Introduction

One afternoon in October 2001, Alan Leidner took a quick break from his work and sat down to talk about using GIS in disaster management. In the space of a few weeks, he'd become an expert on the issue. As director of Citywide GIS for the New York City Department of Information Technology and Telecommunications (DOITT), Leidner and dozens of others had been doing nothing but GIS and disaster management since September 11—working fifteen-, eighteen-, and twenty-hour days at the Emergency Mapping and Data Center on Pier 92. Leidner explained how he and teams from city agencies, consulting firms, and hardware and software vendors had been rebuilding the GIS system right there in the cavernous pier building on the Hudson River—rebuilding it because much of it had been destroyed when terrorists assaulted the World Trade Center only a few miles south.

Since that day, the GIS teams had been working relentlessly, scrounging backup data sets from everywhere, administering databases, geocoding buildings, creating three-dimensional models of the Ground Zero debris pile, reconstructing the underground geography of lower Manhattan—not to mention making hundreds of maps for anyone who asked for one—from the world-famous mayor on down the line.

Leidner is a soft-spoken man, but there is no mistaking his commitment to GIS, or his pride in what the teams were able to accomplish with the technology. There had been some, however, who had questioned whether all these maps, however pretty they looked, really did all that much good.

Leidner searched in the air for a second for the words he needed to respond to that point of view.

"This stuff," he said, "saves lives."

GIS INTEGRAL TO DISASTER MANAGEMENT

Leidner's belief is the premise of this book also: that now, as never before, GIS technology has become integral to any comprehensive disaster management plan—as essential for dealing with a catastrophic event as bandages and radios.

That premise has taken on new validity after the events of September 2001. GIS was a key tool for those responding to the terrorist destruction in New York City and at the Pentagon—or, to put it another way, there was never any consideration given to *not* using GIS in those response and recovery efforts.

And as the United States begins to focus its disaster management efforts on a new goal—defending against future attacks under the banner of homeland security—the need for GIS will become even more clear.

This premise has been enunciated by a growing number of figures in the field of emergency and disaster management.

The assessment of Roy C. Price, past president of the National Emergency Management Association, is representative: "Geographical Information Systems provide the best method to efficiently support emergency management information needs. Emergency crisis events will impact more than people and facilities; they have an impact on the environment, agricultural crops, livestock, ocean food stocks, and economic dislocation of communities. GIS provides the means for widely diverse organizational and governmental agencies to participate in the full range of emergency management activities at all levels of government."

VISUALIZING DATA

No other technology allows for the visualization of an emergency or disaster situation as effectively as GIS. By placing the accurate physical geography of a disaster event on a computer monitor, and then aligning other relevant features, events, conditions, or threats with that geography, GIS lets police, fire, medical, and managerial personnel make decisions based on data they can see and judge for themselves. This visualized information can be of critical relevance to a disaster manager: the size and direction of wildfire perimeters, the location of broken levees or of hazardous chemical spill release points, or the whereabouts of surviving victims inside a bombed building.

It is difficult to understate the innate connections in the brain that this kind of visualization creates; a spatial or geography-based method presents necessary information in a way far more real than any other.

Leidner says it is sometimes easier for skeptics to understand this concept if they think of GIS in a different way—as a tool that visualizes data, any kind of data.

GIS is also a data consolidator. Decision makers, whether in the state capitol or at the scene of a toxic chemical spill, are almost always faced with much more information than they can deal with. GIS brings many information sources into one focus, helping clarify which elements in a disaster need immediate attention, which can wait, and which can be delegated. These are the kinds of choices and compromises—for it is a sad reality in a disaster that you can't save everything—that are

intrinsic to disaster management. GIS allows them to be seen with new clarity.

With the right data and the right GIS, understanding of where help is needed becomes instantaneous. And in a disaster, instantaneous is the speed at which responders want to be moving.

PURPOSE

This book is designed for several different audiences, each with a stake in disaster management but each with different interests and point of view. It is not intended to be a comprehensive enumeration of all GIS disaster-management applications in the United States, nor a technical or policy manual. It is more in the nature of a survey—-synthesizing some of the lessons that have been learned so far, showing a glimpse of what a few of the experts are doing around the county, and, it is hoped, giving the reader a firm enough footing to investigate whether a particular application or piece of advice may have local relevance.

For GIS professionals and managers, articulating the underlying premise of the book is preaching to the choir. They already understand the power of GIS to convey information.

However, they may not be fully aware of how making maps and doing GIS analysis in a disaster response situation—where seconds count—can be a far different experience from daily GIS tasks such as analyzing watersheds or mapping new property tax boundaries. The point is succinctly made by David Kehrlein, head of GIS operations for the California Governor's Office of Emergency Services.

"It's one thing to say, 'make me a map'," Kehrlein says. "It's a lot different to stick a gun to your head and say, 'make me a map'."

Among the goals of this book is to show those in the GIS community ways that some of their colleagues have learned to make maps and to do GIS analysis under gunpoint conditions.

EMERGENCY MANAGERS

Another audience is the men and women who are already quite familiar with what it is like to make split-second decisions affecting human life while the chaos of disaster rages around them.

Within this community, however, promoting the use of new technologies has sometimes been uphill work. It is not hard to understand why: the tradition-rich task of responding to disaster, of saving lives and property, is a basic kind of labor, one that doesn't require a lot in the way of high-tech. You don't create a fire line, for example, by equipping a squad of firefighters with notebook computers; you equip them with a no-nonsense, axe-like tool known as a Pulaski.

Moreover, being the first on the scene of some soul-wrenching panorama of human devastation, such as the one that took place on September 11, requires qualities from human beings that often make machines and software seem entirely irrelevant.

But it is equally true that there is more to disaster management than the first, adrenaline-filled, on-scene response to it. Knowing *where* to

respond, which is what GIS lets you do, is a critical piece of knowledge for everyone at a disaster scene. And knowing well ahead of time the location of the most dangerous areas (when GIS is used in a planning and preparation context) can only benefit those on the front lines, not hinder them.

DECISION MAKERS

It is also hoped this book will help legislators and managers in government who are eager, in the wake of September 11, to learn new ways to protect their communities and constituents. While this volume is not intended to be a definitive handbook on homeland security, many lessons from implementing GIS in a disaster management context can easily be transferred to the homeland security arena.

These decision makers may in fact already be ahead of the game: if they look around their own public agencies, they will probably find GIS being used in some capacity easily turned to a disaster management purpose. A property-tax database, for example, usually contains names and phone numbers of homeowners, information that can be imported into an emergency notification application.

STOVEPIPES OF DATA

Managers and decision makers may find that their data holdings put them ahead of the game, but it is also quite possible they will find that data in disarray. That leads to another premise for this book: the key to an effective GIS-based disaster management operation is the freely flowing interchange of data among every organization that needs it.

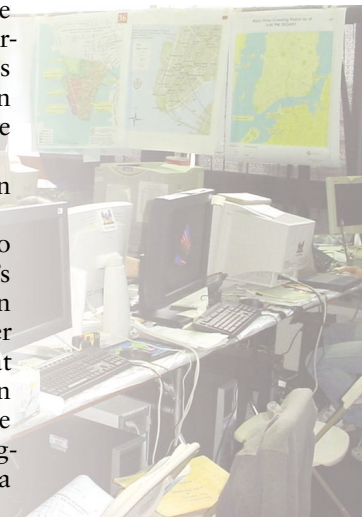
In many communities and states in the United States at present, data relevant to disaster management is scattered across the enterprise, and often in incompatible formats. "Data stovepipes" are common—data created or purchased by one department or agency for its own GIS applications, and not shared with other departments and agencies. Indeed, another agency may not even know of the existence of that data, even though it may contain information directly relevant to its own mission. In many cases, bureaucratic turf wars and a perceived need to "protect" data from "outside" agencies form another barrier, preventing the effective use of geographic data for all constituents.

Indeed, one important factor in the workload of those laboring in the Mapping and Data Center on Pier 92 was the effort involved in getting access to relevant, complete, and compatible data for the myriad layers of New York City—much of which was held by departments and agencies that had no history of data-sharing, or even of carrying on effective communication. One salutary effect of the tragedy was that it helped to start bringing down those barriers.

To create an effective GIS-based disaster management plan and an effective homeland security plan, such stovepipes and barriers must be eliminated. The beginnings of a solution are being seen in such initiatives as the National Spatial Data Infrastructure (NSDI), created by executive order in 1994 to encourage geospatial data acquisition and access. The order specifically enumerates emergency response efforts

as one of the areas where the initiative should be targeted, and it seems likely the events of September 11 may bring additional energy to the NSDI goals.

DATA CHALLENGES



As with any application of a GIS, data is the key to its most effective use—its accessibility, its quality, and its compatibility with other formats and systems. The principles of good data management, such as laying a solid foundation with thorough, current metadata, are even more of an imperative in the disaster context. So is backing up the data itself, at two or three remote locations.

The most effective disaster management systems are those built on an enterprise, or centralized, basis.

An enterprise GIS solution—in which all agencies have access to a centralized base of geographic data layers—leverages the public's already considerable investment in data by reducing redundancies in both data and processing. An enterprise-based system allows disaster and emergency management agencies to access any data layer that might be most useful to them during a time of crisis. Because it can never be predicted which data layer that might be, accessing the entire system allows for more flexibility than one in which disaster managers access only a previously selected, compartmentalized set of data layers.

INTERNET

The effects of the Internet and of mobile, wireless applications are impacting disaster management GIS even as this book is being written. GIS applications such as ESRI® ArcPad™, deployed on personal digital assistants (PDAs), are now allowing for field-level assessments of conditions at a disaster scene in real time, which can then be transmitted back to emergency operations centers. The same kind of immediacy is also available through the Internet, also enhancing disaster decision making; interactive mapping applications such as the GEOMAC system for monitoring wildfires (geomac.usgs.gov) are allowing for real-time assessment of rapidly changing disaster conditions from anywhere in the country.

STAGES OF DISASTER MANAGEMENT

The book is organized to follow roughly the accepted methodology of disaster management (although some authorities consolidate some stages and use slightly different names). These are: planning and identification; mitigation; preparedness; response; and finally, recovery. The first three stages deal with tasks that an organization or community can take before a disaster event, while the latter two focus on postdisaster efforts.

In general, GIS applications in disaster management have been integrated unevenly across these five stages in the United States, depending on the amount of experience, the area, and the size of budget.

Disaster management agencies in California, Florida, and North Carolina have developed more robust systems than have those in other parts of the country, and so receive more attention here. Having been hit with many hurricanes, floods, earthquakes, and wildfires over many decades, they have by necessity gained much experience at confronting catastrophe, with GIS.