Mapping out crime: expanding the boundaries
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Panel: *Mapping around the world*

Crime clocks and target performance maps

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1. Background

Funded by the Innovation Fund of the Department of Arts, Culture, Science and Technology in South Africa, the CSIR has been assisting the South African Police Service (SAPS) in projects to investigate the operational analysis of crime information for the prevention and management of crime. This paper describes two innovative techniques that we developed for analysing crime: *crime clocks* and *target performance maps*.

Unlike the United States of America and many other countries, South Africa has one police force responsible for preventing and solving crime across the whole of the country. South Africa is divided up into nine Provinces, 42 Police Areas and over 1100 Police Stations. Our projects have focussed on assisting SAPS in the Johannesburg Police Area, one of seven Police Areas in Gauteng, the smallest Province. Johannesburg is the largest city in South Africa and is the economic heartland of the country. Figure 1 shows the location of the Johannesburg Police Area.

Over 70% of the police stations in South Africa have online access to SAPS' Crime Administration System (CAS), and they record over 80% of all crime reported in South Africa in near real time on CAS. Hence, at any time one can get a report of the crime situation for most of the country that is no more than a few hours old. Much of our analysis has been on data drawn from CAS and other corporate systems of SAPS. In addition, we have also helped to develop a special questionnaire and data base focussing on the *modus operandi* of vehicle hijackings (a particular scourge in Johannesburg), which is now being rolled out to other Police Areas and which will be applied to other priority crimes. The figures used in this paper draw on CAS and this hijacking data base.

Currently, CAS does not have a front-end providing a geographical information system (GIS) capability, though such an interface is in the process of being developed. Nevertheless, CAS has always provided the capability to record geographical data, such as the street address, suburb and the CAS Block number - the CAS Block is the smallest geographical unit used by SAPS for analysing data. In urban areas, CAS

Blocks range in size from a few city blocks or a segment of highway, up to several suburbs, depending on the needs of the relevant police station. In an American context, a CAS Block could be equated to a Beat. Using the centroids and/or faces of the CAS Blocks, one can readily map the crime data using a GIS.

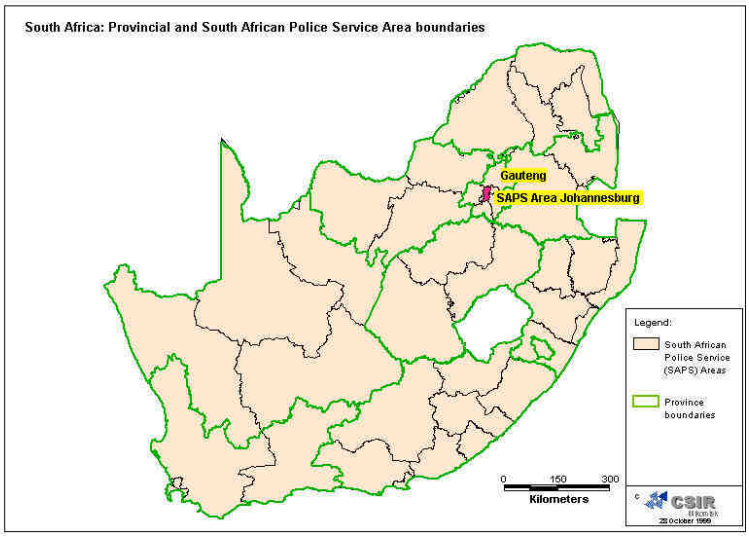

Figure 1: Location of the study area

Traditionally, automated crime mapping and analysis has been based on the pin-mapping of individual crime scenes, using geocoded street addresses - that is, street addresses or ranges linked to geographical coordinates. Unfortunately, geocoded street addresses are currently prohibitively expensive in South Africa, which has led us to concentrate on the analysis of crime data aggregated to CAS Blocks or police-station precincts. However, SAPS are digitising manually several priority crimes on a daily basis in Johannesburg and we have helped them with the analysis of these data.

This presentation describes two innovative and powerful techniques that can be applied to aggregated data, namely *crime clocks* and *target performance maps*, and that can be created using desktop GISs (eg: MapInfo and ArcView), spreadsheets (eg: Excel) and data bases (eg: Access).

2. Crime clocks

A map of *crime clocks* displays the distribution of crime in time and space using scaled pie charts to show the relative crime rates for the selected period being analysed. Each pie chart shows the total aggregated crime for an area (eg: CAS Block or precinct) and is positioned on the centroid of the relevant area. Hence, the size of each pie chart is proportional to the amount of crime that occurred in that area over the period of analysis. Each segment of a pie chart represents a selected part of the day (eg: a two- or three-hour period) or a day of the week. The first and last segments in the day or

week are then adjacent, ensuring that there is no artificial break at the end of the day or week. One can use crime clocks to map one type of crime, a set of selected crimes or all crimes in the area.

Figure 2 shows time-of-day crime clocks for car hijackings in a part of Johannesburg. A year's data has been used and each clock consists of two-hour segments, with midnight at the top of the clock. It is immediately apparent that the patterns of hijackings vary across the area. For example, the two large pies in the South (mainly industrial/commercial areas in Jeppe and downtown Johannesburg) show significant risk between 08:00 and 10:00, while those in the North (around Hillbrow with its nightlife) show significant risk between 20:00 and 04:00.

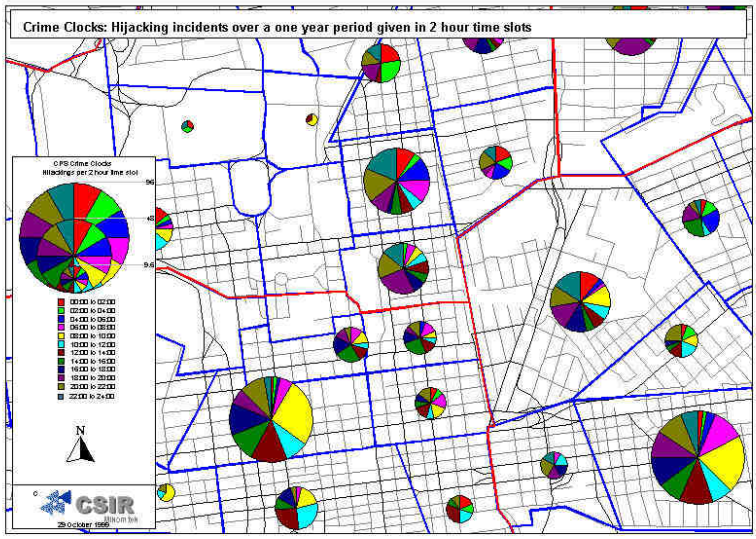

Figure 2: Time-of-day crime clocks

Figure 3 shows day-of-the-week crime clocks for a similar part of Johannesburg, using the same data set of a year's car hijackings. Each clock has a segment for each day of the week, with Sunday and Monday at the top of the clock. Again, there are quite striking differences between the different areas – it is almost as if each area has a different peak (worst day)!

For these examples we have used the default colours assigned by the GIS, but the shading of the segments could be used to differentiate between daytime and night-time, or between the week and the weekend. The advantages of the crime clocks are that one can see immediately when during the day there are peaks of the crime(s) being analysed, and midnight (or any other time) does not provide an artificial break.

Unfortunately, the exact time-of-day when a crime occurred is often not known, and one can only map what is recorded in the system. We do not include the unknown times in the crime clock as another segment, as this would introduce an artificial break somewhere in the clock. One approach might be to show the unknown times as a

scaled circle in the middle of the clock, while adding proportionally to all the segments to maintain the correct ratios.

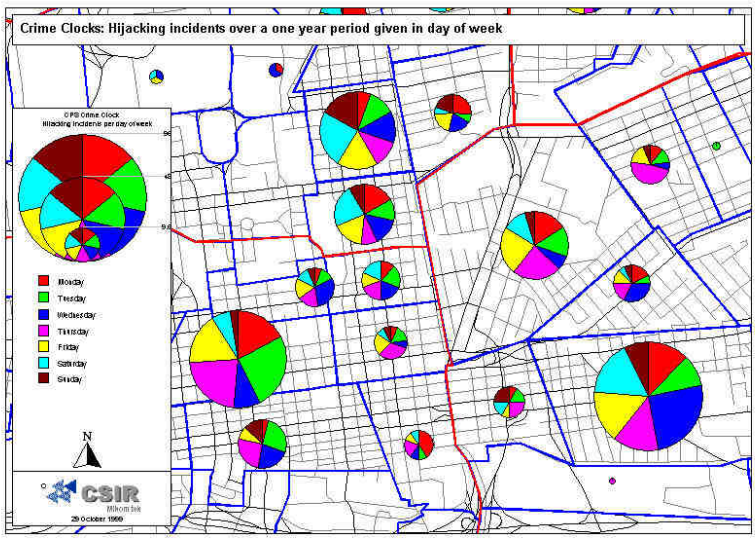

Figure 3: Day-of-the-week crime clocks

We have also used crime clocks to map the proportion of crimes that occur during normal police working hours (07:00 to 16:00, Monday to Friday, in the case of the Johannesburg Area), against those that occur outside these hours.

3. Target performance maps

Target performance maps are choropleth or mosaic maps that compare actual, normalised crime rates against realistic targets, to show the police's progress in combating crime. They provide a quick view of where concentrations of crimes occur. Using data over a long period for selected priority crimes and analysing the trends, we have adapted the Cusum method (used in quality assurance) to give early warnings of significant deviations in quality (ie: crime rates) by determine realistic, achievable targets for the crimes. For each crime, we have also identified a lower, *stretching* target, that when achieved regularly, signals a significant and sustained reduction in the level of that crime. The aim is to have *never-ending improvement* in the crime situation – once the targets are being met consistently, they can be revised downwards.

Typically, we set the targets for a week, but they are linear, so it is easy to use them for other time periods (eg: a fortnight or four weeks). We determine the targets for both the Police Area and the police stations, as the police stations are not homogenous, and individual police stations need their own targets. It would also be feasible to set targets for individual CAS Blocks, though owing to the cost of doing so, this would be done only for selected hot-spots of crime. These targets for individual CAS Blocks would enable the police to measure their progress in even the worst crime areas.

For the target performance map, we compare the crime rate for each CAS Block against the targets, and colour each CAS Block accordingly. It is crucial that the data be normalised first, otherwise the maps can be misleading. For example, with data that are not normalised, a very large CAS Block will invariably show up as a high crime area and a very small CAS Block as a low crime area. One needs to compensate for this difference by normalising the data, which we have usually implemented as a crime rate per unit area (eg: per km^2), as it is easy to do in a GIS. Unfortunately, even this does not necessarily give the correct picture, as one should perhaps rather use other variables as the basis for normalisation, such as the number of housing units in the area (eg: for housebreaking of residential premises) or the population of the area, for crimes against people. However, even here there is a danger, as one could probably only access the static population per area (eg: as measured by a census), and not the dynamic population (ie: the people moving through that area on a daily basis).

Target performance maps are then mosaic maps with each CAS Block coloured red if the normalised crime rate is worse than the normalised realistic target, yellow if it is between the two normalised targets, and green if it is better than the normalised stretching target. The map is also supplied with a table of the actual rates, to provide the police with the details. One advantage of these maps that SAPS has found is that they can be used in discussions with the community to show the crime situation, without having to disclose the actual numbers of crimes.

Figure 4 shows a target performance map for the whole of the Johannesburg Area assessing the rate of car hijackings over a four-week period - in spite of its notoriety in Johannesburg, the hijacking rate is too low for assessment over shorter periods. The map uses the same two targets for the whole Area. One can see an arc of red areas running from the North-East (around Alexandra, an impoverished area) along the Louis Botha Avenue axis down to Jeppe, Hillbrow and the centre of Johannesburg, and this area is well-known for its hijacking danger. However, what the map also highlights is other danger areas that might not be known as such, for example, the South-East.

Target performance maps are particularly useful for determining the impact of specific crime prevention interventions by the police. They could also be applied to monitor the effectiveness of other aspects of crime prevention, such as the recovery of firearms or arrest rates.

4. Conclusions

This paper has described two innovative techniques developed by the CSIR for analysing aggregated crime data, namely *crime clocks* and *target performance maps*. We believe that these techniques can make a useful contribution to operational crime prevention, especially with the appropriate allocation of policing resources. These techniques have been illustrated in this paper by several examples drawn from the data

on car hijackings in the Johannesburg Area, and will be supplemented by other examples in the actual presentation.

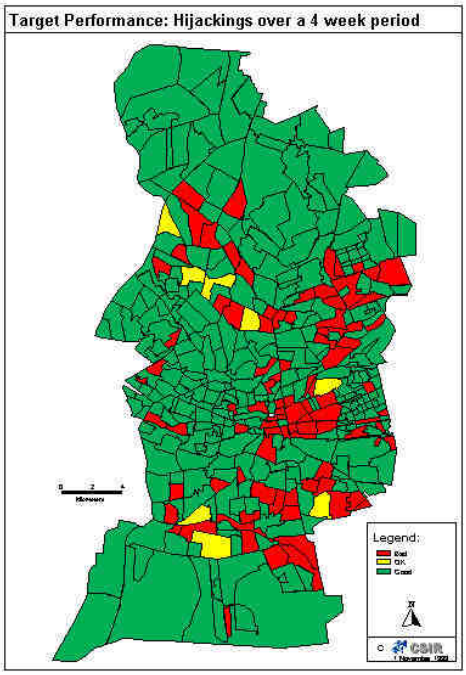

Figure 4: Target performance map

5. Acknowledgements

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