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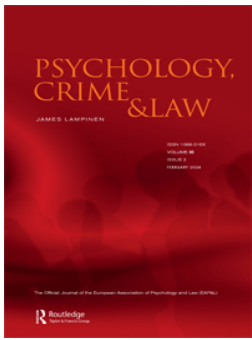


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A typology of rural arsonists: characterising patterns of criminal behaviour

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ABSTRACT

Rural arsonists are responsible for a significant part of fires that cause environmental and community damage. Despite its prevalence in several countries, few studies have examined the characteristics and typologies of rural arsonists, contributing to the continuing lack of awareness of rural crime. Therefore, this study identifies the discriminant characteristics of rural arsonists and develops a typology of the criminal patterns associated with this rural crime. For this purpose, the sociodemographic and psychosocial characteristics, criminal behaviour and crime scene information of 450 rural arsonists' criminal records were analysed. Findings indicate that 61% of rural arsonists had mental health and alcohol problems. However, compared to previous literature, most were older adults ($M = 45.64$; $SD = 16.02$), had no criminal record (66%) and were employed (54%). By focusing on overcoming the limitations of previous typologies, the current one has been improved conceptually and methodologically, resulting in the classification of rural arsonists into three groups: Expressive – Mental Health Problems (39%), Expressive – Alcohol Consumption (38%), and Instrumental – Socially Adjusted (23%). This study enhances the comprehension of rural crime and establishes the groundwork for future research in the field by increasing knowledge of the characteristics of Portuguese rural arsonists and assisting criminal investigations.

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Introduction

The number of deliberately set fires per 100,000 population varies from 40 to 200, according to Gannon et al. (2022). The deliberate setting of a fire to cause damage to property and personal belongings (Barrowcliffe & Gannon, 2015; Fritzon, 2015), resulting in arrests,

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charges, or convictions for deliberate firesetting (Douglas et al., 2013), is defined as arson. Although diverse jurisdictions use different legal definitions to describe this crime (Gannon & Pina, 2010), arson is a serious offence with multiple consequences for communities and the environment (Stanley, 2013). In addition, compared to starting a fire in an urban setting, starting a fire in a rural area may be related to different behavioural, psychological, and motivational characteristics. It is not always possible to confirm these distinctions, as rural crime is rarely studied independently of urban crime (Donnermeyer et al., 2006, 2013). However, the opportunities to start a fire differ in both settings (e.g. environmental and wildlife crime, cf. Ceccato & Abraham, 2022) and fires ignited in rural areas result in high financial, human, and environmental costs (e.g. Elvan et al., 2021; Sistema de Segurança Interna, 2020; Smith et al., 2014). Thus, it is essential to analyse deliberate firesetting in rural areas separately from urban ones to identify the specific characteristics of arsonists, their motivations and define classifications and intervention programmes (Willis, 2005).

The act of setting fires in forests, bushes, agricultural land, or pastures is known as forest firesetting, rural arson, or bushfires (Bush Fires Act, 1954; Cozens & Christensen, 2011; Incendio Forestal, 1995; Incêndio Florestal, 1995; Vélez, 2003). Approximately 50% to 95% of rural fires are deliberately set (Doley et al., 2015; Elvan et al., 2021; Greenpeace, 2008; San-Miguel-Ayanz et al., 2012). In Australia, over 60,000 bushfires are registered annually, almost half of which are deliberately set, resulting in millions of dollars spent annually (Smith et al., 2014; Stanley, 2013). In Portugal, over 100,000 cases of arson were reported in a decade (Estatísticas da Justiça, 2021; Sistema de Segurança Interna, 2020), of which 86,503 were in rural areas, resulting in approximately 8,000 cases of rural arson per year and over two million acres burned (Sistema de Segurança Interna, 2020). Although many rural and urban arson offences are reported yearly in several countries, detention rates for these crimes are low (Barrowcliffe & Gannon, 2015; Sistema de Segurança Interna, 2020). To illustrate this problem in the rural setting, Portugal registered 5,908 cases of rural arson in 2020, of which only 2% resulted in detention or arrest (Estatísticas da Justiça, 2021). A similar scenario can be found in other countries (e.g. Turkey, Elvan et al., 2021; Australia, Stanley, 2013; and Spain, Álvarez et al., 2017).

Rural crime is theoretically underdeveloped and rarely studied, either independently or in comparison to urban crime (Donnermeyer et al., 2006, 2013). Additionally, not many studies identify the psychological characteristics of rural arsonists (Ducat & Ogloff, 2011), highlighting the importance of analysing their characteristics separately from urban arsonists (Gannon et al., 2022). Furthermore, there is also a lack of classification systems that take into account the rural setting. Therefore, this study improves some methodological aspects of the classification systems by using a conceptual approach to gather information and select relevant variables that characterise rural arson based on the psychosocial characteristics and criminal patterns of the offenders in the Portuguese context.

Rural arsonists characteristics

In general, arsonists can be distinguished from other offenders by several psychological functioning characteristics, including fire-related factors, emotional/self-regulation, and self-concept issues (Gannon et al., 2022). For instance, psychiatric history/mental disorder is present in a disproportional way in arsonists (Anwar et al., 2011; Burton et al., 2012; Ellis-Smith et al., 2019; Gannon & Pina, 2010; Gannon et al., 2012a; Fritzon & Miller,

2016; Morewitz, 2019; Soeiro & Guerra, 2014; Wyatt et al., 2018), compared to other offenders (e.g. Anwar et al., 2011; Ducat et al., 2013a; Ducat et al., 2013b; Enayati et al., 2008). Among female and male arsonists, learning disabilities (Burton et al., 2012; Enayati et al., 2008) and schizophrenia (Anwar et al., 2011; Burton et al., 2012; Long et al., 2015) are two of the most prevalent mental disorders. Moreover, one-third of arsonists may have a personality disorder (Sambrooks et al., 2021), such as antisocial personality disorder (Enayati et al., 2008; Gannon et al., 2022; Koson & Dvoskin, 1982; Nanayakkara et al., 2015; Repo & Virkkunen, 1997; Tyler & Gannon, 2012) and borderline personality disorder (Ducat et al., 2013b; Gannon et al., 2022; Ó Ciardha et al., 2015). Compared to other offenders, some studies suggest that arsonists have a higher prevalence of personality disorders (e.g. Bradford, 1982; Ritchie & Huff, 1999). In addition, mental disorders are highly associated with comorbid alcoholism among recidivist arsonists (Lindberg et al., 2005). The abuse of substances by arsonists, particularly alcohol, is commonly reported in the literature (e.g. Burton et al., 2012; Jayaraman & Frazer, 2006; Ritchie & Huff, 1999; Rix, 1994) and is considered one of the risk factors for arson (Burton et al., 2012). However, research has also yielded inconsistent findings. For example, evidence suggests that arson offenses are primarily committed by adolescents and young adults (e.g. Burton et al., 2012; Caudill et al., 2012; Gannon & Pina, 2010; Morewitz, 2019), but it also suggests that older individuals commit a significant number of these offenses (e.g. Butler & Gannon, 2021; Gannon et al., 2012a; Nanayakkara et al., 2020), particularly in rural areas (e.g. Soeiro & Guerra, 2014; Sotoca et al., 2013). These studies indicate the existence of some specific characteristics of rural arsonists. It is crucial to develop further studies on the specificity of these offenders, taking into account the setting (rural or urban) as a differentiating variable (e.g. Gannon et al., 2022).

Research focusing on the characteristics of rural arsonists is scarce. Until now, findings on these rural offenders show that most are male (Muller, 2009; Soeiro & Guerra, 2014) and have alcohol abuse and mental disorder (Soeiro & Guerra, 2014). The motivation for offending is often expressive (e.g. excitement, attention-seeking, Soeiro & Guerra, 2014; Willis, 2005). However, it can also be instrumental, such as land clearing (Salvador, 2016; Varma, 2003), protesting against land use or state environmental regulations (Holmes, 2007; Kull, 2004), and making a profit (Willis, 2005).

Based on Cohen et al. (1981) definition, the act of setting a fire as a sole 'reward' is identified as expressive motivation, whereas setting a fire as a means to gain something or achieve an external goal (also corroborated by Hennessey et al., 2015) is described as instrumental motivation. Therefore, expressive motivation includes anger/rage, revenge/vengeance, excitement, pleasure, and/or attention-seeking (e.g. Barrowcliffe & Gannon, 2015; Bradford, 1982; Canter & Fritzon, 1998; Douglas et al., 2013; Gannon & Pina, 2010; Kocsis & Cooksey, 2002; Lamon & Haas, 2003; Prins et al., 1985; Rix, 1994; Willis, 2005). On the other hand, instrumental motivation includes setting fires for criminal reasons/ crime concealment, vandalism, work-related, or profit (Douglas et al., 2013; Inciardi, 1970; Mojtahedi et al., 2017; Prins et al., 1985; Rix, 1994; Willis, 2005). Although some of these studies highlight an instrumental purpose for setting a fire, setting a fire in rural areas is typically associated with psychological motives rather than material or political rewards (Ducat & Ogloff, 2011). These studies indicate the existence of some specific characteristics of rural arsonists. It is crucial to develop further studies on the specificity

of these offenders, considering the setting (rural or urban) as a differentiating variable (e.g. Gannon et al., 2022).

Challenges in classifying rural arsonists

Classification systems or typologies are necessary 'to make sense of the patterns that characterise criminal offending' (Schmallegger, 2013, p. 282). For several years, some classification systems have attempted to define the individual, psychological and criminal characteristics of arsonists. Previous research has proven that arsonists have heterogeneous characteristics which result in their organisation into different groups of arsonists (Bradford, 1982; Canter & Fritzon, 1998; Hewitt et al., 2021; Inciardi, 1970; Kocsis et al., 1998). Many of these classification systems characterise the arsonist's motivation (e.g. Bradford, 1982; Canter & Fritzon, 1998; Hewitt et al., 2021; Inciardi, 1970; Kocsis et al., 1998), mental disorders (e.g. Lewis & Yarnell, 1951; Rix, 1994) and criminal behaviour, as well as the analysis of the crime scene (e.g. Canter & Fritzon, 1998; Hewitt et al., 2021; Kocsis et al., 1998). However, there are some limitations to the methodology and nature of these typologies. The difficulty in comparing different classification systems for deliberate firesetting is due to the selection of different methods and variables across studies (cf., Tyler & Gannon, 2021). For example, arsonists may have multiple and overlapping motivations for setting fires, contributing to the inconsistency and subjectivity in grouping variables and dimensions when developing the typologies (cf., Hewitt et al., 2021). Nevertheless, a combination of theoretical, empirical, and statistical approaches could address some of these methodological concerns (Tyler & Gannon, 2021). Furthermore, most classification systems studies do not present information on the setting of the fire (i.e. urban or rural). However, those that do, they include rural arsonists in a single small group and compare them disproportionately to a larger number of urban arsonists (e.g. Inciardi, 1970; Kocsis et al., 1998; Kocsis & Cooksey, 2002).

Three classification systems can be found in the literature to characterise rural arsonists. Willis (2005) proposed a five-group theoretical typology based on the motivations of bushfire arsonists: *Excitement* (when arsonists set a fire to relieve excitement or boredom relief), *Attention Seeking* (associated with the need for pleading and heroism), *Gain* (fire set for a specific purpose, mainly for material gain), *No Apparent Motivation* (when the arsonist have a mental illness) and *Mixed Motives* (when the arsonist have two or more motivations mentioned before). However, there is no further characterisation of these offenders, limiting the knowledge about their psychosocial and behavioural characteristics.

Soeiro and Guerra (2014) developed a Portuguese behavioural data-driven classification (cf. Tyler & Gannon, 2021) based on Canter and Fritzon's typology (1998). It is based on the technique of criminal profiling, taking into account variables such as socio-demographic and psychological characteristics, criminal behaviour and crime scene information. Four main patterns of criminal behaviour were identified in a sample of 452 rural arsonists: *Instrumental-Retaliatory* (motivated by anger, revenge or family problems and alcohol consumption), *Instrumental-Benefit* (motivated by the benefits of obtaining material rewards, money or other benefits), *Expressive-Clinical* (psychiatric and alcohol problems) and *Expressive-Fire Attraction* (motivated by attraction to fire and related activities such as helping firefighters). As the typology resulted from an exploratory study that

collected data based on risk factors highlighted in the arson literature, the variables used in the typology were not specifically discriminative for rural arson (e.g. gender was included as a representative variable for rural arson, albeit the transversal fact that most offenders are predominantly male despite the crime, cf., Nicholls et al., 2015).

Lastly, through the study of 117 rural arsonists, Sotoca et al. (2013) established a typology with five groups based on the type of rural area burned: *Rancher* (may have a criminal record and are motivated by revenge or punishment), *Forest* (have a low level of education, are motivated by the hostility towards feel against the owner of the rural area, and have alcohol consumption abuse), *Road Forest* (unemployed arsonists, have substance/alcohol abuse, and are motivated by revenge) and *Agricultural Hunting* (work in the agricultural sector or are unemployed, have substance abuse and a criminal history related to arson, and they are motivated by profit). Using a similar approach to the study by Soeiro and Guerra (2014), this typology analysed sociodemographic, psychosocial, and criminal behavioural characteristics and crime scene information. However, it focused more on the type of rural area (e.g. forest) rather than the criminal behaviour of rural arsonists. In addition, some groups did not report the motivation for setting the fire, representing the conceptual limitation of this typology, and contributing to the aforementioned methodological problems.

Rural crime is a relevant topic that has received limited attention (cf., Donnermeyer et al., 2006, 2013). Given the shortcomings of the literature on rural arsonists, the current study aims to identify the characteristics of Portuguese adults arrested for rural arson and to develop an updated typology that overcomes the limitations of previous ones (e.g. Soeiro & Guerra, 2014). Through this analysis, this study aims to elaborate a statistical data-driven typology of rural arson based on the literature review about arson (cf., Tyler & Gannon, 2021). To achieve this, the current study will 1) present the *Recidivism Risk Factors of Rural Arson* checklist based on the arson literature review to gather information about rural arsonists; 2) provide a descriptive characterisation of rural arsonists by evaluating their sociodemographic, psychosocial, criminal behaviour and crime scene information, thus increasing the knowledge about the characteristics of these rural offenders; 3) determine how many groups of rural arsonists exist by analysing a set of variables and clustering them to distinguish within-group differences, which contributes to the development of an improved typology of rural arsonists. With updated methods that should benefit further research in this area, this study provides insight into the characteristics of rural arsonists in the Portuguese context, improving the study of rural crime and assisting criminal investigations.

Method

Data characterization

The current study sample included 450 criminal cases of rural arson arrested by the Portuguese Judicial Police between 2015 and 2020. In the Portuguese jurisdiction, rural arson is typified as 'anyone who causes a fire on land covered with forest, including woods, or pasture, bush, spontaneous plant formations or in agricultural land, on their own property or that of others ...' (Incêndio Florestal, 1995, Act 274^o), which differs from the definition of urban arson: 'anyone who causes a major fire, in particular by setting fire to a building,

structure or means of transport, thereby creating a danger to the life or physical integrity of others or to the property of others of high value'. (Incêndios, explosões e outras condutas especialmente perigosas, 1995, Act 272°). Hence, in the present study, we have only included the criminal cases typified by the Act 274° (*Rural Arson*) of the Portuguese jurisdiction. Regarding the distribution of these cases across years, 12% were in 2015 ($n = 52$), 20% in 2016 ($n = 90$), 24% in 2017 ($n = 110$), 13% in 2018 ($n = 57$), 12% in 2019 ($n = 54$) and 19% in 2020 ($n = 87$).

Measures

The *Recidivism Risk Factors of Rural Arson Checklist* (IPJCC, 2015) is a multiple-choice checklist with 23 variables designed to assist police officers in gathering information about rural arsonists. Based on a review of the literature on arsonists (e.g. Canter & Fritzon, 1998; Douglas et al., 2013; Gannon et al., 2012b; Gannon & Pina, 2010), it is divided into four main sections as presented in Table 1: 1) sociodemographic characteristics (e.g. sex, age); 2) psychosocial characteristics (community and family integration, and presence of alcohol consumption problems / mental health problems); 3) criminal behaviour (e.g. criminal record, relationship with the owner of the rural property); 4) crime scene characteristics (e.g. type of rural area burned, type of ignition). Given the limitations of motive-based typologies, we operationalised the 'Motivation' variable as 'Expressive Motivation', 'Instrumental Motivation' or 'Both' (i.e. to include situations where arsonists had mixed motives for setting a fire).

Procedure

As part of their work, police officers from all Portuguese Judicial Police departments in Portugal, including the Azores and Madeira, interviewed the arrested rural arsonists to collect information for scientific investigation purposes. Subsequently, these police officers completed the *Recidivism Risk Factors of Rural Arson* checklist (IPJCC, 2015) and sent it to the Psychology Department of the Institute of Judicial Police and Criminal Sciences (IPJCC). The psychologists in this department exported each checklist to the confidential rural arson database for statistical analysis. The authors were allowed to access and analyse the data for the purposes of this study, ensuring that the privacy and confidentiality of the information was respected in accordance with the General Data Protection Regulation (Regulation, 2016).

Statistical approach

Machine learning aims to leverage the automated potential of computing and the availability of datasets and information to produce mathematical models that help find patterns or classify information, among other utilities (Helm et al., 2020). The present study analysed variables that systematically characterise rural arsonists and their similarities by using the clustering method. This methodology uses a set of generated clusters to group individuals with similar patterns and act based on the groups' characteristics (e.g. sex, profession, marital status). It can also create groups with a minimal number of variables as long as they are representative of the cluster (cf., Badillo et al., 2020).

Table 1. Codification of the variables in the rural arson database.

Characteristics	Variables Names	Variables' Values Categorization
Sociodemographic	Year	1 = 2015; 2 = 2016; 3 = 2017; 4 = 2018; 5 = 2019; 6 = 2020
	Sex	1 = Male; 2 = Female
	Age	1 = 29 years old or younger; 2 = 30 to 39 years old; 3 = 40–59 years old; 4 = 60 years old or older
	Qualifications	1 = No qualifications/Primary School; 2 = Middle school; 3 = High School; 4 = Higher Education
	Marital Status	1 = Single; 2 = Married; 3 = Divorced; 4 = Domestic Partnership 5 = Widowed
Psychosocial	Occupation	1 = Unemployed; 2 = Agricultural or forestry workers; 3 = Services and sales workers; 4 = Craft and related trades workers; 5 = Industry workers; 7 = Retired; 8 = Students; 9 = Firefighters; 10 = Others
	Community and Family Integration	1 = Dysfunctional Family; 2 = Difficulty in Integrating Community; 3 = Lives with the Family; 4 = Lives with Parents; 5 = Lives Alone; 6 = Lives in an Institution; 7 = Various
	Mental Health or Alcohol Consumption Problems	1 = Without; 2 = Alcohol Consumption Problems; 3 = Mental Health Problems; 4 = Both
Criminal behaviour	Criminal Record	1 = Without; 2 = Previous Arson Convictions; 3 = Previous Convictions for Other Crimes; 4 = Other (e.g. Suspect)
	Type of Substance Used at the Time of the Crime	1 = Alcohol; 2 = Drugs; 3 = Medicine; 4 = Various
	Motivation	1 = Expressive; 2 = Instrumental; 3 = Both
	Type of Motivation: Attention Seeking	1 = Yes; 2 = No
	Type of Motivation: Revenge / Rage	1 = Yes; 2 = No
	Type of Motivation: Boredom	1 = Yes; 2 = No
	Type of Motivation: Pleasure	1 = Yes; 2 = No
	Type of Motivation: Gains	1 = Yes; 2 = No
	Substance Abuse at the Time of the Crime	1 = Yes; 2 = No
	Behaviour After Crime	1 = Leaves the Crime Scene; 2 = Remains at the Crime Scene; 3 = Returns to the Crime Scene; 4 = Helps Extinguishing the Fire; 5 = Various
Crime scene	Confession of the Crime	1 = Does Not Confess; 2 = Confesses
	Relationship with the Victim	1 = Unknown; 2 = Acquainted; 3 = Neighbor; 4 = Family Member; 5 = Friend; 6 = Own; 7 = Various
	Coauthors	1 = No; 2 = Yes
	Type of Rural Area Burned: Bush	1 = Yes; 2 = No
	Type of Rural Area Burned: Forest	1 = Yes; 2 = No
	Type of Rural Area Burned: Pasture / Agricultural Field	1 = Yes; 2 = No
	Type of Ignition	1 = Simple (e.g. lighter); 2 = Complex (e.g. bomb)
	Distance of Fire Set from Offender's House/Work	1 = Close to the Arsonist's House; 2 = Close to the Arsonist's Workplace; 3 = Far from the Arsonist's House; 4 = Close to the Arsonist's House/Workplace; 5 = Others
	Number of fires set	1 = One; 2 = Two or more
	Day of the Crime	1 = Working Days; 2 = Weekends; 3 = Both

This study used the clustering method, *k-modes*, proposed by Huang (1997). We aimed at clustering categorical data by matching a dissimilarity measure, using modes to represent cluster centres, and updating modes with the most frequent categorical values in each iteration of the clustering process. The dissimilarity metric used for *k-modes* is the Hamming distance from information theory. The algorithm worked as follows: 1) it selected *k* unique objects randomly as the initial cluster centres (modes); 2) the distances between each object and the cluster mode were calculated and then assigned to the cluster whose centre is closest; 3) the process was repeated until all objects were assigned

to clusters and 4) a new mode for each cluster was selected, and it was compared with the previous mode. If the results were different, it was necessary to repeat the second step (cf., Vos, 2013). The last step of the approach was determining the best value for k . To achieve this, the number of clusters was assorted, with random initialisation and five data points used to compute the mode of each cluster. A cost function was then applied to each of the clusters obtained, computed as the sum distance of all points to their respective cluster centroids. Finally, the iteration of k was chosen, where there is an abrupt drop in the cost function value. This method provided the optimal value of k for the current dataset. The last step of the analysis consisted of validating the population elements within each cluster by observing their feature distribution.

The analysed dataset initially consisted of 23 categorical variables. Due to the challenging circumstances of obtaining the information, two of these variables had 30% or more missing values (i.e. dimension of the area burned, previous identification of the offender by the police). Considering the data's categorical nature, filling in the missing values with methods such as the mode or interpolation would not be beneficial (cf., Stavseth et al., 2019). It would be cost-productive to interview each rural arsonist to gather the missing information, especially when some criminal cases were already from 2015, therefore, there was no imputation of missing values to reduce bias, leading to the exclusion of these variables for the current study and resulting in the analysis of 21 variables.

Results

The characteristics of rural arsonists

Sociodemographic information

Most arsonists were male ($n = 403$, 89.6%), almost half of them were between 40 and 59 years old ($n = 210$, 46.7%) (mean [M] = 45.64; standard deviation [SD] = 16.02) and single ($n = 234$, 53.9%). A low level of education was emphasised (i.e. no education or only primary education level) ($n = 182$, 40.2%). Most were employed ($n = 182$, 54.4%), with a significant proportion working in agriculture/forestry ($n = 84$, 18.7%), although the rate of inactivity was also noteworthy ($n = 193$, 42.9%).

Psychosocial characteristics

In this sample, offenders usually lived with their families ($n = 134$, 29.4%) and a small number had known community integration difficulties or a dysfunctional family ($n = 45$, 9.9%). In terms of mental health and alcohol problems, a small percentage of rural arsonists in this sample had no mental health or alcohol problems ($n = 157$, 34.4%). Therefore, of the remaining 60.6% of available data ($n = 276$), most had alcohol problems ($n = 149$, 32.7%), 21.1% had a mental disorder such as depression, schizophrenia, personality disorder, cognitive impairment or other ($n = 96$) and the remainder had both ($n = 31$, 6.8%).

Criminal behaviour

Overall, only one fire was set before the arrest ($n = 367$, 81.6%) ($M = 1.77$; $SD = 4.45$) and the motivation was often described as expressive ($n = 286$, 63.6%), especially rage and/or revenge ($n = 102$, 33.2%). Half of rural arsonists did not know the owner of the property they set fire to ($n = 225$, 50%). A robust finding is that most offenders set the fire alone (n

= 411, 91.3%) and the fire was usually started near their home ($n = 346$, 76.9%). After setting the fire, most rural arsonists left the scene ($n = 307$, 68.2%) but confessed to the crime when questioned ($n = 304$, 68.2%). Almost half of the sample had abused substances at the time of the crime ($n = 224$, 49.8%), especially alcohol ($n = 199$, 88.8%). Finally, a substantial group of rural arsonists had no previous criminal record ($n = 303$, 66.4%).

Crime scene information

Most cases of rural arson occurred on working days ($n = 305$, 67.8%) and almost all fires were started with a simple ignition (i.e. lighters, candles, matches, etc.) ($n = 419$, 93.1%). Usually more than one type of rural area was burned, such as forests ($n = 312$, 47.6%) and bushes ($n = 302$, 46%) (see [Table 2](#)).

Development of the rural arson typology

Of the variables analysed using the *k-mode* clustering method, seven variables were discriminative in characterising rural arsonists: *Age, Qualifications, Occupation, Community and Family Integration, Alcohol Consumption at the Moment of the Crime, Psychiatric History or Alcohol Problems* and *Motivation*. By considering the significant variables and their categories within each cluster, it was possible to characterise three different clusters: *Expressive – Mental Health Problems* (Cluster 1), *Expressive – Alcohol Consumption* (Cluster 2) and *Instrumental – Socially Adjusted* (Cluster 3) (see [Table 3](#)).

Cluster 1 (*Expressive – Mental Health Problems*) comprised 38.9% ($n = 175$) of the total sample. It includes rural arsonists aged 29 or younger ($n = 66$; 37.7%), who generally had middle school education ($n = 49$; 27%) and were not employed ($n = 58$; 33.1%). Most offenders lived with their parents ($n = 73$; 41.7%). Although most of these rural arsonists did not report drinking alcohol at the time of the crime ($n = 113$; 64.6%), almost half of the sample reported mental health problems (i.e. depression, schizophrenia, personality disorder, cognitive impairment or other problems, $n = 82$; 46.9%). Furthermore, the reported motivation for intentionally setting fire was mainly expressive ($n = 140$; 80.9%).

Cluster 2 (*Expressive – Alcohol Consumption*) included 38.4% of the total sample ($n = 173$). Rural arsonists in this cluster were aged often aged between 40 to 59 years old ($n = 120$; 70.6%), had low educational qualifications (on the primary school level) or no qualifications at all ($n = 99$; 57.2%) and were also unemployed ($n = 68$; 39.3%). They typically lived alone ($n = 80$; 46.2%). The main highlight of this group was the presence of alcohol consumption at the time of the crime in over 95% of the sample included ($n = 165$; 95.4%). Additionally, these rural arsonists usually demonstrated previous problems with alcohol consumption ($n = 134$; 77.5%). Most of these offenders also had an expressive motivation to commit the crime ($n = 139$; 81.3%).

Finally, Cluster 3 (*Instrumental – Socially Adjusted*) comprised 22.7% of the total sample ($n = 102$) and was characterised by rural arsonists who were typically 40 to 59 years old or older ($n = 75$; 73.5%) and also had low to no qualifications ($n = 45$; 44.2%). Unlike the previous groups, most of these rural arsonists were more likely to be employed in agriculture or forestry ($n = 37$; 36.3%). Offenders in this group usually lived with their family (i.e. spouse, children, etc.) ($n = 71$; 69.6%). Many offenders in this group did not show any alcohol consumption at the time of the crime ($n = 79$; 77.5%). Rural arsonists in this

Table 2. Characteristics of rural arsonists.

Variables	Categories	N	%
Sex	Male	403	89.6
	Female	47	10.4
Age	29 years old or younger	84	18.7
	30 to 39 years	75	16.7
	40 to 59 years	210	46.7
	60 years old or older	75	16.7
	N/I	6	1.2
Marital Status	Single	234	53.9
	Married	108	24
	Divorced	64	14.2
	Domestic Partnership	17	3.8
	Widowed	11	2.4
Qualifications	N/I	16	3.6
	No qualifications/Primary School	182	40.2
	Middle School	109	24.2
	High School	47	10.4
	Higher Education	3	.7
Professional Occupation	N/I	109	25.2
	Unemployed	134	29.8
	Agricultural or forestry workers	84	18.7
	Retired	59	13.1
	Craft and related trades workers	54	12
	Service and sales workers	40	8.9
	Industry workers	18	4
	Students	12	2.7
	Firefighters	12	2.7
	Others	27	6
Community and Family Integration	N/I	10	2.2
	Lives with the Family	134	29.4
	Lives with Parents	101	22.1
	Lives Alone	106	23.2
	Lives in an Institution	14	3.1
	Dysfunctional Family	36	7.9
	Difficulty in Integrating the Community	9	2
	Various	37	8.1
	N/I	19	4.2
	Criminal Record	Without	303
Previous Convictions for Arson		79	17.3
Previous Convictions for Other Crimes		24	5.3
Other (e.g. Suspects)		43	9.4
N/I		7	1.5
Mental Health or Alcohol Consumption Problems	None	157	34.4
	Alcohol Consumption Problems	149	32.7
	Mental Health Problems	96	21.1
	Both	31	6.8
Number of Fires Set	N/I	23	5
	One	367	81.6
	Two or more	74	16.4
Motivation	N/I	9	2
	Expressive	286	63.6
	Instrumental	78	17.3
Type of Expressive Motivation	Both	86	19.1
	Revenge / Rage	102	33.2
	Boredom	82	26.7
Type of Instrumental Motivation ^a	Attention-seeking	78	25.4
	Gains	164	100
	Relationship with the Victim	225	50
Relationship with the Victim	Unknown	77	17.1
	Neighbor	59	13.1
	Family Member	20	4.4
	Own	19	4.2

(Continued)

Table 2. Continued.

Variables	Categories	N	%
	Friend	7	1.6
	Various	28	5.8
	N/I	17	3.8
Coauthors	No	411	91.3
	Yes	36	8
	N/I	3	.7
Distance of Fire from Arsonist's House/Work	Close to the Arsonist's House	346	76.9
	Far from the Arsonist's House	50	11.1
	Close to the Arsonist's Workplace	29	6.4
	Close to the Arsonist's House and Workplace	12	2.7
	Others	10	2.2
Behaviour After Crime	N/I	3	.7
	Leaves the Crime Scene	307	68.2
	Remains at the Crime Scene	74	16.4
	Returns to the Crime Scene	37	8.2
	Helps Extinguishing the Fire	13	2.9
Confession of the Crime	Various	11	2.4
	Confesses	304	67.5
	Does Not Confess	112	24.9
	N/I	34	7.5
Substance Abuse at the Time of the Crime	Yes	224	49.8
	No	198	44
	N/I	28	6.2
Type of Substance Used at the Time of the Crime	Alcohol	199	44.2
	Medicine	11	2.4
	Drugs	3	1
	Various	11	2.4
	N/I	226	50
Day of the Crime	Working Days	305	67.8
	Weekends	124	27.6
	Both	12	2.7
	N/I	9	2
Ignition	Simple (e.g. lighter)	419	93.1
	Complex (e.g. bomb)	20	4.4
Type of Rural Area Burned ^b	N/I	11	2.4
	Forest	312	47.6
	Bush	302	46
	Pasture / Agricultural Field	42	6.4

Note: ^aThe only type of instrumental motivation reported in the checklist was gains; ^bMore than one type can be selected; N/I = No Information

group differed from the others in having an instrumental motivation (e.g. work-related motives such as land clearance) for the crime ($n = 74$; 72.5%) and no mental health problems or previous alcohol problems ($n = 82$; 46.9%).

Discussion

The purpose of this study was to identify the characteristics of adults arrested for rural arson and develop a typology that overcomes the limitations of previous typologies. To overcome these limitations, in first place, we conducted a literature review of studies on arson and rural arsonists to select the relevant variables to characterise this crime and to develop a checklist to help police officers to gathering the information about de sample's cases. The Recidivism Risk Factors of Rural Arson Checklist allowed specific information on rural arsonists to be collected and exported to the database used in this research.

Table 3. Representation of the variables within clusters.

Variables	Categories	Cluster 1 Expressive – Mental Health Problems (n = 175; 38.9%)	Cluster 2 Expressive – Alcohol Consumption (n = 173; 38.4%)	Cluster 3 Instrumental – Socially Adjusted (n = 102; 22.7%)
Age	29 years or younger	n = 66 (37.7%)	n = 7 (4%)	n = 11 (10.8%)
	30 to 39 years	n = 32 (18.3%)	n = 27 (15.6%)	n = 16 (15.7%)
	40 to 59 years	n = 55 (32%)	n = 120 (70.6%)	n = 38 (37.2%)
Qualifications	60 years or older	n = 21 (12%)	n = 17 (9.8%)	n = 37 (36.3%)
	No qualifications/ Primary School	n = 38 (21.7%)	n = 99 (57.2%)	n = 45 (44.2%)
	Middle School	n = 49 (27%)	n = 39 (22.5%)	n = 21 (20.6%)
Profession	High School	n = 28 (16%)	n = 6 (3.5%)	n = 13 (12.7%)
	Higher Education	–	–	n = 3 (2.9%)
	Unemployed	n = 58 (33.1%)	n = 68 (39.3%)	n = 8 (7.8%)
	Agricultural or forestry workers	n = 21 (12%)	n = 26 (15%)	n = 37 (36.3%)
	Service and sales workers	n = 16 (9.1%)	n = 12 (6.9%)	n = 12 (11.8%)
	Craft and related trades workers	n = 14 (8%)	n = 34 (19.7%)	n = 6 (5.9%)
	Industry workers	n = 13 (7.4%)	–	n = 5 (4.9%)
	Retired	n = 22 (12.6%)	n = 17 (9.8%)	n = 20 (19.6%)
	Students	n = 12 (6.9%)	–	–
	Firefighters	n = 7 (4%)	–	n = 5 (4.9%)
Community and Family Integration	Others	n = 9 (5.1%)	n = 11 (6.4%)	n = 7 (6.8%)
	Dysfunctional Family	n = 9 (5.1%)	n = 22 (12.7%)	n = 5 (4.9%)
	Difficulty in Integrating Community	n = 3 (1.7%)	n = 6 (3.5%)	–
	Lives with the Family	n = 41 (23.4%)	n = 22 (12.7%)	n = 71 (69.6%)
	Lives with Parents	n = 73 (41.7%)	n = 17 (9.8%)	n = 11 (10.8%)
	Lives Alone	n = 17 (9.7%)	n = 80 (46.2%)	n = 9 (8.8%)
	Lives in an Institution	n = 12 (6.9%)	n = 2 (1.2%)	–
Alcohol Consumption at Moment of the Crime	Various	n = 16 (9.1%)	n = 18 (10.4%)	n = 3 (2.9%)
	Yes	n = 44 (25.1%)	n = 165 (95.4%)	n = 15 (14.7%)
Mental Health / Alcohol Consumption Problems	No	n = 113 (64.6%)	n = 6 (3.5%)	n = 79 (77.5%)
	None	n = 57 (32.6%)	n = 15 (8.7%)	n = 85 (83.3%)
	Alcohol Consumption Problems	n = 10 (5.7%)	n = 134 (77.5%)	n = 5 (4.9%)
	Mental Health Problems	n = 82 (46.9%)	n = 6 (3.5%)	n = 8 (7.8%)
Motivation	Both	n = 15 (8.6%)	n = 15 (8.7%)	n = 1 (1%)
	Expressive	n = 140 (80.9%)	n = 139 (81.3%)	n = 7 (6.9%)
	Instrumental	n = 2 (1.1%)	n = 2 (1.2%)	n = 74 (72.5%)
	Both	n = 33 (18%)	n = 32 (17.5%)	n = 21 (20.6%)

Note: The highest values in each category within clusters are represented in bold.

To develop an improved typology of rural arsonists, we analysed the variables collected to identify those that categorised these offenders and clustered them using the machine learning algorithm *k-modes*. By doing this, it was possible to create a mathematical model to find patterns and determine how many groups of rural arsonists exist. Therefore, this study developed a method for clustering the variables that allow us to identify the similar characteristics of rural arsonists while laying the groundwork for tools that automatically classify individuals into domain-relevant classes related to previous

research. The nature of this analysis allows this classification to be generalised to unidentified rural arsonists, which is essential for a good classification system (Tyler & Gannon, 2021). Therefore, it is an essential resource for future research and criminal investigation into rural arson, overcoming conceptual, empirical, and statistical limitations in the development of rural arsonist typologies. (i.e. Soeiro & Guerra, 2014; Sotoca et al., 2013; Willis, 2005).

The main characteristics of rural arsonists in this study show that these offenders are older than in most studies (e.g. Butler & Gannon, 2021; Nanayakkara et al., 2020), with less than 20% of the sample aged 29 or younger. It may suggest that those living in rural areas are typically older than those living in urban areas (e.g. Day et al., 2016). Furthermore, it is not surprising that the majority of rural arsonists in this study were male, given the prevalence of male offenders across crimes (e.g. Muller, 2009; Nicholls et al., 2015; Soeiro & Guerra, 2014). However, studies suggest the existence of differences between male and female arsonists, such as female arsonists not consuming psychoactive substances or alcohol and having fewer mental health problems than their male counterparts (cf. Gannon & Pina, 2010; Nanayakkara et al., 2020). Therefore, a detailed study of female arsonists in the rural setting would be pertinent. Regarding rural arsonists' professional occupation, 54% were professionally active, mainly employed in agricultural or forestry jobs and craft-related trades. The rural arsonists that were professionally inactive were mainly unemployed and retired. Given that 86% of the rural arsonists in the current study started fires close to where they lived or worked, it is possible that in some cases the fire was set during working hours. In addition, the possibility and accessibility of reaching the target area is higher if the offender lives or works close to the area (e.g. forest, agricultural land). Thus, rural arsonists who are agricultural or forestry workers are at a higher risk of setting fires, especially during working hours, than arsonists with other occupations. This supports the finding that specific criminal opportunities may only exist in rural areas (cf., Ceccato & Abraham, 2022).

As for the psychosocial characteristics of rural arsonists, most had mental health or alcohol problems. Previous research had already highlighted the prevalence of mental disorders among arsonists (e.g. Anwar et al., 2011; Burton et al., 2012), and a large proportion of rural arsonists in the current study also had mental health problems (e.g. depression). Furthermore, given that alcohol consumption has been reported among arsonists (e.g. Burton et al., 2012; Jayaraman & Frazer, 2006), it was also not surprising that a significant proportion of rural arsonists had problems with alcohol consumption and that almost half of the sample had abused substances at the time of the crime, particularly alcohol. Moreover, in this study, rural arsonists tended to live with their families, and a small number had known difficulties in integrating into the community or had a dysfunctional family. These findings are consistent with other studies of arsonists (e.g. Burton et al., 2012; Ellis-Smith et al., 2019; Gannon & Pina, 2010; Hewitt et al., 2021; Morewitz, 2019) and rural arsonists (e.g. Soeiro & Guerra, 2014; Willis, 2005), suggesting that some characteristics are transversal to the setting of the crime.

Over 65% of rural arsonists did not have a previous criminal record, contrary to other arson studies (Burton et al., 2012; Ellis-Smith et al., 2019; Morewitz, 2019). Considering that, in general, detention rates for arson are low (Barrowcliffe & Gannon, 2015), it is possible that some of these rural arsonists may have set fires that went unreported prior to their arrest. Therefore, the number of reoffending arsonists may be higher than reported

in these findings. In addition to the low reporting rates of crime in rural areas (cf., Donnermeyer et al., 2006), there is a growing need for further research into the recidivism of rural arsonists. The study of a sample of unapprehended rural arsonists could provide a more in-depth perspective on this premise.

Most rural arsonists had an expressive motivation for setting the fire (especially for rage or revenge), which is consistent with the literature (e.g. Canter & Fritzon, 1998; Rix, 1994; Willis, 2005). Furthermore, this supports Ducat and Ogloff's (2011) study that setting a fire in rural areas is typically associated with psychological motives, especially considering the presence of mental health problems in this sample. Moreover, half of the rural arsonists in this sample did not know the owner of the property they set fire to and after setting the fire, most left the crime scene but confessed to commit the crime when questioned. These findings are similar to previous research on this subject (e.g. Barrowcliffe & Gannon, 2015), confirm that most rural arsonists have mental health problems and that might trigger their motivation and modus operandi for setting a fire (cf., Lamon & Haas, 2003).

One of the main findings of this study is the heterogeneity of the characteristics of rural arsonists. This heterogeneity is represented by three distinct groups. The variables that majorly differentiate them are mental health problems, alcohol consumption, and instrumental motivation. Considering the characteristics of the group with greater prevalence (*Expressive – Mental Health Problems*), it is noteworthy that rural arsonists with mental health problems tend to be younger than those from other groups. Therefore, it is possible that rural arsonists aged 29 or younger were more likely to report struggling with mental health problems or having been diagnosed with a mental disorder than older arsonists.

Moreover, most rural arsonists had a middle school education level higher than the remaining groups. Considering the socioeconomic difficulties and unequal opportunities in rural areas compared to their urban counterpart, several educational programmes have been implemented to address these issues, particularly in attracting and retaining learners (e.g. Gardiner, 2008). Therefore, the fact that most of these rural arsonists lived with their parents highlights the importance of further research that examines the relationship between parental roles, education, and arson behaviour in rural areas.

The second group with higher prevalence (*Expressive – Alcohol Consumption*) reinforces that rural arsonists with alcohol problems also have an expressive motivation for setting the fire. It is known that dangerous alcohol use is higher in rural areas than in urban ones (Friesen et al., 2022) and, in this group of rural arsonists, the misuse of alcohol can be considered in two ways: alcohol use at the time of the crime and generalised alcohol problems. The large majority of this group reported alcohol consumption at the time of the offence, reinforcing the disinhibitory effect of alcohol (Bushman, 2002) on deliberate firesetting behaviour. Furthermore, the number of arsonists with an alcohol problem is less representative than those who were drinking at the time of the offence. Although a large proportion of arsonists who were drinking at the moment of the crime also had previous alcohol problems, this finding suggests that a smaller proportion of arsonists may have been prompted to start a fire by alcohol intoxication. To understand the impact of alcohol misuse among rural arsonists, further research is needed on the relationship between generalised alcohol problems and the level of alcohol consumption at the time of the crime. Regardless, alcohol misuse is an intensifying risk factor for rural arsonists. Furthermore, considering that a substantial proportion of rural arsonists in this

group lived alone, alcohol may be part of their social activities (e.g. Allan et al., 2012), especially given the overall positive views, beliefs, and values about drinking alcohol in rural communities (e.g. Allan et al., 2012).

The last group (*Instrumental – Socially Adjusted*) is represented by rural arsonists that set fire motivated by material gains or rewards that may come with this behaviour. The characterisation of the rural arsonists in this group differs substantially from the other two, considering they lived with their family, had jobs related to agriculture or forestry and did not report mental health or alcohol abuse problems, suggesting a better integration into the community. However, it is implied the need of an in-depth study to analyse what may motivate these rural arsonists to set a fire for an instrumental reason (e.g. offence supportive thinking, Tyler et al., 2017). Lastly, the fact that this group is less prevalent than the other two suggests that rural arsonists often have mental health or alcohol problems and are expressively motivated to set a fire, corroborating with previous typologies (e.g. Soeiro & Guerra, 2014; Willis, 2005).

The typology developed in this study attempts to overcome the limitations of previous ones identified in the literature by using a more integrated approach that goes beyond motive/characteristic-based classifications (cf., Tyler & Gannon, 2021) by simply categorising arsonists on the basis of their motivations/mental health (e.g. Rix, 1994; Willis, 2005) or solely on the basis of criminal behaviour and crime scene information (e.g. Kocsis et al., 1998). Instead, rural arsonists were classified on the basis of their characteristics in terms of sociodemographic information (age, qualifications and occupation), psychosocial variables (community and family integration, and mental health or alcohol problems) and characteristics of criminal behaviour (alcohol consumption at the time of the crime and motivation).

Although it contributes to the study of rural arsonists and their characteristics, the present study has some limitations. It was not possible to further detail the mental health problems variable due to the design of the checklist, which limited the knowledge of the most prevalent mental disorders and how these might reflect on the criminal behaviour. Interviewing the offenders would overcome this limitation, notwithstanding the underlying difficulty of the interconnection between the mental health area and the legal system. Furthermore, it is suggested that future research in this area should compare a sample of rural arsonists with urban arsonists to test whether some variables would show a significant difference when considering the setting of the fire (for example, would age still be a discriminative variable if the offenders were setting fires in urban areas, or is it a variable specific to rural arsonists? Would rural arsonists be significantly older than urban arsonists or vice versa?). Given the scarce research on about rural arsonists, further research is still needed. This research may also contribute to future studies if the present typology is replicated with other groups of arsonists, taking into account the similarities and differences between, for example, rural and urban arsonists. Nonetheless, the current study contributed to the improvement of the groundwork in this area while assisting the police work and investigation in Portugal.

The behaviour of rural arsonist has a negative impact on communities, environment, and economy. Mental health problems, substance abuse and social integration are three of the most important issues to be addressed by legal, political and health systems. Therefore, the identification of the most important characteristics of rural arsonists and their classification in this study contributes to the improvement of existing

research on rural crime. This provides a basis for defining prevention strategies and implementing intervention and treatment programmes.

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Data availability statement

Data not available due to ethical and legal restrictions.

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References

- Allan, J., Clifford, A., Ball, P., Alston, M., & Meister, P. (2012). You're less complete if you haven't got a can in your hand': Alcohol consumption and related harmful effects in rural Australia: The role and influence of cultural capital. *Alcohol and Alcoholism*, 47(5), 624–629. <https://doi.org/10.1093/alcalc/ags074>
- Álvarez, J. L., Espinosa, V. M., Alcázar, M. C., & Plaza, A. S. (2017). Perfil psicossocial del incendiario forestal español privado de libertad. *Behavior & Law Journal*, 3(1), 26–34. <https://doi.org/10.47442/blj.v3.i1.39>
- Anwar, S., Långström, N., Grann, M., & Fazel, S. (2011). Is arson the crime most strongly associated with psychosis?—A national case-control study of arson risk in schizophrenia and other psychoses. *Schizophrenia Bulletin*, 37(3), 580–586. <https://doi.org/10.1093/schbul/sbp098>
- Badillo, S., Banfai, B., Birzele, F., Davydov, I. I., Hutchinson, L., Kam-Thong, T., Siebourg-Polster, J., Steiert, B., & Zhang, J. D. (2020). An introduction to machine learning. *Clinical Pharmacology & Therapeutics*, 107(4), 871–885. <https://doi.org/10.1002/cpt.1796>
- Barrowcliffe, E. R., & Gannon, T. A. (2015). The characteristics of un-apprehended firesetters living in the UK community. *Psychology, Crime & Law*, 21(9), 836–853. <https://doi.org/10.1080/1068316X.2015.1054385>
- Bradford, J. M. (1982). Arson: A clinical study. *The Canadian Journal of Psychiatry*, 27(3), 188–193. <https://doi.org/10.1177/070674378202700302>
- Burton, P. R., McNeil, D. E., & Binder, R. L. (2012). Firesetting, arson, pyromania, and the forensic mental health expert. *Journal of the American Academy of Psychiatry and the Law Online*, 40, 355–365. <https://pubmed.ncbi.nlm.nih.gov/22960918/>
- Bush Fires Act*. (1954). (CC), s. 32 (Australia).
- Bushman, B. J. (2002). Effects of alcohol on human aggression: Validity of proposed explanations. *Recent Developments in Alcoholism: Volume 13: Alcohol and Violence-Epidemiology Neurobiology Psychology Family Issues*, 227–243. https://doi.org/10.1007/0-306-47141-8_13

- Butler, H., & Gannon, T. A. (2021). Do deliberate firesetters hold fire-related scripts and expertise? A quantitative investigation using fire service personnel as comparisons. *Psychology, Crime & Law*, 27(4), 383–403. <https://doi.org/10.1080/1068316X.2020.1808978>
- Canter, D., & Fritzon, K. (1998). Differentiating arsonists: A model of firesetting actions and characteristics. *Legal and Criminological Psychology*, 3(1), 73–96. <https://doi.org/10.1111/j.2044-8333.1998.tb00352.x>
- Caudill, J. W., Diamond, B., Trulson, C. R., DeLisi, M., & Marquart, J. W. (2012). Sifting through the ashes: Processing arsonists in juvenile justice. *American Journal of Criminal Justice*, 37(3), 306–320. <https://doi.org/10.1007/s12103-011-9142-2>
- Ceccato, V., & Abraham, J. (2022). Reasons why crime and safety in rural areas matter. In V. Ceccato & J. Abraham (Eds.), *Crime and safety in the rural* (pp. 9–28). Springer. https://link.springer.com/chapter/10.1007978-3-030-98290-4_2
- Cohen, L. E., Kluegel, J. R., & Land, K. C. (1981). Social inequality and predatory criminal victimization: An exposition and test of a formal theory. *American sociological review*, 505–524. <https://doi.org/10.2307/2094935>
- Cozens, P., & Christensen, W. (2011). Environmental criminology and the potential for reducing opportunities for bushfire arson. *Crime Prevention and Community Safety*, 13, 119–133. <https://doi.org/10.1057/cpcs.2010.24>
- Day, J. C., Hays, D., & Smith, A. (2016). A glance at the age structure and labor force participation of rural America. *Census Blogs December 8*. https://www.census.gov/newsroom/blogs/random-samplings/2016/12/a_glance_at_the_age.html
- Doley, R., Dickens, G., & Gannon, T. (Eds.). (2015). *The psychology of arson: A practical guide to understanding and managing deliberate firesetters*. Routledge.
- Donnermeyer, J., Scott, J., & Barclay, E. (2013). How rural criminology informs critical thinking in criminology. *International Journal for Crime, Justice and Social Democracy*, 2(3), 69–91. <https://doi.org/10.5204/ijcjsd.v2i3.122>
- Donnermeyer, J. F., Jobs, P., & Barclay, E. (2006). Rural crime, poverty, and community. *Advancing Critical Criminology: Theory and Application*, 199–218.
- Douglas, J. E., Burgess, A. W., Burgess, A. G., & Ressler, R. (2013). *Crime classification manual: A standard system for investigating and classifying violent crimes* (3rd ed.). Wiley.
- Ducat, L., McEwan, T., & Ogloff, J. R. (2013a). Comparing the characteristics of firesetting and non-firesetting offenders: Are firesetters a special case? *The Journal of Forensic Psychiatry & Psychology*, 24(5), 549–569. <https://doi.org/10.1080/14789949.2013.821514>
- Ducat, L., & Ogloff, J. R. (2011). Understanding and preventing bushfire-setting: A psychological perspective. *Psychiatry, Psychology and Law*, 18(3), 341–356. <https://doi.org/10.1080/13218719.2011.598633>
- Ducat, L., Ogloff, J. R., & McEwan, T. (2013b). Mental illness and psychiatric treatment amongst firesetters, other offenders and the general community. *Australian & New Zealand Journal of Psychiatry*, 47(10), 945–953. <https://doi.org/10.1177/0004867413492223>
- Ellis-Smith, T., Watt, B. D., & Doley, R. M. (2019). Australian arsonists: an analysis of trends between 1990 and 2015. *Psychiatry, Psychology and Law*, 26(4), 593–613. <https://doi.org/10.1080/13218719.2018.1556131>
- Elvan, O. D., Birben, Ü, Özkan, U. Y., Yıldırım, H. T., & Türker, YÖ. (2021). Forest fire and law: an analysis of Turkish forest fire legislation based on food and agriculture organization criteria. *Fire Ecology*, 17(1), 1–15. <https://doi.org/10.1186/s42408-021-00102-7>
- Enayati, J., Grann, M., Lubbe, S., & Fazel, S. (2008). Psychiatric morbidity in arsonists referred for forensic psychiatric assessment in Sweden. *The Journal of Forensic Psychiatry & Psychology*, 19(2), 139–147. <https://doi.org/10.1080/14789940701789500>
- Estatísticas da Justiça*. (2021). *Incêndios Florestais*. https://estatisticas.justica.gov.pt/sites/siej/pt-pt/Paginas/Incendios_florestais.aspx
- Friesen, E. L., Bailey, J., Hyett, S., Sedighi, S., de Snoo, M. L., Williams, K., Barry, R., Erickson, A., Foroutan, F., Selby, P. P., Rosella, L., & Kurdyak, P. (2022). Hazardous alcohol use and alcohol-related harm in rural and remote communities: A scoping review. *The Lancet Public Health*, [https://doi.org/10.1016/S2468-2667\(21\)00159-6](https://doi.org/10.1016/S2468-2667(21)00159-6)

- Fritzon, K., & Miller, S. (2016). Female firesetters. In R. M. Doley, G. L. Dickens, & T. A. Gannon (Eds.), *The psychology of arson: A practical guide to understanding and managing deliberate firesetters*. Routledge.
- Fritzon, K. S. (2015). Arson. *The Encyclopedia of Crime and Punishment*, 1–3.
- Gannon, T. A., Ciardha, C. Ó., Doley, R. M., & Alleyne, E. (2012b). The multi-trajectory theory of adult firesetting (M-TTAF). *Aggression and Violent Behavior*, 17(2), 107–121. <https://doi.org/10.1016/j.avb.2011.08.001>
- Gannon, T. A., & Pina, A. (2010). Firesetting: Psychopathology, theory and treatment. *Aggression and Violent Behavior*, 15(3), 224–238. <https://doi.org/10.1016/j.avb.2010.01.001>
- Gannon, T. A., Tyler, N., Barnoux, M., & Pina, A. (2012a). Female arsonists and firesetters. In G. Dickens, P. Sugarman, & T. A. Gannon (Eds.), *Firesetting and mental health: Theory, research and practice* (pp. 126–142). RCPsychiatrists. [https://kar.kent.ac.uk/35082/1/Gannon%20et%20al.%20Female%20Firesetters%20\(2012\).pdf](https://kar.kent.ac.uk/35082/1/Gannon%20et%20al.%20Female%20Firesetters%20(2012).pdf)
- Gannon, T. A., Tyler, N., Ciardha, C. Ó., & Alleyne, E. (2022). *Adult deliberate firesetting: Theory, assessment, and treatment*. John Wiley & Sons.
- Gardiner, M. (2008). Education in rural areas. *Issues in Education Policy*, 4, 1–33.
- Greenpeace. (2008). *Incendios forestales, ¿el fin de la impunidad?*. Available at: www.greenpeace.org/espana/Global/espana/report/bosques/incendios-forestales-el-fin.pdf
- Helm, J. M., Swiergosz, A. M., Haeberle, H. S., Karnuta, J. M., Schaffer, J. L., Krebs, V. E., Spitzer, A. I., & Ramkumar, P. N. (2020). Machine learning and artificial intelligence: definitions, applications, and future directions. *Current reviews in musculoskeletal medicine*, 13(1), 69–76. <https://doi.org/10.1007/s12178-020-09600-8>
- Hennessey, B., Moran, S., Altringer, B., & Amabile, T. M. (2015). Extrinsic and intrinsic motivation. *Wiley Encyclopedia of Management*, 1–4. <https://doi.org/10.1002/9781118785317.weom110098>
- Hewitt, A. N., Beaugard, E., & Sea, J. (2021). Motivation and crime scene behavior in Korean fire setting: a new typology. *Policing: An International Journal*, <https://doi.org/10.1108/PIJPSM-06-2020-0096>
- Holmes, G. (2007). Protection, politics and protest: Understanding resistance to conservation. *Conservation & Society*, 5, 184–201. <https://www.jstor.org/stable/26392880>
- Huang, Z. (1997). Clustering large data sets with mixed numeric and categorical values. *Proceedings of the 1st Pacific-Asia conference on knowledge discovery and data mining*, (PAKDD), 21–34.
- Incêndio florestal*. (1995). (CP) 274° (Portugal).
- Incendio forestal*. (1995). (CP) 352 (Spain).
- Incêndios, explosões e outras condutas especialmente perigosas*. (1995). (CP) 272° (Portugal).
- Inciardi, J. (1970). The adult firesetter. *Criminology*, 8(2), 132–149.
- Instituto da Polícia Judiciária e Ciências Criminais (IPJCC). (2015). *Ficha resumo – Fatores de risco de reincidência: Crime de Incêndio Florestal* (confidential document not published).
- Jayaraman, A., & Frazer, J. (2006). Arson: a growing inferno. *Medicine, Science and the Law*, 46(4), 295–300. <https://doi.org/10.1258/rsmsl.46.4.295>
- Kocsis, R. N., & Cooksey, R. W. (2002). Criminal psychological profiling of serial arson crimes. *International Journal of Offender Therapy and Comparative Criminology*, 46(6), 631–656. <https://doi.org/10.1177/0306624X02238159>
- Kocsis, R. N., Irwin, H. J., & Hayes, A. F. (1998). Organised and disorganised criminal behaviour syndromes in arsonists: A validation study of a psychological profiling concept. *Psychiatry, Psychology and Law*, 5(1), 117–131. <https://doi.org/10.1080/13218719809524925>
- Koson, D. F., & Dvoskin, J. (1982). Arson: A diagnostic study. *Bulletin of the American Academy of Psychiatry and the Law*, 10, 39–49.
- Kull, C. (2004). *Isle of fire: The political ecology of landscape burning in Madagascar*. University.
- Lamon, P., & Haas, H. (2003). Les incendiaires non-détectés. *Revue internationale de criminologie et de police technique et scientifique*, 4, 451–466. <https://doi.org/10.5167/uzh-225288>
- Lewis, D., & Yarnell, H. (1951). *Pathological firesetting (Pyromania)*. (Vol. 82). Nervous and Mental Disease Monographs.
- Lindberg, N., Holi, M. M., Tani, P., & Virkkunen, M. (2005). Looking for pyromania: Characteristics of a consecutive sample of Finnish male criminals with histories of recidivist fire-setting between 1973 and 1993. *BMC Psychiatry*, 5(1), 1–5. <https://doi.org/10.1186/1471-244X-5-47>

- Long, C. G., Fitzgerald, K. A., & Hollin, C. R. (2015). Women firesetters admitted to secure psychiatric services: Characteristics and treatment needs. *Victims & Offenders, 10*(3), 341–353. <https://doi.org/10.1080/15564886.2014.967901>
- Mojtahedi, D., Prince, R. J., & Ryan, S. (2017). Making an arsonist: A psychological approach to understanding expressive arson. *EC Psychology and Psychiatry, 4*, 94–99. <http://eprints.hud.ac.uk/id/eprint/32489/>
- Morewitz, S. J. (2019). Arson and arson-associated homicides. In S. J. Morewitz (Ed.), *Clinical and psychological perspectives on foul play* (pp. 171–196). Springer. https://doi.org/10.1007/978-3-030-26840-4_7
- Muller, D. A. (2009). *Using crime prevention to reduce deliberate bushfires in Australia*. Australian Institute of Criminology. <https://apo.org.au/node/2376>
- Nanayakkara, V., Ogloff, J. R., Davis, M. R., & McEwan, T. E. (2020). Gender-based types of firesetting: Clinical, behavioural and motivational differences among female and male firesetters. *The Journal of Forensic Psychiatry & Psychology, 31*(2), 273–291. <https://doi.org/10.1080/14789949.2020.1720266>
- Nanayakkara, V., Ogloff, J. R., & Thomas, S. D. (2015). From haystacks to hospitals: An evolving understanding of mental disorder and firesetting. *International Journal of Forensic Mental Health, 14*(1), 66–75. <https://doi.org/10.1080/14999013.2014.974086>
- Nicholls, T. L., Cruise, K. R., Greig, D., & Hinz, H. (2015). Female offenders. In B. L. Cutler, & P. A. Zapf (Eds.), *APA handbook of forensic psychology, Vol. 2. Criminal investigation, adjudication, and sentencing outcomes* (pp. 79–123). American Psychological Association. <https://doi.org/10.1037/14462-004>
- Ó Ciardha, C., Alleyne, E. K., Tyler, N., Barnoux, M. F., Mozova, K., & Gannon, T. A. (2015). Examining the psychopathology of incarcerated male firesetters using the millon clinical multi-axial inventory-III. *Psychology, Crime & Law, 21*(6), 606–616. <https://doi.org/10.1080/1068316X.2015.1008478>
- Prins, H., Tennent, G., & Trick, K. (1985). Motives for arson (fire raising). *Medicine, Science and the Law, 25*(4), 275–278. <https://doi.org/10.1177/002580248502500409>
- Regulation, P. (2016). Regulation (EU) 2016/679 of the European Parliament and of the Council. *Regulation (EU), 679*. <https://eur-lex.europa.eu/EN/legal-content/summary/general-data-protection-regulation-gdpr.html>
- Repo, E., & Virkkunen, M. (1997). Young arsonists: History of conduct disorder, psychiatric diagnoses and criminal recidivism. *Journal of Forensic Psychiatry, 8*(2), 311–320. <https://doi.org/10.1080/09585189708412013>
- Ritchie, E. C., & Huff, T. G. (1999). Psychiatric aspects of arsonists. *Journal of Forensic Sciences, 44*(4), 733–740. <https://www.astm.org/jfs14546j.html>
- Rix, K. J. (1994). A psychiatric study of adult arsonists. *Medicine, Science and the Law, 34*(1), 21–34. <https://doi.org/10.1177/002580249403400104>
- Salvador, R. (2016). Jumping from the frying pan into the fire: A criminological study of forest firesetting in Spain. In *The Routledge international handbook of rural criminology* (pp. 339–349). Routledge. <https://www.taylorfrancis.com/chapters/edit/10.43249781315755885-38/jumping-frying-pan-fire-rafa-salvador>
- Sambrooks, K., Olver, M. E., Page, T. E., & Gannon, T. A. (2021). Firesetting reoffending: A meta-analysis. *Criminal Justice and Behavior, 48*(11), 1634–1651. <https://doi.org/10.1177/00938548211013577>
- San-Miguel-Ayanz, J., Durrant, T., Boca, R., Maianti, P., Liberta, G., Artes Vivancos, T., Jacome Felix Oom, D., Branco, A., De Rigo, D., Ferrari, D., Pfeiffer, H., Grecchi, R., Nuijten, D., & Leray, T. (2012). *Forest Fires in Europe, Middle East and North Africa: 2011*. Publications Office of the European Union. <https://publications.jrc.ec.europa.eu/repository/handle/JRC122115>
- Schmallegger, F. (2013). *Criminology today: An integrative introduction (6th Edition)*. Prentice Hall. <https://www.ojp.gov/ncjrs/virtual-library/abstracts/criminology-today-integrative-introduction-third-edition>
- Sistema de Segurança Interna. (2020). *Relatório Anual de Segurança Interna 2020*. <https://www.portugal.gov.pt/download-ficheiros/ficheiro.aspx?v=%3D%3DBQAAAB%2BLCAAAAAAABAAzNDQ1NAUABR26oAUAAA%3D>

- Smith, R., Penny, J., Sweeney, J., & Fuller, G. (2014). Counting the costs of crime in Australia: A 2011 estimate. *Research and Public Policy Series*, 129, 1–83. <https://www.aic.gov.au/publications/rpp/rpp129>
- Soeiro, C., & Guerra, R. (2014). Forest arsonists: criminal profiling and its implications for intervention and prevention. *European Police Science and Research Bulletin*, 11, 34. <https://heinonline.org/HOL/LandingPage?handle=hein.journals/elerb11&div=9&id=&page=>
- Sotoca, A., González, J. L., Fernández, S., Kessel, D., Montesinos, O., & Ruiz, MÁ. (2013). Perfil del incendiario forestal español: aplicación del perfilamiento criminal inductivo. *Anuario de Psicología Jurídica*, 23(1), 31–38. <https://doi.org/10.5093/aj2013a6>
- Stanley, J. (2013). The real cost of bushfire arson. Retrieved March 20, 2019, from <http://www.monash.edu.au/news/show/the-real-cost-of-bushfire-arson>
- Stavseth, M. R., Clausen, T., & Røislien, J. (2019). How handling missing data may impact conclusions: A comparison of six different imputation methods for categorical questionnaire data. *SAGE Open Medicine*, 7, 1–12. <https://doi.org/10.1177/2050312118822912>
- Tyler, N., & Gannon, T. A. (2012). Explanations of firesetting in mentally disordered offenders: A review of the literature. *Psychiatry*, 75(2), 150–166. <https://doi.org/10.1521/psyc.2012.75.2.150>
- Tyler, N., & Gannon, T. A. (2021). The classification of deliberate firesetting. *Aggression and Violent Behavior*, 101458. <https://doi.org/10.1016/j.avb.2020.101458>
- Tyler, N., Gannon, T. A., Lockerbie, L., & Ó Ciardha, C. (2017). An evaluation of a specialist firesetting treatment programme for male and female mentally disordered offenders (the FIP-MO). *Clinical Psychology & Psychotherapy*, 25(3), 388–400. <https://doi.org/10.1002/cpp.2172>
- Varma, A. (2003). The economics of slash and burn: a case study of the 1997–1998 Indonesian forest fires. *Ecological Economics*, 46(1), 159–171. [https://doi.org/10.1016/S0921-8009\(03\)00139-3](https://doi.org/10.1016/S0921-8009(03)00139-3)
- Vélez, R. (2003). Los incendios forestales en la cuenca mediterranea. In R. Vélez (Ed.), *La defensa contra incendios forestales: fundamentos y experiencias* (pp. 3–1). McGraw-Hill.
- Vos, N. (2013). *Kmodes*. [GitHub dataset]. <https://github.com/nicodv/kmodes#id1>
- Willis, M. (2005). Bushfires—How can we avoid the unavoidable? *Global Environmental Change Part B: Environmental Hazards*, 6, 93–99. <https://doi.org/10.1016/j.hazards.2005.10.001>
- Wyatt, B., Gannon, T. A., McEwan, T. E., Lockerbie, L., & O'Connor, A. (2018). Mentally disordered firesetters: An examination of risk factors. *Psychiatry*, 82(1), 27–41. <https://doi.org/10.1080/00332747.2018.1534520>