Establishing Communication *Before* the Disaster: A State of Idaho Emergency Operation Center Experiment Using ArcIMS to Share Critical, Real-Time Information

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Abstract

Sharing real-time information is a critical need in disaster response. GIS addresses this need. The challenge is to develop GIS infrastructure, data and skills *in advance* of a disaster to help decision-makers make better decisions. The Idaho Departments of Water Resources, Transportation, and Disaster Services, and the Idaho National Guard conducted an experiment in the Idaho Emergency Operation Center (EOC). Posting pre-arranged updates to ArcIMS layers demonstrated the utility of ArcIMS and revealed challenges including bandwidth issues, incompatibilities of data sets, and standardization of update procedures. Participants plan to expand use of ArcIMS for future EOC activities.

Introduction

Before, during and after emergencies, the accurate sharing of real-time information is critical. Difficulty with communication is cited as the number one problem common to all disasters (Lokey, 2003). The effectiveness of every element of an organization is enhanced if full knowledge about the activities and capabilities of other elements is shared. GIS provides an excellent tool for this sharing of information.

Evidence of this concept is aptly portrayed in the aftermath of the September 11th terrorist attack. Within one week of the attack, New York City's Director of Citywide GIS Systems received 100 requests for GIS support (Walsh, 2002). During the following week his office responded to 1,000 requests. GIS was cited as a significant contributor to the recovery effort.

The urgency for establishing GIS is detailed by Greene (2002). While GIS played a pivotal role in helping to organize rescue and recovery efforts in New York City after September 11th, additional preparation would have assisted in the effectiveness of GIS utilization. This hindsight enables the emergency preparedness community to better plan for future events. The benefit of having well-established GIS capability is clear – the challenge is how best to incorporate this capability *before* a disaster occurs. The intent is to maximize preparedness given limited time and resources.

One tool that appears to have significant applicability is ArcIMS. The ability of this software to serve updated layers to websites on a real-time basis makes the utilization of this tool attractive for Emergency Operation Center (EOC) activities. To test the effectiveness and applicability of this tool, emergency planners in Idaho conducted a pilot

program, an experiment, to monitor capabilities on a small scale. This paper depicts the conduct of the experiment, discusses the results, identifies conclusions and proposes recommendations resulting from the experiment.

Experiment

The small-scale pilot ArcIMS exercise was designed during a series of scoping meetings with the participants. These meetings, held during October 2002, benefited from input from representatives of each of the following organizations:

Idaho Bureau of Disaster Services (BDS)
Idaho Department of Water Resources (IDWR)
Idaho Department of Transportation (IDT)
Army National Guard, Office of Engineering Services
101st WMD Civil Support Team (CST)
Air Force and Army Emergency Preparedness Liaison Officers (EPLOs)

The conduct of the exercise was deliberately limited to the six entities above, plus the Bureau of Hazardous Materials, in order to have a manageable pilot. Participants developed a disaster scenario involving flooding on the Boise River resulting in the rupture of a chlorine tank and disruption of transportation due to debris and weakened bridges.

The scenario consisted of three timed phases. Each phase was designed to last one hour (real-time), simulating two hours of elapsed time in the scenario.

Phase 1. An earthquake along the Boise foothills weakened Lucky Peak dam, a major dam 10 miles upstream from downtown Boise. The U.S. Army Corps of Engineers decided to perform an emergency drawdown of the reservoir to lower the risk of rupture and the consequences if it did rupture. The emergency drawdown resulted in a initial flow of 10,000 cubic feet per second (cfs), which was above the normal bank-flow carrying capacity of 6,500 cfs, but below the 100 year flood stage of 16,700 cfs. Higher flows were forecasted. Debris flowing in the river endangered two bridges in downtown Boise, and a tanker truck carrying chlorine gas was trapped on one of the bridges.

Phase 2. Two hours later the Boise River flow had increased to 16,700 cfs; first responders had limited access; two bridges closed; the chlorine truck toppled and the contents spilled.

Phase 3. Four hours since the decision-makers arrived at the EOC, the flow increased to 20,000 cfs; first responders had more limited access; four bridges in downtown Boise closed; a chlorine plume drifted westward over heavily populated area; and evacuation was underway.

The first part of each hour was devoted to using ArcIMS to assess the situation and make decisions. The latter part of the hour included a discussion among all participants regarding the key issues. Most importantly, what action did their organizations need to take in the scenario? Before those decisions could be made, however, participants needed to know the status of the disaster and the status of response assets. Decision makers also had to decide what information was needed to make decisions and what information they had that other organizations needed. Finally, participants considered ways to improve the ArcIMS tool.

For phase one, the only available information was a verbal BDS situation brief and ArcIMS layers in existence prior to the disaster. At the beginning of each follow-on phase, an updated dataset was available to show simulated real-time updates. The flood and chlorine plume continued to expand and complicate disaster relief efforts. Bridge status also changed which hindered relief efforts.

Updates to the ArcIMS layers consisted of scripted changes to flood areas and chlorine plumes. These updates were performed in advance of the exercise and each subsequent layer was made available at the appropriate time in the scenario. Updated layers also showed changes in bridge status by changing the color of the icon associated with the bridge of interest. Screenshots are depicted in Figures 1 and 2.

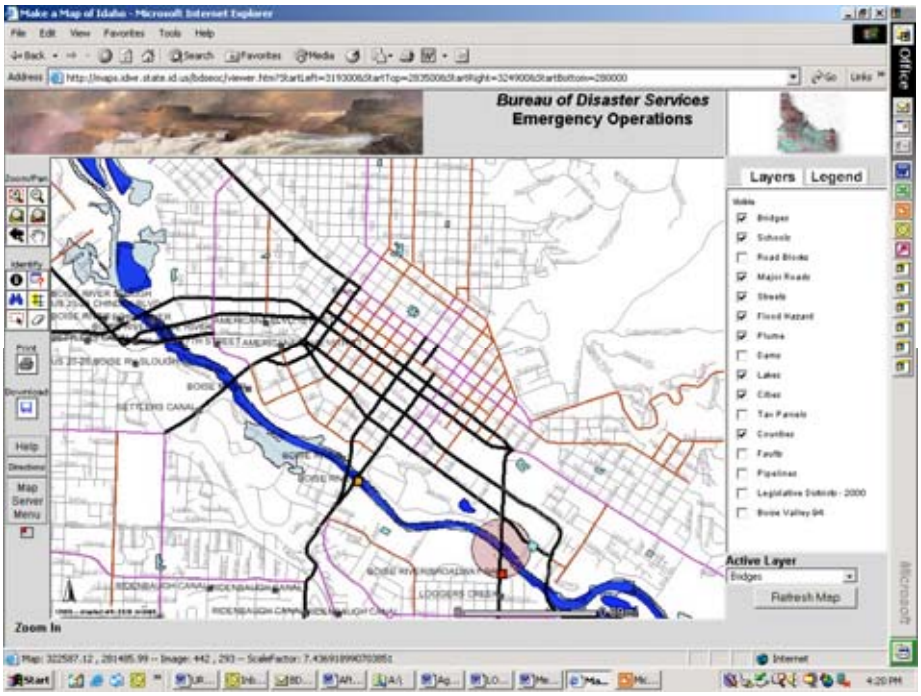

Figure 1. Screen-shot of the ArcIMS depiction of the Boise River at Phase 2 of the exercise. Note the purple circle of the chlorine plume at the site of the overturned truck, and the light blue areas of flooding.

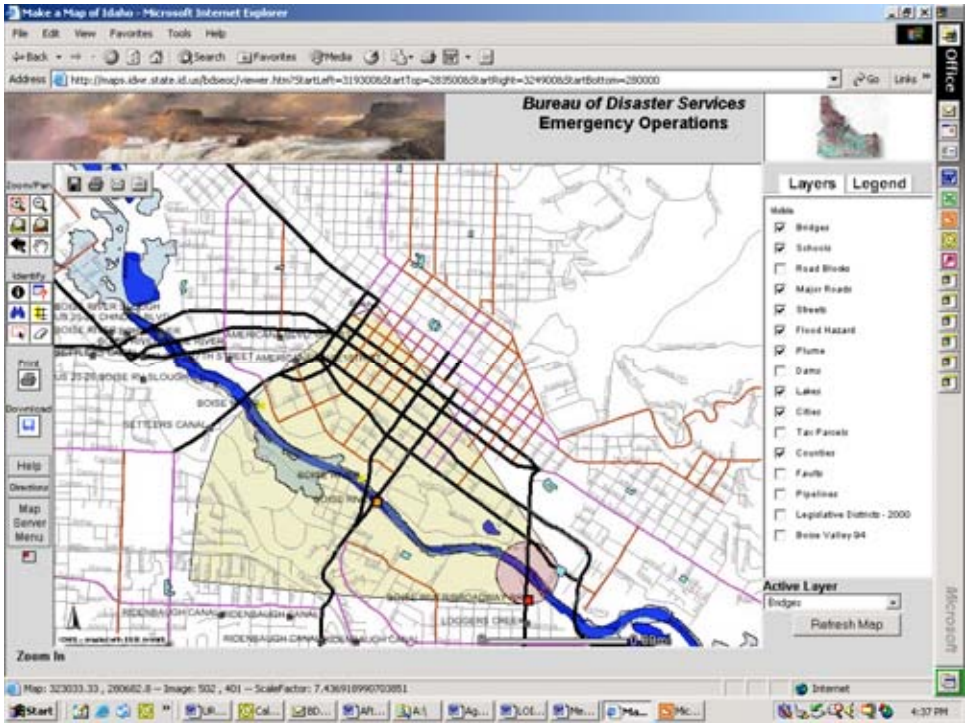

Figure 2. Screen-shot of the ArcIMS depiction of the Boise River at Phase 3 of the exercise. Note the extended tan fan of chlorine plume and the enlarged light blue areas of flooding.

In addition to viewing the scenario, ArcIMS provided an opportunity for participants to explore and analyze data. For example, the representative from IDWR was asked about the maximum discharge rate of Lucky Peak Reservoir. This information would normally not be available in the EOC but instead would be in the files of the agency. However, the layer of dams available on ArcIMS was available to be queried. One attribute on the dam layer is maximum discharge capacity – which for Lucky Peak was identified to be 30,500 cfs. In a similar way all participants in the EOC can take advantage of a vast amount of data made available via ArcIMS. Figure 3 depicts some of the layers provided for the exercise.

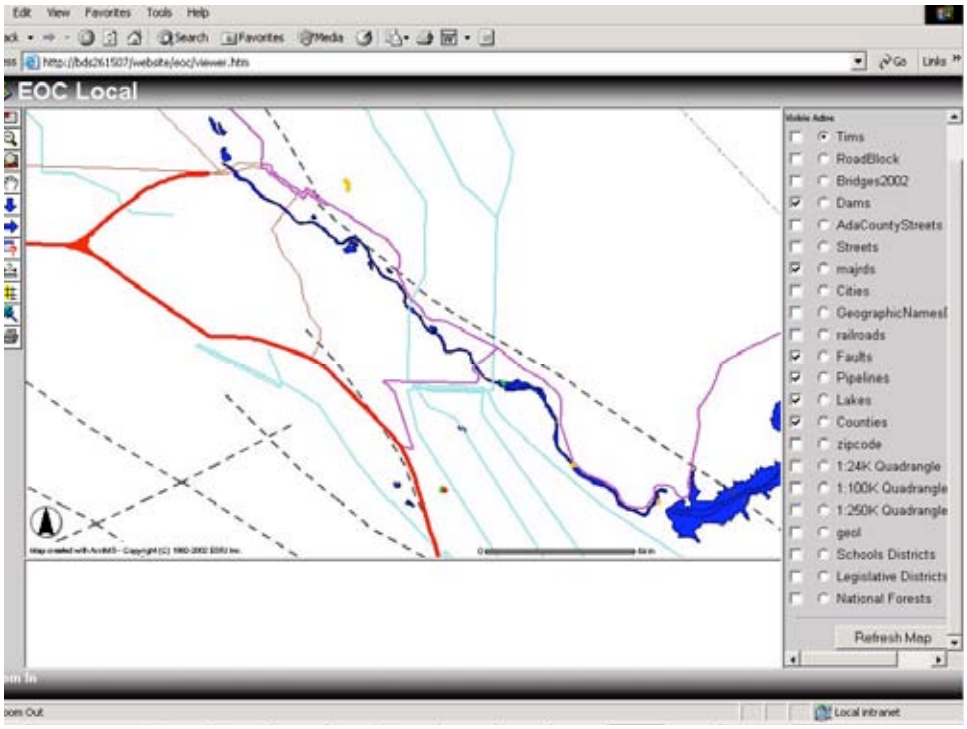

Figure 3. Data layers provided on ArcIMS.

Results of the Exercise

The Exercise Design Team identified six objectives for the exercise. The results of the exercise are organized by objective below. These results were compiled from discussions during the exercise and during the after-action review.

1. Show how GIS can help decision-makers make decisions. Decision-makers involved in the exercise agreed that the spatial information provided by ArcIMS assisted in understanding of the situation and thus assisted in decision-making. While different agencies have different needs, the layers made available can be tailored accordingly.

2. Show that many GIS assets are available. The consensus of participants was that GIS information was broader than had been known prior to the exercise. Participants recommended that letters of cooperation for data exchange be developed for EOC situations. Data currency was an issue – a need for real-time updating was identified. ArcPad applications for field-generated updating were of interest. The custodian for updating each layer must be the responsible agency for each layer – this requires a fully coordinated update procedure.

3. Identify additional data sets that are necessary. Additional data sets, such as those maintained by local government organizations, were discussed. "InsideIdaho", a State of Idaho forum of information, has much data that would be useful. Some counties are GIS-savvy and are good sources of information. Map services provided by federal

agencies such as USGS are also important. One primary problem that surfaced in the exercise was incompatibility of data sets. Professional staff who assembled the layers in ArcIMS identified this as a significant time commitment in preparing the ArcIMS site. Additional data sets that were suggested include: Hospitals/medical facilities; major canals; electric transmission/gas pipeline differentiation; and shelters (schools and armories).

4. Demonstrate the power of quickly updated data sets – using ArcIMS. The exercise effectively demonstrated the power of graphical depictions of spatial data including updates on the chemical spill plume, areas inundated by flood water, and locations of endangered bridges. However, participants desired the capability to track incidents related to the emergency events beyond the capability provided by ArcIMS.

5. Identify the speed difference between an onsite server and the IDWR server. This difference was significant. The best refresh rate for the IDWR server, accessed via Internet pipelines, was eight seconds, and was often much slower. The refresh rate for the onsite server was about one second. Thus, the presence of an on-site server made use of ArcIMS feasible and useful whereas only having an offsite server would have been unacceptably slow.

6. Identify improvements in user interface design (ArcIMS application). Discussions resulted in many useful recommendations, for example improvements on scales of visibility, higher visibility of screen pages, installation of 19" screens to reduce visibility problems, and use of local printing of key layers at key times.

Conclusions

This experiment resulted in the following conclusions:

1. ArcIMS provides a powerful and useful capability in an EOC.

2. ArcIMS is not a sufficient implementation of technology in an EOC. GIS needs to be integrated in disaster management software that tracks incidents with both tabular and spatial attributes.

3. Additional exercises integrating technology in the EOC are warranted and needed.

Recommendations

In response to the results and conclusions developed from Exercise 1, the Idaho EPLO Team is planning to develop and conduct four additional exercises, in conjunction with the partner agencies described above and additional agencies as required.

Exercise 2 will utilize a scenario set in another part of the State, incorporating a weapons of mass destruction event. This exercise will integrate disaster management software in an effort to incorporate the real-time incident reporting and management needs identified in Exercise 1. Participants will include all agencies that normally participate in the BDS EOC. Thus, the number of participating agencies will expand from six in Exercise 1 to fifteen in Exercise 2. The exercise is anticipated to use an on-site server to ensure rapid response, and participants will receive training on the use of software as part of the exercise. This exercise is intended to test the following hypotheses:

1. Disaster management software assists with the organization and implementation of EOC activities.
2. Disaster management software optimizes the utilization of GIS capabilities in an EOC operation.
3. Modern disaster management software is sufficiently intuitive to be used by novices with brief initial training.
4. Setup and implementation of disaster management software can be conducted within budgetary constraints of state operations with limited seed funding.

Exercise 3 will build on the scenario from Exercise 2, and will integrate off-site operations, including the local county EOC (Ada County), a federal Base Support Installation (Mountain Home Air Force Base), the Idaho State Police and other designated agencies. This exercise is intended to test the following hypotheses:

1. Web-based disaster management software assists with the coordination and integration of off-site participants in an EOC operation.
2. Web-based disaster management software enhances the cost-effectiveness of agency participation by allowing members of participating organizations to work from their normal locations, utilizing their references and local assets.

Exercise 4 will include participation by the Federal Coordinating Officer, the State Coordinating Officer, the Defense Coordinating Officer and related participants. Exercise 5 will include the participation of a neighboring state.

Integration of ArcIMS in the framework of web-based disaster management software is anticipated to incorporate the vast amount of information presently available in GIS layers throughout the state, in a manner that is useful and applicable to disaster response operations.

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