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EVIDENCE-BASED VS. EXPERIENCE-BASED TARGETING OF CRIME AND HARM HOTSPOTS IN NORTHERN IRELAND

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1. Abstract

Crime concentrates in space and time. These are hotspots. Recent research evidence has proposed a "law of crime concentration" (Weisburd, 2015: 143), where 2.1% to 6% of street segments account for 50% of all recorded crime. This research adds UK evidence to support this finding. Crime concentration patterns were observed across a range of crime types and in both urban and rural environments. Furthermore, the degree of concentration is comparable over the three year study period. More importantly, there is a high level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period. In terms of crime counts, the Pearson coefficients were around r=.80. In addition to crime counts, this research has considered the concentration of harm associated with crime using the Cambridge Crime Harm Index (Sherman et al 2014b; see also Bland and Ariel, 2015; Weinborn et al., 2016) and finds that harm is concentrated to a higher degree than count. However the degree of consistency in the locations of harmspots was lower than for hotspots, with the Pearson coefficients around r=.40.

Identifying concentrations of crime and harm is only a worthwhile endeavour if targeting resources to these concentrations is an effective crime control tactic. Of all evidence-based policing strategies the evidence for targeting police resources at hotspots is the strongest, both in terms of the volume of substantive research and the effect sizes in terms of crime reduction. The accurate identification of spatial crime concentrations is the first step to a successful hotspots policing strategy. The paper compares two commonly employed methods of identifying 'hotspots' by police agencies: professional judgement and data analysis. The results support the argument that data analysis is as good as, if not better, than professional judgment for forecasting future events (Kahneman, 2011). The vast majority (>97%) of street segments which were included in 'Waymarkers' were not identified as hotspots or harmspots resulting in wasted police resource. In addition, over 60% of street segments which were identified using data analysis were excluded from 'Waymarkers' which represents missed opportunities to prevent crime and harm.

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3. Introduction

3.1. Overview and Context

Evidence indicates that there is a "law of crime concentration" (Weisburd, 2015: 143), where between 2.1% and 6% of street segments account for 50% of all recorded crime. An extensive body of research has identified that crime is concentrated in place (Weisburd et al., 2012; Sherman, 1995; Sherman et al., 1989; Weisburd, 2014; Sherman, 2007; Chainey and Ratcliffe, 2005; Eck et al., 2005) and time (Ariel et al., 2016; Ratcliffe, 2004a), in what is commonly referred to a 'hotspots'. Furthermore these hotspots are stable over time. Crime does not unsystematically shift from one place to the next, instead hotspots remain 'hot' for prolonged periods of time (Weisburd, 2015; Weisburd et al., 2012; 2004; Weisburd, 2008; Ariel et al., 2016; Ariel, 2011). This allows for the forecasting of future crime based on historic trends.

Sherman identified that "crime is six times more predictable by address of the occurrence than by the identity of the offender" (1995: 36). This makes logical sense given that, on average, the offender is only identified in around a quarter crimes, ranging from 10% for burglary to 30% for violent offences (PSNI, 2015). Conversely the location of a crime is known in the majority of events. The ability to forecast *where* and *when* crime will take place can be harnessed to develop cost-effective crime prevention strategies by analysing crime concentrations over time (Ratcliffe, 2010; Chainey et al., 2008).

Targeting these hotspots with both traditional and new policing tactics can reduce crime (Braga et al., 2014; 2012; Braga, 2005; Braga, 2001; Sherman, 2013; Sherman and Weisburd, 1995). Targeting small geographical areas is the most likely strategy for achieving any further crime reduction gains compared to targeting offenders (Weisburd, 2004; Braga et al., 2014). There is also evidence to indicate that these crime prevention efforts extend into the immediate neighbours of targeted locations, rather than the displacement of crime occurrence (Weisburd et al., 2006; Bowers et al., 2011).

Collectively, 'hotspots policing; is arguably the best known, and purportedly used, example of evidence-based policing (Sherman, 1998; 2013). Evidence-based policing is a paradigm according to which adopting the scientific approach, with a heavy research

component in evaluating police effectiveness to continue to improve the understanding of 'what works'. The growing interest in evidence-based policing and increasing fiscal challenges for policing have created an opportunity to make improvements to police methods, as current systems and processes can no longer be sustained. Policing may be in a better position to address the "power few" problem (Sherman, 2007) by targeting the small number of places which account for a disproportionate volume of crime.

The key to an effective hotspots policing strategy begins with problem identification and definition: targeting (Sherman, 2015). There are two predominant methods for the identification of hotspots: data analysis and professional judgement. The increasingly easy access to, and sophistication of, crime mapping and Global Positioning System (GPS) software available to police services has created significant opportunities to develop refined hotspots policing strategies based on the analysis of large volumes of data. However installing the software is not the end of the process because understanding the underlying crime theories and practical experience of the criminal environment can significantly improve its use (Eck, 1997; Weisburd and McEwen, 1997). In practice, professional judgement is more commonly used based on the assumption that experienced officers know where the problems are and that crime mapping will only tell them what they already know (Ratcliffe and McCullagh, 2001; Chainey and Ratcliffe, 2005).

Many studies in a variety of fields have identified that predictions of future events based on data analysis are better, or at least as good, as clinic judgment (Kahneman, 2011; Sherman, 2013). These findings have been replicated in studies concerning the ability of officers to identify hotspots of crime based on their professional experience and judgement (Rengert and Pelfrey, 1997; Ratcliffe and McCullagh, 2001; Chainey and Ratcliffe, 2005). Regardless, there is still a reliance on professional judgement over data analysis (Bond and Braga, 2013; Ratcliffe, 2004a; Lum, 2009; Lum et al., 2012; Rousseau, 2006; Sherman, 2013).

3.2. Purpose and Structure of this Research

There are two major premises for this paper. Firstly, to replicate the crime concentration pattern in Northern Ireland. It is hypothesised that the level of crime concentration will be consistent with the evidence supporting a "law of crime concentration" (Weisburd, 2015: 143).

The second and novel premise of this paper is that accurate identification of spatial crime concentrations is the first step to a successful hotspots policing strategy. Robust identification of the areas of crime concentration is necessary to prioritise resources. In practice, hotspots tend to be identified on a regular, most often monthly, basis and are driven by the most recent crime sprees or spates and officer perceptions. It will be shown that, by definition, these are not hotspots as they are unpredictable, unstable and inconsistent. Nevertheless, the current practice involves increasing patrol in these locations. The problem reduces, either due to the short-term impact of increased police presence (which may or may not have occurred) or regression to the mean (the most statistically likely cause), and the hotspots strategy is proclaimed a success. More often than not the so-called hotspots re-emerge which results in officers, and in all likelihood the residents in the affected communities, becoming increasingly frustrated and disillusioned with hotspots policing.

Instead, altering the methods used to identify the hotspots is required, so that consistent and predictable hotspots will be used rather than gut-feeling, short-lived concentrations of crime. Identifying hotspots based on short-range crime trends and implementing unsophisticated generic interventions can only result in temporary benefit. Currently, and I suspect this is the case for most UK forces, the targeting stage of developing hotspots strategies rarely involves sufficient analysis using actuarial rather than clinical predictions. Ensuring that genuine locations of crime concentration are identified and that there is a desire to develop long-term problem-oriented strategies to tackle the problem is required. This paper illustrates these issues quantitatively.

Thus, the study will compare the locations of crime concentration, for a variety of crime categories, identified using crime mapping techniques with 'hotspots' created by officers. The study will consider the stability of these locations of crime concentration to

ensure that persistent hotspots which allow for the forecasting of future crime can be identified. Furthermore, an emerging area of interest is crime harm as opposed to crime volume (Sherman, 2013; Ratcliffe, 2014, 2015; Sherman et al., 2014b) which will also be examined in this research.

Finally, yet another addition to the literature which this paper offers is a focus on rural rather than urban areas. This study will help to identify potential crime control benefits to be gained from hotspots policing in rural environments and smaller towns as well as urban areas (Hinkle et al., 2014). This will be of particular interest to many police services in England, Wales and Scotland who have responsibility for policing large rural areas.

The next section outlines the existing literature in relation to crime concentrations, identification of hotspots, and the effectiveness of hotspots policing. A detailed account of the methodology follows which outlines the research questions, data and analytical techniques employed. Data limitations and external validity are also addressed. The results chapter presents the detailed findings to each research question in turn.

The discussion chapter focuses on the contribution of this paper to existing research evidence and the policy implications of the findings. It is hoped this research can help form the basis of a targeting strategy for hotspots policy which is more evidence-based rather than experiential. Finally, the paper concludes with a summary of the key findings and the next stages for the development of effective hotspots policing strategies.

4. Literature Review

This section will outline the key research in relation to crime concentration (hotspots), defining hotspots, techniques for the identification of hotspots and the effectiveness of targeting hotspots for crime prevention.

4.1. Concentration of Crime

Since as early as the 1800s it has been recognised that crime concentrates in some areas and not others (Chainey and Ratcliffe, 2005; Sherman et al., 1989). This finding is unsurprising as crime is a relatively rare event when considering the large numbers of potential targets, furthermore not all locations contain suitable targets therefore cannot experience crime (Sherman, 1995; Sherman et al., 1989). For a generation academics have worked with the police to help them understand the spatial distribution of crime and it is now accepted that crime clusters in space and time: hotspots (Weisburd, 2014; Weisburd et al., 2012; Sherman, 1995; Sherman et al., 1989; Sherman, 2007; Ratcliffe, 2010).

Farrell (1995) argues that crime is not evenly distributed across the population as "a relatively small proportion of the population experience a large proportion of all crime" (p. 470). The term ‘population’ could refer to all cities in a country, neighbourhoods in a city, streets in a neighbourhood or houses on a street, depending on the unit of analysis. Some of these places are repeatedly targeted and consequently suffer a disproportionately high number of crimes (Pease, 1998; Farrell, 1995). Sherman (2007) refers to this group as the "power few". An early study of micro-places in Minneapolis found that 3 percent of addresses generated over half of all calls for service (Sherman et al., 1989b). This finding has been replicated in a longitudinal study of street segments in Seattle where around 50% of occurred in 4-5% of street segments in each year of the study (Weisburd et al., 2004; 2012).

Research indicates that there are varying levels of concentration by crime category, however most crime categories (including burglary, assault, sexual offences, robbery and vehicle theft) are concentrated in certain locations (Sherman et al., 1989; Weisburd et al., 2004; Weisburd et al., 2012). A recent paper proposes a “law of crime concentration” which

describes a bandwidth of between 2.1 and 6 percent of street segments produces 50 percent of crime which is consistent across a number of difference cities (Weisburd, 2015: 143).

This knowledge suggests that policing should be similarly focused however is not sufficient on its own. There are two largely unanswered questions: why is crime concentrated and what crime prevention strategies can reduce crime in those locations (Weisburd et al., 2012; Ratcliffe, 2010)?

4.1.1. Causal/Explanatory Theories

In order to explain why crime clusters and the difference between crime categories, the field of environmental criminology has evolved. The theories focus on the availability of opportunities to commit crimes and the behaviours of victims and offenders.

Routine activity approach (Cohen and Felson, 1979) states that everyday patterns of behaviour explain the occurrence of crime (Chainey and Ratcliffe, 2005). For a crime to occur a likely offender and a suitable target, in the absence of a capable guardian, must meet in space and time (Clarke and Eck, 2003). "Neither opportunities nor routine activity of offenders and victims are randomly distributed, therefore clustered patterns are the most common type of pattern observed" (Chainey and Ratcliffe, 2005: 127). Furthermore, even if the population of offenders remains the same, changes in the activities of capable guardians or victims can have an impact on crime (Johnson, 2010).

A further theory is rational choice perspective which contends that offenders make decisions based on the perceived risks and rewards of criminal opportunities which vary across place and time (Cornish and Clarke, 2008; Clarke and Felson, 1993). The rational choice perspective concentrates on the interaction between the potential offender and their current situation to to explain why crime occurs (Cornish and Clarke, 2008). The inference being that some situations present better opportunities than others and that influences the potential offender's decision about whether or not to commit a crime.

Crime Pattern Theory coalesce the ideas of routine activity theory and rational choice perspective (Brantingham and Brantingham, 1984) by including the environmental backdrop

of the crime. The theory is based on the notion that individuals have an 'awareness space' (Brantingham and Brantingham, 1993) which describes the locations, and routes between these locations, with which people are familiar. Crime occurs when locations for crime opportunities overlap with offenders' awareness spaces (Johnson, 2010). The decision-making capabilities of offenders are enhanced by their familiarity with an area therefore making suitable targets in their awareness space more attractive than similar targets in areas that are less well-known.

"Together, the three theories suggest that where the routine activities of offenders and victims overlap in space and time to provide sufficient (and suitable) crime opportunities in the absence of adequate guardianship, hotspots of crime will form" (Johnson, 2010: 358).

4.2. Definition of a Hotspot

Understanding the causes and features of hotspots is informative from an academic perspective, but it has sparked practical interest as well, particularly on how to identify them (Ratcliffe, 2004a). Techniques for identifying crime concentrations and the definition of a hotspot vary between research studies. Diagnosing the causes of crime concentrations and, subsequently, the appropriate crime prevention programmes is dependent on accurately identifying hotspots (Ratcliffe, 2010). However, despite significant academic and practical interest, there is no single universally accepted definition of a hotspot (Eck et al., 2005; Weisburd et al., 2012). In general the term is used to describe an area which experiences a higher than expected level of crime (Sherman et al., 1989; Sherman and Weisburd, 1995).

While hotspot studies provide a definition of a hotspot (usually the unit of analysis, for example a neighbourhood or street segment) few provide a detailed description of the methods employed to classify them as "hot". A notable exception is the paper by Buerger et al (1995) which is solely dedicated to the difficulties encountered in relation to data quality, the types of crimes and premises to include and topographic features when defining hotspots. Poor identification of hotspots leads to the ineffective targeting of police resources (Weisburd et al., 2012; Ratcliffe, 2010). There are a number of factors to be considered

including size (unit of analysis), crime types, volume and stability, which are discussed below.

4.2.1. Unit of Analysis

Crime concentrations can be identified at various geographical levels including police beats, census tracts, street segments, clusters of addresses and specific addresses (Eck et al., 2005). The unit of analysis used to identify crime concentrations has moved from macro to micro in recent years (Weisburd et al., 2012). Early studies examining concentrations used datasets which often aggregated data to geographical areas such as police beats or census tracts (Sherman, 1995; Sherman et al., 1989).

More recent research has focused on individual addresses, clusters of addresses and street segments and concentrations are more acute at these micro-levels (Sherman, 2013). Studies comparing the sizes of hotspots have revealed that using higher levels of geography can mask underlying local patterns which results in the ineffective allocation of police resources (Weisburd et al., 2012; Andresen and Malleson, 2011). Street segments are recently emerging as a promising unit of analysis, as they seem to group similar types of premises and social demographic characteristics together so identifies small homogenous areas (Weisburd et al., 2012; Weisburd et al., 2004).

The increasing academic interest in micro places is not reflected in practice, at least in UK standards; police services still tend to use larger areas (neighbourhoods or beats) to al'Locate' and manage police resources. The more precise the definition of the problem areas and therefore the targeting of resources the greater the chance of the policing activity achieving the desired effect, assuming that police activity is being delivered as directed (Sherman et al., 2014b; Hinkle et al., 2014; Skogan and Frydl, 2004; Weisburd and Eck, 2004).

4.2.2. Crime Type and Volume

Many hotspots studies have focused on a single crime type or a subset of all crimes. Differences in the spatial distribution between crime types have also been identified

(Chainey, Tompson and Uhlig, 2008; Evans, 2001; Ratcliffe and McCullagh, 1999). While there are differences in the levels of concentration across crime types, for example robbery is more concentrated than assault (Andresen and Malleson, 2011; Sherman et al., 1989); this can often be linked to the volume of crime. Less frequent crime events such as robbery, homicide, serious sexual offences, are more concentrated due to the high number of units (street segments or neighbourhoods) which have no events (Sherman, 1995; Andresen and Malleson, 2011).

Despite the variation in the strength of concentration across crime types there is also evidence that the same geographical areas are hotspots for a variety of crime types: co-morbidity (Ratcliffe, 2010; Sherman, 2007). It is essential to understand the purpose of identifying the hotspots when considering the unit of analysis and crime type. If creating hotspot maps to predict future events, hotspots of high volume crime types are more reliable than other less common crimes (Chainey et al., 2008: 26).

4.2.3. Count vs Harm

A further consideration is the emerging literature on the harm associated with crime. Although it is implicitly understood that some crimes are more harmful than others the identification of hotspots has concentrated on the volume of crime (Sherman et al., 2014a; Sherman, 2013; Ratcliffe, 2014, 2015). The Cambridge Crime Harm Index (CHI) (Sherman et al 2014b; see also Bland and Ariel, 2015; Weinborn et al., 2016) provides a metric, based on sentencing guidelines, to compare the harm associated with crime across all units of analysis. Using this metric suggests that harm has not declined as crime counts have in the UK (Weinborn et al., 2016; Sherman et al., 2014a).

The question is whether or not harm is spatially and temporally distributed in the same way as volume. Emerging research indicates that harm is more concentrated than volume (Weinborn et al., 2016), which suggests that police activity could focus on even fewer places and still reduce harm; however the effects of increased policing activity in harmspots has yet to be tested.

4.2.4. Temporal Stability and Variability

Linked to the volume of crime is the time period considered for identifying hotspots. There are benefits and drawbacks to using both long-term and short-term datasets. Using several years' worth of data may provide a high volume of crimes/incidents for analysis however the resulting hotspots may be misleading if the problems have changed. "Long-term hotspots (based on 1 year or more) are both relevant and reliable units for targeting extra patrol dosage" (Sherman et al., 2014b: 14). Evidence of stability of crime concentrations over a number of years have been demonstrated in Seattle, New York, Brooklyn Park, Tel Aviv-Yafo (Weisburd 2015) and Vancouver (Curman et al., 2015; see also Wesiburd et al., 2004; 2012; Sherman et al., 2014a).

Although the temporal aspect of hotspots has received less attention than the spatial nature of crime concentration, emerging research evidence suggests that hotspots are often stable over time within days of the week and hours of the day which can help improve the forecasting accuracy of hotspots (Ratcliffe, 2010, 2004a; Johnson et al., 2008).

To be sure, using a short-time frame (e.g. 30 days of data) is susceptible to the "regression to the mean" problem (Kahneman, 2011; Rosenbaum, 2006). When less data points are used to identify locations of hotspots, the hotspot can represent a random fluctuation in the data which will "right itself" without any intervention.

4.3. Hotspot Identification Techniques

"Engaging in 'good' hotspot policing is not feasible if the hotspot itself cannot be easily identified or well defined" (Rosenbaum, 2006: 247). However, in practice techniques adopted to identify hotspots are based on convenience, often not addressing the complexities of defining a hotspot outlined above. There are two predominant methods currently employed: professional judgement and data analysis, both of which have their strengths and weaknesses.

4.3.1. Professional Judgement

Despite limited research into the reliability of officers' perceptions of high crime areas there is an assumption that police officers develop an accurate picture of problem areas during their daily activities (Ratcliffe and McCullagh, 2001). Officers often believe that crime mapping will only tell them what they already know (Chainey and Ratcliffe, 2005). In fact, studies show that perceptions of high-crime areas are not consistent with official recorded crime data (Rengert and Pelfrey, 1997; Ratcliffe and McCullagh, 2001; Chainey and Ratcliffe, 2005).

Rengert and Pelfrey (1997) compared Philadelphia officers' familiarity with a city and the ability to identify high crime areas. How accurately participants could identify the locations of landmarks on a map was the measure of familiarity while participants were asked to rank zones from 0-10 to indicate how safe they were. Perceptions of safety were compared to the actual level of safety based on violent crimes (assault, robbery, rape and homicide). The results show that familiarity with an area is not correlated with accurate perceptions of safety.

Likewise, Ratcliffe and McCullagh (2001) compared hotspot maps using computerised crime mapping techniques with officers' 'perception maps'. Hotspots were identified based on a year's crime data for residential burglary, non-residential burglary and vehicle crime using a two-stage computerised crime mapping process (KDE and Gi* - see Ratcliffe and McCullagh, 1999 for full details). Operational officers were surveyed and asked to mark high crime areas for each of the crime types on a map. The results of both methods were then discussed at a focus group with a small number of officers.

In the majority of cases the officer perceived hotspots differed significantly from the computerized hotspots. The findings showed that officers were better at identifying burglary hotspots than the other crime types and the focus groups suggested that this was because burglary was a priority. Not attending (physically) to other crime scenes (e.g. vehicle crime) may also have contributed to the lack of awareness of hotspots.

A replication of the Ratcliffe and McCullagh (2001) study was carried out in London with a group of crime reduction professionals which included police officers, a police analyst,

council community safety officers and representatives from partner agencies such as housing, education, justice, and health (Chainey and Ratcliffe, 2005). The participants were asked to mark the locations of burglary, robbery and vehicle crime hotspots on three separate maps which were then compared to crime mapping hotspot maps. None of the participants identified the main robbery hotspot, none of the burglary hotspots were correctly identified and there was only a 6% match between the perceived hotspots and actual hotspots of vehicle crime (Chainey and Ratcliffe, 2005). This example demonstrates that respondents from different areas of expertise, although with a responsibility for crime reduction, are equally poor at accurately identifying high crime areas.

The main reason for the differences between perception and reality is that humans rely on heuristics and cognitive biases to make judgements (Kahneman, 2011; Heuer, 1999; Rousseau, 2015). The first problem is availability; no matter how experienced an officer is, he or she has only been exposed to a fraction of all of the cases that have been reported and is highly unlikely to be able to remember all of their experiences (Sherman, 1984; Rousseau, 2015). Officers will likely be able to recall events which happened most recently or were particularly traumatic or personal (Heuer, 1999). This was apparent in the study in London where one of the hotspots was identified because a member of the partnership had been a victim of crime in the location and had told the other members of the partnership creating a false impression of the risk at that location (Chainey and Ratcliffe, 2005). Related to availability is confirmation; human brains look for patterns to make sense of the world around them therefore officers will automatically recall events which are consistent with their current opinions (Kahneman, 2011; Heuer, 1999; Rengert and Pelfrey, 1997; Rousseau, 2015).

Both availability and confirmation result in officers only being able to recall a small sample of events and even when statistical evidence is presented people are more compelled by personal experience and causal stories than abstract facts (Heuer, 1999). Therefore professional judgement hotspots are often identified based on a very small number of crimes assuming that they are representative of the whole population demonstrating an "exaggerated faith in small samples." (Kahneman, 2011: 118). Small

samples are less statistically reliable than large samples as it is more difficult to control for random variation.

A further problem related to the variability in small samples in regression to the mean (Kahneman, 2011). Hotspots tend to be created as soon as an unusually high level of crime in a particular area, it all probability the level will return to the normal level without any intervention. Considering longitudinal datasets will help to identify genuine hotspots worthy of intervention rather than random fluctuations (Spelman, 1995). Even when it is recognised that judgements are biased it is difficult to overcome that weakness (Heuer, 1999). The alternative to professional judgement is systematic computer based analyses of large datasets which provide an objective method for the identification of hotspots (Rousseau, 2015).

4.3.2. Data Analysis

In recent years there have been significant developments in techniques and software for the detection of hotspots (Ratcliffe, 2004a; Johnson et al., 2008). The emergence of GIS and associated software tools has made the process of identifying hotspots from geo-coded police data appear deceptively simple. These systems make it relatively quick to identify hotspots using large volumes of data creating an artifice of validity and reliability. In truth the users of these systems often have had very little training in using the software far less the underlying theories of the causes of crime concentrations and the complexities of hotspot identification (Weir and Bangs, 2007). Installing the software is not the end of the process, understanding the underlying crime theories and practical experience of the criminal environment can significantly improve its use (Eck, 1997; Weisburd and McEwen, 1997).

There are a number of different hotspot detection techniques and the most appropriate method is linked to type of data available and the unit of analysis (Eck et al., 2005). There are five mainstream crime mapping techniques: point mapping, standard deviational spatial ellipses, geographic boundary thematic mapping, grid thematic mapping and kernel density estimation (KDE) (Eck et al., 2005; Chainey et al., 2008; Ratcliffe, 2010;

Johnson et al., 2008). It is essential to note that the different methods can produce different results (Chainey et al., 2008).

Point maps are the most basic and earliest form of crime mapping. They are simple to create and do not require any specialist software although they can be difficult to interpret and misleading, particularly when considering high volume crime (Johnson, 2010). Using point maps to identify hotspots has phased out since police agencies began investing in geographical information system software (Chainey et al., 2008).

Standard deviational spatial ellipses use descriptive statistics (mean and standard deviation) to draw an ellipse around concentrations of crime which indicate the size and direction of the hotspot (Chainey and Ratcliffe, 2005; Chainey et al., 2008). This is an improvement over point maps although the ellipse does not accurately define the hotspot. The process highlighted the usefulness of spatial analysis and acted as a catalyst for the development of more sophisticated techniques (Ratcliffe, 2004b).

A popular mapping technique is geographic boundary thematic mapping which involves aggregating point data to existing boundaries, such as census tracts, wards or police beats, which are shaded dependent on the number of crimes within them (Chainey et al., 2008; Johnson, 2010). This method allows crime levels to be connected to other data sources such as population and deprivation measures which may uncover underlying causes. One of the key problems with the use of areas, such as census tracts, is the modifiable areal unit problem (MAUP) which describes the issue of aggregating data to arbitrary boundaries which can result in identifying different hotspots depending on which boundary is used (Openshaw, 1984). A further problem with using pre-defined areas is the ecological fallacy: the inference that crime and disorder is spread evenly across each unit of analysis within the area (Chainey and Ratcliffe, 2005; Andresen and Malleson, 2011; Johnson, 2010).

An alternative to geographic boundary thematic mapping is grid thematic mapping. Instead of aggregating crimes to existing boundaries a grid of the study area is used. This makes the areas directly comparable however does not avoid the MAUP (Chainey et al., 2008; Eck et al., 2005; Chainey and Ratcliffe, 2005).

Currently, the most favoured hotspot mapping technique is Kernel Density Estimation (KDE) which involves aggregating point data to a grid and shading each cell based on the number of crimes within a certain radius of the centre of the cell (Johnson et al., 2008). Crimes closer to the centre are given a higher value therefore contributing more to the cells' total value (Eck et al., 2005). Therefore there are two important parameters to be set to determine the size of the grid (cell size) and the search radius (bandwidth) which is one of the main weaknesses of this approach. The manipulation of these parameters can produce extremely varying hotspot maps and there is no "universal doctrine" on how to set these (Chainey et al., 2008: 9). One of the key limitations of KDE mapping is the smoothing effect it has that creates hotspots in locations where there was no crime or even into locations where it is not possible for crime to be committed due to topological features (Chainey and Ratcliffe, 2005).

The crime mapping techniques discussed above require access to specific software and a certain degree of training and skill. From an operational policing perspective, a simple calculation of crime concentration to examine whether or not the "80-20 rule" applies may be the most beneficial (Ratcliffe, 2004a; Clarke and Eck, 2003). This involves identifying the total number of potential targets (such as residential addresses, shops, commercial premises, car parks, street segments, etc.) and then calculating how much crime each target experiences. The potential target can vary depending on the crime type, for example domestic burglaries can only take place at residential addresses. This then raises the question of what unit of analysis (target) to use to calculate the level of concentration for all crime or calls for service. Street segments are emerging as the preferred unit of analysis as it tends to group similar types of premises and social demographic characteristics together so identifies small homogenous areas (Weisburd et al., 2004; 2012).

A further benefit of data analysis is the ability to quantify the harm associated with crime. Although it is implicitly understood that some crimes are more harmful than others the identification of hotspots has concentrated on the volume of crime (Sherman et al., 2014a; Sherman, 2013; Ratcliffe, 2014, 2015).

4.3.3. Combining Professional Judgement and Data Analysis

It appears that there is a “gap between the rhetoric and the reality” of hotspot policing similar to that identified in problem-oriented policing (Braga and Bond, 2008: 585). The term hotspot is used in academic research and practical policing although the definition varies dramatically both within and between each environment. Many police services purport to be utilising crime mapping techniques to direct resources (Weir and Bangs, 2007) however the detail about the processes employed for the definition and identification of hotspots are largely unknown. There is also scepticism that the espoused hotspots policing strategies are actually an integral part of daily policing activity (Weisburd, 2008; Weir and Bangs, 2007).

Evidenced-based policing is about combining professional judgement and data analysis to helps decision-makers to overcome inherent cognitive biases (Sherman, 2013; Rousseau, 2015). Even when the benefits of combining data analysis and professional judgement are recognised there is a disconnect between the techniques used to identify hotspots. "Although the use of crime data and analyses for problem and hotspot identification were a centerpiece of the Compstat process, the captains rarely referenced data beyond personal perceptions and police reports to understand the conditions that cultivate crime patterns and hotspots." (Bond and Braga, 2013: 3).

A UK study of police officers found that professional experience was more influential in decision making than research evidence (Palmer, 2011 cited in Lum et al., 2012). This finding has been replicated in a number of studies in the United States where experience was "placed on a much higher pedestal than analytic or scientific knowledge, which may be viewed with suspicion” (Lum et al., 2012: 81; Telep and Lum, 2014). Limited training for police officers on crime analysis and crime mapping may create a lack of trust and understanding of the outputs resulting in officers relying on their professional judgement (Ratcliffe, 2004b; Lum, 2009; Barends et al., 2014). A further consideration is the existence of a police culture where police officers dislike and resist civilian staff members directing their day-to-day activities (Skogan, 2008; Lum et al., 2012; Taylor and Boba, 2011). Essentially the debate about experience versus evidence is reduced to police officers versus staff.

4.4. Effectiveness of Hotspots Policing

Identifying concentrations of crime and harm is only a worthwhile endeavour if targeting resources to these concentrations is an effective crime control tactic. Hotspots policing is one of the earliest examples of an evidence-based policing intervention which has resulted in three decades of experimentation.

A substantive body of research exists which confirms that concentrated police activity can significantly reduce crime in hotspots with little evidence to support displacement (Braga et al., 2014; Braga et al., 2012; Braga, 2005; Braga, 2001; Sherman, 2013; Sherman and Weisburd, 1995; Bowers et al., 2011). Studies have demonstrated prevention effects of hotspots policing on all calls for service/crime reports (Sherman et al., 1989; Hope, 1994; Sherman and Weisburd, 1995; Sherman and Rogan, 1995a; Caeti, 1999; Braga and Bond, 2008) and specific crime and disorder problems including drug-related crimes (Hope, 1994; Weisburd and Green, 1995; Mazerolle et al., 2000, Cohen et al., 2003; Lawton et al., 2005 and Weisburd et al., 2006), prostitution (Weisburd et al., 2006), violent crime (Sviridoff et al., 1992; Sherman and Rogan, 1995b; Braga et al., 1999; Lawton et al., 2005; Taylor et al., 2011; Ratcliffe et al., 2011 and Braga et al., 2011) and property crime (Braga et al., 1999; DiTella and Schargrodsky, 2004; Taylor et al., 2011). Hotspots policing is therefore an effective strategy to tackle a wide variety of crime and disorder problems.

A further consideration is the type of police activity which is most effective. Studies which have been conducted to date have been split fairly evenly between traditional police activities, such as enforcement and patrol, and problem-oriented policing initiatives which aim to address the underlying causes of crime at hotspots (Braga et al., 2014). The most recent meta-analysis of hotspots policing shows that problem-oriented policing interventions are marginally more effective than traditional police activities (Braga et al., 2012). A finding which seems to be consistent for most crime types (Braga et al., 2014).

There is currently a lack of evidence on the existence of crime concentration and the effectiveness of hotspots policing in the United Kingdom. Operation Beck was the first example of a British hotspots policing randomised control trial, showing that both crimes and

calls for service to the London Underground decreased significantly in the six month period compared to the control hotspots (Ariel and Sherman, 2012).

4.4.1. Displacement and Diffusion of Benefits

Displacement of crime as an unintended consequence of hotspots policing has been highlighted as an area of concern (Barr and Pease, 1990; Gabor, 1990; Hesseling, 1994). Critics have highlighted that there can be many types of displacement including spatial, temporal and crime type (Repetto, 1976). Measuring all types of displacement is incredibly difficult, if not impossible, and as yet there is no evidence to completely refute its existence.

Following this critique research methods were developed to measure the, primarily spatial, displacement of crime which uncovered the diffusion of benefit effect (Clarke and Weisburd, 1994; Ratcliffe and Makkai, 2004; Ratcliffe and Breen, 2011; Bowers and Johnson, 2003; Bowers et al., 2011).

The most recent evaluation of hotspots policing found that, in the studies which measured displacement and diffusion effects, there were crime prevention benefits (Braga et al., 2012). Even when displacement does occur it is possible that the overall impact is still a crime reduction (Ratcliffe et al., 2011; Bowers et al., 2011). Although spatial displacement of crime cannot be entirely ruled out it appears that diffusion of benefit is at least equally, if not more, likely (Bowers et al., 2011; Weisburd et al., 2006; Braga et al., 2012). The lack of evidence to support spatial displacement and the presence of diffusion of benefit is consistent with the theories of routine activities, rational choice and crime pattern as it suggests that offenders are less likely to commit crime in locations which are unfamiliar to them (Weisburd et al., 2006; Bowers et al., 2011).

4.5. Summary

Crime concentrates in space and time. These are hotspots. Despite the limited research into crime concentration in the UK, it is hypothesised that crime concentrates to a similar degree as the studies in the US. The accurate definition and identification of crime hotspots is complex, in practice the processes employed are simplistic. Despite the

increasing availability of software packages and the improvement in the accuracy of geocoded data there is still a reliance on professional judgement over data analysis (Bond and Braga, 2013; Ratcliffe, 2004b; Lum, 2009; Lum et al., 2012; Rousseau, 2006; Sherman, 2013). Of all evidence-based policing strategies the evidence for targeting police resources at hotspots is the strongest, both in terms of the volume of substantive research and the effect sizes in terms of crime reduction.

5. Methods

5.1. Study Area

The study is the north west of Northern Ireland which encompasses approximately 2,410 square kilometres. The most recent population statistics indicate that the usual resident population is 226,294 (Northern Ireland Statistics and Research Agency, 2014). Over ninety-five percent of the landmass has been designated as rural by the Northern Ireland Planning Service (2005) which accounts for approximately a third of the population. Over two thirds of the study area population live in urban areas. The four main conurbations are Londonderry (population 85,000), Strabane (population 17,500), Limavady (population 12,000) and Magherafelt (population 8,500). Just over half of the population live in these four towns which encompass just two percent of the landmass and is the location for over three quarters of all crime in the region.

In terms of ethnicity and nationality, the north west of Northern Ireland is a homogenous society with over ninety-eight percent of the population being of white ethnicity and over eighty-nine percent of residents were born in Northern Ireland and a further seven percent were born in another country in the United Kingdom or the Republic of Ireland.

The main cause of segregation in Northern Ireland is political ideology, the divide between Unionists who want to remain part of the United Kingdom and Nationalists who want to be part of the Republic of Ireland. Since political affiliation is not measured in the Census, Religion is used a proxy measure as broadly speaking Unionists are Protestant and Nationalists are Catholic. On Census Day 2011, 69.1% of the residents in the study area stated they were Catholic, 28.4% stated they were Protestant, 2.5% said they belonged to a

different or no religion. However, similar to crime events, there are distinct patterns within the study area. Almost three quarters of the Census Small Areas in the north west of Northern Ireland have a majority of Catholic residents. This is the lowest geographical area for which data is available however it is expected that there are differences within the Census Small Areas.

This creates a challenging environment in terms of police resource allocation. In addition to the ongoing terrorist threat, which makes it difficult for officers to patrol certain geographical areas, there is also pressure to ensure that resources are divided equally between each community. It is not unusual to be asked to identify hotspots in both Nationalist and Unionist areas separately which is methodologically unsound. Continuing to deploy resources to locations with less need to appease political opinion cannot be a cost-efficient or effective strategy. Objectively identifying hotspots using robust statistical routines will help to ensure informed conversations with local communities and partner agencies about ensuring that service provision is directed to the locations with greatest need where there can be the most benefit.

The average crime rate per 1,000 people over the study period was 74, in urban areas the rate was 97 and 28 in rural areas. The higher crime rates in urban areas than rural areas are consistent with routine activities theory (Sherman, 1995) and it is expected that a large number of the crime concentrations will be in urban areas. However this does not preclude the existence of crime concentrations in more rural areas. Furthermore it is not realistic or ethical to only deploy police resources in the urban areas. For this reason the analysis will assess the concentrations in both the urban and rural regions of the study area.

Table 1 has been compiled from information on various studies of crime concentration collated by Weisburd (2015) and a further study in Vancouver (Curman et al., 2015) and shows how the study area compares on key characteristics. The table indicates that the study area is geographically larger with a smaller population density although the length of the street segments and the violent crime rate is fairly similar to the smaller cities examined in previous studies.

Characteristics	Population	Land Area (sq km)	Population Density (per sq km)	Number of Street Segments	Average length of Street Segment (m)	Number of Violent Crimes per 1,000
Current Study						
North West, Northern Ireland, UK	226,294	2,410	94	19,217	242	3.8
Londonderry, Northern Ireland, UK	85,016	34	2,504	4,908	80	5.8
Strabane, Northern Ireland, UK	17,670	6	3,008	843	86	3.1
Limavady, Northern Ireland, UK	12,135	5	2,602	803	76	3.7
Magherafelt, Northern Ireland, UK	8,372	4	1,956	613	85	4.4
Rural North West, Northern Ireland, UK	103,101	2,361	44	12,050	338	2.1
Previous Studies						
Cincinnati, Ohio, USA	296,204	206	1,438	13,550	136	9.7
Seattle, Washington, USA	626,865	217	2,821	24,023	118	6.0
Tel Aviv-Yafo, Israel	414,600	51	8,195	14,149	56	3.6
New York, New York, USA	8,289,415	789	10,506	87,279	120	6.4
Sacramento, California, USA	476,577	259	1,838	22,867	127	7.4
Brooklyn Park, Minnesota, USA	77,346	68	1,146	2,937	182	3.4
Redlands, California, USA	70,399	94	752	4,674	207	3.1
Ventura, California, USA	108,511	56	1,935	4,568	208	2.9
Vancouver, British Columbia, Canada	578,041	114	5,335	12,980	Unavailable	Unavailable

Table 1: Comparison of Study Area to Previous Studies

5.2. Data

5.2.1. Crime and Antisocial Behaviour

The study utilised police recorded data of all crimes, in accordance with the Home Office National Crime Recording Standard. The analysis will include only those crimes which are categorised as "Victim-based" – as opposed to police-generated outputs such as stop and search, traffic stops, etc. - which account for around ninety percent of all recorded crime. The analysis will also include all antisocial behaviour (ASB) incidents which are a key concern to local communities and occupy a significant amount of police time.

Rare crimes such as homicide (which includes the following offences: murder, attempted murder, manslaughter, corporate manslaughter, conspiracy to murder, causing death by dangerous driving, procuring illegal abortion) and sexual offences will be excluded from the analysis. Assaults on Police have also been removed as these tend to be secondary offences which could not be committed if the police were not present. Domestically-motivated crimes have also been excluded. Furthermore crimes which were reported during the period but occurred historically will be excluded so that the analysis provides the current picture.

Crime and ASB data for the calendar years 2012, 2013 and 2014 will be used to identify concentrations. The decision to use validated crimes and antisocial behaviour incidents instead of all calls for service was to allow for the calculation of the CHI. In order to identify concentration of harm the CHI values provided in the paper by Sherman et al. (2014a) will be used to weight the crimes. The crime classification field allowed for the identification of differences in concentration levels between crime categories and to calculate the CHI.

5.2.2. 'Locate'

'Locate' is the name of the GPS tracking software used by the Police Service of Northern Ireland. It records the locations of all incidents, police officers and police vehicles. The software also allows front-line police officers to create polygons for areas which have been identified for additional patrol; these are called 'Waymarkers'. These 'Waymarkers' are

created by police officers as and when required, primarily based on their professional judgement and current crime levels.

Data fields available for each 'Waymarker' included the geographical location, name, active time period, compliance time, description, created by and date created. The 'Waymarker' name includes the type of crime that is of concern in the location. The active time period field refers to the period when the 'Waymarker' was supposed to be patrolled and the compliance time is the amount of time each patrol was tasked to spend in the 'Waymarker'. The description field provides a rationale for the creation of the 'Waymarker' and instructions to the officers about what they are expected to do at the location. Finally, the date created field will ensure that the ‘Waymarkers’ can be compared to the correct crime and antisocial behaviour data.

5.3. Unit of Analysis

Crime concentrations can be identified at various levels including police beats, census tracts, street segments, clusters of addresses and specific addresses (Eck et al., 2005). The unit of analysis used to identify crime concentrations has moved from macro to micro in recent years (Weisburd et al., 2012). Street segments are recently emerging as a promising unit of analysis, as they seem to group similar types of premises and social demographic characteristics together so identifies small homogenous areas (Weisburd et al., 2004; 2012). The units of analysis for this study are street segments and officer defined hotspots - ‘Waymarkers’.

5.3.1. Street Segments

In general, a street segment encompasses the properties on either side of the street between junctions (Weisburd et al., 2004). Street segments are emerging as a preferred unit of analysis as they tend to group similar types of premises and social demographic characteristics together so identifies small homogenous areas (Weisburd et al., 2004; 2012).

5.3.2. Officer Defined Hotspots – 'Waymarkers'

'Waymarkers' are polygons of any shape or size which are created by manually drawing them on the 'Locate' software program. They also tend to be created for a short period of time (generally 4 weeks). As such they are difficult to compare to each other.

5.4. Procedure

The research will be a descriptive analysis of existing data to calculate the concentration of crime and harm and assess how accurately the 'Waymarkers' on 'Locate' reflect these concentrations. The following research questions will be addressed.

1. How does crime count and harm concentrate in Northern Ireland?
2. Does the concentration vary according to
    a. crime category?
    b. between urban and rural environments?
3. To what degree do 'Waymarkers' correlate with hotspots maps?

The following sections outline the procedure followed.

5.4.1. Crime Count Concentrations

There are a number of different hotspot detection techniques and the most appropriate method is linked to type of data available and the unit of analysis (Eck et al., 2005). In this study simple concentrations of crime will be used to identify hotspots which are valuable for targeting resource allocation (Ratcliffe, 2004a). The GIS (ArcMap v10.1) will be used to conduct a spatial join between the crimes and incidents and the street segments. Each crime or incident will be assigned the properties of the closest street segment using GIS spatial join functionality. This combined dataset will be used to calculate descriptive statistics including mean, mode, minimum, maximum and standard deviation for each of the three years in the study period. Using the method outlined by Clarke and Eck (2003) the percentage of all crime and antisocial behaviour incidents can be calculated for each street segment to identify hotspots. Street segments which have a higher than average plus one standard deviation number of crimes will be classified as 'hotspots'. The mean and standard

deviation will be based only on the street segments where at least one crime has been recorded during the study period. All crime free streets were excluded from the calculation.

Next the stability of the hot streets will be examined by comparing the magnitude of concentration for each year and then by assessing if the same streets are problematic over time (Weisburd et al., 2004). The Pearson product-moment correlation coefficient will be calculated to measure the strength of the association between crime concentrations in 2014 with crime concentrations in 2012 or 2013. The stronger the correlation, the more likely that the street segment can be predicted to be a hotspot in 2014, based on these historic figures.

The analyses outlined above will be repeated for each of the crime categories and urban and rural locations within the study area to ascertain if there are any differences.

5.4.2. Identifying Crime Harm Concentrations

Firstly, the Crime Harm Index (CHI) will be calculated using the guidelines outlined by Sherman and colleagues (2014a). Each crime is multiplied by the starting-point number of days in prison which an offender would be sentenced to if it was a first offence and there is no aggravating or mitigating factors. These values were derived from the England and Wales sentencing guidelines. Table 2 shows the CHI values applied to each of the crime categories.

Category	Sub-Category	CHI Value
Violence against the Person	Violence with injury	20
	Violence without injury	1
Robbery		**365**
Burglary	Dwelling	20
	Non-Dwelling	20
Theft	Theft of vehicle	20
	Theft from vehicle	2
	Theft from the person	20
	Bicycle theft	2
	Shoplifting	2
	All other theft offences	2
Criminal Damage	Arson	33
	Other	2
Antisocial Behaviour		0.8

Table 2: Crime Harm Values for each Crime Category

A value of 0.8 was assigned to antisocial behaviour incidents, based on the rationale that for weighting pedestrian and traffic stops outlined by Ratcliffe (2014), suggesting that an antisocial behaviour incident is less serious than any of the reported crimes but is still harmful. This ensured antisocial behaviour was included in the harm analysis as it is of importance to local communities and demands a large proportion of officers' time.

Street segments which have a higher than average plus one standard deviation CHI value will be classified as 'harmspots'. The mean and standard deviation will be based only on the street segments where at least one crime has been recorded during the study period. All crime free streets were excluded from the calculation. Based on recent research it is hypothesised that harm will be more concentrated than counts of crime incidents (Weinborn et al., 2016).

The study will also explore the stability over time of harm concentrations which is currently unknown. The Pearson product-moment correlation coefficient will be calculated to measure the strength of the association between harm concentrations in 2014 with harm concentrations in 2012 or 2013. The stronger the correlation, the more likely that the street segment can be predicted to be a harmspot in 2014, based on these historic figures.

The analyses outlined above will be repeated for each of the crime categories and urban and rural locations within the study area to ascertain if there are any differences.

5.4.3. Comparison of 'Waymarker' Locations to Hotspots and Harmspots

The study will consider the 'Waymarkers' created in 2013 and 2014. A spatial join will be conducted using the GIS to identify the hotspots and harmspots which were included in the 'Waymarkers'. Where possible 'Waymarkers' for specific crime categories will be compared with the relevant crime categories concentrations. This data will be used to identify the percentage of false positives (the street segments that **are** included in the 'Waymarkers' but are **not** hotspots or harmspots) and false negatives (the street segments

which **are** hotspots of harmspots but **not** included in the 'Waymarkers'). Theses scores were converted into odds ratio effect sizes[1] to test the magnitude of the results.

5.5. External Validity

It is anticipated that this study will demonstrate that the predominantly American city-based studies of crime concentration are relevant to police services in the United Kingdom who, in the main, deliver a service to both urban and rural communities. However it should be noted that the findings from these studies are highly consistent despite a high degree of variability between the cities (Weisburd, 2015).

5.6. Data Limitations

5.6.1. Availability

The use of official police data provides an incomplete picture of total crime due to reporting and recording practices (Evans, 2001; Braga and Bond, 2008) although is the only data available at point level. It is also possible that the level of under-reporting is not consistent across the study area. Given the political situation in Northern Ireland it is possible that people who believe that Northern Ireland should be part of the Republic and do not recognise the legitimacy of the British Government or any of its agencies (such as the Police Service of Northern Ireland) may not report crime.

Victimisation surveys, such as the Northern Ireland Crime Survey which, may to some extent address these issues, do not provide information on the exact locations of the crimes therefore do not allow for the identification of crime concentrations.

5.6.2. Accuracy

The geo-coding accuracy of the crime and antisocial behaviour point data was assessed using the methodology outlined by Chainey and Ratcliffe (2005: 61-63). The

[1] http://www.campbellcollaboration.org/resources/effect_size_input.php

sample size of 382 records was calculated using a freely available online calculator[2] for a 95% confidence interval. A random sample of records from the complete dataset was generated using an online statistics package[3]. Over 85% of the crimes were accurately geocoded, which is acceptable for a reliable analysis (Ratcliffe, 2004c).

5.7. Summary

The methods outlined in this paper describe the analysis of routinely collected data using quick and simple crime mapping and statistical procedures which could be replicated by most police services in the United Kingdom. The methods employed will clearly assess the effectiveness of the most common hotspot identification techniques (data analysis and professional judgement) compared to each other.

[2] http://www.calculator.net/sample-size-calculator.html?type=1andcl=95andci=5andps=93490andx=61andy=20

[3] http://www.graphpad.com/quickcalcs/

Table 3 compares key demographics of the study area with the whole of Northern Ireland and the police services which have been identified as the Home Office Most Similar Forces.

Key Demographics	North West Northern Ireland	Northern Ireland	Greater Manchester	Northumbria	Nottinghamshire	West Midlands	West Yorkshire	England and Wales
Population[4]	229,489	1,840,498	2,732,854	1,434,700	801,390	2,808,356	2,264,329	57,408,654
Land Area *(sq km)*[5]	2,410	14,257	1,276	5,630	2,087	902	2,029	154,172
Population Density *(per sq km)*	95.2	130.3	2,141.7	254.8	384.0	3,113.5	1,116.0	372.4
% Males4	49.5	49.0	49.6	49.0	49.2	49.4	49.2	49.3
% Children *(0-17 years)*4	25.1	23.5	22.5	19.5	20.3	23.8	22.6	21.3
% Young Adults *(18-24 years)*4	9.5	9.2	9.9	10.1	7.9	10.7	10.2	9.1
% Adults *(25-59 years)* 4	46.8	46.6	47.0	45.6	45.9	45.2	46.0	46.5
% Older People *(60 years and older)*4	18.7	20.7	20.5	24.7	25.8	20.3	21.1	23.1
% White Ethnicity[6]	98.8	98.2	83.7	94.5	95.5	70.1	81.7	80.7
Crime Rate 2014/15[7]	54.9	56.1	73.3	50.8	90.4	62.8	69.7	62.4
ASB Rate 2014/157	30.2	33.1	49.2	54.1	47.9	23.3	27.2	33.5
Crime and ASB Rate 2014/15	85.1	89.2	122.5	104.9	138.2	86.1	96.9	95.9
Crime and ASB Density *(per sq km)*	8.1	11.5	262.8	27.1	51.3	268.4	108.2	35.7

Table 3: Comparison of Study Area to other United Kingdom Police Services

[4] Office for National Statistics (2015) MYE2: Population Estimates by single year of age and sex for local authorities in the UK, mid-2014 retrieved on 05/05/2015 from http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-368259

[5] Office for National Statistics (2014) County and Unitary Authority Boundaries retrieved on 21/10/2015 from https://geoportal.statistics.gov.uk/geoportal/catalog/content/filelist.page?redirect=Docs/Boundaries/County_and_unitary_authorities_(E+W)_2014_Boundaries_(Full_Extent).zipandpos=3andcat=#BD_County_and_unitary_authorities_(E+W)_2014_Boundaries_(Full_Extent).zip

[6] Office for National Statistics (2013) 2011 Census: Key Statistics and Quick Statistics for Local Authorities in the United Kingdom retrieved on 21/10/2015 from http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-327143

[7] Police Service of Northern Ireland (2015) Latest Annual Trends Bulletin, period ending 2014/15 retrieved on 21/10/2015 from http://www.psni.police.uk/index/updates/updates_statistics/updates_crime_statistics.htm and Office for National Statistics (2015) Crime in England and Wales, Year Ending March 2015 retrieved on 21/10/2015 from http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-373428

6. Results

6.1. Roadmap and Major Findings

The following chapter will outlines the detailed results of the findings for each research question. Firstly an overview of the major findings is presented. Secondly, the descriptive statistics of the data will be reported, next the level of crime concentration will be reported and the level of crime concentration for each year of the study period will be examined. Next the locations of the hotspots and harmspots will be identified and the results of the Pearson product-moment correlations reported to assess the stability of the locations of concentrations - hotspots and harmspots. Comparisons to existing research evidence on crime concentration will be presented and finally the data analysis hotspots and harmspots will be compared to the professional judgement 'Waymarkers'.

6.1.1. How does crime count and harm concentrate in Northern Ireland?

Crime is concentrated in the North West of Northern Ireland and the degree of concentration is consistent with the "law of crime concentration" bandwidth (Weisburd, 2015: 143). Approximately 2.5% of street segments accounted for 50% of crime. As expected the degree of concentration is more similar to the smaller cities that have been previously studied (Brooklyn Park, Redlands and Ventura) (Weisburd, 2015). Furthermore, the degree of concentration is comparable over each of the three years in the study period. More importantly, there is a high level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period. In terms of crime counts, the Pearson coefficients were around r=.80.

Also as expected, crime harm is more concentrated than count (Weinborn et al., 2016). Half of all harm is concentrated in just 1% of street segments which is stable over the study period. However the degree of consistency in the locations of harmspots was lower than for hotspots, with the Pearson coefficients around r=.40.

6.1.2. Does the concentration vary according to crime category?

As crime harm is closely associated with crime category in this analysis unsurprisingly there were differences in the level of crime concentration. Violence against the person offences are the most concentrated in terms of both count (1.1% of street segments account for 50% of crime) and harm (0.8% of street segments account for 50% of harm). However the biggest difference in the degree of concentration between count and harm is for criminal damage, 2.4% of street segments account for 50% of crime compared to just 1.5% of street segments accounting for 50% of harm. The degree of crime concentration was stable across each year of the study period for each crime type.

The level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period for each crime type varies. Again violence against the person offences demonstrate the highest levels of consistency with Pearson correlation coefficients of around r=.70.

6.1.3. Does the concentration vary between urban and rural environments?

Crime is most concentrated in rural areas with 73.2% of street segments being crime free during the study period. This is likely due to the topographic and demographic features of this area as there will be larger sections where people do not live or frequent therefore few potential targets. Crime is least concentrated in the largest town (Londonderry) although 41.8% of streets are still crime free; this is probably due to the large availability of suitable targets in this a fairly small geographical area. The level of concentration in each of the towns is consistent with the “law of crime concentration” bandwidth (Weisburd, 2015: 143). Overall, concentration levels for 50% of crime were relatively stable over time with less than a one percentage point variation between the three years in all locations. In all of the main towns the degree of concentration increased year one year.

In both urban and rural areas there is a high level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period. In terms of crime counts, the Pearson coefficients were at least r=.66.

6.1.4. To what degree do 'Waymarkers' correlate with hotspots maps?

Professional judgement hotspots - 'Waymarkers' - accounted for 8.5% of the landmass and 18.6% of street segments which captured 30.8% of all crimes and 30.6% of the harm. Statistical analysis identified 1.4% of street segments as hotspots which account for 39.1% of crime and 0.9% of street segments as harmspots which account for 51% of harm.

'Waymarkers' identified 4,070 street segments as 'hot' compared to the statistical analysis identifying just 263. Of the 263 statistically identified hotspots just 99 were correctly included in the 'Waymarkers'. Statistical analysis identified just 164 harmspots, of which 59 were correctly included in the 'Waymarkers'. Therefore, vast majority (>97%) of street segments which were included in 'Waymarkers' were not identified as hotspots or harmspots. These patterns were replicated in each of the towns included in the study area and for each crime type.

6.2. Descriptive Statistics

6.2.1. Crime and Antisocial Behaviour Data

The analysis was based on over 50,000 crimes and incidents which were reported and occurred during the three year period in the North West of Northern Ireland. Table 4 below shows the numbers and types of crimes included in the study. Overall crime count has reduced year on year during the study period however harm has not followed the same pattern. More than 40% of the demand in each of the three years is in relation to Antisocial Behaviour (ASB) which indicates that police officers spend a significant amount of time dealing with non-crime related matters. Violence against the Person, Theft and Criminal

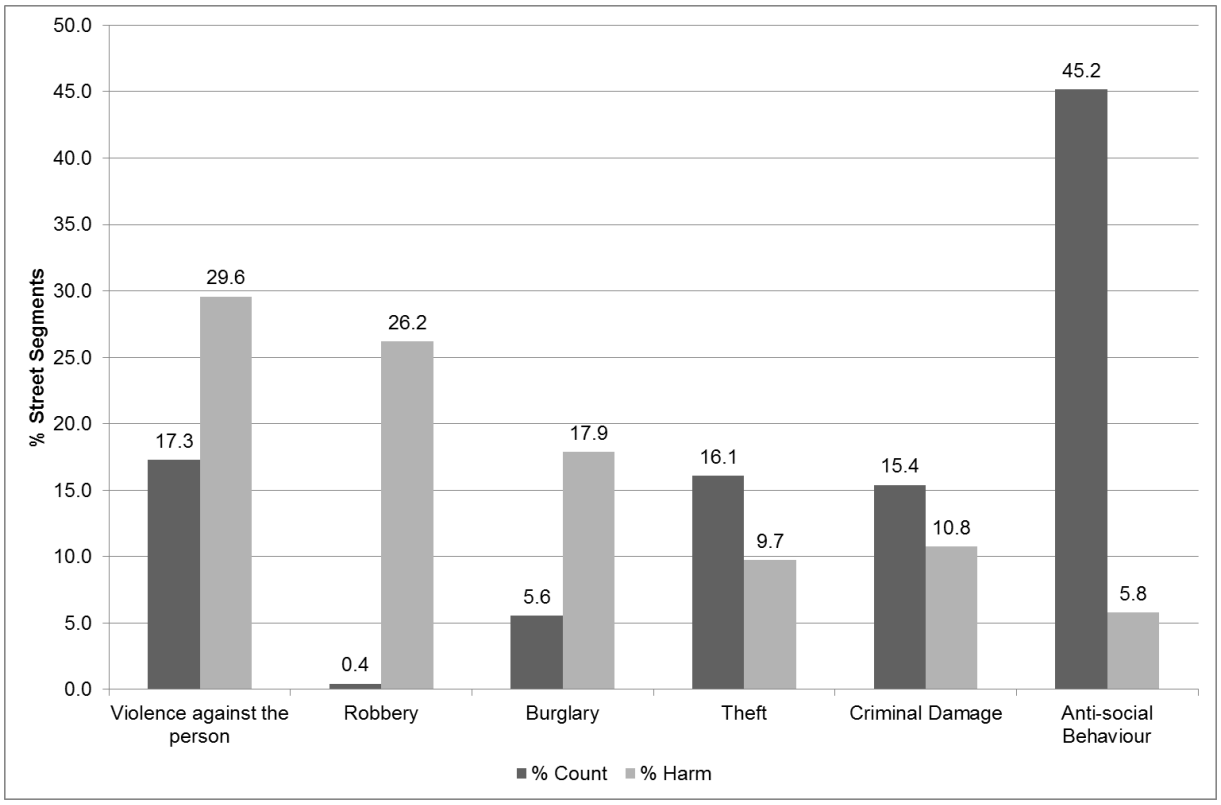
Damage offences are the most common crime categories. Burglary and Robbery account for 5.6% and 0.4% respectively, of all crime and ASB.

Category	Sub-Category	2012	2013	2014
Violence against the Person	Violence with injury	1,594	1,471	1,356
	Violence without injury	1,378	1,418	1,465
	Total Violence against the Person	**2,972**	**2,889**	**2,821**
Robbery	Personal	52	45	52
	Business	24	20	32
	Total Robbery	**76**	**65**	**84**
Burglary	Dwelling	599	536	578
	Non-Dwelling	386	355	346
	Total Burglary	**985**	**891**	**924**
Theft	Vehicle offences	573	578	599
	Theft from the person	50	67	33
	Bicycle theft	92	72	87
	Shoplifting	510	565	657
	All other theft offences	1,507	1,380	1,316
	Total Theft	**2,732**	**2,662**	**2,692**
Criminal Damage		**2,965**	**2,437**	**2,335**
Antisocial Behaviour		**8,539**	**7,239**	**6,913**
Total Crime and ASB		**18,269**	**16,183**	**15,769**

Table 4: Count of Crime and ASB in the North West by Category and Year

Figure 1 compares the crime count and harm by crime categories. When considering the harm associated with each crime category Violence against the Person continues to account for the largest proportion, however robbery and burglary are now second and third most common. ASB only accounts for 5.8% of harm compared to 45.2% of count.

Figure 1: Comparison of Crime Count and Harm in North West by Crime Category, 2012-2014



This pattern is replicated in each of the towns across the study area (see Appendix 10.1). However there are differences between the total percentage of crime count and harm attributable to each location. Table 5 shows the crime count and harm for each of the locations within the study area. The largest conurbation in the study area, Londonderry, accounts for 55.4% of crime and ASB and 59.5% of all harm. The smaller towns and rural areas all account for less harm than volume.

Location	Count	Harm	% Count	% Harm
North West	50,221	313,272	100	100
Londonderry	27,815	186,396	55.4	59.5
Strabane	3,165	18,270	6.3	5.8
Limavady	4,541	23,808	9.0	7.6
Magherafelt	3,003	14,296	6.0	4.6
Rural North West	11,697	70,502	23.3	22.5

Table 5: Crime Count and Harm by Locations within Study Area, 2012-2014

6.2.2.'Waymarker' Data

It was intended to use 'Waymarker' data for 2013 and 2014 however uptake of the software was slow and ‘Waymarkers’ were not created until September 2013. Only ‘Waymarkers’ from 2014 have been included and will be compared to the crime concentration data for the same calendar year. In 2014, 79 ‘Waymarkers’ were created which accounted for 8.5% of the total landmass and 18.6% of street segments in the study area, 30.8% of all crime and 30.6% of harm. Table 6 summarises the key features of the ‘Waymarkers’ by crime category.

Crime Category	Number of ‘Waymarkers’	% Landmass (Sq Km)	% Street Segments	% of Crime in ‘Waymarkers’	% of Harm in ‘Waymarkers’
All Crime and ASB	79	8.5	18.6	30.8	30.6
Violence Against the Person	1	0.0	0.4	1.5	1.2
Domestic Burglary	12	0.8	3.8	13.3	13.3
Vehicle Crime	3	0.9	1.8	5.0	4.7
Criminal Damage	1	0.0	0.0	0.1	0.1
Antisocial Behaviour	27	0.2	3.0	10.1	10.1
General	35	6.6	13.1	N/A	N/A

Table 6: ‘Waymarker’ Details by Crime Category

The most commonly created 'Waymarkers' are in relation to Domestic Burglary and ASB which is consistent with the local policing priorities in the North West. Despite Violence against the person offences accounting for the highest proportion of both count and harm only one 'Waymarker' was created to tackle this problem.

The ‘General’ category includes locations of concern in relation to rural crime, road accidents, drugs and the security situation. In some cases the 'Waymarker' was created for increased patrol although it was unclear what the perceived problem in the location was.

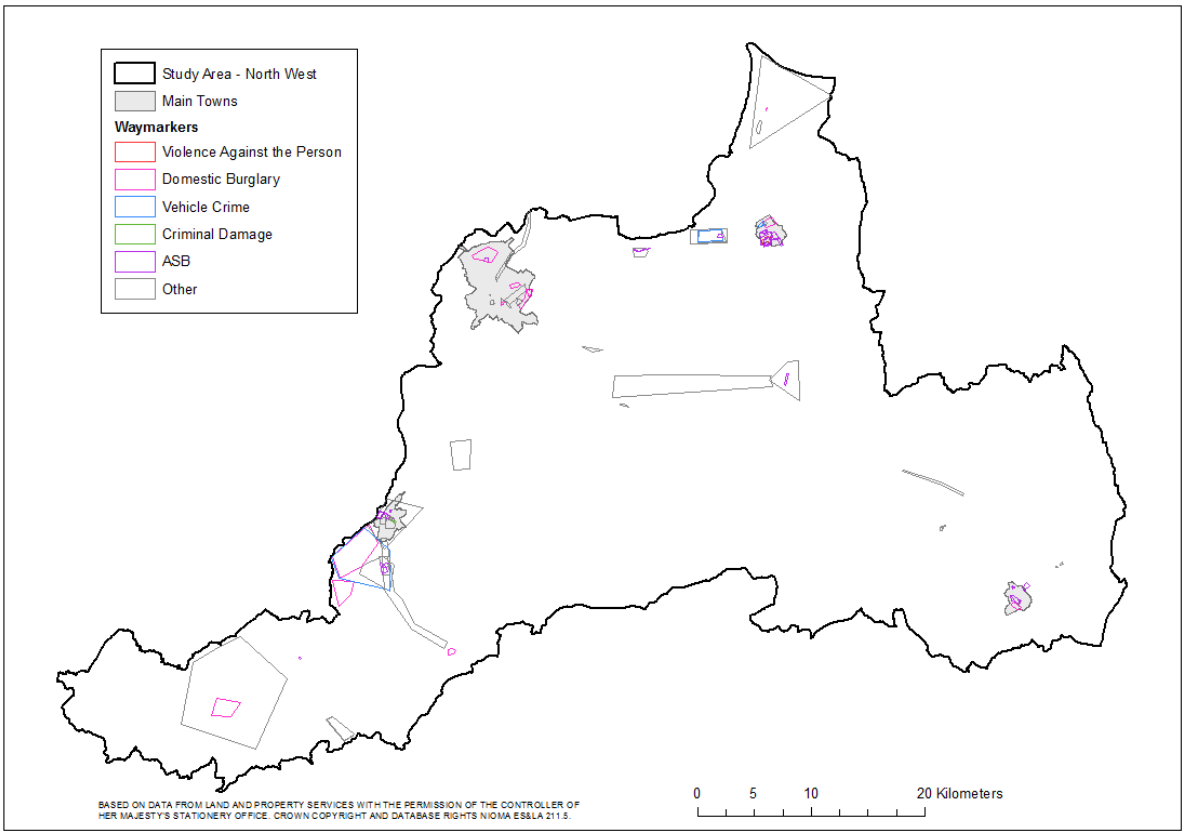
6.2.3. Locations of 'Waymarkers'

Table 7 shows the breakdown of the key features of the 'Waymarkers' by location. Figure 2shows the geographical location of each of the 'Waymarkers'. See Appendix 10.2 for maps of the 'Waymarkers' in each of the main towns.

Location	Number of 'Waymarkers'	% Landmass (Sq Km)	% Street Segments	% of Crime in 'Waymarkers'	% of Harm in 'Waymarkers'
North West	79	8.5	18.6	30.8	30.6
Londonderry	13	18.3	21.3	18.9	19.1
Strabane	9	211.1	94.7	101.3	101.3
Limavady	11	77.2	54.4	78.5	80.5
Magherafelt	9	19.3	23.7	28.5	25.2
Rural North West	37	7.7	13.7	22.5	24.7

Table 7: 'Waymarker' Details by Location

Figure 2: Locations and Types of 'Waymarkers'



Note that a number of 'Waymarkers' overlap each other in all locations. This may happen because the location has been created for different crime categories or the location

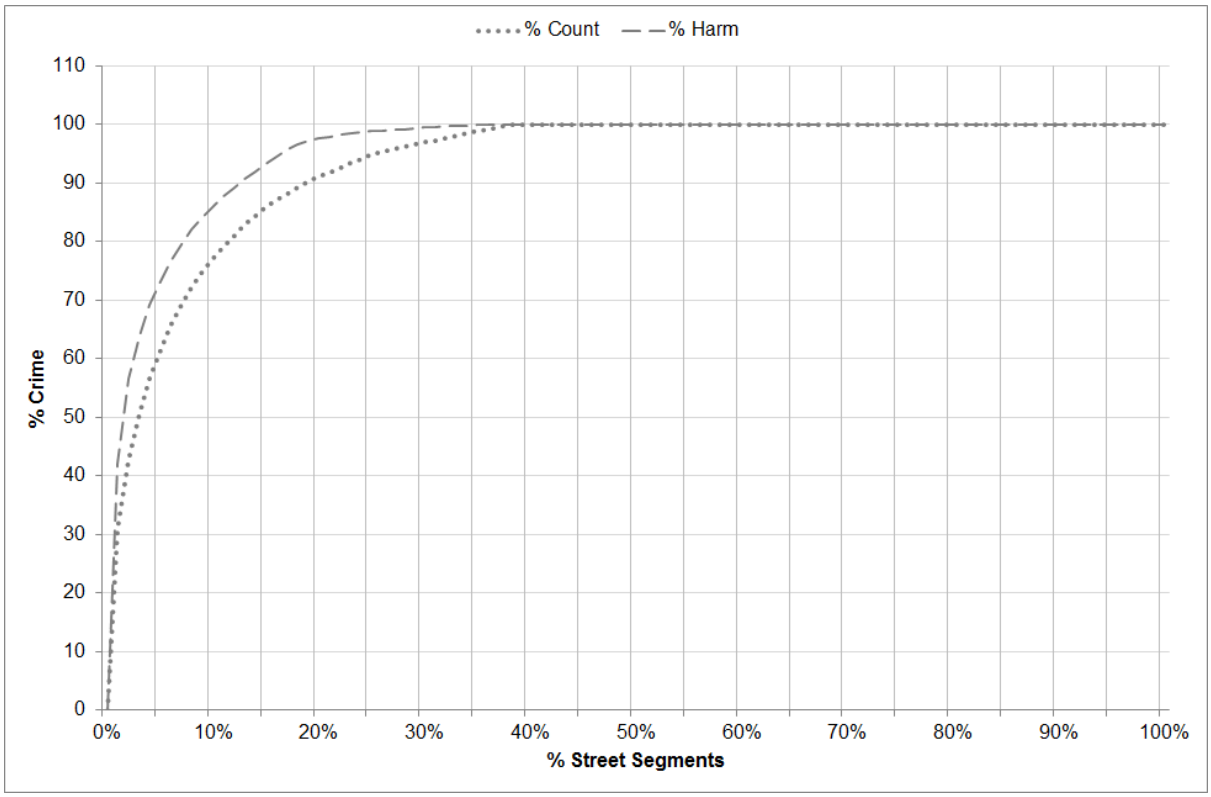
has been identified on more than one occasion as a hotspot. This explains why the Strabane 'Waymarkers' contain more than 100% of the landmass of the town. One of the Strabane 'Waymarkers' encompasses the majority of the town. Also, some of the 'Waymarkers' extend across the boundary of the town. The percentage of crimes and harm captured in the Strabane 'Waymarkers' exceeds 100% as it includes crimes which occurred in the outskirts of the town as the 'Waymarker' extends across the boundary.

6.3. Crime Concentration

6.3.1. Level of Crime Concentration

During the study period 7,309 of the 19,217 street segments recorded at least one crime or ASB incident. This equates to over 60% of street segments being crime free during the study period. If crime and ASB were evenly distributed across all street segments each would have experienced 2.6 incidents. The average number of crimes per affected street was 6.9 during the study period. Figure 3 demonstrates that crime count and crime harm are highly concentrated.

Figure 3: Concentration of Crime Count and Harm by Street Segment



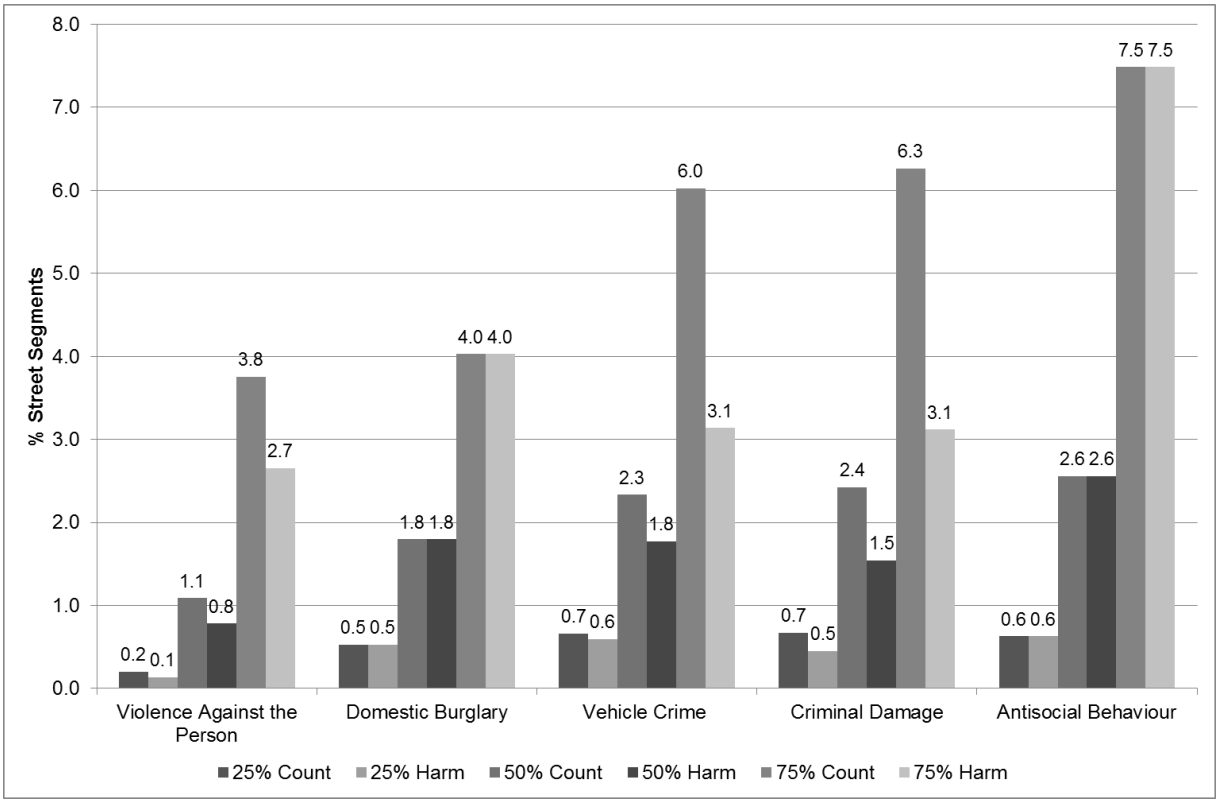
Just 5% of street segments account for 61.5% of crime count and 73.3% of crime harm. Harm is more concentrated than crime. All crime and harm occurred in just 38% of street segments. The degree of concentration varies by location, with more street segments affected in towns than in the rural area (as shown in Table 8).

	Count				Harm			
Location	**25%**	**50%**	**75%**	**100%**	**25%**	**50%**	**75%**	**100%**
North West	0.6	2.9	8.9	38.0	0.4	1.4	5.3	38.0
Londonderry	1.0	4.6	14.0	58.2	0.8	2.6	8.7	58.2
Strabane	1.7	5.2	14.8	55.3	0.7	2.4	8.1	55.3
Limavady	1.6	5.0	12.2	54.4	1.0	3.0	8.5	54.4
Magherafelt	0.8	3.4	10.6	51.5	0.5	1.5	5.4	51.5
Rural North West	0.8	3.2	8.8	26.8	0.3	1.4	5.1	26.8

Table 8: Concentration of Crime Count and Harm by Street Segment and Location

Both count and harm are concentrated in each of the main towns of the study area and in the rural areas. Levels of concentration by crime category were also examined, see Figure 4.

Figure 4: Concentration of Crime Count and Harm by Street Segment and Crime Category



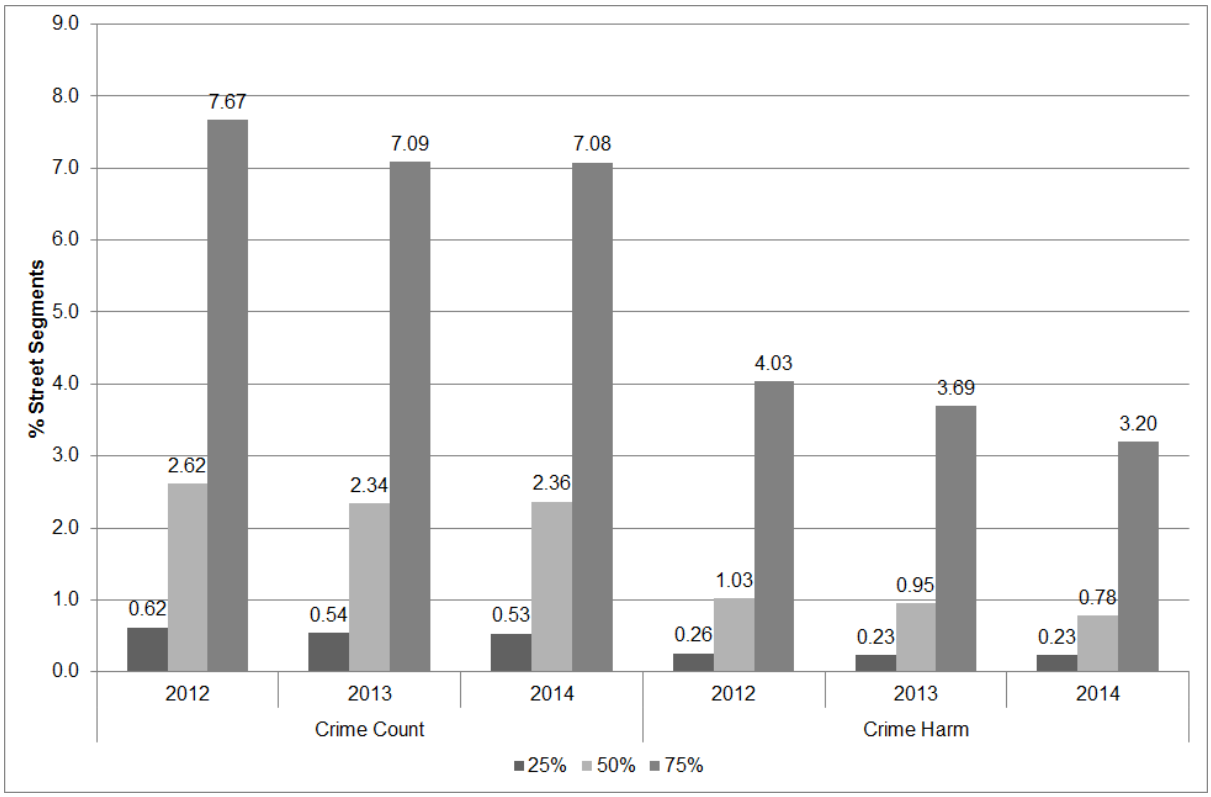
Robbery was excluded due to the small number of crimes. Harm is more concentrated than count for all crime categories, except burglary and antisocial behaviour. The crime count and crime harm concentration is the same for Burglary and Antisocial Behaviour as all offences within that crime category have the same CHI value.

6.3.2. Crime Concentration Levels over Time

The previous section demonstrates that crime and harm is concentrated across the study area, in both the towns and rural areas, and by all crime categories. Next the stability of the level of crime concentration across the study period will be examined. The level of crime concentration is stable across the three year study period, see Figure 5. Just less than 0.5% of street segments account for 25% of all crime and ASB in each year of the study (2012 = 0.62%, 2013 = 0.54%, 2014 = 0.53%). Around 2.5% of street segments accounted for 50% of crime and ASB (2012 = 2.62%, 2013 = 2.34% and 2013 = 2.36%).

As previously noted harm is more concentrated than count and again this has remained stable across each year of the study period. Around a quarter of a percent of street segments account for 25% of harm (0.26% in 2012, 0.23% in both 2013 and 2014). Half of all harm is concentrated in just 1% of street segments.

Figure 5: Concentration of Crime Count and Harm by Street Segments and Year



Next the data were examined to identify if this stability is present across each of the geographical locations in the study area (see Appendix 10.3). The level of concentration for 25% of crime was relatively stable over time with less than half a percentage point variation between the three years in all locations. Finally the levels of concentration across crime categories over the study period were examined (see Appendix 10.3). Again levels of crime and harm concentration are stable or, for most crime categories, increasing over time.

6.3.3. Locations of Crime Concentrations: Hotspots and Harmspots

This section will identify the locations of the "power few" streets which contribute the most crime and harm (Sherman, 2007). In this study street segments which have a higher than average plus one standard deviation number of crimes or CHI value will be classified as hotspots or harmspots. The mean and standard deviation will be based only on the street segments where at least one crime has been recorded during the study period. All crime free streets were excluded from the calculation.

During the study period 2.1% of street segments were identified as hotspots and accounted for 43.8% of crime across the whole study area. Only 1.8% of street segments were identified as harmspots and these locations accounted for 54.3% of harm. A similar ratio was identified across all locations in the study area (see Table 9).

Location	Year	Hotspots		Harmspots	
		% Street Segments	% Count	% Street Segments	% Harm
North West	2012	1.5	38.8	1.0	49.1
	2013	1.5	41.1	0.8	46.8
	2014	1.4	39.1	0.9	51.0
	2012-2014	2.1	43.8	1.8	54.3
Londonderry	2012	3.7	46.3	2.6	58.1
	2013	3.8	49.6	2.0	54.5
	2014	3.0	44.9	2.0	55.0
	2012-2014	5.0	51.5	4.3	61.4
Strabane	2012	2.7	34.1	1.5	37.6
	2013	2.1	30.6	0.9	31.5
	2014	2.8	43.2	1.4	58.6
	2012-2014	3.4	40.6	2.5	50.5
Limavady	2012	5.0	50.1	2.5	43.4
	2013	4.9	51.7	2.1	49.9
	2014	4.2	51.8	2.0	50.0
	2012-2014	6.6	57.2	3.9	55.8
Magherafelt	2012	2.9	50.8	1.1	56.1
	2013	3.4	52.5	1.0	47.5
	2014	3.4	52.2	1.8	59.0
	2012-2014	4.6	55.9	2.8	63.2
Rural	2012	0.3	14.9	0.2	28.7
	2013	0.2	15.6	0.2	28.8
	2014	0.3	15.9	0.2	36.5
	2012-2014	0.4	17.7	0.5	34.5

Table 9: Percentage of Hotspot and Harmspot Streets by Year and Location

Next the geographic locations were visualised on the ESRI ArcMap v10.1 software. The maps in Figure 6 and Figure 7 show the geographical locations of the hotspots and harmspots for the whole study area and the specific locations. A visual inspection of the maps indicates that hotspots and harmspots tend to cluster together. See Appendix 10.4 for more detailed maps of each of the hotspots and harmspots in each of the main towns.

Figure 6: Locations of Hotspots

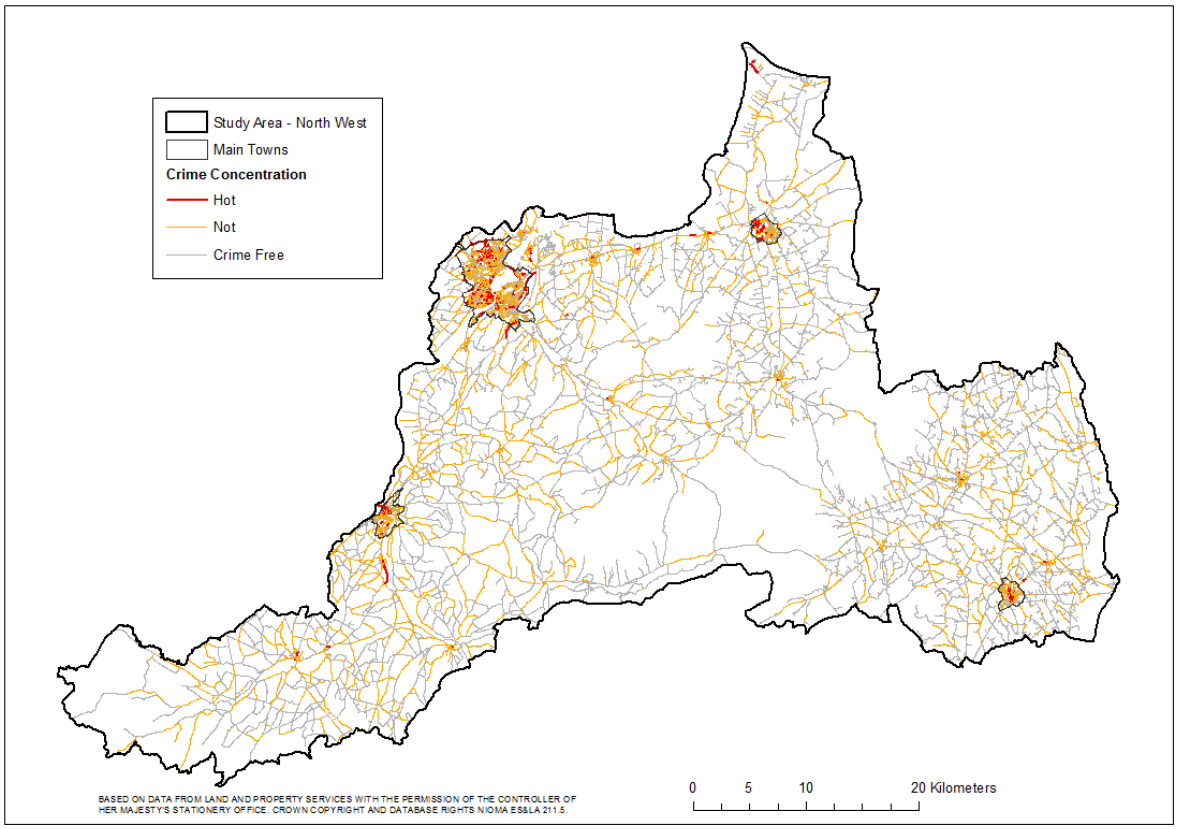
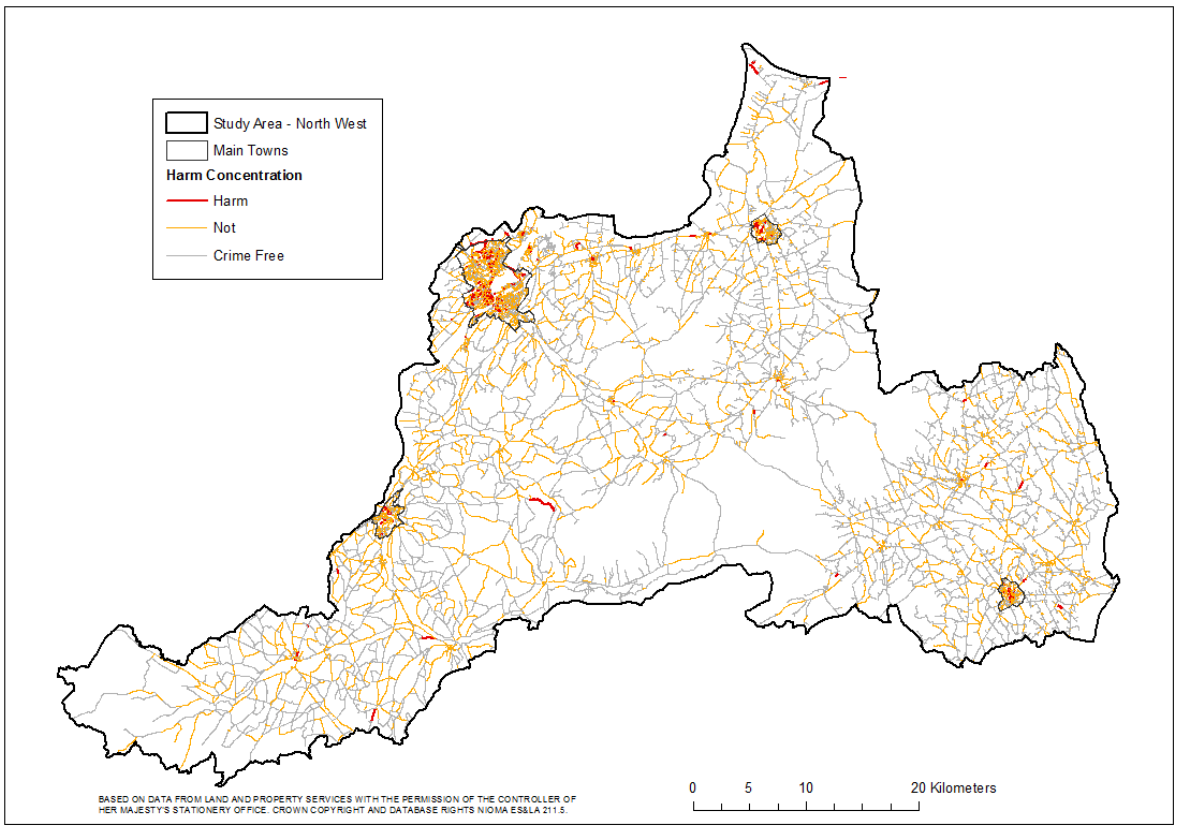


Figure 7: Locations of Harmspots



Next the locations of hotspots and harmspots were examined by crime category. Table 10 shows the percentage of street segments which have been identified as hotspots and harmspots and the percentage of crime and harm which occurred in those streets.

Crime Category	Year	Hotspots		Harmspots	
		% Street Segments	% Count	% Street Segments	% Harm
Violence Against the Person	2012	0.27	32.03	0.28	36.93
	2013	0.34	34.58	0.35	39.67
	2014	0.39	34.70	0.42	44.92
	2012-2014	0.52	37.28	0.49	41.53
Domestic Burglary	2012	0.38	27.88	N/A	N/A
	2013	0.32	28.17	N/A	N/A
	2014	0.11	14.19	N/A	N/A
	2012-2014	0.53	24.52	N/A	N/A
Vehicle Crime	2012	0.63	30.20	1.28	70.19
	2013	0.50	26.72	1.06	66.16
	2014	0.46	26.67	0.90	64.08
	2012-2014	0.84	28.43	1.59	46.07
Criminal Damage	2012	0.80	30.86	1.07	64.22
	2013	0.67	30.73	0.86	61.55
	2014	0.57	28.65	0.86	62.90
	2012-2014	1.46	38.49	2.56	68.67
Antisocial Behaviour	2012	1.07	35.39	N/A	N/A
	2013	1.09	36.69	N/A	N/A
	2014	1.00	35.54	N/A	N/A
	2012-2014	1.72	41.26	N/A	N/A

Table 10: Percentage of Hotspots and Harmspots by Year and Crime Category

The spatial distribution of the hotspot and harmspot streets was also examined using ESRI ArcMap v10.1. The maps indicate that hotspots and harmspots tend to be in the main towns for all crime categories (see Appendix 10.5).

6.3.4. Stability of Crime Concentration Locations

The analyses presented so far show that the degree of concentration and the proportion of hotspots and harmspots is stable across the study period. Perhaps more importantly it is necessary to establish if the *same* locations are problematic. Pearson

product-moment correlation coefficients were computed to assess the relationship between the number of crime and ASB incidents for hotspots and the CHI value for harmspots in each affected street segment (N = 7,309) across the study period, the results of which are summarised in Table 11.

	Hotspots		Harmspots	
	r	P	r	p
2012 v 2013	0.819	0.00	0.414	0.00
2012 v 2014	0.751	0.00	0.348	0.00
2013 v 2014	0.840	0.00	0.432	0.00

Table 11: Pearson Correlation Coefficient Results

There is a strong positive correlation between the number of crimes and antisocial behaviour incidents from year to year (r=.80). There was also a positive relationship between the harm caused by crime in each street segment from year to year although it was weaker (r=.40). This indicates that crime harm is less predictable by street segment than crime count. Further analysis was conducted to ascertain if this pattern was present in all locations (Table 12) and crime categories (Table 13).

Location		Count		Harm	
		R	p	r	p
Londonderry (N = 2,858)	2012 v 2013	0.832	0.00	0.405	0.00
	2012 v 2014	0.762	0.00	0.358	0.00
	2013 v 2014	0.866	0.00	0.458	0.00
Strabane (N = 464)	2012 v 2013	0.788	0.00	0.426	0.00
	2012 v 2014	0.723	0.00	0.342	0.00
	2013 v 2014	0.789	0.00	0.620	0.00
Limavady (N = 437)	2012 v 2013	0.739	0.00	0.643	0.00
	2012 v 2014	0.662	0.00	0.502	0.00
	2013 v 2014	0.751	0.00	0.475	0.00
Magherafelt (N = 316)	2012 v 2013	0.906	0.00	0.769	0.00
	2012 v 2014	0.864	0.00	0.635	0.00
	2013 v 2014	0.873	0.00	0.587	0.00
Rural North West (N = 3,234)	2012 v 2013	0.635	0.00	0.194	0.00
	2012 v 2014	0.550	0.00	0.132	0.00
	2013 v 2014	0.659	0.00	0.204	0.00

Table 12: Pearson Correlation Coefficient Results by Location

In all locations there are strong positive correlations in the crime count between each year during the study period, all of which are statistically significant. Again the correlations are weaker for harm across all locations. The weakest correlations for both count and harm are in the rural areas of the North West.

In terms of crime categories, for both count and harm, there are strong positive correlations between the street segments accounting for violence against the person offences. There is a weak negative correlation across the years of the study period for domestic burglary offences.

Crime Category		Count		Harm	
		r	p	r	p
Violence against the Person (N = 2,407)	2012 v 2013	0.717	0.00	0.674	0.00
	2012 v 2014	0.658	0.00	0.700	0.00
	2013 v 2014	0.734	0.00	0.724	0.00
Domestic Burglary (N = 1,210)	2012 v 2013	-0.180	0.00	N/A	N/A
	2012 v 2014	-0.193	0.00	N/A	N/A
	2013 v 2014	-0.003	0.91	N/A	N/A
Vehicle Crime (N= 2,302)	2012 v 2013	0.229	0.00	0.028	0.18
	2012 v 2014	0.181	0.00	0.048	0.02
	2013 v 2014	0.231	0.00	0.007	0.73
Criminal Damage (N = 3,001)	2012 v 2013	0.400	0.00	0.131	0.00
	2012 v 2014	0.366	0.00	0.117	0.00
	2013 v 2014	0.425	0.00	0.161	0.00
Antisocial Behaviour (N = 4981)	2012 v 2013	0.698	0.00	N/A	N/A
	2012 v 2014	0.570	0.00	N/A	N/A
	2013 v 2014	0.680	0.00	N/A	N/A

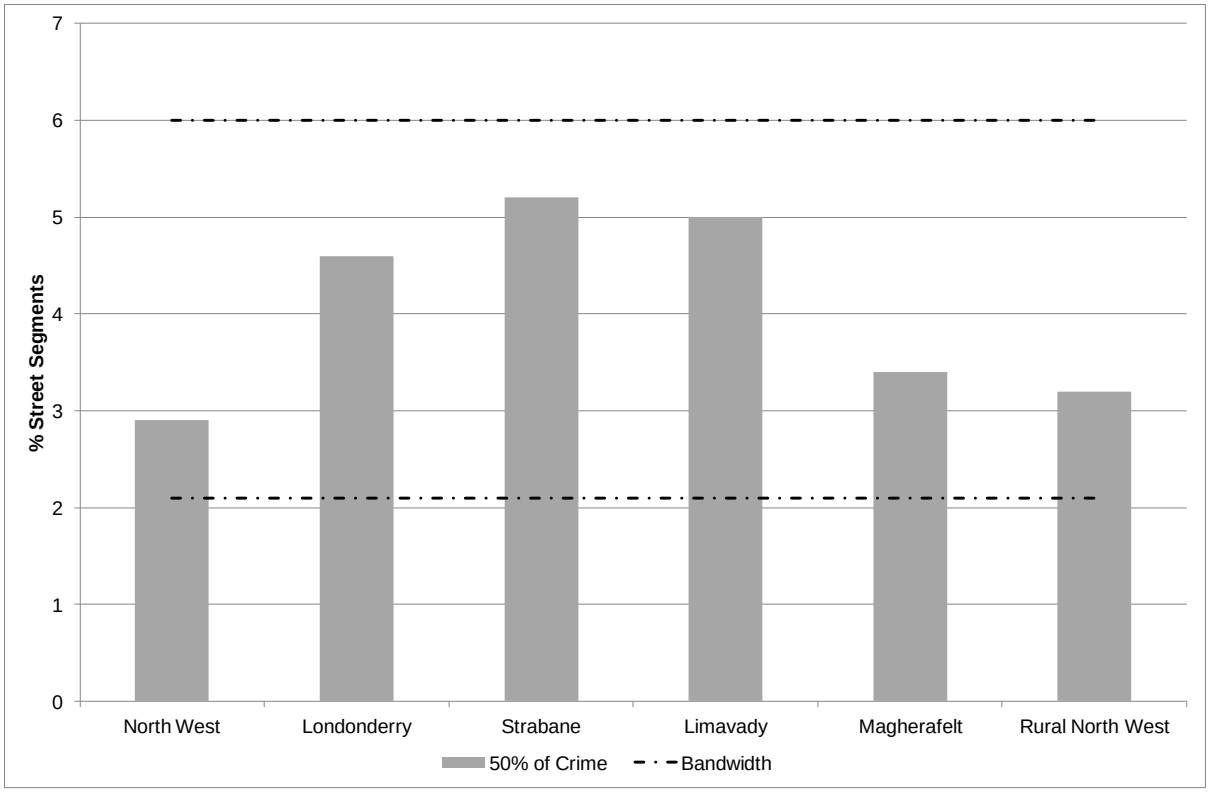
Table 13: Pearson Correlation Coefficient Results by Crime Category

6.3.5. Comparison to Existing Research Evidence

Crime is highly concentrated in Northern Ireland. This study has contributed UK evidence which is consistent with the already extensive body of research to support the "law of crime concentration" (Weisburd, 2015: 143). Figure 8 shows the level of crime concentration identified in this study compared to the bandwidth of crime concentration described by Weisburd (2015). The level of concentration in the study for 50% of crime is consistent with the bandwidth of between 2.1 and 6%. The study considered a number of

smaller towns and found that the same degree of concentration was present. Furthermore the study identified that levels of crime concentration for different crime categories are consistent the bandwidth.

Figure 8: Comparison to Law of Crime Concentration Bandwidth



The stability of the level of crime concentration was also consistent with the existing research evidence (Weisburd et al., 2004; Weisburd et al., 2012; Sherman et al., 2014a; Curman et al., 2015). Furthermore the same locations were problematic year-on-year which indicates that these places are worthy of further analysis and intervention. These results were replicated in each of the towns in the study area although the correlations between years for crime categories were weaker. However, there is evidence to support the existence of long-term stable hotspots for overall crime and most volume crime categories.

6.4. Comparison of Evidence-Based Hotspots and Experience-Based Hotspots

The final stage of the analysis is to compare the locations of the 'Waymarkers' (experience-based hotspots) to the locations of the hotspots and harmspots (evidence-based hotspots). This section will identify the percentage of false positives (the street segments that *are* included in the 'Waymarkers' but are *not* hotspots or harmspots) and false negatives (the street segments which *are* hotspots or harmspots but *not* included in the 'Waymarkers'). Table 14 shows the number of street segments which were correctly and incorrectly identified by the 'Waymarkers'. The number of correctly identified hotspots and harmspots are indicated in **bold**.

		'Waymarker'		
		Y	N	All
Hotspot	Y	**99**	164	263
	N	3,971	**14,983**	18,954
	All	4,070	15,147	19,217

		'Waymarker'		
		Y	N	All
Harmspot	Y	**59**	105	164
	N	4,011	**15,042**	19,053
	All	4,070	15,147	19,217

Table 14: Experience-Based vs Evidence-Based Hotspots and Harmspots

Overall, the majority of streets included in 'Waymarkers' were neither hotspots nor harmspots; resulting in a false positive rate of over 97%. At the same time, the majority of hotspot and harmspot streets were excluded from the 'Waymarkers', this represents a false negative rate of over 60%. The results are presented in Table 15.

	Hotspots	**Harmspots**
% False Positives	97.6%	98.6%
% False Negatives	62.4%	64.0%
Odds Ratio	2.278	2.107
95% Confidence Intervals	1.771 - 2.930	1.529 - 2.904

Table 15: False Positive and False Negative Rates of 'Waymarkers'

The odds ratios indicate that 'Waymarkers' include the wrong streets more than twice as often as they correctly identify 'hot' and 'harmful' streets [(OR=2.278; 95% CI 1.771-2.930) and (OR=2.107; 95% CI 1.529-2.904) respectively]. The same comparisons were then made for each of the main towns in the study area (see Appendix 10.6) and although there was variation between the percentages of false negatives, all locations had a false positive rate of at least 93%. The results are summarised in Table 16.

Location		Hotspots	Harmspots
North West	False Positives	97.6%	98.6%
	False Negatives	62.4%	64.0%
	Odds Ratio	2.278	2.107
	95% Confidence Intervals	1.771 - 2.930	1.529 - 2.904
Londonderry	False Positives	97.5%	97.8%
	False Negatives	82.4%	76.5%
	Odds Ratio	0.784	1.14
	95% Confidence Intervals	0.511 - 1.205	0.711 - 1.827
Strabane	False Positives	97.0%	98.5%
	False Negatives	0.0%	0.0%
	Odds Ratio	∞	∞
	95% Confidence Intervals	NaN - ∞	NaN - ∞
Limavady	False Positives	93.6%	97.3%
	False Negatives	17.6%	25.0%
	Odds Ratio	4.108	2.555
	95% Confidence Intervals	1.682 - 10.033	0.817 - 7.992
Magherafelt	False Positives	93.1%	97.2%
	False Negatives	52.4%	63.6%
	Odds Ratio	3.077	1.868
	95% Confidence Intervals	1.28 - 7.402	0.539 - 6.475
Rural	False Positives	99.3%	99.5%
	False Negatives	69.4%	70.4%
	Odds Ratio	3.231	2.668
	95% Confidence Intervals	1.587 - 6.579	1.166 - 6.104

Table 16: False Positive and False Negative Rates of 'Waymarkers' by Location

In all locations, the Odds Ratios indicate that 'Waymarkers' more often identify street segments which are not hotspots or harmspots.

Next the ‘Waymarkers’ for specific crime categories were compared to the statistically identified hotspot and harmspot street segments (see Appendix 10.7). Table 17 summarises the results which are consistent with the overall findings.

Crime Category		Hotspots	Harmspots
Violence Against the Person	False Positives	99.0%	99.0%
	False Negatives	98.7%	98.8%
	Odds Ratio	2.710	2.505
	95% Confidence Intervals	0.373 - 19.691	0.345 - 18.191
Domestic Burglary	False Positives	99.9%	N/A
	False Negatives	95.2%	N/A
	Odds Ratio	1.093	N/A
	95% Confidence Intervals	0.147 - 8.151	N/A
Vehicle Crime	False Positives	97.8%	98.0%
	False Negatives	89.8%	95.3%
	Odds Ratio	5.417	2.3032
	95% Confidence Intervals	2.699 - 10.873	1.125 - 4.716
Criminal Damage	False Positives	100.0%	100.0%
	False Negatives	100.0%	100.0%
	Odds Ratio	0	0
	95% Confidence Intervals	0 - NaN	0 - NaN
Antisocial Behaviour	False Positives	95.4%	N/A
	False Negatives	84.4%	N/A
	Odds Ratio	5.452	N/A
	95% Confidence Intervals	3.663 - 8.114	N/A

Table 17: False Positive and False Negative Rates of 'Waymarkers' by Crime Category

Professional-judgement hotspots do not reliably identify the street segments which are experiencing the highest volume of, or most harm from, crime for any of the crime categories.

7. Discussion

There are two major premises of this paper. First, to replicate the crime concentration pattern in Northern Ireland and the second, and novel, premise of this paper is that accurate identification of spatial crime concentrations is the first step to a successful hotspots policing strategy. The paper then compares the two most commonly used methods of hotspot identification: professional judgement and data analysis.

The results presented above provide United Kingdom evidence on crime concentration at place which supports the extensive body of research on the "law of crime concentration" (Weisburd, 2015: 143). Next the methods for identifying these hotspots and harmspots were examined. The results support the argument that data analysis is as good as, if not better than, professional judgment for forecasting future events (Kahneman, 2011). The vast majority (>97%) of street segments which were included in 'Waymarkers' were not identified as hotspots or harmspots.

This chapter will examine the implications of these findings. Firstly the implications for existing research will be addressed to examine what this study adds to the current evidence base and what further opportunities for research it presents. Next the practical implications of how these findings can be used to improve and develop police agencies use of hotspots policing strategies. Finally the limitations of the study will be discussed.

7.1. Research Implications

Crime is highly concentrated in Northern Ireland, with 50% of crime occurring in approximately 2.5% of all street segments. This study has contributed UK evidence to the already extensive body of research to support the "law of crime concentration" (Weisburd, 2015: 143). As expected the degree of concentration is more similar to the smaller cities that have been previously studied (Brooklyn Park, Redlands and Ventura) (Weisburd, 2015). Crime concentration patterns were observed across a range of crime types and in both urban and rural environments. Furthermore, the degree of concentration for each year is

comparable study period. More importantly, there is a high level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period. In terms of crime counts, the Pearson coefficients were around r=.80.

The results of this study also contribute to the emerging literature in relation to crime harm. Consistent with current research, levels of harm were more concentrated than crime count (Weinborn et al., 2016). However the degree of consistency in the locations of harmspots was lower than for hotspots, with Pearson coefficients of around r=.40. The variability in the consistency of the locations affected makes it difficult to identify clear policy implications. This area of study in its infancy and results to date indicate that it warrants further examination.

In itself the fact that patterns of crime concentration in Northern Ireland are consistent with research evidence is interesting. However the underlying premise of this paper is that the effectiveness of a hotspots policing strategy is inextricably linked to the accuracy and specificity of the hotspot identification process. The findings in relation to crime and harm concentration suggest that targeting locations of persistent crime concentration – 'hotspots' or 'harmspots' – is potentially a worthwhile crime prevention tactic.

Data analysis techniques identified a higher degree of concentration than professional judgement. 'Waymarkers' accounted for 8.5% of the total landmass of the study area, 30.8% of all crime and 30.6% of harm. This compares to the 7.3% of street segments which accounted for 75% of crime.

Furthermore, the findings of this research indicate that the vast majority (>97%) of street segments which were included in officer-defined hotspots - 'Waymarkers' - were not identified as 'hot' or 'harmful' using data analysis techniques. These patterns were replicated in each of the towns included in the study area and for each crime type. This is consistent with previous studies which identified that perceptions of high-crime areas are not consistent with official recorded crime data (Rengert and Pelfrey, 1997; Ratcliffe and McCullagh, 2001; Chainey and Ratcliffe, 2005).

The results show that the experienced-based hotspots were poorly aligned with the locations of crime concentration. This represents a significant amount of wasted effort. In addition, over 60% of street segments which were identified using data analysis were excluded from 'Waymarkers' which represents missed opportunities to prevent crime and harm. Thus, this study demonstrates that professional judgement and experience are not an effective method for identifying hotspots or harmspots.

Knowing that crime is concentrated, and how to identify hotspots, is not sufficient to be able to tackle the problem (Weisburd et al., 2010). Further examinations of crime concentration, while interesting, are almost redundant given the volume and consistency of the existing research evidence. "Identifying a hotspot is not the same as understanding it. The analysis phase of problem-oriented policing is often lacking in hotspots policing. Too often the data analysis team is satisfied with colourful crime maps as the final product. Rarely do we see a detailed analysis of the characteristics of the hotspot and the nature of the problem." (Rosenbaum, 2006: 248).

The more important questions are what are the underlying causes of criminality in these locations and what can be done to address them? Much more research is required to understand the criminogenic features of a hotspot to inform long-term problem solving solutions (Rosenbaum, 2006). The next stage for hotspots research is to link environmental criminology and the more traditional person-focused study of crime causation to properly identify why crime concentrates in certain locations and what tactics work to alleviate these problems. This will make the research evidence in relation to place-base crime prevention strategies more attractive to police practitioners as it will provide a comprehensive framework for reducing crime.

7.2. Policy Implications

Crime concentrates in certain locations and these locations remain the same, at least for three years. This presents crime reduction opportunities but not a complete solution

(Rosenbaum, 2006) particularly when crime levels are already historically low. Of all evidence-based policing strategies the evidence for targeting police resources at hotspots is the strongest, both in terms of the volume of substantive research and the effect sizes in terms of crime reduction. These hotspots must first be identified.

This study has demonstrated that professional judgement and experience is not an effective method for identifying hotspots or harmspots. The false positive rate in excess of 93% in all locations and for all crime categories indicates that a considerable amount of police resource is being wasted. The false negative rate of over 50% in most locations and for all crime categories represents missed opportunities to prevent crime and harm. On the other hand, the results of this study indicate the previous crime occurrence is a good predictor of future crime when identified using data analysis. The key elements for accurately identifying hotspots and harmspots using data analysis are readily available: data and technology.

The identification of crime hotspots employed in this study has relied on routinely collected data. "In data-driven analysis, accuracy depends primarily upon the accuracy and completeness of the available data" (Heuer, 1999: 59). Hence identifying hotspots should be a data-driven process as the availability and completeness of the data is as good as any information available to policing, despite under-reporting, under-recording and geocoding accuracy issues. It is certainly superior to the data available in relation to offenders, which are regularly relied on to inform crime prevention strategies.

Current technology exists to perform fairly simple spatial statistical analyses to identify long-term hotspots. The evidence-based methods employed in this study exemplify how the multi-million pound investment in crime mapping and GPS over recent years can be used for crime reduction, presumably the purpose for which they were purchased.

Furthermore, the processes involved in identifying crime concentration at street segment level are simple to compute and explain which may build trust in the data analysis techniques. This is important as the results show that the experienced-based hotspots were poorly aligned to the locations of crime concentration, despite the fact these locations had

been problematic for at least two years prior to the creation of the 'Waymarkers'. One of the perceived barriers to the use of data analysis within policing is a lack of training and understanding of crime mapping, and crime analysis more generally, therefore it essential that the processes can be easily explained to build trust and confidence in the outputs (Ratvliffe, 2004b; Lum, 2009; Barends et al., 2014).

In addition to the accuracy of the identification of the hotspots a further consideration is the ability of the police to respond. Due to the ongoing security threat in Northern Ireland there are certain areas in which it is potentially unsafe for officers to be present. It is possible that some of the identified hotspots are these locations therefore professional judgement will be required to assess what, if any, policing activities are appropriate.

In a broader context, the identification of hotspots represents only the scanning phase of developing a hotspots policing strategy. Hotspots policing tactics need to become more sophisticated in practice. It is not just about doing the same thing in a different place (Rosenbaum, 2006). Hotspots policing strategies need to become about why not just where. It needs to identify and treat the causes not just the symptoms of crime and disorder. Further analysis is required to identify the causes of the concentrations to assess what types of activities should be tested at these locations and how best to track the delivery of the outputs and the resulting outcomes (Ratcliffe, 2004b).

Identifying the interventions to be implemented at these locations may involve an experience-based approach as this involves understanding why these locations are problematic. A blend of craft and science is perhaps the best method of identifying and defining hotspots (Willis, 2013; Buerger et al., 1989; Skogan, 2008; Sherman, 1984, 1989, 2013; Braga and Bond, 2008; Barends et al., 2014). This will help ensure 'buy-in' from operational police officers who will be delivering the hotspots policing strategy (Lum et al., 2012; Telep and Lum, 2014). The debate should not be experience-based or evidenced-based but how much of each. "Evidence-based practice is not one-size-fits-all; it's the best current evidence coupled with informed expert judgment" (Rousseau, 2006: 267).

A key challenge facing all government agencies is reducing budgets which means that it is no longer possible to provide the same level of service to all sections of the community. The objective and statistically sound data-driven identification of crime concentrations can inform discussions with partners and communities about how best to ensure that resources are divided equitably, not equally, to target crime and disorder for the whole community (Ratcliffe, 2004a; Sherman, 1995: Rosenbaum, 2006). Targeting evidence-based hotspots provide a sound basis for tackling the 'power few' problem (Sherman, 2007) by combining data analysis and professional judgement.

Another consideration for targeting places is that prevention is often cheaper than cure, both in terms of financial cost and harm. Policing is under-going a period of significant change including challenging budget cuts and organisational re-structuring. Decreasing numbers of officers in front-line policing makes it imperative to ensure that these limited resources are being used to best effect. In the current economic climate professional judgement may become more difficult to justify. Reducing resources and increasing expectations will require police agencies to prioritise their activities and be able to evidence those decisions to the communities they serve. An objective, data-driven process for the prioritisation of resources to some communities, at the expense of others, is likely to be the most reasonable and acceptable approach.

7.3. Limitations of this Study

The key limitation of this study is that it is purely descriptive, it has not attempted to assess whether or not experience-based or evidence-based hotspots predict the most future crime. The study benefited from an existing data set of experience-based hotspots which were genuinely created by officers in their day to day activities rather than as part of an experiment. Officers were not asked to explain why the selected the areas were created as ‘Waymarkers’ therefore it is difficult to assess why they did not more closely match the hotspots and harmspots derived from the analysis of reported crime and ASB data.

Furthermore, it is based on police recorded data therefore may not be an accurate representation of the crime and disorder problems experienced in locations. However the classification of crime in this study is standardised across the United Kingdom which may improve the relevancy of these findings to other services.

While the consistency of the findings in relation to the magnitude and stability crime concentration is encouraging, the study has only examined a short time period. It may be that the findings are not replicated over a longer study period. Furthermore more detailed temporal analysis has not been conducted to examine the seasonal, daily or hourly trends in the data.

The research has identified that there are different levels of concentration across crime categories but it has not considered co-morbidity (Ratcliffe, 2010; Sherman, 2007). Are the same street segments 'hot' for a variety of crime types? Crime harm was included in this study and the values were based on categories of crimes rather than individual offences, it is possible that the findings may be altered if more specific CHI values were employed. This is a very innovative area of research therefore improvements in the technique are inevitable.

Despite these limitations the findings add non-US evidence to the "law of crime concentration" (Weisburd, 2015: 143) which has been developed from studies in a number of diverse cities. This suggests that other UK police services may experience similar levels of crime concentration and stability worthy of targeting. The results further support the research evidence that police officers professional judgement is not an accurate or effective method of identifying hotspots (Rengert and Pelfrey, 1997; Ratcliffe and McCullagh, 2001; Chainey and Ratcliffe, 2005). Furthermore this is consistent with studies in a number of fields which find that statistical prediction is as good as, or superior to, clinical judgement (Kahneman, 2011).

8. Conclusions

Hotspots policing is such a ubiquitous term in policing that it appears to be a standard police strategy. Despite the research evidence that it can be an effective crime control tactic there is little practical evidence that it is properly understood far less employed. Prior to implementing a hotspots policing strategy it is necessary to identify if there are spatial concentrations of crime in the jurisdiction. Often this targeting stage is paid little attention which can have a significant impact on the success of hotspots policing activity.

The importance of hotspots policing is likely to increase as police services face further budget cuts and can no longer provide the same level of service to all sections of the community. Policing needs to be able to make defensible resource allocation decisions which balance the increasing expectations of communities and partner agencies against the threat, harm and risk associated with crime.

This study examined in excess of 50,000 crime and antisocial behaviour incidents reported to the Police Service of Northern Ireland in the North West of the jurisdiction over a three year period (2012 -2014). The study area is predominantly rural with a number of medium-large towns, which is more similar to other UK police services than previous US urban focused studies. The volume of data and the structure of the study area allowed for this research to consider crime concentration patterns across crime types and in both rural and urban settings. In addition to crime counts, the harm caused by crime was examined.

The data showed that while the crime count has reduced year on year over the study period the levels of harm have not followed the same pattern. Small changes in the numbers of the most serious offence included in this study (robbery) have a significant impact on the level of harm. Robbery accounts for 0.4% of all reported crime but 26.2% of all harm. This compares to antisocial behaviour, the least serious incident considered in the research, equating to 45.2% of all reports but just 5.8% of harm.

Crime count is concentrated in Northern Ireland and it is similar to concentrations in other cities in America, Canada and Israel. Over 60% of street segments were crime free

during the study period. Approximately 2.5% of street segments accounted for 50% of crime. As expected, crime harm is more concentrated with half of harm occurring in just 1% of street segments. Not only were similar levels of concentration observed across the three years there was a high degree of correlation between 'hot' street segments year on year (r=.80). While harm was more concentrated there was less stability in the locations of harmspots (r=.40).

Although there were variations, all crime types displayed concentration patterns with violence against the person being the most concentrated (50% of crime occurred in less than 1% of street segments) and antisocial behaviour being the least concentrated (50% of ASB occurred in 2% of street segments). Variations between crime types may be explained, in part by volume, there were more than twice the number of ASB incidents than violent crimes reported during the study period (Andresen and Malleson, 2011; Sherman et al., 1989). The level of consistency in the locations of the street segments which are identified as hotspots in each year of the study period for each crime type varies. Violence against the person offences hotspots are the most stable.

This study has demonstrated that crime is concentrated in rural areas. This is likely due to the topographic and demographic features of this area as there will be larger sections where people do not live or frequent therefore few potential targets. Crime is least concentrated in the largest town (Londonderry) although 41.8% of streets are still crime free; this is probably due to the large availability of suitable targets in this location. The level of concentration in each of the towns is consistent with the "law of crime concentration" bandwidth (Weisburd, 2015: 143). In both urban and rural areas there is a high level of consistency in the locations of hotspots in each year of the study period.

This provides the basis for an effective hotspots policing strategy for a range of crime categories and in both urban and rural settings, at least for count hotspots. The study then compared the use of crime mapping software for identifying crime concentrations to hotspots created by officers using their professional judgement and experience – 'Waymarkers'.

'Waymarkers' accounted for 8.5% of the landmass and 18.6% of street segments which captured 30.8% of all crimes and 30.6% of the harm. This compares to the statistical analysis which identified 1.4% of street segments as hotspots accounting for 39.1% of crime and 0.9% of street segments as harmspots capturing 51% of harm. The study found that the majority experience-based hotspots do not correlate with evidence-based hotspots of crime.

The vast majority (>97%) of street segments which were included in 'Waymarkers' were not identified as hotspots or harmspots. These patterns were replicated in each of the towns included in the study area and for each crime type. This represents a significant amount of wasted effort. On the other hand over 60% of street segments which were identified using data analysis were excluded from 'Waymarkers' which represents missed opportunities to prevent crime and harm.

In practice, professional judgement continues to form the basis for decision making despite the availability and superiority of data analysis. The significant investment in technology will continue to be misplaced as long as it eschewed on the basis of experience and professional judgement. A combination of data analysis to identify where to target and when and professional judgement to define the policing tactic is required to develop effective hotspots policing strategies.

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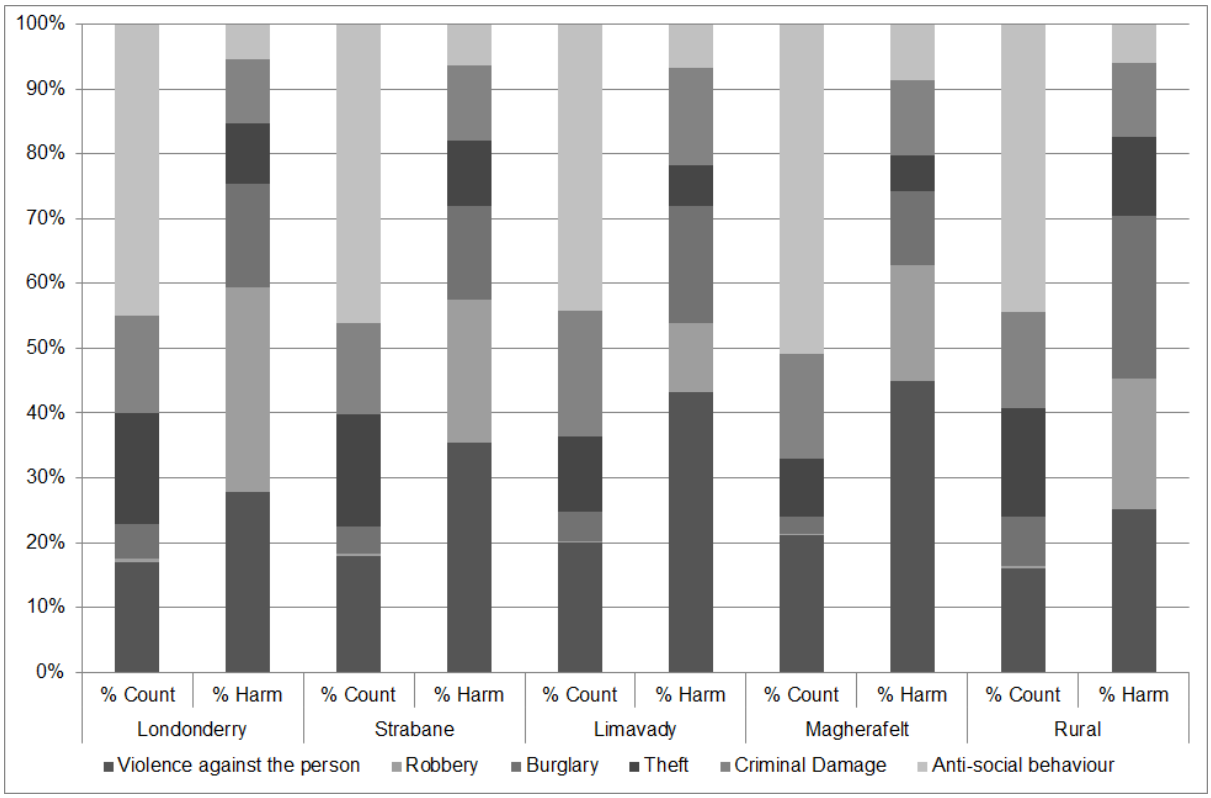
10. Appendices

10.1. Count and Harm by Crime Category and Location

Figure 9: Comparison of Crime Count and Harm by Crime Category and Location, 2012-2014



10.2. Maps of 'Waymarkers'

Figure 10: Locations and Types of 'Waymarkers' – Londonderry

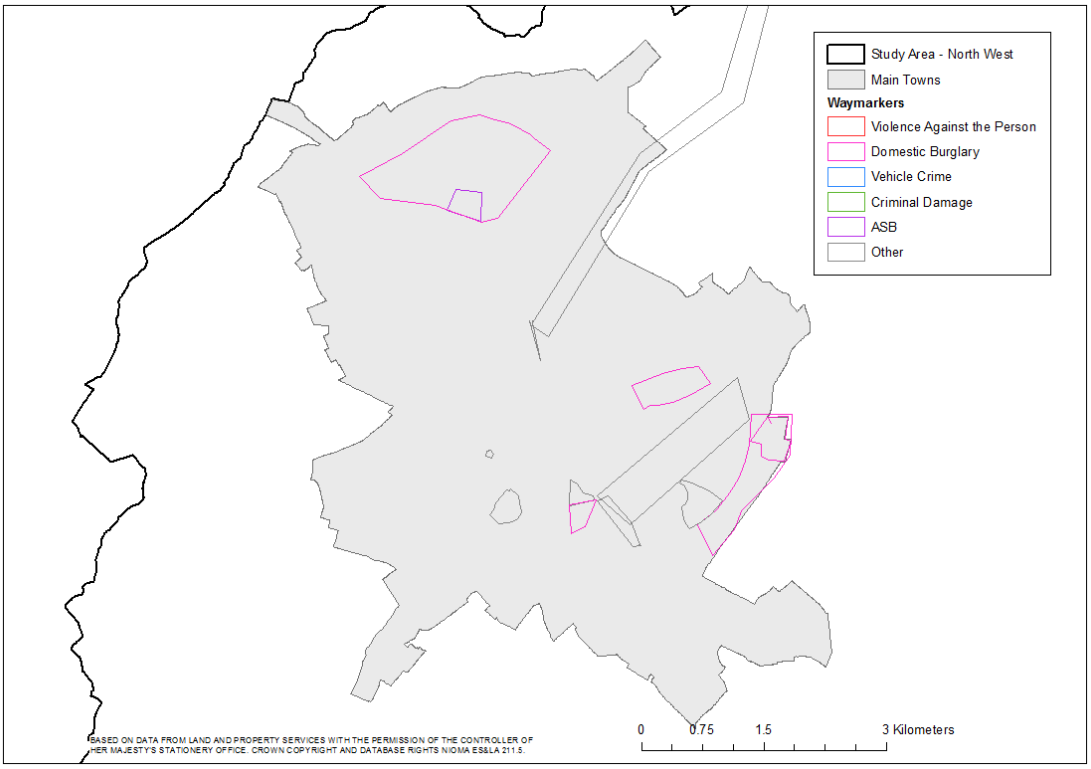


Figure 11: Locations and Types of 'Waymarkers' – Strabane

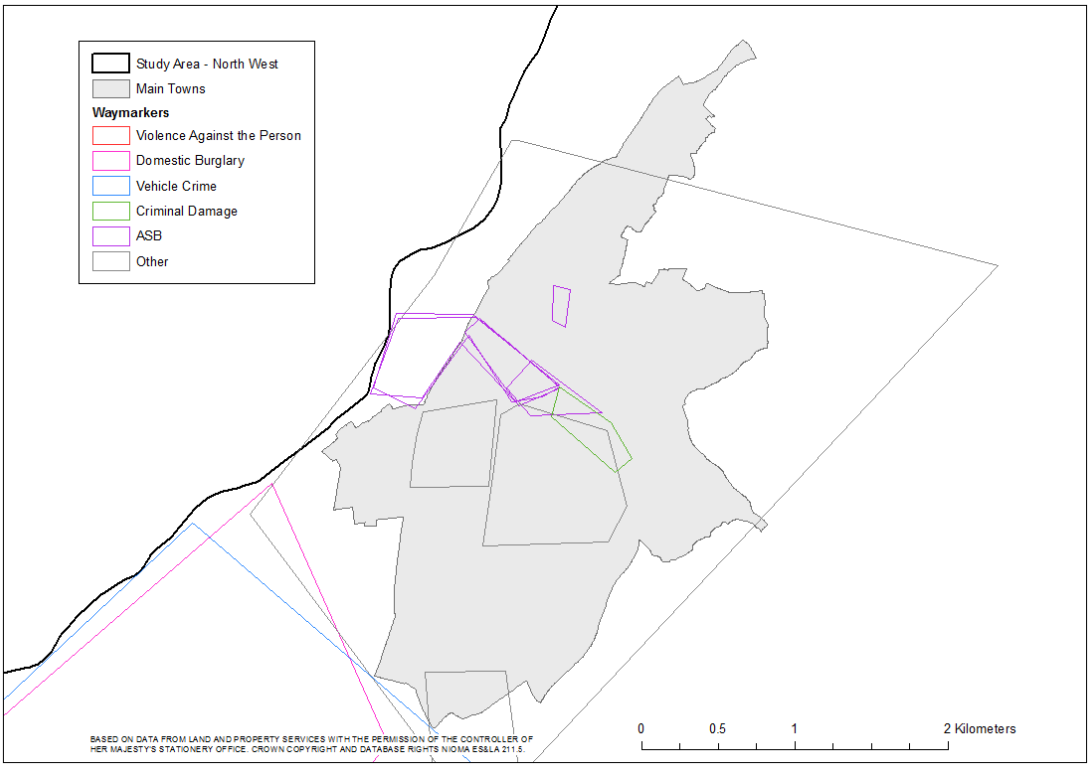


Figure 12: Locations and Types of 'Waymarkers' – Limavady

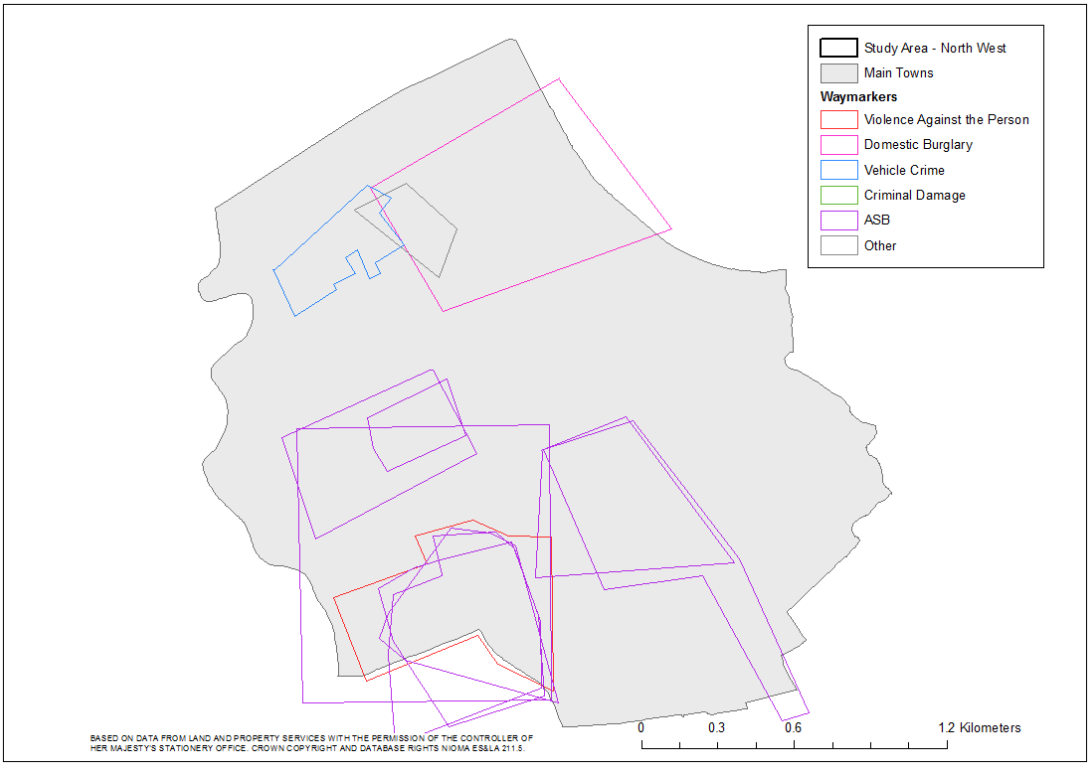
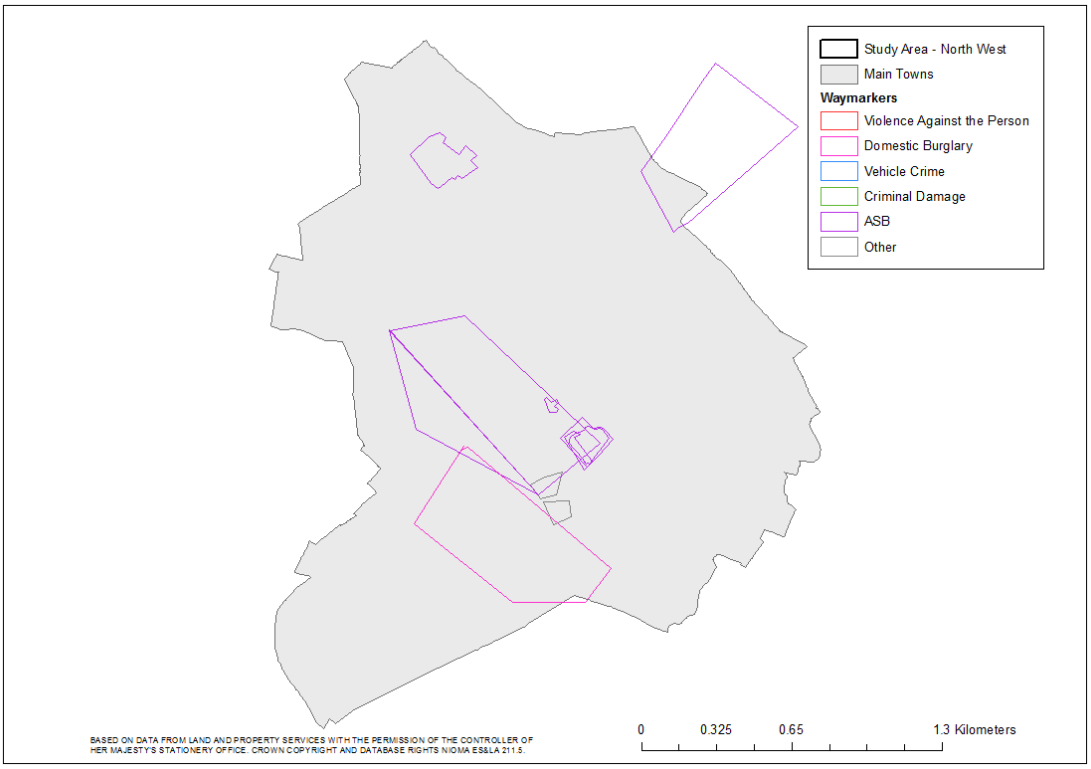


Figure 13: Locations and Types of 'Waymarkers' – Magherafelt



10.3. Crime Concentration Levels over Time by Location and Crime Category

Location	Year	Count			Harm		
		25%	50%	75%	25%	50%	75%
Londonderry	2012	1.06	4.30	12.35	0.55	1.59	6.34
	2013	0.86	3.85	11.37	0.45	1.47	6.03
	2014	0.86	3.87	11.61	0.51	1.47	5.95
Strabane	2012	1.78	5.10	13.29	0.71	2.73	6.52
	2013	1.54	4.98	12.46	0.59	2.85	7.59
	2014	1.19	3.80	10.68	0.36	0.95	3.80
Limavady	2012	1.49	4.86	12.08	0.87	3.24	8.97
	2013	1.49	4.61	10.96	0.62	2.24	6.72
	2014	1.25	3.99	9.96	0.62	1.99	5.23
Magherafelt	2012	0.65	2.94	9.30	0.33	0.82	4.40
	2013	0.82	3.10	9.14	0.33	1.14	4.40
	2014	0.82	3.10	8.97	0.49	1.14	3.92
Rural North West	2012	0.64	2.46	6.26	0.15	1.10	3.20
	2013	0.57	2.29	5.83	0.12	0.88	2.76
	2014	0.61	2.40	6.12	0.11	0.65	2.41

Table 18: Concentration by Street Segment by Location and Year

Crime Category	Year	Count			Harm		
		25%	50%	75%	25%	50%	75%
Violence Against the Person	2012	0.15	0.79	2.36	0.11	0.59	1.75
	2013	0.17	0.82	2.39	0.12	0.59	1.75
	2014	0.20	0.86	2.40	0.12	0.53	1.49
Domestic Burglary	2012	0.33	1.06	1.84	N/A	N/A	N/A
	2013	0.28	0.92	1.62	N/A	N/A	N/A
	2014	0.27	0.88	1.63	N/A	N/A	N/A
Vehicle Crime	2012	0.48	1.45	3.48	0.35	0.86	1.47
	2013	0.45	1.42	3.31	0.34	0.77	1.45
	2014	0.41	1.32	3.17	0.28	0.67	1.46
Criminal Damage	2012	0.55	1.92	4.77	0.25	0.76	1.85
	2013	0.48	1.65	4.09	0.25	0.66	1.67
	2014	0.45	1.60	3.95	0.25	0.64	1.58
Antisocial Behaviour	2012	0.55	2.13	5.89	N/A	N/A	N/A
	2013	0.52	2.02	5.56	N/A	N/A	N/A
	2014	0.49	2.00	5.45	N/A	N/A	N/A

Table 19: Concentration by Street Segment by Crime Category and Year

10.4. Maps of Hotspots and Harmspots by Location

Figure 14: Locations of Hotspots – Londonderry

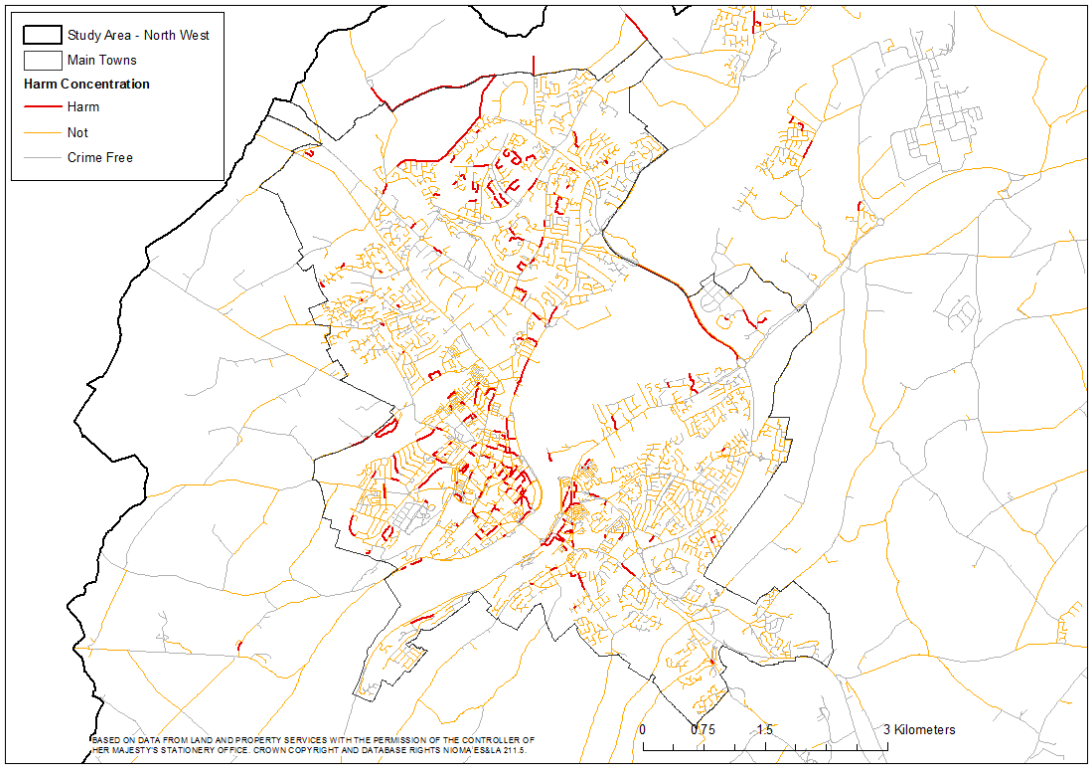


Figure 15: Locations of Harmspots – Londonderry

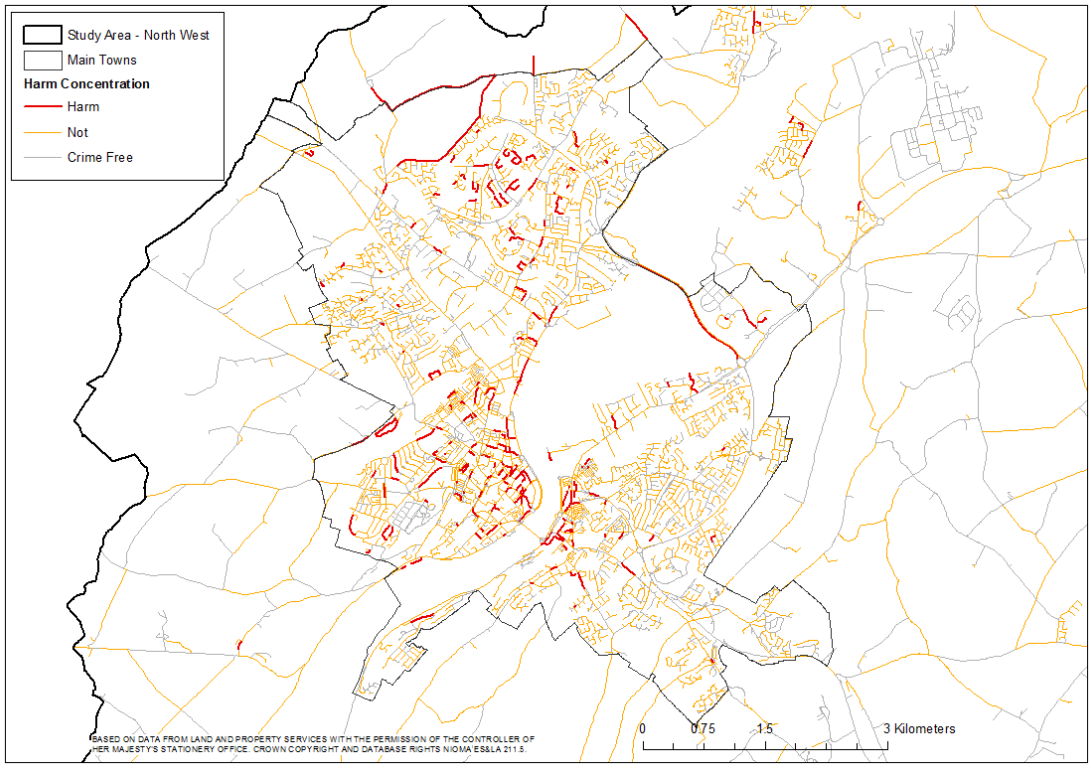


Figure 16: Locations of Hotspots – Strabane

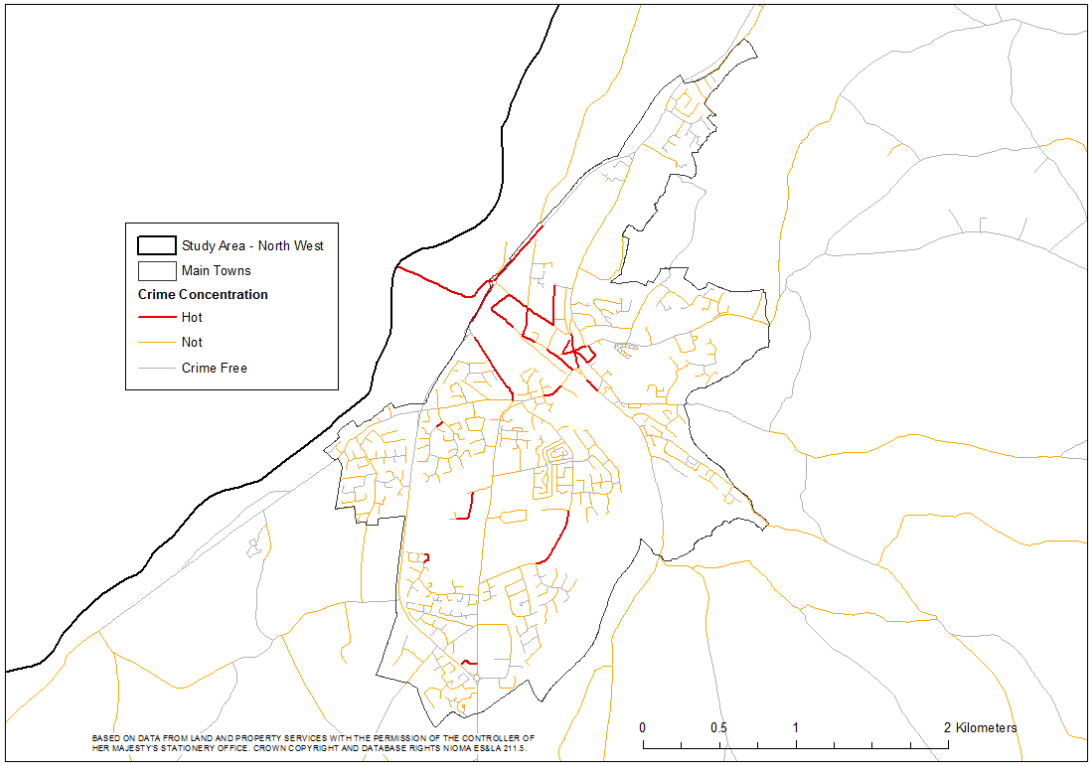


Figure 17: Locations of Harmspots – Strabane

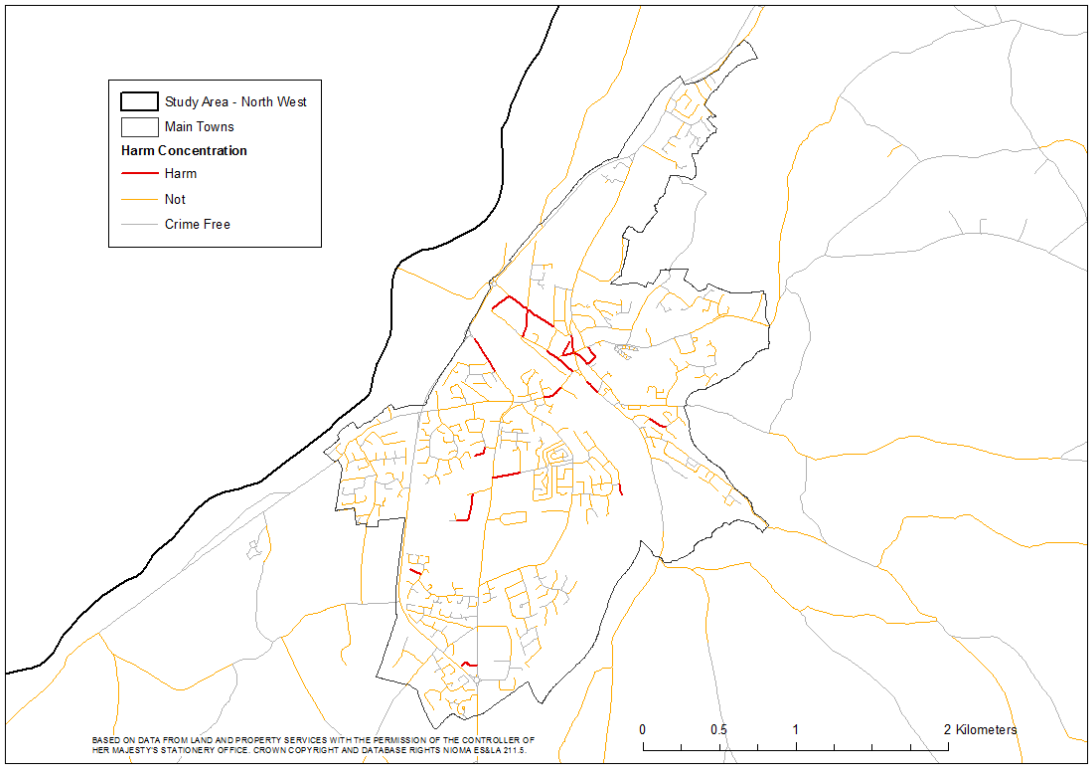


Figure 18: Locations of Hotspots – Limavady

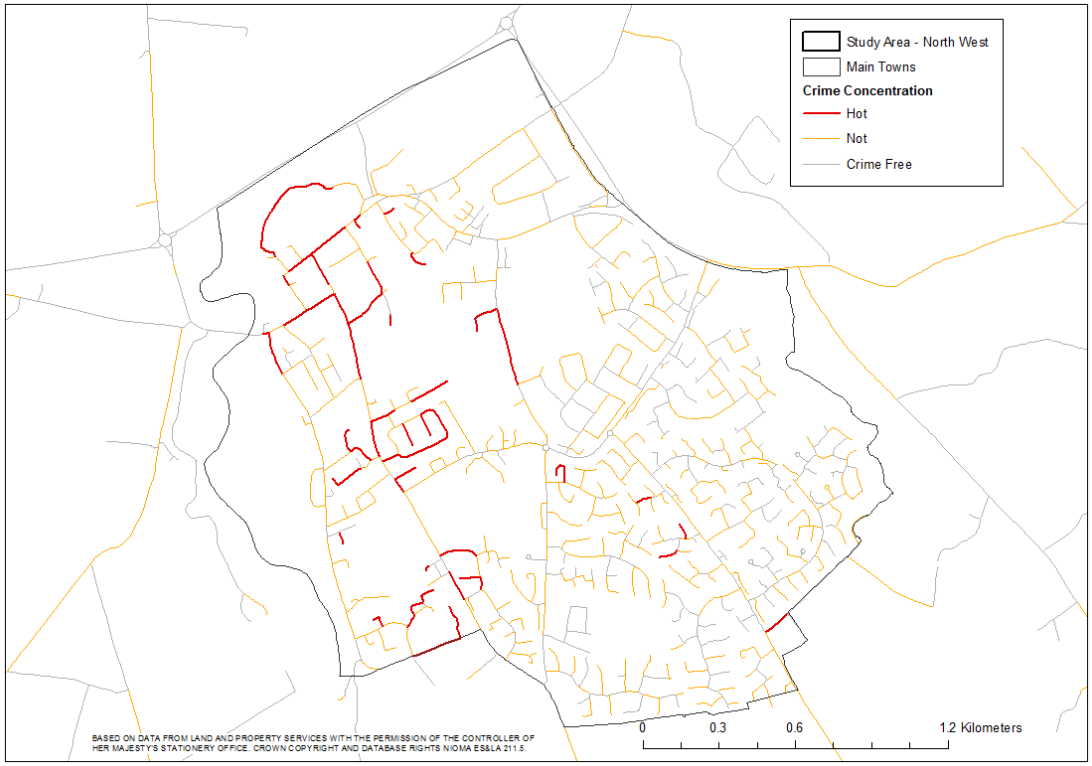


Figure 19: Locations of Harmspots – Limavady

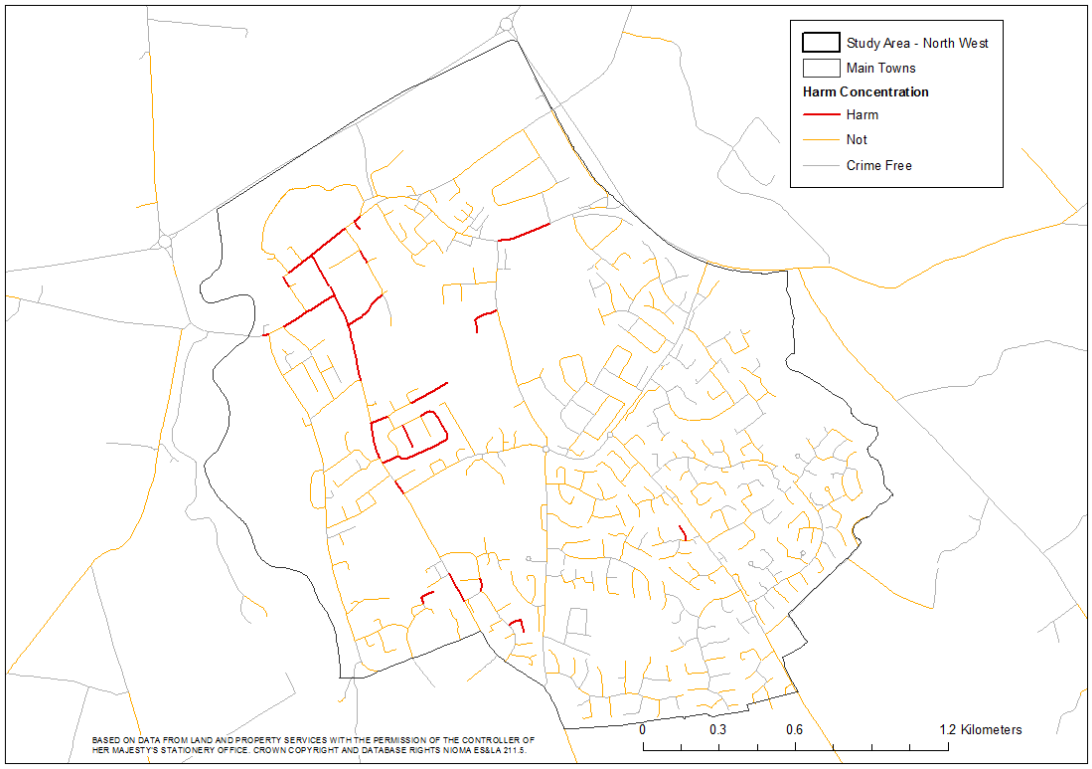


Figure 20: Locations of Hotspots – Magherafelt

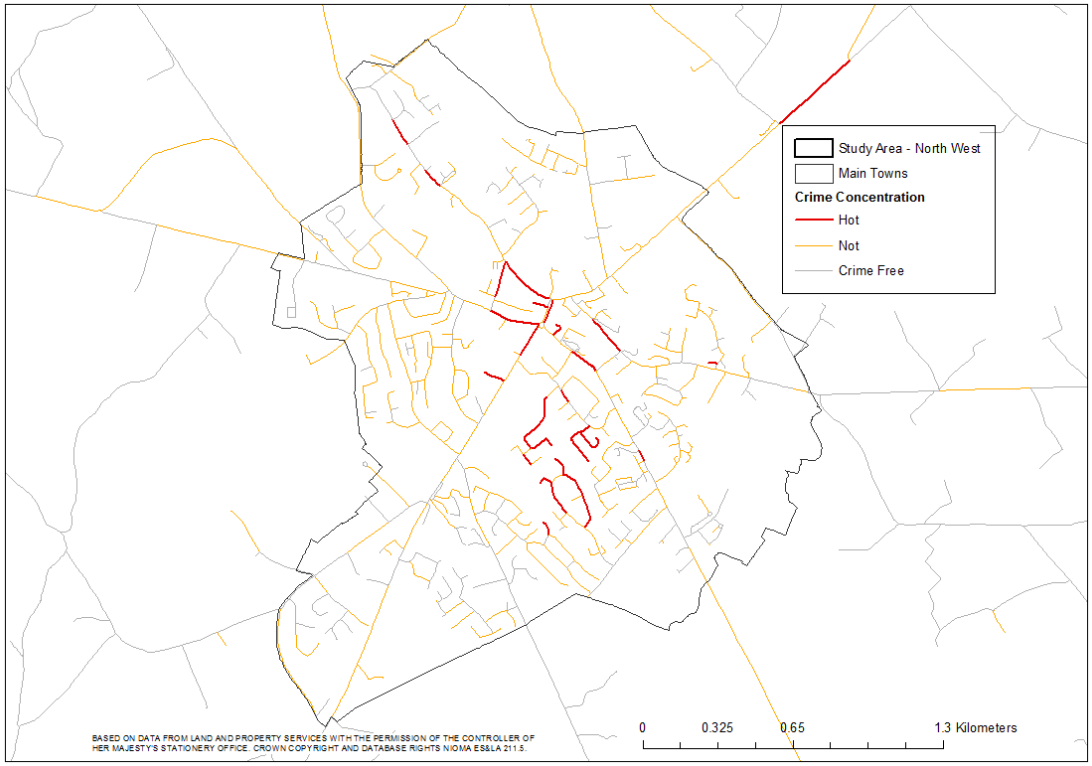
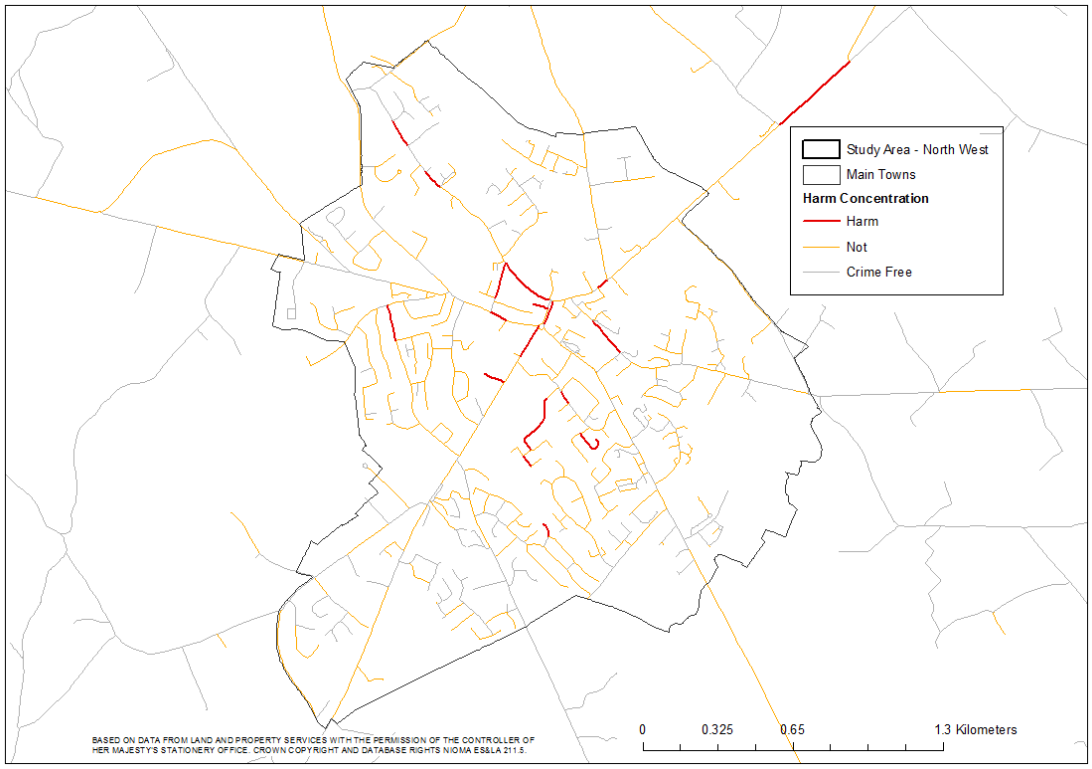


Figure 21: Locations of Harmspots – Magherafelt



10.5. Maps of Hotspots and Harmspots by Crime Category

Figure 22: Locations of Hotspots – Violence Against the Person

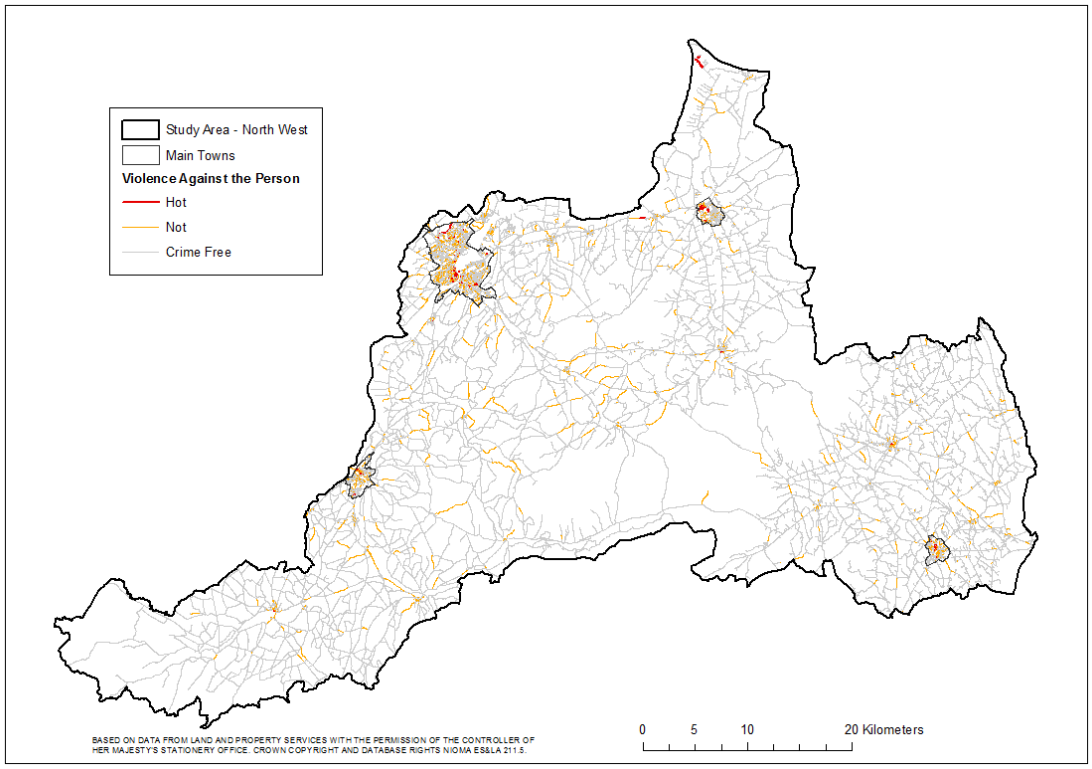


Figure 23: Locations of Harmspots – Violence Against the Person

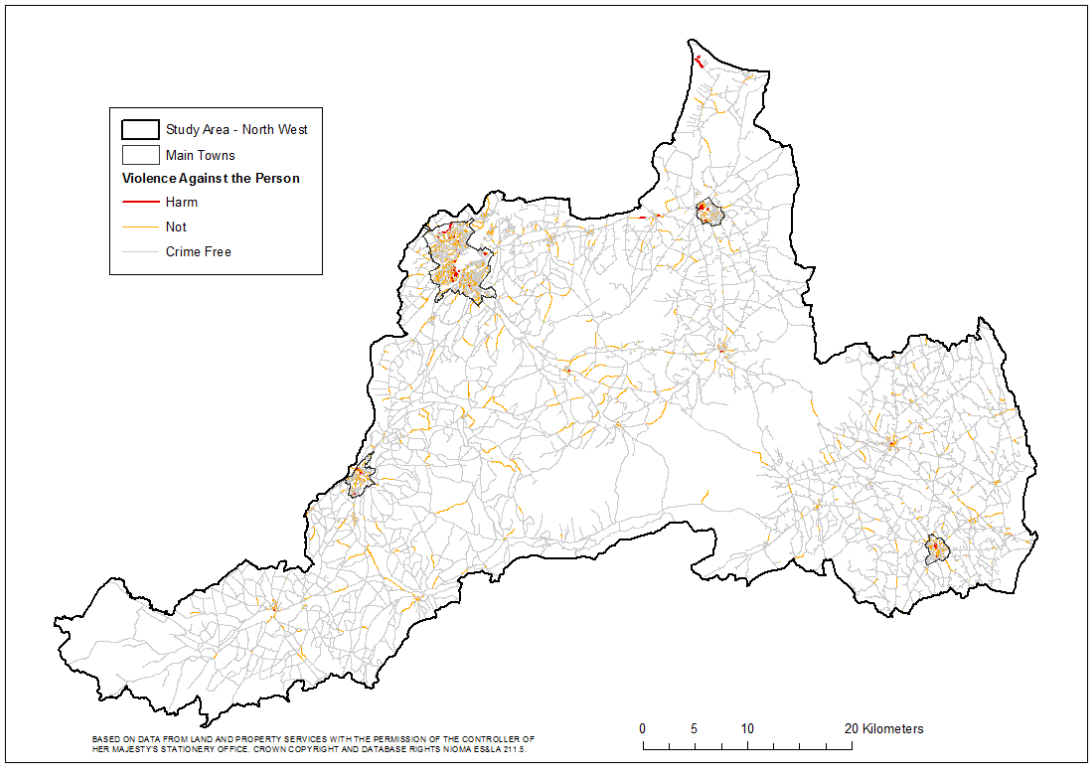


Figure 24: Locations of Hotspots – Vehicle Crime

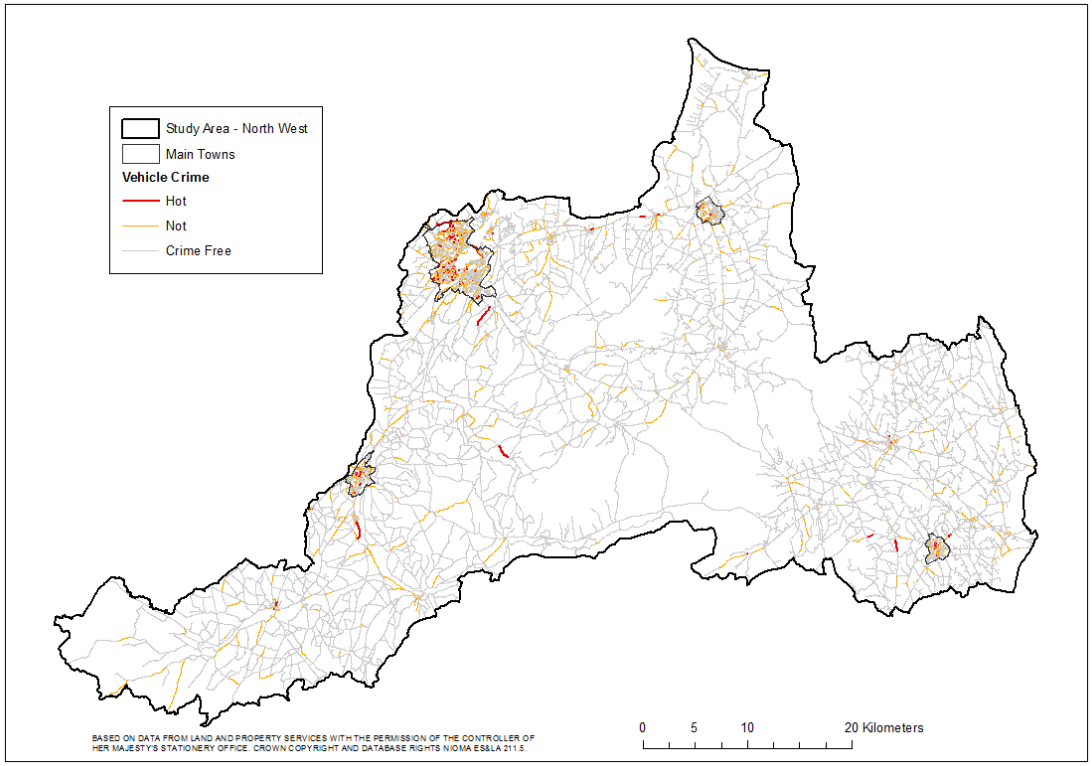


Figure 25: Locations of Harmspots – Vehicle Crime

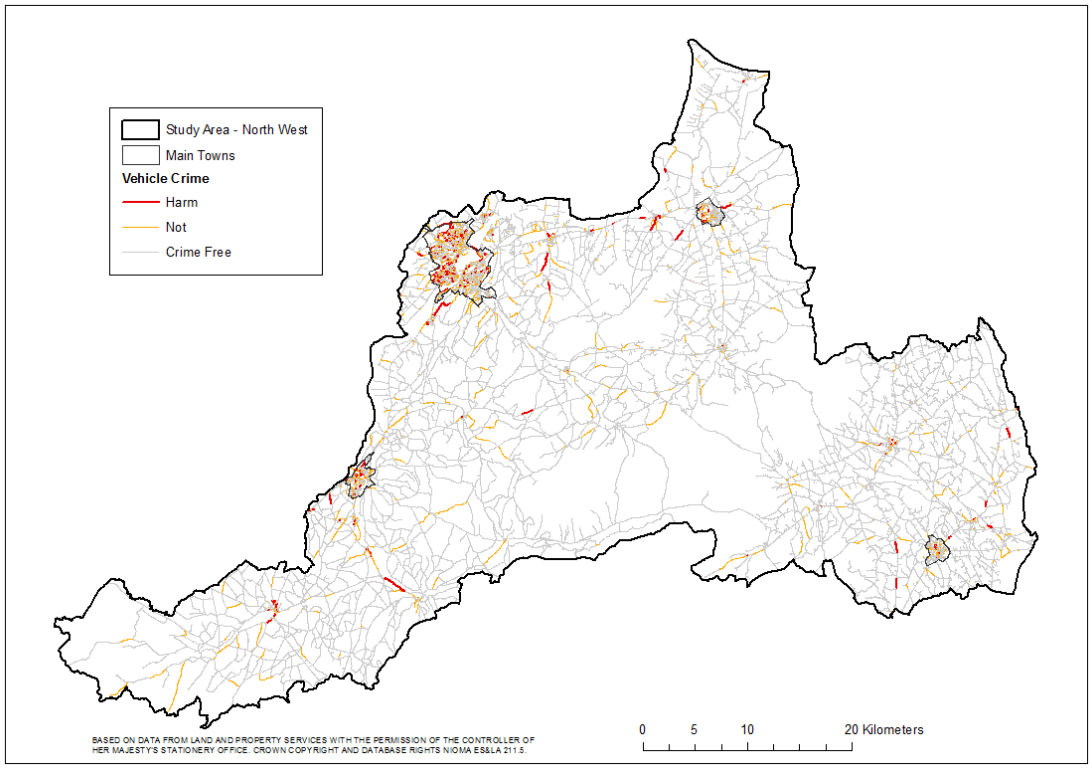


Figure 26: Locations of Hotspots – Criminal Damage

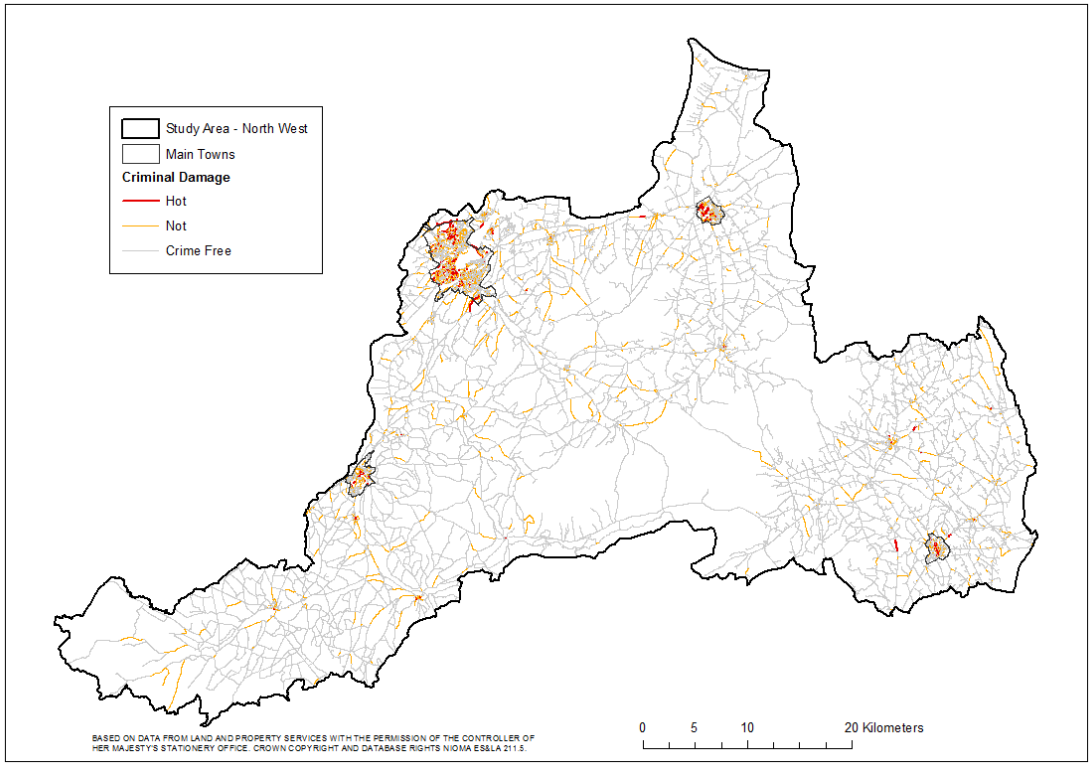


Figure 27: Locations of Harmspots – Criminal Damage

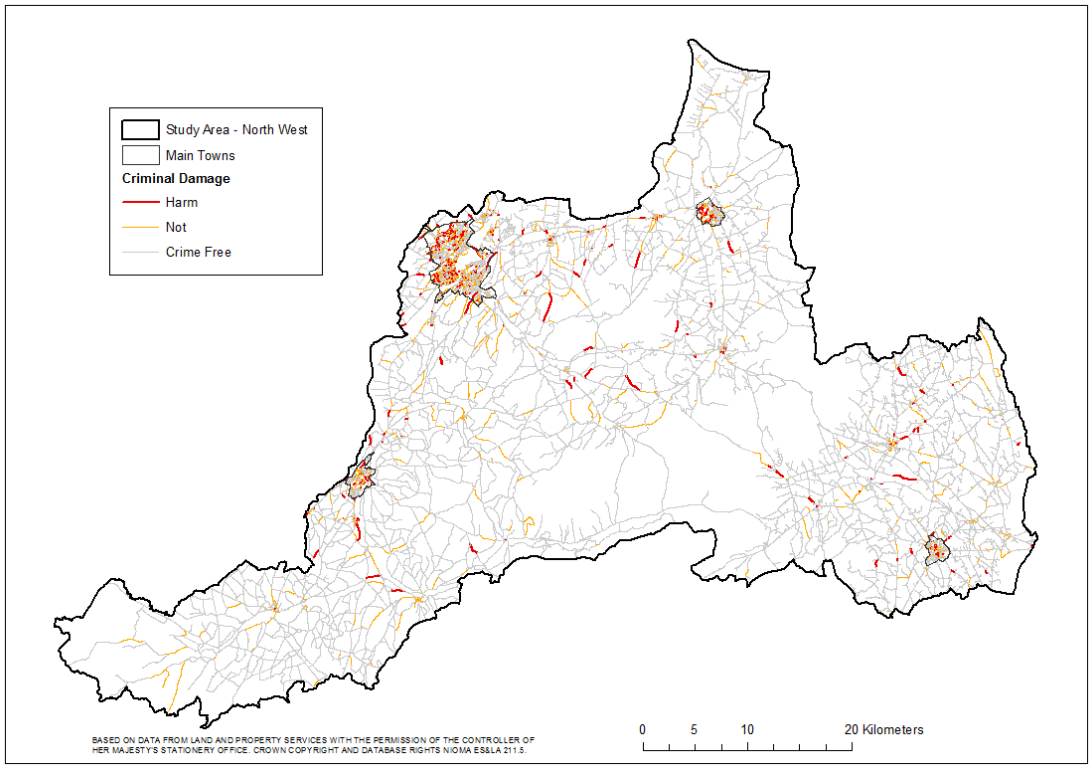


Figure 28: Locations of Hotspots – Domestic Burglary

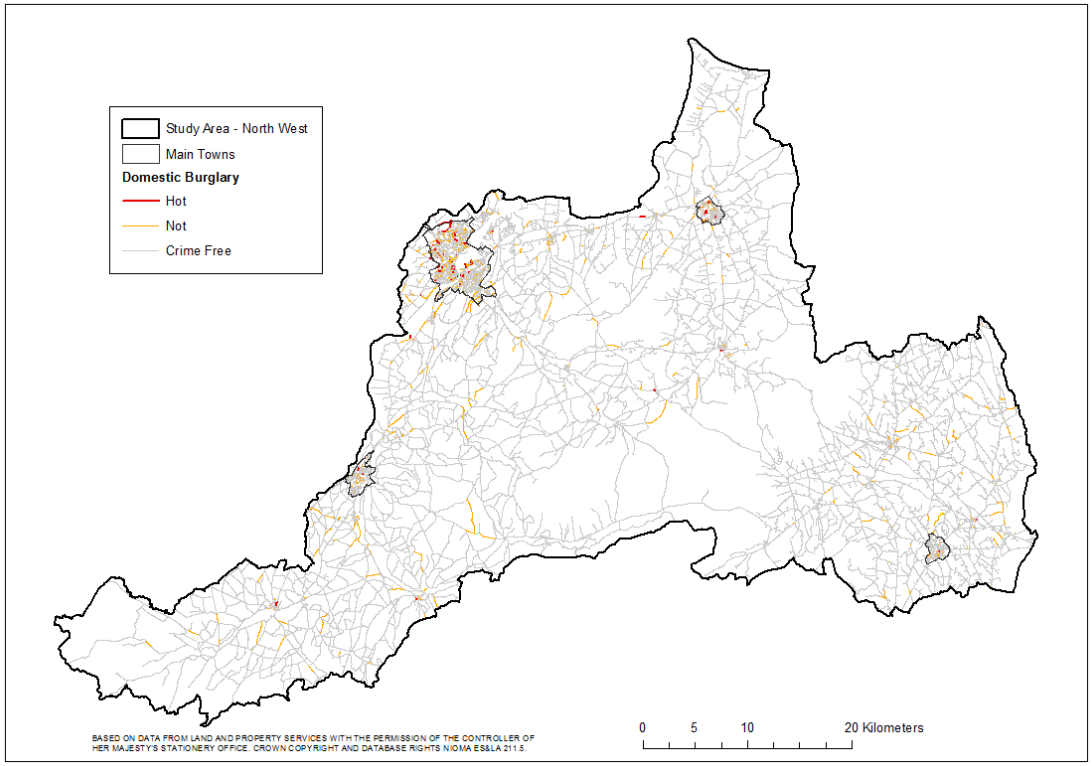
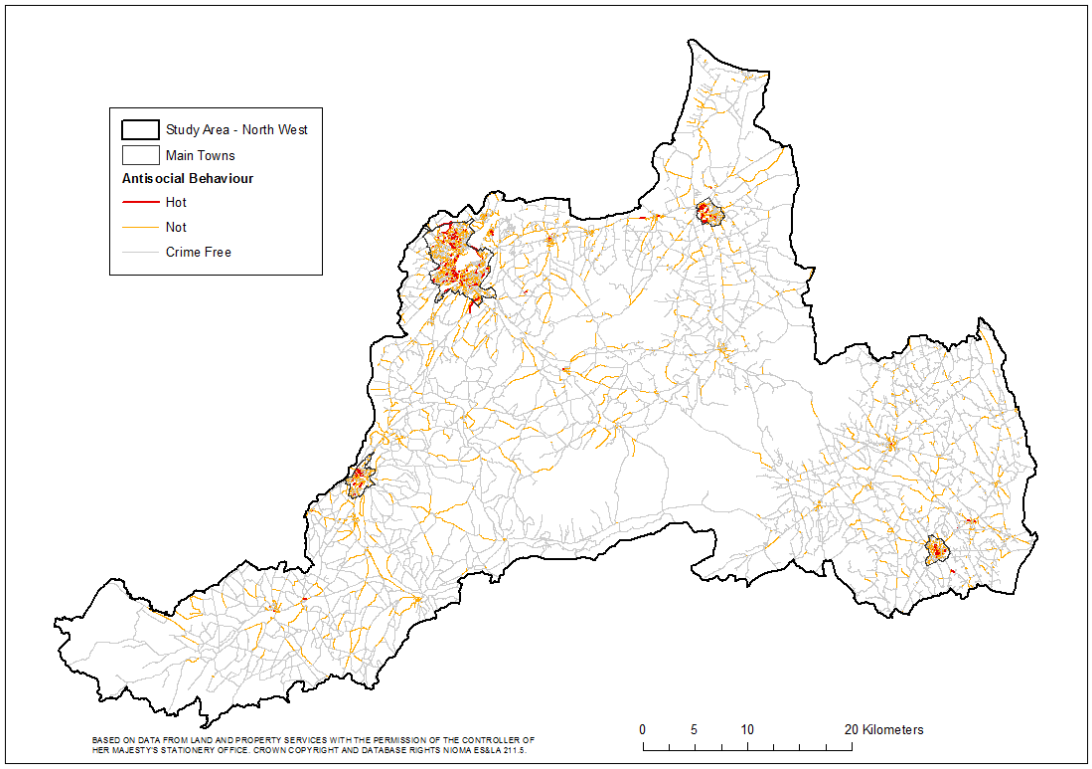


Figure 29: Locations of Hotspots – Antisocial Behaviour



10.6. Comparison of Evidence-Based and Experience-Based Hotspots by Location

		'Waymarker'		
		Y	N	All
Hotspot	Y	**26**	122	148
	N	1,017	**3,743**	4,760
	All	1,043	3,865	4,908

		'Waymarker'		
		Y	N	All
Harmspot	Y	**23**	75	98
	N	1,020	**3,790**	4,810
	All	1,043	3,865	4,908

Table 20: Experience-Based vs Evidence-Based Hotspots and Harmspots – Londonderry

		'Waymarker'		
		Y	N	All
Hotspot	Y	**24**	0	24
	N	774	**45**	819
	All	798	45	843

		'Waymarker'		
		Y	N	All
Harmspot	Y	**12**	0	12
	N	786	**45**	831
	All	798	45	843

Table 21: Experience-Based vs Evidence-Based Hotspots and Harmspots – Strabane

		'Waymarker'		
		Y	N	All
Hotspot	Y	**28**	6	34
	N	409	**360**	769
	All	437	366	803

		'Waymarker'		
		Y	N	All
Harmspot	Y	**12**	4	16
	N	425	**362**	787
	All	437	366	803

Table 22: Experience-Based vs Evidence-Based Hotspots and Harmspots – Limavady

		‘Waymarker’		
		Y	N	All
Hotspot	Y	**10**	11	21
	N	135	**457**	592
	All	145	468	613

		‘Waymarker’		
		Y	N	All
Harmspot	Y	**4**	7	11
	N	141	**461**	602
	All	145	468	613

Table 23: Experience-Based vs Evidence-Based Hotspots and Harmspots – Magherafelt

		‘Waymarker’		
		Y	N	All
Hotspot	Y	**11**	25	36
	N	1,636	**10,378**	12,014
	All	1,647	10,403	12,050

		‘Waymarker’		
		Y	N	All
Harmspot	Y	**8**	19	27
	N	1,639	**10,384**	12,023
	All	1,647	10,403	12,050

Table 24: Experience-Based vs Evidence-Based Hotspots and Harmspots – Rural

10.7. Comparison of Evidence-Based and Experience-Based Hotspots by Crime Category

		'Waymarker'		
		Y	N	All
Hotspot	Y	**1**	74	75
	N	95	**19,047**	19,142
	All	96	19,121	19,217

		'Waymarker'		
		Y	N	All
Harmspot	Y	**1**	80	81
	N	95	**19,041**	19,136
	All	96	19,121	19,217

Table 25: Experience-Based vs Evidence-Based Hotspots and Harmspots – Violence against the Person

		'Waymarker'		
		Y	N	All
Hotspot	Y	**1**	20	21
	N	840	**18,356**	19,196
	All	841	18,376	19,217

Table 26: Experience-Based vs Evidence-Based Hotspots – Domestic Burglary

		‘Waymarker’		
		Y	N	All
Hotspot	Y	**9**	79	88
	N	394	**18,735**	19,129
	All	403	18,814	19,217

		‘Waymarker’		
		Y	N	All
Harmspot	Y	**8**	164	172
	N	395	**18,650**	19,045
	All	403	18,814	19,217

Table 27: Experience-Based vs Evidence-Based Hotspots and Harmspots – Vehicle Crime

		‘Waymarker’		
		Y	N	All
Hotspot	Y	**0**	110	110
	N	9	**19,098**	19,107
	All	9	19,208	19,217

		‘Waymarker’		
		Y	N	All
Harmspot	Y	**0**	165	165
	N	9	**19,043**	19,052
	All	9	19,208	19,217

Table 28: Experience-Based vs Evidence-Based Hotspots and Harmspots – Criminal Damage

		‘Waymarker’		
		Y	N	All
Hotspot	Y	**30**	162	192
	N	625	**18,400**	19,025
	All	655	18,562	19,217

Table 29: Experience-Based vs Evidence-Based Hotspots – Antisocial Behaviour