‘When, where, if, and but’: qualifying GIS and the effect of streetlighting on crime and fear

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Abstract. Geographical information systems (GIS) are increasingly used in England and Wales as a tool to monitor crime and aid community-safety planning. This is despite the widely known limitations of police-recorded data on crime victimisation, and concerns about the quality and specificity of available data on fear of crime. Meanwhile, improving streetlighting is a popular strategy both for improving community safety and for reducing fear of crime. In this paper we report on research carried out in Northumberland, northeast England, which aimed to identify locations most in need of new streetlighting. First, GIS crime hotspot maps and lighting coverage maps were analysed to identify potential areas to target. Qualitative rapid appraisal techniques were then used in these areas to explore local residents’ perceptions and understandings of the relationships between streetlighting, victimisation, and fear of crime. The qualitative data were used to interpret the hotspot maps further, and to inform the location and type of streetlighting interventions. The research demonstrates that people’s experiences of crime and fear, and their understandings of the relationships these have to streetlighting, are complex and reflective. At most, streetlighting was held to have a marginal and even then contradictory influence on the problems of crime and fear that people face. The implications are considered. We conclude that qualifying the outputs of GIS mapping was essential in this case, and has wide potential in critical policy research to promote more inclusive knowledge and more effective decisionmaking.

Introduction
In this paper we report on a research study in Northumberland, northeast England, which aimed to identify locations most in need of new streetlighting. We used a combination of geographical information systems (GIS) mapping of crime hotspots and lighting coverage, and rapid qualitative appraisal of residents’ perceptions and priorities. This was markedly different from the usual way in which areas in need of improved streetlighting are identified: such planning rarely uses either method. GIS are becoming far more widely applied in other types of community-safety planning, as is the case in a number of other countries, but here too the use of qualitative methods in parallel is barely ever practised. We argue that not only does this dual methodology make eventual planning outcomes more inclusive of local communities, and thereby more effective, but when combined the two sources of data provide an interesting contribution to debates over the relationship between streetlighting, crime and fear. Thus the approach to qualifying GIS which we propose can add significant value to both research processes and findings.

The use of critical action research strategies in human geography, which go beyond the production of critical and radical theory to have material impacts and outcomes which challenge social inequality, is now a well-established if still a minority interest...
This wider shift is reflected in debates about a more critical GIS, which have moved beyond some negativity about the potential of GIS to be used as a force for social change, to more nuanced recent discussions about their role in critical policy and theory (see Curry, 1998; Kwan, 2002; Pickles, 1995; Schuurman, 2000). As a group of researchers who have worked with a wide range of policymakers on numerous projects, we dismiss any methodological dogmatism as to which approaches are most suitable for critical policy research (see Pain, 2006). We support recent claims that it is how GIS (as other methods) are used and interpreted which is crucial. We do not want to reduce this debate to the value of ‘bottom-up’ versus ‘top-down’ planning, as the potential for positive social change varies in different geographical and political contexts, but one promising perspective is a more participatory GIS (Abbot et al, 1998; Craig et al, 2002; Williams and Dunn, 2003).

The project reported here illustrates how GIS may be used within a conventional top-down policy framework to promote more democratic and inclusive planning. We are not suggesting that the project represents ‘deep’ participation (see Kesby et al, 2005). Local residents were not involved in constructing the GIS, or in contributing qualitative data which were technically integrated into the system, nor did we use GIS interactively: all increasingly popular strategies in research which combines GIS and qualitative methods. In our study the qualitative stage of the research was separate. Our aim was to augment maps of crime and streetlighting coverage (which tell us ‘where’) with residents’ evaluations of the extent to which they feel that streetlighting ameliorates their vulnerability to crime and fear, as well as of the social and physical circumstances in which it does and does not make a difference to them—in other words, qualification of the ‘when’, ‘if’, and ‘but’. Residents’ perceptions about crime rates and the adequacy of existing streetlighting, and views on the relationships between lighting, crime, their own fear of crime and precautionary behaviour, are surprisingly absent from much of the criminological and geographical literatures on streetlighting and crime, which tends to measure the effects on behaviour more remotely. Yet they are very important to the success of interventions.

We begin by describing the background to the study, outlining the use of GIS in monitoring crime and planning for community safety in England and Wales and beyond, before going on to discuss evidence for the relationships between streetlighting, crime, and fear of crime. We then describe the methodology, present some of the findings, and discuss their significance. Towards the end of the paper we reflect on the limitations of the methodology and its potential for wider application in critical policy research.

GIS and community-safety planning
GIS are increasingly used in England and Wales as a tool to monitor crime and aid community-safety planning. They have been strongly promoted by the Home Office (2001) and by other government departments such as the Audit Commission (1999), which have drawn attention to the gains of a spatial perspective on data, noting that GIS do not detract from other forms of data analysis but support a fuller analysis of the ‘what, where, when, and who’ aspects of crime-and-disorder data.

The popularity of GIS is despite some widely known limitations of police-recorded data on crime victimisation, and despite concerns about the quality and specificity of available data on fear of crime. Much crime is not reported, and this is especially so for the poorer neighbourhoods and social groups most affected by crime, including people on lower incomes, council tenants, younger people and children, and ethnic minority groups (Pain, 2000). Crime is also widely considered to be underrecorded in
England and Wales (see Simmonds and Dodd, 2003). In addition to data problems of representativeness, accuracy of geocoding, and attribution, there are potentially serious problems associated with the use of GIS even when applied to a sound dataset. As with any tool GIS can be used badly—for instance through the failure to consider or understand the parameters of a technique such as hotspot mapping. At the output end, GIS have rendered cartography a seemingly minor adjunct to the data preparation and analysis phases, and, yet, as the literature demonstrates, it is easy to draw map users to any one of a range of conclusions from a single dataset. The very attraction of maps of crime—that they appear accessible and are usually readily understood—is double edged (Dorling and Fairbairn, 1997).

There are also difficulties with the use of GIS to map levels of fear of crime. Fear has, over the last decade, become an important plank in auditing and addressing crime and crime-reduction strategies in England and Wales (Marlow and Pitts, 1998). It is potentially useful to be able to map and compare crime and fear of crime. However, data on fear of crime are often unavailable at the requisite scale and coverage, and results of surveys on fear of crime rarely disaggregate below the local authority level (for example, MORI, 2002). Moreover, strong critiques have been made of the ways in which data on fear of crime are produced through surveys. Difficulties include the varying conceptualisations of fear employed, the attempt at quantitative measurement of a subjective and shifting emotional state, the comparison of objective crime levels and subjective fear levels, and the ‘snapshot’ of fear of crime in relation to immediate social and environmental factors when fear is dynamic over time and space and subject to many influences over individual life courses (see Farrall et al, 1997; Hollway and Jefferson, 1997; Pain, 2000). More sophisticated survey questioning and qualitative approaches which contextualise and measure fear in specific localities (for example, Farrall, 2004; Loader et al, 1998; Koskela, 1997; Pain and Townshend, 2002) are not widely used in the increasingly resource-constrained and audit-driven policy sphere.

**Streetlighting, victimisation, and fear of crime**

Meanwhile, improving streetlighting has been a popular strategy for improving community safety and reducing the fear of crime. This reflects a shift towards situational crime prevention using environmental improvements to ‘design out’ opportunities for crime and features which provoke fear. As critics argue, it is an approach which bypasses the deeper socioeconomic causes of crime (Gilling, 1997; Koskela and Pain, 2000; Walklate, 1989), but it has had some success in reducing crime and fear in certain areas (Clarke, 1992; Oc and Tiesdell, 1997).

The research on streetlighting illustrates both the possibilities and the problems of the wider situational approach. From the 1980s onwards, experimental programmes in the United States and Europe have shown differing results on the effect of streetlighting on crime and fear of crime: some positive (for example, Herbert and Davidson, 1995; Painter, 1996; Tien et al, 1978; Vrij and Winkel, 1991) and others mixed, contradictory or negative (for example, Atkins et al, 1991; Nair et al, 1993; Ramsey and Newton, 1991). Two recent reviews by British criminologists have concluded that, if precisely targeted, increases in streetlighting do tend to reduce crime, and that most interventions also have some positive impacts on fear of crime (Farrington and Welsh, 2002; Pease, 1999). The fact that some studies show improvements in streetlighting to be followed by daytime as well as nighttime reductions in crime suggests that the effect may be working through increased community pride and sense of ownership of the local area, rather than simply through deterrence (Pease, 1999). This is further evidenced by the finding that streetlighting seems to work best in more homogenous and stable communities (Farrington and Welsh, 2002). The reviews both note that the
relationship appears very sensitive to local circumstances, and therefore the use of lighting in crime prevention should be context appropriate. It seems anomalous that neither GIS nor qualitative techniques are commonly used to aid the siting and monitoring of streetlighting schemes.

Methodological problems with studies of streetlighting and crime have been highlighted (see Farrington and Welsh, 2002; Nair et al, 1993; Painter, 1991), and the need to use alternative sources of victimisation data to police statistics is now more widely recognised (Farrington and Welsh, 2002; Painter and Farrington, 2001). Knowledge about people’s perceptions and attitudes to streetlighting and to their safety is also in short supply (Townshend, 1997) and little qualitative research exists; ‘before and after’ surveys linked to particular interventions are still predominant. Further, the majority of academic and policy research studies take a top-down approach to community planning; people are rarely asked what improvements they think are needed or where these should be sited, nor invited to make their own connections between crime, fear, and streetlighting or other factors which may intervene or be more important. Current practice does not sit happily with wider imperatives about the inclusion and participation of local people in planning their communities (Ballentyne and Fraser, 1998).

Methodology

The research reported here was commissioned by the Environment Directorate of Northumberland County Council, who were responsible for installing new streetlights in southeast Northumberland. Funding sources had been identified for targeted investment, and, under the Crime and Disorder Act 1998, all sections of a local authority must consider the crime and disorder implications of investment (Home Office, 1998). The methodology of the study was twofold. First, GIS hotspot maps of crime and streetlight coverage maps were analysed to identify areas where the incidence of crime was high with low lighting coverage as priorities for intervention. Second, qualitative rapid community appraisal was conducted in ten of these areas identified as most problematic, and the resulting data were used to interpret the hotspot maps and to inform the eventual location and type of streetlighting interventions.

Study area

Northumberland, one of the largest counties in England, is beautiful, sparsely populated, and predominantly rural. Overall, crime is low compared with national averages, but it is highly concentrated in urban centres. Those most affected lie within the southeast of the county where the study took place, an area in which industrialisation flourished over several centuries but which saw deindustrialisation and increasing deprivation during the 20th century. Hotspot mapping focused on the small towns of Ashington and Bedlington (ex-coalmining towns), Blyth (a coastal port), and Cramlington (a new town chiefly functioning as a commuting centre for the nearby city of Newcastle upon Tyne) (see figure 1). In all four towns, crime hotspots were largely located in the more deprived neighbourhoods, either inner areas of 19th-century terraced housing or peripheral council estates—a distribution which mirrors national patterns (Simmonds and Dodd, 2003).

GIS hotspot mapping

Hotspot mapping describes approaches to identify concentrations in the spatial distribution of point features such as crime locations. As with many GIS-based techniques, the results of hotspot mapping are contingent on the data used and technical parameters selected for the analysis. An attraction of hotspot maps is their accessibility in visual terms and their ability to draw a user’s attention to the highest concentrations of
`the problem`, subject to the integrity of the underlying data and appropriateness of the parameters employed.

The first stage of the research involved the analysis of police-recorded crime data, data on streetlighting coverage, and requests for new streetlighting to Northumberland.

Figure 1. Location of Northumberland and study areas.
County Council. Five categories of crime were identified for analysis: burglary, criminal damage, drug crimes, vehicle crime, and violent crime. Analysis was restricted to crimes recorded within the hours of darkness. ArcView 3.2 GIS was used to extract those crimes falling within the above towns, and an attribute query was run to extract those that fell, on a month-by-month basis, between the monthly average sunset and sunrise times. This gave a nighttime crime dataset for all the towns in the sample of 3677 cases, which was the total number of nighttime crimes that fell within the defined urban areas which made up the study area for this research. The breakdown by type can be seen on Table 1.

Table 1. Breakdown of all nighttime crimes in the study area by type.

<table>
<thead>
<tr>
<th>Crime type</th>
<th>Number of crimes</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td>802</td>
<td>22</td>
</tr>
<tr>
<td>Criminal damage</td>
<td>1592</td>
<td>43</td>
</tr>
<tr>
<td>Drug incidents</td>
<td>210</td>
<td>6</td>
</tr>
<tr>
<td>Vehicle crime</td>
<td>684</td>
<td>19</td>
</tr>
<tr>
<td>Violent crime</td>
<td>389</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>3677</td>
<td>100</td>
</tr>
</tbody>
</table>

Analysis was accomplished using the Crimestat extension (Levine, 1999) to the Arcview GIS. Following best practice guidelines (Chainey et al, 2002; Home Office, 2001) the creation of the maps was in four stages. First, the point distribution of each crime type was analysed using the nearest neighbour analysis (NNA) technique. NNA compares the actual distribution of the crime or disorder data against a dataset of the same sample size but in which the distribution is completely random. This establishes whether each crime type in each area (where there are sufficient numbers) is clustered, random, or regular. Only those distributions that were identified as clustered at this stage were then carried forward for hotspot mapping.

Second, the standard distance statistic was calculated. Measures of standard deviation distance help to explain the level of dispersion in crime-and-disorder data. The standard distance deviation, or standard distance, is the standard deviation of the distance of each point from the mean centre and is expressed in measurement units (for example, metres). It is the two-dimensional equivalent of a standard deviation. The higher the relative standard distance, the more dispersed the crime locations are. In this way it is possible to compare the relative distribution of different crime types.

Third, hotspot maps were created. Those crime types identified as clustered in stage 1 above (NNA analysis) were used to create hotspot maps through kernel density estimation, which is a statistical method to create a density surface, which in turn can be seen as a tool to guide further enquiry. The precise method used was adaptive quartic kernel density estimation (Chainey et al, 2002). This moves a circle of variable radius over the crime points, weighting each point within the radius. According to Levine (1999) an adaptive bandwidth/radius method adjusts the radius interval so that a minimum number of points are found. When used with crime-related data specifically, this provides constant precision of the estimate over the entire study area. Thus, in areas that have a high concentration of points, the radius is narrow, whereas in areas where the concentration of points is more sparse, the radius will be larger, that is, it is reactive, depending on the distribution of the points. Amongst the many distributions used in kernel density estimation, quartic is that favoured by crime analysts, as it applies added weight closer to the centre of the bandwidth, and according to Levine (1999)
gives fewer problems with ‘spikes’ at the edge of the grid and results in a smoother distribution.

In this study, a cell size of 15 m was used consistently across a study area, with a small $K$ order of 5 ($K$ values define the bandwidth for the nearest neighbour analysis). For hotspot mapping of small areas lower $K$ values are appropriate. Hotspot mapping over larger areas would require a larger value, such as the figure of 20 proposed by Chainey et al (2002) and by the Home Office (2001). The use of a $K$ value of 5 reflects the requirement to identify locally significant concentrations. From this a grid-based density surface is created.

The crime data relate to the calendar year 2000. The records used in hotspot mapping were crime records rather than incidents, that is to say they were formally recorded and classified as crimes rather than as minor incidents such as disorder or unsubstantiated emergency calls. Police data are well known to have quality problems in respect of locational accuracy (the records may be in the wrong place); temporal accuracy (crime records typically have two time and date fields which indicate from—the earliest possible time of the offence, and to—the latest possible time, and most audits and research use the former); and attribute accuracy (the crime-type classification may not always be consistent between recording staff and between police forces) (Chainey and Ratcliffe, 2005). Little can be done to verify the validity of coding; in this study the ‘date and time from’ field was used and in the absence of geocoding software only those records which were already geocoded by the police force were included in this study. This is well known to be more accurate when offences relate to properties that exist in the police gazetteer (for example, burglary) and less accurate when the offences took place on streets, open ground, or other ‘nonaddressable objects’ (for example, car parks or areas of waste ground). Between 80% and 90% of all crime records were geocoded and available for this research.

Hotspot maps are valuable aids in a study such as this, and in community-safety planning more broadly, but they are subject to the same kinds of interpretative issues as more conventional choropleth maps. One of the most significant of these issues is at which threshold level to define a hotspot. Continuous surface density maps (see figures 2 to 4, over) illustrate the relative density of crime and victimisation across an area by using standard deviation around the mean value but they do not identify where the ‘worst’ areas are; this requires a user to define a threshold, above which a hotspot is defined. Consistency of approach is critical to the generation of meaningful results.

For purposes of targeting the qualitative research the top 2.5% of the crime density was used as the threshold which defined the boundary of the hotspots selected for further research. This threshold was selected on the basis of exploratory data research. For further details see MacFarlane et al (2001). Figures 2, 3, and 4 are examples showing hotspots for three different crimes and the location of streetlighting requests in Ashington, Blyth, and Cramlington. Much more detailed hotspot maps for multiple crimes were also produced for each town, used to target areas for qualitative appraisal, but for reasons of confidentiality cannot be reproduced here. Maps of lighting coverage are also not shown for the same reasons.

Streetlighting data
The location of individual streetlights was supplied, in highly accurate $x,y$ coordinate form, by the local authority streetlighting engineers. The approach taken to investigate the spatial relationship between crime hotspots and the distribution of streetlights was to apply the $\chi^2$ test. This established that the observed number of streetlights within each spatially defined hotspot was proportionately lower than the expected number, calculated as a ratio of streetlights: area for each study area ($p < 0.05$). This was the case
Figure 2. Hotspot map of criminal damage for Ashington. Colour versions of figures 2–4 can be viewed on the Environment and Planning website at http://www.envplan.com/misc/a38391.

Figure 3. Hotspot map for burglary in Blyth.
for all categories of nighttime crime analysed (criminal damage, drug-related offences, burglary, violent crime, and vehicle crime) that were identified as clustered and for which hotspot maps were produced.

This is a relatively broad approach that does not take account of two specific characteristics: (1) the precise area of illumination of individual streetlights, and (2) whether these lights were working at the time of specific offences. In relation to the first point, lighting coverage maps were produced on the basis of illumination spread data from the council, but we could not conduct a comparison at this finely grained scale as the police data did not enable location of crime incidents to the same degree of accuracy. In relation to the second issue, time-specific crime data were available, but time-specific data on whether individual lights were working were not. This microscale analytic approach, relating accurate and precise crime locations to equally accurate and precise lighting coverage maps at the time of individual crimes, would of course be feasible given appropriately fine-grained and attributed data.

The locations of requests for new streetlighting are shown on figures 2 to 4 in relation to particular examples of crime hotspots. These requests can come from a number of different sources, and the number and location of requests for new lighting do not necessarily reflect the pattern of high crime levels or local people’s perceptions of risk and their fear of crime. For example, it has been suggested that some elected local councillors are more active and vocal in requesting such investments in their areas of responsibility than are others, and one of the problems that the local authority officers have is in balancing these requests with those from other individuals and groups in local communities.

**Figure 4.** Hotspot map for vehicle crime in Cramlington.
Identification of priority areas

From the crime hotspot maps, ten priority areas were selected for the qualitative phase according to certain criteria. Hotspots were selected which were largely residential and had the highest crime rates, with particular attention paid to multiple-crime hotspots (where the density of several types of crime was particularly high). Crime hotspots with low levels of lighting coverage were given particular attention, though two with high lighting coverage were also selected where crime hotspots were particularly intense, and two had mixed coverage lighting. Often quality rather than coverage is an issue for residents, as we go on to discuss. Areas where requests had been made to the council for new lighting which met the above criteria were all included. The ten hotspots selected are described in table 2.

The qualitative stage of the research was separate to rather than integrated with the GIS in this study. We did not use maps with local residents, to avoid creating a certain impression of each area in advance or influencing the answers people gave us. As part of the standard consent procedures, we introduced the research to residents by explaining that the neighbourhood was one area the council was considering for new streetlighting, and that we were interested in learning about residents’ views.

Rapid community appraisal

The second stage of the research involved rapid qualitative appraisal within the ten priority hotspots in order to help us verify, qualify, and interpret the GIS output. It aimed to establish:

1. The main crimes which local residents view as most problematic. Police statistics include only crime which is reported, and in these areas we would expect levels of reporting to be low.
2. A current picture of levels of fear of crime in each area.
3. The ways in which fear of crime affects people’s mobility and use of the local neighbourhood.
4. Views on existing lighting provision and whether residents feel improvements are needed.
5. Views on how far lighting improvements would decrease crime and fear of crime.
6. Where blackspots are within the areas identified by GIS. A blackspot in this context is a particular section of street(s), a park, alleyway(s), etc, which has a reputation for high crime rates and/or poor lighting.
7. The nature of perceived lighting problems. For example, insufficient lamps, problems with brightness, or poor maintenance may be cited.

Rapid community appraisal requires consulting with as wide a cross-section of residents as possible, accessed in their homes or neighbourhood areas, and prioritising their local expertise in understanding the issues which affect them (Chambers, 2002). We used observation techniques and short semistructured interviews. For the interviews we had a number of set topics (above) but asked about these openly and flexibly, so that the research had a strong emergent component allowing residents to raise the concerns which mattered most to them. This method was considered the best compromise between collecting information which fronted people’s own priorities and collecting data in a priori categories. It has the additional benefit of being as inclusive as possible of different groups.

Door-to-door and street-work approaches were considered the best way of targeting residents, as they are more likely to reach and include a wide spectrum of residents in a socially and economically deprived area than are other methods (for example, telephone, mail, or electronic surveys), especially ‘hard-to-reach’ groups (for example, young adult men, children, and disabled people). Almost all of the hotspots were in
economically deprived areas, where mistrust of the council and the police are greatest, and where traditional survey methods tend to achieve poor response rates. The hotspot areas produced by GIS were quite small, mainly consisting of a few streets each. These were copied onto detailed street maps. In the smaller hotspots, all households were targeted, whereas in larger areas particular streets were sampled, concentrating on those which appeared to have the lowest density lighting according to the GIS output and field observations. Interviewing was carried out in each area on different days and

Table 2. Hotspot priority areas selected for rapid qualitative appraisal.

<table>
<thead>
<tr>
<th>Hotspot</th>
<th>Crime and lighting</th>
<th>Recommendation after qualitative stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashington</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1: inner-area 19th-century</td>
<td>Burglary, violence, and criminal damage hotspots. Low coverage of lighting in most</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td>terraced housing</td>
<td>of hotspot.</td>
<td></td>
</tr>
<tr>
<td>A2: outer-area council estate</td>
<td>Burglary and criminal damage hotspots. Low coverage of lighting and three requests</td>
<td>New or significantly improved lighting</td>
</tr>
<tr>
<td></td>
<td>for new streetlighting made to council.</td>
<td></td>
</tr>
<tr>
<td>A3: inner-area 19th-century</td>
<td>Burglary and criminal damage hotspots. High coverage of lighting except periphery</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td>terraced housing</td>
<td>of hotspot.</td>
<td></td>
</tr>
<tr>
<td>Blyth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1: inner-area, largely council housing</td>
<td>Burglary hotspot. Low-density lighting.</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2: inner-area, largely council housing</td>
<td>Burglary, violence, criminal damage, vehicle crime, and drug offence hotspots. High-density lighting and two requests for new streetlighting made to council.</td>
<td>New or significantly improved lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3: outer-area, mixed housing, and industrial land</td>
<td>Burglary hotspot. Low coverage of lighting.</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td>Cramlington</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1: town centre, housing with pubs and restaurants</td>
<td>Burglary, violence, criminal damage, vehicle crime hotspots. Mixed coverage lighting.</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2: outer-area estate</td>
<td>Burglary and criminal damage hotspots. Low coverage lighting and one request for new streetlighting made to council.</td>
<td>New or significantly improved lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3: outer-area estate with housing, health centre, and secondary school in hotspot</td>
<td>Burglary and criminal damage hotspots. Low coverage lighting.</td>
<td>Better maintenance of existing lighting</td>
</tr>
<tr>
<td>Bedlington</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BD1: separate village centre close to town, housing with pubs and clubs</td>
<td>Burglary and criminal damage hotspots. Mixed coverage lighting and five requests for new streetlighting made to council.</td>
<td>Better maintenance of existing lighting</td>
</tr>
</tbody>
</table>
at different times to maximise the range of people included. Most contact was usually made by knocking on the front doors of houses, but, as much of the research was conducted on warm summer days, we also talked to many people who were sitting outside their houses or standing on the street. This helped us to include children and young people, whose opinions on community-safety issues are frequently ignored in surveys (Mason, 2000). These approaches are likely to have excluded some people who avoid going out because of fear, or who feel insecure opening the door to a stranger, though research elsewhere suggests they are in a very small minority (Hough, 1995).

The rapid appraisal was successful in accessing a reflective mixture of males and females, a range of age groups, and disabled as well as able-bodied residents. However, only one member of an ethnic minority group was included, which reflects very low proportions in this part of Northumberland. Response rates were excellent and a large amount of qualitative data was recorded by taking notes during and after interviews. All of the quotes used here are given verbatim. Our observations of the areas were guided by information from residents; for example, verifying particular problems with lighting.

Issues of analysis and triangulation: comparing or qualifying?
In using qualitative research to evaluate GIS analysis of police-recorded data in this way, our aim was not to draw an overall comparison (although we do compare the results from the two methods at a number of points, largely as a device to highlight the methodological limitations of the use of police-recorded data in this context). This is because the issues are not the same—the quantitative data refer to specific crimes recorded by police, and the qualitative data refer to experiences of crime, disorder, and harassment which are sometimes less categorisable. Local residents have ways of interpreting and framing incidents which differ from those of the police. However, we argue that qualifying GIS analysis of police-recorded data in this way presents a significant improvement on how analysis of crime data is often carried out. We also reflect on the messiness of the task to inform researchers who might use similar techniques in the future.

Results
In this section we outline the main themes from the qualitative findings with residents, and make comparisons with the patterns of crime and lighting suggested by the GIS output. There are some findings which are unexpected, and several occasions on which the GIS analysis comes into conflict with the qualitative findings. Our aim is to show that detailed information on local concerns and environments is sometimes vital to help unravel and evaluate the patterns which GIS appear to show, but that the triangulation which follows is often not straightforward.

Residents’ views on crimes that are especially problematic in their area
Residents were asked which crimes they thought were most problematic in the immediate area they lived in, and what problems these caused. In all ten hotspots, residents felt that their area suffered from high rates of crime. Many older residents saw this as relatively recent and related it to “the area going downhill”, particularly in terms of economic decline—“[town name]’s become a deprived area.”

Table 3 compares the crimes which residents identified as problems in each area with those prioritised by the hotspot maps. Burglary and criminal-damage hotspots are the most common and these crimes were usually, though not always, raised as problems by a majority of residents when they emerged as hotspots from the GIS mapping. On the other hand, drug offences, theft, and youth disorder were more likely to be mentioned by residents than to appear as hotspots. This is partly because these crimes
are underreported to police, especially drug offences. For residents, knowledge of dealing and using drugs caused considerable concern to many, both for their children’s safety and because they related them to other crimes. Youth disorder does not appear in crime statistics under that term as it is not a crime in itself, but noise, nuisance, harassment, or simply the presence of young people in public space were widespread concerns reported to the research. Some incidents are likely to appear under ‘criminal damage’, but many were not reported to police or else had not been recorded as crimes. Residents voiced complaints such as “kids are always hanging around frightening old people”, “the brats hang around getting up to mischief, breaking into cars, putting windows out, kicking doors”, “kids have no respect, they’re not afraid of punishment” (see also box 1). Although some incidents may be overblown, others are significant as they clearly contributed to feelings of insecurity locally, both for adult residents and for other young people (see Brown, 1995; Loader et al, 1998; Matthews et al, 2000). Yet, these crimes—also significant to residents in determining their reactions to streetlighting, as we go on to discuss—would not have figured if we had used an analysis of the police-recorded crime data alone.

### Table 3. Comparison of crimes appearing as hotspots, and those mentioned by the majority of residents, for ten areas selected.

<table>
<thead>
<tr>
<th></th>
<th>Appear as hotspots and mentioned by residents</th>
<th>Mentioned by residents but do not appear as hotspots</th>
<th>Appear as hotspots but not mentioned by residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Criminal damage</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Violence</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vehicle crime</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Drug offences</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Theft</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Youth disorder</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Residents’ views on the relationship between streetlighting and crime

Local streetlighting was viewed as problematic by a majority of residents in five of the ten study areas. However, the geographical pattern of dissatisfaction does not correlate with the lighting coverage maps which partly informed the choice of the study areas, as table 4 illustrates. To different degrees, residents’ views on streetlighting were mixed within each area, and this often reflects very localised aspects of lighting (for example, good or bad lighting directly outside the respondent’s house, in their back lane, or in a feature they use frequently such as a subway). Further, lighting may appear to be adequate from the coverage map, but in many areas it was not always working.

### Box 1. Hotspot A2

Hotspot A2 is in a suburban area on the outskirts of Ashington. The maps showed hotspots for burglary and criminal damage. The main problems identified by residents were car crime, criminal damage, and youth disorder. Most residents did not feel safe and avoided going out at night. GIS output showed low lighting coverage, and most residents felt that streetlighting was inadequate in terms of coverage, brightness, and maintenance.

The main problem areas identified were nearby shops and residents’ car parks, where it was reported that children hung around, vandalised and broke into cars, started fires, and intimidated other residents. These car parks lie between short terraces of housing, and residents have to walk past them to reach their front doors. A significant proportion felt that improved streetlighting would help to reduce their fear of crime, particularly in using these specific areas.
As we go on to demonstrate later, and as research elsewhere has suggested, these micro features of lighting are often what determines satisfaction, yet they are difficult to convey accurately on coverage maps.

As regards the relationship with crime and safety, this is only one aspect of streetlighting which influences residents’ satisfaction with it. Poor streetlighting can create a range of other problems with getting around (Herbert and Davidson, 1995; Painter, 1992; 1996; Townshend, 1997), especially for respondents with a disability or those who had young children: “You can’t see where you are going, it makes potholes that are uncovered vulnerable”; “being partially sighted, finding the edge of the pavement is not easy”; “I fell down in the street because of the lighting.” However, a minority of residents did feel that crime was also made worse by poor streetlighting, some reasoning “if a burglar had to choose, he’d choose the dark area”, and some citing particular incidents: “the burglary took place after the light was put out deliberately.” Others said it depended on the crime: “it may reduce vandalism”; “there’d be less theft”; “it won’t stop kids, but it will stop burglars.” In one area, there was strong consensus that a particular problem of youth disorder was made worse by poor lighting (see box 1). Most of those questioned, though, did not believe that streetlighting had a significant impact on crime levels. Many expressed a belief that crime had deeper causes and would happen anyway: “it’s due to the people not the lighting”, “crime is caused by unemployed young lads taking drugs”; “streetlighting is the least of our worries.” One man commented typically that “it’s [town name]—it’s a hell-hole for crime.” Several mentioned that crime “happens in daylight too”, “I’ve been burgled whether light or dark.” Some proposed that, in some instances, lighting actually helps criminals: “lighting makes it easier for them to see what they’re doing”; “streetlighting makes crime easier.” There was a strong feeling, in particular, that improved lighting would not help with the problems many residents perceived were to do with youth disorder. Here it was felt that the relationship was more likely to be inverse: “no, the young people hang round the lights”; “lighting can attract kids” (though see Box 1 for an exception in one particular context). Many also said that children in their areas vandalised streetlights before committing petty crimes such as graffiti, so again the relationship is not straightforward.

Residents’ perceptions of the relationships between streetlighting and the incidence of crime, then, are reflexive and critical. Research surveys have tended to be premised and designed on the basis of fairly simple cause–effect relationships, but such relationships were dismissed by the majority of those interviewed; at most, streetlighting was held to have a marginal and even then contradictory influence on local rates of crime.

### Table 4. Residents’ views on adequacy of lighting in high, mixed, and low coverage lighting areas, for ten areas selected.

<table>
<thead>
<tr>
<th>Classification of lighting in area from coverage map</th>
<th>Majority of residents say lighting is adequate (n areas)</th>
<th>Majority of residents say lighting is inadequate (n areas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High lighting coveragea</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mixed lighting coverageb</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Low lighting coveragec</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

*a ‘High’—greater than expected number of lights per unit area.
*b ‘Mixed’—greater than expected number of lights or proportionate to unit area but visual analysis indicates an uneven spatial distribution within the hotspot area.
*c ‘Low’—lower than expected number of lights per unit area.*
Residents’ views of the relationship between streetlighting and fear of crime
Fear of crime was a significant problem in most of the areas surveyed. For residents who had lived in the area for more than a decade or so, this was viewed as a relatively recent phenomenon: “I used to walk all over but now it’s too dangerous.” This was related to perceptions of these areas having undergone recent and quite dramatic social change, although many residents knew their neighbours and had close local ties with family and friends. Adult men were most likely to say they felt safe, and young people, women, and parents of young children were most likely to feel worried about crime, reflecting research elsewhere (Mirrlees-Black and Allen, 1998; Pain and Townshend, 2002; Stanko, 1987). The impacts of fear of crime meant that, for some, “I stay in”, “I avoid places”, “I don’t use the back entrance”, “I take the long route.” A minority felt worried leaving their houses at all because of the risk of burglary, and some made sure that there was always someone at home, even if this made it impossible to go away on holiday. Many of those who were parents said that they did not let their children out alone, or at least not after dark. Physical and sexual assault, bullying, and burglary were the crimes most likely to be feared directly by residents, but youth disorder, criminal damage, and knowledge of drug use and dealing also made many feel fearful of more serious crimes.

There was considerably more support for the premise that streetlighting can have a role in reducing fear of crime than for the idea that streetlighting can affect the occurrence of crime itself, reflecting the results of some studies (for example, Herbert and Davidson, 1995; Tien et al, 1978; Vrij and Winkel, 1991). Not all of those who were fearful held this view, but in general those who were fearful felt most anxious at night or in the winter: “when it gets dark early”; “you don’t know who’s there on a dark winter’s night”; “I avoid dark areas as I have been assaulted before”; “I don’t feel safe when lights aren’t working”; “you don’t know who’s there”; “at the moment I wouldn’t stand at the bus stop as there’s no lighting.” If there was more streetlighting, most of those who worried about crime said they “would feel happier going out”; “would be able to use the back lane”; “would let the children out”; “would go out more on a night”; and that “older people would walk through the estate and not round it.” Reasons commonly given were that they “would feel able to see who’s around” and would have “more peace of mind” (see also box 1).

However, some felt streetlighting was fairly insignificant and improvements would not have an impact: “I don’t feel safe and lighting wouldn’t change that”; “I would still avoid the cut”; “I would still get taxis everywhere as I don’t feel safe in the area”; “it wouldn’t affect fear.” Reasons given included beliefs about the causation of crime as well as the fact that criminals were often known to be local: “it’s not just the lighting, it’s the people”; “some burglaries are done by my next door neighbours”; “I would still be dubious living on this estate” (see also box 2, over). As recent research has suggested, place and context appear highly significant to the relationship between streetlighting, crime, and fear: lighting is most likely to ameliorate problems in stable, homogenous areas (Farrington and Welsh, 2002; Pease, 1999). In these study areas, residents’ caution appears to be well founded.

The nature and location of lighting problems
The specific problems with streetlighting that residents reported to the research were much less likely to be about the simple presence or absence of lights (though this was a complaint in some areas) than about other issues. In some cases they concerned the quality of the lighting: “they’re not bright enough”; “it’s orange so you can’t see a lot” (see box 3, over). The majority of the areas had low-level orange lighting, typical of 1960s and 1970s schemes but providing poor visibility for pedestrians (Townshend, 1997).
However, the most common complaint was that lights did not work properly or were broken: “they’re hardly ever working, the lights have been out for months and months so it’s dark, we’re always complaining”; “old people are falling as they can’t see.” There were many reports that children throw bricks at the lights to break them, or “kids climb to the top and shake them off.” In some of the areas, residents also felt that: “it takes a long time to make repairs”; “usually two or three people phone before they come and fix it”; “I have made four complaints that the light was not working properly, I am sick of complaining” (see also box 3).

Residents were asked exactly where they perceived lighting problems to be within the hotspots identified by GIS (for example, particular sections of streets, parks, cuts, etc). Often, their concerns about lighting were very localised and close to home (see boxes 1 and 2). In areas of terraced housing, back lanes were mentioned frequently as blackspots. There was often better lighting at the front of houses, but poorer provision to the rear, where there was already poorer surveillance because of high back walls and fences. Residents tended to avoid back lanes at night: “[poor lighting] affects the routes I take—I don’t take shortcuts through back lanes.” And some suggested that lighting improvements were needed: “in the back streets it would make people feel safer”; “you could see the junkies [drug users] in the back lane.” Other sites of poor lighting were more specific, including subways, small rows of shops, patches of waste ground between housing, car parks (see box 1), individual buildings, walls, trees, or hedges which were blocking lights. In one area, a single tree blocking a light in an alleyway

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**Box 2. Hotspot B1**
Hotspot B1 is within a council estate close to Blyth town centre. The map shows a single pronounced hotspot for burglary. Residents identified other crimes as problematic, including drug use and dealing, theft, criminal damage, and car crime. One had been burgled three times during the last year. Residents were also concerned about children and ‘weirdos’ hanging around.

The GIS output showed low lighting coverage. Some described it as ‘pathetic’, ‘rubbish’, ‘terrible’, but the majority of residents felt that it was adequate: “quite well lit”; “better than it was five years ago”; “okay here compared to some areas.” The main complaint was that, often, individual lights did not work: “whenever one gets fixed it is broken again”; “one light is nearly always out”; “all the lights recently went out for a few days.” However, few of the fearful residents felt that better streetlighting would make them feel safer, as their worries about high rates of crime in the area were so pronounced.

One small problem area was singled out by many residents: a streetlight in a cut (alleyway) which is the main walking route to the supermarket. They reported that drugs are dealt there, kids hang around, there is vandalism and graffiti, and people are afraid to use it. People with disabilities said it was a long walk round to the supermarket otherwise. The streetlight in question is new, but obscured by a tall tree in a private garden. The occupant had been asked to cut the tree back, but he felt that the tree afforded him privacy.

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**Box 3. Hotspot A3**
Hotspot A3 lies in an inner area of older housing in Ashington. The maps show hotspots for burglary and criminal damage. The residents identified these crimes plus drug use, youth disorder, car crime, and theft as problematic. The majority said they did not feel safe at night, fitted security lights, bolts, padlocks, and alarms, and took many behavioural precautions when they were out.

Although classified from the GIS output as having high lighting coverage, most residents felt that streetlighting was inadequate because of its colour (orange), its age, and the fact that broken lights were not mended promptly. Opinions were divided as to whether better lighting would reduce crime and fear.

However, the most common complaint was that lights did not work properly or were broken: “they’re hardly ever working, the lights have been out for months and months so it’s dark, we’re always complaining”; “old people are falling as they can’t see.” There were many reports that children throw bricks at the lights to break them, or “kids climb to the top and shake them off.” In some of the areas, residents also felt that: “it takes a long time to make repairs”; “usually two or three people phone before they come and fix it”; “I have made four complaints that the light was not working properly, I am sick of complaining” (see also box 3).
caused a great deal of concern (see box 2). In sum, not only is lighting coverage a poor indicator of satisfaction with lighting or of problems such as fear of crime, but often the problems that residents do identify are relatively localised and minor yet have a significant impact.

**Summary and discussion: “the council should walk round and see the bad bits”**

The qualitative data from residents confirm that crime is a considerable problem in these areas. They indicate that many crimes which are not measured in police statistics are as great a problem as those which are. As a result, fear of crime is a significant problem in most of the areas, and one role of the rapid appraisal was to add this important information to that provided by the GIS output. However, most of those questioned did not believe that changes to streetlighting would have a significant impact on crime levels. More of them felt streetlighting would go some way to reducing their fear of crime, though by no means all of those who were fearful held this view. Surveys have tended to be premised and designed on the basis of fairly simple cause–effect relationships existing, but such relationships were dismissed by the majority of those interviewed; at most, streetlighting was held to have a marginal and even then contradictory influence on the problems of crime and fear that they face.

Pease (1999) speculates that, where streetlighting does reduce crime and fear, the effect works through increased community pride and sense of ownership of the local area. Most of the study areas we targeted were deprived areas in which community pride was described as decreasing rapidly by residents. This may be one reason for their doubt over whether streetlighting would do much to improve safety. It is worth pointing out that improved streetlighting schemes are likely to have a range of other benefits for communities in the study areas. However, crime was perceived by residents as endemic, committed largely by insiders in each neighbourhood, and underpinned by deep-seated processes of economic deprivation and social breakdown. Under such circumstances a technical fix might be expected to have little effect, and should be part of wider social policies which also address the socioeconomic context of the area (Gilling, 1997). One implication of this critique is that quantitative geographical analysis is not necessarily the best way to identify factors influencing crime and fear. We suggest that qualitative research is an excellent tool for suggesting what these factors are, and may be usefully employed in this way before quantitative analysis is embarked upon. Notwithstanding this, it must be acknowledged that our study (of point-referenced data) used only one set of GIS techniques, as outlined above. There are others which might be usefully applied to the spatial analysis of community-safety-related data, including area-aggregated data, such as local indicators of spatial association (LISA) approaches.

In this paper we have not integrated qualitative data with GIS, nor used it participatively with local communities, both increasingly popular strategies in the push to democratise GIS. Yet, the qualification of GIS outputs we undertook has three important benefits. First, it has the potential to make the processes of research, planning, and policymaking more democratic and inclusive, and as such could be far more widely applied. Planning on issues such as lighting or community safety is widely experienced as top-down. The statement “the council should walk round and see the bad bits”, as one man put it, reflects a wider feeling that there is little consultation with communities or feedback on the effect of strategies put into place, despite government imperatives (Home Office, 1998; Newburn and Jones, 2001).

Second, we would argue that such an approach produces a more widely referenced evidence base on which to found decisions. Detailed information on local concerns and environments can help to unravel and evaluate the patterns which GIS show.
The information from residents about crime, fear, and their perceptions of the relationship of these with streetlighting made more significant differences to our understanding than if we had we simply begun and ended analysis with police-recorded crime data. The qualitative research also underlines the importance of context, the particularities of each small area, and its social and physical microgeographies and lived experiences of these to patterns of fear of crime (Brown, 1995; Loader et al, 1998; Pain, 2000). Methods widely used in streetlighting research are often poorly placed to elucidate these aspects.

Thirdly, we would hope that this means more effective outcomes. We recommended that three of the areas studied should be considered for new or significantly improved lighting schemes (hotspots A2, B2, and C2, classified as having low, high, and low coverage of lighting, respectively; see table 1). Each has since seen major improvements to streetlighting, and the research was also used in a successful bid for Home Zone funding (targeted at small areas and involving a range of environmental changes including road-safety planning). In most of the remaining areas we recommended that improvements in quality of life could be made by better maintenance of lighting in particular sites.

It is important to note that a significant part of the difficulties with quantitative analysis we have discussed in this paper is to do with the quality and nature of available data and not always the capability of GIS analysis itself. One promising line of further enquiry of this nature would be to conduct a local survey of crime and to input the findings to be analysed with GIS—for example, the relationship with temporarily inoperable streetlights.

Nonetheless, some caution is needed in using multimethod strategies. The different layers used in this study were not always mutually reinforcing—for example, crime hotspots often did not reflect residents’ experiences of crime, and satisfaction with streetlighting bore little relation to mapped lighting coverage. Triangulation should make for better, deeper, more accurate findings and outcomes; yet findings from different methods rarely fit easily together like jigsaw pieces to produce one set of meanings. Triangulation justifies far more debate in the growing literature on GIS and qualitative methods. In our study, as we argued in the methodology section, we were not directly comparing like with like.

Caution also needs to be exercised where qualitative or participatory elements are simply added onto GIS analysis. We would robustly defend the benefits of our methodology given the research outcomes, but we have been careful not to present the qualitative stage of our research as equating with participation by the residents: it affected the outcomes of the research quite profoundly, but less so the processes. Nonetheless, the simple and relatively resource-efficient methodology we have presented here might have far wider application in critical policy research, so long as both stages are conducted critically and reflectively.

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