

## Application of GIS in crime analysis and geographic profiling



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### Abstract

**Geographic profiling** is an investigative methodology that uses the locations of a connected series of crimes to determine the most probable area of the residence of the offender. Advances in GIS technology have made tactical crime analysis effective by identifying the activity space of a serial offender by means of journey-to-crime estimation, investigative psychology.

Geographic profiling can be used as the building block for several investigative strategies, including suspect and tip prioritization, address-based searches of police record systems, patrol saturation and surveillance, neighborhood canvasses and searches, DNA screening prioritization. GIS technology, by high-end spatial analysis and querying highlights the crime location, any physical boundaries that were present (that might not otherwise be noticed), and the types of roads and highways that come into both the abduction and body dump sites.

The basis of geographic profiling is the link between geographic crime site information and the known propensities of serial criminals in their selection of a target victim and location. GIS can be used to produce a map of the most probable location of the criminal's centre of activity, which in most cases is the offender's residence. When linked with additional information relating to the crime incidents, and with additional data sources, such as motor vehicles databases and suspect databases, geographic profiling has been proven to have a profound impact on the effectiveness of a police investigation. Geographic crime patterns are clues that, when properly decoded, can be used to point in the direction of the offender.

This paper will give an overview of how GIS can be used as a potential analytical tool in this type of tactical investigative forecasting.

### Introduction

Until quite recently most applications of Geographical Information Systems (GIS) have focused on land-based studies rather than criminal investigations. Crime Analysis through GIS is today is becoming more necessary as the rates of crimes are very much on the rise. Crimes have situational relevance, and hence have a geographic element attached to them. It is here that GIS can be used as a very useful tool to display and apply spatial analysis to data, which reside in large databases to yield a strong visual appreciation of the patterns of crimes.

### The Technique and GIS

Geographic profiling helps to organize an abundance of information via geographical links in order to accelerate the apprehension process. While geographic profiling is an effective tool to hit upon the most probable residence of the offender, it cannot "solve" cases. Geographic profiling enables crime

officers and analysts to focus the investigation in a small area of the community, rather than on the whole metropolitan area, which means it cuts down on the amount of time and resources required for what can shape up to be a major investigation.

Geographical analysis highlights the crime location, any physical boundaries that were present (that might not otherwise be noticed), and the types of roads and highways that come into both the abduction and body dump sites. It can also track the routine activity of the victims, because people tend to stick with familiar territory. That means that an analysis of all the crime scenes could provide clues about where an offender lives.

Like psychological profilers, those who concentrate on geographical analysis are also trying to determine how sophisticated and organized an offender is, whether the crime was planned or opportune, and whether the offender approached a high or low risk victim. However, they are also trying to take it a step further to use objective measurements to pinpoint as precisely as possible the locus of criminal activity.

The construction of a geographical profile involves:

- Complete familiarity with the case file
- Examination of the crime scenes
- Interviews with investigators and witnesses
- Study of area maps
- Analysis of neighborhood demographics for both the abduction site and body dump site
- Computerized analysis

Using this information, the next step is to determine the geographical coordinates of incident and the physical address of where the victim was last seen or abducted from. The best measures are made by visiting all crime locations and obtaining geographical coordinates with a global position unit. GIS can be used as a technology to produce maps which can indicate the exact location of the incidents and the physical address of the victim. The maps hence produced are amenable to spatial analysis. Since most offenders tend to have a certain place in mind where experience has taught them that a suitable victim can be found. Since the area of interest reduces to a great extent, detection chances increase since GIS can produce results of spatial queries in specific areas of interest.

One of the counties in the United States of America have used GIS to track crimes and add spatial interpretation to the legacy databases of crimes they have maintained for a long time. The databases are a wealth of information and have data relating to-

- Crime type-Aggravated, Embezzlement, Burglary, Murder, Rape, Homicide, Kidnapping, Extortion etc
- Location of the crime- Airport, Banks, Entertainment Areas, Motels, Bus/Rail Terminals etc.
- Modus Operandi- Abduction, Forced Entry, Trickery, Shot Victim, Threat, Bodily Force etc
- Method of Attack- Smash and Grab, Remove Door, Hiding in the building etc
- Point of Attack- Rear, Front, Garage, Open Space, Roof, Window etc
- Weapon Used- Acid/Potash, Explosives, Rifles(type of rifles), dagger, knife etc
- Features of Weapon- Long Barrel, Short Barrel etc
- Vehicle used (if any) for the incident- Type of Vehicle, Model, Top Color, Bottom Color, State of Registration etc
- History of arrestees, victims, suspects- Sex, Race, Height, Physical Characteristics, Hair Color, Ethnicity etc
- Age details of suspects, victims, arrestees
- Actual address of the location of the incidents
- Actual address of the location of the victims and suspects

These data exist for a time span of 60 years and hence can serve as a base for crime analysis. Since the exact address of the crimes is known, these can be geocoded to arrive at the exact co-ordinates of the crime incidents. The criteria for multi dimensional querying is set up from the database and GIS can render complex maps to display the actual locations of the crimes as point features. Since the victim residence is also known, exact coordinates for these can be computed and displayed on the maps as well. **This is particularly very useful since a direct mapping from the victim residence to crime incident location can be very easily produced. This helps analysts to quickly identify**

areas of interest and hence investigative efforts are clearly focused upon specific areas, which are usually the zones where the criminals are most comfortable. Since any of the above parameters can be used as a criterion for querying serial crimes, these parameters will serve as a basis for crystallizing crime patterns.

GIS can be used to produce thematic maps on any of the above parameters enumerated and these can provide analysts with clues to patterns of crimes. A thematic map with age of victims as a criterion, for instance, will quickly present the officers with specific areas highlighted in different colors for different age groups. Hence a crime officer investigating cases of serial killers targeting victims of a particular age group can easily shift his focus to a specific area. Locating operational patterns of crimes in an area of interest identified by specifying the search radius from incident locations are another feature which is offered very efficiently by GIS.

Another very popular approach to geographic profiling is a psychological theory called the **least-effort principle**. This concept proposes that criminals tend to commit acts of crimes within a comfort zone located near but not too close to their residence. With at least five or six incidents traceable back to the perpetrator, the search area for the criminal's residence is reduced by more than 90 percent. Key locations are weighted and then geocoded onto a map. The end process is known as a "**jeopardy surface**", a map that resembles a topographical map showing peaks and valleys color ramped to highlight the most likely area where that criminal resides.

### **Summary and Conclusions**

Growing interest in the use of Geographical Information Systems (GIS) has led to more and more applications being undertaken. All too frequently, however, the applications of such technology by non-GIS specialists ignore the recognized problems associated with geographical datasets.

Geographic profiling has been used effectively for cases such as serial rape, a series of burglaries, serial murder, bank robbery, kidnapping, arson, and bombings. What a good geographic profile can do is provide information that helps investigators to narrow the area in which to do door-to-door canvassing and set up police stakeout surveillance. It can also prioritize suspects, develop strategies for linkage analysis of information, and even help to make up an effective polygraph session with a suspect. Yet, although a crime scene can provide clues about an offender's spatial perception and mobility, it remains the case that insight into psychological motivation, degree of organization, and lifestyle make an important contribution to an investigation as well.