Use of Geographic Information Systems in Counterterrorism

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Geographic information technologies, combined with appropriate sets of geospatial information, create an invaluable tool for the handling, display, and analysis of every aspect of critical infrastructure security information in terms of detection, preparedness, prevention, protection, response, and recovery. This paper classifies the applicability of such technology in combating terrorism. The five principle pillars that represent the application of GIS and related geospatial technologies as part of effective counterterrorist strategy and tactics consist of the following: Intelligence Analysis, Attack Simulation, Immediate Response, Impact Assessment, and Directed Retaliation.

Key Words: Counterterrorism • GIS • GPS • terrorist attack • bombings • decision making

Geographic information systems (GIS) and related geospatial technologies such as global positioning systems (GPS) and satellite remote sensing and digital aerial photography image processing technologies can be applied to counterterrorism in five principle manners. Firstly, GIS and related technologies can serve as a tool for intelligence analysis. Secondly, GIS can be employed to simulate scenarios for terrorist attacks to identify and, ideally, to harden targets. Thirdly, GIS can be used to coordinate the immediate response to an actual attack by providing information on the proximity of attacked sites to first responders—police, fire, medical, and other resources. Fourthly, GIS as well as GPS and airborne technologies such as aerial videography, infrared detection, and laser detection and ranging (LIDAR) can be used to assess the short-term and intermediate-term effect of an attack and aid in establishing the boundaries of evacuation zones, locating evidence, locating and rescuing victims, and controlling fires and minimizing the potential for secondary damage from delayed explosions, building collapse, and so on. Fifthly, and lastly, GIS, and in particular satellite remote sensing and digital aerial imagery, can be used to coordinate retaliation in the form of air strikes and to assist a whole range of more subtle military, paramilitary, and law enforcement responses.

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Background

What Is GIS?

Geographic information systems are a suite of computer programs designed to store, analyze, manipulate, and create output such as maps, charts, and reports from geographic data linked to descriptive attribute\(^3\) data. The geographic data typically consist of features that can be portrayed on maps or in aerial photographs; these data are stored in a special topological structure\(^4\) (Burrough, 1986). In this unique topological format, scale relationships and geometric interrelationships such as contiguity and adjacency are maintained explicitly. GIS also supports multiple coordinate systems, projections, and datums, which can be applied and inter-converted to different reference measurements (coordinate systems, projections, etc.). The descriptive attribute data are stored in a tabular format and linked to the geographic data. Thus, for every single geographic feature—such as points representing crime incident locations or the residences of suspected criminals or parolees, or lines representing streets or polygons that identify the boundaries of a police beats, districts (precincts), or municipal or provincial boundaries—a series of corresponding records appear in one or more database tables.

GIS data tend to be structured as a series of layers. These layers are co-registers,\(^5\) thus they have the same spatial\(^6\) extent, coordinate system, and projection. For example, a GIS might have a layer of police beat and district boundaries; a layer of streets and highways; a layer of streams, lakes, and wetlands (hydrography); a layer of municipal, regional, and national boundaries; and a layer of crime incident locations. There might also be layers of police station, fire station, and other government facility locations, and a layer of demographic data subdivided spatially by enumeration area. Each distinct layer has at least one database table containing as many records as there are features in the corresponding geographic (map) layer to which it is linked. So, if 706 crime incident addresses have been geo-coded,\(^7\) then the database table linked to these incident locations would contain 706 records. Each record would have a unique identifier that served to identify and link that (crime incident report) record to the corresponding point feature (the crime incident location). Presumably a series of other fields in that particular record would contain applicable information such as type of offense, victim name, victim address, victim contact information, responding officer name, and perhaps case clearance information, name of offender arrested (if any), disposition of the case, and, potentially (usually in other database tables maintained in a relational data base management system), information on past offenses by the same offender, known associates of the offender, other cases in which the same offender was a suspect, information about any
criminal, terrorist, or subversive groups to which the suspect was affiliated, and so on ad infinitum.

GIS Functions
The structuring of data in a GIS in this rather complex fashion has its reward in the many unique forms of spatial analysis that can be performed on the data stored in the GIS. Thus one can readily generate buffer zones around features and then select the corresponding records for the other features falling within a designated buffer zone. For example, for a suspect arrested for an unprovoked assault, one could generate buffer zones around his residence and place of work to determine whether any other assaults had occurred within a kilometer of these locations. The crime incident reports for each incident would then be accessible immediately. One could then peruse each record for a physical description of the assailant, which might then match the attacker in the incident in which an arrest was made. Similarly, one could generate buffer zones around locations of terrorist attacks and see whether any suspected terrorists resided or had been observed within a specified distance of these attack locations. One could expand the analysis beyond crime incident locations to include the demographic or sociopolitical characteristics of areas falling within a specified distance of an incident or incidents such as anti-government disturbances or the proximity of subversive or suspect individuals to critical infrastructure or high profile potential targets. The ability of police and security agencies to analyze these other societal and infrastructure factors depends on data collected by the national or regional mapping, public utility, and/or census or population registry apparatus. In turn, these data vary widely from country to country. So, for example, in the United States, about 59 direct responses from the decennial census are available. In other countries, such as Great Britain or Sweden, more data are available, while in other countries less data are available. The frequency of data collection and detail of such demographic data varies widely (Leipnik & Mehta, 2002).

Another example of a feasible and useful spatial analysis (although somewhat more complicated than the previous example) would be to determine the areas within 5 minutes’, 10 minutes’ and 20 minutes’ travel time from every terrorist attack. The street data this analysis uses would need to be merged together into the buffer zone data and would require speed limit data linked to every block. Once determined, travel-time zones for each incident could be compared with actual suspect locations (if previously encoded) and demographics of the area for enumeration zones or municipalities falling within these travel-time limits to get continuous accurate data on possible whereabouts of accused terrorist or terrorists after the incident to make proper decisions regarding establishment of checkpoints and roadblocks. These examples only scratch the surface of spatial
analysis methods with off-the-shelf GIS software and employing readily available data sets. It is important to note that the spatial analysis methods discussed above can all be conducted in real-time over secure intranet connections with central servers at national police agencies (Leipnik & Albert, 2003).

Sources of Software and Data
The leading GIS is the ARCGIS product from ESRI (the Environmental Systems Research Institute of Redlands, California, Web site: www.esri.com). Of significance is development of a crime mapping and analysis extension termed CRIMEVIEW (developed by the Omega Group of San Diego, California, Web site: www.theomegagroup.com) and an ARCVIEW spatial analyst extension. ESRI’s ARCGIS is the leading GIS software for it combines higher end applications with their complexity and accuracy with user friendly applicability, and it has recently further distinguished itself from a dwindling pack of competitors by introducing an object-oriented approach to design applications, consisting of data fields and methods together with their interactions in the underlying database structure. This object-oriented approach adds sophisticated database structure to a wide range of functions, spatial analysis tools, specialized extensions, and a fully topological structure to cement ESRI’s position as the world’s leading supplier of sophisticated GIS software.

A major competitor of ESRI is MapInfo Corporation of Troy, New York, with its MapInfo Software. This lower end, but more affordable, GIS has been dominant in what is referred to as desktop mapping applications of GIS (versus server-based applications) MapInfo offers low cost, easy to use software. Also MapInfo has a strong presence in Australia where the Australian Bureau of Statistics (the census authority) has selected MapInfo software as its standard for GIS development and data dissemination. In Canada, MapInfo has acquired CanMap, the leading purveyor of nationwide street data, which is frequently an essential component of law enforcement GIS. Within the last few years, as the popularity of GIS has expanded, other firms have entered into the business; these include companies such as AutoDesk and Bentley Systems, which have dominated the computer-aided design (CAD) field, and Intergraph Corporation, which specializes in high-end turnkey solutions for government and industry. Most of the GIS software of these latter companies is not particularly suitable for law enforcement applications (although Intergraph has developed a statewide real-time crime mapping application for the Delaware State Police [Leipnik 2003]): the software tends to be used in conjunction with engineering software. A more significant entrant is Microsoft Corporation, which has developed a GIS called MapPoint, which is intended to compete directly with MapInfo and like MapInfo has a rather limited range of functions and a commensurately lower price.
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compared with ARCGIS. MapPoint currently has a relatively small share of the market for GIS, but given the massive resources of Microsoft Corporation, it is worth taking very seriously over the coming years.

The Five Pillars

The five principle pillars of the application of GIS and related geospatial technologies as part of effective counterterrorist strategy and tactics are Intelligence Analysis, Attack Simulation, Immediate Response, Impact Assessment, and Directed Retaliation.

*Intelligence Analysis*

The use of geospatial technologies in counterterrorism intelligence analysis primarily takes advantage of the spatial analysis functions of GIS to allow an analyst to assemble multiple layers of data and mine multiple database tables to extract connections in space, in time, or other relationships such as financial or familial relationships that may exist among apparently unrelated attacks, organizations, persons, places, bank accounts, and so on. Typically to start such analysis would require a base-map containing geopolitical boundaries of and transportation routes (including road, rail, air, and even marine links) to and from the aforementioned features. Then specific locations such as sites of attacks, residential locations for suspected members of subversive groups, and possibly vulnerable facilities would be added. Depending on the situation, the analysis might portray other features such as locations of financial institutions possibly involved in money laundering, and locations of sites where subversive groups were known or suspected to meet. Of course, census data, phone records from pen registers, and/or any other databases could be integrated into any layer of information. In the context of the Middle East, universities or religious schools might figure as features of interest. In Great Britain certain mosques might be significant, while in the U.S., gun shops/shows and the sanctuaries of certain religious cults (typically quasi-Christian) have been identified as hubs of counter-government activities. The intelligence analyst would seek to determine connections in space and/or in time among and between these disparate elements. For example, one of the authors (Leipnik), on behalf of the U.S. Secret Service, has analyzed the relationships between the financial institutions that members of suspected Nigerian organized crime groups have used to wire transfer illicit cash. These transfers were from offices and banks in major U.S. cities to banks and financial institutions in various European, Middle Eastern, Asian, African, Caribbean, and Central American countries. Specifically, the links were strongest between suburbs of New York City (Queens) and Detroit, Michigan, and Southern Italy, Lebanon, Pakistan, West Africa, the Cayman Islands, and Panama. A similar study on drug trafficking connections from Iran, Pakistan,
and Afghanistan through the Balkan route into Europe (Operation Kilis Connection) was conducted by one of the authors (Hakan) for Interpol (International Police Organization) to reveal and visualize relationship between the organized crime groups and terrorist organizations. In another example, the German Federal Police Agency (Bundeskriminalamt, or BKA) has analyzed the connection between seizures of heroine and the purported source and destination of such shipments. In this case, Istanbul is featured along with Bangkok and Kabul as major source points and Prague, Belgrade, Milan, Warsaw, Moscow, and Hamburg as intermediate destinations along a route to markets in Munich, Dresden, Frankfurt, and Berlin as well as in Hamburg itself (Leipnik & Albert, 2003).

These three examples demonstrate the mapping of movements of illicit money and drugs that might be used to finance terrorist operations, but the mapping could extend to movement of arms, including radiological materials, and the physical movements of international terrorists. One indication that such an approach would be valuable is the active movement exhibited by key players in the 9/11 attacks on the World Trade Center and Pentagon. A retrospective analysis of the participants in those attacks revealed that they moved from Saudi Arabia through Pakistan and Afghanistan to Germany and Britain, Spain, the Czech Republic (possibly), Malaysia, the Philippines, Somalia, and Canada to south Florida, Arizona, Virginia, and Maryland and then to Boston, Newark, New Jersey, and Washington, D.C. Such a study could be done routinely to develop different algorithms to predict future terrorist activities or the soft targets that might be the next targets of terrorist ideologies. Another approach involves making connections not only between places but between people residing or working or traveling through or arrested at various locations. Thus Scotland Yard has used GIS along with neural network analysis\textsuperscript{10} methods to find connections in space and time among members of traveling criminal gangs (so-called Irish Travelers, although in many cases they are what are frequently termed gypsies). These connections link these extended criminal families to crimes ranging from vandalism to bank robbery and murder across the length and breadth of Great Britain. The connections are primarily ones of kinship, although connections established among formerly unrelated people made in prison can also be important. The GIS helps show where these members of extended criminal conspiracies reside and/or are apprehended. Then crime locations can be analyzed by proximity to the residence of any member of the extended gang. These gang members (and memberships) of specific locations in turn can then be related to other members of the gang who may be passing through the area and are residing temporarily with an affiliated criminal. This approach seems well suited to analysis of the inter-relationships between the membership and complex web of activities of terrorist groups. These groups may have a hard core of “underground” members, but they typically have a much larger above-ground support

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structure of sympathetic affiliated members who provide financial backing and “safe houses” that may be used to reconnoiter sites for potential attacks. By identifying the locations associated with these supporters along with developing a robust database of the activists and their antecedents, one can then obstruct a map of the web spun by these nefarious human spiders. This web can then be used to entrap the terrorists themselves.

**Attack Simulation**

GIS is a powerful tool for simulation. In conjunction with specialized spatial analysis methods and/or customized algorithms imbedded in finite element, finite difference, optimization, and statistical analysis programs, it is the foremost tool for simulation of phenomenon such as movement of groundwater contaminant plumes, extent of petroleum reservoirs and ore bodies, movement of oil spills, change in forest composition, and behavior of invasive species (Webb & Can, 2005). In the human sphere it is used to simulate patterns of land-use change, economic development, and spread of diseases such as AIDS, SARS, and the Ebola virus. With a pedigree stretching back several decades in the area of simulation of processes and phenomena that have a spatial component, GIS can be adapted readily to simulation of aspects of terrorist attacks and the response to such attacks. Of particular relevance is the work of Dr. Lee Griffin at Louisiana State University and investigators at the Technical University of Brno in the Czech Republic, all of whom have used GIS to simulate movement of vapor clouds and air pollutants in cities (Borgharkar, Griffin, Fan, & Maverick, 1999).

The relevance of these simulations to terrorist attacks is that these models can be used to simulate the effect of release of toxic vapors from attacks on petrochemical facilities or breaches of tank cars due to deliberate derailments. With modifications, the effect of radiological aerosols or biological weapons such as anthrax can be simulated. Simpler simulations can be conducted to estimate blast effects and impacts from attacks such as truck bombings and suicide hijackings of commercial or package delivery aircraft that are then crashed into structures. Even cruder methods can be employed to assess vulnerabilities of facilities and security deployment strategies to safeguard vulnerable targets. In the latter case, high resolution digital aerial photography is likely to be most helpful in “gaming” scenarios for terrorist attacks and instituting preventive measures. United States National Capitol Planning Commission GIS analysts use this approach in preparing event security plans for Washington, D.C. In addition to helping to place security personnel, barriers, fences, security cameras, and other sensors in optimal and previously vulnerable locations, GIS can be used to simulate an attack, determine the effects, estimate the zones of total devastation and major and minor damage, and show the appropriate locations and routes to evacuate those affected and where and how to
limit entry. Specific situations and critical incidents such as hostage taking and extraction can also be rehearsed. By obtaining CAD-based floor plans along with aerial photography and incorporating these additional data types into a GIS, law enforcement agency personnel can be ready to respond to a wide range of potential attacks in an efficient manner. Thus by having data on the interior layout of vulnerable facilities such as foreign consulates, response teams will be ready to respond more effectively to critical incidents.

Simulations can be particularly valuable if integrated into a three-dimensional CAD rendering and engineering design program. Thus a truck bomb can be simulated in an actual architectural environment and the impact of its blast can be modeled. Not only can architectural design deficiencies of buildings such as the Oklahoma City Federal Building or Istanbul branch of the HSBC bank be determined before they are exploited by terrorists, but counter measures can be employed such as blocking off access to the plaza in front of a public building that would otherwise be subject to catastrophic damage from a blast undermining its cantilevered and/or curtain wall construction.12

Likewise, by having an understanding of the dispersal of toxic vapors or radiological weapons such as “dirty bombs,” incident response coordinators can better decide the magnitude and extent of necessary evacuation zones in the downwind path of the contaminants. The critical factors of wind direction, intensity, and duration in the dispersal of certain contaminants can be simulated in the GIS by using information about prevailing winds and potential release points and volumes of sources of chemical or biological or radiological hazards and the distribution of downwind population and infrastructure. The value of GIS in determining the influence of spatial factors on the outcome of potential attacks is evident in the case of biological agents such as weaponized anthrax (used in attacks on the U.S. Senate Office Building in 2001). GIS was used by creating a plume (hydrodynamics) model to identify the contaminated area in the Soviet Union when weaponized anthrax was inadvertently released from a bioweapons research facility in the Urals where all the fatalities were in a beeline directly downwind from a point source. In both cases, emergency personnel used GIS application to create a model of the contaminated area to respond rapidly and efficiently to save countless lives.

An essential component of effective simulation would be the development of an inventory of vulnerable targets in the community and then entry of that data into a GIS that had information about the location and characteristics of that area. Thus one would want to inventory every mosque, synagogue, church, and other religious and historical sites and to have data on not just the location of each, but the number of persons likely to be present and the times such facilities were in use. Similarly, government buildings, particularly security related facilities, foreign embassies and consulates, would need to be identified. Foreign owned business might be likely targets. In addition, places where
hazardous chemicals are stored and where munitions are present and the locations of critical communications and transportation infrastructure should be incorporated into an evolving homeland security GIS.

Immediate Response
In the immediate aftermath of an attack, the emergency response functions of law enforcement must be activated rapidly and coordinated effectively. Many dispatching centers in the United States and other developed countries use GIS to create and maintain the maps that are critical to expediting the dispatch of police, fire, and emergency medical resources to the scene of a critical incident. Dispatch and emergency communications centers also use GIS imbedded in computer-aided dispatching systems to call forth the specialized resources that might be required for hostage extraction, for counterterrorist sniper teams, for chemical-biological-radiological weapons response, or for crowd control and the suppression of civil unrest. Besides helping dispatch first responders quickly and efficiently to a location where a particular service is needed, GIS can determine the proximity of that location to the nearest available resources. As the magnitude of the problem increases, GIS can expand the extent of the area it considers to draw in more numerous and/or more specialized resources. Terrorist attacks are likely to call on a large number and wide range of first responders and follow-up teams such as forensic investigators. Spatial optimization in the form of shortest path and travel-time optimization methods can be employed as part of computer-aided dispatching systems, and, in fact, many decisions about the very location of police stations or fire stations are made by using GIS-based spatial analysis methods such as the hierarchical objective set covering model.13 In addition to getting appropriate resources to a location as quickly as possible, GIS can help establish evacuation zones around the location of an actual attack by identifying critical choke points either to limit access to an area or for evacuation of an area. Its value in this regard was demonstrated in the evacuation of lower Manhattan in the aftermath of the 9/11 attacks.

It is particularly important to note that the insidious signature of terrorists such as Al Qaeda is the use of multiple simultaneous attacks such as those in Riyadh, Saudi Arabia; Casablanca, Morocco; in Kenya and Tanzania; in New York and Washington D.C. on 9/11; and in Istanbul. In the case of multiple simultaneous attacks, the response resources of security forces and other government entities are likely to be stretched thin, and in that situation efficient international deployment is particularly important. See Figure 1 for a map of the global reach of Al Qaeda related terrorism activities. The map shows the distribution of the attacks and, subsequently, that response to these attacks requires international effort and consensus for greatest efficacy.
Wise deployment of response resources becomes critical if diversionary attacks are part of a carefully coordinated assault. One strategy that has been exhibited by terrorists other than Al Qaeda (including American extremist Erik Rudolph) and by the Irish Republican Army is the use of an initial explosive device (or hostage) to lure responders into an area where an antipersonnel bomb is then detonated with a time delay or by remote control. All security and law enforcement agencies facing the possible dispatch of highly trained and valuable personnel such as bomb disposal teams, forensic investigators, and on-site command level officers need to be cognizant of the potential of secondary explosives designed to accomplish the real primary objective of the terrorists, which was to kill or maim government counterterrorism and other response team members. Another aspect of appropriate response is to determine other secondary sources of peril. So, for example, if a petrochemical complex was the target of an attack, it would be the flammable, explosive, or toxic chemicals stored at the complex rather than the direct impact of a bomb, airplane, or derailment that would be or paramount concern.
GIS would help identify the contents of nearby tanks, vats, and pipelines at such a facility and prioritize fire fighting and other response efforts.

**Impact Assessment**

Once the dust begins to settle and while the fires are yet smoldering in the rubble of sites such as the World Trade Center (WTC) or the Beth Israel Synagogue, the process of assessing the effects of an attack, including death and injury from the blast or building collapse as well as injury from toxic smoke and ash clouds as in the case of the WTC attack, can begin. Such effects can be evaluated by using GIS augmented by a technology termed LIDAR (laser detection and ranging), which can be particularly effective in creating a three-dimensional image of a site such as the WTC. LIDAR uses aircraft-based laser devices to generate high-resolution rectified three-dimensional computer representations of an area. If an area such as the WTC was mapped by using LIDAR before an attack; post attack LIDAR visualization can be superimposed. This imagery can be used to estimate the volume of material to be removed (in the case of the WTC, more than 100 million tons of material was removed ultimately). Effects requiring assessment may include rescue of persons living and recovery of dead trapped in the rubble of collapsed buildings. In this case, in addition to GIS, GPS technology in conjunction with CAD and laser and infrared surveying/sensing technologies can be helpful. All these methods were employed at the WTC to determine the location from which approximately 20,000 disparate and typically fragmentary body parts were recovered from the approximately 3,000 victims.

Another way that GIS and satellite and digital aerial photography can be used is in assessing the effects of a cloud of toxic smoke or aerosol. In the case of the WTC, smoke and dust containing asbestos fibers, PCBs, dioxins, and heavy metals settled over a significant and densely populated portion of lower Manhattan, which is the very heart of the largest city in the United States. Subsequent analysis indicated an increase in respiratory complaints among New Yorkers, particularly responders, which could perhaps have been mitigated had the available geospatial data been analyzed and used to implement expanded evacuation zones and more stringent respiratory protection measures. The insult to the lungs of Manhattanites was an indirect consequence of the attack, so how much more serious would the consequences be of an attack with an air dispersed biological agent such as anthrax or tularemia or a vapor cloud released from breach of a chlorine or hydrogen fluoride cylinder? The potential magnitude of the effects of such an event can be comprehended by comparison with the Bhopal incident on December 3, 1984, in Madhya Pradesh province of India, which may have caused the...
ultimate demise of upwards of 20,000 persons from methyl isocyanate, a less toxic agent than either chlorine or hydrofluoric acid, both of which are widely used in industry.

Directed Retaliation
A whole volume could be written about the use of geospatial technologies in that most logical and arguably most efficacious response to terrorism: carefully directed and selective retaliation. The U.S Defense Department’s immediate response to the attacks (which some would characterize as military and others are terrorist) on the U.S.S. Cole on October, 10, 2000, in Yemeni port of Aden was to lob a salvo of cruise missiles at a pharmaceutical factory (or chemical weapons plant depending on what one cares to believe) in the Sudan and at rather crude structures at an Al Qaeda training camp in the wilds of Afghanistan. This prompt and precise response, which used geospatial data and GIS analysis integrally, did not cost tens of millions of dollars in cruise missiles. GIS was used to identify the targets based on spy satellite and/or high level spy plane imagery, then a GIS was used to determine the coordinates of targets, then a highly specialized GIS program containing a digital elevation model was used along with GPS and inertial navigational inputs to guide these missiles to their intended targets accurately.

Whether this response was efficacious or counterproductive or was even warranted in the Sudanese case is debatable in hindsight. One can argue that geospatial data and technology can be used more effectively to target GPS-guided bombs or, in the form of GPS and digital maps and terrain models, direct special operations teams to travel through unfamiliar and unfriendly country at night to carry out assaults, make arrests, or conduct selective neutralization operations. And counterterrorism forces in countries that do not possess cruise missiles but with assets on the ground and/or greater familiarity with an area can also find aerial imagery, GPS, and digital mapping of great benefit.

While GPS technology allows an immediate aerial response in an unfamiliar area or area lacking ground assets, the attacking entity also risks bombing the wrong target, injuring the innocent, and creating negative reactions in the international community as these technologies are subject to high tech snafus. Take, for example, the attack on the People’s Republic of China (PRC) Embassy in Belgrade in May, 7, 1999, which killed three PRC citizens in the Embassy building (Rosenthal, 1999). In this case, two U.S. cruise missiles were targeted on a building identified incorrectly as the Yugoslav Directorate of Logistics in a GIS developed by the National Imagery and Mapping Agency and based on interpreted satellite imagery. Similarly, a nearly calamitous outcome resulted from the use of GPS binoculars containing a laser range finder and providing data to a digital radio communicating to a fighter bomber using a GIS based navigation system while flying over Northern Afghanistan. In this case, on December, 5, 2001, the
U.S. special operations soldier directed a 500-pound bomb on his own position rather than the Taliban Held ridgeline miles away near Sayd Alim Kalay in Afghanistan, and it killed three U.S. troops and five allied Afghans, injured more than 40, and almost killed just-appointed Afghan Interim Authority leader Hamid Karzai. It was later ascertained that the changing of a GPS receiver’s battery in the middle of the American air raid caused the incident The receiver defaults to display its own coordinates after the battery is replaced, something the operator either did not know or overlooked in the heat of battle (Crittenden, 2002).

These examples underscore the observation of noted Vietnam War era counterinsurgency expert Colonel John Paul Vann that “the best counterinsurgency weapon is a dagger, then a pistol, then a rifle, then a machine gun, then a mortar, then artillery, and only as a final and generally ineffective last resort should aerial bombardment be employed” (Sheehan, 1988, 181). However, whether directing cruise missiles or covert agents, geospatial technologies are playing an important role in counterterrorist operations.

Conclusion

As the preceding examples make clear, geospatial technologies are not a panacea for the wide range of woes that global terrorism has unleashed on the new millennium 21st century. However, these 21st century technologies are finding an increasingly important place in the arsenal of modern counterterrorist techniques.

Notes

1. Author names appear in alphabetical order.
2. Refers to technologies such as GIS (Geographical Information Systems), GPS (Global Positioning Systems), and remote sensing that are used to measure, analyze, and visualize the attributes of the surface of the earth.
3. Data that relate to a specific, precisely defined location. The data are often statistical but may be text, images, or multimedia. These are linked in the GIS to spatial data that define the location.
4. The explicit definition of how map features represented by points, lines, and areas are related; specifically, issues of connectivity and adjacency of features are accounted for.
5. Data on the different layers use the same spatial extent, coordinate system, and projection
6. Relating to, occupying, or having the character of space
7. Added as points at the appropriate spatial location in a new layer co-registered with the underlying street layer along the side of the corresponding street.

8. An area of land specifically designed to separate one zoning use from another, such as separating a residential neighborhood from an industrial area.

9. An electronic device that records all numbers dialed from a particular telephone line.

10. A decision-making tool that uses artificial intelligence applications to create mathematical modeling.

11. Using platforms such as SimCity or Second Life to simulate terrorist incidents in real geographical settings with real data (infrastructure, deployment, stockpile, weather conditions, etc.) to train personnel.

12. Theories that explain the vulnerability of the buildings with their design deficiencies include target hardening or crime prevention thru environmental design (Cross-Drew, 1989), defensible space (Newman, 1972), and routine activities (Cohen & Felson, 1979). In our examples, the building deficiencies were not determined before the incidents; however, after such incidents, several precautions were introduced to fix these deficiencies such as strong concrete blockings around the government buildings.

13. Model used by Emergency Medical Services to notify the vehicles needed to cover all zones while simultaneously maximizing the extent of multiple coverage of zones.

14. A computer aided system that uses satellite signals received with two spatially separated antennas (motion and rotation sensors) to achieve improved heading estimates for a mobile platform without any external references (coordinates).

References


