IMPROVING UTILIZATION OF GEOSPATIAL INFORMATION IN COASTAL HAZARD PLANNING IN MARYLAND

A.E. Luscher

Maryland Department of Natural Resources, Coastal Zone Management Division, Annapolis, MD 21401

ABSTRACT

Through an open forum and panel discussion, the importance of geographic information systems (GIS) and information technology (IT) in state and local government responses to Hurricane Isabel's passage across Maryland was recognized and lauded. More notably, discussion identified additional capacities and processes that could be implemented to prepare the state and its responders for future events more fully. Specific recommendations for expanding state preparedness include: increasing statewide standards, protocols, and centralized access for geospatial information including better capabilities to transfer and use information at the county/local level; identifying and implementing better coordinated communication from state to county/local level *and* the public; increasing capacities for more data-rich products, such as light detection and ranging (LIDAR) elevation information as well as georeferenced addresses for vulnerable buildings, structures, etc.; securing fiscal resources (e.g., reserves) permitting continuous, across-budget-year upgrades of GIS and IT capacities at the county/local level; and expanding government-academic partnerships to increase training opportunities and science-based emergency response planning.

INTRODUCTION

Advances in data gathering, geographic information systems (GIS), and information technology (IT) have greatly improved the ability to identify vulnerable areas and improve the sophistication of planning for hazard response and mitigation. The events surrounding the preparation and recovery from Hurricane Isabel provided many examples for which the benefits of advancing technologies and planning became obvious. The use of GIS and forecasting assessments in hazard planning and mitigation has significant advantages. Although many examples exist in which GIS and modeling assisted in forecasting the potential impacts from Hurricane Isabel, the sophistication and capacity to use GIS-based information are not equal across all levels of government. Issues impeding the incorporation of geospatial information into coastal hazard planning and decision-making, particularly at the local level, will be discussed in this paper. Recommendations are also provided to enhance local technical capabilities and to address specific issues associated with the accessibility and utility of geospatial products.

GIS tools and technologies are not as useful during the event itself, as emergency response decisions and activities are facilitated through more traditional means, such as radio announcements, word of mouth, and the first-hand experience of residents and long-time emergency management staff to guide citizens out of harm's way. Institutional and experiential knowledge are powerful tools; at times they provide the best information in emergency situations. For instance, the decision to evacuate an area may depend more on emergency responder or citizen awareness of areas that regularly flood versus use of a floodplain or inundation map to guide such decisions.

Issues covering utilization of geospatial technologies in pre-disaster planning depend on the user group and whether analysis results were provided in a format appropriate for the specific

K.G. Sellner (ed.). 2005. Hurricane Isabel in Perspective. Chesapeake Research Consortium, CRC Publication 05-160, Edgewater, MD.

target audience. Many counties are capable of receiving raw spatial information (point data, etc.) and incorporating it into ongoing GIS activities. In an emergency response situation, however, critical information may need to be provided in a map layout format available for immediate printing to allow comparisons with other maps at the local emergency operation center (EOC) to assist in decision-making. Therefore, the ability to transition GIS for use in emergency response and information transfer depends on whether the information is provided in an array of formats that accommodate users of variable skill levels.

In the days after the storm hit the Chesapeake Bay, differences in the capacity to use GIS-based information were highlighted at the county level. Metropolitan counties with numerous staff and more advanced GIS facilities were more capable of using advanced technologies in the recovery process. Examples of map products surfaced at the Maryland State Geographic Information Committee (MSGIC) meeting just after the storm, showcasing how some counties used GIS to track damages spatially, identify damage trends, and support decision-making.

To achieve the efficiency that mapping technologies offer at all levels, issues and outstanding needs concerning formatting, housing, and distribution of data technology and modeling products should be addressed. Advanced modeling and mapping tools prove especially useful to local governments in land use decisions and comprehensive planning before a disaster. These mapping and modeling products, however, are often not in a useful or accessible format, particularly for local planning and response agencies.

ISSUES

The transfer of geospatial information and mapping tools at the local level faces a suite of technological and capacity hurdles. This section highlights transfer issues, pointing to specific examples where the utility and accessibility of geospatial information is being impeded. These obstacles relate to five broad issues: 1) statewide institutional structure and technical framework for sharing information; 2) communication and coordination; 3) outstanding data and information needs; 4) technical assistance and capacity building opportunities; and 5) funding needs and resources.

1) Statewide institutional structure and technical framework

The MSGIC represents the main coordinating body for the development of protocols and standards related to geospatial information. This volunteer organization seeks consensus-building to coordinate data acquisition, standards development, and other activities [1]. Despite important contributions made by MSGIC to information standards and management, data needs are often fulfilled through a piecemeal approach scattered among agencies and academic institutions. No single state agency focused on GIS and information technology exists that oversees data-gathering activities and also has the authority to contract for data and services in Maryland.

Improving county capacity to use technical information is contingent on enhancing the overall institutional and organizational structure and technical framework on data acquisition and handling. Issues concerning the use and accessibility of new technologies go beyond data acquisition and deal with the gathering, sharing, housing, and maintenance of the data. The housing of geospatial information represents a significant issue for many local governments as file sizes grow with increasingly detailed information and higher-resolution imagery. Furthermore, modification to land use and zoning occurs daily and these changes must be represented in the spatial applications, challenging local governments to maintain the data sets on a continuous basis. Such data management issues significantly affect the use and applicability of GIS tools.

Issues of scale, lack of consistent datums, formats, and projections also affect the capability to transfer and use information. Lack of consistency decreases the ease and ability to share digital files and information. Some of the issues could be partially resolved by complying with

existing MSGIC standards across all levels of government.

Some county information technology operations are at a disadvantage with respect to available technical and financial resources. At the federal and state levels, the transition from hard copy mapping and assessment to digital capabilities has taken place relatively quickly. This process has not been fully achieved at the county level, however, particularly in rural communities. County technical and hazard response systems require assistance in transitioning from "small-town" operations to networked structures that are more technical in both approach and scale. Effective use of new information technologies often requires an executive-level commitment to build and maintain the required technological and organizational infrastructure. For example, managers at the local level should develop a structure to institutionalize their GIS capabilities (develop metadata, create permanent technical positions, etc.) that maintains their technical capacities even with turnover of staff.

2) Communication and coordination

Federal, state, and county agency participation in coastal hazard mitigation and planning varies in the scope of responsibilities due to specific agency mandates, jurisdictional boundaries, and level of involvement. These differences are especially apparent between land use planning and emergency response agencies. Although activities and communication styles vary, coordination between planning and response remains essential. Feedback from emergency response agents to the planning staff on experiential accounts of disasters assists in future delineation of regional vulnerabilities and risks to specific demographics (non-English-speaking, disabled, etc.). Communicating these risks affects comprehensive planning and land use decisions, which play a considerable role in mitigating coastal hazard impacts. The connection and level of communication between these groups varies on a county-by-county basis, however, with some agencies coordinating frequently and others having little contact.

The public is also an important component in the hazard mitigation process, but communicating risk and vulnerability to these stakeholders has proven difficult. Mitigation is a localized process, with homeowners often making choices that directly influence the extent of impact to private property and infrastructure. A need exists to involve the public in the mitigation process more closely by improving access to the products and results of vulnerability mapping.

The public is often not kept in mind when developing mapping applications and management tools. Such communication gaps were exemplified by the passage of Hurricane Isabel. Although the track and magnitude of the storm were forecast quite accurately through spatial models, damage occurred that could have been avoided. Significant numbers of vehicles and private property were destroyed from floodwaters created by the 1.2–2.4 m (4–8 ft) surge in the Chesapeake Bay. The surge forecasts were provided with sufficient time to evacuate automobiles and move personal items to higher ground. Communicating this risk to the public proved ineffective.

3) Outstanding data and information needs

The availability of pertinent data at a scale relevant to local governments is essential to the development of specific strategies and the identification of activities to mitigate coastal hazards vulnerability. Significant progress in gathering more refined imagery and LIDAR-based (LIght Detection And Ranging) elevation information has occurred. Digital layers with specific georeferenced positions of infrastructure and special-need populations are still lacking, however. Capturing these vulnerabilities at a more-detailed resolution will make them compatible with the high-resolution imagery and elevation data being gathered.

Most vulnerable populations and critical facilities are housed in databases described by a physical (mailing) address. As no geographical coordinate is assigned to these residences, this information cannot be used in geospatial applications. Therefore, a significant effort is

underway at the local level to relate addresses to geographical coordinates—a process known as geocoding. This effort is a resource-intensive process particularly with respect to staff time; however, such an effort is essential for fully merging GIS technologies into planning and response activities.

4) Technical assistance and capacity building

At times, technical resources and assistance are difficult to locate since information and assistance are not centralized. File size and data management/storage have become an issue of concern, especially when using LIDAR-based products. Currently, LIDAR data files are stored at two federal agencies: mass points (elevation points of the earth with objects (e.g., trees, buildings) removed) are housed at the National Oceanic and Atmospheric Administration (NOAA) and the digital elevation model at the U.S. Geological Survey (USGS) [2]. As LIDAR data can be analyzed and applied to multiple geospatial applications, needs should be prioritized and processing issues identified.

Most counties are at a crucial, transitional juncture with information technology (IT). A significant IT solution (updated hardware/software, increased networking, staffing, etc.) in any agency is often required to change its ability to house data, update data as needed, and disseminate the data to target groups and users as necessary. Currently, most local governments are in the process of improving their technical capabilities by both increasing their IT hardware and networking capabilities while also gaining staff trained to work with geospatial technologies and software.

Multifaceted approaches to deal with technical issues at the local level, rather than piecemeal changes, have a better chance of improving local capacities to use data and technology. The acquisition of better hardware and software forms an important step in the process of building local government technical capabilities. These activities alone, however, will most likely not facilitate the change necessary to maximize the utility of the technology and justify the investment. The tools must be developed in a manner that assists those in decision-making roles.

5) Funding needs and resources

Funding is a key issue and a major limiting factor when considering any new tools or technologies and their maintenance. A financial strategy is needed that not only considers the cost of acquiring data, but also addresses how information is shared and maintained. Essential to this process is identification of mechanisms to make information accessible to a broader audience, particularly the public. Distribution plans to employ data tools and technologies should also be developed before the acquisition of information. The allocation of resources in the initial stages of acquiring the data and information should also be considered for the distribution and accessibility of the product as well.

Existing funding mechanisms are often slow to react given the speed at which the technical marketplace operates. For example, state agencies find it difficult to establish financial partnerships with counties to leverage funding in acquiring data cooperatively. This issue has been highlighted in the acquisition of LIDAR data. The state procurement process is often not sufficiently responsive to allocate funds in a timely manner to achieve data acquisition objectives during the appropriate season (e.g., with leaves off trees in the autumn).

Until long-range and predictable fiscal acquisition strategies are implemented, funding partnerships need to be flexible and have the ability to respond quickly. Identifying overall funding needs and potential resources may prove advantageous in developing a financial strategy to implement and improve technical capabilities. As funds become available, projects can be considered among the suite of potential needs.

RECOMMENDATIONS

The following recommendations represent potential ideas to enhance the current effort to make technical information accessible to an array of

target audiences. Along with the effort to build GIS and information technology capacities, improving cooperative relationships and increasing coordination and communication are also essential. These recommendations are targeted examples; they will not resolve all issues, but could greatly improve the utility of technical services to county and public stakeholders if applied strategically.

Recommendation 1: Build local capacities to use spatial information through the support and use of regional GIS councils.

Gaining technical assistance from emerging GIS councils in Maryland is a practical option to further build the capacity of local government agencies to use geospatial information. The GIS councils align policies, identify local and regional GIS needs, and operate as a focal point for partnerships to build Maryland's geographic information infrastructure. Only recently has technical assistance with GIS for rural lower Eastern Shore counties become available. The Eastern Shore Regional GIS Cooperative (ESRGC) is lending support by providing access to GIS technology, data, technical support, and training to the local governments of Maryland's Eastern Shore [3]. The ESRGC is a joint effort among the Mid-Shore Regional Council (Dorchester, Caroline, and Talbot counties), the Tri-County Council of the lower Eastern Shore of Maryland (Worcester, Wicomico, and Somerset counties), and Salisbury University.

The goal of the ESRGC is to improve the GIS technology capabilities of the county and municipal governments of the six counties of the middle and lower Eastern Shore of Maryland. The services provided by the councils to assist in capacity building include: 1) advice on GIS implementation; 2) technical support; 3) equipment loans; 4) data collection; 5) data analysis exercises; 6) cartographic services; and 7) GIS training. These services are provided at either no cost to the county or municipality or at a very reduced cost.

With counties cooperatively working as a group through the councils, resources can be compiled and the technical and financial disadvantages are reduced for counties with smaller population bases. For example, counties partnering to acquire expensive data, such as aerial photography, benefit from economy of scale since the cost of acquisition is reduced when larger areas are flown. File size and data management/storage of LIDAR-based products can also overwhelm the technical capacity of a local government. Therefore, the council can also assist in storing information on Salisbury University's data servers, centralizing access to assorted projects for a single region. In the near future, ESRGC also intends to make data available publicly via an online data server.

Potential Actions:

- Identify a process to institutionalize GIS councils (formalize activities, allow eligibility for state support and resources) and expand efforts to other regions statewide as these councils currently exist only on the lower Eastern Shore.
- Target resources and support to councils to fill technical gaps on a regional scale rather than dealing with recurring technical capacity issues on a project-by-project basis.
- Promote economies of scale when acquiring large data sets (e.g., a MSGIC implementation team strategy) or for large data acquisition projects (e.g., LIDAR or floodplain mapping) to reduce cost and improve coordination through a cooperative effort to unite public organizations and private contractors.
- Consider working with independent contractors/specialists to review local government IT capabilities in order to develop recommendations and a plan that can be followed incrementally to improve capabilities over time. Periodically conduct a needs assessment to determine if enhancements or upgrades to software and hardware are needed.

Recommendation 2: Increase web-based distribution options and Internet mapping applications to improve access and utility of the information.

The identification of mechanisms to make data accessible to a broader audience, particularly the public, is essential to the utility of data tools and technologies. A concerted effort in making information available over the web through Internet mapping applications and online data servers is a sensible option. The web is quickly becoming a universal tool that all demographic and skill levels can use to retrieve information. If data servers are made accessible online, data become available directly to the desktop of any potential user. This alternative significantly reduces the cost of traditional distribution though printing materials or CDs/DVDs.

When considering new data opportunities, funding strategies are needed that not only consider the cost of creating data, but also how information is shared and maintained. The development of web-based Internet mapping tools and data servers may appear financially burdensome due to up-front costs. However, their use can save future staff time and redistribution costs for information as digital data sets are continually updated. Web-based options—particularly Internet mapping applications that provide a mapping software interface—may also prevent data from being unavailable to members of the public without access to mapping software. These products would provide visualization of vulnerability and risk in an interactive format never before offered.

A specific application implemented and distributed through the web to improve response capacities at the local level is the Emergency Management Mapping Application (EMMA) [4]. Developed by Towson University, EMMA is an incident response tool for the emergency management community. The application is capable of displaying relevant information before, during, and after an incident and enables the emergency responders to identify incident locations from the field, generate location-specific reports, visualize incident locations via a map, perform site-specific analysis, and coordinate response efforts. Using a simple web browser, such as Internet Explorer, EMMA provides basic and advanced tools for map visualization, location analysis, and report generation. This system will be deployed at state and local emergency operation centers to provide improved response capabilities statewide and at the county level.

Maryland's Coastal Zone Management Division, in cooperation with Towson University, is also developing another web-based tool for coastal hazard and shoreline management, "Shorelines Online." The product is a one-stop portal for information and tools for coastal managers and decision makers, educators, and the public on coastal hazards and shoreline management. The portal will enhance shoreline activities by centralizing access to information and involving a wider array of stakeholders—particularly the public—in viewing and using shoreline data and assessments. More specifically, the site will house an Internet mapping application that allows users to identify their shoreline erosion risk and determine appropriate shoreline protection and restoration options to mitigate hazards and enhance natural shoreline habitat.

Potential Actions:

- Develop a web-accessible "clearinghouse" to centralize data and information, handle requests for information and distribution of data to decrease hardships on individual data creators, and resolve proprietary issues associated with data distribution.
- Continue to promote adoption and implementation of open and interoperable standards. These standards provide the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those standards.

Recommendation 3: Build upon existing relationships.

One of the most important means of enhancing the application of geospatial technology is the relationship between governmental and academic institutions. Academic institutions often act as a keystone to fill technical assistance gaps that cannot

be addressed by governmental organizations alone. Support of these relationships and strengthening linkages between the two sets of institutions foster innovation in the use of geospatial application at the local level. The existing cooperative relationship between academia and government established through development of geospatial hazard applications would improve the ability to apply scientific principles to policy decisions.

Towson University's Center for Geographic Information Sciences (CGIS) fills technical gaps for state GIS and management activities. The center often serves as a "geospatial hub" for Maryland's geospatial information and it supports many of the state's activities through data and application development, training, and hosting of applications such as the Maryland Metadata Resource Guide (MMRG) [5]. The MMRG website is a convenient one-stop source for: 1) maps and geographic data relating to Maryland; 2) information on GIS and mapping projects; 3) contact information for Maryland State Geographic Information Committee (MSGIC) members; and 4) other resources related to mapping. The MMRG is coordinating many of the geospatial activities in Maryland. If widely supported and utilized, this application could help to coordinate and improve statewide geospatial activities.

Potential Actions:

- Identify mechanisms to formalize partnerships between governmental and academic institutions by developing memoranda of understanding (MOU) to define roles in capacity building and data sharing/storage activities to address local government needs. For example, universities could expand their role as training centers for local and state managers and planners.
- Involve all levels of government and academia in existing steering committees (e.g., MSGIC, ESRGC) that periodically review agency roles in data collection and responsibilities for storage and maintenance, and provide a means to coordinate potential modifications of these processes.
- Seek competitive grant fund opportunities through academia to conduct studies on hazards in a manner that stresses the importance of developing and communicating a message for local governments and the public. The University of Maryland Integration and Application Network is one example of academia developing management and public-friendly products from science-based monitoring and assessments.
- Report regionally significant academic studies and findings routinely to county commissions to effect change at the local level.
- Identify relationships to streamline multi-year contracts for improving the efficiency of existing funding processes and mechanisms such as: developing an account that local and state governments can pay into when they have available funds, which could be maintained across budget cycles; or designating a contract manager outside the state system (such as a university) and developing an MOU.

Recommendation 4: Capitalize on emerging issues.

One of the biggest emerging issues facing our nation and state is homeland security. Establishment of the Department of Homeland Security constituted one of the most comprehensive reorganizations of the federal government in a half-century. The department consolidated 22 agencies and 180,000 employees, unifying once-fragmented federal functions in a single agency dedicated to protecting America from terrorism [6].

Although addressing terrorism is the department's main objective, many of the tools to track, analyze, and assess risk can also be used in natural hazard assessment and disaster response. Populated areas such as Baltimore have already benefited from Homeland Security funds as high-resolution aerial photography was flown for the largest American cities. Capturing high-resolution photography before a disaster is quite useful for

comparison with post-disaster imagery to assist in assessing structural and economic impacts.

The Maryland Emergency Management Agency (MEMA) receives most of the federal financial assistance from Homeland Security. This agency is the first-line responder in emergencies and houses the state EOC [7]. It is also responsible for providing awards and grants to support local and county emergency management activities and planning. One of the most significant provisions from Homeland Security funds has been the placement of an additional staff member and technical instruments (e.g., radios, GPS, computers) at each county emergency management office [8]. The funds have assisted local government in initiating the process to geocode addresses and gather crucial socioeconomic information. This information is being housed in spatial databases and is facilitating the identification of vulnerable populations and places, whether from the impact of an explosion or inundation from flooding.

Potential Actions:

- Identify linkages and merge hazard mitigation with Homeland Security objectives to optimize limited financial and technical resources. For example, continue using Homeland Security funds from the State Hazard Mitigation Office to purchase equipment and communication devices, and support staff positions in a manner that addresses both terrorism and hazard vulnerability mapping.
- Communicate across jurisdictional boundaries, including state borders. Encourage participation of local and state agencies in interjurisdictional groups, such as the Delmarva Emergency Management Task Force.

SUMMARY

Hurricane Isabel provided a "learning moment" for many people in the Chesapeake Bay region, but especially for coastal managers and planners. The event put comprehensive planning and associated land use decision/mitigation activities to the test. In many cases, the planning worked; however, examples still exist that illustrate where our current process and activities can be improved to assist in better pre-disaster planning.

Hurdles facing the capacity to use GIS and modeling tools/technologies in pre-disaster planning are not limited to our ability to acquire data. The issue is much greater in scope and also relates to statewide institutional and organizational structures and how information is shared, stored, and maintained. Modifying institutional structures or formalizing processes to increase awareness and participation may be needed. Support and buy-in by executive levels build the institutional capacity and organizational structure to utilize new tools and technologies effectively. Such actions could include formalizing GIS councils and expanding their efforts statewide; only the lower Eastern Shore currently has these resources. Centralizing access to data and information through a state clearinghouse represents another potential organizational change that could facilitate use of information and reduce duplication of effort. Furthermore, program managers at the local level should address their IT structure and consider options to institutionalize their GIS capabilities (e.g., develop metadata, create permanent technical positions) to maintain their technical capacity even with staff turnover.

When considering new data opportunities, funding strategies are needed that not only consider the cost of acquiring data, but also address how information is shared and maintained. A potential mechanism is to establish relationships that streamline multi-year contracts. Such processes include developing an account that local and state governments can pay into when they have available funds, which could be maintained across budget cycles. Essential to any data-funding plan is a strategy to develop the information into a useful management tool with a comprehensible public message. These tools should be provided in a format readily available to local decision-makers and the public. A concerted effort to make information available over the web through Internet mapping

application and online data servers is a feasible option. Academia could also develop a larger role in these efforts and seek opportunities to augment training and partnerships with state and local governments.

REFERENCES

1. Maryland State Geographic Information Committee. 21 June 2004. *www.msgic.state.md.us/.*
2. K. Miller. Pers. comm. Maryland Department of Natural Resources.
3. Eastern Shore Regional GIS Council. 31 December 2004. *www.esrgc.org.*
4. Towson University Center for Geographic Information Sciences. *EMMA: Emergency Management Mapping Application.* 12 January 2005. *http://cgis.towson.edu/downloads/EMMA_whitepaper.pdf.*
5. Maryland Metadata Resource Guide. 15 January 2005. *www.MarylandGIS.net.*
6. Department of Homeland Security. 17 January 2005. *www.whitehouse.gov/homeland/.*
7. Maryland Emergency Management Agency. 12 January 2005. *www.mema.state.md.us/.8.K* . Golden-Brandt. Pers. comm. August 2004. Maryland Emergency Management Agency.