Incidences of deliberate fire in West Yorkshire: Spatio-temporal patterns and influences on trends

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Summary

Arson is of increasing concern to both the police force and the fire and rescue service; the potentially life-threatening consequences of this crime, which is reportedly rising as a form of youth anti-social behaviour, make tackling the issue a key priority for the bodies involved. The study investigates the spatio-temporal patterns of arson in West Yorkshire, England, utilising a variety of spatial statistical tools. The aim of this project was to investigate the relationship between rates of arson and socio-demographics factors and to provide an updated case study of spatio-temporal patterns of arson in England.

KEYWORDS: arson, crime, spatio-temporal, hotspots, geodemographics

1. Introduction

Arson is the single largest cause of fire in England and Wales and has been recognised as one of the most destructive crimes potentially resulting in loss of life, injury and significant financial cost to individuals and businesses. In West Yorkshire, in the financial year 2012/2013, there were 4,803 deliberate fires which accounted for 62% of the total number of fires attended by the West Yorkshire Fire and Rescue Service; this is 17% higher than the proportion of deliberate fires than in the UK on average (West Yorkshire Fire and Rescue Service, 2013). Arson damaged properties can induce feelings of vulnerability for some individuals within a community and can produce a fear of crime in the area (Wilson and Kelling, 1982).

There are few empirical studies which examine both spatial and temporal patterns of fire, especially at low aggregation level (Jennings, 1999) (Grubb and Nobles, 2015). The lack of existing research, particularly within a UK context presents an opportunity to provide a case study utilising popular methods to understand why particular stratums of society experience higher incidences of fires than others. However, before we can make progress in our understanding of the spatio-temporal patterns of arson, we need to determine whether there is a relationship between socio-demographic characteristics and arson rate.

2. Methods

The methods utilised within this work are already established within spatio-temporal studies but have not previously all been applied to the study of deliberate incidences of fire. These methods include spatial autocorrelation (Moran's I), hotspot analysis (Getis Ord Gi*) and cluster and outlier analysis (Anselin Local Moran's I). A regression analysis was conducted to assess the relationship between rates of deliberate fires and socio-economic factors which have been associated with fire risk in previous studies (Donner and Karter, 1997) (Jennings, 1999) (Corcoran et al, 2007). The methods of analysis were applied to data for each financial year between 2008 and 2016 in order to determine whether spatial patterns differed over the period.

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3. Findings

There were four main findings of value from this work, which are as follows:

1. The mean age, the rate of households deprived in at least four dimensions and the rate of people long-term unemployed are all significantly correlated with the rate of deliberate fires
2. The variable which has the largest impact on the rate of deliberate fire is the rate of households deprived in at least four dimensions, with high rates of deprivation being associated with areas experiencing high rates of deliberate fires
3. The wards most severely affected by incidences of deliberate fire are the most deprived wards of Bradford and Leeds
4. The study found that three wards demonstrated the strongest relationship between fire rates and the underlying demographic factors analysed; which are Bolton and Undercliffe (Bradford), Killingbeck and Seacroft (Leeds) and City (Bradford).

The calculation of Global Moran's I suggests that in every year between 2008 and 2016 the patterns of deliberate fires are clustered; therefore, the pattern has not randomly occurred. This indicates the presence of underlying factors which influence the locations in which the incidences of deliberate fires occur.

The study also found that within West Yorkshire, factors which had previously been identified as having a correlation with rates of arson were not of significance, as demonstrated in **Table 1**. These factors include the proportion of socially rented households and low rates of educational attainment. Additionally, from 2012 onwards car ownership no longer had a relationship with rates of deliberate fire.

Table 1 Coefficient and significance values calculate using a regression for six socio-economic variables for 2015-2016

Socioeconomic variable	Coefficient	Significance
Rate of people with no car or van access (per 1000 people)	0.02254	0.019
Mean age	-0.2596	0.000
Rate of people with no qualifications (per 1000 people)	0.0029	0.622
Rate of households deprived in at least four dimensions (per 1000 households)	0.7582	0.000
Rate of people long term unemployed (per 1000 people)	0.2466	0.000
Rate of socially rented households (per 1000 households)	0.0005	0.925

The hotspot analysis indicated that coldspots were more consistent than hotspots, which were primarily concentrated around the areas of central Leeds and Bradford. From 2008 onwards, the number of hotspots in Leeds decreased significantly and the number of coldspots increasing, while the number of hotspots in Bradford wards increased, demonstrated in **Figure 1**, also became more statistically significant.

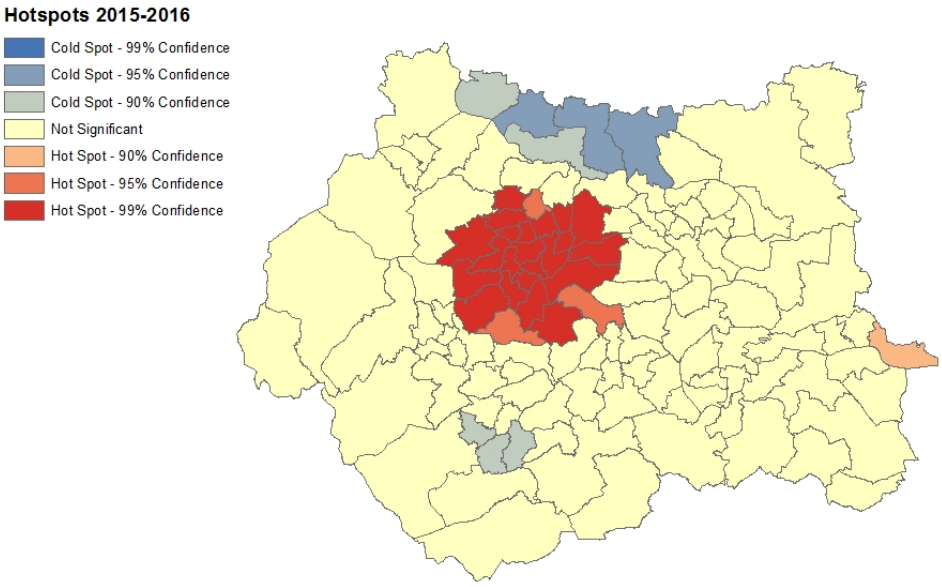

Figure 1 Hotspots and coldspots of deliberate fires in West Yorkshire in the financial year 2015-2016

Cluster and outlier analysis identified that areas with high rates of deliberate fires tend to be clustered together, as do those with low rates. This support Tobler's First Law of Geography (Tobler, 1970), which states that things which are located in closer proximity are more similar than those further apart.

4. Potential issues

Under reporting is substantial for every crime, particularly for crimes against the property (Tarling and Morris, 2010). The willingness of victims to report crimes is a key aid to the police, fire service and researchers as a true reflection of crime allows for a more comprehensive understanding of how crime affects both individuals and communities (Tarling and Morris, 2010) and allows a relationship to be established between crime levels and socioeconomic characteristics where appropriate. There are a number of factors which may influence a victim's decision to report a crime, with individuals from higher income households, those who have achieved higher level educational attainment and the employed the most likely to report a crime (Baumer, 2002). Another issue is that perpetrators travel to locations in order to commit a crime, therefore inhabitants of the targeted areas may not share the demographic characteristics of the offenders.

5. Conclusions

The results of this work confirm findings of previous work which established a link between rates of arson and deprivation. The study has also provided evidence that two factors previously associated with rate of fire `the proportion of socially rented households' and 'low rates of educational attainment' are not associated with fires in this study area. This work adds to the very limited number of UK based studies by providing an investigation of rates of deliberate fires within West Yorkshire. The results have the potential to be utilised by the police and fire and rescue service in order to aim arson prevention schemes at areas which are most severely affected. Initiatives can be instigated in the highlighted locations to limit the opportunities for fire; including strategies such as ensuring refuse and bins are not permitted to accumulate for long periods outside a property and ensuring abandoned building or vehicles and properly secured. Understanding the demographic factors that are associated with the rates of deliberate fires is also valuable. The ability to associate high levels of deprivation, mean age and the rate of people who are long term unemployed with arson rates can enable the prediction of areas which may begin to experience more incidences of arson. However, it is important to note that arson is not

limited to areas with the aforementioned demographic characteristics although resources can be focused on more vulnerable locations.

6. Opportunities for further research

A key opportunity for the development of this work is the application of the methods utilised to other counties within England to allow comparison between regions and test whether certain socio-economic variables consistently have a relationship with fire rate. In this study total deliberate fire rates are utilised for analysis; however, this could be divided into primary and secondary fires to enable an investigation as to whether spatial and temporal patterns differ between the two types of fires.

7. Acknowledgements

The incidences of deliberate primary and secondary fires from the financial years 2008/2008-2015/2016 were acquired from the West Yorkshire Observatory website, which is no longer available.

Demographic data was acquired from the 2011 UK Census via InFuse (http://infuse.ukdataservice.ac.uk).

References

Baumer, E.P. 2002. Neighbourhood disadvantage and police notification by victims of violence. *Criminology.* **30** (3) pp 579-616.

Corcoran, J., Higgs, G., Brunsdon, C., Ware., & Norman, P. 2007. The use of spatial analytical techniques to explore patterns of fire incidence. A South Wales case study. *Computers, Environment and Urban Systems.* **31** (1) pp 75-85.

Donner, A. and Karter, M. 1997. *Fire Rate and Census Characteristics- an Analytical Approach.* Boston: National Fire Protection Association.

Grubb, J. and Nobles, R. 2015. A Spatiotemporal analysis of Arson. *Journal of Research in Crime and Delinquency.* **53** (1) pp 66-92.

Jennings, R.C. 1999. Socioeconomic characteristics and their relationship to fire incidence: A review of the literature. *Fire Technology.* **35** (1) pp 10-34.

Kelling, G. and Wilson, K. 1982. Broken Windows: the police and neighbourhood safety. [Online]. [Accessed 16th January 2019]. Available from: https://www.theatlantic.com/

Tarling, R. and Morris, K. 2010. Reporting Crime to the Police. *British Journal of Criminology.* [Online]. **50** (1) pp 474-490.

West Yorkshire Fire and Rescue Service. 2013. PRE-PRO-005 Arson Reduction Procedure. [Online] West Yorkshire Fire and Rescue Service. [Online]. [Last Accessed: 14th January 2019]. Available from: http://www.westyorksfire.gov.uk/

Biographies

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