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DAMNED IF YOU DON'T, DAMNED IF YOU DO: CRIME MAPPING AND ITS IMPLICATIONS IN THE REAL WORLD

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A small but growing North American trend is the publication of maps of crime on the Internet. A number of web sites allow observers to view the spatial distribution of crime in various American cities, often to a considerable resolution, and increasingly in an interactive format. The use of Geographical Information Systems (GIS) technology to map crime is a rapidly expanding field that is, as this paper will explain, still in a developmental stage, and a number of technical and ethical issues remain to be resolved.

The public right to information about local crime has to be balanced by a respect for the privacy of crime victims. Various techniques are being developed to assist crime mappers to aggregate spatial data, both to make their product easier to comprehend and to protect identification of the addresses of crime victims. These data aggregation techniques, while preventing identification of individuals, may also be inadvertently producing maps with the appearance of 'greater risk' in low crime areas. When some types of crime mapping have the potential to cause falling house prices, increasing insurance premiums or business abandonment, conflicts may exist between providing a public service and protecting the individual, leaving the cartographer vulnerable to litigation.

Keywords: Crime mapping; Spatial labelling; Geocoding; Ethics

INTRODUCTION

When members of the public are asked to list their main areas of concern, crime is usually at (or very near) the top. A BBC poll reported in the Economist (1995) found that people were more worried about violent crime than unemployment, inflation, the state of the health service or education. The public seems to have an insatiable appetite for news on criminal activity, as witnessed by the proclivity of crime-oriented television programmes and newspaper articles. Fiction and fact seem to be almost indistinguishable, such that a number of studies of the fear of crime have shown that the public in general are not good at evaluating their realistic likelihood of victimisation (Economist, 1995; Grabosky, 1995; Borooah and Carcach, 1997; Kemshall, 1997).

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Police services are now attempting to counter not just the level of criminal activity, but also the public perception of crime victimisation. A number of police services have the reduction of public fear of crime built into their mission statements.

Fortunately, the police are ideally placed to reassure and inform the public. Most sectors of society have a higher-than-realistic fear of crime, particularly the elderly. In the current 'risk society', the police are positioned as the 'gatekeepers' to information about crime (Ericson and Haggerty, 1997) with the attendant responsibility of informing the public and the outside world. Indeed as Ericson and Haggerty note; "Most of the crime-related knowledge produced by the police is disseminated to other institutions" (1997, p. 5). A 1997 US Bureau of Justice Statistics report found that 35% of local police departments provided the public with access to crime statistics or maps, and in departments with a catchment population over 100,000, this figure increased to 80% (Wartell and McEwen, 2001). This public and institutional (both internal and external) thirst for information, however, imposes a drain on police resources and assets that might be better used elsewhere. As a result, the Internet offers what seems to appear to be an ideal medium for dissemination of information that, once automated in some fashion, might provide savings in time and human resources. Information can also be controlled by the police to ensure that a less dramatic slant is placed on the data and information.

Maps can be an ideal way to convey crime-risk information and have been used within some police services for a few years. A number of US police agencies are now using crime maps on the Internet to inform the public about relative risk. The maps are used because they are easy to understand and are able to convey data, that used to be shown in tabular format, in a more informative way.

Although there are currently no agencies in the UK or Australia mapping crime for public access over the Internet, a number of law enforcement agencies are examining the possibility of developing an online mapping capability. This would therefore seem an ideal time to examine some of the technical and ethical issues surrounding crime mapping.

There are a number of factors to consider in this area, including the respect of individual privacy, and the accuracy of the subsequent mapped information. This article will examine sources of error in the creation of maps of crime, and begins with a discussion of personal privacy and the errors inherent in crime map production. It continues by examining the problems associated with the use of the Internet for crime mapping before concluding with the proposition that there is the potential for both progress and for problems in this area, highlighting that further work is required.

PERSONAL PRIVACY

One point with which few people disagree is the notion that personal privacy should be protected. Few victims of crime would be happy to report details of their victimisation to the police knowing that they would be identifiable moments later via the Internet. For example, victims of a burglary would not want their address to be in the public domain, advertising that their property was vulnerable to burglary. Even when an actual address is not available, it may be possible to extrapolate the address of the victim from a dot on a map. The privacy of crime victims is not in dispute. Various countries and states have created, or are in the process of creating, legislation to protect the privacy of people who report crime to the authorities. In many cases this legislation, which places severe restraints on criminologists and those seeking to assist the police with strategic research, can dictate that the information can only be used for the purpose for which it was given. There is currently some debate as to whether the crime victims who supply information are in fact doing so to catch a specific criminal (the offender of their specific incident) or to help catch criminals in general (leaving open the criminological research potential of crime data).

The corollary of this legislative condition is that crime data must be masked or aggregated in some fashion prior to being disseminated beyond the criminal justice system. The many processes of aggregation can result in the production of a number of errors in crime data that are, in turn, replicated in crime maps. The errors resulting from aggregation must be understood to fully appreciate the potential and disadvantages of these maps. This paper is intended to be interpreted constructively. The author is a firm supporter of this technology for both policing intelligence and strategic criminological research, however appreciates that this technology is not yet perfected for crime mapping. As Peter Grabosky has said, just because we might wish to analyse engineering failures does not mean we should forsake the use of bridges and buildings, hence just because problems are identified with some types of crime prevention, it does not mean that we should dismiss the whole area of research and policy (1996). The conclusions drawn here promote a realistic appraisal of the current 'State of the Union' of geocoding in the areas of law enforcement, Internet protocol and Geographical Information Systems (GIS), which can not only serve as a warning in research and policy areas that have not received sufficient attention, but also as a research agenda for the future. The discussion might also be timely for policy considerations in countries such as the United Kingdom and Australia which have high levels of Internet access, but have yet to foray into the area of public crime mapping. The following sections seek to provide a brief overview of the existing potential for error in crime mapping.

MAPPING CRIME

In most countries, the police are the main body responsible for the collation of recorded crime information. Attitudes and legislation differ from country to country but in general, aggregated and summarised information of this nature is considered to be public property and can be viewed by the population. In the US, unlike Europe or Australia, much crime information collected by public agencies is deemed to be public records. A number of US law enforcement agencies are taking a lead by disseminating this information, not in tabular statistical form, but visually, showing the distribution of crime in an area over a period of time (see www.ojp.usdoj/cmrc). Wartell and McEwen (2001) report that in May 2000, the Crime Mapping Research Center was aware of 38 agencies that had maps of crime available for viewing on the Internet. The quality of the information varies from site to site; some show a static map with preselected dates and specific types of crime, while others are interactive and permit the viewer to select dates and types of crime. A more up-to-date list of law-enforcement crime-map sites is available from the Crime Mapping Research Center (www.ojp.usdoj/cmrc). Wartell and McEwen (2001, pp. 5–6) list a number of benefits for law enforcement that develop Internet crime mapping projects. These are summarised below:

1. Providing crime maps on the Internet may provide a saving in police workload,
2. Increased community knowledge about crime may increase community co-operation,
3. Maps can assist in community policing and problem solving,
4. Maps can increase public awareness of neighbourhood problems,
5. Maps can facilitate partnerships with researchers and other agencies,
6. Data provision by the police service can help prevent its figures from being misinterpreted,
7. Maps and data increase police department accountability.

Thirty-eight sites showing crime maps may not seem numerous given that the US is a mosaic of about 19,000 relatively autonomous law enforcement agencies, but given the attendance at crime mapping conferences and the level of activity of the Crime Mapping Research Center this number is set to increase. It is worth noting that, irrespective of the generally agreed need for confidentiality, the majority of these sites actually display the exact crime location as a point on a map. With the current paradigm of community policing there is a clear appeal for a technological solution that both informs and engages the public. However the publishing of maps on the Internet relies on a technology that is not yet firmly established, and on which development is still taking place. Automated maps of crime require human and computer processing through a number of stages, each of which can introduce a degree of error. While it might be stimulating to work in an innovative area of criminal justice and information technology, representing the gatekeeper of this knowledge also confers responsibility and a need to recognise the limitations of this emerging science.

LIES, DAMNED LIES AND WEB PAGES

Crime is always a matter of public interest, and it is frequently an emotive issue. This was highlighted most noticeably in the UK in 2000 when a tabloid newspaper, the News of the World, began to publish the personal details (including addresses) of convicted sex offenders. Although the paper did publish warnings advising against public action, the vigilante mobs were soon out in force. Warning pages are frequently ignored, if they are even read at all. One doctor in Wales had her property daubed with threatening graffiti when an apparently illiterate individual could not tell the difference between ‘paedophile’ and ‘paediatrician’. Similar problems exist on the Internet where caveats can be ignored, and pages containing disclaimers regarding limitations or data accuracy can be avoided in direct links or immediately clicked past, unread. Few people read the licence agreements with new software packages once they have loaded more than a couple of new programs, and the situation regarding caveat and warning pages on the Internet is similar.

Much of the debate about the suitability of criminal justice information available via the Internet has already taken place due to the requirements placed on US law enforcement by ‘Megan’s Law’. Seven year old Megan Kanka was killed in 1994 by a sex offender who lived across the road from her house. Subsequently the ‘Jacob

Wetterling Crimes Against Children and Sexually Violent Offender Registration Act' was amended by President Clinton to require US states to make available to the public the details and locations of all sex offenders. A number of agencies, such as the Virginia State Police[1], make this information available over the Internet. Debate is still ongoing as to the accuracy of these databases, and their impact on the criminal justice administration. Police in the UK reported losing contact with a number of registered sex offenders once the News of the World began their campaign against paedophiles.

Disseminating information about crime to the public is different from passing information to criminal justice professionals. The latter group is generally aware of the limitations of recorded crime data, both in terms of the accuracy of individual records, and the veracity of total numbers.

Giving information to the public is a different matter, and while some people are highly educated and knowledgeable about criminal justice, this does not hold for the majority. As Herbert Dreyfus has recognised, "...no one assumes responsibility for the accuracy of the information on the Web. The information has become so anonymous that no one knows or cares where it came from. Of course, in so far as one does not take action on the information, no one really cares if it is reliable." (Dreyfus, 1999, p. 16). With maps of crime on the Internet however, there is a very real possibility that policy makers, local community groups, vigilante mobs (especially with the case of maps displaying the residences of sex offenders) or any number of interested parties might convert information into action. Accuracy and accountability become issues at this point, however, fewer web pages are now carrying information that indicates who actually created the page, and by implication, who is prepared to testify to the accuracy thereof. You might find a link to a webmaster, but lack of personal details makes it harder to contact an individual if the webmaster fails to reply to a query. It is also harder to attribute blame. Beyond static information sites that do not frequently change much information, there are web sites that constantly and automatically update themselves by referring to databases maintained on automated servers. Pages that retrieve information from databases seem to have an implied acceptance that they automatically portray truth: it would almost be heretical to suggest that an error could have occurred or that the information is out of date. Examples can be easily found in the web sites of airlines that offer on-line ticketing. Many sites offer the ability to select from a number of flight times and destinations, but how often do you see a sentence along the lines of "If you think any of this information is wrong, e-mail Bob.Smith@airline.com"? There is an assumption that the database is infallible and will always return the requested data, that the information it contains is devoid of error, and if 'facts' are disgorged from a computer, then they must be true.

Crime Recording and Geocoding

If we now go on to examine the possible sources of error in a geographical database of crime, it will be seen that the information available to generate a web page might deviate considerably from the actual spatial distribution and volume of crime. Before

[1]Virginia State Police Sex Offender and Crimes Against Minors Registry Home Page: http: //sex-offender.vsp.state.va.us/cool-ICE/ (accessed 24 Sept 2001).

a crime can be mapped, it must go through a complex process capable of introducing error at every point. Research on the 'dark figure' of crime (that portion of the total crime in a community that is never reported to authorities) immediately tells us that some types of crime are considerably under-reported (Coleman and Moynihan, 1996) suggesting that any eventual map will underestimate the actual instances of criminal activity. An easy solution to this trail of error potential is to add the caveat that a map shows only those locations of crimes reported to and recorded by the police, but as mentioned earlier, caveats and warning pages are not necessarily heeded. Spatial accuracy is also a major concern in crime mapping. Once a crime is reported to a police officer, accurate recording relies on the victim knowing the correct incident location, conveying this to the police officer, and that officer dutifully recording the correct location. An additional source of error springs from the necessity to geocode crime locations to generate a point on a map. The science of geocoding is still under development and data quality varies from state to state, and across international boundaries (Harries, 1999). Arguably, for geocoding purposes, the British AddressPoint data is one of the most accurate in the world. AddressPoint is a database that contains x and y coordinates for every address in the UK. Unfortunately, it is also expensive, and the prohibitive cost can limit its widespread use. In other countries, the use of centre-line geocoding can limit the accuracy of a geocoded point, placing a dot, tens (or occasionally, hundreds) of metres from the actual crime location. Centre-line geocoding uses collections of street segments (generally a single line purporting to represent the centre of the road) containing address ranges as attributes. A software geocoding 'engine' estimates the location of an address based on the address range attributes and the street segment direction and length.

Different agencies can achieve different success rates of geocoding, with some able to geocode nearly 100% of their data. Others have published maps with little more than 70% of the available data mapped. Geocoding crime locations that do not occur at or near premises creates an additional problem. Some crime sites, such as robberies in the street or crimes in rural locations, are difficult to geocode with any degree of reasonable accuracy. Ratcliffe (2001), expanding on the work of Harries (1999), provides a 10-point summary of geocoding errors that gives some flavour of the multitude of possible errors in the geocoding process:

1. Out-of-date street directories that do not recognise new addresses or roads.
2. Abbreviations of street and road names (for example, 'gdns.' in place of 'gardens') that cannot be recognised by geocoding software.
3. Local name variations that do not match database entries.
4. Address duplication problems that are caused by dozens of streets with the same name across a city.
5. Non-existent addresses caused by typographical errors (for example, '3700 Chestnut Street' that should read '370 Chestnut Street').
6. Line simplification that does not reflect the true curves of a street and places geocoded points in the wrong place. Line simplification is the process of using sections of small, straight lines to represent curved and winding roads. It is commonly done with GIS to reduce file sizes and to simplify the visualisation of bending roads and shapes.
7. Noise in the address file that causes geocoding software to skip records. Additional terms in addresses such as '*outside* 12 Smith Street' or '*near* 12 Smith Street' can be unreadable to many geocoding programs.

8. The inability to geocode non-address locations, such as 50 m along a street, or in a rural location a few miles from a town.
9. General geocoding imprecision that places a point some distance from the actual address.
10. Ambiguous or vague addresses that make it impossible to identify an actual address.

The trauma of geocoding might be thought to be the last challenge prior to map generation, but of course these individual points must be masked or aggregated in some fashion prior to being viewed by the general public, if the privacy of the individual is to be truly protected. There are a number of different aggregation processes. Some generate a smoothed surface of event density, while others aggregate crime distribution to fixed boundaries such as census tracts. The former can be undertaken by a variety of means that produce different outputs from the same data, while the latter is vulnerable to the Modifiable Areal Unit Problem (MAUP), identified as a serious problem by a number of authors (Openshaw, 1984; Bailey and Gatrell, 1995; Unwin, 1996). The MAUP can occur when a change in the position of boundaries can generate different maps with the same data, inviting different interpretations. To demonstrate the potential for discord, this paper will now review two methods that seek to go beyond many current smoothing processes by generating definite hotspot areas.

COMPARISON OF TWO HOTSPOT METHODS

The software package for the Spatial and Temporal Analysis of Crime (STAC) has been in existence for many years now, and is probably the most widely used software for delineating crime hotspot areas in use by American police agencies. It is available free of charge from the Illinois Criminal Justice Information Authority. STAC uses a combination of statistical routines to show hotspot areas as standard deviational ellipses (ICJIA, 1996). The limitations of this software have been discussed elsewhere (Ratcliffe and McCullagh, 2001), but it has undoubtedly been a significant innovation in the past, and remains a popular product. The Getis and Ord Gi* statistic is one of a newer range of techniques termed Local Indicators of Spatial Association, or LISA statistics (Anselin, 1995). LISA statistics have already been used in the study of crime (Chakravorty, 1995; Ratcliffe and McCullagh, 1999), and in the following example the methodology for the LISA statistic uses the process described in Ratcliffe and McCullagh (1999). Although this methodology has not yet been made easily available for crime mappers and still requires programming skill on their part, the technique has been favourably reviewed at more than one Crime Mapping Research Center International Annual Conference.

The data for this study are taken from the Eastern Suburbs of Sydney (Australia) and draw on six months of burglary data containing 783 incidents (two separate periods of April to July 1998 and November 1998 to March 1999 have been combined). Figure 1 shows the Eastern Beaches Local Area Command, a basic command unit of the New South Wales Police Service. It is a generally affluent area with compact housing just East of the Sydney CBD. Figure 1a depicts the 783 incidents where the size of the circle indicates the number of incidents that have occurred at the same location (the largest circle has a value of 11). This is useful as a way to show the distribution of all incidents in the dataset, but has its limitations. As the number of incidents increases, the functionality of the map to accurately convey the areas of higher crime intensity diminishes as the viewer is swamped with too much information. Secondly, the larger dots can either obscure smaller dots, or can themselves be obscured by lots of smaller symbols placed over them. If the road network is shown, the location of individual premises could be calculated with enough effort. Figure 1(b) shows the same set of 783 data points displayed as STAC hotspots (grey ellipses) and Gi* hotspot regions (black bordered regions). Both of these techniques employed the same parameters where possible[2].

As can be seen from Fig. 1b, there are seven STAC hotspot regions marked, each indicated by a standard deviational ellipse. There are many more hotspot regions indicated by the Getis Ord Gi* statistical analysis, varying greatly in area and shape. The relative merits of each system could be discussed in relation to the underlying geography of the crime distribution or the application to police operational intelligence. For example, one quantitative method to decide the most appropriate hotspot detection method might count how many actual crime locations are contained within the hotspots, with the argument that an ideal system will identify those regions with the highest density of points within the smallest area, aiming for the highest number of points per square kilometre. This approach would be suited to police operational use as, even with high density/high rise housing areas, police can still derive value in

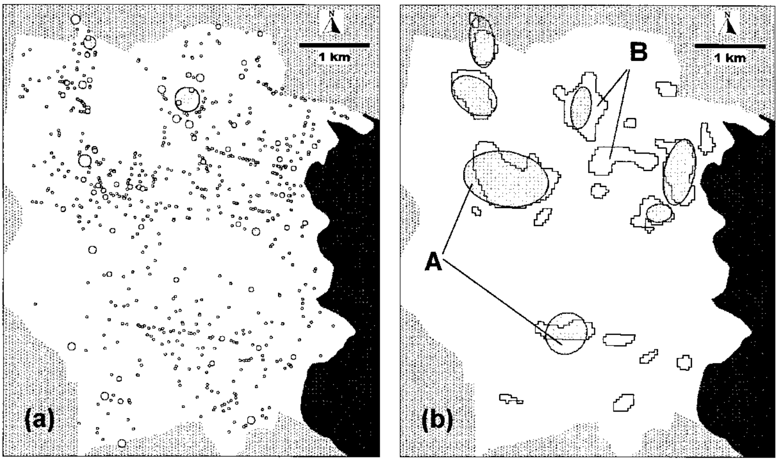

FIGURE 1 (a) shows the location of all 783 burglary incidents in the Eastern Beaches Local Area. Command of the New South Wales Police Service (Sydney, Australia) with circle size weighted to reflect the number of repeat incidents at each location, (b) shows hotspot regions defined for the same data as (a) by both STAC (grey ellipses) and the Ratcliffe and McCullagh method employing a Gi* algorithm (solid black outlined areas). In figure (b) areas marked ‘A’ show example areas that are within STAC hotspots and not Gi* regions, while ‘B’ areas show examples of the reverse.

[2]For the technically-minded, the STAC hotspots were generated by choosing a 200 m search over a rectangular pattern with a minimum number of 5 points per hotspot. Further methodological details are available in ICJIA (1996). The Getis Ord Gi* method used a resolution of 40 m, a bandwidth of 200 m, and Gi* fixed radius of 120 m, a quartic kernel algorithm for the surface interpolation, and a p value of less than 0.01 for the Bonferroni test. Details of the full methodology are available in Ratcliffe and McCullagh (1999).

identifying those areas with the highest level of crime irrespective of population density. If this rule was applied, then Table I shows that the highest density of points is found here by using the Getis Ord Gi* statistical approach. Although the Gi* regions cover a larger part of the study area, they have a higher density of points within the regions. A converse operational policing argument might argue that there are too many hotspot regions generated using the Gi* approach, and what operational commanders need is something simpler. With fewer hotspots, even if they are slightly less accurate, the STAC regions are easier to prioritise for resource allocation and to explain to patrolling officers.

The main point from this is that while many areas are overlapping, there are also regions that are only hotspots according to STAC (example areas are indicated '*A*'), and others are only hotspots according to the Gi* analysis (example areas marked '*B*'). This lack of correlation across significant areas of the map indicates that living and working in a crime hotspot is not only a function of the location of surrounding crime, but also of the analytical process applied to that crime data. Choice of hotspot detection algorithm will influence the map display and subsequent interpretation, giving the choice of computer program a political inclination. Ignoring this dimension of the software is to believe in what Corbett and Marx have termed the fallacy of technical neutrality (Corbett and Marx, 1991). Different analytical processes can be applied to different problems, and a number of different equable techniques could be applied to the same data, in the same way as has been done here. The problem is that in the absence of an unambiguous 'right' answer, different techniques can arguably be applied to the same data generating different answers that could be interpreted as equally right, or equally wrong.

This example is used here to demonstrate the capacity for discord in analytical processes that could be translated into error and imprecision when mapping solutions are used. At the time of writing this article, the author is unaware of any site that currently shows hotspot maps using STAC or Gi* to the public, though they are used as internal dissemination tools within the police and criminal justice system. Maps that show hotspot surfaces are available publicly on the Internet[3], as are maps that shade crime amount by census tract[4], arguably an even more questionable technique

TABLE I Comparison of hotspot methods from Fig. 1(b). Although the Getis Ord Gi* approach generates hotspots that cover a larger area, these regions are more tailored to the spatial pattern of the crime points, and contains a far higher number of points, resulting in a more dense pattern of points per km^2

	Total area of hotspot regions (% of study area)	*Points contained in regions (% of all points)*	*Density of points* (points/km^2)
STAC ellipses	2.02 km^2 (8.7%)	240 (31%)	119
Getis Ord Gi*	2.81 km^2 (12.1%)	399 (51%)	142

[3]Internet links are notorious for going dead prior to the publication of an article, but one example was available at the time of writing at www.ci.mesa.az.us/police/crime_analysis, and others through the links page of the Crime Mapping Research Center (www.ojp.usdoj.gov/cmrc). Accessed 24 September 2001.

[4]Same caveat as the previous footnote should apply, but try Tempe, Arizona Part 1 crimes map at www.tempe.gov/cau/, or again through the Crime Mapping Research Center (www.ojp.usdoj.gov/cmrc). Both pages accessed 24 September 2001.

due to the difficulties with the modifiable areal unit problem. Space does not permit here, but a number of articles demonstrate the limitations and problems of mapping in this way (Openshaw, 1984; Bailey and Gatrell, 1995; Unwin, 1996).

CONSEQUENCES OF MAPPING ERROR

The geographer and GIS expert Stan Openshaw recognised the potential pitfalls that face GIS users when deciding to use the technology for potential public benefit, and he could have been easily talking about law enforcement. He noted the potential for well-meaning decisions based on GIS having a detrimental effect. "To put it more bluntly, when GISs are used, there is a danger of some GIS-inspired decisions killing people, ruining businesses, and wasting public resources" (Openshaw, 1993, p. 451). He went on to list four types of GIS sin[5]:

1. Type 1 – When a GIS application fails completely,
2. Type 2 – When a GIS application causes measurable harm,
3. Type 3 – When GIS is not used and the lack of use results in a poorer decision, and
4. Type 4 – When vendors make GIS so complex that it is impossible for users to improve the system.

Given the recent commercialisation that has taken place in the GIS industry, and the number of associated programming languages that are available for modern GIS, it is to be hoped that type 1 and type 4 GIS sins are now few and far between. The quandary that can occur with the current picture of crime mapping is the conflict between the potential to commit either a type 2 or type 3 GIS sin. A type 3 incident can occur if maps are not employed when their use would educate the public, inform police officers and criminal justice officials responsible for resource allocation and policy making, and assist detectives in case investigation. Certainly the first reason is a primary rationale for going to the effort of putting crime maps on the web at all, and other reasons were discussed earlier in this paper.

But if an area is labelled a crime hotspot by mistake, or a geocoding error places a dot indicating a sex offender's house in the wrong place, what are the possible consequences? Before identifying areas of concern it should be pointed out that there are some positive consequences of residing in an erroneously labelled high crime area. With the current paradigm of targeted policing, residents of a region accidentally perceived to have a crime problem are likely to receive prioritised policing and possible greater access to scarce crime prevention resources. This is of course to the detriment of more needy areas, but there can be little dispute that the residents would be unlikely to complain about additional policing and safer streets as a result!

The reality is that there are potentially a greater number of negative factors associated with the label of 'high crime area'. Public access to maps that show high crime regions may affect insurance premiums and even the accessibility of insurance, residential and commercial property prices may suffer as a result, and good employees may be unwilling to work in high crime regions. This last factor might therefore impact on the quality of education available to schoolchildren in the region, the skill level of workers

[5]Openshaw actually lists four types of GIS 'crime'. To avoid confusion the term 'sin' is used here.

available to local businesses and the quality and experience of the local police service. In the place of a resident who owns a business in an area labelled as 'high crime' in error, whom might they blame? They might see their children receive a worsening standard of education as all the good teachers get jobs elsewhere, their business unable to fill available positions, and the value of their home depreciating. This could certainly be in Openshaw's area of causing measurable harm; a type 2 GIS sin, and in an information-rich society it would be a relatively simple process to generate some measure of loss or harm.

The paradox is the possibility of being too reticent in publication and inadvertently causing a type 3 event, where crime continues to be a problem because the spatial analysis that identified the problem was not publicly available for fear of litigation. Megan's Law, mentioned earlier in this paper, was legislation born from a desire to prevent further serious crimes being the result of insufficient public access to information. A similar desire to protect agencies from future litigation is no doubt behind the collection of US legislation loosely termed 'Clery's Law'. The 1990 legislation requires universities and colleges in the US to show their campus crime statistics on a centralised web site. Six thousand seven hundred colleges are eligible with a maximum fine of US$25,000 possible for each unreported crime. The law[6] was named for 19-year-old Jeanne Clery who was killed in 1986 in a dormitory room at Lehigh University in Bethlehem, Pennsylvania. Unbeknown to Jeanne Cleary or her parents, there had been 38 violent crimes on campus in the preceding three years[7].

Spatial Labelling

The type of neighbourhood problems discussed in the previous section (such as falling property prices and deteriorating educational standards) could be seen as the result of spatial labelling. Labelling theory relates to the possibility that stigmatisation can generate the formation of criminal subcultures (Braithwaite, 1989; Williams, 1994), though empirical work has questioned its validity in certain circumstances (Weatherburn and Coumarelos, 1994). Spatial labelling is the notion that negative impressions and stigmas can be attached to an area, with a knock-on effect on the tolerance to crime of the residents and people passing through the region.

> The mere identification of a place as dangerous or rowdy sends a signal. Persons who are risk-aversive and who value tranquillity will be inclined to avoid such a location, while those who would be producers and consumers of risk would be attracted to such a place. Where signals of danger do not initially reflect empirical reality, they may operate as self-fulfilling prophecies, transforming the image and reality of a place (Grabosky, 1996).

Crime mappers run the risk of starting a downward trend by labelling an area as 'high crime'. Large-scale public dissemination of maps highlighting high crime areas is certainly likely to have an adverse affect on a number of socio-economic indicators such as real estate value. Given that some of the areas may not actually experience a great deal of crime, flawed publicly-available crime maps might provide the first

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[6]Jeanne Clery Disclosure of Campus Security Policy and Campus Crime Statistics Act, 20 USC 1092 (f) as a part of the Higher Education Act of 1965.

[7]More information is available at http://www.campussafety.org/ (accessed 24 September 2001).

'broken window' to initiate the spiral of decay described by 'Broken-Windows' theory (Wilson and Kelling, 1982), a crime generation scenario that the police can ironically play an important part in preventing at an early stage (Weatherburn and Grabosky, 1999). This self-fulfilling prophecy of secondary deviance might be perceived by a litigation-oriented community as the fault of the cartographer, blamed for a case of 'erroneous spatial labelling'.

ETHICS

To summarise the dilemma, the crime mapper is left with the situation that maps of crime published on the Internet can provide a public good, by informing and educating the public as to their realistic level of risk in different locations, but the necessity to aggregate the data to protect the individual privacy of crime victims introduces an element of inaccuracy. The result of this necessary blurring of data integrity can generate the cartographic appearance of greater risk in low crime areas and vice versa.

Is there a role for utilitarianism here? The principle of act utilitarianism has been applied previously in a law-enforcement situation in the area of recruiting informants (Cooper and Murphy, 1997), and there is some overlap in general arguments. Act utilitarianism suggests a course of action that produces the best results with regard to satisfaction for society as a whole. It is also possible to derive rules, based on utilitarian principles as a more constructive guide (Boylan, 2000, p. 85). Act utilitarian theory might therefore suggest that the general benefit of a more enlightened and crime-aware broad public far outweighs the problems that might occur from public interpretation of less accurate areas of the map. A rule utilitarian approach might, however, draw up a rule that if sufficient portions of the map are inaccurate, then the cartographic image should not go on public display. This type of rule would be specific enough to be useful and not broad enough to simply be a restatement of an act utilitarian principle. However, this rule is open to interpretation. What constitutes a significantly large portion of the map? How much is considered to be too much error? In this case, consider Fig. 1(b). Are the discrepancies between the STAC hotspots and the Gi* hotspots insignificant enough to warrant publication on the web of a STAC hotspot map?

It is possible to take an alternative view, which is the view from well beneath the parapet of a police service legal department. Protection from litigation is undoubtedly a high concern in such arenas (the only concern?) and a more restrictive rule of 'any map that might leave the department vulnerable to litigation must not be published' would seem sensible to such an organisation. If so, then could we publish any map of crime, given the sources of error outlined earlier in this paper? And if that is the case, where does public good lie in such a discussion?

Professional ethics is another area that can contribute to a discussion on the value of data integrity. The field of professional ethics is certainly a broad one and it could be easily argued that ethics does apply to mappers of crime data. Those involved have varying ethical and legal obligations to others (colleagues and public) and these obligations may change depending on the audience for their work. Weckert and Adeney quote the Australian Computer Society Code of Ethics when they explain that members should "endeavour to preserve the integrity and security of others' information" (Weckert and Adeney, 1997). The term 'preserve' is open to interpretation, but still brings us back to the core of the dilemma: given that you have to aggregate data to produce an acceptable output, and aggregation introduces error, how do you produce maps of crime and still maintain data integrity?

CONCLUDING COMMENTS

As an indication of the complexity of the issue, consider the case of the police department in Redding, California. They have responded to Megan's Law by showing on their web site, maps of registered sex offenders living near a number of schools. The following disclaimer accompanies the maps:

> PLEASE NOTE: The symbols identifying the street location DO NOT represent the exact location of where the offender lives. The symbols have been enlarged and offset to keep an exact location from being determined.[8]

The problem that they have tried to address is the confidentiality issue and to avoid an exact location being determined. The advantage for parents of children at the school may be clear, but some local residents may be upset to have a symbol showing the location of a sex offender offset so that it sits right on their house, and then enlarged. It is hardly likely to improve the resale value of their property. The value of this 'offset and enlarge' approach may be questionable, but the caveat is a sensible attempt to deal with some of the issues. It remains to be seen (possibly in some future litigation) if it is sufficient to protect the police department. Litigation is a growth industry in many developed world countries and the public service cartographer might be vulnerable. Once the map is in the public domain, it is beyond the control of the mapmaker, and a caveat can be easily separated from the original image. One suggestion to make is to improve the technology and analytical techniques, but many of the errors inherent in the geocoding process are human and occur before the cartographer even sees the data. As knowledge about the spatial and temporal dimensions of crime increases it is becoming apparent that crime hotspots also vary over time (Ratcliffe, 2000). A crime hotspot during the afternoon could easily become one of the safest neighbourhoods after nightfall increasing the complexity of crime distribution that must be conveyed to the public.

The whole area of crime maps on the Internet seems to require further discussion. The US approach indicates that the information is important enough to publish on the Internet, but this medium does not reach the whole community. Only those with access to the Internet will be able to make informed decisions regarding crime around suburbs and schools and be better educated. It is a sad reality that the least fortunate in society are the most victimised and it could be argued that their need to information is the most pressing. Is the Internet therefore the most effective method of sharing information?

Misinterpretation, or worse, accurate interpretation of erroneous information is always a possibility. "We know that if we do not establish a legal regime that constrains citizens' access to weapons, the likelihood that innocent people will be shot increases. In information societies, information is comparable to guns and ammunition"

[8]Capitalisation in original. Source: http://ci.redding.ca.us/rpd/rpdmap_enterprisehs.html (accessed 24 September 2001).

(Hoven, 1999, p. 34–35). There is a real responsibility placed on crime mappers to maintain the highest levels of data integrity and to convey to their new Internet audience the limitations of that data and the limitations of the methods they have used to preserve the identity of victims.

Maps of crime are an effective method of communicating crime hotspots to law enforcement agencies, especially when there is often discord between the perceptions of police officers and the actual distribution of crime (Ratcliffe and McCullagh, 2001). The mapping of crime for public consumption would also appear to have real potential to engage the public with local community problems, but it would appear that further work is necessary to improve some of the technical issues, and as the number of web sites increases, a wary eye should be kept on the socio-economic and ethical situation.

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