Crime mapping and analysis: filling the gaps

by Chris Overall, Shalendra Singh and Bhekekhaya Gcina

The use of geographical information systems in crime analysis by law enforcement agencies is rapidly coming into its own as an invaluable decision support system in tackling crime through the identification of crime patterns, trends, clusters and application of more sophisticated types of analyses.

Being able to overlay additional layers of socio-economic and demographic data allows for the formulation of more cost effective and contextual crime reduction strategies through the appropriate deployment of resources based on mapped and analysed incidents of crime [1, 2 and 3].

Critical issues around crime mapping and analysis in South Africa

Geocoding of crime is seen as a crime mapping imperative where a crime may be plotted to an address point/range, post code or land parcel with geocoding scores or “hit rates” of 80% to 90% being seen as desirable amongst law enforcement agencies [4, 5].

In the South African context, both Breetzke [6] and Styllianides [7] identify critical issues in crime mapping and analysis such as data collection protocols, data integrity and variance between spatial data sets in use by the South African Police Service (SAPS) all of which makes geocoding of crime a constant challenge for law enforcement in South Africa.

Considering such issues we may certainly find higher levels of geocoding accuracy in urban areas such as city centres where the core development of road networks, land parcels and address point data sets are complete and unlikely to change as rapidly as peri-urban areas, informal settlements and new housing schemes/estates which are constantly changing.

Law enforcement agencies in South Africa are inevitably faced with a sliding scale of crime mapping accuracy in that some crime incidents are mapped to address points while others are mapped to the spatial mean of a road segment within a land parcel, CAS 1 block 2 or centroid of either of these polygons.

This level of mapping accuracy may well be acceptable if the aim is to be able to visualise the general distribution of crime as a whole across the police station area of operation.

However, this generalised approach to the location of crime incidents also precludes law enforcement agencies from developing an understanding of the interaction between the physical environment, local residents and causal factors of crime which is central to the concept of crime analysis [8].

The effect of mapping crime incidents to the centroid of a CAS block or land parcel on accurately determining the location of a crime hotspot through spatial analysis is illustrated by the fact that crimes, such as residential burglary and theft of motor vehicles, may be located in the middle of vacant land which is clearly misleading and inaccurate considering that it is this type of analysis which drives crime reduction actions [9].

Furthermore each CAS block or land parcel may be upward of a square kilometre in extent which would essentially diffuse crime reduction actions as they would be spread over a wider area reducing efficiency levels and service delivery to the community in question.

In practical terms law enforcement agencies are then limited in their ability to identify and act against those specific locations which are crime generators as well as causal environmental and socio-economic factors associated with those crime generator/s [10, 11].

Mapping crime in the Cato Manor project area

The Crime Mapping and Analysis Project of the Durban Metropolitan Police Service began mapping reported crime incidents in the Cato Manor area from October 2005 onwards as one of its component areas in conjunction with the Area Based Management (ABM) cluster of the Ethekwini Metropolitan Council and SAPS Cato Manor.

Using an ArcView 3.3 GIS platform and a dedicated data input script with additional crime and spatial analysis software, daily reported crime incidents were mapped using the Ethekwini Metropolitan Council’s road centre line, land parcels, address point databases and digital orthophotographic imagery as a backdrop.

As a pilot project the aim was to extend the current crime mapping and analysis activities from a purely formally developed area, such as the Durban CBD area, to test the robustness of the mapping and analysis processes in a policing area such as Cato Manor which contains both formal and informal areas.

It soon became apparent that a percentage of reported crimes could not be mapped using the address point database for reasons that they occurred in places where the current address point database did not extend to such as vacant land parcels, informal areas or along main arterial

Footnotes

1 Refers to the Crime Administration System of the South African Police Services.
2 Refers to the geographic subdivision of a policy station area of jurisdiction [7].
roads that are flanked by undeveloped land on either side. In these instances the reported incidents of crime were mapped to the mean of the road segment or centroid of the CAS block.

As was expected some subsequent crime density and hotspot analyses were located at the mean of road segments and centroids of CAS blocks which held little value for the tactical facet of crime analysis in those areas [12]. The effect of this as stated earlier in the text was that we had not advanced our knowledge regarding the location of crimes nor the factors associated with the generation of such crimes.

An alternative approach to this situation was to develop a spatial database of local landmarks, locations or demarcations that were significant enough to give a general representation of how the community perceived their immediate environment. The decision to research this approach was driven by the fact that we knew the names of some crime incident locations but we didn’t know where they were. In short, we did not know enough about a particular physical environment that we were policing in order for us to police effectively.

Development of alternative spatial databases to enhance crime mapping and analysis processes

Many South African cities have informal settlements or peri-urban areas interwoven with formally developed areas, but few spatial databases contain information on the location and name of places as determined by the communities living in informal settlements and peri-urban areas. Interaction with these communities indicates that names of places within informal settlements or peri-urban areas are in part determined by socio-cultural and historical events which have taken place at that location [3].

It is not surprising that there is the potential to create a spatial database that would allow law enforcement to map and respond to crime incidents reported in informal settlements and peri-urban areas which were previously consigned to the centroid of a CAS block, land parcel or mean of a road segment [7].

The value in developing the concept of an alternative spatial database is underlined in Weisburd’s [13] assertion that successful place-based policing is dependant on law enforcement agencies’ ability to capture rich and relevant data relating to places in their area of jurisdiction.

Creating such a spatial database rests on the premise that people have a cognitive map of the area that they live in which begins with the identification and recognition of landmarks, locations and the paths that develop between these landmarks and locations [14].

The process of cognitive mapping as defined by Downs and Stea [15] is “a series of psychological transformations by which an individual acquires, stores, recalls and decodes information about the relative locations and attributes of the phenomena in his every day spatial environment.” Canter [16] aptly describes the constant interaction between man and his environment by which we gather spatial information as, “where we go depends on what we know and what we know depends on where we go.”

Identification of landmarks, places and paths that are of common significance to the community albeit from the subjective contributions of residents will allow us to begin gathering the type information needed to construct an alternative spatial database. With the concept of an internalised geographic information system or cognitive map established through research, individuals using an ortho-photograph would be able to orientate themselves spatially by using environmental cues or landmarks and in doing so be able to identify other locations and/or paths relative to those significant internalised locations or landmarks [17].

The data collection process

After discussions with the Cato Manor Area Based Management component it was decided to engage members of the Cato Manor community policing forum (CPF) of sector one [4] (also known as Cato Crest) as a starting point to outline the basic framework, aims and objectives of this particular project and secure their collective buy in. A presentation was done in September 2007 with the Durban Metropolitan Police Service project team, ABM representative and four members of the sector one CPF where the concept and role of using cognitive maps to identify landmarks, locations and paths in the project was explained.

Footnotes

3 Interviews with Mhlengi Gumede, Area Manager, Cato Manor Area Based Management, Durban.

4 Cato Manor SAPS is divided into five policing sectors.
The data collection process commenced in October 2007 with an AO size 1:2000 scale orthophotograph of Sector One, Cato Manor presented to the CPF members with instructions to identify as many landmarks, locations, paths etc. as they could and then mark the AO size orthophotograph accordingly. A total of thirty-seven locations, landmarks and demarcations were identified by the CPF representatives within the area demarcated as Sector One, none of which appear on any of the Ethekwini Metropolitan Council spatial databases.

Location types identified by the CPF representatives ranged from an informal crèche to spaza shops, foot bridges, informal businesses and taverns amongst others. An interesting aspect of the collected data included the fact that the community within Sector One had also informally demarcated this sector into nine separate areas.

A data set containing all the identified locations and demarcated areas in Sector One was then compiled with the assistance of the Development Planning, Environment and Management Component, Ethekwini Metropolitan Council and incorporated into the directory of spatial data-bases used by the analyst working on the Cato Manor project area.

Discussion

An understanding of environmental psychology and social geography coupled with the application of GIS technology has allowed the project team to gather data in a more cost effective and less intrusive manner than tasking law enforcement personnel to take GPS readings of identified locations and demarcations in loco.

This cost saving is reflected in the time it took for the Cato Manor Sector One CPF representatives to plot all thirty-seven locations and demarcations, this exercise took approximately four hours and the creation of the data layers another six hours. The time span taken to complete this exercise from gathering data to its inclusion into the crime mapping project spatial database was less than two working days.

A visual comparison of Figs. 1 and 2 indicates the extent to which this alternative approach to collecting spatial data has not only provided us with a richer understanding of the socio-economic mechanics of the Sector One area, but also the means to map crimes to locations that could not have been done before. The levels of mapping accuracy in locating landmarks and locations in this instance may not be as accurate as those that may be obtained from using hand held GPS devices, however the project team felt that considering the matter in terms of the cost benefit-accuracy ratio this would be acceptable.

The project team is now in a position to look at various potential relationships such as those between location type and crime type leading to a more accurate analysis and effective crime reduction actions on the part of law enforcement in this policing sector. Practical results were noted soon after the inclusion of the new spatial database into the Sector One area crime mapping and analysis activities where the number of mapped crimes have increased by an average of fifteen percent since having added this spatial information database.

Another “value add” of this exercise is that it requires law enforcement agencies to work closely with CPFs and other community structures. In doing so it creates a sense of empowerment which is seen in the physical production of maps containing the data contributed by the community members themselves.

Anecdotal information also indicates that this exercise has been viewed by the community as a positive step in community–police relations.

Work is currently under way to extend this exercise to include all five policing sectors in the SAPS Cato Manor operational area and should be completed by May 2008 for incorporation into the existing spatial database used by the Durban Metropolitan Police Service Crime Mapping and Analysis Project team.

Way forward

The potential for this process to serve as a data collection model, for use by law enforcement agencies in South Africa as a means of mapping crime in informal settlements and peri-urban areas, will require further research and refinement to test its true value. Local government can play a vital role in this process as they are repositories of vast amounts of spatial data which can be accessed by law enforcement agencies such as the SAPS and Metropolitan Police Services and may also provide some level of technical support for this type
of data collection and compilation. Such partnerships are imperative for improving crime analysis, intelligence driven actions and reducing crime on a national basis.

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References

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