IMPROVING EMERGENCY PLANNING, PREPAREDNESS AND RESPONSE WITH GIS

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OVERVIEW OF EIS AND GIS

A Geographic Information System (GIS) is a multipurpose analytical tool that performs a seemingly endless variety of calculations to describe the geographic features of the earth. This includes natural and human systems, such as land use, roads, rivers, railroads, topography, building use, etc. The description of these features is both graphic (lines or areas on a map) and textual (short database entries designed by the user and "attached" to the lines or areas). Analyses performed include the selection of attributes (for example, how many electric utility transformers) located in a geographic area (called a polygon which might represent a zoning district); the calculation of how many of something (for example, utility poles) are needed to distribute evenly over a distance (measured by lines, sometimes called arcs, between two points, usually called nodes); and the determination of how long it will take a moving object (like a car) operating at a certain speed to traverse the roads (again, translated into lines on a computer screen) from one location (a node) to another. The key advantage of a GIS is that with the proper set-up of its analytical tools and with the proper data available, it will do just about any analysis conceivable. GIS strengths are in spatial analysis with the database and record-keeping systems required for textual applications a weakness.

The Emergency Information System (EIS) is a special purpose decision-support and record-keeping tool used to aid the performance of virtually every task required of corporate or governmental emergency, environmental, health & safety, security, and risk management decision-makers. The tools of EIS assist staff in the mitigation of hazardous conditions, preparedness for emergencies, response to incidents, and recovery from disasters. Regulatory compliance, specialized modeling, and integration with real-time communication and warning systems are its strengths.

EIS employs maps to assist in the spatial understanding of the requirements of emergency planning or decisions made during a crisis. Displayed on maps are all the geophysical features of the earth (roads, rivers, railroads, topography, land use, etc.) plus detailed graphic descriptions and representations of human structures (building floorplans, dams, airports, facility site plans, subway stations, and so on). Interacting with these maps are many custom datafiles which contain information traditional to emergency planning: event log, resource inventory, shelters, transportation, personnel, plans, chemical inventory, hazard analysis, and others. Each record in a datafile has "attached" to it a graphic representation consisting of one of more than 200 multi-colored icons, 16-color lines (solid, dashed, dotted), and circles or areas (with hollow, solid, or cross-hatched fill). These EIS graphics overlay the maps, blink selectively, easily change color, and can be juxtaposed in endless variety to display for decision-makers the geographic nature of the emergency. Using the on-screen pointer, any of these graphic overlays can quickly be expanded to show summary or complete information contained in the data record.

Significant analysis is part of EIS, including: what attributes (for example, nursing homes) are located in a geographic area, what the distance is along a road, what current resources are deployed, what actions have been completed in standard operating procedures, what are current weather conditions and forecasts, and the current inspection status for an infrastructure unit. Most important and critical to the decision-support capabilities of EIS is integral, multichannel communications. The product of any analysis can be flashed in seconds --- by telephone,

cellular telephone, packet radio, or satellite --- to any other users in remote locations or even in moving vehicles. EIS gathers that critical data quickly from widespread sources and delivers it to key decision-makers.

In summary, GIS is a powerful analytical tool while EIS is a special focus action tool. Both GIS and EIS are extraordinarily valuable for emergency management agencies. GIS will provide planning information and analytical support that is not sensitive to short time requirements. EIS will translate GIS products into critical, time-sensitive, transactional and operational real-time decision-support information.

THE GIS INFORMATION MANAGEMENT CONCEPT

The basic concept of Geographic Information Systems is the establishment of "layers" of data which are geocoded to display in the right location when plotted by the computer. Using a common geocoding system (the most common being latitude and longitude), different types of data can be selectively layered together to create a map.

What the map becomes when created depends on the use being made of the data. Often, there are more than 30 different sets of data being maintained by a GIS department for its client departments and agencies. Any one of the clients can selectively pull out layers of data to create its own specialized map. A utility department may have the GIS department create a map of water, sewer, and gas lines with the street network being added for clarity. Or the local bus company may lay its bus stops on top of a street network showing only single lane streets that include traffic signals to study how stopped buses might affect traffic flow.

The concept behind GIS information management is that any or all data layers can be combined to make a map. In a sense, in GIS there is no such thing as a map, there are multiple layers of data, all of which are combined to complete the GIS analysis.

HOW EIS AND GIS WORK TOGETHER

The fundamental distinction in information management between GIS and EIS is that EIS maps are a composite of "layers" of information presented as one single display image on the computer. EIS maps usually consist of roads, rivers, railroads, and feature names. While GIS defines all its layers as data and any combination of data as a map, EIS clearly distinguishes between the map and its data overlays. The information management concepts of EIS and GIS differ in this specific regard.

That is because EIS is specific to emergency management applications while GIS must be all things to all people. Thus, a user in EIS can define exactly which layers should be combined in the digitizing process. From then on, every time a map is displayed, it has those layers. As a result, instead of the computer processing data layers for a minute or more every time a map is displayed, the EIS map with its predefined data layers intact is displayed in two or three seconds.

Thus, making EIS maps begins with the selection of GIS data layers and their combination into an EIS map. Importing digital cartographic data is done using a utility product called EIS/ARC (TM) which is a customized version of the leading GIS software, ARC/INFO (R). ARC/INFO gives us the capability of importing more than 20 GIS data formats, including TIGER, DLG, AutoCad (R), and Intergraph (R). Once imported into EIS/ARC, the EIS map is produced from data layers selected in consultation with the client.

MAKING EIS DATA OVERLAYS FROM GIS DATA

Other GIS data layers not used in the EIS map become EIS data. The EIS Data Import program translates the textual data into an EIS record format, interprets the GIS graphic into a corresponding EIS graphic that is "attached" to the EIS record, and then uses the GIS latitude/longitude data for exact registration of the data to its proper map location.

ADDING EIS DATA OVERLAYS FROM NON-GIS SOURCES

Because EIS is unique in its capacity to handle large volumes of textual data in a geographic environment, it has special capabilities to utilize data that has no place or role in a GIS. But, when incorporated into EIS, all such data optionally can have added to it graphic overlays. And, when graphic overlays are added, any data can be exported with latitude/longitude coordinates back to a GIS.

Among the different types of non-GIS data sources

that are commonly used in EIS are:

Management Information Systems --- wordprocessing files, non-geographic databases, bibliographic retrieval systems, and others --- all can become part of EIS emergency decision-support systems. This means that extensive emergency plans and inventories can be quickly imported into EIS. And, geographic data overlays can be linked to non-geographic text data, making for a fully integrated management system.

Models and their results all can be integrated into EIS. Currently, EIS can dynamically incorporate real-time output from two different chemical air dispersion models, a radiological plume dispersion model, and an oil spill model. As well, the outputs from hurricane tracking and surge inundation models can be imported into EIS. Flood inundation model outputs for riverine flooding in both small and large urban areas have also been used in EIS.

Sensors are also available for real-time input to EIS. Sensor data is collected by any sensor system and EIS updates the sensor data in EIS. Sensor ranges can be set up to correspond with different colors or types of icons displaying on the EIS maps. Applications for sensor input to EIS include flood gauges, rain gauges, chemical detection sensors, motion and security sensors, radiation dosimeters, satellite-based tracking systems, and others. Thus, as the environment changes, sensors report the change, and EIS displays the changes by evaluating their impact and importance in real-time.

Communication sources of changing information are also part of EIS. Communication includes text messages sent from other users of EIS which, if they are important, can be added to the permanent EIS data records --- including attaching graphic overlays or icons to the message. Another type of critical information that is communicated into EIS is the National Weather Service Weather Wire. This satellite-delivered warning system is the official source for weather information in the U.S., and it is delivered into EIS computers.

Existing information resident in wordprocessors or spreadsheets are also easily added to EIS. Typing of lists and inventories into EIS databases is readily accomplished with little training. And, at the conclusion of entering each data record, the user has the option of adding a graphic that will form an overlay on the EIS maps. Graphic overlays can be added visually simply by moving the mouse to the proper location on the map and selecting the appropriate overlay graphic, or by entering the latitude/longitude coordinate, if it is known.

Any and all of this information tremendously adds to the capabilities of EIS to provide planning and decision-support to corporate and government emergency staff. The integration of these various forms of information, information that is completely unavailable in a GIS, is one of the hallmarks of EIS that make it a true, operational command, control, and communication systems for crisis decision-making.

USING EIS MAPS AND DATA FOR ANALYSIS AND DECISION-SUPPORT

Two methods provide analysis and decision-support in EIS, each of them operating with the quick response time necessary to handle large volumes of data fast enough to meet the needs of key executives. Because maps, geographic data, and non-geographic data are fully integrated and linked by EIS, the variety of retrieval and display options are exhaustive --- all designed to provide the right information at the right time in the right form.

Displaying EIS Geographic Overlays

The background map, defined by permanent layers of geographic information, has selectively added to it any EIS data overlays desired by the user. These overlays can be defined in several ways.

First, data records from a database can be retrieved. All records can be retrieved or records can be selected by matching text using boolean logic and functions to define the exact subset of data to be displayed.

Second, a multiple geographic area can be marked with any shaped polygon. Records can then be retrieved from the database (either all or through matching of text contained in the record) resulting in the display of records limited to the geographic areas marked with the polygon.

Third, multiple databases and combinations of the above retrieval methods can be used to display multiple and interacting EIS data overlays on EIS maps. This permits the clear depiction of spatial relationships of many different types of data to aid in decision-support. And, because EIS does not

have to process the basic background map as data during the display process, the addition of EIS data overlays to the background map takes only a few seconds. Thus, the map and overlay display capabilities lend themselves to crisis decisions where seconds count --- and to executive briefings where seconds count just as much.

COMMUNICATION WITH EIS

Without a question, the distinction between GIS and EIS is most clearly made for emergency managers in the communication capabilities of EIS. Using telephone, cellular phone, packet radio, satellite, and FAX, EIS data quickly appears on other EIS computers anywhere in the world.

Communication is of two forms: free-form messages and data records (with the attached data overlays). Free-form messages function like an email system, allowing EIS users to broadcast a message to a number of others or target the message to another user. When a free-form message arrives, it can be pasted into the EIS Incident Log. And, when added as data, a graphic overlay can be quickly included with the data record to show the spatial relevance of the message.

Data records can be transmitted in the same broadcast or point-to-point format. When a data record arrives at another location, it can be viewed and thrown away or it can be added to the receiver's EIS database. When added, any graphic overlays included with the data record will automatically appear on the receiver's EIS maps.

The receiver does not have to be using EIS to receive messages. The communication program operates in the background, assuring reception of important messages and data even when being used for routine office work.

Transmission of data and messages can be classified in three priorities, each of which evokes a higher pitched and more frequent beeping when received. Together with the ability to carry out both broadcast and individual communication, these capabilities make EIS the most powerful emergency management data communication system available.

FAX communication is accomplished through the use of any Windows compatible FAX program. EIS map images (including appropriate data overlays) can be quickly faxed to any standard fax machine. Text listings and full record screens similarly can be delivered anywhere.

Real-time communication makes EIS unique among geographic information management systems.

Exchanging EIS Data with GIS

Data overlays in EIS are an extraordinary source of information for GIS departments. All emergency management information can be kept up-to-date on EIS and then transferred to the GIS department for inclusion in the GIS.

In a sense, this brings us full-circle. Data which was obtained from a GIS is maintained throughout the year by emergency management organizations. Then, when it is time for the GIS department to update its records, their job actually has become easier. No paper needs to be transferred. Rather, EIS outputs in a file format that can be read by all GISs.

Recall, as well, that non-geographic information can be added to EIS. All such data optionally can have added to it geographic overlays. And, when geographic overlays are added, any data can be exported with latitude/longitude coordinates. Thus, the GIS department has the opportunity to receive from EIS significantly more --- more accurate, more valuable, more current --- information than ever before.

EIS and GIS indeed are a value-added partnership for emergency management and GIS management organizations.

IN SUMMARY: GEOGRAPHY FOR COMMAND, CONTROL, AND COMMUNICATION

Every emergency management organization improves its performance, becomes more efficient, and protects lives and property better with the Emergency Information System. EIS is command, control, and communication for crisis decision support. It is also a valued resource for the development and maintenance of geographic information.

GIS is an extraordinarily valuable tool for emergency management spatial analysis. Any emergency management office would improve its analytical capabilities with a GIS.

However, GIS is no operational --- and does not try to be. GIS may even be a detriment in an emergency because the time allowed to perform a complex GIS analysis may prelude carrying out the actions determined by the analysis.

EIS, in turn, is operational but clearly lacks some of the analytical capabilities --- network analysis, transportation modeling, address matching --- that GIS was built to do.

EIS and GIS are not a case of either/or. It is a case of defining the needs of emergency management organization and beginning with the software that best meets those needs. If the needs are emergency management planning and operations, then the first choice is EIS. If the needs are for exhaustive spatial analysis, then the first choice is GIS. The products of those analyses then can be productively used in EIS for real-time response and planning.

EIS and GIS make for an unbeatable combination that should be standard operating procedures for every emergency management organization hoping to cope effectively with the complex hazards of the 21st Century.

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