Development of the Spatial Information Clearinghouse in Support of Humanitarian Demining

James Madison University's Geographic Science Team's humanitarian demining project focuses on the development of a web-based Spatial Information Clearinghouse, which provides information on spatial data issues, Global Information Systems, and data systems. It also tracks where spatial data for different countries can be found.

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Background

During the past five years, the Geographic Science team has:

1) Developed customized Geographic Information Systems (GIS) for the specific needs of humanitarian demining organizations and operators,

2) Evaluated GIS software for a Humanitarian Demining Support System,

3) Hosted an international conference on mapping and GIS for humanitarian demining,

4) Conducted a feasibility study for a spatial data clearinghouse for humanitarian demining, and

5) Designed and tested a prototype spatial information clearinghouse on the World Wide Web.

The Department of Geographic Science and Humanitarian Demining

The Department of Geographic Science (GS) at James Madison University (JMU)

The GS department is within the College of Integrated Science and Technology of JMU. The Department of Geographic Science offers the Bachelor of Science and the Bachelor of Arts degrees for a major in geography with concentrations in the following areas:

- Geographic Information Science
- Environmental Studies
- Global Studies

The Department has teaching and production labs with 27 Dell PC Precision Workstations, high-quality color printers and plotters, digitizing tablets, scanners and a GPS base station. Personal computer software includes Arc/Info 8, ArcView, AutoCad, MapInfo, MapViewer and ERDAS Imagine.

The GS/Demining Team at James Madison University

The GS/Demining team is one of six mine action teams at James Madison University. The team is a part of the Mine Action Information Center (MAIC).

GS/Demining Team

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Examples of Previous Demining Projects

Reviewed Commercial GIS Software for a Demining Support System

The GS Department obtained detailed information on a wide variety of GIS software packages. This information was categorized and compared to provide the basis for the review. Further inputs in this process were the technical reviews found in the literature available on the various software packages. The basic facts and capabilities of the GIS packages were summarized in a large spreadsheet to provide some overview for judgments.[1] The final results of the project were delivered in a report by the GS Department. This report included a proposed hardware and software architecture for a customized GIS.

Developed a Customized GIS for Humanitarian Demining

The GS Department developed a GIS prototype including spatial databases for a portion of Bosnia. The GIS was developed using ArcView from the Environmental Systems Research Institute (ESRI). ESRI is a dominant GIS software vendor on the world market, and ArcView is one of the most widely available GIS software tools in the world.

With ESRI programming language, "Avenue," students used ArcView to create a greatly condensed and simplified graphical user interface. When the software wakes up, the customized ArcView screen is visible. It allows certain basic operations to take place almost with the push of one button on the newly-designed toolbar. A user can, for example, display any of several different data layers for a desired geographical location. He or she can also take basic measurements from the screen of such things as distances, areas and ground coordinates.

New geographic features can be added in the field by simply digitizing the screen with the map or aerial imagery in the background. The user can combine the desired layers into a standardized map composition and print it. The amount of training necessary for a beginner to accomplish this is absolutely minimal—a day or two at most.[1]

The Importance of Spatial Databases and Humanitarian Demining

Spatial databases are an integral part of any GIS and provide bases for mapping and analyzing minefields. The most important part of creating a GIS for humanitarian demining is selecting the appropriate spatial data. In general, a spatial database can be described as data about the spatial location of geographic features recorded as points, lines, areas or images as well as their attributes[2] (Fig. 1).

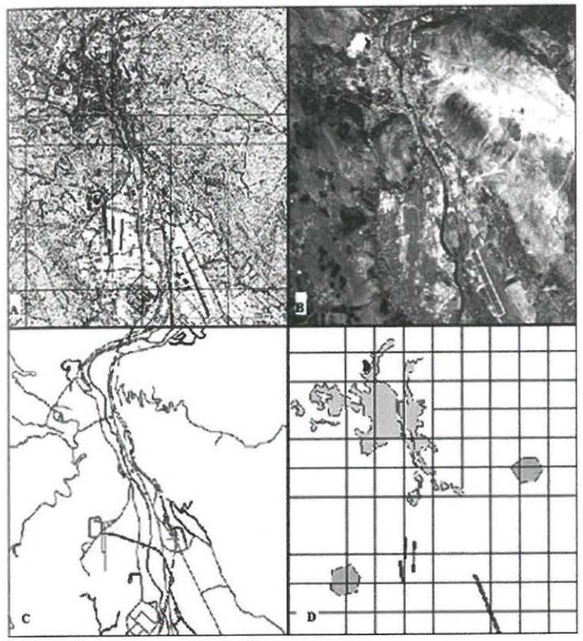

Figure 1: Examples of different layers of a spatial database; taken from the GIS for humanitarian demining in Mostar-Buna, Bosnia.
A) Digital Topographic Map (NIMA 1:50,000)
B) Satellite Image (Spot Panchromatic & Landsat TM Image Merge)
C) Road, railroad and stream data
D) Built-up area, minefields, airports and UTM grid data

Data Needs in Humanitarian Demining

The spatial database needed for humanitarian demining depends upon the objectives of the demining task. In previous GIS projects for humanitarian demining, JMU found, in general, the following digital databases essential: topographic raster maps, satellite images, point features (e.g. schools, hospitals), line features (e.g. bridges, roads, streams and tunnels), and area features (e.g. minefields, airports, built up areas and lakes). For specific demining tasks, other spatial databases might be necessary. For instance, certain types of data will be needed for the three different survey levels outlined in The International Standards for Humanitarian Mine Clearance Operations. These survey levels are defined as follows:

- *Level 1 – General Survey:* "to collect information on the general locations of suspected or mined areas."[3]
- *Level 2 – Technical Survey:* "to determine and delineate the perimeter of mined locations initially identified by a level 1 – general survey. The marked perimeter forms the area for future mine clearance operations."[3]
- *Level 3 – Completion Survey:* "to be conducted in conjunction with the mine clearance teams, and accurately record the area cleared. The benchmark is to be left in the ground to serve as a minimum marker of the initial minefield area. It is also recommended that permanent markers be used to indicate turning and intermediate points of the perimeter of the mined area."[3]

To fulfill these tasks with the support of a GIS, the following spatial databases might be necessary:

- Place name data
- Topographic reference maps
- Land cover data
- Water features
- Roads and bridges
- Administrative boundaries
- Digital elevation models
- Population concentrations
- Global Positioning System data—(to provide coordinates for benchmarks, reference points, turning points, intermediate points and perimeters).[3]

The Spatial Information Clearinghouse (SIC) at the JMU-MAIC

Developing a Prototype Spatial Information Clearinghouse on the World Wide Web

In just seven years, the World Wide Web has revolutionized the way data is accessed. It is the most widely used, easily accessed and single largest data repository in the history of the world. When new data is made available, it does not require years to become accessible but can be made available to the world in a matter of seconds.

Spatial data is one type of data that the World Wide Web has tremendously impacted. The sheer volume of spatial data available for acquisition through the World Wide Web makes finding the best spatial data sets for a project time consuming. Without question, the most time-consuming, expensive and difficult task in a GIS project of any size is the selection and acquisition of spatial data. In order to confront this challenge, many GIS projects use combinations of spatial data that have been obtained in the past and publicly available data layers.

For these reasons, it was necessary to choose the World Wide Web as the medium through which the data in our clearinghouse would be made available to demining organizations.

In designing the overall layout of the website, our goal was to create a site that is easy to navigate and aesthetically pleasing. In order to accomplish this, the first task was to create a central home page that features links to the different areas of the site. Next, topics for the link pages were decided upon and subsequently, the pages were designed. The four areas we are currently expanding upon are Spatial Data Issues, Clearinghouse, About Us and Links.

The Content of the Spatial Information Clearinghouse on the World Wide Web

An integral part of the SIC website is the section on spatial data issues. This section allows the deminer to gain a better understanding about copyright, Geographic Information Systems (GIS), Global Positioning Systems (GPS), Remote Sensing and Spatial Data Standards.

The website included each topic because of its importance to the deminer when

Figure 2: SIC Interactive World Map

using GIS technology. All topics describe in general terms, what they are and why they are important to the deminer.

The primary plan for the Spatial Data Issues section is simply to keep the information as current as possible. Constant changes and developments in technology provide an endless source of information that could be used in humanitarian demining. The goal of our team is also to make the information more applicable to humanitarian demining. Citing specific examples of how this technology can be applied to the deminer's work will accomplish this goal.

The Clearinghouse features an interactive world map that is linked to the various spatial data sets in the different regions of the world (see Fig. 2). The world map is divided into several different regions. Within these regions, the user can select another larger scale map that displays individual nations (see Fig. 3). When a specific nation is selected, information about that country is displayed including: population, area, population growth rate, birth rate, death rate, life expectancy and the nation's flag. Currently, spatial data sets are accessible for the countries of Myanmar, Thailand, Cambodia, Laos and Vietnam and consist of:

- Land use/land cover
- Elevation data
- Vector layers
- Topographic data

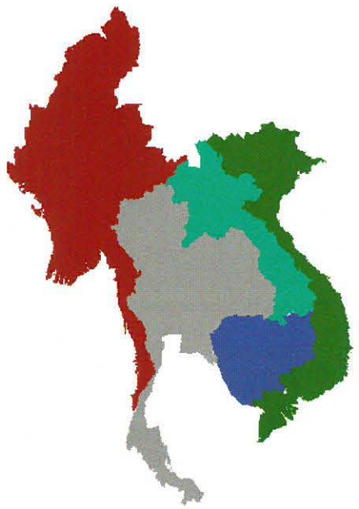

Figure 3: South East Asia

- Imagery

Any of these topics can be selected through the use of an interactive pull-down menu, and after a nation and type of data have been selected, metadata about the available data sets are displayed (see Fig. 4). Important elements of this metadata are the owner of the data set, the date of publication, the cost and how the data set may be obtained.

In the near future, many changes will take place within the Clearinghouse. Currently, we are populating the database with spatial data from five major regions of the world: Africa, Asia, Eastern Europe, the Middle East and South America. Our goal is to have data for the nations in these major regions. In addition, as the need for further information is revealed to us through an international working group, we will focus on finding these data sets for specific nations. The country information that is displayed when a nation is selected is also being updated on a yearly basis.

In addition to the changes of the contents of the Clearinghouse, we are also making significant changes in the way that the Clearinghouse works. The user will still be able to select countries in the same manner, but all of the spatial data gathered about the countries can be accessed more efficiently through a web-based database engine. Therefore, we developed interactive web pages that allow the user to query the entire country database by using a combination of keywords. The results will be displayed in real time by using active server pages technology. The newly-developed database holds all of the metadata gathered as well as the country information. As soon as this database is implemented on the SIC website, the information will be easier to update and more accessible to deminers. This will also allow the user to search with more specific criteria

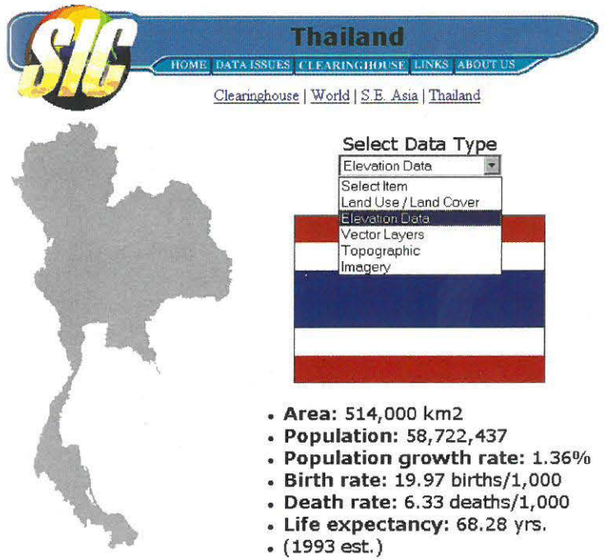

Figure 4: SIC display of available data types and country information for Thailand.

to find what he/she needs, rather than having to look at each data set that is available for that particular area.

A survey was compiled to ensure an accurate representation of the spatial data needs for humanitarian demining, in addition to serving as the basis for creating the Spatial Information Clearinghouse. The survey evaluated the computer usage, data source and type, as well as the software packages used by deminers. The responses given, from approximately 10 representative organizations, were used to get a better idea of what the focus of the Clearinghouse should be and, therefore, served as an integral part of the Clearinghouse design.[4]

All of the information contained in the Spatial Information Clearinghouse on the World Wide Web will also be captured on a CD-ROM. The CD-ROM version will be equally accessible to any user who needs the Clearinghouse in this format.

Summary and Conclusions

The GS team has been working since 1996 on several projects for humanitarian demining. The latest project focuses on the development of a web-based Spatial Information Clearinghouse.

After researching the feasibility of a web-based SIC in 2000, the first prototype was published on the World Wide Web. Today the SIC provides information on spatial data issues, GIS, data standards and where spatial data for different regions in the world can be found.

In the near future, the Spatial Information Clearinghouse will hold metadata information for most countries that can be accessed through a web-based search engine.

In 1996, the Mine Action Information Center (MAIC) was founded at James Madison University (JMU) in Harrisonburg, Virginia. The Department of Geographic Science (GS) at JMU supports the MAIC with a team of faculty, staff and advanced students. ■

References

1. Gentile, J.; Gustafson, G.; Kimsey, M.; Kraenzle, H.; Wilson, J.; Wright, S. (1997): Use of Imagery and GIS for Humanitarian Demining Management. In: *SPIE Proceedings:* The International Society for Optical Engineering, Vol. 3128, pp. 104-109.

2. Kraenzle, H.; Baggett, M.; Brooks, L.; Coombes, R. (1999): *GIS and Spatial Database Support to Humanitarian Demining Activities.* In: *Proceedings of the Australian-American Joint Conference on the Technologies of Mines and Mine Countermeasures,* Sydney, Australia, July 12-16, 1999.

3. *International Standards for Humanitarian Mine Clearance Operations.* United Nations. 13 May 1999 <http://www.un.org/Depts/Landmine/Standards/s-index.htm>.

4. Kraenzle, H.; Gustafson, G.; Wright, S; Grimsley, L.; Pippet, A.; Vaughan, J. (2000): Spatial Information Clearinghouse Survey Results. In: *Technical Report from Department of Geographic Science,* James Madison University, Harrisonburg, Virginia 22807, USA, 17 pages.

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