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The Use of GIS for Hazard Mitigation of Historic Resources

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The Use of GIS for Hazard Mitigation of Historic Resources

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Abstract

The Use of GIS for Hazard Mitigation of Historic Resources

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Geographical Information Systems (GIS) offers preservationists a unique tool with the potential to revolutionize hazard mitigation for historic resources. The program's ability to link information to a specific geographical location and efficiently disperse this information can solve two of the most destructive issues of current natural disaster response practices: a lack of organized information and an efficient means of disseminating this data. The resources necessary to implement a GIS program and to the requisite cooperation between both public and private preservation organizations may seem prohibitive to many preservation programs; yet, the benefits make this initial investment cost-effective.

Despite efforts to mitigate disasters, both natural and man-made, their effects constantly threaten historic resources. In the past two decades, the United States has made significant strides toward a greater protection of these sites; yet damage continues

to occur. In this thesis, I have investigated methods of risk mitigation implemented in the United States at both the state and local level, and in the public and private sectors, using New Orleans, Louisiana after Hurricanes Katrina and Rita as a case study. Through this analysis, I discovered that a lack of accessible, organized information and cooperation between preservationists compounded the damage caused by the actual event itself. I argue that the implementation of GIS could solve many of these issues by providing a means of both consolidating data and distributing it among responders.

In this work, I demonstrate the ability of GIS to easily solve the problems of current mitigation practices for historic resources. By discussing the tools and basic functions of the program, I clearly illustrate this utility to those unfamiliar with the program, while arguing its potential as a mitigation implement to all preservationists.

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I. Introduction

Figure 1: Beauvoir, Historic Home of Jefferson Davis, Before and After Hurricane Katrina. Left photo courtesy of NCPTT Media. Right photo courtesy of U.S. Government.

Disasters, both natural and man-made, constantly threaten cultural resources [Figure 1]. In responding to the devastation caused by terrorist attacks, fires, earthquakes, hurricanes, oil spills, and other events, cultural resources have often been overlooked as individuals, governments, and relief organizations attempt to stabilize the community. In the last two decades, preservationists have attempted to include historic resources into local and state disaster plans with some success. The National Trust for Historic Preservation has developed an extensive website offering information on disaster planning and response for individual homeowners as well as state and local governments.[1] In 2003 the state government of Florida in conjunction with 1000 Friends of Florida, developed the first disaster plans that integrated historic resources.[2] This publication has since served as an important reference for local governments, as they

[1] "Natural Disasters: Preparedness, Planning & Response," National Trust for Historic Preservation, accessed May 28, 2010, http://www.preservationnation.org/resources/technical-assistance/disaster-recovery/.

[2] 1000 Friends of Florida is a non-profit group dedicated to healthy urban and natural places through the management of growth and change. http://www.1000friendsofflorida.org/

construct their own disaster plans.[3] Despite much advancement in integrating historic resources into the disaster planning and recovery process, very little investigation has been performed into disaster mitigation for historic structures. The existing plans have achieved the first critical step of ensuring that cultural resources receive the physical protection they need, however, the same reports have done little to explore new means of minimizing potential damage.

Despite its growing use in disaster planning, Geographical Information Systems (GIS) has not been strongly researched as a means of hazard mitigation for historic resources.[4] The program's potential, accessed through software, in hazard planning and response has only recently begun to be explored with little or no inquiry into the possible use of GIS for hazard mitigation. What investigation has been pursued into hazard mitigation with GIS does not involve historic or cultural resources in any way. Groups like the Texas Geographic Society have developed maps that detail each region of the state's potential risk from natural disaster,[5] but where they succeed in conveying valuable information about natural events, they fail to offer any information concerning man-made, physical structures. These maps provide useful knowledge for basic planning purposes such as new construction, however they need detailed analysis of existing structures in order to present a comprehensive mitigation package. Following Hurricane Katrina on 29 August 2005, Federal Emergency Management Agency and the National Park Service did utilize GIS in the recovery effort to expedite the Section 106 and

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[3]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources* (1000 Friends of Florida, 2003), 4.

[4]In my research I only discovered one work investigating the use of GIS for hazard mitigation of historic resources, Profile of the Lower Ninth Ward Neighborhood: A Case Study for Hazard Mitigation Strategies by a number of LSU faculty. I discuss this work in the Literature Review.

[5] "Texas Hazard Mitigation Package," Texas Geographic Society, accessed May 28, 2010, http://www.thmp.info/.

National Environmental Policy Act requirements; however, the use of GIS did not extend beyond the recovery process.[6]

In this investigation I will examine the potential uses of GIS as a tool for hazard mitigation involving historic structures. By exploring the effects of disasters on historic resources in New Orleans following Hurricanes Katrina and Rita, I will evaluate the success of current hazard mitigation practices and discuss the ways in which GIS could have improved responses. I have chosen New Orleans following the 2005 hurricane season due to the large number of historic resources in the city and the particular severity of Hurricanes Katrina and Rita. Finally, I will discuss the extensive benefits, exceeding far beyond the realm of disaster management, of implementing a GIS system into any preservation organization.

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[6] Deidre McCarthy, *Historic Preservation Response Methodology: Based on the Hurricane Katrina Model* (U.S. Department of the Interior, National Park Service, FEMA, and National Park Service CRGIS).

II. Literature Review

A dearth of material exists concerning hazard mitigation with an almost equal lack of resources concerning the use of GIS for hazard mitigation. Significantly fewer publications exist regarding the hazard mitigation of historic resources, and only a few sources even reference the use of GIS for hazard mitigation of historic structures. In this review, I have included a selection of materials discussing the history of hazard mitigation internationally and in the U.S. With this analysis, I strive to illustrate the basic methodology behind hazard mitigation in the U.S. I have selected a series of resources concerning hazard mitigation of historic sites to demonstrate the presence of these resources in past and present mitigation practices. I then offer a selection of works regarding the use of GIS for hazard mitigation. The vast amount of information available on this topic makes a comprehensive review of the material impractical. Finally, I discuss the only two sources discovered in my research that discuss the use of GIS for hazard mitigation of historic resources. We cannot commence any discussion upon the advancement of hazard mitigation of historic resources without these analyses of the processes and tools we wish to utilize.

The United Nations designated the 1990s as the International Decade for Natural Disaster Reduction in response to the increasing loss of human life and property damage as a result of natural disasters.[7] Co-authored by members of the Board on Natural Disasters (BOND) of the United States' National Research Council, the article, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters," reviews significant achievements of the decade particularly noting the

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[7] Board on Natural Disasters, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters," American Association for the Advancement of Science. *Science* 284 (1999): 1943-1947.

movement of focus away from disaster response and recovery toward the importance of mitigation.[8][9] In the U.S., researchers at the California Institute of Technology attributed increasing disaster losses to population and social reasons rather than a rise in the severity of the disasters. They identified a rise in population and a general movement of people toward the nation's more disaster-prone coastal areas as major factors in this trend.[10] For example, in California the population had grown from ten million in 1950 to thirty million by 1999; while in Florida, the population had increased fivefold since 1950.[11] Once in these risk areas, people settled in larger cities, concentrating major infrastructure and utilities in a single location. As a result one event could disrupt and damage larger amounts of businesses, government facilities, and other necessary infrastructure.

In an effort to defend against the rising cost of damage from disasters, the U.N. defined disaster mitigation and response, identifying these two phases as the most important in the struggle to decrease destruction costs. The Board on Natural Disasters identified mitigation as "all those actions that are taken before, during, and after the occurrence of a natural event that minimize its impacts."[12] Response was deemed "response includes those actions that are taken during and immediately after the event to reduce suffering and hasten recovery of the affected population and region."[13] The U.N

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[8] 1999 Members of BOND: Wilfred D. Iwan, Chair, California Institute of Technology, Pasadena; Lloyd S. Cluff, Pacific Gas and Electric, San Francisco, CA; James F. Kimpel, University of Oklahoma, Norman; Howard Kunreuther, Wharton School, University of Pennsylvania, Philadelphia; Stephanie H. Masaki-Schatz, Ranchos Palos Verdes, CA; Joanne M. Nigg, Disaster Research Center, University of Delaware, Newark; Richard S. Roth Sr., Northbrook, IL; Harvey Ryland, Institute for Business and Home Safety, Boston, MA; Ellis Stanley Sr., Los Angeles, CA; and Frank H. Thomas, Loudon, TN. National Research Council staff contributing to this article are Robert M. Hamilton, Patricia A. Jones, and Stephen D. Parker.

[9]Board on Natural Disasters, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters."

[10] *Ibid*.

[11] *Ibid*.

[12] Board on Natural Disasters, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters,"1943-1947.

[13] *Ibid*.

recognized that in practice, the response phase was much more heavily emphasized than mitigation and in turn sought to direct efforts toward the initiation of mitigation strategies.[14] The development of individual government mitigation plans was one of the major goals of the decade. To achieve this end, governments needed to: determine the location and nature of potential hazards; identify populations and structures vulnerable to specific hazards; establish standards for acceptable levels of risk; and adopt mitigation plans based upon the relative costs and benefits of achieving these levels.[15]

The U.S. government has been involved in disaster management since the Congressional Act of 1803, providing assistance to a New Hampshire town following a devastating fire.[16] Since this time the increasing number of natural disasters and corresponding damage has caused increasingly more legislation concerning hazard management.[17]The Robert T. Stafford Disaster Relief and Emergency Assistance Act serves as the current federal legislation concerning federal assistance for disaster relief.[18]This Act has been repeatedly amended, with the latest alterations occurring in 2011.[19] As stated in the Congressional Findings section, the purpose of this Act is "to provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from disasters."[20] Although this Act was successful in guiding Federal aid in disaster management, it follows the common trend of focusing the majority

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[14] *Ibid*.
[15] *Ibid*.
[16] "FEMA History," FEMA, accessed March 30, 2011, http://www.fema.gov/about/history.shtm.
[17] *Ibid*.
[18] 42 U.S.C. §5121 *et seq*.
[19] The Predisaster Hazard Mitigation Act, Pub. L. No. 111-351, 124 Stat. 3863 (2011)
[20]42 U.S.C.§ 5121(b).

efforts on recovery rather than mitigation as noted by the U.N Board on Natural Disasters.[21]

One of the major results of the International Decade for Natural Disaster Reduction in the U.S. was the approval of the Disaster Mitigation Act of 2000.[22] The purpose of this act is fivefold:

> (A) form effective community-based partnerships for hazard mitigation purposes; (B) implement effective hazard mitigation measures that reduce the potential damage from natural disasters; (C) ensure continued functionality of critical services; (D) leverage additional non-Federal resources in meeting natural disaster resistance goals and; (E) make commitments to long-term hazard mitigation efforts to new and existing structures.[23]

This act provides the necessary legal basis for FEMA to require state, local, and Indian Tribal governments to implement disaster mitigation plans in order to receive Federal mitigation grant assistance. For state governments, the formation of a disaster mitigation and implementation plan is a requirement to receive disaster assistance, with additional incentives should the state increase mitigation efforts through the establishment of multiple levels of mitigation and implementation planning.[24]

Through the conditions discussed in the Disaster Mitigation Act of 2000, FEMA was able to strongly promote the implementation of disaster mitigation plans on the state and local level. Historic and cultural resources, however, were not directly accounted for in mitigation planning. In 2006, Preserve America, a federal program designed to encourage and support efforts to preserve the nation's cultural heritage, hosted the Preserve America Summit in New Orleans. At this event, preservation professionals

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[21] Board on Natural Disasters, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters," 1943-1947.
[22] Disaster Mitigation Act of 2000, Pub.L.No.106-390, 114 Stat. 1552 (2000).
[23] Disaster Mitigation Act of 2000, § 101(a)(5)(A)-(E), Pub.L.No.106-390, 114 Stat. 1552, 1553 (2000).
[24]*Ibid*.

examined the evolution of historic preservation in the U.S. since the ratification of the National Historic Preservation Act in 1966.[25] As part of the discussion, the group developed several recommendations to further advance preservation at the local level. One of these tenets was to research new ways to integrate historic and cultural resources into hazard mitigation planning at the local, state, and federal levels.[26] The group argued that a region's landmarks provide a source of comfort and stability for a community faced with the destruction and upheaval of a disaster. Due to this intrinsic value, governments at all levels should include these resources into disaster planning as a source of comfort and recovery for afflicted communities.[27] The document defines areas of the disaster cycle (mitigation, preparation, response, and recovery) in which historic resources should be involved and offers suggestions for preservationists seeking to accomplish this integration.[28]

Preparing to Preserve: An Action Plan to Integrate Historic Preservation into Tribal, State, and Local Emergency Management Plans provided the preservation community with a much-needed effective advocacy tool, offering sound arguments for the inclusion of historic resources into hazard mitigation planning. In 2005, FEMA had released a document, *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning,* directed at state and local governments however, this work assumed that government officials would be supportive of historic

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[25] Preserve America, *Preparing to Preserve: An Action Plan to Integrate Historic Preservation into Tribal, State, and Local Emergency Management Plans* (Preserve America: December 2008).
[26] Preserve America, *Preparing to Preserve*, 1.
[27] Preserve America, *Preparing to Preserve,* 2.
[28] Preserve America, *Preparing to Preserve,* 8-13.

preservation.[29] It only briefly mentions the value of historic resources as sources of economic benefit.[30]

Despite its lack of preservation advocacy, FEMA's how-to guide presents a valuable planning tool, dividing the mitigation process into four distinct phases: organization of resources; assessment of risks; development of a mitigation plan; and implementation of the plan and progress monitoring.[31] Each of these phases is then subdivided into further steps with accompanying worksheets that planners can utilize to construct mitigation efforts for historic resources. Through the conditions discussed in the Disaster Mitigation Act of 2000, FEMA was able to strongly promote the implementation of disaster mitigation and implementation plans on the state and local level. Historic and cultural resources, however, were not directly factored into mitigation planning. In 2006, Preserve America, a federal program designed to encourage and support efforts to preserve the nation's cultural heritage, hosted the Preserve America Summit in New Orleans at which preservation professionals and advocates examined the evolution of the program since the ratification of the National Historic Preservation Act in 1966.[32] As part of the discussion, the group developed several recommendations to further advance preservation at the local level. One of these tenets was to research new ways to integrate historic and cultural resources into hazard mitigation planning at the local, state, and federal levels.[33] The group argued that a region's landmarks provide a source of comfort and stability for a community faced with the destruction and upheaval of a disaster. As a

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[29] FEMA, *Integrating Historic and Cultural Resource Considerations into Hazard Mitigation Planning* (FEMA: May 2005).

[30] FEMA, *Integrating Historic and Cultural Resource Considerations into Hazard Mitigation Planning*, V-VI.

[31] FEMA, *Integrating Historic and Cultural Resource Considerations into Hazard Mitigation Planning*, VII.

[32] Preserve America, *Preparing to Preserve*.

[33] Preserve America, *Preparing to Preserve,* 1.

result, governments at all levels should include these resources into disaster planning as a source of comfort and recovery for afflicted communities.[34] The document defines areas of the disaster cycle in which historic resources should be involved and offers suggestions for preservationists seeking to accomplish this integration.[35]

In 2003, 1000 Friends of Florida and the Florida Departments of Historic Resources and Emergency Management produced one of the first disaster plans involving historic resources, *Disaster Planning for Florida's Historic Resources*.[36]This document serves as a template for integrating historic resources into the disaster planning for Florida's local governments. The document divides the process into three segments: "Historic Preservation and Emergency Management: An Overview;" "Enhancing the Local Historic Preservation Process;" and "Integrating Historic Preservation into Local Emergency Management."[37] In the first section, the work explains basic historic preservation and emergency management procedures. The second segment focuses on the historic preservation process, listing recommendations to aid in the care of historic resources during a disaster as well as in normal planning procedures.[38] These suggestions include creating an historic resource inventory; developing an historic preservation response network; expediting historic preservation review procedures; and developing site-specific emergency response plans.[39] The final section details the disaster response procedure, noting when and how historic preservation can be inserted into this process. It also discusses available grants to aid in the recovery and mitigation phases.[40]

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[34] Preserve America, *Preparing to Preserve,* 2.
[35] Preserve America, *Preparing to Preserve,* 8-13.
[36]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources*.
[37]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources*, 4.
[38]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources,* 20-32.
[39] *Ibid*.
[40]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources*, 67-74.

Disaster Planning for Florida's Historic Resources, unlike FEMA's *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning*, was directed at historic preservationists, offering these professionals a model for aiding in the integration of historic resources into disaster planning. Although FEMA had produced the how-to document, local governments were not required to comply with its directions.[41] Instead the burden of protecting a community's historic resources fell to historic preservationists, including those in the public and private sector. Preserve America's *Preparing to Preserve: An Action Plan to Integrate Historic Preservation into Tribal, State, and Local Emergency Management Plans* presented an initial, broader tool for preservations; however, *Disaster Planning for Florida's Historic Resources* provided a much needed detailed, step-by-step model for preservation professionals and advocates.

Five years later, 1000 Friends of Florida and the Florida Departments of Historic Resources and Emergency Management produced a follow up report to their 2003 work, *Disaster Planning for Florida's Historic Resources,* entitled *Disaster Mitigation for Historic Structures: Protection Strategies*.[42,43]This work seeks to provide both a groundbreaking sample mitigation plan for Florida's historic resources as well as a model for other communities seeking to create their own mitigation strategy. Florida's *Disaster Mitigation for Historic Structures* strongly emphasizes mitigation efforts centered upon building construction; examining what products and construction techniques might be used to prevent damage in a disaster. The first section discusses Florida's building code as a means of ensuring mitigation of structures; for example, buildings within a windborne debris region must meet additional glazing protection requirements, while

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[41] FEMA, *Integrating Historic and Cultural Resource Considerations into Hazard Mitigation Planning*.
[42]Division of Historical Resources et al., *Disaster Planning for Florida's Historic Resources*.
[43]Division of Historical Resources et al., *Disaster Mitigation for Historic Structures: Protection Strategies*(1000 Friends of Florida, 2008).

those structures within a high velocity hurricane zone must meet similarly stringent standards.[44] The following sections focus on different building systems, discussing mitigation options for roofs, windows, doors, porches, and walls and foundations. Each division offers many preventative construction options in defense against natural disasters [Figure 2].[45] The final two sections provide a discussion of products to be used when following the previously mentioned recommendations and a list of certified local governments with contact information.[46]

Figure 2: New Orleans Home with Protective Storm Shutters. Photo courtesy of Alysha Jordan.

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[44]Division of Historical Resources et al., *Disaster Mitigation for Historic Structures: Protection Strategies*, 7.

[45]Division of Historical Resources et al., *Disaster Mitigation for Historic Structures: Protection Strategies*, 19-50.

[46]Division of Historical Resources et al., *Disaster Mitigation for Historic Structures: Protection Strategies*, 50-68.

Florida's *Disaster Mitigation for Historic Structures: Protection Strategies* offers an extremely valuable tool and model for hazard mitigation involving historic structures. It explains clearly how historic and existing structures might be retrofitted to withstand natural disasters. Later mitigation plans from other communities, like the city of Galveston and the state of Minnesota, adopt a similar emphasis on physical construction strategies, placing little to no focus on planning or other potential mitigation strategies. Unlike both *Disaster Planning for Florida's Historic Resources* and Florida's *Disaster Mitigation for Historic Structures: Protection Strategies*, these plans combine planning for the different phases of disaster management into a single document.

The City of Galveston, Texas produced a disaster plan for historic resources in 2007. Despite its title, *Disaster Preparation for Historic Resources,* this publication offers advice for mitigation and recovery in addition to disaster preparation.[47] This document divides disaster preparation by the timing of the event, pre-disaster and post-disaster. Both sections list the steps to be taken to physically protect an individual historic structure. An example of one such pre-disaster recommendation is to "add concealed hurricane *straps* and tie-downs to secure roof and wall [Figure 3]."[48]

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[47]City of Galveston Department of Planning and Community, *Disaster Preparation for Historic Properties* (City of Galveston, 2007).

[48]City of Galveston Department of Planning and Community, *Disaster Preparation for Historic Properties*, 4.

Figure 3: Corner Anchor. This constructive action can be used to secure a structure against winds up to 130 mph. Photo courtesy of Louisiana Sea Grant College Program, Louisiana State University.

The post-disaster segment is further organized by type of event including, wind, flood, and fire damage. As with the first section, post-disaster recommendations focus on immediate construction actions; for example, under Flood Damage the first course of action is to "remove water, mud, and debris after groundwater has subsided. Hose down walls and floors." [49]

Minnesota's disaster plan for historic resources, *Thinking About the Unthinkable: A Disaster Plan for Historic Properties in Minnesota*, provides a similar plan for mitigation involving detailed construction preparation while at the same time including basic information regarding the creation of local community mitigation plans.[50] The plan discusses actions to be taken before, during, and after wind, flood, fire, and snow and ice threats.[51]

All three plans offer preservation and planning officials tools for integrating historic resources into disaster plans as well as practical recommendations for strengthening an individual home against threats. None of these resources, however, seem to plan for dealing with the often widespread destruction following a disaster.

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[49] City of Galveston Department of Planning and Community, *Disaster Preparation for Historic Properties*, 6.
[50] "Thinking About the Unthinkable: A Disaster Plan for Historic Properties in Minnesota," Minnesota State Historic Preservation Office, accessed September 20, 2010, http://www.mnhs.org/shpo/disaster/disaster4.html.
[51] *Ibid*.

Galveston's and Minnesota's plans do offer recommendations for basic stabilization, but none offer a structured method of dealing with hazard mitigation and response on a broader spectrum, looking at districts and collections of historic structures rather than individual resources. The broader, spatial relationships neglected by preservationists have been investigated by other disaster management researchers and professionals. These people have recognized the potential of Geographical Information Systems (GIS) as an analytical tool in dealing with disasters.

In his article, "GIS in Hazard Mitigation," T.J. Cova discusses the potential of GIS in the four phases of disaster management: mitigation, preparation, response, and recovery.[52] In the first phase, disaster mitigation, Cova recognizes the growing use of GIS as a risk assessment and long-term mitigation planning tool. He describes the two methods of studying the effects of disasters, hazard mapping and vulnerability studies.[53] Hazard mapping focuses on the physical environment and its related processes, generally taking the human vulnerability component as implicit; vulnerability studies, however, concentrate on the human environment, for example populations and individual structures.[54]Cova offers sample spatial questions that could be used to help mitigate disasters some of which include: "What is the inherent spatial variation in the potential for a natural hazard;" "What is the inherent spatial variation in human environmental vulnerability;" and "Which spatial strategy can be developed to reduce the effects of a particular hazard phenomenon?"[55] For each of these questions, Cova lists a number of

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52 T.J. Cova, "GIS in Emergency Management," University of Colorado at Boulder, accessed June 30, 2010, http://www.chicagomanualofstyle.org/tools_citationguide.html.
53 "GIS in Emergency Management,"4.
54 *Ibid,*
55 "GIS in Emergency Management," 4.

studies performed, in which GIS was used to answer these queries for a particular type of disaster.[56]

In the preparedness and response section, Cova discusses the use of GIS to help create and execute emergency response plans.[57] According to him, the major benefit of GIS in this phase is its ability to integrate and disseminate information quickly. Currently this ability is used to design hazard management systems to serve the needs of agencies and groups responding to disasters.[58]

In the final recovery phase, Cova describes the use of GIS as a spatial inventory system for organizing recovery initiatives.[59] The program can be used to educate and reassure the public, assess damage, and rebuild while providing information to aid in the mitigation of future events.[60]Cova's article provides a summary of the current use and potential of GIS in disaster management. In his work he mentions many studies more closely investigating the use of GIS in particular aspects of the disaster cycle.

Geospatial Techniques in Urban Hazard and Disaster Analysis, edited by Pamela S. Showalter and Yongmei Lu, offers a compilation of a number of these studies performed both in the U.S. and internationally.[61] In chapter three, "Urban Expansion and Sea-Level Rise Related Flood Vulnerability for Mumbai (Bombay), India Using Remotely Sensed Data," Firooza Pavri presents her vulnerability study on the increasing risk of flood hazards compared with the increasing population density in vulnerable

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56 *Ibid*.
57 "GIS in Emergency Management," 6.
58 *Ibid*.
59 "GIS in Emergency Management," 9.
60 *Ibid*.
61 Pamela S. Showalter and Yongmei Lu, eds., *Geospatial Techniques in Urban Hazard and Disaster Analysis* (New York: Springer , 2010).

regions of the city.[62] In another study, "GIS for Flood Risk Management in Flanders," Pieter Deckers, Wim Kellens, Johan Reyns, Wouter Vanneuville, and Phillipe De Maeyer discuss their analysis of flooding in Flanders and the corresponding water management system. Using hydrologic models, land use information, and socio-economic data in GIS, the authors were able to quantitatively assess flood risk.[63] In chapter twelve, "Spatial Information Technologies for Disaster Management in China," Jing Li, Yunhao Chen, A-du Gong, and Weiguo Jiang describe the use of GIS in China's disaster management system to provide mitigation and relief.[64]

Despite the large number of studies available in *Geospatial Techniques in Urban Hazard and Disaster Analysis* and elsewhere, the use of GIS in hazard mitigation of historic resources has been largely neglected. Very few studies have been undertaken into the potential of GIS in the disaster cycle of historic resources, and those that exist do not fully explore the potential of the program. John C. Pine, Director, Disaster Science & Management, Louisiana State University (LSU), Baton Rouge Bruce Sharky, Professor, School of Landscape Architecture, LSU; Justine Lemoine, Student, School of Landscape Architecture, LSU; Barrett Kennedy, Professor, School of Architecture, LSU; and Jay Edwards, Professor, Department of Geography & Anthropology used GIS to study the vulnerability of the of the Lower Ninth Ward in New Orleans, Louisiana in *A Community Profile of the Lower Ninth Ward Neighborhood: A Case Study for Hazard Mitigation*

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[62]Firooza Pavri, "Urban Expansion and Sea-Level Rise Related Flood Vulnerability for Mumbai (Bombay), India Using Remotely Sensed Data," in *Geospatial Techniques in Urban Hazard and Disaster Analysis,* eds. Pamela S. Showalter and Yongmei Lu (New York: Springer , 2010) 31-49.
[63]Pieter Deckers et al., "A GIS for Flood Risk in Flanders," in *Geospatial Techniques in Urban Hazard and Disaster Analysis,* eds. Pamela S. Showalter and Yongmei Lu (New York: Springer, 2010), 51-69.
[64]Jing Li et al., "Spatial Information Technologies for Disaster Management in China," in *Geospatial Techniques in Urban Hazard and Disaster Analysis,* eds. Pamela S. Showalter and Yongmei Lu (New York: Springer , 2010), 245-254.

Strategies.[65] In this work, the authors utilized GIS to analyze new mitigation strategies based on risk assessment and past flood data. Another LSU project, the Hurricane Katrina and Rita Clearinghouse Cooperative, illustrates the demand for dissemination of GIS information.[66] LSU students and professors created a web page in order to facilitate the collection, dissemination, and archiving of GIS data related to Hurricanes Katrina and Rita.[67]

FEMA and the National Park Service used the aftermath of Hurricane Katrina to perform one of the best investigations into the potential of GIS for hazard response organization. Using GIS as an organizational, inventory, and assessment tool, FEMA and the NPS were able to expedite the Section 106 process through the quick gathering and dissemination of information through the program. FEMA and the NPS published a report, *Historic Preservation Response Methodology: Based on the Hurricane Katrina Model,* following this trial thoroughly documenting the methodology utilized.[68] This model successfully combined the information from several organizations, provided an interface between various agencies, and offered a means of tracking the progress of the recovery effort. This strategy provides a good basis for the application of GIS to hazard mitigation or historic resources; however, there remains much room for improvement with this system. None of the data from these Section 106 reviews have been published leaving many residents unable to claim mitigation money from FEMA. Although the GIS data has been given to various state and local governments as well as private

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[65] John C. Pine et al., A Community Profile of the Lower Ninth Ward Neighborhood: A Case Study for Hazard Mitigation Strategies, Louisiana State University.
[66] "Hurricane Katrina and Rita Clearinghouse Cooperative," Louisiana State University, accessed March 30, 2011, http://katrina.lsu.edu.
[67] *Ibid*.
[68] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model.

organizations but few of these groups have the resources to fully access the data.[69] Likewise, only the Louisiana Division of Historic Preservation, the National Park Service, and FEMA were involved in the creation and maintenance of this database. If we are truly to advance the hazard mitigation of historic resources we must expand upon this example.

The U.S has a strong foundation in hazard mitigation, however, historic structures represent only a small portion of this effort. Current practices for the mitigation of these resources predominantly involve the use of construction techniques designed to aid the structure in resisting the physical forces of the disaster. Yet by performing the most basic analysis of historic resources following a disaster, one can easily observe that current strategies are insufficient to prevent all damage. Although the use of preventative hardware should not be abandoned, preservationists must search elsewhere for effective tactics in the reduction of damage caused by disasters. In *Geospatial Techniques in Urban Hazard and Disaster Analysis,* scientists report of their successful use of GIS for the hazard mitigation of certain communities. This collection demonstrates a similar understanding for the need of a new approach to mitigation in general. The studies utilize the program in order to gather information that will affect future building programs in those same communities. Thus by incorporating an element of data analysis before resorting to construction techniques, these scientists attempt to advance the efficacy of current constructive mitigation practices. The team of professors from LSU attempted a similar effort in their study, *A Community Profile of the Lower Ninth Ward Neighborhood: A Case Study for Hazard Mitigation Strategies,* involving historic resources. The endeavors described in all these works do attempt to advance mitigation,

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[69] The Freedom of Information Act requires that the GIS information be made available to anyone who asks. Few however, have the resources to access the data once it has been obtained.

but the focus remains on construction practices. GIS is a useful tool with the potential to revolutionize mitigation however, we must continue to expand our approach to mitigation, looking beyond construction techniques. By examining the preservation response to Hurricanes Katrina and Rita as a case study, we may determine further needs of historic resources that can inform novel mitigation practices.

III. New Orleans Case Study

Hurricanes Katrina and Rita in Louisiana, specifically New Orleans, provide informative examples of the disaster response system at the local, state, and federal levels in both public and private forums. The stresses imposed by the sheer magnitude of these disasters have exposed the successes and failures of preservationists in the disaster management cycle.[70] In addition to this factor, the high concentration of historic resources in New Orleans and the reliance of the city upon historic tourism further magnify the role of historic structures within the hazard system. We can easily observe how historic resources survived the initial storms, were treated by responders, and determine the success or failure of these actions.

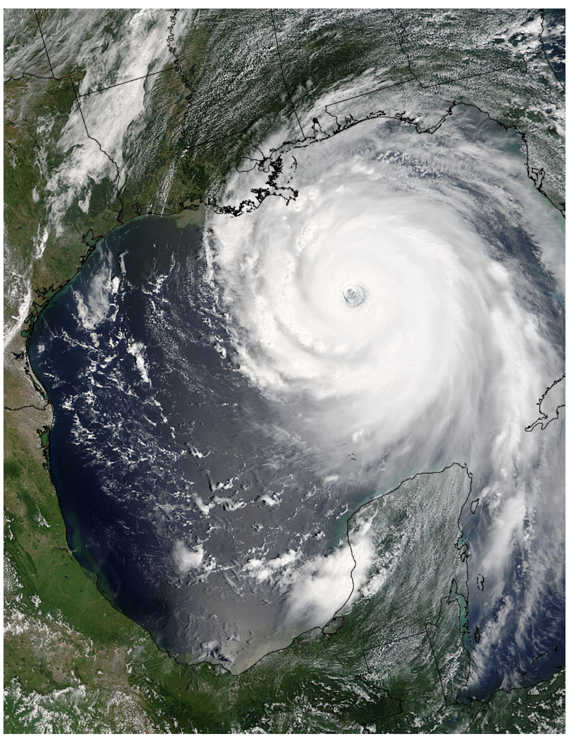

Figure 4: Satellite Image of Hurricane Katrina. Photo courtesy of MODIS Rapid Response Team at Goddard Space Flight Center.

On 29 August 2010, Hurricane Katrina made landfall in southern Plaquemines Parish, Louisiana as a category three storm on the Saffir-Simpson hurricane scale with winds estimated at 125 miles per hour [Figure 4].[71] The storm caused severe destruction from the gulf coast of Florida to the gulf coast of Texas.

[70] Hurricanes Katrina and Rita occurred so closely that I am considering them as a single disaster because of the lack of recovery between the two.
[71] "Hurricane Katrina-Most Destructive Hurricane Ever to Strike the U.S.," National Oceanic and Atmospheric Administration, accessed November 12, 2010, http://www.katrina.noaa.gov/.

The majority of this damage was caused not by hurricane force winds, but by storm surge. This storm proved the most destructive hurricane event in U.S. history according to economic losses.[72] The 1900 Galveston hurricane however, remains the most destructive hurricane in terms of loss of human life.[73] The insurance industries estimated at total of sixty billion dollars in insured damages in all the affected states as of late August 2006.[74] The true magnitude of this storm becomes clear in comparing this number with the approximately twenty one billion dollars in economic losses incurred during Hurricane Andrew in 1992, the second costliest U.S. land-falling hurricane.[75]

Less than a month after Hurricane Katrina, Hurricane Rita made landfall on 23 September 2005 between Sabine Pass, Texas and Johnsons Bayou, Louisiana as a category three storm on the Saffir-Simposon scale with winds at 120 mph [Figure 5].[76]Despite being well-prepared for the storm, the damage across the coasts of Texas and Louisiana was widespread; however, the loss of human life was minimal compared with that of Hurricane Katrina and the 1900 Galveston Hurricane due in large part to evacuation efforts.[77] Despite the seemingly large scale of the damage, the economic losses only reached ten to eleven million dollars, small when compared with the catastrophic losses of Katrina.[78]

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72 "Hurricane Katrina-Most Destructive Hurricane Ever to Strike the U.S."
73 *Ibid*.
74 *Ibid*.
75 National Climatic Data Center, "Hurricane Rita," National Oceanic and Atmospheric Administration, accessed November 12, 2010, http://www.ncdc.noaa.gov/special-reports/rita.html.
76 *Ibid*.
77 *Ibid*.
78 *Ibid*.

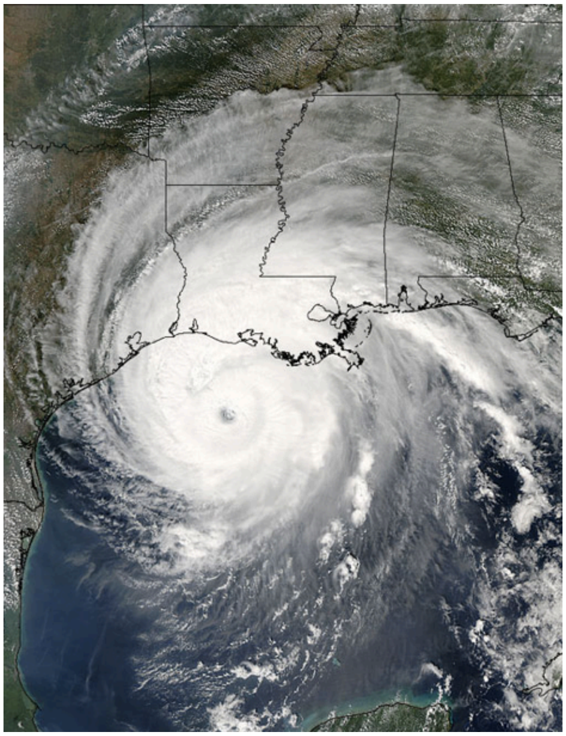

Figure 5: Satellite Image of Hurricane Rita. Photo courtesy of MODIS Rapid Response Team at Goddard Space Flight Center.

When a hurricane or other natural disaster like Rita and Katrina occur, a pre-arranged process of events must occur before FEMA and other federal aid may take action. First, local emergency personnel, local government public works personnel, volunteers, and humanitarian and other private interest groups provide emergency assistance to protect the public's health and safety and any other immediate needs.[79] If deemed necessary, the governor may declare a state of emergency and initiate the state's emergency plan to aid local public and individual resources. After consulting with local government officials of afflicted areas, the governor may then determine that the resources needed for recovery appear beyond the state and local government's abilities. Once this decision has been reached, the governor must then request federal aid under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act).[80] The governor must confirm the execution of the state's emergency plan and certify that the magnitude and severity of the disaster exceeds the limits of the state and local government's response infrastructure, disaster relief organizations, and available compensation by insurance agencies for disaster related losses.

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[79] "Declaration Process Fact Sheet: The Emergency Response Process," FEMA, accessed November 10, 2010, http://www.fema.gov/media/fact_sheets/declaration_process.shtm.
[80] *Ibid*.

During this declaration process, FEMA assists state and local governments with a preliminary damage assessment to ensure that the request for assistance is necessary.[81] FEMA personnel, the state's emergency management agency, county and local officials, and representatives of the U.S. Small Business Administration comprise the survey team. The team examines five different issues: types of damage; emergency costs incurred by the units of government; the impact to critical facilities, for example public utilities, hospitals, schools, or fire and police departments; the effect on individuals and businesses including, the number damaged, the number of people displaced, and the threat to health and safety; and finally, data from the Red Cross or other volunteer agencies may also be reviewed.[82] The information obtained through the survey can then be used to support the governor's declaration request.

As ordered by the Stafford Act, the governor must seek a presidential declaration of a major disaster by submitting a written request to the President of the U.S. through the FEMA regional office.[83] The FEMA regional and national offices review the request and preliminary damage assessment. FEMA then provides the President with an analysis of the situation and a recommended course of action. Federal law restricts the use of mathematical formulas or objective standards as the sole basis for determining the need for federal aid. In addition to such tools, FEMA studies a number of factors to determine the severity, magnitude, and impact of a disaster. Some of these issues include: amount and type of damage; impact on the infrastructure of affected areas or critical facilities; imminent threats to public health and safety; impacts to essential government services and functions; the capability of the Federal government; dispersion or concentration of

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[81] *Ibid.*
[82] "Declaration Process Fact Sheet: The Emergency Response Process."
[83] *Ibid.*

damage; level of insurance coverage in place for homeowners and public facilities; assistance available from other sources; state and local resource commitments from previous undeclared events; and frequency of disaster events over a recent time period.[84] Once the President has issued an official declaration of a major disaster then FEMA becomes free to utilize the many federal resources at its disposal to begin the recovery process.

In reviewing the actions taken several days before Hurricane Katrina by Louisiana State and New Orleans local governments, we can observe the U.S. disaster system as it occurs in practice. At 11:00 PM Friday 26 August, three days before landfall, Louisiana Governor Blanco declared a state of emergency in keeping with state protocol.[85] By 5:00 PM Saturday 27 August, New Orleans Mayor Nagin issued a state of emergency within the city and initiated a voluntary evacuation. By that Sunday, Mayor Nagin elevated the evacuation directive to mandatory, with shelters in the Superdome and nine other locations for those who could not leave. That same day President George W. Bush initiated a state of emergency for Mississippi, Alabama, and Louisiana, allowing FEMA to access some federal funds in the preparation of these states for the oncoming hurricane.[86] This pronouncement, however, is not the equivalent of an Emergency Disaster Declaration that only occurs following an event. On Monday 29 August, Katrina made landfall. Within five hours FEMA had dispatched one thousand employees, giving them two days to arrive.[87] Less then a month later, Hurricane Rita made landfall although with less destruction in New Orleans than Hurricane Katrina.

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[84] *Ibid*.
[85] "Hurricane Katrina Timeline," The Brookings Institution, accessed March 20, 2011, http://www.brookings.edu/fp/projects/homeland/katrinatimeline.pdf.
[86] *Ibid*.
[87] *Ibid*.

Figure 6: Remnants of an Historic Shotgun Style House in New Orleans. Photo ca. November 2007, courtesy of Ryan Thomas.

Hurricanes Katrina and Rita presented the largest disaster for cultural resources in the U.S. since the inception of the National Historic Preservation Act (NHPA) of 1966.[88] Both hurricanes caused widespread devastation to the city of New Orleans [Figure 6]. The safety of those present and the basic infrastructure necessary for the security of the city were of primary concern to initial responders; yet at the same time, preservationists had to assess the damage to historic resources, stabilize, and begin repairing them. Despite the many valiant efforts of preservationists toward this end, in many aspects they failed. On 23 September, the U.S. National Committee of the International Council on

[88] "GPS and GIS Technologies Speed Assessment of Historic Sites in Post-Katrina New Orleans."

Monuments and Sites (US/ICOMOS) released a statement expressing regret for the level of destruction of both hurricanes and concern that, "a cohesive program of survey, damage, recordation, and assessment and emergency stabilization [had] yet to emerge for our historic resources in the region, especially in New Orleans and its surrounding parishes."[89] Although FEMA eventually did develop a survey system in cooperation with the National Park Service, by examining the responses of preservationists at all levels, we may learn in what direction mitigation efforts should extend in the future.

As seen in the disaster response process, local representatives provide the initial response to an affected area. In New Orleans, these responders belonged to the city government and infrastructure. The New Orleans Historic District Landmarks Commission served as the city representatives for historic preservation. This Commission works in conjunction with the New Orleans Central Business District HDLC to oversee a total of fourteen historic districts and several landmarked structures within the city. Following Hurricane Katrina, the city needed to create a list of condemned structures to be demolished.[90] Prior to the storm the HDLC possessed a significant database of local surveys; most however, were paper-based with little data on individual buildings.[91] When trying to distinguish the historic from non-historic structures from the damage, surveyors had no descriptions of the significant buildings by which to distinguish them. Thus preservationists were unable to identify those sites that merited special attention, as well as those that needed mitigation by FEMA according to Section 106. In addition to this basic issue, the neighborhoods suffering the worst damage had the least documentation.

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[89] "Heritage Recovery in the Aftermath of Hurricane Katrina," US/ICOMOS, accessed April 1, 2011, http://www.usicomos.org/usicomos-news/heritage-recovery-aftermath-hurricane-katrina-0.
[90] "GPS and GIS Technologies Speed Assessment of Historic Sites in Post-Katrina New Orleans."
[91] *Ibid*.

FEMA historic preservationist Gail Lazaras described the HDLC's survey information as "fragmented, paper-based, and not in a format that was easily shareable."[92]

The Louisiana statewide Division of Historic Preservation (DHP) encountered similar problems with their data. The larger scope of the division's work, necessitated in several parishes, compounded these issues, making the effects even more damaging to the recovery of historic resources. The magnitude of the damage was so apparent directly following Hurricane Katrina that the state's involvement in New Orleans occurred almost immediately. As with the HDLC, the state's surveys were largely paper-based before Hurricane Katrina. About a month before the disaster, the Division of Historic Preservation had begun to enter this information into GIS; however, very little headway had been achieved prior to the storm.[93] The NPS gave the division 1.6 million to aid in the recovery for historic resources following both Katrina and Rita.[94] The DHP directed theses funds specifically to eight parishes surrounding Lake Pontchartrain. As with the HDLC in New Orleans, the DHP needed to create a red tag list of structures to be demolished. The city's list was to be added to this master guide that would then be given to FEMA.

In addition to struggling with the composition of this demolition list due to a lack of site-specific information, the DHP encountered two other major issues. During the first response, debris needed to be collected and sorted in an attempt to salvage as much historic material as possible. Much of the wood debris could not be removed very far however, due to the presence of Formosa termites and the corresponding restrictions in place to prevent the spread of infestation. Likewise, in the proscribed area, no location

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[92] "GPS and GIS Technologies Speed Assessment of Historic Sites in Post-Katrina New Orleans."
[93] Grace Cynkar, Personal Interview with Nicole Hobson-Morris, Executive Director of the Louisiana Division of Historic Resources, December 8, 2010.
[94] *Ibid*.

could be found that did not compromise the safety of archaeological sites. The second major problem the DHP met involved the organization and management of the preservation response effort. Volunteers arrived unfamiliar with local architecture, archaeology, and basic terminology. In some cases volunteers would identify one structure as historic and the one next to it as a modern-copy of an historic site when in actuality the reverse was true.[95] New historic districts were identified in many of the damaged areas, highlighting the lack of maintenance previously performed on the statewide surveys. Finally, the massive amount of damage necessitated a different system for Section 106 review.[96] Throughout these issues, the DHP struggled to get information to preservationists in the field and to FEMA. The division's lack of organized, detailed information regarding historic sites, and their inability to effectively communicate this data to volunteers and relief workers proved a major hindrance in the recovery effort for historic structures in New Orleans.

Following Katrina and Rita FEMA faced the largest Section 106 compliance project ever under the NHPA.[97] FEMA recognized the potential of this challenge to explore innovative methods of meeting Section 106 requirements in extreme circumstances. The agency enlisted the aid of the National Park Service Cultural Resource GIS Facility (CRGIS) to create a strategy for FEMA to meet its obligations under Section 106 to all cultural resources facing adverse effects through recovery activities in New Orleans, Louisiana.

A typical Section 106 compliance process involves two phases. First, a FEMA survey and evaluation of all potential undertakings that may interact with historic

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[95]Cynkar, Personal Interview with Nicole Hobson-Morris.
[96] *Ibid*.
[97] *Ibid*.

resources; and second, consultation with the State Historic Preservation Officers or Tribal Historic Preservation Officers to develop an agreement concerning the significance of the historic structures affected and possible actions to mitigate or compensate for the potential damage to these resources. To accomplish these actions, FEMA requires three sets of information: accurate location information for historic resources; an evaluation of the significance, integrity, and character of the structures; and an understanding of the area as a whole including contributing and non-contributing structures.[98] The locational information is crucial both in allowing FEMA to understand the full scope of its actions, and to prevent further accidental destruction of cultural resources through the ignorance of responders. The assessment of the resources significance and integrity, in other words eligibility for the National Register of Historic Places, helps FEMA to understand and propose compatible actions and mitigation efforts affecting the structure. Finally, the information regarding the resource's setting enables FEMA to consider the broader implications of their efforts for the immediate community, tailoring their actions to the unique relationships therein.

The efficient distribution of this data to FEMA is critical to the overall response and recovery phases of the natural disaster. Before FEMA can begin demolishing or removing any debris or damaged structures, historic resources or not, the entire Section 106 process must first be completed.[99] Normally under Section 106, FEMA has ninety days to complete the compliance procedure. When faced with the magnitude of the Katrina/Rita project compliance, FEMA desperately needed a way to hasten the process. The National Park Service identified quickly and accurately identifying all cultural resources that might suffer as a result of actions taken by FEMA, and expediting the

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[98] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 2.
[99] *Ibid*.

concurrence between the SHPO or the THPO and FEMA as the keys to meeting the Section 106 disaster compliance challenge.[100]

In addition to the central challenge of designing a new method for Section 106 compliance in extreme situations, the NPS also encountered three additional problems. First, the large number of agencies, state and federal, as well as private preservation groups all had varying sources of information from individual surveys of New Orleans. All of these groups wanted to give their data to FEMA, however, the information had varying degrees of accuracy and value.[101] An organizational and indexing system had to be arranged so that FEMA could quickly identify and utilize the necessary accurate information. Second, the existing paper-based surveys offered little information on individual historic sites, focusing instead on historic districts. In addition to this issue, the third problem presented to FEMA and the NPS was the movement of historic resources due to flooding and wind. For example, historic homes were lifted off their foundations and moved down the street so not only did the NPS and FEMA need to note where the structure originally stood but also its current location.[102] The NPS CRGIS resolved all of these issues through the use of GIS and GPS.

NPS solved the first issue, the abundance of unorganized information, by manipulating their draft cultural resource spatial data standards. The CRGIS developed this data model to describe how to create cultural resource spatial data, how to link spatial data to external databases, how to safeguard sensitive cultural resource information, and what to include in feature level metadata.[103] CRGIS utilized this data model for the Katrina/Rita response as a geodatabase, based on the draft cultural resource spatial data

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[100] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 2.
[101] Grace Cynkar, Telephone Interview with Deidre McCarthy, National Park Service. October 15, 2010.
[102] *Ibid*.
[103] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 4.

standards, within the framework of the Section 106 survey and evaluation process.[104] The data model uses geographic information to link external databases together allowing various agencies at all levels of government to share information.

Contents | Preview | Metadata | NPS Metadata Editor

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Record: 1 Show: All Selected Records (of 41299) Options

Figure 7: A-Spatial CR_Link table inside the FEMA Geodatase. Used to link various databases containing descriptive information concerning each historic site. Photo courtesy of Deidre McCarthy, NPS.

CRGIS assigned each cultural resource a unique ID which was then matched to other records in exterior databases, for example SHPO or THPO inventories, so that all preservation or government entities share the same geographic key yet maintain their own proprietary database information [Figure 7].[105]

CRGIS next implemented GIS and GPS to fulfill the survey and evaluation requirements of Section 106 while additionally registering the original and current

[104] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 4.
[105] *Ibid*.

locations of moved structures. Trimble GeoExplorer GPS units were used by survey teams to digitally collect a location for each resource and to include attributes that aid in defining the character, significance, and integrity of each structure [Figure 8].

Figure 8: Trimble GeoExplorer GPS Unit. Photo courtesy of Zach Welty

Volunteer architectural historians and preservationists working as surveyors recorded these attribute descriptions on the GPS unit itself using a pre-loaded data dictionary tailored to the unique architectural history of New Orleans.[106] At the end of the day, these GPS units were brought back to the GIS base of operation and the information was loaded into the GIS geodatabase. CRGIS had constructed the geodatabase around the features listed in the data dictionary.[107] GPS converts each feature into a separate layer to be included in the GIS geodatabase. All spatial data collected becomes a point, line, or

[106] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 8.
[107] See Appendix A for New Orleans data dictionary.

polygon feature class related to the resource identified in the field from the data dictionary. All descriptive information collected for the resource becomes the attribute table for that feature class.[108] Thus in a single day, surveyors may go into the field, survey a dozen or so resources, return and load them onto the GIS.

To include the concurrence process on the same GIS geodatabase, CRGIS created extra attribute fields to accommodate the determinations of eligibility made by FEMA and the SHPO and the determination of any adverse effects.[109]After the survey information had passed quality control and quality assurance and been added to the geodatabase, FEMA and SHPO preservationists could open the GIS data either in the same office or remotely, assess the survey information and any other connected data, and then record their opinions directly in the GIS about whether a resource meets National Register Criteria.[110] In this manner, a process that originally could take up to ninety days to complete was expedited into the work of less than a day, as SHPO and FEMA staff could determine the eligibility and adverse effects of many more than one resource daily. CRGIS produced a document that organized and expedited one of the major steps of disaster recovery.

Using this system, FEMA was able to organize data and share it with the city and state governments. As the various levels of government struggled to make order of the chaos resulting from Katrina and then Rita, preservationists in the private sector also fought to alleviate the damage to historic sites. The Preservation Resource Center of New Orleans (PRC) serves as the primary preservation advocacy organization for the city. Their mission entails the promotion of preservation, restoration, and revitalization of

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[108]McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model, 9.
[109] McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model,10.
[110] *Ibid*.

New Orleans and its neighborhoods.[111] As a private organization, the PRC does not need to follow the same bureaucratic protocol required of the public sector preservationists. As such they are free to directly offer aid to individuals and owners of historic sites. This fundamentally different approach clearly reveals itself in the comparison of the PRC's response with that of local, state and federal governments.

The PRC staff, along with all the citizens of New Orleans, evacuated the city shortly before Hurricane Katrina. Despite the level of destruction, Patricia Gay, the executive director, was able to return to the city eight days after the storm.[112] Ms. Gay described her first impression of the situation in New Orleans as 'chaos.'[113] No one in or out of the city seemed to know what was happening. Many of those who had evacuated believed the city to have been leveled by the storm.[114]Ms. Gay's first action after performing a superficial windshield survey of the city was to reassure those historic homeowners that she was able to reach. Following this initial survey, she completed a more detailed review of the older neighborhoods with the aid of PRC staff as they began to return to the city. She then presented this information during a National Trust meeting in Baton Rouge to discuss the flooding and damage following Katrina.[115] Ms. Gay continued to work with the National Trust, attempting to recruit preservation architects to New Orleans to help assess the damage to historic structures. After Hurricane Rita made landfall, she, with the support of the PRC, struggled to rally people. The combined damage of both storms had severely lowered the city's morale causing the recovery effort

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[111] "About PRC," Preservation Resource Center of New Orleans, accessed April 3, 2011, http://www.prcno.org/.
[112] Grace Cynkar, Personal Interview with Patricia Gay, Executive Director, Preservation Resource Center of New Orleans, December 10, 2010.
[113] *Ibid*.
[114] Cynkar, Personal Interview with Patricia Gay.
[115] *Ibid*.

to lose momentum.[116] In an effort to revitalize this process, the PRC offered workshops concerning recovery flood recovery to the citizens of New Orleans. The most popular of these workshops covered the process of mold removal from an historic home.[117] For the majority of their efforts to aid the city, the PRC received little support from the local, state, or federal government.[118]In December of 2011 however, the PRC was able to participate in the Programmatic Agreement negotiations between FEMA and the state's Division of Historic Resources.[119]

Due to the various governments' lack of interest in private sector aid during the initial recovery phase, the PRC turned to other national non-profit organizations, serving as *in situ* coordinator for all the their efforts.[120] The national organizations involved included, Beacon with Hope, the Order of Malta, Greater New Orleans Foundation, The Rockefeller Foundation, the National Trust, and others.[121] Together these groups collected resources for the afflicted citizens, gathering food, flood buckets, and tools among many other benefits.[122]

The preservationists confronting the damage of both Hurricanes Katrina and Rita faced seemingly insurmountable odds. They needed to identify all the historic structures affected by the storm, many of which had been moved by the flooding or damaged almost beyond recognition. Once distinguished from the flotsam and jetsam, preservationists needed to conduct conditions reports for the buildings and stabilize them. In addition to dealing with the damage from the actual storms, these responders needed to protect the

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116 *Ibid*.
117 Cynkar, Personal Interview with Patricia Gay.
118 *Ibid*.
119 *Ibid*.
120 *Ibid*.
121 *Ibid*.
122 *Ibid*.

structures from untrained volunteers. In many instances, over-zealous volunteers, believing they were aiding the owners, would remove historic wood floors or other features that appeared to be beyond repair. Unfortunately, many of the items removed from the building could have been repaired without much expense if the volunteers had had more direction. The homeowners then returned home to find their floors gone along with the historic integrity of their home.[123] The struggles and successes of preservationists at all levels of government, in the private and public sector, offer insight into the needs of hazard mitigation.

[123] Cynkar, Personal Interview with Nicole Hobson-Morris.

IV. Hazard Mitigation

We have seen the effects of hazard mitigation and the necessary response after Hurricanes Katrina and Rita. Before we can investigate the ways GIS might strengthen this system however, we must first review hazard mitigation's structure and supporting theory with in the U.S. disaster management cycle. Used internationally, the disaster management cycle aims to minimize or avoid potential losses from hazards, ensure a prompt and efficient response to the disaster, and to provide an effective recovery in the least amount of time.[124] The process has been divided into four phases, two occurring before the event and two after [Figure 9].[125] Despite this seemingly straight-forward timeline, this cycle, as the name suggests, should be thought of as a circular pattern revolving around the occurrence of various disasters. Each phase leads into the next with the cycle regenerating after an event. The first step of this pattern, hazard mitigation, begins long before an event occurs. This phase involves a cost-effective action taken to reduce loss of life and property to disasters; for example, adding storm windows to a building, elevating the building, or seismic retrofitting. The next step, disaster preparedness, encompasses any preparative action taken directly before

[124] "The Disaster Management Cycle," The Global Development Research Center, accessed February 8, 2011, http://www.gdrc.org/uem/disasters/1-dm_cycle.html.
[125] Hazard Mitigation, Preparation, Response, and Recovery.

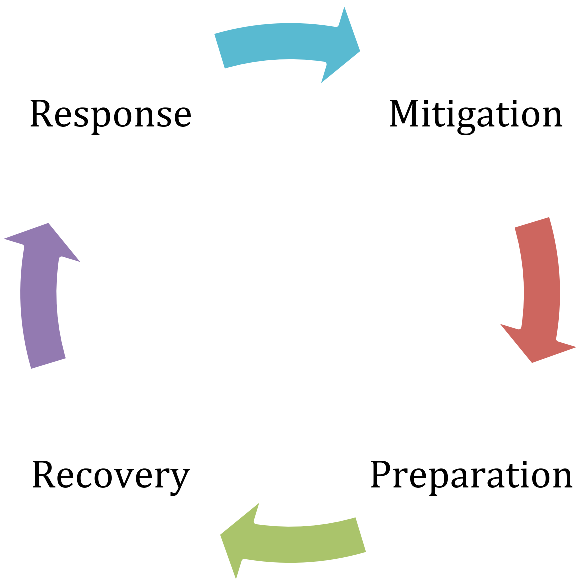

Figure 9: Four Phases of Disaster Management. Graphic by author.

a pre-warned event. Actions taken during this phase may include evacuation, the activation pre-arranged of emergency response teams, or the stock piling of necessary supplies. The third phase, disaster response, occurs directly after the event during the first wave of responders to the damaged area. The purpose of this step is to stabilize the affected area and population. The final phase of the cycle, disaster recovery, attempts to restore the affected location to its previous state. Unlike the response phase, this step occurs over a much longer time frame and begins with a survey of the damaged region and population. It is in this stage that the cycle returns to the beginning for as the community rebuilds special attention should be given to the weak points in the area's defenses with effort made to reduce these risks through hazard mitigation. Countries, organizations, and emergency management teams throughout the world utilize this same pattern in order to globally maximize communication and aid. The United States adheres to this cycle as well, allowing emergency management teams at the federal, state, and local levels to cooperate as efficiently as possible during all phases of a disaster.

The Federal Government has two laws defining its role within the disaster management process: the Stafford Act and the Disaster Mitigation Act of 2000. On 23 November 1988, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was signed into law, amending the Disaster Relief Act of 1974, and has since been amended in June 2007.[126] The Stafford Act provides the statutory authority for most Federal disaster response activities, especially those pertaining to FEMA and related programs such as, the Hazard Mitigation Grant Program and Severe Repetitive Loss grant program.[127]The purpose of this act, as described by Congress, is to provide "an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from disasters."[128] Following this statement, the act lists six means by which the Federal Government may achieve this goal, with each of these methods corresponding to a different phase of the disaster management cycle.[129] Several of these pertain to efforts in hazard mitigation: one, "encouraging the development of comprehensive disaster preparedness and assistance plans, programs, capabilities, and organizations by the States and by local governments;" two, "achieving greater coordination and responsiveness of disaster preparedness and relief programs;" and three,

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[126]42 U.S.C. § 5121 *et. seq*.

[127] "Hazard Mitigation Grant Program," FEMA, accessed February 14, 2011, http://www.fema.gov/government/grant/hmgp/index.shtm.

[128] 42 U.S.C. § 5121(b)

[129] 42 U.S.C. § 5121(b) (1-6)

"encouraging hazard mitigation measures to reduce losses from disasters, including development of land use and construction regulations."[130]

The Disaster Mitigation Act of 2000 serves as an amendment to the Stafford Act in order to establish a national disaster hazard mitigation program.[131] In this act Congress recognized the growing expenditure of disaster relief funds and the continued occurrence of disasters. They attempt to mitigate this spending through promoting the creation of hazard mitigation plans in state and local governments by leveraging federal funds following a disaster.[132]

The Federal Emergency Management Agency (FEMA), part of the U.S. Department of Homeland Security, is the federal entity tasked with carrying out the goals of both the Stafford Act and the Disaster Mitigation Act of 2000. Following this legislative authority, FEMA assists state and local governments in all aspects of the disaster management cycle: mitigation, preparation, response, and recovery.[133]FEMA offers state and local governments, as well as individuals, information regarding hazard preparation and mitigation. Their mitigation planning page offers useful resources for state or local governments attempting to create a mitigation plan.[134] After an event occurs, FEMA cannot aid state or local governments until the governor has initiated his or her request for Federal aid.

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130 42 U.S.C. § 5121(b)(2),(3),(5);42 U.S.C. § 5121 (b)(2); 42 U.S.C.§ 5121 (b)(3); 42 U.S.C.§ 5121 (b)(5)
131 42 U.S.C. § 5121(b)
132 42 U.S.C. § 5121(a)(4-5)
133 "About FEMA," FEMA, accessed February 8, 2011, http://www.fema.gov/about/index.shtm.
134 "Hazard Mitigation Planning Resources," FEMA, accessed February 8, 2011, http://www.fema.gov/plan/mitplanning/resources.shtm.

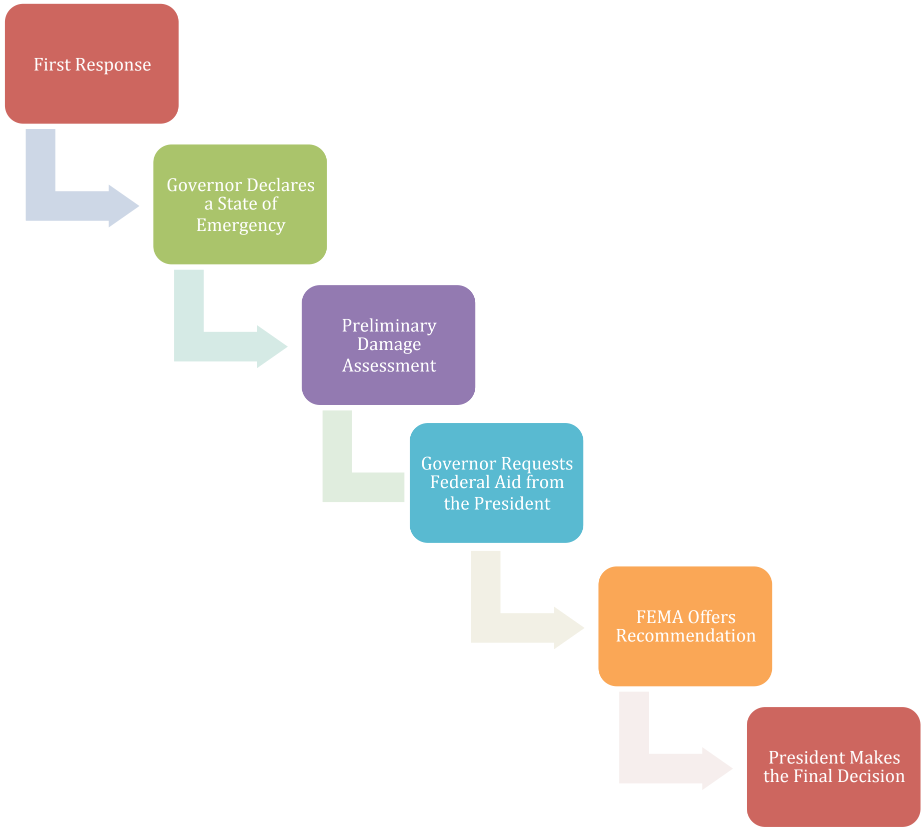

Figure 10: Process for Gaining Federal Assistance Following a Disaster. Graphic by author.

The process begins with a damage assessment by local, state, federal, and volunteer agencies in order to determine the extent of the damage and recovery needs.[135] If the damage assessment reveals the level of destruction to be more than the state or local governments can handle, the governor requests a major disaster declaration of the president. FEMA reviews the request, recommending action to the White House based upon the local community, the disaster, and the state's ability to recover. If the president approves the request then FEMA disaster workers travel to the location to set up a central

135 "The Disaster Process and Disaster Aid Programs," FEMA, accessed February 14, 2011, http://www.fema.gov/hazard/dproc.shtm.

field office from which to lead the recovery effort.[136] Upon approval, FEMA's actions officially become a 'federal undertaking' according to Section 106 of the National Historic Preservation Act; any action must take into account "the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register."[137] FEMA offers both individual and public assistance to an affected area; however, the agency cannot begin this work until Section 106 proceedings have been completed. Throughout this recovery time, FEMA encourages victims and public entities to learn from the disaster and to implement new measures of hazard mitigation in order to lessen risk from future disasters.[138]

The Stafford Act and the Disaster Mitigation Act of 2000 require state and local governments to develop an hazard mitigation plan in order to receive types of non-emergency disaster assistance, for example funding for mitigation projects.[139] Part 201 of Title 44 of the Code of Federal Regulations explains the requirements for each state and local government's hazard mitigation plan.[140] Under these regulations, state governments are required to at minimum, submit a Standard State Mitigation Plan to FEMA. If the state wishes to be considered for twenty percent funding under the HMGP it must submit an Enhanced State Mitigation Plan. Each of these plans must be reviewed and updated every three years in order to maintain accordance with these regulations.[141] Likewise, local governments are required to prepare a jurisdiction-wide hazard mitigation and update it every five years in order to receive HMGP funding.[142]

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136 *Ibid*.
137 16 U.S.C. § 470(f)
138 "The Disaster Process and Disaster Aid Programs."
139 "Mitigation Planning, Laws, Regulations, and Guidance," FEMA, accessed February 14, 20111, http://www.fema.gov/plan/mitplanning/guidance.shtm.
140 44 C.F.R § 201.3
141 44 C.F,R§ 201.3 (c) (2),(3).
142 44 CFR § 201.3 (d) (1),(2)

Under the Federal Code of Regulations, a Standard State Mitigation Plan must include a set list of sections to be considered complete.[143] The first element must describe the planning process including: how the plan was prepared; who was involved; and what other agencies were involved.[144] A risk assessment composes the next section, enumerating and analyzing the natural hazards and threats to offer a statewide overview.[145] A mitigation strategy following the risk assessment records the state's strategy for minimizing the threat from the hazards listed in the previous section.[146] The next element must describe how the state will coordinate local mitigation plans; for example, criteria for the prioritization of communities that would receive planning and project grants.[147] Description of the plan's maintenance and adoption processes follow the coordination section. Assurances that the state will comply with all applicable Federal statues and regulations once it receives grant funding with a plan for reviewing and updating the plan, conclude the required elements for a Standard State Mitigation Plan.[148]

A state with an approved Enhanced State Mitigation Plan at the time of a disaster is eligible to receive additional funding from the HMGP.[149] This enhanced plan must include all the elements of a standard plan with the addition of several sections. These divisions must take into account: cost-effectiveness; coordination with other planning initiatives within the same state; a system for meeting HMGP requirements; a commitment to support local mitigation efforts; and other details designed to increase the plan's efficacy.[150]

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143 44 CFR § 201.4
144 44 CFR § 201.4 (c) (1)
145 44 CFR § 201.4 (c) (2)
146 44 CFR § 201.4 (c)(3)
147 44 CFR § 201.4 (4)
148 44 CFR § 201.4 (6,7)
149 44 CFR § 201.5 (a)
150 44 CFR § 201.5 (b)

Local mitigation plans cover the smallest jurisdiction with the closest detail. Their role is to guide both the community in minimizing risk and decision makers in allotting resources for mitigation.[151] These plans adhere to a structure, similar to the state mitigation plans, including the critical components of risk assessments and mitigation strategy.[152] The mitigation strategy must be designed utilizing existing policies, resources, and programs but with a section discussing how these items may be improved upon.[153] It must identify and analyze specific mitigation actions intended to reduce the risk identified in the previous section.

Private and non-profit organizations also play a major role in the disaster cycle. Although they may be unable to enforce hazard mitigation efforts, these organizations often offer the education and support necessary for a community to successfully overcome the devastation caused by natural disasters. The U.S. Government Accountability Office acknowledged the role of the private sector in its review of the Hurricanes Katrina and Rita Response stating, "the private sector is an important partner with the government in responding to and recovering from natural disasters."[154] The National Trust serves as the leading nationwide private preservation organization. In addition to providing funds for the recovery of afflicted areas as seen in Louisiana, the organization offers in depth information regarding historic resources and disasters for a multitude of audiences including: homeowners, local governments, and businesses.[155] Most states also have at least one statewide private preservation organization. Several

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[151] 44 CFR § 201.6

[152] 44 CFR § 201.6 (c)

[153] 44 CFR § 201.6 (3)

[154] David E. Cooper, "Hurricanes Katrina and Rita: Contracting for Response and Recovery Efforts" (Testimony Before the House Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, Washington D.C., November 2, 2005).

[155] "Natural Disasters: Preparedness, Planning, and Response."

examples of these include: Preservation Texas, the Louisiana Trust for Historic Preservation, and Preservation Iowa.[156] These and the many other statewide preservation organizations offer similar support to that of the National Trust but more specialized the particular state's needs. Likewise, local preservation organizations like the Preservation Resource Center of New Orleans offer even more specialized aid and outreach to their communities, conducting workshops based upon the particular risk of the area and interacting directly with historic homeowners. In addition to education and outreach, these preservation organizations may be involved in the negotiations for programmatic agreements or memorandum of agreements between the federal and state governments. They bring a unique representation of the needs of local historic resources and their owners to the conversation. Following the 2008 Cedar Rapids floods, Preservation Iowa participated in the Section 106 surveys as well as the mitigation memorandum of agreements with FEMA.[157] In New Orleans, the PRC was able to join the discussions regarding the programmatic agreement between the state and FEMA however; they were not permitted to join in the Section 106 review.[158]

In theory, the U.S. system of disaster management should work well. The established system is organized roles. It fails however, to consider the emotional trauma caused by witnessing the destruction of one's home and general human fallibility. In the chaos following an event, cultural resources are often, understandably, people's last concern. As a result of this practice historic sites continue to suffer despite the regulated

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[156] "Preservation Texas," Preservation Texas, accessed April 3, 2011, http://www.preservationtexas.org/; "Louisiana Trust for Historic Preservation," Louisiana Trust for Historic Preservation, accessed April 3, 2011, http://www.lthp.org/index.html; "Preservation Iowa," Preservation Iowa, accessed April 3, 2011, http://www.preservationiowa.org/.
[157] Rod Scott, "Disaster Session" (presentation given at the National Trust for Historic Preservation 2010 Conference, October 30, 2010).
[158] Cynkar, Personal Interview with Patricia Gay.

response. No restrictions enforce the addition of historic resources to government hazard mitigation plans. Likewise, no regulations exist in place to ensure the cooperation with private preservation organizations. Thus these non-profit groups are often ignored during the initial recovery phase, neglecting their valuable expertise. Even with preservationists doing their utmost to work within the protocol of the government we continue to see losses that could have been salvaged. Although it is imperative to understand hazard mitigation within the U.S. and the role of historic resources in this cycle, we must consider how historic resources fare in practice if we are to truly advance their protection.

Hazard mitigation refers to actions intended to reduce or eliminate risks caused by natural disasters or hazards.[159] The majority of current mitigation plans are concerned primarily with minimizing the risk posed during a disaster; for example, high water during a flood, or high winds during a hurricane. These initiatives, however, forget that damage can continue to occur during the aftermath of an event, especially to historic resources. A disaster of any type can be a traumatic experience. Watching one's home and possessions destroyed can cause deep emotional distress. These feelings can often be compounded for civic leaders who in addition to loss, feel the burden of making an efficient and effective response. Disaster plans, established long before an event work to minimize the post-disaster confusion, while bringing efficient aid to the affected area. Unfortunately as we have clearly seen following Hurricanes Katrina and Rita, these plans rarely succeed in full.

Directly after an event seeming chaos ensues as individuals attempt to establish the extent of the damage and begin the recovery process. During this frenzied response

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[159] "What is Hazard Mitigation?" Public Safety, accessed February 19, 2011, http://www.mass.gov/?pageID=eopsterminal&L=4&L0=Home&L1=Homeland+Security+%26+Emergency+Response&L2=Hazard+Mitigation&L3=Planning&sid=Eeops&b=terminalcontent&f=mema_disaster_recovery_what_is_hazard_mitigation&csid=Eeops.

period historic resources can be further damaged or destroyed by uninformed or unrestrained public, private, or volunteer response personnel. Mitigation for historic resources needs to extend beyond reducing the risk posed by the actual event to include the threat from overzealous or traumatized responders.

Section 106 of the National Historic Preservation Act, as it applies to FEMA and other federal response agencies, should prevent some of this additional damage.[160] Due to the required process for obtaining federal aid, FEMA often does not arrive in the affected area with any authority until some time after the event.[161] Before this time the responsibility for protecting historic resources relies on local and state government officials. They must rely upon the existing records of historic structures to identify which structures to protect. These files however, are often outdated or inaccessible. In Cedar Rapids, Iowa, following the 2008 flooding, responders were unable to access the records because they were only available in hard copy, located on the second floor of a building on an island. The floodwaters prevented responders from reaching the records but even once they had been obtained, they needed to be sorted through and new surveys performed.[162] Likewise, following Hurricane Katrina and Rita, the Louisiana SHPO's records of historic structures were only partially digitized.[163] As a result of these delays, historic structures suffered additional damage from unknowing responders.[164] In addition, FEMA was forced to resurvey the entire town of New Orleans as well as Cedar Rapids before the agency could aid in any way in the recovery process. [165]

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[160]16 U.S.C. § 470(f).

[161] See FEMA page for details

[162]Scott, "Disaster Session."

[163]Cynkar, Personal Interview, Nicole Hobson-Morris.

[164] Cynkar, Personal Interview, Patricia Gay.

[165] Grace Cynkar, Telephone Interview with Gail Lazarus, FEMA Historic Preservation Specialist, December 7, 2010; Scott, "Disaster Session."

By further analyzing the response after Hurricanes Katrina and Rita, we can clearly observe the reality of these issues. Two common themes emerge from the scrutiny of both public and private sector preservation responses: a lack of organized information and a lack of access to this information. Neither the state nor the city government preservation offices possessed accurate, up-to-date surveys of their areas. As a result, both the response and recovery times were irreparably stalled. In addition, the various governments were unprepared to disseminate what information did exist to either relief workers or volunteers. Despite these fundamental failures, preservationists did achieve some measures of success; yet even these could be greatly improved upon.

The lack of sufficiently organized information at the local and state levels provided the initial obstacle for preservation responders. Surveys at the state and local level were incomplete and inaccessible to large numbers of people. The paper-based format required manually searching through massive files for even the most basic of information. Despite the large number of survey forms, little data existed regarding individual historic sites.[166] In addition, many of the areas suffering the most damage had yet to be surveyed.[167] Thus once an individual located a particular file, if it existed, it may or may not contain useful information in identifying damaged significant structures.

The lack of sufficient information, located in single copies of paper files, lead to a much larger problem: the inability to quickly disseminate information. A massive number of relief personnel flooded New Orleans following the storm, all of whom needed some direction or information. Preservationists from other regions needed information regarding the architectural styles and terminology of New Orleans. FEMA personnel needed to know which structures were historic in order to fulfill their Section 106

[166] "GPS and GIS Technologies Speed Assessment of Historic Sites in Post-Katrina New Orleans."
[167] *Ibid*.

requirements. There was no way to quickly make and distribute copies of the survey information to all the responders. Likewise, there were no pre-designed publications to educate the workers on the basic characteristics of New Orleans historic architecture. As a result of this lack of information, historic buildings suffered even more damage from responders who were unaware of which structures were historic.

A similar issue concerning the sharing of information exhibited itself once more between different levels of preservationists within the city as citizens. Despite the appeals of the PRC, government preservationists refused to include them in the Section 106 survey process or share the findings.[168] A greater knowledge of the conditions of historic sites could have greatly assisted the PRC in reassuring homeowners as well as setting up educational resources such as the workshops. The PRC eventually became involved with the programmatic agreement decided upon this past December; however, they were not invited to attend until the middle of the proceedings.[169]

The findings of the Section 106 surveys were stored in GIS geodatabases according to the response methodology created by FEMA and the NPS. In keeping with the Freedom of Information Act, FEMA released the database to the HDLC and the state.[170] Technically, if any private citizen wished to access the information, he or she could request a copy from any of these agencies. The server space and software necessary to even open the geodatabases however, make accessing the survey data almost impossible for the average citizen. Even the HDLC and the DHP cannot fully access the data yet due to a lack of technical resources. The state at least is in the midst of obtaining enough server space to utilize the data, although an estimated completion date remains

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[168] Cynkar, Personal Interview with Patricia Gay.
[169] *Ibid*.
[170] 5 U.S.C. § 552; Cynkar, Personal Interview with Gail Lazaras.

unknown.[171] The public's lack of access to this information has been detrimental to the recovery effort. After the initial panic following Hurricane Katrina, people wanted to know the condition of their historic homes and business yet they could not access the survey reports. Those that did not return directly after the storm relied upon Ms. Gay's reports. FEMA believed that the knowledge that their home had been designated for demolition would prove too traumatic for the citizens of New Orleans.[172] Ms. Gay however, felt that this lack of confidence severely inhibited the public's energy, removing all adrenaline from recovery efforts.[173] In addition to the emotional products from this lack of communication, the inability or unwillingness of any government officials to present the findings of the Section 106 surveys to the public has hindered construction on many homes. For example, contractors attempting to provide mitigation for flooded homes by lifting them above the flood plain cannot progress with work without knowledge of the determination of eligibility during the Section 106 process. This information however, cannot be found because the authorities with it, such as the HDLC, cannot access the databases to find the appropriate data.[174]

In many aspects, preservationists failed in their response to Hurricanes Katrina and Rita. The issues that arose cannot be blamed on any one organization or person. Natural disasters occur with little or no warning and preservationists in New Orleans and Louisiana as a whole were caught unprepared. Despite the problems that occurred, several response methods utilized by preservationists did prove effective. The PRC's coordination with other private organizations to provide as much relief to the affected

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[171] Cynkar, Personal Interview with Nicole Hobson-Morris.
[172] Cynkar, Personal Interview with Gail Lazaras.
[173] Cynkar, Personal Interview with Patricia Gay.
[174] Grace Cynkar, Personal Interview with Rod Scott, Historical Preservationist, Patterson Shoring, and Preservation Iowa, Former Board President, December 6, 2010.

area proved to be both a valuable resource to and a source of inspiration to the failing morale of the community. The expedited Section 106 review created by the NPS and FEMA explored new avenues of communication during a crisis. Both of these strategies sought to expand communication following a disaster. In the PRC's efforts we see the benefit of cooperating with other organizations both in preservation and other fields. In FEMA and the NPS' work we observe how technology might be utilized to both speed communication but also serve as a means of information storage. We must remember these successes as we search for new means of mitigating destruction caused by disasters.

From hazard mitigation in both theory and practice, we can identify certain changes that must be made. Three distinct issues arise from this analysis. First, we must broaden our view of mitigation, acknowledging that destruction can continue to occur after the actual event if preservationists are unprepared to deal with the response process. Second, we need to better organize the information concerning historic resources so that it can easily be retrieved and disseminated. Finally, preservationists need better cooperation in the face of destruction caused by a disaster, most basically through the sharing of data.

In attempting to advance hazard mitigation we must broaden our conception of the process. Past mitigation plans and strategies have confined mitigation actions to those efforts occurring only before an event. We must remember instead, that mitigation and the disaster process form a cycle with sometimes little delineation between different phases. Recovery and mitigation can occur almost simultaneously. For as we rebuild, we can further strengthen both our structures and our strategies. FEMA defines hazard mitigation as, "sustained action taken to reduce or eliminate long-tem risk to people and their property from hazards."[175] During the initiation of the Decade for Natural Disaster Reduction, the UN defined hazard mitigation as, "all those actions taken before, during, or after an event that minimize its effects."[176] In these definitions we find neither time restrictions nor constraints upon the source of the losses. Currently in mitigation plans for historic resources such as those of Florida, Galveston and Minnesota, we see only construction efforts designed to lessen the damage caused by the actual storm. As we have seen in New Orleans and Iowa however, additional destruction may occur resulting from the chaos following the storm. In both areas, preservationists were unprepared to manage the recovery efforts resulting in additional damage caused by uninformed relief workers. We need to consider that even after the hurricane has passed or the tremors have ceased, historic structures remain in peril. A lack of organization and coordination can cause buildings that may have been salvaged or retained their integrity to be lost. Thus, we need to consider mitigation practices targeted at the response directly following the disaster as well as the damage caused by the actual event.

Increasing the organization of information concerning historic resources will greatly aid in minimizing damage to these sites by responders. Surveys must be maintained with much more extensive information concerning individual resources. These files must contain enough data for responders unfamiliar with the architectural styles of the area to identify historic structures or their remains. These forms must also offer enough information for a National Register eligibility determination to be made. By including this level of data, FEMA only need identify which of these historic sites might

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175 "Multi-Hazard Mitigation Planning," FEMA, accessed April 5, 2011, http://www.fema.gov/plan/mitplanning/.

176 Board on Natural Disasters, "Mitigation Emerges as a Major Strategy for Reducing Losses Caused by Natural Disasters."

be affected by their actions rather than performing a full-fledged survey as in New Orleans.

In addition to maintaining highly informative surveys, preservationists must also ensure that this information be kept safe during the actual event and accessible immediately after. The Galveston Historical Foundation suffered huge losses during Hurricane Ike when the room containing all the property files for the island was flooded with several feet of water.[177] The ability for multiple individuals and organizations to have access to this information would also greatly aid in the dissemination of information to responders. Rather than creating endless copies or scans, preservationists can simply access the data directly from their individual organizations.

This sharing of information must also be expanded from cooperation between certain groups, such as between FEMA and local governments in New Orleans, to a much broader spectrum of preservationists. The level of destruction following an event can become too massive for one organization or even several organizations to overcome. As we saw in New Orleans, the State and local governments were entirely unprepared to mange the response and recovery activities. Out of necessity, they focused their efforts on managing the bureaucracy of working with FEMA, focusing primarily on the buildings themselves. The citizens in New Orleans received very little attention from government officials. The PRC instead served as an information and support resource for those individuals attempting to repair their historic homes. Without the organizations, outreach to the public many more sites could have been lost to frustration or ignorance of preservation practices, as people struggled to return their lives to normal. The actions of both public and private sector preservationists provide crucial services to historic

[177] Grace Cynkar, Personal Interview with Matt Farragher, Galveston Historical Foundation Preservation Services Project Coordinator, June 18, 2010.

resources following a disaster. The lack of cooperation between these two divisions however, inhibits the progress to recovery. A fuller communication of information between these two parties will allow for a much stronger reaction to disasters.

The damage caused to historic resources during the initial, often frenzied response can be mitigated through planning. Organization of these significant resources and communication are the most important tactics by which these structures will be protected. We must have as much knowledge of the existing historic structures as possible, located in a digital arena that can easily be accessed in the field. Likewise, we must ensure better communication between the various levels of government and the private sector. Many state officials consider historic resources unimportant; those with respect for historic structures must work together. In the aftermath of Katrina and Rita, valuable preservation resources were left unutilized. If we are to prevent further destruction to valuable historic resources, it is imperative preservationists cooperate fully, sharing all the knowledge they possess. GIS offers preservationists the perfect opportunity to achieve all these goals. Used in many other fields as well as preservation, GIS offers a system of data storage according to spatial information. The NPS and FEMA recognized the potential for this program in expediting the Section 106 process following hurricane Katrina.[178] By using as examples, the ways in which other fields have utilized GIS as well as the manipulating the capabilities of the program itself, we can implement a system prior to an event that will allow government officials to coordinate response efforts which respecting historic resources.

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[178]McCarthy, Historic Preservation Response Methodology: Based on the Hurricane Katrina Model.

V. Geographical Information Systems (GIS) for Hazard Mitigation of Historic Structures

ESRI's ArcGIS offers preservationists the ability to revolutionize hazard mitigation for historic resources. This software allows users to organize and disseminate data concerning historic resources in a single tool. The program stores information based upon geographic location defined by one or more sets of x,y coordinates. These points coincide with geographic latitude and longitude. They can either be assigned to a feature based upon existing information or identified using a GPS device. These combinations of coordinates define objects, referred to as features, which possess a distinct geographical location. For example, they may represent a city, a country, a house, a river, a census block, or anything that exists in a location. GIS can even be used to track the movement of herds of animals, noting their positions at defined times. Thus, because historic structures exist in a distinct place, they may be shown in GIS.

ArcGIS assigns each feature a unique numerical identifier used to connect it with an attribute table. This table serves as storage for data about the object. In the case of historic resources, the table may list the year built, any modification, character-defining features, the name of the owner, pictures, condition reports, and any other information the creator of the GIS might wish. ArcGIS attribute tables can hold vast amounts of physical and organizational data about a single resource.

The features recorded in GIS and their corresponding attribute tables can be shared via ESRI server GIS software; efficiently dispensing current information about historic resources to any concerned. Some preservation organizations have already implemented GIS programs. Few however, have fully investigated the software's potential. Other resource management fields, for example environmental and archaeological, have long been using GIS for organizational purposes. Likewise, some emergency management divisions at various governmental levels have been exploring the use of ArcGIS servers as agents of information dispersal during a crisis. By both understanding the capabilities of ArcGIS and examining its current uses, we begin to understand how this remarkable tool may greatly aid in the mitigation for historic resources facing disasters.

Many providers of GIS exist on the market including Autodesk, Bently Systems, Smallworld, and others. ESRI however, has become the most pervasive of these providers, holding thirty percent of the GIS market shares worldwide.[179] The company has developed a community of GIS users through conferences, user groups, and other events.[180]ESRI's products serve as the standard software for many government agencies, organizations, and contractors around the world, making integration with other databases and communication much simpler.[181] In addition, the extensive support structure compounds the benefits of ESRI's extensive worldwide presence. For new users of GIS, the company offers online and classroom based training as well as technical support.[182] The company also offers searchable help pages for all of their most recent versions of GIS software with clear, concise explanations. One can also search online for ArcGIS aid, outside of ESRI's domain, accessing the advice of the company's multitude of users. The company also invests much of its revenue into advancing the capabilities of its products through research.[183] These efforts ensure that ESRI users will remain at the

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179 "Autodesk GIS Design Server," Autodesk, accessed April 5, 2011, http://usa.autodesk.com/adsk/servlet/pc/index?siteID=123112&id=971522/; "Bentley Map V8i," Bentley, accessed April 5, 2011, http://www.bentley.com/en-US/Products/Bentley+Map/Architecture-Datastores.htm; "Geospatial Enabled Solutions," GE Energy, accessed April 5, 2011, http://www.gepower.com/prod_serv/products/gis_software/en/index.htm; "COTS GIS: The Value of a Commercial Geographic Information System," *An ESRI White Paper* (August 2002) 4-5.

180 "Events," ESRI, accessed April 5, 2011, http://www.ESRI.com/events/index.html.

181 "COTS GIS," 6.

182 "Training," ESRI, accessed April 5, 2011, http://training.ESRI.com/gateway/index.cfm.

183 "COTS GIS," 6.

forefront of GIS capabilities. The company's already large community and the excellent support resources far exceed the benefits of any other GIS provider, making ESRI's ArcGIS the logical choice for preservationists. ESRI offers three different levels of their GIS software, ArcGIS, all of which perform the same basic operations. With each version, the user has access to more and more tools with which to manipulate their data. We will discuss the different versions and various other options in the following chapter.

At its most basic, GIS allows the users to gather, store, and manipulate spatial information in the form of maps. Unlike traditional paper maps, GIS maps are dynamic. They can be queried and manipulated to reveal large amounts of data. For example, if you had a map locating all the structures with any landmark status, you could ask GIS to highlight only those on the National Register. In addition, you could ask to highlight only those on the National Register that are above a certain age. The possible iterations of these queries are massive, with the potentially discoverable data equally as large. One could of course locate this same information using paper maps, however, the time difference between finding the data in this way and a GIS map is significant. One can also utilize different symbols or colors to emphasize the individual attributes of certain features compared to other similar objects.

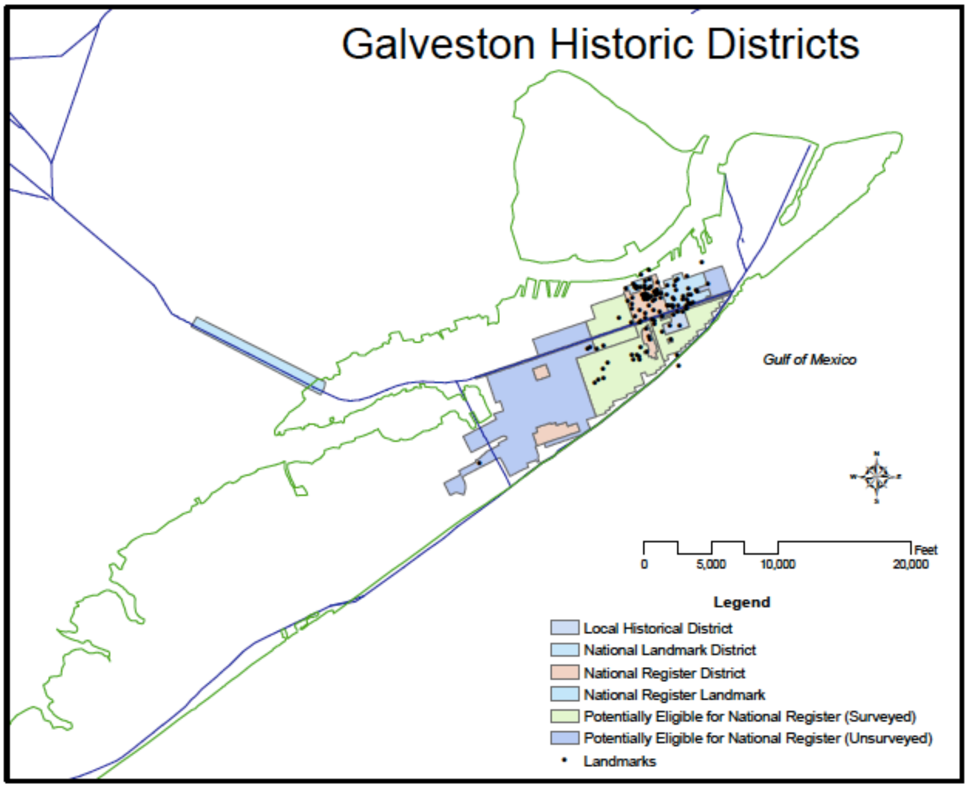

Figure 11: Map of Galveston, TX Historic Districts and Landmarks. In this map we see three types of features represented by three different geometries. Points represent individual historic landmarks. Polygons indicate the areas of different historic districts. While, lines delineate roads and the outline of Galveston Island. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

For example, if one wished to convey the type of landmark status certain buildings possessed at a glance, he or she could assign a different symbol to each type of landmark and then apply this style of representation to the map. The result provides an easy to decipher record of landmarks by both location and status. These two functions compromise only a sample of the most fundamental capabilities of GIS. ESRI designed ArcGIS to be a flexible program, able to be manipulated to meet the needs of organizations both large and small. By understanding the basic abilities of this software, we begin to see how it may prove useful to preservationists.

GIS stores information by linking it to a real-world object through a set of geographical coordinates. Anything existing within the geography of the real world can be stored in a GIS map, whether these objects represent topological features or cultural resources. Although in the real world these features may possess a unique shape, in a GIS map they can only be represented by a point, line, or polygon, depending upon the scale and nature of the feature [Figure 11]. For example, an historic house may be shown as a point if the map is at a smaller scale, but as a polygon defining the building foot print if the map is at a larger scale. One or more x,y coordinates demarcate these geometries. For example, a single pair represents a point while several sets mark the vertices of a polygon. These coordinates can be obtained by either entering in existing information, possibly from older paper surveys, or by utilizing hand-held GPS devices to identify the geographical coordinates of the feature.

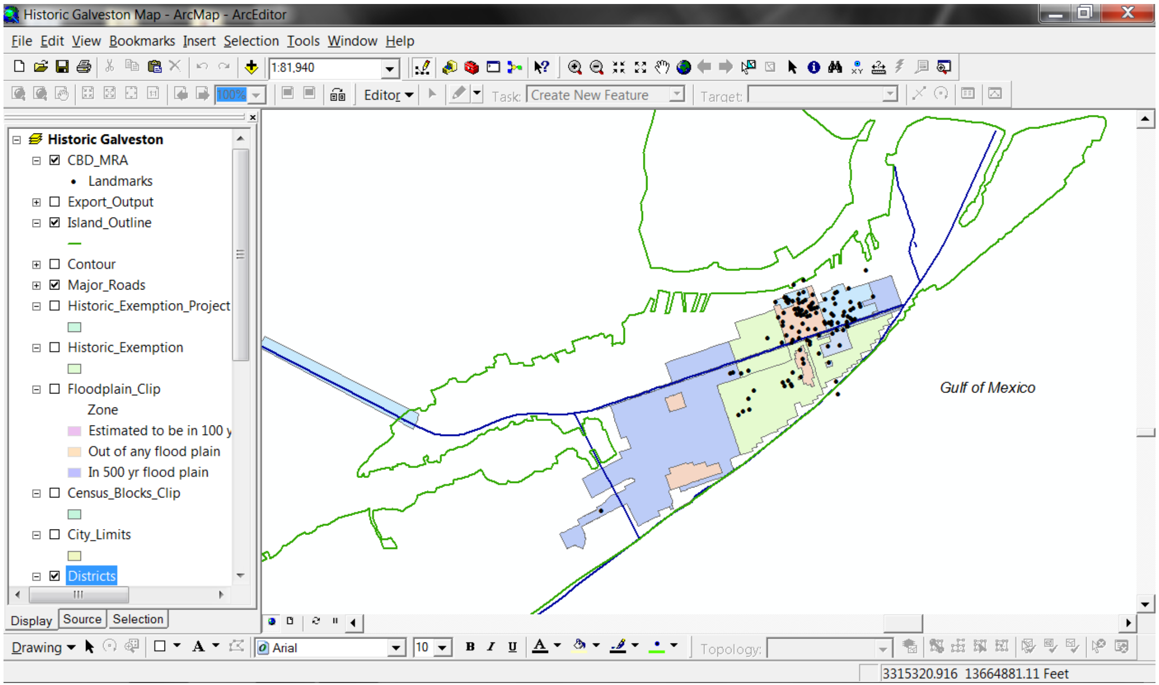

Figure 12: Screen Shot of Galveston Historic District and Landmarks Map with Table of Contents. The table of contents on the left side of the screen shot holds the layer tree, indicating what layers are contained in the open map. The layers with checks next to them are currently visible in the map. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

The features representing real-world objects are organized into groups, referred to as thematic layers, of similar features with the same geometry. One of these layers, for example, may contain a group of features all representing historic homes while another layer might be all line geometries representing roads. The user arranges these layers into groups known as data sets [Figure 12]. The layers in a data set all share a common theme, usually related to the focus of the project. For example, the layers may all concern the geographical information of a town, a county, or a state. Base maps are those layers that offer background information about the focus area. These layers may include roads, county lines or topography, that allow the user to better contextualize the map. Without these basic layers, an historic resources layer alone would simply appear to be points or polygons on a blank screen.

Even without any other actions, the raw locational data of the features offers users the ability to perform a fundamental analysis. By simply observing the map, one can deduce areas in which a larger number of historic resources may be located compared with less populated districts. This information, given to responders, could alert them as to when they may be near historic structures. They can then be alert, exercising additional care in cleaning up or debris removal. The information also conveys a raw count of historic sites residing within the affected area. It provides preservationists with the first step toward a digital organization of resources. Although this map alone may prove useful, by adding more information to this document we may find many more useful tools for preservationists.

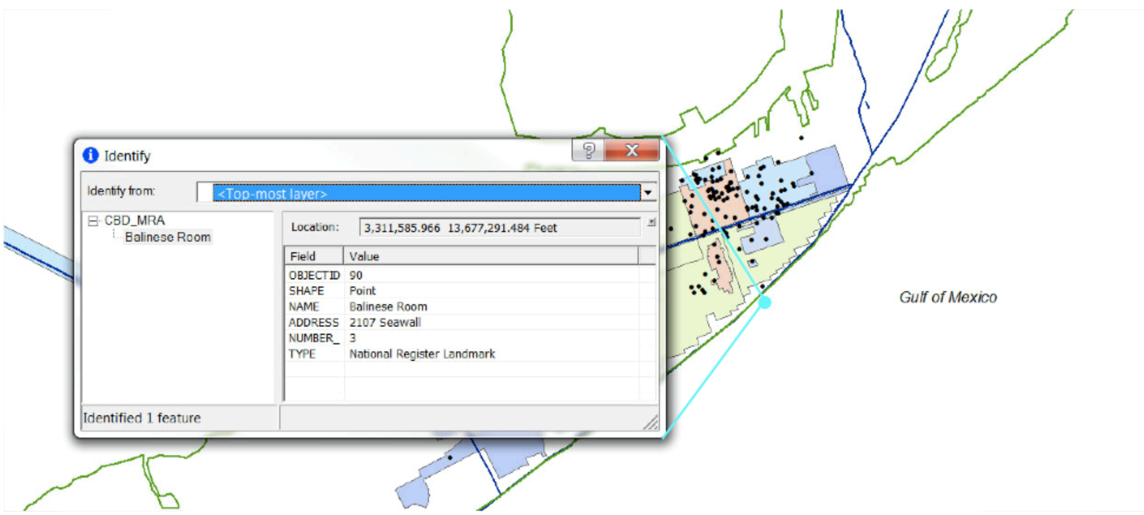

Figure 13: Sample Attribute Table for a Galveston Landmark. In this image we see a short attribute table only listing the feature's name, address, and landmark type. The attribute table however, can be as large as the creator of the map wishes it to be. Map and graphic by author.

Each feature on a GIS map possesses associated information, the scope of which may be determined by the creator. A unique numerical identifier connects the feature with this information, stored in table form, known as an attribute table [Figure 13]. This table may hold as much or as little as the creator of the map wishes. A field defines the category of data stored. For example, it may be the architectural style, character-defining features, or the condition of the historic structure. A user can include as many or as few fields as he or she wishes [Figure 14]. When creating the table, the user identifies the different fields he or she desires to use, selecting rules that restrict the possible attribute values. For example, the user can determine that only integers may be entered as values for the field, "year built" or a string of text with a maximum of one hundred characters may be utilized in the "address" field.

Attributes of Red-Tagged Buildings

Eligibility Recommendation	SHPO Concurrence	FEMA Determination	SHPO Reviewer	FEMA Reviewer	Date of Concurrence	Reviewers Comment
not Nat.Reg.eligible	Yes	Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	Contributes to Uptown NRHD
not Nat.Reg.eligible	Yes	Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	Contributes to Uptown NRHD
not Nat.Reg.eligible	Yes	Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	Contributes to Algiers Point NRHD
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	10/31/2007	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson	4/18/2008	Lacks Integrity
not Nat.Reg.eligible	Yes	Eligible	Valerie Gomez, SHPO	Elizabeth Amisson	4/18/2008	Contributes to Holy Cross Historic District
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	10/31/2007	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	10/31/2007	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	12/3/2007	Lacks integrity
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	1/28/2008	lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	12/21/2007	Lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	12/21/2007	Lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	12/21/2007	Lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	9/27/2007	Lacks Significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	12/21/2007	Lacks significance
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	6/4/2008	<Null>
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	6/4/2008	<Null>
not Nat.Reg.eligible	Yes	Not Eligible	Valerie Gomez, SHPO	Elizabeth Amisson, FEMA	6/4/2008	<Null>

Record: 0 Show: All Selected Records (0 out of 15903 Selected) Options

Figure 14: Sample Building Point Attribute Table from the FEMA Database. In this attribute table we see the inclusion of much more information. Those fields shown in this image are only a small portion of the information attached to each feature in the FEMA database. In this section, we see the records of the eligibility recommendation by the SHPO and the positions of the various government parties. Image courtesy of Deidre McCarthy, NPS.

The link between the feature and the attribute information plays a crucial role in allowing the user to quickly discover information by querying data as well as perform some of the more complex functions of ArcGIS.

The lack of information concerning specific historic structures proved to be a major issue in the response to both Hurricane Katrina and Hurricane Rita. The capability of GIS to link these attribute tables to a feature represents one of the most useful tools to preservationists. These tables can hold all of the information of a traditional paper survey and much more. Several examples of applicable fields include: building owners; year built; address; condition; significance; photographs; bibliography; hyperlinks; and any other data the user might wish. In addition to this initial storage, attribute tables may be updated at any time, allowing preservationists room for updates and edits to the survey information. We have seen how FEMA and the NPS manipulated these attribute tables in their use of GIS to expedite the Section 106 process. The were able to collect all the information needed to establish the eligibility of a particular resource for the National Register, then record the determination in a pre-defined field. The easily accessible information held in attribute tables will greatly aid preservationists in responding to a disaster. In addition to expediting the Section 106 process, responders can immediately begin to survey historic structures, communicating their findings through GIS, and designing further recovery efforts based on the reported damage. For example, a preservationist surveying for the city might identify a damaged historic structure based upon the building description previously stored in GIS. He or she might then add a record of the current condition and a photograph to the existing fields within the attribute table. Preservationists working for the local advocacy organization might then reach out to the owner with information about how this damage might be repaired without losing the resource’s integrity. Having as much information in the attribute table before the event as possible in addition to the structure to add more information, such as condition reports, following the disaster can greatly accelerate the response and recovery actions of preservationists. No longer will they need to sort through files attempting to find some description or information regarding a particular resource, instead, with the click of a button, one will be able to find a wealth of information that can easily be maintained.

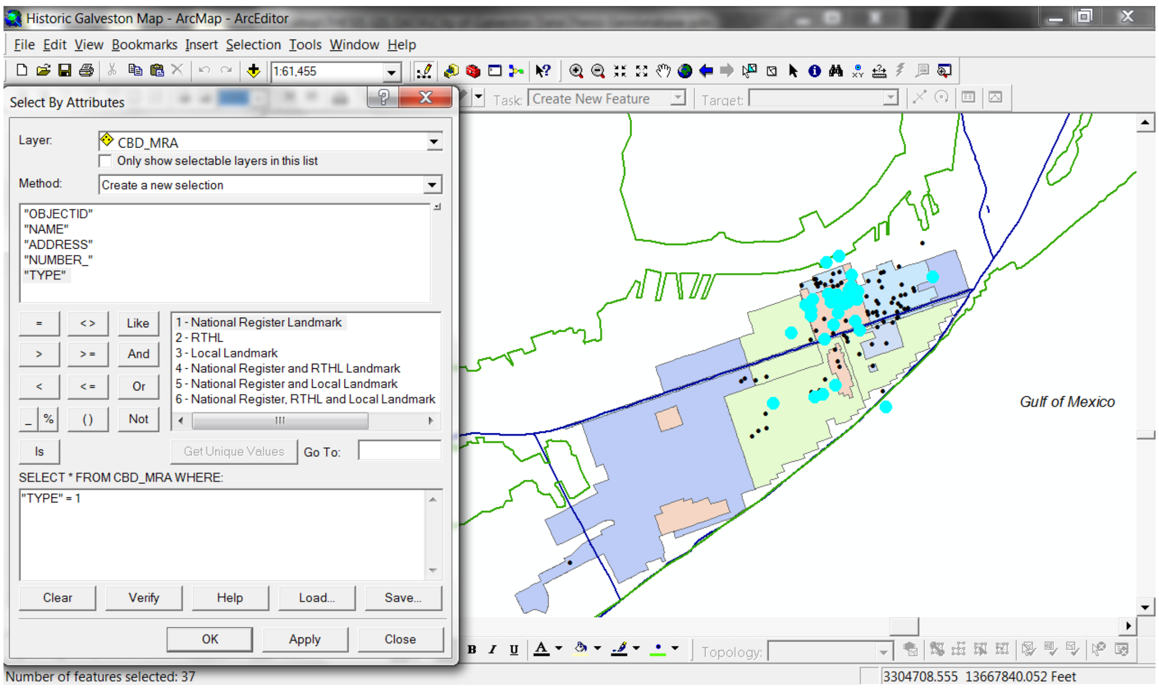

Figure 15: Selection Based Upon Attributes. In this screen shot we see a selection based upon the "Type" attribute of the landmarks layer. We have chosen to select only those features that are listed on the National Register. The box on the left-hand side shows the selection query; while the right of the screen shows the highlighted features. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

The presence of these attribute tables in a GIS map enable other functions that can greatly expedite the analysis of a number of features. Using the several methods of selection, a user can easily highlight features that meet certain criteria. For example, a user might wish to make a selection based on the attributes of a certain layer [Figure 15].

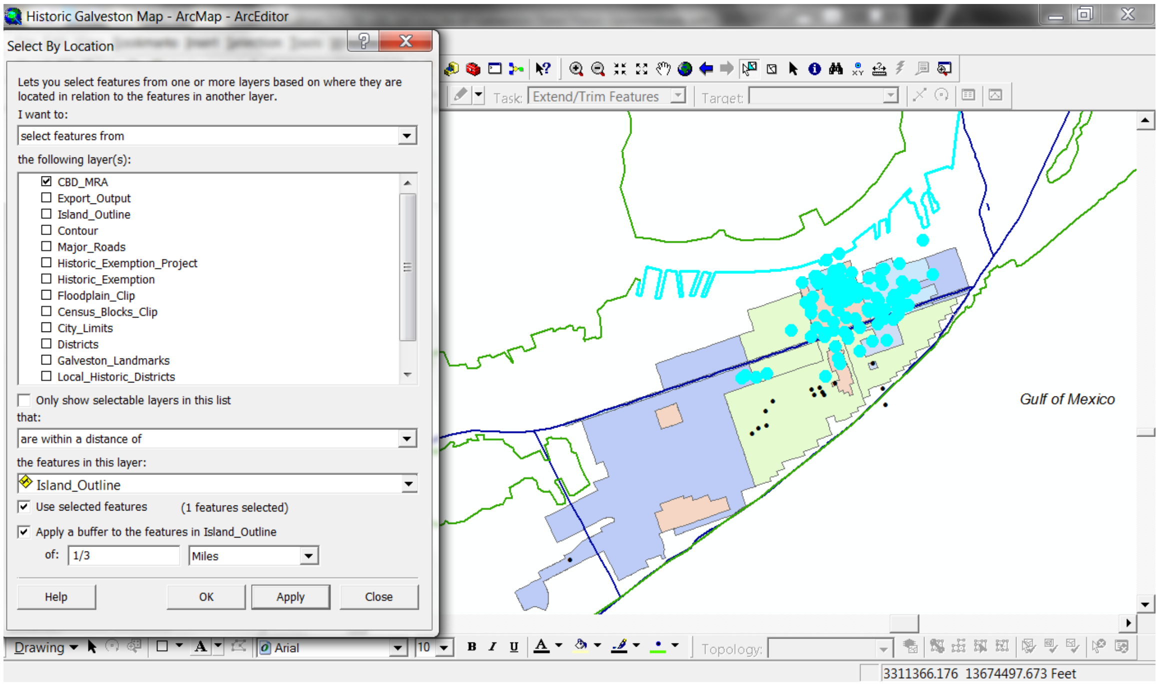

Figure 16: Selection Based Upon Location. In this image we see a screen shot of a selection based upon the location of features in relation to another feature. In this hypothetical situation, Galveston has flooded from the bay side as it did during Hurricane Ike. We know that the flooding extended a third of a mile in land and we wish to determine which features were affected. Using the selection tool we have selected those landmarks within one third of a mile of the breached coast. The left side of the screen shot displays the query necessary to highlight the endangered features. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

In this case, he or she might select a layer from which to choose from, define the field name of the attribute in question, and then enter a desired value. GIS offers a predetermined set of expressions that aid the user in creating these queries. For example, he or she may select a field, in this case, "year built," then choose the value to be equal to or less than "1911." GIS would then highlight all buildings that have construction dates over one hundred years old. GIS provides means of selection based upon the location of the feature as well [Figure 16]. Using similar parameters, he or she can choose to select features of one layer within a certain distance of a feature from another layer. For example, a preservationist could select all the historic sites located within a mile of the levee break; identifying those structures that most likely suffered flood damage. The user may also combine these selection activities by using previously selected features as inputs for another selection process. For example, he or she could select the buildings in poor condition prior to the storm, then use this selection to discover which of these structures lies within a mile of the levee break. In this way, a preservationist might easily and quickly discern which historic structures most likely suffered the most damage from the resultant flooding from the levee break.

The ability to quickly determine information concerning groups of historic resources provides an incredible resource to preservationists following a disaster when speed is crucial. Instead of having to search through multitudes of files, a preservationist can quickly determine which historic structures may be most affected based upon their location and other attributes. Depending upon the number of fields in an attribute table, any number of ways exist to manipulate the selection process, learning more information. The ability to query encompasses the first phase in gaining more detailed information, than simply a feature's location. By manipulating the symbology of the different layers based upon the attributes, the user can progress to the same conclusions as those discovered through querying, instantly through visual representation.

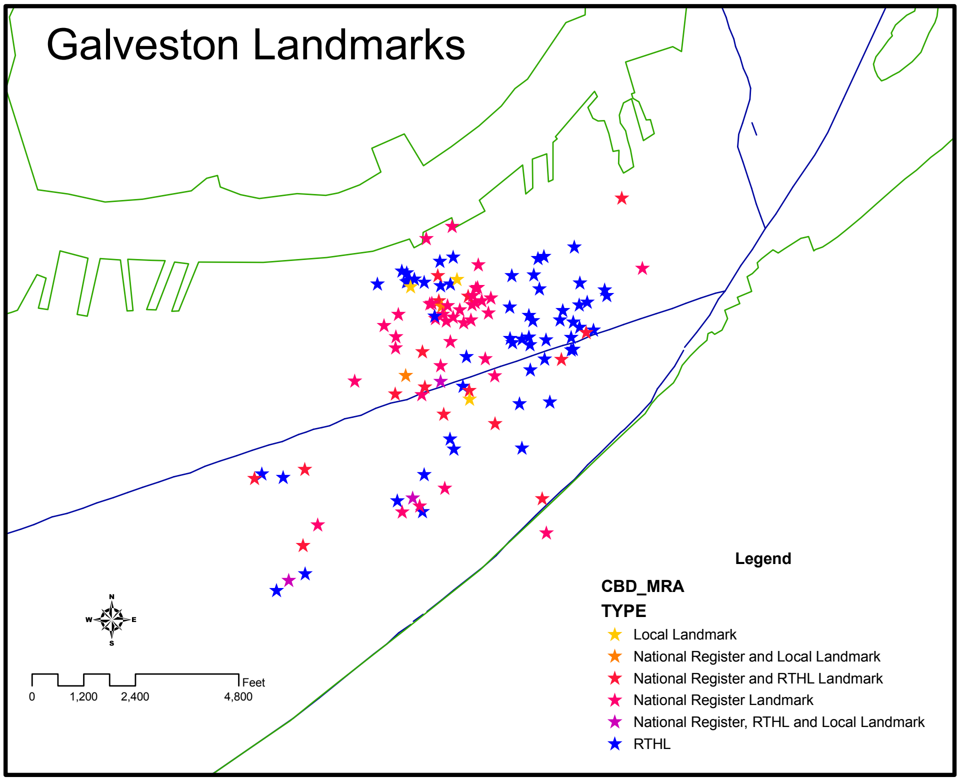

Figure 17: Galveston Landmarks Differentiated by Color. In this map we see different colors used to distinguish different types of landmarks. We have also changed the standard point identifiers to stars. GIS allows the user to create unique symbologies for the attributes of a feature class using different colors, sizes, of shapes. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

The link between attribute tables and features also allows the user to control the mode by which certain features in the same layer may be represented. By altering the symbols used to identify certain features, the user may instantly convey important relational information. He or she may utilize different colors, shapes, or sizes to illustrate different quantities or categories of features [Figure 17]. For example, if the user had a layer of historic landmarks represented by points, he or she could use different colors to denote the different types of landmarks. The color red could indicate those structures listed on the National Register, while the blue could represent the citywide landmarks, and green might identify statewide landmarks. If the user also wished to convey the landmarks' ages relative to each other, he or she could make the point locating the feature larger for older structures and smaller for newer structures. As with selections, GIS offers a multitude of iterations for symbology. The more information included in the attribute table the more varied the symbols may be and thus the more information presented.

In the wake of a disaster, preservationists often need to quickly disseminate information to volunteers and relief personnel. In the Katrina response, we saw the failure of paper-based surveys to efficiently provide enough information. Using different symbology strategies, preservationists can quickly create maps that detail large amounts of data. He or she can demonstrate the locations of historic resources, identifying their pre-disaster conditions based on color, symbol, or size. At the same time, preservationists can illustrate the depth of flood-waters in certain areas based on a color gradient; the darker the color, the deeper the water. The symbology of a map can be easily manipulated to fit any scenario depending upon the amount of attribute information. This ability offers preservationists an unparalleled tool for the dissemination of information following a disaster.

These previous functions of GIS represent the basic capabilities of the software. In order to perform the analysis and actions listed above, the user need only have a few layers of data. By incorporating more information in the form of layers however, one can uncover further data utilizing the more complex functions of GIS. The geodatabase and geoprocessing are two of these utilities that bring GIS closer to its full potential. The geodatabase serves as a data storage format introduced by ESRI in their ArcGIS software. It acts as a relational database composed of tables, feature classes, and raster sets. ArcGIS also offers to other forms of data storage, coverages and shape files. The geodatabase however, provides unique options that make it the best option for preservationists. Geoprocessing allows the preservationist to gain new information from existing data through a series of operations. Just as with the basic functions of GIS, the user cannot begin analyzing the data before he or she has organized it.

Geodatabases possess several advantages as a data storage system. One, all the program stores all the data in one, central location rather than being spread throughout different files. This factor becomes especially important when multiple organizations utilize the information, such as preservationists following a disaster. Two, the specific structure of a geodatabase allows users to maintain a clear overview of data holdings. Finally, this structure also promotes a faster and more accurate data entry. The creator can define rules for geodatabase features, allowing only certain values to be valid for a particular attribute. This tool goes beyond simply defining the format of the value as we discussed earlier. Instead of allowing only integers for a "year built" field, in a geodatabase, the user can define which actual attributes may be named. For example, if the user implements a "roof style" field, he or she may allow only certain answers such as hipped, gable, cross-gable, or any other answer applicable to the architecture of the area in question. He or she can also create relationships among feature classes so that when the user updates a feature in one class, related features in others change as well. With these qualities, preservationists can ensure a level of quality control in surveys conducted by volunteers unfamiliar with the region.

ESRI offers three types of geodatabases: a file geodatabase; a personal geodatabase for Microsoft Access; and an ArcSDE geodatabase. The purpose of the database and the organization utilizing it determine which type of geodatabase should be used. A file geodatabase performs best for small organizations with a single editor. It can efficiently manage very large data sets with almost unlimited storage space. This type of database might work for a preservation organization wishing to use GIS only for the organizations actions, without the need to interface with other groups. In the event of a disaster however, preservationists need to communicate information both to each other and to outside workers. As a result, a file geodatabase does not work for our purposes. A similar demographic might use a personal geodatabase. This version works with Microsoft Access, a program already in use by many organizations. Unlike the file geodatabase however, it has only a two-gigabyte storage limit. As with the file geodatabase, the personal geodatabase cannot meet the needs of preservationists for either data storage or communication. The ArcSDE geodatabase primarily serves large organization with multiple editors. This type of geodatabase requires ArcGIS server software in addition to a relational geodatabase management system like Oracle, DB2, or SQL server. Despite the additional technology requirements, the ArcSDE geodatabase meets all the needs of preservationists following a disaster.

FEMA and the NPS chose an ArcSDE geodatabase in their Katrina Response Methodology, expediting Section 106 requirements, for its ability to have more than one editor and multiple users [Figure 18]. As surveyors returned with information from the field, multiple preservationists could check the data then upload it into the GIS database. Both FEMA and the Louisiana DHP could then access the geodatabase, reviewing the new information, and efficiently determining National Register eligibility. FEMA and the NPS methodology serves as a valuable template for increasing communication and organization in preservation following a disaster. Preservationists can expand the number of organizations with access to the database, allowing public and private preservation groups a fuller knowledge of the situation with which to aid in the response efforts.

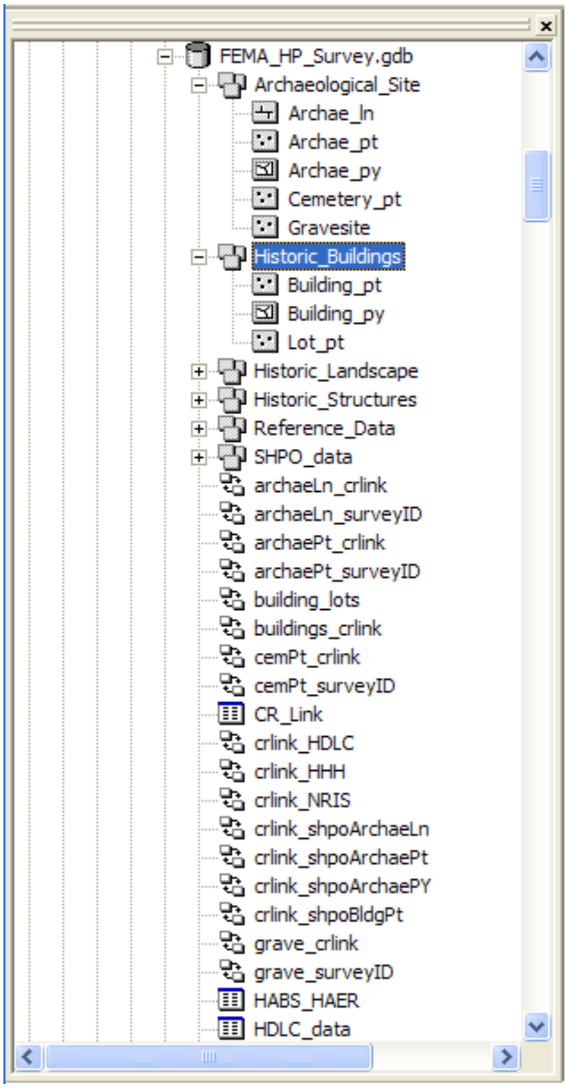

Figure 18: FEMA Geodatabase Tree. This geodatabase tree shows the different feature classes and structure of the geodatabase. Data courtesy of Deidre McCarthy, NPS.

As we have seen, the amount of information contained within a GIS map directly affects the utility of the map; the more data stored, the more fully the potential of GIS' capabilities may be accessed. Arc GIS offers two ways to add data to a GIS map. Upon creation of a geodatabase, the user can directly enter existing survey information into the program or information may be collected in the field using a GPS device with GIS integration capabilities. FEMA and the NPS used Trimble Geoexplorers following Hurricane Katrina to quickly survey New Orleans. The user must first create a data dictionary to be used in the field data collection devices [Figure 19]. This same data dictionary also serves as the corresponding basis of the GIS database. The information collected with the GPS devices using the data dictionary will form the attribute table for features within GIS. The data dictionary can and should be made to represent the areas specific architectural styles. The user defines what types or fields of information must be collected. For example, condition reports, character-defining features, roof style, materials, and any other information deemed necessary. Then he or she may designate appropriate values for these different categories based upon the local style. A surveyor, for example, may only be able to select ‘gable,’ ‘hipped,’ or ‘mansard’ roof types if those are the only options the data dictionary creator has designated. The data dictionary performs similar to a digital survey form on the GPS device in the field. The proscribed answers provide an important level of quality control impossible to achieve using paper-based survey forms.

Feature	Attribute	Attribute Value	Required	Description
Building_Pt				Point location of building or structure
	GPS_ID	text	Required	Unique ID assigned by field surveyor
	Property Name	text		Resource name, if known
	Street Number	text	Required	Street number of address
	Street Name	text	Required	Street name of address
	City Tag	red	Required	Type of tag assigned by city/Parish
		yellow		
		green		
		none		
		removed		
		changed		
		unknown		
		other		
	City Database	bldg on city list	Required	Whether the structure is on a city/Parish demolition list
		bldg not on cty list		
		unknown		
		other		
	Historic Neighborhood	text		Name of historic neighborhood if known
	Construction Date	text		Date of the building construction
	Date Estimated?	yes		Flag to indicate if the construction date is estimated
		no		
	Less than 45 yrs old	yes	Required	Flag to indicate if the building is less than 45 years old
		no		
		unsure		
	Listed Status	National Register		Indicates if the building is recongized officially
		NR historic district		
		NHL		
		local listing		
		local hist district		
		multiple		
		unknown		
		other		
		none		
	Contributes to NR HD	yes		Flag to indicate if the building contributes to a historic district
		no		
		unknown		

Figure 19: Portion of the Louisiana Data Dictionary from the FEMA Database. Image courtesy of Deidre McCarthy, NPS.

The ability to add information, collected in the field, to an ArcGIS geodatabase, represents one of the most critical tools to preservationists following a disaster. Even with a large amount of existing information prior to the event, responders must ascertain the level of damage to historic resources by surveying the data. GIS provides an extremely efficient means of gathering this data. Likewise, the data dictionary aids in the prevention of inaccuracies or biases to mar the quality of the data. Surveyors may only enter predefined answers to each of the survey questions. Examples of these predetermined selections may be seen in the "Attribute Value" column of Figure 19. This same regulation of survey answers was also applied to building descriptions such as building type, style, or materials. Although the data dictionary does leave some room for surveyors to express bias or record mistaken information, the tool greatly diminishes the chances of incorrect data. In Iowa, following the 2008 flooding Cedar Rapids experienced a vast disparity between individual FEMA surveyors. Some individuals were much more critical of changes to structures than others, refusing to consider certain historic districts.[184] These fluctuations between individual surveyors resulted in particular communities receiving less compensation for adverse effects, while others received more. GIS' ability to institute a level of quality control upon data gathering can greatly aid in the prevention of such biases.

Once GIS data has been organized the user can begin analyzing the data utilizing the many different tools ArcGIS has to offer. One method of investigating data, geoprocessing, involves any operation that creates new data from existing data. ArcGIS contains a toolbox offering a multitude of geoprocessing functions. These tools typically fall into three categories: data extraction, overlay, and proximity. When utilizing a data extraction tool, the user creates a new subset of features based upon the extent of another feature class. In an overlay function, the map author combines two layers in order to

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[184]Cynkar, Personal Interview with Rod Scott.

extract needed attribute information from both. Finally, in a proximity operation, one uses ArcGIS tools to find features that are new or within a certain distance of other items [Figure 20]. When processing data, one can perform these operations individually or create a model. A model contains a selection of geoprocessing tools that automatically execute in order when run.

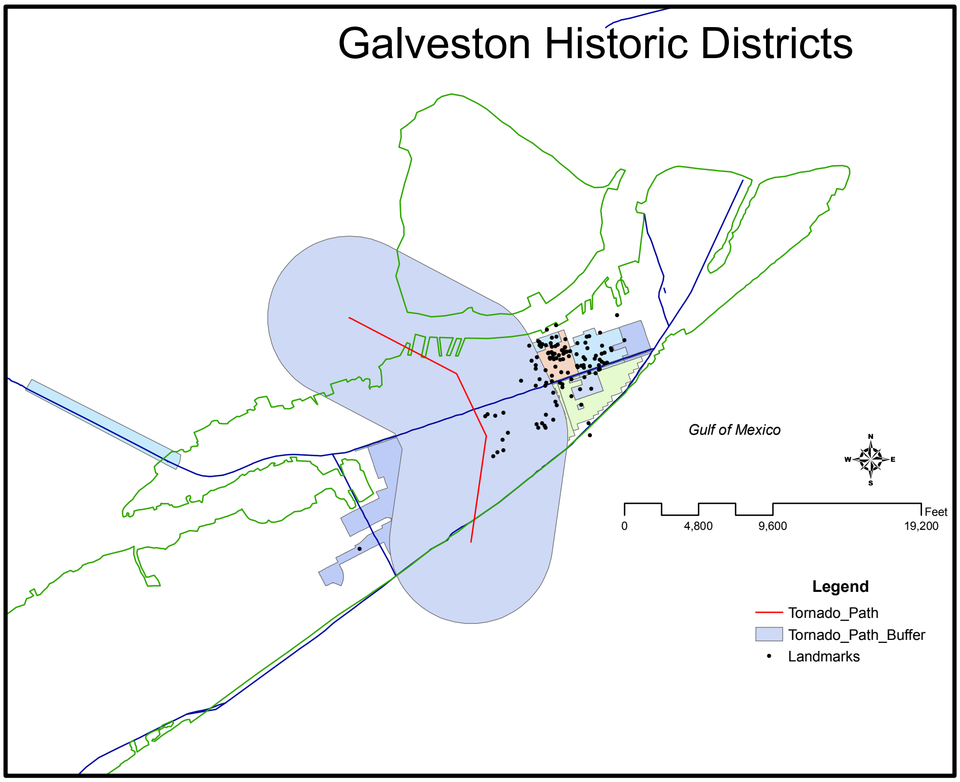

Figure 20: Sample Use of the Buffer Geoprocessing Tool. In this map we have used a proximity tool known as 'Buffer' to discover which historic resources might have been affected by a hypothetical tornado. Using the existing layer with a line feature of the tornado's path, we then used the buffer tool to illustrate the breadth of the damage from the storm. We can now easily identify which landmarks could have been damaged by the event. Data courtesy of the City of Galveston and the Houston Galveston Area Council. Map by author.

This technique produces the same final output data as operating the geoprocessing tools individually however, models provide a number of extra benefits, especially useful for large organizations with many editors. Models provide a graphical representation of all the processes used to find the end information, offering an easy tool to explain a complex workflow. A model can be reused indefinitely or have its parameters altered to perform new functions. Likewise, models can be shared so that every team member working in GIS can quickly perform the exact same process. The management of intermediate data exemplifies another asset of models. After every process GIS produces output data. When this data is utilized as input data for another later function, it is known as 'intermediate data.' By creating a model to allow all the processes to run automatically, the author no longer has to be concerned with managing this intermediate data.

Although the geoprocessing capabilities offer an entirely new realm of analysis to preservationists, its utility following a disaster remains minimal. Like GIS' ability to query and alter the symbology of features, the tools encompassed by geoprocessing allow for an easy, quick analysis providing large amounts of new data concerning historic resources. In the event of a disaster however, communication and organization serve as the most important functions of GIS. The geoprocessing tools add to the many benefits of GIS extending beyond the disaster management system. These advantages will be discussed in the next chapter.

Altogether, the capabilities of GIS present preservationists with an extremely powerful tool. In this chapter, we have discussed the basic functions and operations of the software that will play a major role in the hazard mitigation for historic resources. Although we have primarily discussed the strategies of GIS in terms of hurricanes and flooding, the software can support preservationists responding to any type of disaster, natural or man-made. The flexibility of GIS to meet the needs of many different organizations extends to multiple types of hazards as well as regions. The program's utility as an organizational tool and agent of information dissemination function independently of what data one wishes to document. As preservationists, we of course wish to utilize historic resources. By manipulating the basic functions above, we can then use GIS in any manner we wish, to convey any meaning we wish, the potential for preservationists is endless. It is important to understand however, that we must also increase cooperation between preservationist groups, fundamentally altering the current practice between these organizations, if we are to access the full potential of GIS.

In order to further understand the scope of this program's utility in practice, we can envision how the preservation response to Hurricanes Katrina and Rita in New Orleans might have proceeded differently with the use of GIS. If a geodatabase had been in place with the participation of preservation groups at the local, state, and federal level as well as in the public and private sectors much of the surplus damage caused by confusion and inefficiency could have been avoided. The city and state governments would have been able to quickly identify those structures with the most damage. FEMA could then begin accessing adverse effects much earlier than actually occurred; thus releasing federal money much sooner to the recovery process. As the various government entities strived to assess the level of damage, private organizations, like the PRC, could simultaneously be organizing recovery aids, such as workshops and flood buckets, based upon the data documented by the public sector. By re-examining the actions of the various preservation groups in detail, we can observe the ability of even a smaller implementation of GIS, for example involving only a single organization or a cooperation between two groups, to greatly improve the success of mitigation efforts.

If the city of New Orleans' HDLC had possessed a GIS database concerning the city's historic structures, the local entity could have greatly expedited response efforts, preventing further damage to these cultural resources. Directly following the event, instead of scrambling to gather sufficient information regarding the individual resources in historic districts, the HDLC could have accessed all the requisite data from a single location. Using geoprocessing tools, such as those used in Figure 20 to discover the area of destruction caused by a tornado, the HDLC could have produced maps identifying the historic structures most likely to have sustained damage from the hurricane. They could have charted the levee breaks and resulting floodwaters to find those structures that were most likely flooded while at the same time noting those sites that suffered only wind damage. Using this information, combined with the survey data, the HDLC could have immediately sent out survey teams to assess the damage to the city's historic resources. If the organization had developed a data dictionary prior to the storm, these survey teams could have used GPS devices compatible with GIS to digitally record condition reports directly into the program. Although the HDLC would gather roughly the same information using GIS that it did without the program, the key difference lies in the amount of time taken to obtain the data. Using GIS and GPS devices, the HDLC can shorten their recovery efforts by days, while greatly simplifying the process through the use of a digital medium.

Even if the HDLC was the only preservation body with access to this hypothetical GIS database, the increased efficiency of the survey process would have protected many historic structures that suffered damage as a result of the confusion following Hurricane Katrina. By quickly ascertaining the areas with the most damage, the city could have created a red-tag list of structures to be demolished much more quickly. This knowledge, combined with the condition reports of other historic structures, could have enabled the HDLC to begin issuing permits much sooner, expediting the recovery process. In addition, the publicized knowledge, possibly through signs or other marking systems, of which structures were to be demolished and which were to be saved, could have prevented volunteers from assuming most structures were beyond salvation and proceeding to destroy the site themselves. Likewise, HDLC could easily communicate to the leaders of the various volunteer organizations in New Orleans information concerning the historic status and condition of certain structures using GIS maps with manipulated symbologies such as those used in Figure 17.

GIS could have greatly aided in the response to Hurricane Katrina at the State level as well, further preventing damage incurred after the event. If the state had possessed a GIS database, they could have both aided individual cities in their assessment of damage and compiled this data to better direct state funding for relief. Likewise, the State could have been better prepared to present this information to both FEMA and volunteer workers. As with the HDLC, these same actions were performed by the state following Hurricane Katrina, the value of GIS in this scenario lies in its ability to expedite the process through organization and dissemination of this information.

By using GIS instead of paper surveys to organize data, preservationists can avoid the time taken to compile the survey results into files, then to copy or scan these files, and finally to distribute these documents. Instead, the survey data can be uploaded to the GIS database which is then immediately available to all those organizations with access to the server. These preservation groups can then act upon this data, educating volunteers, issuing permits, and organizing long term recovery efforts much sooner than actually occurred following Hurricanes Katrina and Rita. This additional speed provided by GIS would help prevent the further destruction of historic resources by relief personnel working without the aid or guidance of preservationists.

FEMA did utilize GIS following Hurricanes Katrina and Rita to great effect. They successfully expedited the Section 106 process, implementing GIS to speed the survey and determinations of eligibility. Unfortunately, the methodology using the program had not been established prior to the events, therefore a delay of several months occurred before FEMA and the SHPO could begin Section 106 review. This initial interruption of the response process could have been avoided if a geodatabase were in place prior to the event. Without this pre-existing framework and with the lack of specific information provided by the city and state governments, months passed before FEMA was able to truly begin aiding in the recovery process.

With access to their GIS databases, the private sector PRC could have used the condition reports to strengthen the public support they gave following Hurricane Katrina. Instead of having to perform a windshield survey to notify homeowners of the state of their households, Ms. Gay could have simply accessed the database to learn of individual damages. The organization could also have immediately begun coordinating workshops to inform the citizens of repair methods and funding opportunities based upon the specific damage of the storm. With access to the government survey assessment, the PRC could have immediately begun contacting large non-profit organizations, coordinating supplies and donations to help restore the damaged historic resources. As we saw with the government preservationists, GIS does not greatly alter the final goal of the PRC, to aid historic home and business owners in recovering from the disaster, instead it heightens the efficacy of the group's actions through organization and speed.

Finally, if even some of the GIS information was made accessible to the public through the web, individuals could be comforted by the knowledge of the government's actions as well as begin the process of applying for recovery and mitigation grants. Some of the monetary incentives they could gain include state and federal income tax credits, rehabilitation property tax exemptions, and building code exemptions for rebuilding substantially damaged structures in the one hundred year flood plain.

Clearly the potential for GIS to expedite the recovery process following a disaster presents preservationists with a powerful tool. The operations encompassed by ESRI's program present an unparalleled method of organization and information dispersal. The program's capabilities can be manipulated to support the architecture of any region with risk from any type of disaster. As we have seen with New Orleans, the presence of a GIS database could have greatly lessened the damage caused by relief workers, while at the same time expediting the recovery efforts. The benefits GIS offers to preservationists are enormous however, access to these benefits requires investment in addition to a change of outlook. To truly gain the full benefits of this software, preservationists must be willing to alter their current practice of isolation from one another. The public sector must be willing to share information with the private sector and vice versa. This cooperation and the initial cost of implementing GIS into preservation may seem prohibitive but the extensive potential of GIS beyond disaster management makes this outlay more than cost-effective.

VI. Implementing GIS

GIS presents definite challenges to preservationists seeking to implement the program within their organizations, however, the benefits strongly exceed the expenditure. Any group seeking to initiate a GIS program must acquire licenses, technology, and skilled personnel. The massive capability of the programs involved in GIS make it difficult to learn without a formalized class. Likewise, the cost of obtaining a license and the requisite server space may be daunting to some private or non-profit groups. In addition, for GIS to fully reach its potential as a mitigation tool, preservationists must re-examine their relationships with their colleagues.

The potential uses and benefits far exceed this investment, moving beyond disaster management, into planning, education and outreach. Altogether, the potential GIS products could revolutionize the practice of preservation. Many fields both similar to preservation and greatly differing have utilized GIS to meet the demands of an increasingly digital society. Currently, preservation remains far behind other resource management fields in use of GIS. This position can often hinder preservationists as they attempt to enfold preservation initiatives into the public consciousness and governmental regulations. Although currently preservationists succeed with minimal use of GIS, we as a field face becoming irrelevant if we cannot implement new technologies as well or as quickly as related resource management fields.

Implementing GIS requires investment of both technological and human resources. First, the correct programs and licenses must be obtained, followed by the technology to utilize the software. Then, the group must possess the personnel with the skills to manipulate the program into producing these effects. Finally, GIS necessitates time and money. Of all the resources needed to run GIS, money and time may pose the largest issue for preservationists; however, we must remember the multitude of benefits that will make this cost effective.

ESRI offers a number of different ArcGIS combinations and products, all based upon the storage of spatial data [Figure 21]. Desktop GIS provides the fundamental access to GIS. One can choose from ArcView, ArcEditor, and ArcInfo software. All of these options allow one to model, analyze, and present spatial data however, each has a certain number of tools. ArcView presents the most basic option for running GIS. With this version, one can perform all the operations discussed earlier in this chapter.

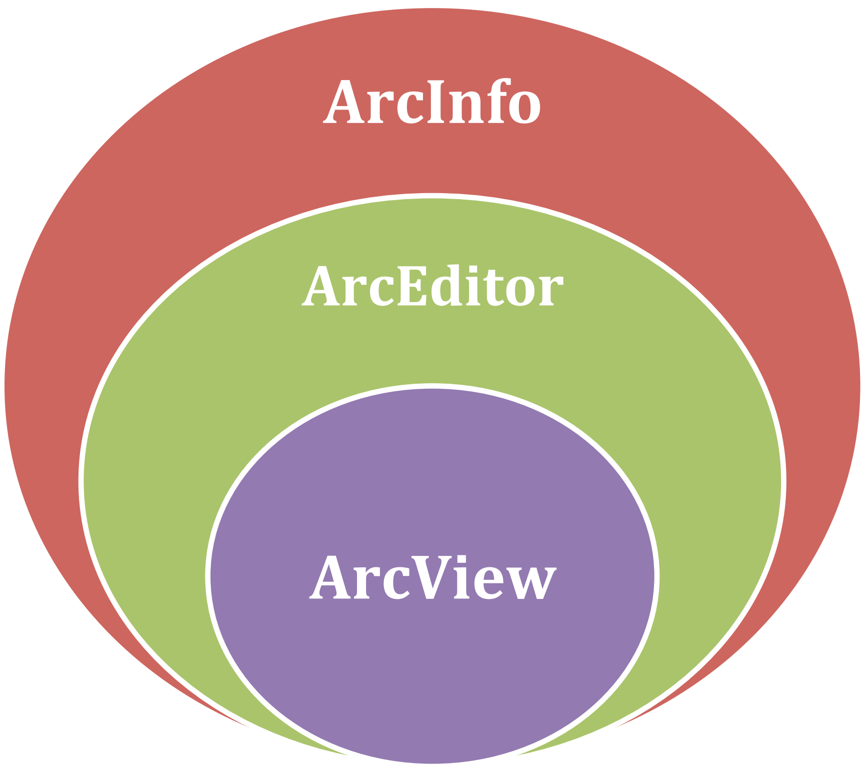

Figure 21: Different ESRI GIS Licenses. Graphic by author.

ArcEditor can perform all the function of ArcView in addition to further editing and analyzing tools. ArcInfo provides the most comprehensive form of ArcGIS with additional editing and analyzing tools not present in the other too versions. In addition to the basic software offered in Desktop GIS, ESRI also produces programs to extend the impact of maps and information. Server GIS allows users to distribute maps over the web to large organizations and onto the web. Online GIS provides users with a platform to share, discuss, and construct new GIS applications via the internet. Finally, Mobile GIS allows organizations to send data from centralized servers to mobile devices. Using the extension ArcPad, representatives in the field can verify, edit, and add data to geodatabases.

Finding personnel sufficiently proficient in GIS to be able to successfully implement this mitigation strategy presents a unique challenge. Not only must an organization obtain an employee with the necessary skills to edit GIS, but the rest of the staff must also become at least slightly conversant. Although one need not have a graduate degree or even a bachelor's degree to learn GIS, a familiarity with computers greatly eases the education process. This challenge can be almost as daunting as that of the money for earlier generations of preservationists who have not developed during the computer age.

Even for those who have some skill with computers, GIS can be a difficult to learn. Although it offers a huge number of options for spatial analysis, accomplishing these operations often proves to be unintuitive. Likewise, the shear number of these functions makes it difficult for a student to access the full potential of the program without organized, formal instruction. When beginning research for this work, I had hoped to educate myself in GIS through only the combination of books, the Internet, and a system of trial and error. Unfortunately, the large number of possible functions and the lack of intuitiveness in performing these operations, made it impossible for me to create the mitigation program I had envisioned. I could however, manipulate and read existing maps with no formal instruction. In order to obtain the level of proficiency I desired, I pursued the online training offered by ESRI. These classes present the best possible solution concerning money and time. They provide a less expensive option than live courses with much more flexible schedules. I was able to afford the instruction on a student's budget while scheduling the modules around my course load. These classes clearly present the various aspects of GIS, while offering aid to those who need extra help and exams to ensure that the participant has retained the lessons of the module.

The use of these online classes will suffice for those who wish to learn GIS once they have completed their graduate education. If preservation is to compete with other resource management fields we must begin to instruct students in the use of this tool during their education. Not only are other resource managers already full utilizing GIS but they are beginning to explore new manipulations of the program to further aid their work. If the majority of emerging preservationists can barely operate GIS, our field will have significant issues even maintaining the current status, which with the current recession is not necessarily promising.

Hiring personnel with the skill to operate GIS encompasses only the first of a set of actions required to implement this mitigation system. Appropriate licenses and extensions must be bought and installed. In this case, organizations must invest in ArcInfo, Server, and Mobile GIS software. The structure of the geodatabase should be designed along with the data dictionary prior to importing any data into the program. Next existing data should be added to the database whether it be from existing GIS files or from paper documents. Finally, another survey should be conducted to update the existing records, this time using Mobile GIS and ArcPad. Local, statewide, and federal preservationists should be in communication as this system is implemented to ensure that it is compatible with existing systems.

As we have seen in the GIS chapter, this program can greatly aid a single organization; however, its full potential can better be reached through the sharing of its information.[185] A network of preservation organizations willing to participate in the GIS database must be established immediately. These groups must agree upon each organization's contributions and responsibility to the project. Where will the main server be held? Who will be responsible for maintaining the data? How will the costs be shared? These represent only a few of the details that need to be clearly decided upon. The results of these discussions may vary region by region. So long as the involvement of each organization has been clearly determined, the structure of these different agreements need not be the same. Just as programmatic agreements differ from case to case, so may these relationships. The crucial outcome of this discussion is a higher level of cooperation between preservationists in both the public and private sectors. The destruction of a disaster can be overwhelming. Historic preservation concerns can easily be overlooked as officials struggle to return their jurisdiction to normalcy. If we are to protect historic sites throughout this turbulent time, preservationists must work together, sharing their resources.

This basic setup and organization should occur as soon as possible before another event occurs. Possible grant funding through state funds or through FEMA's hazard mitigation grant program should be investigated. This program will only be successful if fully installed prior to an event. As we saw in Louisiana, a partially set up GIS database primarily causes confusion rather than clarity. After this initial goal has been achieved, organizations should explore the many other benefits GIS can offer there group.

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[185] Although the primary argument of this work focuses on the use of GIS as a mitigation tool, I strongly believe that an additional effort must be made to strengthen coordination between public and private sector preservation organizations. As a result I have decided to include a section on the implementation of a large scale ArcSDE server geodatabase that might bridge the public-private divide in preservation.

One of the most important surplus benefits of utilizing GIS to store data is the potential for education and outreach. Using ESRI software, organizations can publish data on the web, making planning information easily available but also providing an invaluable resource to the public. If made user-friendly, any individual could enter the website, view a map of their area and immediately see all the historic structures surrounding them. Using different symbology, preservationists could show which structures are endangered, which structures are on the National Register, or which structures have been lost. Likewise, by accessing the attribute table, individuals could immediately gather useful information on the structure, making the resource seem much more significant than if the visitor only witnessed a date and a name.

VII. Conclusion

Hazard mitigation plays an essential role within the disaster management cycle. It forms the nexus, returning the cycle to the beginning again. During this phase, we learn from a disaster through its recovery phase while applying the new strategies to prevent damage from future events. By analyzing the successes and failures of previous mitigation strategies following a disaster, we can alter our current tactics to better protect against future risk.

Historic resources have not been heavily emphasized in hazard mitigation strategies. The Federal government does not require that they be considered in either state or local plans according to the Disaster Mitigation Act of 2000.[186] FEMA does encourage these governments to protect these structures based upon monetary considerations.[187] The impetus however, remains with preservationists to advocate for these historic sites' inclusion into mitigation plans, educating the public and government officials upon the most effective strategies. Those mitigation plans that do exist for historic resources on construction practices to minimized damage. Plans like Galveston's, Florida's, and Minnesota's advocate for the use of devices such as roof clamps or storm shutters.[188]Although effective in lessening some of the damage caused by an event, historic resources still experience damage after an event. We must accept that we cannot completely prevent damage from occurring. Thus, preventive construction can only succeed to a certain extent. If we wish to further mitigate damage to historic structures, preservationists must identify new protective strategies.

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[186] 42 U.S.C 5121 *et seq*.

[187] FEMA, Integrating Historic and Cultural Resource Considerations into Hazard Mitigation Planning.

[188]City of Galveston Department of Planning and Community, *Disaster Preparation for Historic Properties*; Division of Historical Resources et al., Disaster Mitigation for Historic Structures: Protection Strategies; "Thinking About the Unthinkable: A Disaster Plan for Historic Properties in Minnesota."

Figure 22: Preservationists Surveying Historic Structures Following Hurricane Katrina. Photo courtesy of Deidre McCarthy, NPS.

Just as we learn new means of preventing damage by examining the failures of existing protections following an event, so must we examine preservation response techniques to discover new means of hazard mitigation for historic resources. The preservation response in New Orleans after Hurricanes Katrina and Rita provides a perfect opportunity for this analysis. After examining the response of preservationists in both the public and private sectors, at all levels of government, we observe that a lack of organized information concerning individual historic resources and ineffective dispersal of this data to relief workers greatly hindered the response process. During the time preservationists used to rectify these flaws, historic resources were suffering additional damage from responders unaware of the value of certain buildings.

From the analysis of this work, we understand several new needs of mitigation with which to work. First, the damage caused by a disaster does not conclude with the actual end of that event; for example, the passing for the hurricane or the tsunami. Historic resources remain at risk to damage from relief workers long after the conclusion of the disaster. We also learn that better organization of information in addition to an efficient strategy of distributing this data could greatly reduce the amount of damage inflicted by volunteers. If preservationists are prepared to identify the remains of historic structures and then communicate the location of these to responders, then we can prevent needless demolitions or losses to integrity.

GIS presents preservationists with an ideal tool to accomplish these new mitigation strategies. Combined with a stronger cooperation between preservationists, this software could revolutionize the mitigation of historic resources. The program stores information concerning features according to geographic location in the form of maps. GIS can be used to record the location of historic resources, while attaching all the survey information to a specific resource. Through the basic functions of the software, preservationists can increase the organization of data while making it much more accessible. In addition, the ArcGIS server software allows multiple organizations to access the same database, instantly disseminating information between the various preservation responders.

Implementing a GIS system for hazard mitigation presents preservationists with a distinct challenge. Obtaining the technology and personnel training, while establishing cooperation with other preservationists requires an extensive investment. The potential benefits of this program extend far beyond disaster management making the difficulty worth the expenditure. Once in place, GIS can be utilized as an education and outreach tool, in addition to further aiding cultural resource management. Most importantly however, GIS can bring preservation concerns once more to the forefront of government and public concern. Following a disaster, historic resources are often not even considered by most government officials. GIS allows preservationists to immediately present organized, complete information to decision-makers. The program offers the same potential on a much broader scale as well. In a time when preservation seems forgotten due to budget cuts or green building initiatives, GIS can visually remind the same officials of the significance of these structures.

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Vita

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