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Measuring fire risk perception of residents before and after a fire

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Abstract

Few studies have the opportunity to empirically investigate changing risk perception before and after a fire event. Here, we study the impact a fire within a settlement fire has on the risk perception of residents in a high wildfire risk informal settlement in South Africa. We measured risk perception concerning wildfires and settlement fires. Findings from our questionnaire indicate a fire event raises the perception of wildfire and settlement fire risk. Residents respond differently whether they are directly impacted by the fire or not, with unaffected residents more concerned about personal risk than community risk. While other studies found that a fire event raises the likelihood of residents enacting risk reduction efforts, our results dispute this, with residents indicating they are less likely to commit to personal risk reduction efforts. Finally, a fire event appears to lower the likelihood of residents leaving a settlement due to the perception of wildfire or settlement fire risk.

1. Introduction

Wildfire risk management at the wildland-urban interface (WUI) relies on institutions, politicians and residents who are often at opposing ends with policies and other risk reduction efforts cooperating (Christ et al. 2022). Risk perception is key for understanding how humans respond to interventions to reduce risk and, therefore, successful implementation (Arvai et al., 2006; McGee et al., 2009). Furthermore, experiencing disaster events changes perceptions of the specific disaster and other disasters (ibid). Thus, understanding how fire events change risk perception can improve making tailor-made interventions.

Recently, Dupey & Smith (2019) found that a wildfire can trigger residents to participate in risk mitigation behaviours. Flores Quiroz et al. (2021) disputed this claim after they investigated fire risk perception in Imizamo Yethu (IY) but focused on what the elements residents believe cause fire in IY, not how they perceive the hazard of fire itself. Few studies have empirical data collected on residents' fire perception before and directly after a fire event. Here, we define wildfires as fires that start in the wildland and potentially move into the settlement, whereas settlement fires are those that start in the settlement and may move into wildland.

We investigated IY, an informal settlement, to evaluate what impact a recent settlement fire had on residents' perceptions of wildfires and settlement fires in relation to:

- Perceived fire risk
- Vulnerability to fire and the consequences of fire
- Perceived coping capacity
- Implementation of risk reduction efforts
- Residents' intentions to remain in the area

2. Study Area

IY (0.57 km²) is an informal settlement in the City of Cape Town, bordering the Table Mountain National Park (TMNP), South Africa (Figure 1) (Kahanji et al., 2019). TMNP forms part of the fire-prone and fire-dependent fynbos biome. Over the years, IY has experienced multiple fires, including threats from wildfires in 2009, 2015 and 2022 (African News Agency, 2015; Engel, 2022; Eyewitness News, 2009). Access to IY is difficult due to

the steep incline and the narrow and informal structure of the roads (Gibson et al., 2019). Settlement fires in IY are likely to run up the mountain if wind conditions are favourable (Gibson et al., 2019; Kahanji et al., 2019).

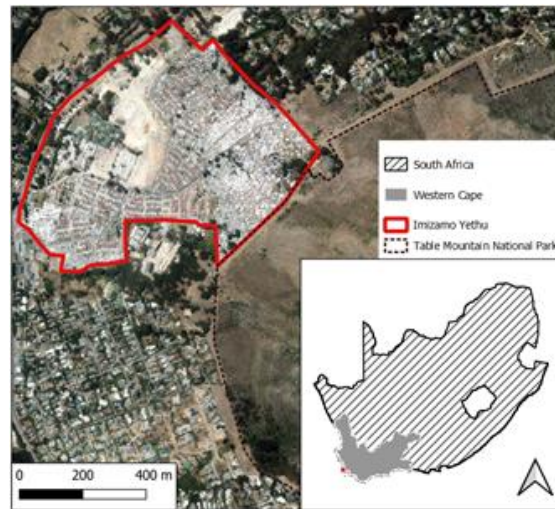


Figure 1- Imizamo Yethu in South Africa

The two most recent fires were on 6 September 2020, 9 months before our first survey and 15 August 2021, 1 month before our second survey (Ntseku, 2021; Stent, 2020).

3. Methods

We developed a questionnaire based on the works of authors who focussed on fire risk perception, housing decision making and fire management (Brenkert-Smith et al., 2012; CapeNature, n.d.; Dupey & Smith, 2019; Ghasemi et al., 2020; Martin et al., 2007; Pharoah, 2012; Statistics South Africa, 2020; Turner, 1968). A fieldwork team surveyed residents using Epicollect (<https://five.epicollect.net/>). First with a battery of 106 questions, using non-probability sampling to capture specific areas for another study. Data collection occurred between 21 June and 08 August 2021 (244 respondents).

To measure changes in perception, we modified the second questionnaire (127 questions) to include factors such as whether a respondent was directly affected by the fire on August 15 or not. Data was collected between 21 September and 3 October 2021. With limited funding, we captured 109 responses (56 directly impacted, 53 not directly impacted).

For this report, we focussed on a selection of 18 questions that address the research objectives. We measured perceptions on a Likert scale 1-7, with 1 representing completely disagree and 7 completely agree. To evaluate if the differences between the groups of residents were statistically significant we used the non-parametric Mann-Whitney U test in SPSS (28.0.1.0) (McKnight & Najab, 2010).

4. Results and discussion

4.1. Basic description

Respondents had a mean age of over 34, and over 11 years in IY (Table 1). Most were employed and about half were owners, indicating potential means for implementing risk reduction efforts if deemed important and effective enough.

Table 1- Basic statistics of groups

	Before fire %	After fire – direct impact %	After fire – no direct impact %
Mean Age	34	44	38
Mean Time in IY	11	15	14
Housing status			
Living rent-free	18	2	25
Owner	55	50	66
Tenant	27	48	9
Employment status			
Full time employed	19	80	68
Part-time employed	37	11	17
Self-employed	17	2	6
Unemployed	26	7	9

*Percentages may not total 100 due to rounding

4.2. Fire risk perception

All residents felt their property was more at risk after the fire, with those that experienced direct impact more aware of the risk of settlement fire (Figure 2). Those experiencing a direct impact considered the community at a higher level of risk of wildfire and settlement fire than before. Those without a direct impact, however, perceived both risks lower than before the fire. These findings agree with what McGee et al. (2009) found comparing residents who lost their homes in a wildfire and those that were at home during the fire but had no losses.



Figure 2- Property and community risk (X represents the mean, * $p \leq 0.05$ between all groups, $\parallel p \leq 0.05$ between before fire and direct impact as well as between before fire and no direct impact only)

Although all residents perceived a raised property risk perception of both wildfire and settlement fire, those that experienced the fire have a more acute sense of settlement fire than of wildfire. Those that did not experience the fire considered both risks equal.

4.3. Vulnerability and consequences

Respondents have always felt vulnerable to fires, with a slightly higher vulnerability to settlement fires (Figure 3). After the fire, those who were directly affected had an increased sense of vulnerability to both fires. They, however, felt the severity will be lower for where they live, indicating they feel it had a direct impact on them, but not so great an impact on their neighbours who may not have been affected. Interestingly, those who were not directly affected by the fire felt less vulnerable than before the fire as well as the impact less severe. It could be that residents now have a tangible idea of what a fire event looks like and believe that they are not as

vulnerable and could recover post-fire as Wachinger et al. (2013) indicated can be the case with people who only witness a disaster but do not experience losses.



Figure 3- Vulnerability (X represents the mean, * $p \leq 0.05$ between all groups)

4.4. Perceived coping capacity

Before the fire, most residents believed that they could defend their properties. This, however, reduced post-fire, with respondents believing they are not able to defend their homes against either type of fire (Figure 4).

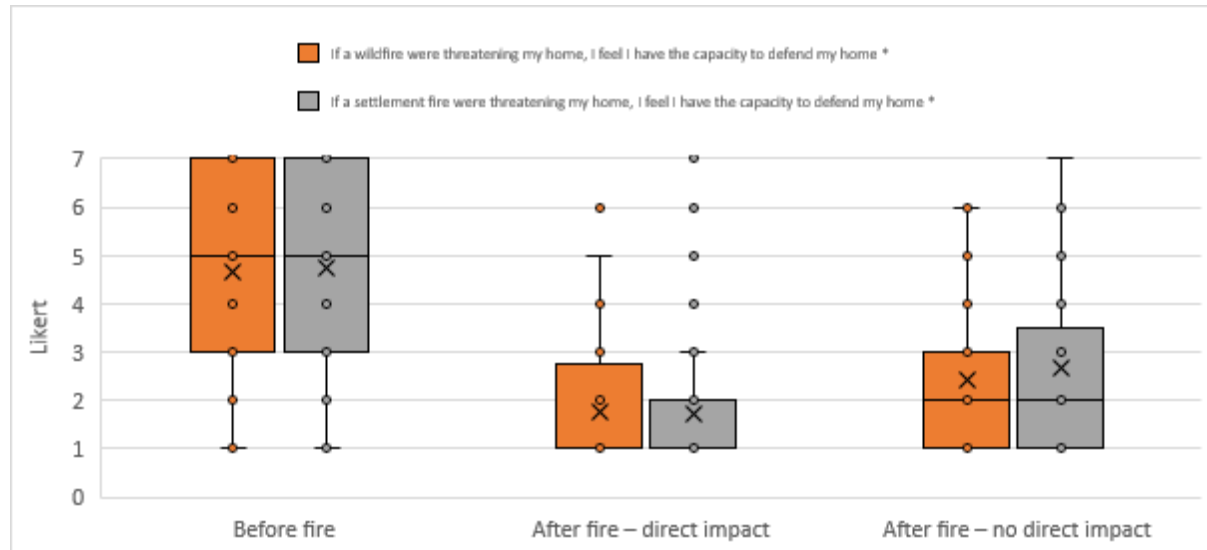


Figure 4- Coping capacity (X represents the mean, * $p \leq 0.05$ between all groups)

4.5. Implementation of risk reduction

Respondents that experienced the fire were less likely to implement risk mitigation efforts (Figure 5). This contrasts with Dupey & Smith, (2019), who found residents more likely to participate in mitigation efforts after a near-miss fire event. However, our finding is in agreement with McGee et al. (2009) who found that those who lost their homes felt it was not possible to mitigate against wildfires. Those with no direct fire impact were still more likely to implement mitigation efforts than those who experienced the fire. This may be as they still believe it to be effective and thus more likely to partake in it (Bubeck et al., 2012). Most respondents were still

willing to implement the low-cost action of keeping their plots free from garbage and vegetation, but the likelihood was reduced and more spread between individuals.



Figure 5- (X represents the mean, * $p \leq 0.05$ between all groups, $\parallel p \leq 0.05$ between before fire and direct impact as well as between before fire and no direct impact only)

The reduction of the intention to keep roads clear of cars can be interpreted as keeping a vehicle close by as a means of escape in case of a fire, but also as a way to protect the asset in high-crime areas such as South Africa (Cheteni et al., 2018). This is illustrated in South Africa through residents fortifying homes for safety from crime but making it difficult to escape in emergencies (Zweig et al., 2018).

South African informal settlers perceive open fire cooking and settlement density as the greatest hazard for fire ignitions and irresponsible drinking in IY (Flores Quiroz et al., 2021; Zweig et al., 2018). However, implementing electrical cooking and settlement density reduction requires a multi-stakeholder approach.

These findings confirm “windows of opportunity” for different mitigation actions that have been theorised by Wachinger et al. (2013) to close even faster for those who did not directly experience the disaster.

4.6. Intention to stay in IY

Residents who experienced the fire directly were more likely to stay in IY even with the fire hazards (Figure 6). The self-selection bias that they are the ones who returned and, thus, are less likely to leave has to be acknowledged. Unaffected residents were more likely to leave due to the fire hazards than residents before the fire. Those that experienced the fire, however, were as likely as before to move to a safer location within IY due to wildfire, but less likely for settlement fires. Indicating that residents are aware of the spatial element of wildfire, and the random nature of settlement fires. Leaving IY due to settlement fire and wildfire, however, agreed with those that experienced fire and those that did not with their intention to leave.

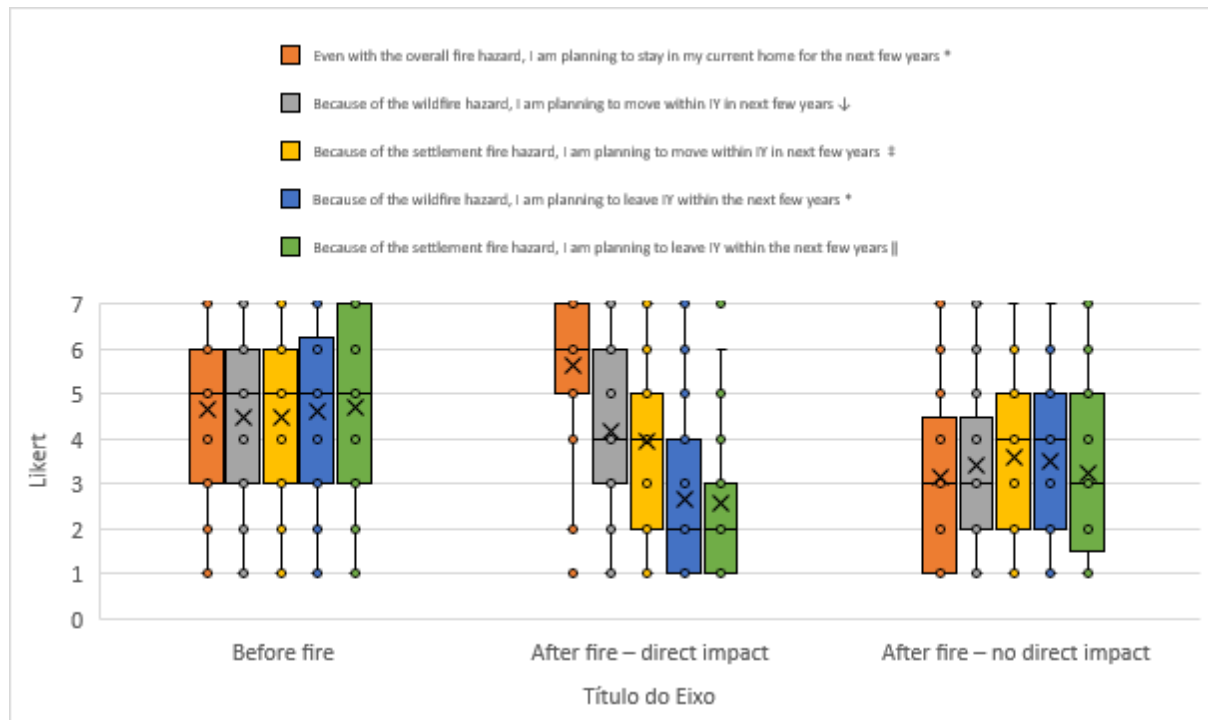


Figure 6- Intention to remain in IY (X represents the mean, * $p \leq 0.05$ between all groups, ‡ $p \leq 0.05$ only between direct impact and no direct impact, ‖ $p \leq 0.05$ between before fire and direct impact as well as between before fire and no direct impact only, ↓ $p \leq 0.05$ between before fire and no direct impact as well as between direct impact and no direct impact only)

5. Conclusions

We highlighted that any fire event affects the perceptions of residents. The level of impact on community risk perception depends on whether a resident was directly impacted. All residents, however, perceived increased fire risk after a fire occurred in the settlement. Those directly affected feel more vulnerable to fires whereas factors such as seeing the recovery may reduce the feelings of vulnerability of other residents. In IY, fires appear to make residents less likely to implement mitigation measures.

Those that experienced the fire and returned are not likely to leave, yet are also less likely to implement risk mitigation efforts and feel the most vulnerable to fire events. Importantly, these perceptions peak briefly after a fire event but are likely to regress towards the pre-fire level as early as nine months after the fire. Interventions relying on residents' perception of self-efficacy are best addressed when residents' perception of their coping capacity improves. Whereas interventions relying on external education and group action could best be implemented while residents feel they are powerless to help themselves individually.

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