

## 2005 ESRI Federal User Conference, Washington, DC

Paper No. 155: Determining Building Vulnerability by Natural and Man-Made Hazards



### Abstract

The Smithsonian Institution (<http://www.si.edu/>) manages approximately 660 buildings and receives approximately 20.4 million visitors per year (CY 2004)<sup>1</sup>.

This year, the Smithsonian's Office of Protection Services launched a geospatial project designed to increase safety and security to visitors and staff. By utilizing existing software applications and collecting geospatial data specific to each site, we will have the ability to create scenarios for potential hazards, both natural and man-made, and take corrective action before a crisis exists. The project was initiated in early summer 2004 and is currently in the field data collection phase for the 29 Smithsonian Institution sites and campuses. These sites are located primarily in the Washington, DC mall area, but also in remote locations, such as the Arizona desert, Hawaiian islands, and Panama rainforest.

### The Smithsonian Institution (SI) Mission and Organization

"The Smithsonian Institution has been in existence for 157 years, since James Smithson bequeathed his entire estate ... *to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase and diffusion of knowledge...* The U.S. Congress accepted the gift in 1836 and enacted the Organic Act of 1846, which established the Institution in its present form.

"The role the Smithsonian plays in American society is unique and fundamental. It engages Americans in experiencing their history and their cultural and scientific heritages more fully than any other institution in the world, engendering a greater understanding of our democratic tradition and of the rich diversity of our country. In its collections resides the material record of what America has been. There are over 142 million incomparably interesting and valuable collections items in our buildings -- including a staggering array of objects and specimens for the natural, cultural, technological, social, and political history of America, as well as important international collections of art and artifacts from around the world. In addition, the Smithsonian Institution houses 1.5 million volumes in its libraries and 79,000 cubic feet of photographs and other documents in its archival collections."<sup>2</sup>

The Smithsonian has over 6,000 employees and 5,000 volunteers. It is open 364 days per year and receives between 17 and 30 million visitors per year. The 29 primary Smithsonian Institution sites are widely distributed. Within these sites there are approximately 662 buildings, 10 million sq. ft. of facility space, 19,000 acres of land, and about 107 miles private roads.

### The SI Office of Facilities, Engineering and Operations (SI OFEO)

The Smithsonian Institution's Office of Facilities Engineering and Operations is responsible for operations, maintenance, safety and security of all 29 sites. Its mission is to provide a safe, secure and quality built environment that enables staff to increase and diffuse knowledge and add to the enjoyment of our visitors. The SI OFEO vision is to be the model for providing and sustaining world-class cultural and scientific facilities.<sup>3</sup>

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In 2004, SI OFEO embarked on an ambitious undertaking to integrate a number of essential facilities engineering and protective services functions and develop a common operating picture using standardized data formats, elements and structure. This task would provide general alignment for the department, and most importantly, address the immediate needs for homeland security initiatives within the organization. Two groups within OFEO that were active participants in the development of this project were the Office of Protection Services and the Geospatial Engineering Division. Both worked closely with the SI Office of the Chief Information Officer to develop a geospatial system that addressed the needs for an All Hazards risk assessment of Smithsonian Institution facilities. This paper will outline the approach the SI is taking to use GIS in support of decision making for the determination of building risk to natural and man-made hazards. The combined GIS and SI enterprise system is the first step in developing a world class Real Property Asset Management program that will meet the requirements of Executive Order 13327 ( <http://www.ofee.gov/eo/13327.pdf> ) signed by the President in February 2004.

### **Geographic Information System (GIS) Rapid Application Development Prototype**

As a trust instrumentality of the United States, the SI uses the federal CIO process. A key criterion was to select and use GIS and CADD standards that would ensure data could be shared across SI offices and applications. The SI GIS Concept of Operations (CONOPS) and High Level Architecture (HLA) were developed and approved to begin the process of deploying GIS throughout the OFEO. Currently, the ESRI Arc 9 Desktop is being used for the Rapid Application Development of the GIS system. The interface is being developed to integrate master architectural records of buildings (CADD), as well as the FEMA HAZUS-MH application ( <http://www.fema.gov/hazus/> ).

### **Determining Risk Assessment Needs at SI**

The SI has taken an aggressive approach in the development of integrated security and disaster management plans for its facilities and assets. Before the events of 9-11, the SI had begun the development of campus specific security and disaster management plans to address the need for preparing for natural hazard events and improvements in the security systems.

Over the past three years, the Smithsonian has been an active participant with the DHS FEMA Risk Mitigation Division as a peer reviewer of several publications, and the National Capital Planning Commission for the development of a master Mall Security Plan. The severe winter storms of 2001 and 2002, as well as a number of times when large crowds were housed in SI facilities during thunderstorms, and the post 9-11 requirements highlighted the need for a comprehensive All Hazards Risk Assessment Analysis.

The Smithsonian elected to use a combination of the traditional DHS FEMA natural hazards risk assessment using the HAZUS-MH methodology ( <http://www.fema.gov/hazus/> ), and the new DHS FEMA 426 Reference Manual to Mitigate Terrorist Attacks Against Buildings ( <http://www.fema.gov/fima/rmsp.shtm> ) for manmade risk assessments.

The SI worked closely with the DHS FEMA and the Department of Veterans Affairs manmade assessment process and adopted them to the specific needs of the SI to meet the requirements of the Homeland Security Presidential Directives. As a result, the SI has a unique All Hazards Assessment process that accounts for both natural and manmade hazards/threats that is directly tied to a risk score, vulnerabilities and mitigations.

### **All Hazards Data Collection Method and Analysis**

A key first step in the development of the Smithsonian Risk Assessment was to standardize all Smithsonian campuses using a common building numbering and naming convention. Each SI campus is designated by the number, building name, and short name; 031-NMAH National

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Museum of American History. Using the common naming convention, the All Hazards Risk Assessment is accomplished in three levels.

**Level 1** is a campus level analysis that is a matrix that has hazards-threats versus likelihood and the current replacement value (CRV). The Inherent Natural Hazard Risk and Inherent Manmade Threat Risk are weighted and multiplied times the CRV to provide a Conditional Risk rating (similar to the insurance industry practice) and provides a macroscopic analysis of which primary hazards-threats affect Smithsonian campuses and the potential dollar damage loss that could occur.

**Level 2** is a site or building level analysis that uses the FEMA 426 critical functions and critical infrastructure matrix to provide a color coded risk score for each building combined with color coded space and asset site/floor plans. This level identifies the primary hazards-threats for each site/building and specific functions such as exhibit galleries, collections, laboratories; and infrastructure such as mechanical, electrical, and IT systems. The Smithsonian, like many other facilities throughout the US, has typically designed buildings so that security, engineering and many major mechanical, electrical, and power systems are in lower levels. The Level 2 Risk Analysis identifies those functions and systems that could be impacted with catastrophic affect. For example, a key finding is that a major flood of the Potomac could inundate the National Museum of American History (NMAH) up to several feet on the first floor and all lower floor systems and functions would be lost, similar to what happened with the US Coast Guard headquarters building during Hurricane Isabel. The Level 2 risk analysis mitigation options are broken into three categories: Capital Infrastructure, Capital Equipment, and Plans, Policies and Procedures. Using the NMAH as an example, to mitigate against flood, the recommendations are to move collections storage out of the lower levels, install a secondary Security recovery area at higher elevation, install exterior utility connections and flood proof the major mechanical and electrical systems.

**Level 3** is the use of a 300 plus checklist that is a compilation of the FEMA natural hazards publications and the FEMA 426 checklist. The Level 3 risk analysis identifies the specific rooms, infrastructure, systems, and interdependencies that a given hazard-threat could affect. The Level 3 has specific vulnerability observations and risk mitigation options and an associated Rough Order Magnitude Cost. The Level 3 risk analysis provides the first detailed information including pictures that the Smithsonian can use in Master Planning and long-term space-asset allocation. A key finding at the Level 3 analysis has been the requirement for increased emergency power to support the new Voice Over IP telephone system being installed through out the Smithsonian.

In Phase 1 of this effort, the data is stored in a Microsoft Access database and on a GIS server with the architecture and structure designed to support the long-term enterprise system currently under development by the CIO to integrate the work order maintenance, time, personnel, and GIS applications. The database is based on the Department of Veterans Affairs manmade risk assessment, but has been significantly redesigned to incorporate the All Hazards process, checklists, and risk analysis.

### **Enterprise Decision System and use of SDSFIE**

The next phase is to develop the GIS system to integrate into the emerging Smithsonian enterprise system. The intent is to implement an Oracle solution for the enterprise. A critical requirement for the GIS system is to use the CADD/GIS Technology Center (<https://tsc.wes.army.mil/default.asp>) Architecture, Engineering and Construction (AEC) and Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) to create a seamless system able to share multiple types of CADD and GIS data. The SI OFEO Geospatial Engineering Division is currently in the process of standardizing file naming convention, file storage protocol, and attributes to enable data sharing throughout the SI.

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In Phase 2 of the GIS effort, a Requirements Analysis will be conducted to develop the data element and field naming conventions consistent with the SDSFIE, tie into the Smithsonian LAN system, and deploy the GIS to power user desktops and through web mapping deployment.

The Smithsonian enterprise system will provide the senior managers, engineering and planning, and security office with a complete view of the Smithsonian facilities risk profile. The ability to make informed capital infrastructure, capital equipment and policy decisions will be significantly enhanced. The next ten years will be a transformation of how the Smithsonian plans, programs, and operates facilities, staffs and supports each campus, and responds/recovers the facilities and assets during and after an event.

### Summary

We expect risk assessment data collection to be completed during early summer 2005. The primary objective is to effectively reduce the risk to the world class museums and research facilities the Smithsonian is known for, provide a safe and secure environment for staff and visitors, and ensure the collections are kept safe for future generations to enjoy.

### Acknowledgments

Establishment of geospatial systems at the Smithsonian Institution, Office of Facilities, Engineering, and Operations is a team effort. Special recognition is given to those that continue to contribute effort and innovation to installing a system specific to the unique needs of our Institution, especially Jon Gibbons, Doug Hall, Scott Krajenta, Cyrus Razavi, and David Sousa.

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<sup>1</sup> Smithsonian Institution, Visit Count Statistics, Multi-Calendar Year Study, December 2004, 9.

<sup>2</sup> Smithsonian Institution Strategic Plan, 1.

<sup>3</sup> Smithsonian Institution, Office of Facilities Engineering and Operations Strategic Plan, 4.