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Graphical Profiling: Knowledge through Prediction

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Abstract

Predicting terrorist activities has proven somewhat difficult. For years law enforcement agencies having been using crime software in an attempt to improve their ability to stop and capture criminals. Our purpose in this research is to apply the crime software, CrimeStat, with terrorist data to determine if the software could help predict future actions. We used the data from the Abu Sayyaf group. We had data from 2001-2009 so we used the years 2001-2007 in the model and used this to try to predict their 2008 activities. The results showed some ability to help predict albeit low in percentages. We think any quantitative ability to assist decision makers in possible upcoming events is better than no prediction ability.

Keywords: Graphical profiling, CRIMESTAT, terrorist actions, Abu Sayyaf, statistical modeling, mathematical modeling

1. Introduction to Predicting Terrorist Action

While it may be difficult to disrupt a terrorist network, perhaps we can anticipate where and when the next attack will occur. The adaptation of terrorists in order to avoid detection has limited the number of characteristics that we can search for or track. If we cannot find the terrorists directly, we must focus our efforts on another strategy. One way that terrorist networks can be exploited is through the determination of when and where the terrorist organization may make its next attack. If counterterrorism forces have an idea of when and where the terrorists will attack, they can plan accordingly in terms of surveillance and security presence, which could lead to the prevention of said attack and/or the apprehension of its perpetrators before, during, or immediately following the commission of their act. While tactics and methods may have changed, the locations of these acts of terrorism have stayed more or less consistent over time, driven by available targets and opportunities as have the individual traits of the perpetrators. These anticipatable variables may be able to yield information concerning the potential whereabouts of both the terrorists as well as the locations of their next attacks. How best to combine these variables together in order to yield the possible locations of terrorists and/or their attacks? Is it possible that these commonalities mean that something that worked so well for law enforcement could be applied to intelligence and security analysis?

The purpose of this research is to determine whether it is feasible to apply a known method of geographic profiling, a method successfully used by law enforcement for hunting serial criminals, for terrorists and terrorist acts. In general, geographic profiling "is based on crime pattern, routine activity, and rational choice theories from environmental criminology, a field of study interested in the interactions between criminals and the physical environment that surrounds them [Rossmo et al, 2005]." Due to the complexity of terrorist networks, we will begin by studying the feasibility of applying geographic profiling toward anticipating the next actions of a terrorist organization and predicting when are where their next attack could occur.

If successful, future efforts may move toward the illumination of terrorist networks and finally, the search for individuals within the organization. We also explored will be whether or not existing models of geographic profiling can be improved upon by including variables not just related to the location of the event but to terrorists as well. We modified the data input for the model CrimeStat from criminal data to data describing terrorist activities. We utilized data concerning terrorist attacks and input these pieces of data into an established model of geographic profiling to see whether they can accurately predict where the next attack will occur. Today, there are four primary models of geographic profiling utilized by law enforcement officials: CrimeStat, Rigel Analyst, Dragnet, and Predator. For this research, CrimeStat Version III program was utilized, due to its ease of access and that additional variables for our terrorist activities can be included in the program. Along with using CrimeStat to conduct analysis of terrorist incidents, information about the Philippines, such as population data, terrain, roads, and built-up places will be incorporated to aid in determining whether where future incidents occurred made sense and could be predicted. This research utilized data received from the Common Operation Research Environment (CORE) Lab concerning terrorist attacks that occurred in the Philippines and input their location data into the preexisting and combination models of geographic profiling. Not all of the data from each set will be entered because the later attacks will serve as the testing criteria for each of the models.

Our goal of this research to determine whether or not geographic profiling software and techniques can be utilized to predict the next terrorist attacks. By leaving out some of the data from the data sets, it will be possible to compare the predictions made by the various models to the actual outcomes and determine the delta between the two in order to see which of the models made the closest prediction to the actual event (the smallest delta).

2. The Applicability of Geographic Profiling to Terrorist Action

2.1 What is Geographic Profiling?

Craig Bennell and Shevaun Corey describe geographic profiling as "using knowledge about the relative locations of an offender's crime sites to predict the highest probable location of his or her residence [Bennell et al., 2007]." This field is relatively young, started in 1987 by D. Kim Rossmo, and is currently utilized by law enforcement agencies to prioritize suspects in criminal investigations and determine the areas where to saturate police patrols. Geographic profiling operates under the premise that the locations of crimes are not completely random but, in fact, have a "degree of underlying spatial structure" to them because there is some rationality behind the selection of their locations [Rossmo, 1995]. The primary goal of geographic profiling is the establishment of an anchor point, or the place where an offender primarily operates from, and likely the single most important place in his or her life. Anchor points can include the offender's home, his or her workplace, a home of a friend of the offender, or even a bar or restaurant. Data can be collected from previous crimes and used to create a profile of the criminal's geography. Rossmo's model [Rossmo, 1995] operates under the following beliefs: that an offender is more likely to choose locations that are closer to his or her anchor point rather than farther away, and though the offender targets areas closer to his or her anchor point, he or she will avoid targeting locations too close to this anchor point in order to avoid being caught.

From his or her focal point, an offender searches outward for the target; this search is typically modeled by some sort of distance-decay function. This distance-decay function illustrates an inverse relationship between the number of incidents and the distance from an offender's anchor point [Rossmo, 1995]. In order to construct a geographic profile, the coordinates of crime scenes are entered into a software analysis program that contains an algorithm known as the CGT (criminal geographic targeting). The GCT algorithm is based on the three-dimensional aspect of the hunt process a criminal goes through when searching for a target. As described in Geographic Profiling for Serial Crime Investigation, the algorithm "divides the hunt area (the area enclosing all of the crime sites) into a fine grid, and then calculates the probability that each individual grid point is the offender's anchor point [Rossmo et al., 2005]." It yields a probability graph, called a jeopardy surface, where the greater the height depicted, the greater the probability, the given location is the offender's anchor point; this can then be converted into a two-dimensional map and overlaid on a map of the area [Rossmo et al., 2005]. Once generated, this geographic profile has a number of applications in the world of law enforcement.

Since the advent of geographic profiling, this method has helped aid in several investigations for law enforcement agencies including the Federal Bureau of Investigation (FBI), the Royal Canadian Mounted Police (RCMP), Scotland Yard, as well as agencies at the state and local levels [Rossmo et al., 2005].

Even though a geographic profile does not mark the exact location of the person who most likely committed the series of crimes, it does help narrow the search window and also provides another possible metric to compare a list of suspects against. An example of the success Scotland Yard has had with utilizing a geographic profile was its 1994 to 1998 search for the Mardi Gras Bomber.

The bomber was responsible for 36 bombings in the London area and when a geographic profile was requested, it produced two areas where it was highly probable that the bomber resided or operated from. When the people responsible were arrested, their residence was located in the top 3.4% of the suspect's hunting area [Rossmo et al., 2005]. This bomber could have well been a terrorist so we pursued this geographic profiling technique. Geographic profiling has also helped to illuminate search areas not previously considered, as was the case of the South Side Rapist in Lafayette, LA. Following 14 rapes that occurred over a period of 11 years, the generated geographic profile highlighted a new neighborhood that served as the foundation for a hotline receiving tips. One tip matched this profile as well as a psychological profile, and surveillance of the suspect led to obtaining his deoxyribonucleic acid (DNA) and comparing this DNA to samples collected at the crime scenes resulted in a match and his arrest [5].

Geographic profiling also has applications outside the search for and apprehension of individual perpetrators; it can also be utilized more generally for the improvement of police patrols. In Memphis, TN, city officials have seen a decrease in crime with the help of operation Blue CRUSH (Crime Reduction Utilizing Statistical History). "Blue CRUSH is a data mining approach to the analysis of location- and time-based criminal patterns and evolving trends" [Rossmo, 2000]. With its help, Memphis has experienced a 16% decline in crime between 2006 and 2008. This program is able to utilize existing as well as incoming data from police patrols on a variety of information such as the location of crimes, the type of crime, day and time of crimes, and victim characteristics, which help generate a tactical crime prediction. Blue CRUSH's timely incorporation of data into a multilayered map allows police patrol and unmarked cars to be placed throughout the city in hopes of catching crimes during their commission and serving as a deterrent. The program has helped Memphis reduce both drug and gang related activity as well as crime in general in the city [Perry et al., 2012].The prevailing methods of counterterrorism currently in use is alone not enough to handle the task of stopping terrorists and their attacks. Terrorists do not operate out in the open; they actively seek to maintain secrecy and the element of surprise because these allow them to instill fear in their enemies and increase their likelihood of survival [Charters, 1990]. While current methods of counterterrorism claim some success, these terrorist organizations still exist. These methods have included counter-messaging, trying to turn the support of the local population away from the terrorists, targeting senior leaders, and seeking to reduce their numbers [Crenshaw, 1991]. All of these methods have relied heavily on intelligence, but intelligence can be flawed, and in turn, negatively impact the choices made based on the collected information.

Intelligence information comes in several forms and from several sources of collection. Due to the abundance of intelligence collected not only by intelligence services, but from tips and unusual or suspicious activity reports, combined with a lack of proper resources to handle the volume of information, an overload can occur [Rossmo et al., 2011]. Even though a large amount of intelligence is received, not every essential piece of intelligence needed to make a decision can be collected. The information, even if accurate, will not always be analyzed and disseminated in a timely manner. Sometimes, the assets needed to collect intelligence are not always available. When utilizing people to collect information, language and cultural barriers can exist that prevent these outsiders from being able to either infiltrate an organization or work with the local population.

Even if able to obtain information from people on the inside in the form of defectors or informants, that intelligence could be unreliable and further set back counterterrorism efforts. The events of September 11 highlight another problem with intelligence: even if the information is collected, if it is not shared among all intelligence agencies and necessary organizations, opportunities can be missed and countries can fall victim to a terrorist attack [Charters, 1990]. Because of these issues, perhaps it is time to incorporate new methods into the fight, methods such as geographic profiling. The information overload problem will continue to exist for the foreseeable future, but geographic profiling would allow for this abundant information to be utilized in a different manner. Rossmo and Harries highlight that "because of the prevalence of spatial information, however, geographic prioritization models can be useful tools in the management of information overload situations [Rossmo et al., 2011]."

In How Does Studying Terrorism Compare to Studying Crime, LaFree and Dugan [2004] highlight how researchers of terrorism could incorporate geographic profiling techniques: An important strategy used by criminologists to study spatial and temporal patterns of events employs geographic mapping techniques. Just as these scholars have imbedded crime incidents into maps of countries and cities, terrorism researchers can create regional and world-wide maps depicting numbers and rates of terrorist activities around the globe [Lafree e al., 2004, p. 68].

Geographic profiling offers a possible solution to the problems caused by a reliance on intelligence. The models of geographic profiling currently in use utilize for their inputs hard data points such as location and distance from a particular point. Geographic profiling also removes the uncertainty about the correctness of the information because the data is based on the location of attacks that have already occurred and that information is able to be verified. It also is able to move past cultural and language concerns because it does not rely on human agents to obtain the needed information. Finally, because the location of attacks is common knowledge, the various agencies would not have to struggle to gather information from each other, which help to reduce the reliance counterterrorism agencies have on one another.

Apart from the possibility that geographic profiling could be utilized in aiding the prediction of where and when a terrorist organization will attack next, geographic profiling could potentially offer other applications to the military such as for incorporation into their cordon and search operations, which would aid in counterinsurgency operations.

2.2 Similarities between Serial Criminals and Terrorists

In order to export the theory of geographic profiling to counterterrorism, a number of assumptions about terrorists and serial criminals need to be examined. At first glance, there may not appear to be many similarities between the two groups, but upon closer examination, the two share several commonalities. In order for a crime to occur, three requirements must be met: a motivated offender, a suitable target, and the lack of an authority's presence [Rossmo et al., 2005], something both serial crimes and terrorist attacks share. Both types of offenders, serial criminals and terrorists, commit multiple offenses; the two can both have a signature, which makes it possible to determine whether or not it is the same individual or group committing a crime or attack. Another similarity exists between the two types during the preparation phase because as a criminal or terrorist prepares for an attack, they generally have a specific sequence of events that they follow. Michael Freeman, David Tucker, and Steffen Merten have divided the actions a terrorist or terrorist organization conducts prior to the attack into nine distinct phases: "networking, training, general planning, attack-specific recruitment, financing, operational planning, weapons procurement, logistical preparation, and operational preparation [Freeman et al. 2010]." Further modeling into these nine distinct phases by Thompson and Fox [Thompson et al., 2014]has given priority values to these phases using multi-attribute decision making (MADM) analysis called Analytical Hierarchy Process. Their results showed that terrorist training, networking, planning, and operational preparation account for 65.2% of the priority value, see Table 1.

Table 1.The final outcome from the AHP analysis [Thompson et al, 2014].

Phases	Percentage	Prioritization or Ranking
Terrorist Training	27.40%	1
Networking	16.40%	2
Planning	11.40%	3
Operational Preparation	10.00%	4
Financing	8.56%	5
Recruitment	8.00%	6
Operational Planning	7.20%	7
Weapons Procurement	6.10%	8
Logistical Preparation	4.86%	9

Further, they applied the technique of order preference by similarity to ideal solution (TOPSIS) and obtained the priorities shown in Table 2 where operational preparation, terrorist training, networking, and recruiting account for 76.46% of their priorities [Thompson et al. 2014].

Table 2. Cumulative Percentages [Thompson et al., 2014]

TOPSIS	Phases	Ranking	Percent	Cumulative Percent
0.816936	Operational Preparation	1	26.1996	26.1996
0.774866	Recruiting	2	24.85038	51.04998
0.49741	Terrorist Training	3	15.95221	67.00219
0.294915	Networking	4	9.458104	76.46029
0.268568	Weapons Procurement	5	8.613136	85.07343
0.174234	Planning	6	5.58778	90.66121
0.126706	Financing	7	4.063533	94.72474
0.086217	Operational Planning	8	2.765018	97.48976
0.078273	Logistical Preparation	9	2.510244	100
3.118124	Total			

These two methods share terrorist training, networking, and operational preparation among their top three variables. These give us insights into the terrorist planning process.

Finally, when narrowing serial criminals down to serial killers, the further comparison of target type can be included to illustrate their similarities because both groups tend to choose soft targets. While several terrorist organizations aim to eventually conduct a large-scale attack against an important landmark or other piece of infrastructure that would likely produce a devastating effect on an entire country, their day-to-day attacks focus more on smaller-scale efforts that target people. Much like the more commonplace attacks made by terrorists the "soft" people over the "hard" pieces of infrastructure; serial criminals tend to target those in society who are more vulnerable to attack.

3. Geographic Profiling Software and Case Study for Geographic Information Systems

We used geographic information systems (GIS), which consists of hardware and software that collects, stores, retrieves, manipulates, queries, analyzes, and displays spatial data. GIS is a computerized fusion of maps with underlying databases that provide information about map objects that, in this case, analysts can use. GIS generates a map and this map can be analyzed visually; however, this visual interpretation can only get someone so far and further, more complete analysis is needed, especially when large amounts of data points are being analyzed. In order to complete further analysis other techniques such as mathematical modeling is required. A modeling software package, CRIMESTAT was used. These more complex calculations, spatial statistics, or "mathematical technique that apply descriptive and multivariate statistics, mathematical modeling, and algorithms to spatial data," are needed and that is where CrimeStat can be utilized [Smith et al., 2008].

3.1 Crimestat

CrimeStat was first released in August 1999, but the edition that was utilized in this research is version 3.3 (CrimeStat III). CrimeStat is designed to help users: identify patterns in crime; identify a "target area" in which a serial offender is most like to strike next; identify and prioritize hot spots; conduct a risk analysis throughout the area of operations based on where previous incidents have occurred; and to produce a geographic profile [Smith et al., 2008]. Most of these specified goals coincide with the goals of this research, making CrimeStat an attractive analysis tool for use.Another attractive element of CrimeStat is that it allows for a secondary file to be included that the primary file can be compared to in the running of certain spatial statistics.

An example of this is placing the location of homicides in the primary file and poverty rates for the same area in the secondary file. Of course CrimeStat is not the only type of software available with application for geographic profiling. "CrimeStat's virtue is collecting different methods of spatial statistical analysis into a single application that works with multiple geographic information systems," and is fairly simple to use even though the analysis it performs can be rather complex [Smith et al., 2008].

3.2 The Data

In this research, the incidents of terrorism that will be analyzed came from a Stanford University dissertation by COL (RET) Joseph H. Felter, titled "Taking Guns to a Knife Fight: A Case for Empirical Study of Counterinsurgency" [Felter, 2009] by way of the Naval Postgraduate School's Common Operational Research Environment (CORE) Lab. The data covered the time period of 2001 to 2008 in the Philippine major island of Mindanao and its surrounding smaller islands. Mindanao is the southernmost island in the Philippines and is the second largest in size. Since the Philippine's achieved independence in 1946, this island in particular has experienced a large amount of terrorist activity from a number of different organizations focused on achieving either independence or autonomy from the government. The data provided includes the date of the incident, where it occurred, who it involved, what sort of incident it was, the number of casualties, and other categories of information. The total number of incidents over this eight-year period was 10,990, but that number includes incidents initiated by counterinsurgency and local police forces. The removal of these counterinsurgency and local police incidents reduces the number of incidents to only 4,601 enemy-initiated events. As there are several different terrorist groups and other organizations responsible for all of these incidents, the data will be further broken down into the four primary organizations: Communist Terrorist Movements (CTM), Lawless Elements (LE), Moro Islamic Liberation Front (MILF), and the Abu Sayyaf Group (ASG). The terrorist organization that this research will focus on is the Abu Sayyaf Group, as their incidents are more concentrated, rather than being dispersed throughout Mindanao, like the other organizations. From 2001 to 2008, of the 4,601 enemy-initiated incidents in Mindanao, 299 incidents were conducted by the Abu Sayyaf group. For the 299 incidents analyzed the breakdown of the type of incidents and how many of each type are depicted in Table 3.

Table 3. ASG-Initiated incidents in Mindanao: 2001–2008

Incident Type	Total Number Initiated	Percentage of Total Incidents
Abduction	27	9.030
Ambush	44	14.716
Armed Clash	2	0.669
Arson	3	1.003
Bombing	13	4.348
Disarming	1	0.334
Encounter	32	10.702
Harassment	47	15.719
Hold-Up	1	0.334
Hostage Taking	2	0.669
Jail Break	2	0.669
Kidnapping	11	3.679
Killing	3	1.003
Land Mining	8	2.676
Liquidation	13	4.348
Mutilation	1	0.334
Raid	10	3.344
Sabotage	1	0.334
Sea Jacking	1	0.334
Shooting	26	8.696
Stabbing	2	0.669
Strafing	3	1.003
Surrender	46	15.385
Total	299	100

1. Analyzing The Abu Sayyaf Group's Activities, Results, And Analysis From CrimeStat

In order to determine whether or not geographic profiling techniques were able to effectively indicate the location of future attacks, the incidents that occurred in 2008 were removed from calculations performed both by CrimeStat software programs. The data the analysis covered the years 2001 to 2007; the results of this analysis were compared to incidents that occurred in 2008 in the same geographic areas (Basilan and Sulu). Apart from comparing the 2008 events to those that happened from 2001-2007, other comparisons will be made: year to year in both number of total incidents and type of incident; and municipality comparisons in both number and type of incidents. In order to measure the success of particular geographic profiling techniques, primarily this research will focus on the associated percentages generated from each portion of analysis. These percentages will either be based on either the accuracy of a particular method in forecasting where an incident will occur (what type of incident it will be), or the percent difference between the calculated average from the 2001-2007 period and the actual outcome from 2008.

The largest portion of analysis was conducted utilizing different types of *hot spot analysis*, a tool used in identifying where crime incidents cluster. Hot spots are defined [Levine et al., 2010] as concentrations of incidents within a limited geographic area that appear over time. Several different types of hot spot analysis methods exist, but for the purpose of this research point location analysis was utilized due to the sheer size of the area being studied. This type of clustering technique involves counting how many incidents occurred at each location; the locations with the highest number of incidents are identified as hot spots.

4.1 Analyzing Historical Data for Incident Number and Type

For the eight years of incident data, the information was broken out into the number of incidents that occurred in total for both Sulu and Basilan and then further broken down by how many incidents occurred in each municipality each year from 2001 to 2008. The resulting break down is depicted in tables 4 and 5.

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Table 4. Sulu Incidents Broken Down by Year and Municipality

	Number of Incidents Occurred in Sulu Municipalities / Percentage of Year's Total Incidents															
Year	2001		2002		2003		2004		2005		2006		2007		2008	
Total Incidents Occurred	44		10		19		10		27		31		17		22	
Municipality																
Indanan	3	6.82	4	40.00	2	10.53	0	0.00	11	40.74	6	19.35	4	23.53	1	4.55
Jolo	5	11.36	0	0.00	3	15.79	1	10.00	0	0.00	14	45.16	0	0.00	0	0.00
KalingalanCaluang	2	4.55	1	10.00	0	0.00	0	0.00	0	0.00	0	0.00	1	5.88	0	0.00
Luuk	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	4.55
Maimbung	5	11.36	0	0.00	2	10.53	4	40.00	4	14.81	4	12.90	1	5.88	4	18.18
Old Panamao	2	4.55	0	0.00	2	10.53	0	0.00	3	11.11	0	0.00	0	0.00	0	0.00
PanglimaEstino	1	2.27	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	5.88	1	4.55
Parang	0	0.00	1	10.00	0	0.00	1	10.00	4	14.81	0	0.00	4	23.53	1	4.55
Patikul	7	15.91	4	40.00	7	36.84	4	40.00	3	11.11	5	16.13	2	11.76	13	59.09
Talipao	19	43.18	0	0.00	3	15.79	0	0.00	2	7.41	2	6.45	4	23.53	1	4.55

For example, as indicated (bolded) in Table 4, there are three municipalities that either saw at least one incident either every year (Patikul), or in seven out of the eight years (88%) (Indananand Maimbung). One other municipality, Talipao, sees an incident in six out of the eight years (75%). Together, these four municipalities outweighed the other six municipalities in Sulu; all of the municipalities that experienced attacks in five of the seven preceding years to 2008, would go on to experience an incident in 2008. In attempting to make a prediction about which municipality would be likely to see an incident occur in 2008, the following observation can be made: if a municipality experiences an incident in four out of the seven years preceding 2008, the municipality has an 83% (5/6) chance of having an incident occur during 2008. It also can be observed that if a municipality experiences an incident in three or less of the years preceding 2008, that municipality has a 50% (2/4) chance of experiencing an incident; though it also appears that if a majority of events take place in the earlier years (2001-2004), the municipality is less likely to be the location of a 2008 incident.

To illustrate how Sulu and Basilan compared to one another overall, the total number of incidents of each were compared. As the total number of incidents that occurred in Sulu over the eight years outnumbered the incidents that occurred in Basilan, the percentage difference between the two islands was also calculated shown in Table 5.

Table 5. Sulu Incident Totals versus Basilan Incident Totals

Year	2001	2002	2003	2004	2005	2006	2007	2008
Total Incidents Occurred in Sulu	44	10	19	10	27	31	17	22
Total Incidents Occurred in Basilan	27	9	8	6	4	0	9	15
Total Incidents Occurred	71	19	27	16	31	31	26	37
Percentage of Events Occurred in Sulu	61.97	52.63	70.37	62.50	87.10	100.00	65.38	59.46
Percentage of Events Occurred in Basilan	38.03	47.37	29.63	37.50	12.90	0.00	34.62	40.54
Percentage Sulu Events Outnumber Basilan Events	23.94	5.26	40.74	25.00	74.19	100.00	30.77	18.92

When the total number of incidents occurring on each island is compared, as expected the total number of incidents that happened on Basilan was less than half of the total incidents that occurred on Sulu. In all seven years leading up to 2008 Sulu experiences more incidents than Basilan, meaning the higher occurrence of incidents in 2008 in Sulu once again make sense. Overall, while Sulu incidents might outnumber the Basilan incidents two-to-one, this ratio is not maintained throughout the years. Out of the eight years, only in two (25%) of them does Sulu have more than twice the number of incidents as Sulu; however, in these two years, the difference is quite large (74.19% and 100%). Finally, the types of incidents that occur in 2008 were: abduction, ambush, arson, bombing (though not on Sulu), harassment, liquidation (though not on Basilan), and shooting. For Sulu, if the island experienced a particular kind of incident in three or more out of the seven years prior to 2008, there is a 63% (5/8) chance that the island would also experience the same type of incident in 2008.

For the three types of incidents that occurred in three or more years but did not occur in 2008 (encounter, kidnap, and surrender), all occasions of these incidents occurred during the 2001-2004 time frame. Out of the six types of incidents that occurred on Sulu during 2008, 83% (5/6) occurred in three or more previous years. As for Basilan, if a type of incident was experienced in three or more years prior to 2008; the chances are similar to those on Sulu at 66% (2/3). Like Sulu, the one incident type that occurred in more than three years yet did not occur in 2008(encounter), never happened after 2003. The same is true if you lower the number of year's threshold to two, though the likelihood of a similar type of incident occurring reduces to 50% (3/6). Out of the six types of incidents that occurred on Basilan in 2008, only 33% (2/6) occurred in three or more years; the same can be said for the incident types happening in only one out of seven years.

4.2 Hot Spot Analysis

Of the 299 incidents that were initiated by the ASG, 180 incidents took place on the island of Sulu, 158 during the years 2001 to 2007 and 22 occurring in 2008. CrimeStat's Hot Spot Mode routine was run on the 2001 to 2007 incidents and generated locations where incidents occurred. The top ten locations from the program are identified in Table 6.

Table 6. Top Ten Most Frequent Locations of ASG Incidents

Rank	Municipality	Number of Incidents
1	Jolo (Capital)	12
2	Indanan	9
	Patikul	9
3	Talipao	6
	Patikul	6
4	Indanan	5
5	Talipao	4
	Parang	4
	Jolo (Capital)	4
	Maimbung	4

The resulting output from CrimeStat showed several of these top 10 also saw terrorist activity incident in 2008.
Of the 119 remaining ASG-initiated incidents, 78 took place on the island of Basilan, 63 from 2001 to 2007 and 15 during 2008. CrimeStat's Mode routine was run on this set of data and the top seven are identified in Table 7.
Table 7.Top Seven Most Frequent Locations of ASG Incidents

Rank	Municipality	Number of Incidents Occurring in Same Location
1	Sumisip	5
2	Tuburan	4
3	Lamitan	3
	Lamitan	3
	Tipo-Tipo	3
	Sumisip	3
	Lantawan	3

Just like the 2008 incidents that occurred in Sulu, one location, the location in the Basilan municipality of Lamitan (122.104057, 6.648478 Decimal Degrees) that was the site of 3 incidents during the 2001 to 2007 years, was the scene of an incident during 2008.

For both of these islands, running CrimeStat's Hot Spot Analysis routine on 2001-2007 incidents and overlaying the 2008 incidents on the resulting output reveals that only one of the identified top hot spots is the location of an incident in 2008. For Sulu this means that 8% (1/12) of 2008 locations are the same location as a top hot spot and for Basilan 14% (1/7) locations are the same location for a top hot spot. However, for Sulu, if all CrimeStat-generated Hot Spots are included, this increases the likelihood a 2008 incident location will be the same as a 2001-2007 hot spot (25% or 4/12).

In both Sulu and Basilan, most of the incidents occur within some proximity of other incidents during 2008, but some of the 2008 incidents appeared to be more isolated than others. Whereas in Sulu where the two outlying incidents really were quite isolated, the "isolated" incidents on Basilan (Sumisip and Tipo-Tipo) were located near other incident sites from between 2001 to 2007. The isolated incidents on Basilan differed slightly from those that occurred on Sulu. Both municipalities saw more total incidents throughout the 2001-2007 period, fourteen and eight respectively. The 2008 incident in Sumisip was an ambush; looking back at the previous seven-years, the municipality saw three other ambushes in 2001, 2004, and 2005; only encounters outnumber the number of ambushes. The 2008 incident in Tipo-Tipo was a harassment, but not the first the municipality had seen; six harassments occurred the year before throughout the municipality. Compared to the incidents that took place on Sulu, the type of incident that occurred in both Sumisip and Tipo-Tipo was more likely to occur.

Out of the twelve locations that experienced an incident on Sulu in 2008, seven (58%) of them occur in locations that were not previously the site of an attack during the 2001 to 2007 period (5/12 or 42% occurred at a previous site). Like Sulu, out of seven sites that experienced an incident in 2008 on Basilan, only one of the sites (14%) was a location that saw an incident during 2001 to 2007. Compared to having absolutely no knowledge, these percentages, although low (especially Basilan's), give rise to the examination of more information to help predict terrorist actions

Although the resulting percentages for successfully identifying locations for future incidents are low, they still indicate that there is some information that can be gathered from this type of analysis, and therefore, hot spot analysis should not be easily dismissed from the intelligence process. However, these software packages take into account neither the total number of incidents nor the population of the area being analyzed when identifying hot spots, something that would help put all the studied municipalities on an equal level; this can be accomplished by normalizing the incident data.

4.3 Incident Normalization

Another method for interpreting the data for both Sulu and Basilan was in taking the total number of incidents that occurred in each municipality and normalizing that number by either the total number of incidents that occurred on the entire island or by the population of the municipality. The total number of incidents in each municipality and for the entire island as well as the resultant normalization value and category for both 2001 to 2007 and 2008 for the island of Sulu are shown below in Table 8 and depicted in figures 1 and 2.

Normalization of Municipality Incidents by Total Sulu Incidents

Municipality	Total Number of Incidents in Municipality: 2001 - 2007	Total Number of Incidents in Sulu: 2001 - 2007	Normalization Value 2001 - 2007	Normalization Category	Total Number of Incidents in Municipality: 2008	Total Number of Incidents in Sulu: 2008	Normalization Value 2008	Normalization Category
Indanan	30	158	0.1899	5	1	22	0.04545	2
Jolo	23		0.1456	4	0		0.000	1
KalingalanCaliang	4		0.02532	2	0		0.000	1
Luuk	0		0.000	1	1		0.04545	2
Maimbung	20		0.1266	4	4		0.1818	3
Old Panamao	7		0.0443	3	0		0.000	1
PanglimaEstino	2		0.0127	2	1		0.04545	2
Parang	10		0.06329	3	1		0.04545	2
Patikul	32		0.2025	5	13		0.5909	4
Talipao	30		0.1899	5	1		0.04545	2

Normalization Category Levels

Normalization Category	Normalization Value Range: 2001 - 2007	Category Color	Normalization Category	Normalization Value Range: 2008	Category Color
1	0.000	Blue	1	0.000	Blue
2	0.00010 – 0.02532	Green	2	0.00010 – 0.04545	Green
3	0.02533 – 0.06329	Yellow	3	0.04546 – 0.1818	Yellow
4	0.06330 – 0.1456	Orange	4	0.1819 – 0.5909	Red
5	0.1457 – 0.2025	Red			

Table 8. Normalization and Category Levels

In this research, the normalization category that is red in color (Category 4 or 5 depending) highlights a strong or high value and the blue normalization category (Category 1) is indicative of a weak or low result.

Figure 1.Normalization of Municipality Incidents by Total Sulu Incidents: 2001-2007

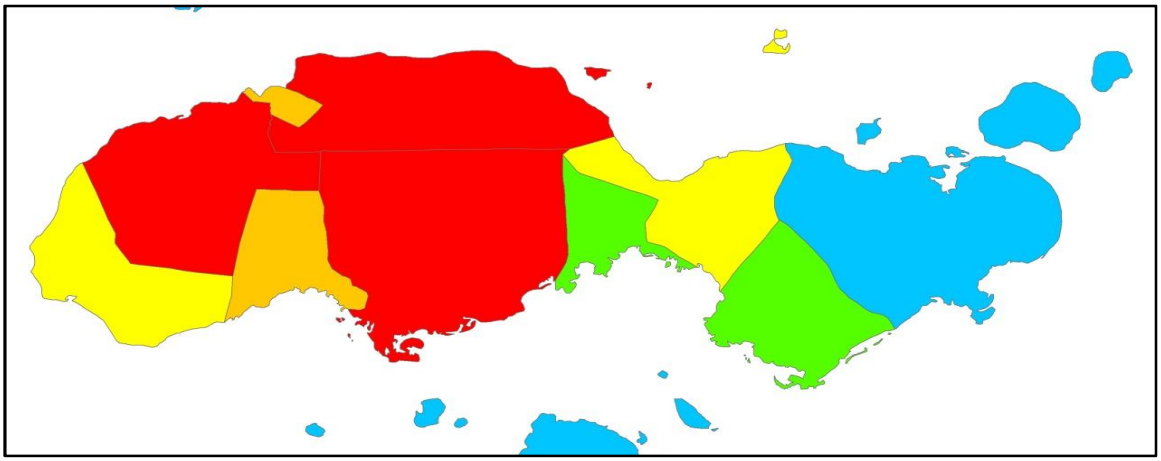
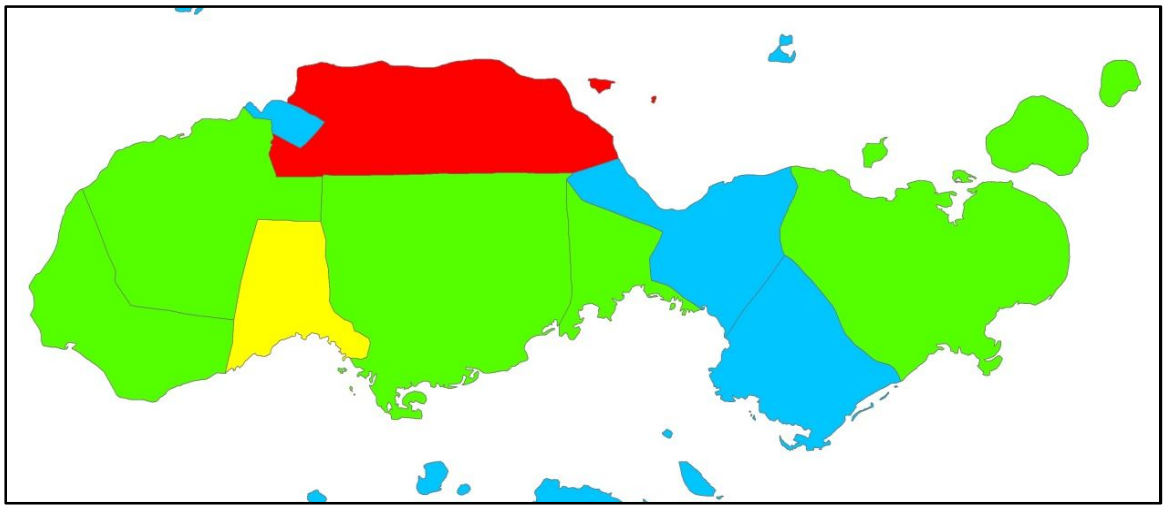


Figure 2.Normalization of Municipality Incidents by Total Sulu Incidents: 2008



Comparing the normalization values of each municipality's incidents by the island's total number of incidents from 2001 to 2007 to the values for 2008, there are two consistencies observed: Patikul and Panglima Estino. In both instances Patikul falls in the highest normalization value, which corresponds to this region experiencing the highest number of incidents in both time periods; Panglima Estino's normalization values keep the municipality solidly in category 2 in both year groupings. In both cases, this can be considered as an important piece of information for security forces; from this they would identify Patikul as an area to watch closely as it see the most activity and Panglima Estino sees consistently less activity, where perhaps they would not focus as much attention. There is only one municipality that's normalization value increases from the 2001 to 2007 time to 2008: Luuk; this municipality only experiences one incident during all eight years, which occurred in 2008, the second time frame. The other eight municipalities all decrease in normalization category, most by a level of one, though Jolo does drop from level (4) to level (1) when it experiences zero attacks in the 2008 year.

Overall, the results of utilizing geographic profiling techniques on the incident data for Sulu and Basilan indicate potential for being useful in the determination of where future incidents could occur, or at least, what type of event could be expected; however, further analysis on different pieces of data is required in order to determine whether or not these techniques could aid in prediction efforts. Perhaps, with different data sets, there lies the possibility of utilizing more complex geographic profiling techniques that were not feasible with this research' data, which could provide more predictive information and therefore, more clear-cut results.

2. Discussion and Conclusions

Utilizing statistical analysis after running CrimeStat, the results of utilizing geographic profiling techniques yielded some useful results. From the statistical analysis conducted, the results of the two islands of Sulu and Basilan tended to contradict each other, meaning that there was not much consistency between the islands, at least when it came to predicting whether or not an incident would occur within a particular area in the future. While municipalities on the island of Sulu were more likely to experience a 2008 incident if they experienced an incident in more of the seven years preceding 2008, the opposite held true in Basilan where a municipality was more likely to be the location of a 2008 incident if they experienced incidents in three or fewer preceding years. In looking at the likelihood of a particular type of incident occurring in Sulu and Basilan, the two islands tend to share more in common with one another because if the island experienced a particular type of incident in three or more out of the seven preceding years, approximately two-thirds of the time, they would experience that type of incident again in 2008. For those incidents that occurred in more than three years leading up to 2008, but did not actually occur in 2008, these types of incidents all occurred in 2004 and before, never after. However, when looking at the 2008 incidents themselves, Sulu's incidents tended to follow the pattern that if a particular type of incident occurred in multiple years, it was more likely to occur again in 2008; but in Basilan only a third of the 2008 incident types occurred in three or more years.

From CrimeStat, the Hot Spot Analysis reveals the locations that experienced the most incidents over a seven year period. We found fifteen percent (or less) of the hot spots saw an incident occur again in 2008. While CrimeStat's Hot Spot Analysis provides a slight indication of where a future incident would likely occur. On both islands, the model only generates one hot spot location, more often than not; the locations of incidents from 2001 to 2007 were categorized as being not significant of a spot, though in a few instances the sites were identified as cold spots. Of the sites identified as hot spots, only on Sulu does a 2008 incident occur at the same location as a previously identified hot spot. Even when looking at the incidents as a whole, the percentage of 2008 incidents that occur in previously attacked locations, only reaches forty-two percent for Sulu and fourteen percent for Basilan, percentages that are not high enough to help serve a predictive function.

Overall, these results do not speak highly of the predictive nature of geographic profiling techniques; however, while the resulting percentages were not very high, the fact that most of these methods of analysis produce even a result at all means that they have future application. The process intelligence analysts and law enforcement officials go through currently to predict likely locations of where terrorists and criminals attack and operate involves multiple methods, which all together aid in the determination of the most likely areas; these geographic profiling techniques provide yet another level of analysis to help in this determination. Perhaps when added into several existing methods, information can be revealed that would have previously gone undetected.

The results of this research may simply highlight that for all the similarities shared between serial criminals and terrorists, the two entities are just too different from one another for a technique that works on one to work for the other. Terrorists tend to be motivated by an ideology and choose their targets in order to generate fear among the population and force the government to take action against a perceived injustice held by the terrorists, while serial criminals and serial killers or rapists in particular tend to target people who fit a certain description in order to act out anger on someone who has wronged them previously, without a further goal of soliciting a government response. Of course, the largest difference, which makes determining the location of a terrorist base of operations difficult, is that serial criminals tend to be an individual, but with a terrorist organization, it is challenging to pick out one individual so instead, the focus turns toward applying efforts meant for one person to an entire group. However, this research focused on the prediction of where a terrorist organization will strike next and not where they operate from; even though this is the case, due to the underlying differences between an individual committing crimes and an entire group conducting attacks, it may be enough to make the application not feasible. Once again, further analysis is required in order to determine whether or not this feasibility exists; from this research, the process at least appears promising.

The utilization of geographic profiling in the hunt for serial criminals has found success for law enforcement agencies. Although it seems difficult, there is room available for incorporation into the analysis process utilized by intelligence personnel to predict where future terrorist activity could occur. Even though this research analyzed a limited amount of data, it still provided key pieces of information from which observations could be made by security forces in the Philippines that have the potential to help aid in planning either operations or security patrols in regions where the Abu Sayyaf Group operates. This serves merely as a beginning for future and more in-depth efforts into determining whether or not geographic profiling is applicable to the intelligence process in the search for terrorists; however, this research has been able to demonstrate, that while small, such possibility does exist and needs to be further explored.

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