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Geographical offender profiling: Dragnet's applicability on a Brazilian sample

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Abstract

Even though geographical offender profiling is already widely used and researched in countries such as England, Canada, and United States, it is still severely overlooked in Brazil, as there are no researches on the subject using a Brazilian sample. Therefore, the present paper aims to start filling this gap by analysing the applicability of the geographical offender profiling and Dragnet on a sample of Brazilian serial killers. In order to achieve this objective, the authors collected data through police records on 15 serial killers that were active between June 2009 and June 2015, in the city of Campina Grande, Paraíba, Brazil. As a result, the circle hypothesis was confirmed, considering that 66.7% of the sample fell into the marauder category. Interestingly, the Dragnet's result accurately informed the area that contained the offender's base in the same cases in which the offender acted according to the marauder model. Also, other important correlations were found such as the influence of age, intelligence, resourcefulness, and method of approach on the distance travelled to commit a murder. Those results show that the geographical offender profiling can be effectively applied in Brazil and thus is a valid investigative tool to aid police officers in serial crimes investigations.

KEYWORDS

Brazil, Dragnet, geographical offender profiling, investigative psychology, serial killer

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1 | INTRODUCTION

Geographical offender profiling is an investigative psychology technique that aims to predict the offender's base approximate location, which could be the residence, place of work, relative's residence, among other possibilities. To achieve it, this technique seeks to analyse significant criminal geographical sites, such as meeting place between victim and offender, actual crime location, body disposal site, and the place where objects used by the offender were abandoned. Furthermore, there are other factors that might influence in the offenders movement, some examples would be familiarity with the location, buffer zone, criminal range, psychological, and physical barriers (Canter, 2003).

The foundation of this technique's functioning is that the crime location is not chosen randomly. On the contrary, it is a decision through rational analysis influenced by the physical environment's characteristics and is capable of reflecting the offender's personality and personal life (Rossmo & Rombouts, 2008). Both development and application of the geographical offender profiling derive from some environmental criminology theories briefly reviewed below.

Crimes are not deprived of careful thinking and planning; otherwise, criminals would be more easily caught, this is shown by the fact that they are considerate enough to take forensic countermeasures not to leave clues. The rational choice theory works on this idea by claiming that the decision of how, when, and where to perform crimes is not random. Instead, it is a resolution reached after considering the effort of the criminal act and the expected reward, taking into account social, economic, and cognitive factors. Therefore, before committing a crime, a criminal weighs the likelihood of getting caught, the severity of the expected penalty, and the value to be gained by committing the act. This means that if offenders perceive the costs to be too high, the act to be too risky, or the payoff to be too small, they will choose not to engage in the act. As already mentioned, where to commit a crime is also a choice and, because of that, it is possible to grasp the offender's rationale as to why that specific place and work our way back to find the offenders and their base (Beauregard, Proulx, & Rossmo, 2005).

The routine activities theory states that three elements must converge in time and space for a crime to occur: a motivated offender, a suitable victim, and the absence of a capable guardian to prevent a crime. This theory relates the pattern of offending to the patterns of everyday social interaction; thus, a teenager, who lives in a violent neighbourhood and is taking part in drug trafficking, is more likely to be killed due to their activities, places they visit, and people they get involved with. Also, burglars are more likely to choose their targets in the geographical area between their base and the places they visit, such as work, parks, clubs, and friend's houses. This is because they assess and find houses deemed suitable for such a criminal act while they are on the journey of their daily routine. After all, every crime is an encounter between the offender and the victim/target in a given place and time, and this intersection usually occurs from a contact between their daily activities (Rebocho & Silva, 2014).

There are some geographic profile analysis guiding principles derived also from environmental criminology. The minimum effort principle states that humans, when given two options, will choose the one that demands less effort, thus criminals, when weighing up the choice between two locations to commit an illegal act, will likely choose the one physically closest to them. From this principle, the distance principle arises, affirming that offenders will commit crimes closest to their base, and the incidence of their crimes will diminish as they moves farther away from his base. There is also the familiarity principle, which claims that perpetrators tend to commit crimes in a familiar area, where they have a vast source of information, providing a more solid base to plan their crimes. It is something equivalent to a comfort zone, where they feel more confident to perform illegal acts without getting caught and punished for them (Canter, 2003).

Based on the foretold principles, Canter and Larkin (1993) developed the circle hypothesis, a theory that claims that the perpetrator's base will be located inside his criminal range. This is represented as a circle made using the distance between the two farthest crimes as the diameter. These authors conducted research on the 251 rapes committed by 45 serial rapists, resulting in the development of two models that represent the way a criminal acts according to their criminal range and its relation to the offender's base. These models were commuter and marauder.

The commuter, which represents the “traveller offender,” is the one who completely leaves their base area to commit crimes in another region; the fact that this offender travels to another territory does not necessarily imply that they are unfamiliar with it. However, there is no clear link between the criminal range and base, which makes it extremely difficult for the accurate use of geographical offender profiling. The second model, “marauder,” corresponds to the offender who has their base situated at the centre of their criminal range, this model presents a meaningful and understandable link between their criminal range and base; therefore, geographical offender profiling is highly capable of accurately determining where the offender lives. On the other hand, the police force is unaware of which type of offender they are dealing with (marauder or commuter) until they are actually caught. Consequently, this technique can only be used in an inverted way, from research to reality; thus, it must be used with caution and always based on serious scientific findings (Canter, Coffey, Huntley, & Missen, 2000).

The research quoted above discovered that 91% of rapists had all their crimes located within the circle established by their criminal range, and 87% of the sample corresponded to the marauder model of act. In conclusion, the authors suggested that the marauder model would be more likely for such offenders but not necessarily the case for all criminals.

Another relevant consideration refers to what has been widely called in geographical offender profiling literature as “buffer zone.” This describes an area immediately next to the offenders' base and where, even though they have more information as to how perform a flawless crime, they will not follow it through due to the high probability of being recognised by local witnesses. In other words, when criminals weigh the pros (greater knowledge of the surrounding area, easiness of access, least effort to reach the crime location, etc.) and cons (being easily recognisable by passers-by) of breaking the law near their base, they choose to stay put until a better opportunity is found (Canter & Youngs, 2008).

The geographical offender profiling works as an auxiliary technique that helps traditional criminal investigation. According to Rossmo and Velarde (2008), it is most commonly used to reduce the search area within which the police should focus their resources; it is also used to prioritise suspects whose known addresses match the “high risk” area found through this technique. Focused patrol, such as increase in surveillance on a given area, is another possible action upon geographical profiling results, specifically if the offender operates in certain time periods.

Geoprofiling is more effective when (a) there is a series of crimes committed by the same perpetrator; (b) traditional criminal investigative techniques are unable to elucidate the perpetrator behind the series of crime; (c) the available evidence reliably links all crimes in series to the same perpetrator; and (d) there is a psychological profile of the possible offender in question (Konvalina-Simas, 2012).

This technique also reaches its maximum effectiveness when some requirements are met, such as (a) the link between the crimes in series is accurate and reasonably thorough, that is, the assurance that all the crimes were committed by the same offender, with certainty that none of the crimes considered were done by someone else; (b) the offender must be a local person and not someone who changes his base constantly to perpetrate crimes; and (c) should more than one offender be the ones responsible for the crimes, they must live together or in the same area, and the perpetrators must not change their base site during the period in which the series of crimes are committed (Rossmo & Velarde, 2008).

By analysing the key findings about the geographical offender profiling, Konvalina-Simas (2012) lists some relevant correlations: Older offenders cover a greater distance than the younger ones, those who have access to vehicles also tend to act in a larger criminal range than those who do not have; men tend to travel longer distances than women; criminals with criminal records and/or sexual fantasies also travel longer distances; psychopaths are those who are willing to go farther from their base to commit crimes, maintaining a frequent traveller movement; more mature criminals roam longer distances, those with a specific type of victim too; finally, the killer will generally be closer to the crime scene the more violent it is.

Due to the expansion, complexity, and effectiveness of geographical offender profiling, software was developed in order to optimise the geographical analysis of the crimes. The main two pieces of software are “RIGEL,” developed by Kim Rossmo (2000) and “Dragnet,” developed by David Canter (Canter et al., 2000; Canter & Hammond, 2006). Such software works on analysing the relevant criminal geographical locations, already mentioned in this study, in

order to predict the likely location of the offender's base, that is, "risk area." After the formulation of the risk surface, it is possible to overlap it on a map, providing areas to focus the investigation (Konvalina-Simas, 2012).

Dragnet, based on the minimum effort principle mentioned above, uses a negative exponential function, in other words, it assumes that the probability of locating a serial offender's home decreases exponentially with increasing distance from his/her crime location. A large amount of research has tried to verify this software's usefulness on criminal investigation, especially in what concerns the reduction of the search cost (the area necessary to search in order to find the offenders base). Canter et al. (2000) report findings that 51% of the serial killers had their base within the first 5% of the search area. Also Sarangi and Youngs (2006) report studies that proved to be only necessary to search 8.8% of the area designated by Dragnet in order to find the serial killer's base. On the other hand, it is important to state that, due to its algorithm, Dragnet is most efficient when analysing marauder criminals.

The current research aimed to apply the techniques of geographical offender profiling used in investigative psychology to already solved Brazilian cases in order to verify the applicability and effectiveness of this technique with regard to accurately pinpointing the location of the offenders' base. The survey also sought to identify psychological and social characteristics from the offenders, as well as support the dissemination of psychology techniques, reiterating its effectiveness, given that the literature on this topic is still quite limited in Brazil. Thus, the final goal was to verify if it was possible to introduce an effective investigative tool, already used in other countries, to cooperate in reducing crime in Brazil.

2 | METHOD

The research consisted of sample of 65 murders, committed by 15 serial killers in the city of Campina Grande, Paraíba, Brazil, during the period between June 2009 and June 2015. Campina Grande is the second most populous city in the State of Paraíba, after the Capital, with the estimate population of 407754 habitants in a 593026 km² area. Over 15% of its residents are university students, and it is also considered one of the main industrial, technological, and educational centres in the north-eastern region of Brazil.

The serial killers in this sample were murderers who had committed three or more homicides at three different times and locations, with a cooling-off period between them. However, the murder cases in which the offender had not reached adulthood at the time of the crime were not included. All the data collection occurred through search on police records.

The extracted data include offender's age at the time of the crime and schooling years; weapon used (including whether it had been taken by the offender to the crime scene or if he had used something from the crime scene as a weapon), the environment in which the crime was committed (indoors/outdoors), means of transportation used by the offenders to travel to the crime scene, and method of approach.

After checking which method of approach each of the serial killers most performed in his crime series, another variable was created: preferred method of approach. Two possibilities were considered: subterfuge (con the victim in order to take his/her to a different location and complete the murder there) and surprise (when the victim did not expect the action).

For the specific analysis of geographical offender profiling, police records provided information about the offender's home address, the residence of the victim, and the crime scene. This culminated in the analysis of the journey to crime by measuring the distance (as the crow flies) between the residence of the offender and the crime scene, generating two sets of variables. The first one refers to the distance travelled in each crime, and it is coded into four categories (from 0 to 1 km, from 1 to 2 km, from 2 to 3 km, and 3 km or more). The second refers to the mean distance travelled by the serial killer, it is coded into two distinct and mutually exclusive variables (less than 1 km and more than 1 km).

In order to analyse the proportion of offender's base location, victim's residence, and crime scene location throughout the city, the geographical distribution of Campina Grande was divided, according to the city's post office data, into North, South, East, and West.

The Statistical Package for Social Sciences and Pearson correlation in a two-tailed test of significance were the statistical procedure used. The variables were decoded into 1 and 0, corresponding, respectively, to whether or not the behaviour/characteristic was present or absent. Therefore, if a positive significant Pearson correlation between two variables appeared, it meant that they often occurred together, and if a negative significant correlation appeared, it meant that when one of them occurred, it was highly likely that the other variable did not. Dragnet was also used in order to verify its effectiveness in a Brazilian sample and in relation to the marauder and commuter pattern of offending.

3 | RESULTS

3.1 | Crimes and criminal's characteristics

According to the data collected, 15 serial killers were operating in the city of Campina Grande, for 6 years (2009–2015). Together, they were responsible for having committed 65 murders, which result in a mean of 4.33 homicides per serial killer, where the minimum were three homicides and the maximum seven. Their period of criminal activity, that is, how many months had passed between the first and last murder committed within the series, ranged from 2 to 36 months, with mean time of 14.8 months ($SD = 9.68$).

All offenders are male and were between 18 and 43 years old at the time of the criminal series. The average age of the sample was 24.43 years ($SD = 5.43$); the age group with the highest number of offenders is 21–23 years (46.2%). In this sample, 66.6% had not completed elementary school, whereas 16.7% completed elementary school, and 16.7% were illiterate; none of the offenders showed equivalent level of education to high school and/or higher.

Regarding the performing of the murders, the firearm was the most used by offenders, accounting for 95.4% of cases, and the use of stabbing weapons, such as knives, appears in only 3.1% of cases. The murders took place mainly outdoors (86.2%), in highways or in the street, whereas homicides committed indoors, homes and bars, accounted for 13.8%. With regard to the locomotion of the offenders to the crime scene, 72.7% used a motorised vehicle, and 27.3% travelled by foot. The surprise approach method, that is, when the victim did not expect action, was the most used by offenders to commit crimes (88%), whereas the use of subterfuge (con) to trick the victim and take them to their death was the least used (12%).

3.2 | Regions

The results show that the highest concentration of crimes occurred in the West of the city of Campina Grande, corresponding to 67.7% of total crimes. The South region is the lowest percentage among the crimes analysed, corresponding to 7.7% of the total. The North and East regions showed an incidence of 15.4% and 9.2%, respectively.

As for the location of offenders' residence: 73.4% of the sample lived in neighbourhoods of the West area of the city, whereas 13.3% lived in the South, and the remaining 13.3% in the eastern region, no serial killers resided in the northern region city. Regarding the location of the victims' residence: 64.6% of the sample lived in neighbourhoods of the West area of the city, 13.8% lived in the northern region, 12.3% in the East, and only 4.6% lived in the South.

3.3 | Geographic data

Considering the distances travelled by offenders to commit crimes, 64.6% of the analysed crimes were committed at a distance of up to 1 km; 12.3% between 1 and 2 km; 10.8% between 2 and 3 km, and 12.3% for crimes that reached a distance over than 3 km (Chart 1).

The mean distance travelled to commit a crime was 1361.58 m, the minimum and maximum distance were 34 m and 6850 m, respectively. The analyzes also showed that, for the first crime, the average distance travelled by offenders was 898.8 m, minimum 53 m and maximum of 4480 m. For the last crime of the series, the mean recorded

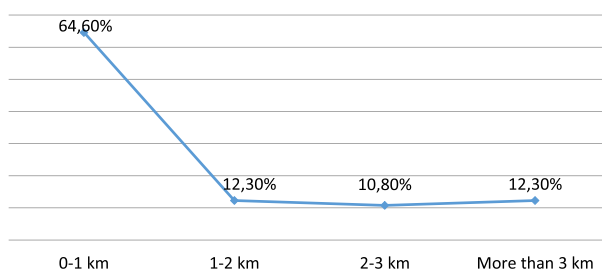


CHART 1 Distance travelled from the offender's base to commit murder

was 1695 m, the minimum 140 m, and maximum 6140 m, an increase of 796.2 m in the distance from the first to the last murders in the series.

3.4 | Correlating distances, regions, and characteristics

The analysis showed, as depicted in Table 1, positive and significant correlations between the region of the offender's base and the crime location. The results here, in fact, confirm that serial killers often attack on the same region where they live, except for the northern region where no killers had a base there.

Analysing the role of formal education on the distance travelled by serial killers, the number of schooling years came up as a possible explanation for the difference on the travelling distances. The results represented by Table 2 showed that individuals who finished elementary school (the equivalent to 9 years of formal education) travelled farther than those of less schooling years.

The analysis between the serial killer's preferred method of approaching the victim and the mean distance travelled to commit his crimes, as can be seen at Table 3, shows some interesting results. Offenders who used the element of surprise to attack are more likely to be the ones acting close to their base (0–1 km), whereas offenders who used the subterfuge were more likely to kill victims in places far from their base (1 km or more).

TABLE 1 Relationship between regions of the offender's base and crime location

	Crime location—North	Crime location—South	Crime location—East	Crime location—West
Offender's base in the North	a	a	a	a
Offender's base in the South	—	.681**	—	–.555*
Offender's base in the East	—	—	.681**	–.555*
Offender's base in the West	—	—	—	.853**

Note. — = no significant correlation.

^aCould not be analysed as at least one of the variables is constant.

* $p < .05$.

** $p < .01$.

TABLE 2 Relationship between mean distance travelled and schooling years

	Offender did not finish elementary school	Offender finished elementary school
0–1 km travelled	.645**	–.645**
More than 1 km travelled	–.645**	.645**

* $p < .05$.

** $p < .01$.

TABLE 3 Relationship between mean distance travelled and method of approach

	Surprise	Subterfuge
0–1 km travelled	.535*	–.535*
More than 1 km travelled	–.535*	.535*

* $p < .05$.
** $p < .01$.

In relation to the circle hypothesis, the results here showed that 66.7% of the offenders' base were within the perimeter defined by his criminal range, thus acting according to the marauder model, thus accusing an overlap between the home range and criminal range. Whereas 33.3% of the sample acted in accordance with the Commuter model, thus there was no overlap between the home range and criminal range.

3.5 | Dragnet

The data analysis using the Dragnet software aimed to verify its applicability in Brazilian's context. The findings were divided into four distinct patterns.

The first pattern (Figure 1) corresponds to the presence of the offender's base in the area delimited by the programme as a top priority (red) to the police actions, thus showing the programme's accuracy. The second pattern (Figure 2) is represented by the case in which the offender's base is inside the area of high priority but not within the top priority one (pink), corresponding to a certain accuracy of the programme but not the ideal desired by law enforcement agencies to avoid wasting time, resource, and risk of not capturing the offender.

The third pattern (Figure 3) depicts cases in which the effectiveness of the programme is not desirable, because, even if the offending base is within the areas of priority set by software, it lies in an area of low priority (blue). The fourth pattern (Figure 4) represents cases in which the programme was unable to predict the offender's base, because it is too far from the priority areas, their base were outside the advised areas of police activity focus that the programme advises.

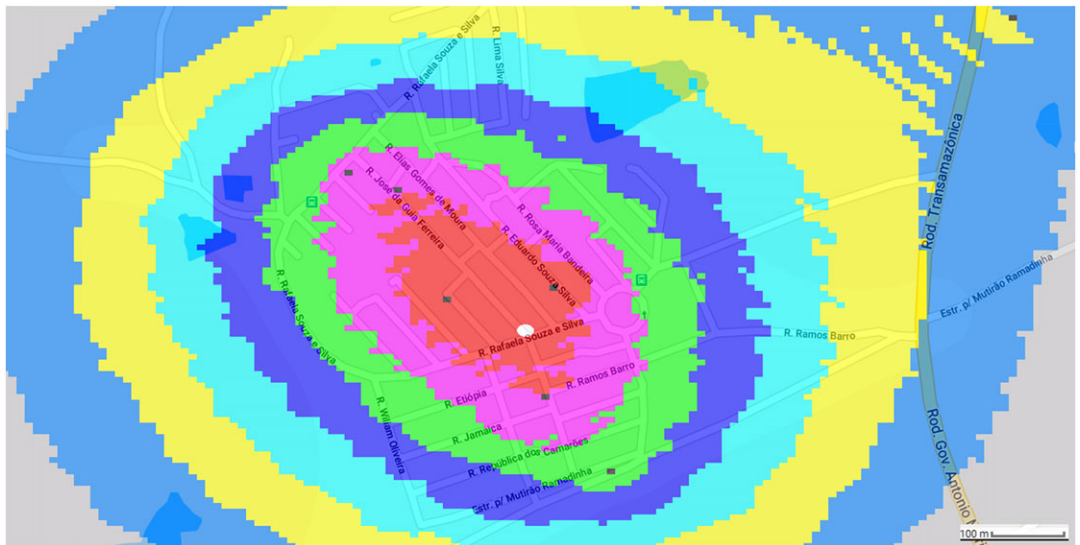


FIGURE 1 First pattern of Dragnet's accuracy

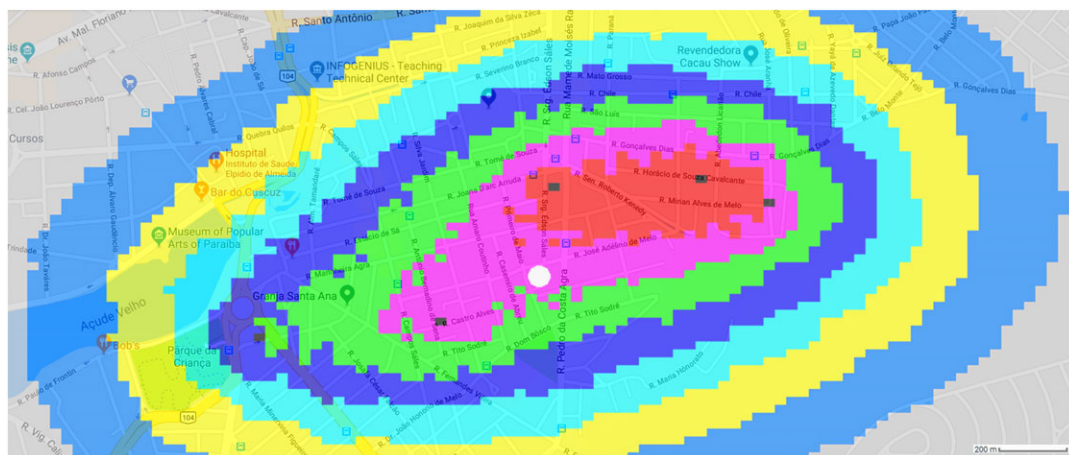


FIGURE 2 Second pattern of Dragnet's accuracy

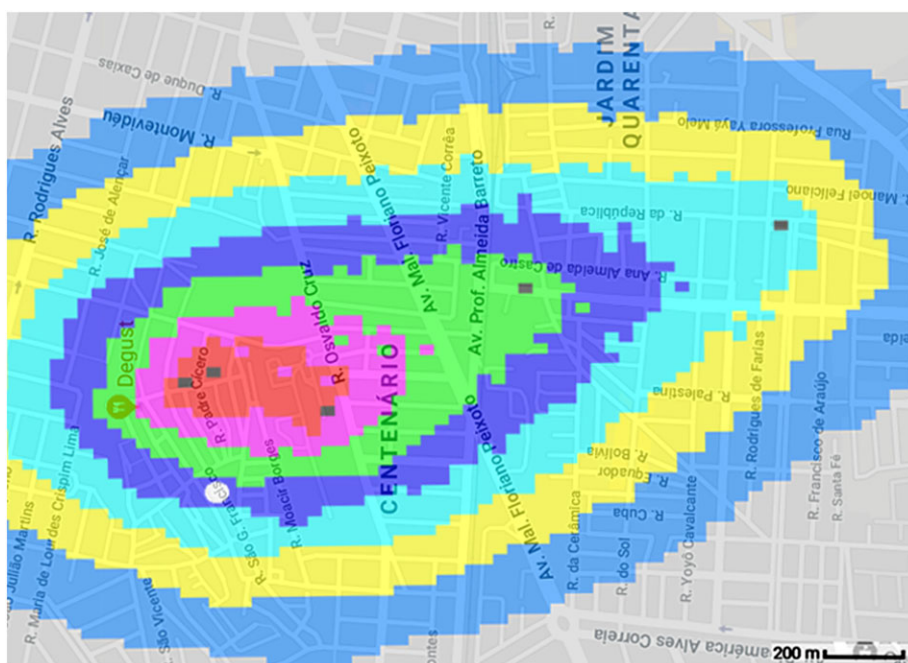


FIGURE 3 Third pattern of Dragnet's accuracy

Considering the findings of the present research, the first pattern (ideal) corresponded to seven of the total sample (46.67%); the second pattern (fit) was found in three cases (20%); the third pattern (weak) was also found in three cases (20%); the fourth pattern (harmful) was found in only two cases (13.33%). Thus, we can say that Dragnet was applicable in 66.7% of cases, because the patterns (ideal and fit) that would effectively improve the police search for the offender correspond to 66.7% of the analysed cases. Decisively, Dragnet showed itself as a reliable investigative tool, able to greatly reduce the search area of criminal investigations on serial killers, in fact confirming its applicability to the sample.

Upon close analysis of Dragnet's efficacy on marauder and commuter patterns of offending, it could be verified that, as the Table 4 presents, this software produces better results on the first than the latter pattern. Dragnet was

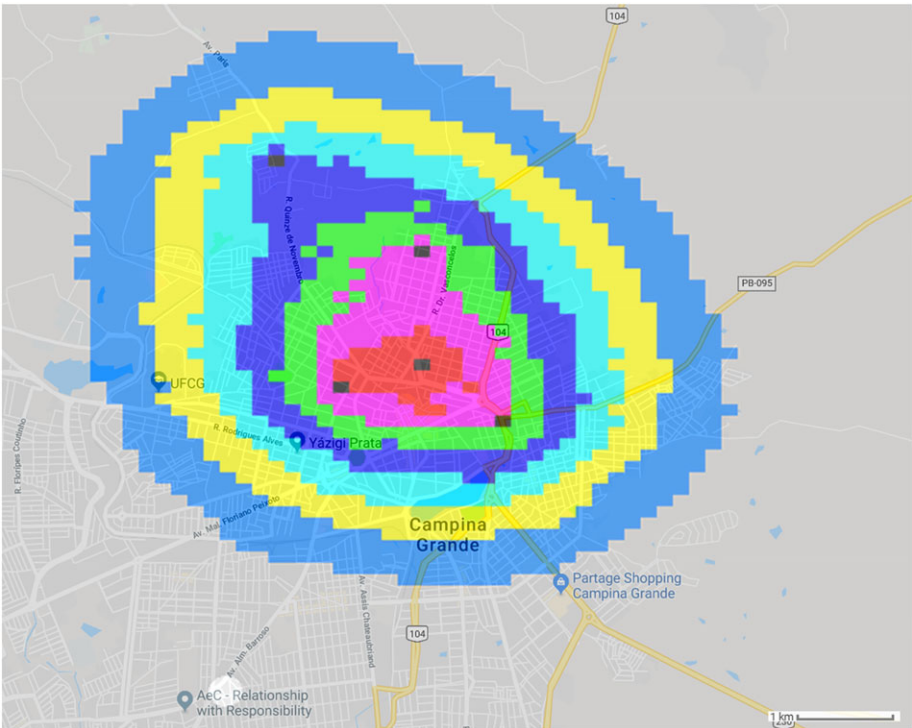


FIGURE 4 Fourth pattern of Dragnet's accuracy

TABLE 4 Dragnet's efficacy on marauder and commuter pattern of offending

	Dragnet ideal (%)	Dragnet fit (%)	Dragnet weak (%)	Dragnet harmful (%)
Marauder (<i>n</i> = 10)	50	30	20	0
Commuter (<i>n</i> = 5)	40	0	20	40

able to accurately point the area in which 80% of the marauder offenders reside, that is, from the 10 offenders identified from this sample as marauders, eight of them had their base within the two best patterns of Dragnet mentioned above (ideal and fit). On the other hand, from the five offenders identified from this sample as commuters, only two were within these Dragnet patterns, putting this software accuracy for commuters at 40%.

4 | DISCUSSION

Findings on the incidence of murder per region corroborate with Bezerra, Lima and Filho's (2011) paper on Campina Grande's geographical distribution of criminality. On their work, it became clear that financial crimes occurred more often on the northern side of the city due to the social prestige and a higher average income in this region. Whereas homicides were more common on western areas due to drug trafficking, organised crime and less social prestige, which leads to aggravated confrontation, resulting in the death of the ones who live in this region.

The routine activities theory sheds some light into why this commonly happens; it provides a macroperspective on criminality, predicting how social and economic conditions influence overall victimisation rates. Consequently, when looking at the western region of Campina Grande, an area locally known for its violence and comprised mostly

of slums, it is only plausible that residents of this region are more likely to become both victims and perpetrators. Between the four regions, the western provides more probability for engaging in risky behaviours, such as drug consumption, gang involvement, and association with other outlaws, increasing the likelihood of coming into contact with or becoming motivated offenders (Beauregard et al., 2005).

When these results are combined with the fact that the crimes were often committed in areas that offenders had their base and that 64.6% of the offences from this sample are within the 1-km limit (between offender's base and the crime location), the idea that most of the homicides committed by serial killers will usually take place close to their homes is strengthened. It also helps to prove the minimum effort and the familiarity principles, after all, the serial killers could travel long distances to perpetrate their crimes, but they chose suitable victims in the vicinities of their base as not to make unnecessary effort or spend time and resources on avoidable travelling. They were also already familiar with their neighbourhood, aware of the areas they should avoid, the most likely places to find victims without a proper guardian to prevent a crime, how to use local escape routes in case it went wrong, and so forth. In the end, they had no impediments to follow their criminal path near their base and no incentives to take it further than necessary (Canter, 2003).

These data also contribute to the discussion of the exponential decay function, wherein the crimes will follow an exponential fall in quantity in accordance with the increase of distance from the offender's base from a crime scene, as shown in Figure 5, extracted as it was on the work of Van der Kemp and Van Koppen (2007).

Even though it seems like the decay function is universally accepted in the environmental criminology field, in this study, it does not apply completely. Because even if most of the crimes occurred within a kilometre of the offender's base, it does not follow the shape of this exponential decay because there were more homicides in a distance of 3 km or more from offender's base than the distance between 2 and 3 km from offender's base to the crime site.

Another important observation can be drawn from the results of the distances travelled by offenders, as it increased according to the order of offences: The average distance travelled for the last crime in series is greater than the average of the first one. The maximum roamed for the first crimes was 4480 m, whereas the maximum for the last crime was 6140 m. Theorists such as Canter (2003) and Kocsis (2006) state that the offender's confidence grows every time he commits a new crime, expanding their offending area, or criminal range.

This increase in confidence and travel range can be explained by several factors; among them is the criminal experience. This type of experience works like any other in life so, the more you practice an action, the better you will be at it and, therefore, feel more confident in your abilities in this regard. Following this idea, the more crimes a subject practice, the more effective and confident he becomes, so that he will risk to operate in places less known to him. Another influential factor that boosts this confidence is time itself, because when people have more time to explore other parts of the world that used to be unknown to them and spend some time in these more distant areas planning their future attacks, they feel more confident in the effectiveness of their actions (Canter & Youngs, 2008).

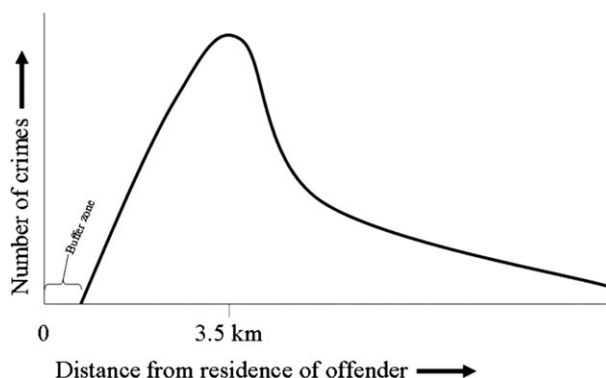


FIGURE 5 The exponential decay function

The confidence of the criminals also grows as the individual avoids being arrested, even after committing several crimes, that way he feels more capable of further breaking the law afield from his base (Konvalina-Simas, 2012). From this perspective of offender's confidence growth comes the "buffer zone." However, not all studies corroborate its existence (Canter & Youngs, 2008). In this study, for example, there were cases where offenders murdered their victims less than 60 m from their bases, implying the absence of such zone or the influence of factors that may cause it to be reduced to very few metres. Therefore, a more focused search in this issue is necessary in order to optimise its effectiveness in police investigation.

Through analysis of the method of approach, it became clear that more sophisticated offenders will travel farther than those who did not have the same expertise or confidence. The offenders, whose mean distances travelled are shortest (0–1 km), committed their murders through a surprise approach, for example, shooting an individual in the back or while he slept. Even though this method requires timing, a distraction, and/or opportunity, it does not require planning or criminal expertise to be effective. In fact, it can be inferred that offenders who chose to act this way were not confident enough in their criminal expertise to use a more effective method of approach or were afraid they would not succeed in their criminal act should they be seen by their victims or be recognised by the other villagers, thus choosing to act swiftly.

Offenders who committed crimes farther from their bases (more than 1 km) used the more sophisticated approach (subterfuge) by tricking victims and usually taking them to a specific location to perpetrate the violent act in order to reduce the risks arising from lack of knowledge of the area. Thus, the method of approach that demands higher criminal competence and draws less attention requires minimum use of physical force and results in less victim resistance and was used by criminal willing to travel farther from their base. It shows that those are skilled criminals, after all they had the confidence to use a more demanding method of approach, travel farther, and act in a less known area.

Feldman (1994) states that the decision-making process of criminals is compelled by the time available to perpetrate (a criminal opportunity has limited life-span, such as an unguarded house or unprotected child), the availability of relevant information, and the offender's own cognitive abilities (namely, IQ). According to this, it can be inferred that schooling years are positively correlated to cognitive abilities; therefore, formal education can be seen as an influential factor on the decision made by offenders to travel longer or shorter distances.

As a matter of fact, one of the forecasts made by the geographical offender profiling theory, according to Canter (1995), is that the more intelligent an offender is, the more likely she/he is to travel greater distances to commit crimes because he feels safer by having more knowledge of the world, how to choose victims, and crime locations even in an unfamiliar environment. In fact, it was proven in this research that offenders who had completed elementary school, that is, about 9 years of regular education (the highest level of education attained by individuals surveyed) were those who travelled the greatest distances: more than 1 km. Thus, the findings here confirming that: The more intelligent the offender, the farther he can attack (Canter & Youngs, 2008).

Furthermore, this research has shown to be valid the circle hypothesis developed by Canter and Larkin (1993), for the residences of criminals are within the area bounded by the circle formed by their criminal range, as 66.7% of the sample cases were located within the perimeter established by this technique. Research in New Zealand by Edwards and Grace (2006) demonstrated the validity of this theory in 84% of cases; studies conducted in other countries came to demonstrate efficacy in up to 87% of cases (Canter & Larkin, 1993). Meaney (2004) had already mentioned that crimes motivated by interpersonal violence are more likely to be committed by criminals acting in a marauder model. Instrumental crimes, financially motivated, are not as likely to be as opportunistic, thus resulting in an equilibrium between commuter and marauder pattern of offence.

Interestingly, Dragnet's applicability on this sample perfectly matches the percentage of marauders serial killers. However, it accurately predicted the risk area where to find the offenders' base in both marauder and commuter pattern of offending, though on different probabilities for each of them. Unsurprisingly, 80% of the marauder offenders had their base found through Dragnet, after all, this software's algorithm assumes that the offenders' base is within the area circumscribed by the crimes linked to them. On the other hand, being able to accurately locate 40% of

commuters' base is amazing, because it was expected that Dragnet would fail to find a base that had no connection to the criminal range.

Through individual analysis of the commuter cases mentioned above, it was possible to verify that Dragnet could only locate their base because they committed at least one of their crimes very close to their base (between 180 and 280 m). Therefore, when this decision support system applied the exponential decay function, it pointed to the area near each crime scene as high-risk area.

Because the police does not know whether they are dealing with a commuter or a marauder serial offender, they would use Dragnet's output to increase surveillance, question local residents and workers through house-to-house inquiries, and talk to informants in the designated areas. Eventually, it would culminate in finding the perpetrator in 66.7% of the investigations, whether he was a marauder or a commuter, a probability above the level of chance.

5 | CONCLUSION

Given the need for validation of international investigative techniques to Brazilian's context, this research has made possible the first look at the application of geographical offender profiling, to our reality. The results showed very similar results to those of other countries, confirming the principles of this technique such as the relationship between the distance travelled by the most experienced and intelligent in relation to his confidence. Thus, even though this technique was developed in the United Kingdom, it is applicable in Brazil. In fact, the present research showed that in 64% of the cases, the killer will reside in an area within a 1-km radius from the crime scene, and 67% of the time the serial killer will reside within his criminal reach.

Some data collection obstacles prevented a greater scope of the current study, for example, some variables originally contemplated for the analysis were excluded because there was not enough information. Indeed, studies that assess the behaviour, looking for patterns, need detailed information, starting from simple actions, such as, the inclusion of crime scenes photos in all records and more detailed and thorough information from the perpetrator's interrogation.

However, even considering the incompleteness of information, the lack of data in some cases, and poor quality in the collection and storage of data on crime and criminals in Brazil, it was possible to prove the applicability of the geographical offender profiling. So this technique is worth disclosure and use in the Criminal Analysis of Public Security entities in Brazil. However, it is also necessary to state the need to conduct similar researches in other regions of Brazil, because this country is very large and contemplates different cultures, which may influence the travelling behaviour of offenders.

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