, is crucial in forming a decision  
448 about whether and how to respond to the threat it poses (Eriksen and Prior, 2011).

449 The model presented in Figure 1 and validated in Figures 2a-2c highlights how thinking about wildfire  
450 preparedness as a decision-making process can help to illustrate the importance of social cohesion in  
451 preparing. Decision-making is plagued by uncertainty, which clouds rational decision-making (Basili, 2006;  
452 Donovan and Blake, 1992; Jones, 1999; Slovic *et al.*, 2004). People often do not reach rational decisions as a  
453 result of their cognitive reasoning. This is partly due to the social construction of risk (Dake, 1992; Hannigan,



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454 2006; Holstein and Miller, 2006; Lupton and Tulloch, 2002; Tierney, 1999), and partly because active cognition  
455 is undertaken with immediate information at hand and with subconscious deductions made to reach the most  
456 agreeable, but not necessarily the most rational outcome (Finucane *et al.*, 2000; Loewenstein *et al.*, 2001).

457 Tversky and Kahneman (1974, 1981) showed that individuals rely heavily on affect heuristics (mental shortcuts  
458 often driven by emotions) to guide their judgement, enabling them to simplify otherwise difficult choices. But  
459 once the choice is simplified in this way, judgemental errors are likely to become more common (see also,  
460 Jones, 1999; Kahneman, 2003; Sjöberg, 1982). This plays a role even in choices familiar to the decision maker.  
461 However, in familiar circumstances individuals are likely to be able to better judge the possible outcomes and  
462 estimate how likely these are to occur, giving them some ability to choose and act 'advantageously' to avert  
463 risk (Bechara *et al.*, 1997; Fox and Levav, 2000; Kahneman, 2003; Keller *et al.*, 2006).

464 Sharing knowledge, support and advice are valuable community activities that allow people to contextualise  
465 irregular and uncertain threats in their daily lives. This information provides some vicarious familiarity to the  
466 uncertain decision-making context. In the case of wildfire, decisions about preparing and mitigating risk are  
467 enhanced by consultation and collaboration with others. Collective action is required to, for example, support  
468 hazard reduction or pile burns and to ensure that all households reduce the level of combustible materials in  
469 and around their properties. Attachment to place and engagement with other members of the community  
470 increase the likelihood that householders consider preparation to be important (Brenkert-Smith, 2011; Eriksen  
471 and Gill, 2010; Eriksen and Prior, 2011; Prior, 2010). Their interactions concerning wildfire preparedness  
472 increase their capacity to understand and address the uncertainty and the challenging nature of events like  
473 wildfire activity (Eng and Parker, 1994; Hardin and Higgins, 1996; Lion *et al.*, 2002).

474 The story is very different in places where cohesive and supportive relationships between community members  
475 do not exist. This issue is illustrated in the validation exercise, which tested the results of the 2006/07 Hobart  
476 survey data (Figure 2a) against the 2007/08 survey data from communities in Hobart (Figure 2b) and Sydney  
477 (Figure 2c). This exercise showed limited success – even though the data fit the model, the measures of fit were  
478 less significant, and the level of variation the substantive model described was lower. While the sampling  
479 techniques were the same and the risk characteristics of sample locations were similar (see section 3.3), the  
480 level of cohesiveness of the different communities was found to be considerably different. Low and Altman  
481 (1992) indicate that attachment to place (analogous to sense of community *place* in our study) often leads to  
482 the development of emotional bonds between community members. This in turn builds a sense of belonging  
483 not just to the location but also to the people living close by. The model validation (Figure 2a) suggested sense  
484 of community has a strong positive influence on wildfire preparedness, but this relationship was considerably  
485 weaker in the validation data from Hobart and Sydney collected during 2007/08.

486 Measurements of the social cohesion decision cues (sense of community *people* and collective problem solving)  
487 were lower amongst residents sampled in Sydney and Hobart in 2007/08. These lowered levels meant that the  
488 factors described less of the variation in the modelled preparedness data. This was particularly evident in the  
489 Sydney sample (Figure 2c). This may be an artefact of greater community heterogeneity within suburban  
490 Sydney, where the larger city supports greater diversity in culture, and the attitudes, beliefs and experiences

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491 this diversity brings. This contention is supported by Wirth's (1969) theory of urbanism that suggests that  
492 increased size, density and heterogeneity in urban populations result in a fragmentation of social ties. Alesina  
493 and La Ferrara (2000) also highlight that greater diversity in the community leads to lower group participation  
494 and less-active social networks based within a locality. Instead, householders in these heterogeneous localities  
495 develop and often rely on social networks outside of their suburbs that do not form around a place-based issue  
496 like wildfire threat (Forrest and Kearns, 2001; Morrison, 2003). In Sydney, where social cohesion was not a  
497 strong feature of the studied communities, wildfire preparation was both less likely and considered less  
498 important. This was even the case among community members living in suburbs that had suffered previous  
499 catastrophic impacts from wildfire in 1994, but with no collective memory of either the wildfire or the  
500 associated deaths. The surveying in Sydney was undertaken in suburbs where the New South Wales Fire  
501 Brigades had placed 'community fire units' (a trailer with equipment to defend against a wildfire), and while  
502 these communities have benefited from these resources, they did not seem to have increased the level of  
503 community cohesion in these suburbs.

#### 504 **4.2. Social cohesion, vulnerability and resilience in the natural hazards context**

505 The results presented here indicate that social cohesion plays a central role in wildfire preparation. The ability  
506 to enact preparations (cognitive, social and structural protective behaviours) is supported directly by the  
507 various 'elements' that contribute to social cohesion. The adaptive capacity these elements confer can increase  
508 resilience and can reduce specific wildfire vulnerabilities by mitigating exposure, reducing sensitivity and  
509 increasing response capacity (Smit and Wandel, 2006; Gallopín, 2006). Sense of community and collective  
510 problem solving contribute to self-organisation and effective response to hazard risk. Social networks that  
511 establish in cohesive communities also permit knowledge transfer, influencing social learning that promotes  
512 the benefits of preparation (Eriksen and Prior, 2011). These social networks also allow network members to  
513 share issues, burdens and emotional responses to the hazard that assist the individual to respond to and  
514 recover from a hazard. "Adaptations are manifestations of adaptive capacity" and "the presence of a strong  
515 kinship network may increase adaptive capacity" because it permits access to resources and other factors that  
516 can increase coping, but which might otherwise be unavailable (Smit and Wandel, 2006, p 287). Community  
517 relationships in this study encouraged short-term wildfire adaptive capacities that become long-term  
518 adaptations through reinforced learning and the creation of social norms around activities that increase  
519 wildfire resilience. However, our findings also support Smit and Wandel's (2006, p. 288) suggestion that "the  
520 conditions that interact to shape exposures, sensitivities, adaptive capacities, and hence create needs and  
521 opportunities for adaptation, are community specific". Influencing these 'community-specific conditions' is  
522 undoubtedly a useful approach that will help to address intractable problems in social-ecological systems.

#### 523 **5. Conclusion: the importance of social cohesion for meaningful action**

524 Many recent studies examining human behaviour in the context of natural hazards and risk communication  
525 indicate that the relationship between the interpretation of an issue and action on that issue is a very  
526 complicated one (for example, Eiser *et al.*, 2012; McCaffrey *et al.*, 2013). Media, word of mouth and formal

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527 communication all influence the way people think about the issues or risks they face in their daily lives, but  
528 action ultimately comes down to a matter of what is salient to the individual (and therefore the perceived  
529 necessity to act or not). The study presented in this paper illustrates that social cohesion increases peoples'  
530 propensity to undertake protective actions in the context of wildfire in two ways: 1) it gives people the support  
531 and resources necessary to confront wildfire risk; and 2) it increases the salience of wildfire threat. Finding  
532 ways to shift the community (and individual) salience of an issue by focussing attention on the way people  
533 interact with others from their communities (whether place- or interest-based) may be an effective way to  
534 influence individual decision-making, and contribute to addressing complicated environmental issues like  
535 climate change and natural hazard management through local action.

536 This study illustrates that a fundamental benefit of social cohesion is the psycho-social and material support it  
537 brings to local community members. This support influences attitudes, values and emotions about wildfire, and  
538 the salience of this environmental 'problem'. While such processes currently lie beyond the remit of most  
539 contemporary modes of environmental risk communication, our results align with Shinn and Toohey's (2003)  
540 view that inserting a focus on social cohesion or social interaction is imperative. For instance, sense of  
541 community fosters emotional belonging as well as belonging through shared knowledge among community  
542 members. These 'resources' positively influence risk and mitigation beliefs so that wildfire preparation  
543 becomes the norm in the community rather than the exception. Without these resources community and  
544 individual protective actions are likely to be less commonly undertaken, less organised or less effective.

545 Another aspect that influences local scale action to combat global environmental issues like climate change is  
546 the often inconceivable nature and scale of these problems. This leads to negative outcome expectancy, as  
547 consequences and solutions are perceived to be beyond the individual's control (Adger, 2003). Indeed, such  
548 issues are typically dealt with by national governments, international organisations (*e.g.* UNEP) and multi-  
549 national institutions (*e.g.* IPCC). Although the 'think global, act local' slogan is widely applied, managers of  
550 climate change issues have often done the opposite because international actors are perceived to have the  
551 power to redress the huge issues society faces in the environment. However, as the empirical data from our  
552 study demonstrate, social cohesion at the community level can positively influence individuals' outcome  
553 expectancy and capacity for action. While international actors are important in coordinating responses to  
554 climate change, refocusing on individuals and empowering their local action through social processes at the  
555 community level may yield more success when it comes to developing adaptive capacity to the impact of  
556 climate change on wildfire and other natural hazards. This point is supported by the vast literature (referenced  
557 throughout this paper) on the benefits of community-based resource/environmental management over top-  
558 down activities.

559 Furthermore, Westley and colleagues (2002) note that differences between social and ecological systems  
560 (particularly in relation to the characterising dimensions of each) contribute to a lack of responsiveness of the  
561 social components to critical environmental signals. Figures 1 and 2a-2c indicate that this may be a result of  
562 less obvious and overt pressure on the social components of the social-ecological system to adapt or respond  
563 to ecological problems. However, when social SES components are directly threatened by environmental or

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564 ecological processes (like natural hazards), the necessity to respond and adapt is paramount and obvious.

565 Transferring lessons learnt from disaster studies on the responsiveness and adaptability of social components

566 to environmental conditions or changes may therefore be valuable in countering abstraction and improving

567 management of human-induced environmental problems like climate change.

568 This paper demonstrates how social cohesion, especially factors like sense of community and the ability of

569 community members to solve the problems they face together, is a key component of wildfire preparedness

570 and resilience. Social cohesion provides a useful frame from which to explore broader considerations about

571 how society impacts environmental processes and how environmental processes impact social practices,

572 because people at risk of wildfire must actively respond to changes in their environment or face serious

573 disruption to their lives. A focus on social cohesion in mitigating chronic (rather than acute) stress and change

574 may also be helpful in other social-ecological systems where the environment puts less overt or immediately

575 felt pressure on social systems, despite being equally important to the social components of the system (*e.g.*,

576 loss of ecosystem services due to biodiversity loss, slow creeping changes in sea level, food security and

577 phosphorus depletion). Establishing ways to build cohesion in communities that are components of stressed

578 social-ecological systems is important, because without cohesion context-specific norms are not formed,

579 information is less likely to be transferred, and skills are not communicated or passed on. Social cohesion

580 facilitates the transfer of information that can influence the social construction of issues or problems. It raises

581 the salience of these issues relative to other everyday considerations among the community members within

582 the social-ecological system.

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