Status and Trends of Coastal Vulnerability to Natural Hazards Project Annual Report for Phase 3

by

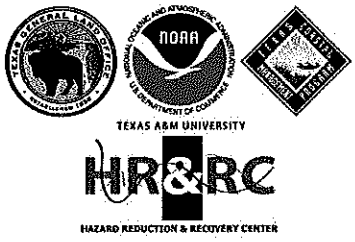
Walter Gillis Peacock, Samuel D. Brody, Himanshu Grover, Douglas Wunneburger,
Jung Eun Kang, Rahmawati Husein, Gabriel R. Burns,
Hee Ju Kim, Forster Ndubisi, and June Martin.

Prepared for the
Texas General Land Office
and
The National Oceanic and Atmospheric Administration
Under GLO Contract No. 09-045-000-3362

A report of the Coastal Coordination Council pursuant to National Oceanic and Atmospheric Administration Award No. NA08NOS4190458.

This investigation was funded by a grant from the National Oceanic and Atmospheric Administration administered by the Texas General Land Office. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

Hazard Reduction and Recovery Center
College of Architecture
Texas A&M University
TAMU 3137
College Station, Texas 77843



June 22, 2011

Status and Trends of Coastal Vulnerability to Natural Hazards Project
Annual Report for Phase 3

Texas A&M University The Hazard Reduction and Recovery Center

When originally conceived, the Status and Trends of Coastal Vulnerability to Natural Hazards project is a multi-phase project designed to undertake a status and trends study of coastal vulnerability to natural hazards of counties located in the Coastal Management Program (CMP) boundary. The target areas for this study will be Harris, Galveston, and Brazoria counties. However, much of the overall analysis will include counties along the entire Texas Coast.[1] The project includes the following tasks:

1. Evaluate content and implementation of the State of Texas Hazard Mitigation Plan (SHMP) (2004) for applicability to the CMP.
2. Assess the regulatory regime and effectiveness of construction codes and land use planning policies to mitigate potential impacts of coastal natural hazards.[2]
3. Identify best practices and emerging technologies related to building code and land use planning that could further mitigate potential impacts of coastal natural hazards.
4. Assess the local, state and federal resources available for mitigation, preparedness, response, and recovery to coastal natural hazards and evaluate their application to the CMP.
5. Evaluate the geographic relationship between current coastal management program boundaries and projected impacts from various categories of hurricanes based on the latest coastal study area maps.
6. Assess the physical and social vulnerabilities of coastal populations to facilitate planning and policy development related to hazard mitigation and response.
7. Assess the adoption of hazard mitigation technologies (e.g., hurricane shutters), issues related to the adoption of these technologies, and disaster planning by households and municipalities so that effective and targeted outreach and education activities can be developed.[3]

It is hoped that the research outlined above will generate policy and programmatic recommendations related to coastal programs, management, and regulations. This research will also develop tools for enhancing public involvement in mitigation decision

[1] The original proposal targeted counties in and around the Lake Sabine area, which included Chambers, Hardin, Jasper, Jefferson, Liberty, Newton, and Orange counties. However, after consulting with GLO staff, it was mutually agreed that the target areas would be Harris, Galveston and Brazoria counties, with an emphasis on those areas and communities within the CMP boundary. Throughout the first phase of this project, other changes were made to the original proposal, always based on consultation and agreement with the GLO staff. This document reflects these changes.

[2] By mutual agreement, the emphasis of this task shifted from construction codes and land-use planning policies, to a focus and assessment of mitigation actions plans and mitigation actions for areas within the CMZ.

[3] By mutual agreement and due to budget cuts in March of 2010 it was agreed that this task would focus on the adoption of mitigation polices by municipalities and not households.

making and planning, as well as for assessing programmatic and policy weaknesses and hazard vulnerabilities along the Texas coast. Finally, it is hoped that this research will generate recommendations to better insure compatibility between and concerted action based on the SHMP and the CMP, strengthening mitigation activities throughout the CMP boundary.

During Phase 1, the focus was on Tasks 1, 2, 5, 6, and the formation of a status and trends project advisory committee. Phase 2 of this project completed Task 1, substantially finished Task 2, initiated Tasks 3 and 4, continued work on Tasks 5 and 6, including a major report on the coastal planning mosaic and also held the first advisory committee meeting. Phase 3 completes Task 2, and continues work on Tasks 3, 4, 5, and 6, and initiated Task 7. The following report provides a brief overview of the accomplishments for the third phase of this project for each task and associated subtask. More detailed information and reports associated with many of these tasks are provided in appendixes which include a reissue of a report actually competed at the end of Phase 2 and a new major report examining the status and trends of the social vulnerability of populations residing in the coastal management zone.

Task 1: Assessment of coastal zone planning regimes

Task 1 Description: Tasks 1 was focus on an assessment of mitigation plans and mitigation actions and their potential consequences for mitigating impacts of coastal natural hazards.

The State of Texas regulatory regime is best described as a complex mosaic of regimes at the state and local municipality level. As a consequence it is highly difficulty to understand potential vulnerabilities because there are not single planning mandates and statewide codes. Phase 1 began the process of developing an understanding of this regulatory mosaic, Phase 2 undertook extensive analysis of the complex regulatory regime and evaluated all local hazard mitigation plans. Phase 3 was to focus on the following activities:

a. Continue the environmental scan, the assessment of the number and spatial boundaries of regulatory regimes related to building codes and land use planning policies, and secondary data gathering activities (e.g., collecting information on building codes, various land use policies, etc.) for the target area counties.
b. Complete any loose end related to the elite survey.
c. Complete final report writing of the elite survey results.

Deliverable(s): 1) Final report on the elite survey (SEE APPENDIX 1 for this report).

1.0 The Elite Survey Report

A purposive elite survey was initiated during phase 1 and completed during phase 2 and the final report was actually turned in ahead of schedule as part of Phase 2's final report. The report is re-issued here and is included as Appendix 1. The following is simply a

restatement of the discussion of this report that partially appeared in the Phase 2 final report.

The purpose of this survey is to gain detailed information and individual insights regarding the SHMP, the CMP, and general issues concerned with and surrounding mitigation planning along the Texas coast. More specifically the objectives of this project was to interview government, planning leaders and other stakeholder to ascertain their perceptions and knowledge of Coastal Management Program, the Texas State Mitigation Plan and mitigation issues along the Texas coast. Secondly, this survey sought to assess general perception of hazard mitigation policies and actions that might be taken by planners and emergency managers in local jurisdictions and how the GLO might enhance and encourage the knowledge and adoption of mitigation policies and actions.

The key methodological strategy employed in this study was the qualitative interviewing of key informants. Two methodological strategies were employed in the qualitative interviewing activities. The first was semi-structured interviews with a purpose sample of key informants. The first phase of this survey targeted individuals who are filling particular positions within state, county and local governmental departments and agencies. The targeted individuals are those holding key staff positions with the GLO, the Texas Department of Insurance (TDI), the Texas Wind Insurance Association (TWIA), The Governor's Division of Emergency Management, and individuals holding key positions in county and municipal emergency management departments, planning departments, building departments, flood plain managers, county judges, etc. As part of the interview, interviewees were asked if there were other individuals (reputational or influential leaders) that should be interviewed. By using this snowballing technique, we were able to get a good purposive sample of individuals who were likely to know about or be involved with mitigation activities.

In addition to the semi-structured interviews with a purpose sample of key informants, the second methodology employed in this study was participant observation. Participant observation is a qualitative method whereby researchers participate in activities and can through that participation informally interview and observe participants engaged in these community activities. In addition, by participating in these activities we gained rich qualitative information of the particular actions being undertaken, obtained reports from participants concerning their perception and thoughts about the activity, observed interactions among participants, and observed the types of activities and conversations are actually being undertaken. In total, project staff participated in fifteen activities generally associated with local mitigation planning, environmental planning, coastal management, community planning charrettes, and coastal research/practitioners workshops. Interviewing during the participant observation was more informal and free flowing in comparison to the semi-structured interviews conducted with key informants during a face to face interview session. However, many of the same topics were covered, particularly if they were germane to the activities at hand. More importantly, participation in these activities provided accesses to representatives of key stakeholders such as local business owners, developers, as well as contractors supporting local efforts in mitigation activities.

The implementation of the semi-structured interviews with key informants and informal interviews during participant observation resulted in interviews with approximately 50 individuals. These individuals included: representatives of state agencies such as the Texas General Land Office, Texas Department of Insurance, Division of Emergency Management, Texas Wind Insurance Association, municipal planning department officials, municipal building inspectors, local and county emergency management officials, Sea-Grant extension agents, floodplain managers, contractors with planning and engineering firms, local business owners and developers, mayors, university coastal researchers, directors of various research centers.

The final report offered 51 findings that emerged from the data collection activities. These were organized into four thematic areas: 1) state level agencies (11 findings); 2) county and local emergency management and managers (11 findings), 3) local planners and related local agencies (18 findings), and 4) mitigation planning activities and mitigation actions (10 findings). On the basis of those findings five recommendations are offered to better promote hazard mitigation in the Texas coastal management zone. Rather than repeating the discussion of the 51 findings – which are available in the full report that can be found in Appendix 1 – the following offers the summary and the five recommendations.

After a quick perusal of the 51 findings in the final report on the elite survey, it will be easy to become discouraged when it comes to addressing mitigation issues along the Texas Coast. There are many constraints that can prevent comprehensive mitigation planning and action including the lack of planning mandates, divisions among and between emergency management and planners, a lack of coordination, and a lack of resources, technical skill, and human resources at so many critical points, but particularly in the many communities scattered through the coastal management zone. At times, the thought of engaging in comprehensive hazard mitigation planning seems like a lost cause.

However, there are also many positive points to build on. First of all there are a large number of dedicated individuals throughout the coastal zone and particularly in the target counties that firmly believe in mitigation and mitigation issues. They may not all agree on the solutions or actions that should be taken, but they do agree that something must be done to address the ever-increasing vulnerability of the Texas Coast. The dedicated individuals at state, county, and local levels that recognize the nature of the problems facing the Texas Coast also impressed us along with the observation that, in general they all saw hazard mitigation is a prime solution. Furthermore, as seen above, there are already the beginning stages of cooperative and coordinated action between the Texas Division of Emergency Management (TDEM) and GLO with respect to mitigation planning, and there is the potential of increasing that coordination with the TDI and TWIA. In addition, recent events related to Hurricane Rita and Ike have provided an important window of opportunity that can perhaps motivate greater participation in broader mitigation activities at the state and local level.

Perhaps the best strategy is to build on the strengths that are already evident and by building on these strengths seek to develop a more comprehensive and integrated program promoting coastal hazard mitigation through the SHMP and the CMP. Some of the actions that might be recommended are as follows:

1. *Build on current cooperation and seek to enhance future coordination:* In a sense the first steps have already been taken with cooperation between the GLO and TDEM focusing on mitigation planning efforts. However, future cooperative efforts among GLO, TDEM, and TDI should be explored. One important step that should be considered is expanding membership on the CCC for TDEM and, perhaps even, the TDI should be considered. Clearly there are commonalities in the missions of these agencies and there is a strong possibility of enhancing synergies through coordinating efforts through the CCC.
2. *Targeted Education and Training programs:* Education programs are often mentioned as a solution to enhancing mitigation, however it might be more strategically sound to target those education programs focusing on local emergency management and planning officials. The goal would be to increase the understanding of broad based mitigation approaches, policies, and actions that can be undertaken. Here again, coordination among agencies will be important. In particular, it makes since for TDEM and the GLO to coordinate efforts. Furthermore, when developing these programs it may well make sense to work with professional emergency management organizations, the Texas Chapter of the American Planning Association, and various state universities that have planning and coastal management programs. These programs should focus on broad based mitigation planning including "soft" mitigation strategies such as: overlay zoning, performance zoning, density bonuses, infill/community redevelopment policies, conservation easements and setbacks, land banking, real estate disclosures, etc. In addition, as noted above, there is little recognition that recovery planning, as part of mitigation planning, can be an important tool for addressing past development problems. Hence education programs might address topics such as land banks, damaged-building acquisition, and development rights acquisition as tools that can, both before and after disasters, promote the conversion of damaged and abandoned properties to more appropriate land-uses, shifting development away from high hazard areas.
3. *Developing policy and planning templates:* In addition to education programs, the development of policy and planning templates might well be a logical next step to promote the adoption of mitigation policies. For example, as part of the Texas Chapter of the American Planning Association's list-serve one constantly encounters local planners asking for examples of ordinances and plans that can be employed as models in their own community. These examples are important, not only because they make it easier for a community considering an ordinance to develop its own, but also because these examples have often withstood legal challenges thus better insuring effective policy and ordinance development.
4. *Providing Strategic Tools and Technical Assistance:* It is clear that many local communities (as well as counties) lack the tools and technical knowledge to engage in the critical elements of hazard mitigation planning: hazard identification, vulnerability assessment, and risk analysis. This is particularly the case with the latter. Investment in hazard risk assessment tools might well be a sound investment toward helping coastal communities better understand their risk. The GLO and TDEM have already developed some of these tools and have

sought to make them available to the public a variety of data sets to help in hazard identification and risk. Perhaps the TDI might be an additional partner in these efforts, working with the GLO and TDEM to enhance the development of tools and data bases related to wind risk, as well as higher resolution flooding and surge mapping tools. Of course the development of tools and technical capacities must be coupled with the creation of additional tools and technologies that can integrate data, model output and enhance the ability of local communities, grassroots organizations, stakeholders, and ultimately the public to visualize the problems they face and potential solutions.

5. *Enhancing visualization and data integration tools:* Community planning and emergency management agencies, stakeholders, and the public must have access to tools that can enable them to better visualize and integrate data necessary to not only understand and analyze their current mitigation status, but also to envision their future under a variety of different scenarios. If tools are only left in the hands of a few, then the hopes of widening access and increasing community involvement in coastal planning in general and hazard mitigation planning in particular is doomed. This is particularly important the case of Texas, where planning can most effectively be undertaken at the local municipality level. The efforts being undertaken as part of this project to develop a coastal community planning atlas is an important step in the direction of creating web-based visualization and data integration tools that be easily accessed by the broader public. However, as important as this effort is at providing as a test of concept, enhancing and maintaining this tool or developing the next generation of tools that can be easily accessed must be considered.
6. *Promoting involvement and increasing stakeholder involvement:* Mitigation planning must be seen as part of the larger solution for developing resilient and sustainable coastal communities in Texas. If disaster mitigation planning is seen as part of a portfolio of related issues for developing resilient communities, then the stakeholder base will be increased and, perhaps, involvement also enhanced. This should be part of the targeted education and training programs mentioned above, but also part of a targeted public education program as well. Specifically these programs can be designed to place hazard mitigation into a large context of environmental sustainably, climate change and variability, sea-level rise, and other issues of critical importance to coastal counties in general and coastal communities in particular. These programs should work through and in conjunction with local elementary, middle, and high schools and local community colleges and universities.

Task 2 Identify best practices and emerging technologies related to hazard mitigation planning, building code, land use planning that could further mitigation against potential impacts of coastal natural hazards.

Task Description: This Task will draw from findings emerging from Tasks 1 and 2 in Phase 2. As part of the interviewing and investigations of building codes and land use planning policies, best practices will, on a continuing basis, be identified. This task will

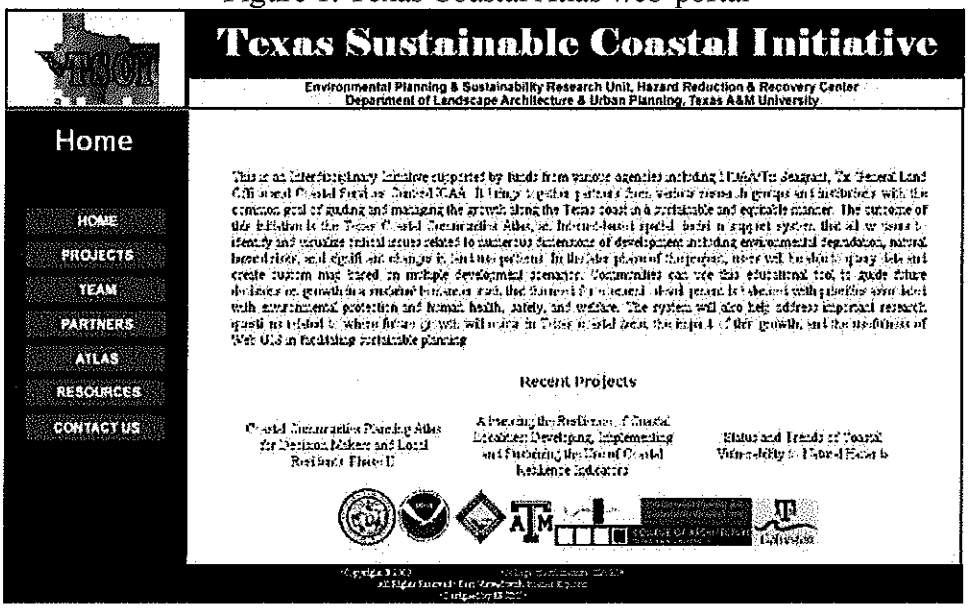
focus on highlighting best practices in terms of their relative effectiveness and outline issues that emerged as local jurisdictions sought to incorporate these practices into their local building codes or land use practices. In the ideal, it would be wonderful to highlight practices that emerged and/or were adopted by local jurisdictions within the State of Texas. However, this task will also review existing and emerging literatures on land use planning, building codes, and emerging construction technologies that can positively impact coastal mitigation actions.

This task will initiate website development for best practices base upon work completed in Task 1 and 2 and reviews of the planning academic literature.

Deliverable(s): Best Practices web page on Coastal Atlas website will be launched and updates provided in progress reports.

The initial *Best Practices* website was launched at the end of November 2008 and can be accessed on the TAMU website (http://coastalatlas.tamu.edu) and the TAMU-Galveston website (http://coastalatlas.tamug.edu) (see figure 1). The content of the website in terms of adding new information and checking existing information and linkages has been updated periodically since its inception.

Figure 1. Texas Coastal Atlas web-portal



After entering the portal, the user clicks on the "Resources" button, which is on the left side of the screen. After clicking the resources button, the resources web-page opens. This page gives users access to two resources pages, one of those pages is the "Best Practice Resources" (see figure 2 and figure3).

Figure 2. The Coastal Atlas Resource Page

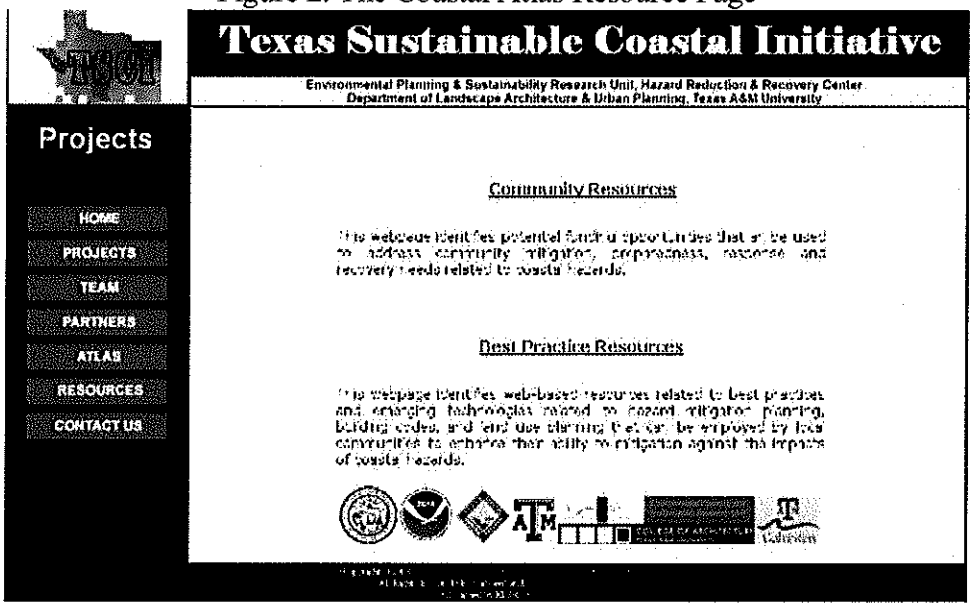
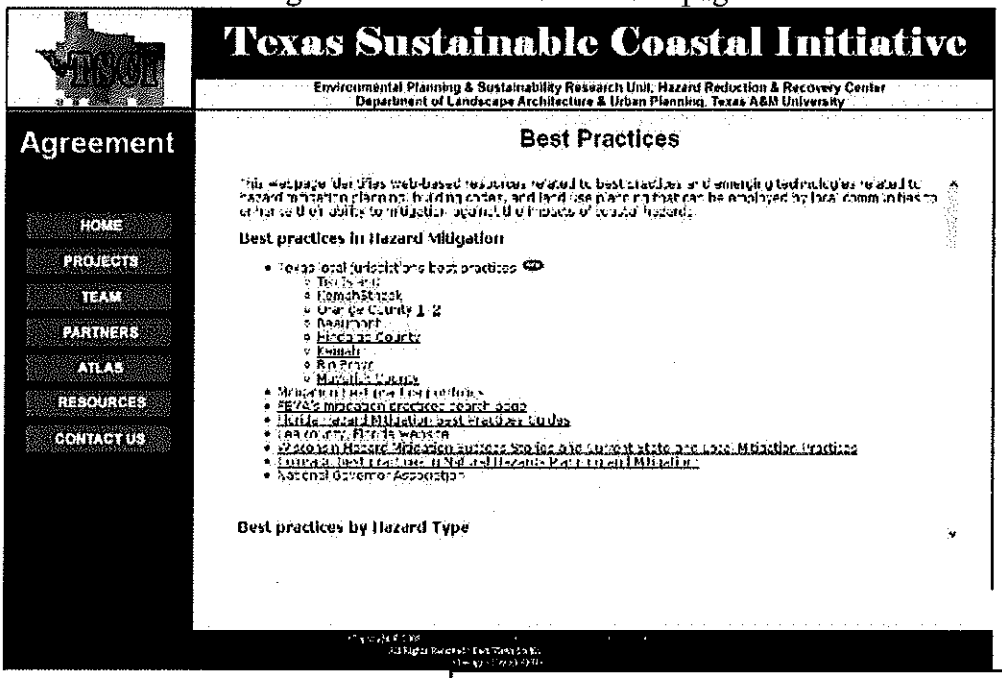


Figure 3. The Best Practices Webpage



The actual locations of the website are: http://coastalatlas.tamug.edu/bestpractices.htm or http://coastalatlas.tamu.edu/bestpractices.htm. The Best Practices web-page displays information regarding special websites that identify a host of suggested best practices related to hazard mitigation policies and actions, videos of best practices projects and examples, and other information. In total the web-pages offers 6 different categories of potential best practices that include over 75 sources including websites, books and articles. The main sections are as follows:

- *Best practices in hazard mitigation*: This section offers a series of websites and even videos. Many of these sites are state or federal government websites that provide general mitigation best practices. In addition to the FEMA mitigation best practices website there are websites from Florida, Wisconsin, Colorado, and the National Governor Association's website.
- *Best practices by hazard type:* This section offers a series of websites that focus on best practices related to flood, wind and wildfire hazards. This section, again targets a variety of websites, including the National Flood Insurance Program (NFIP) and the Community Rating System's website. These two websites are important information that can greatly enhance policies focused on flooding.
- *Best Practices in Planning, Management, and Administration:* This section addresses best practices with respect to land use planning, recovery planning, and building codes. These best practices are particularly important because they offer information on a great variety of non-structural approaches to hazard mitigation, which we found to be under utilized in the mitigation action plan analysis.
- *Technical Tools and Modeling Tools for Best Practices:* This section includes websites that offer information on three sets of tools including FEMA's HAZUS modeling tool, various evacuation modeling tools (HURREVAC, ETIS, and OREMS) and a flooding risk modeling tool (HEC-RAS).
- *Academic Resources on Best Practices:* This section providing a set of references for important research articles and books that discuss mitigation, vulnerability, resiliency and sustainability, recovery, and emergency planning.
- *Organizations and Associations:* This section lists and give web links to organization and associations that address mitigation and hazard mitigation planning. These have been roughly classified into general and specific hazard areas as well as a listing of academic research centers that offer a host of information on mitigation.

The following offers a complete listing of the contents of the best practices website.

I. Best practices in Hazard Mitigation

- Texas local jurisdictions best practices
  - Tiki Island
  - KemahStrizek
  - Orange County 1 2
  - Beaumont
  - Hindalgo County
  - Kemah
  - Rio Bravo
  - Maverick County
- Mitigation best practice portfolios
- FEMA's mitigation practices search page
- Florida Hazard Mitigation Best Practices Guides
- Lee county, Florida website
- Wisconsin Hazard Mitigation Success Stories and Current State and Local Mitigation Practices

- Colorado Best practices in Natural Hazards Planning and Mitigation:
- National Governor Association

II. Best practices by Hazard Type

- Flood
  - NFIP insurance
  - CRS program
  - Stormwater best management practices
  - Best practices for Flood Mitigation
  - Mecklenburg County (Hazard Mitigation Plan, PowerPoint, Storm water management) o Kinston, North Carolina (Flood plain management)
- Wind
  - Texas Department Insurance (TDI), Windstorm inspection program o New School Building "Hardened" Against the Wind
- Wildfire
  - National Database of State and Local Wildfire Hazard Mitigation Programs:
    This database provides various information about current policies and programs related to wildfire.

III. Best practice in planning, management and administration

- Land use planning
  - APA(American Planning Association) APA has conducted research regarding integrating hazard mitigation into local planning and introduced best practices in their webpage Bibliography on literature review regarding integrating hazard mitigation in local planning and best practices
- Recovery planning
  - ASCE (American society of Civil Engineers)
  - American City and County:
    Coastal towns rethink development patterns: Katrina recovery plans incorporate mixed uses. May 2006.
- Building Code
  - IBHS (Institute for Business &Home Safety) building code webpage
  - Building code reference library:
    This webpage provides you with detailed information on building codes for all 50 states, major cities, and some counties. o
    Florida Building code:
    this webpage provide information of Florida building code.
  - Whole Building Design Guide (WBDG) o ASCE (American Society Civil Engineers):
    Building standards guide information o
    Building code examples
    - Miami-Dade County
    - California Code of Regulations (CCR)

IV. Technical tools and modeling tools for best practices

- FEMA HAZUS
  - FEMA
  - NIBS (National Institute of Building Sciences): Multi-hazard Loss Estimation Methodology
- Evacuation modeling
  - HURREVAC (Hurricane Evacuation)
  - CATS/JACE (Consequence Assessment Tool Set/Joint Assessment of Catastrophic Events) o ETIS (Evacuation Traffic Information Systems) Recommended practuces for hurricane evacuation traffic operations o OREMS (Oak Ridge Evacuation Modeling System) o Evacuation Management Decision Support System (EMDSS)(link article " A hurricane evacuation management decision support system", Natural hazards, Lindell and Prater)
- Flood risk modeling
  - HEC-RAS (Hydrologic Engineering Centers River Analysis System) o Source of Assistant (Reducing Damage from Localized Flooding: A Guide for Communities)

V. Academic resources on best practices (Journal articles, books etc.)

- Mitigation
  - David R. Godschalk, (2000) Avoiding Coastal Hazard Areas: Best State Mitigation Practices. Environmental Geosciences Mar2000, Vol. 7 Issue 1, p13-22 o Deyle, Robert E., Timothy S. Chapin, and Earl J. Baker (2008) The Proof of the Planning Is in the Platting An Evaluation of Florida's Hurricane Exposure o Mitigation Planning Mandate. Journal of the American Planning Association, Vol. 74, No. 3, Summer o Nelson, Arthur C., and Steven P. French (2002). Plan Quality and Mitigating Damage from Natural Disasters: Case Study of the Northridge Earthquake with Planning Policy Consideration. Journal of The American Planning Association, Vol: 68. No. 2 o Schwab, J. C. (Ed.). (2010). Hazard mitigation: integrating best practices into planning. Chicago, IL: American Planning Association, Planning Advisory Service. Report Number 560.
- Vulnerability
  - Boruff, B.J.; Emrich, C., And Cutter, S.L., (2005). Erosion hazard vulnerability of US coastal counties. Journal of Coastal Research, 21(5), 932-942. o Simpson, David M. and R. Josh Human (2008) Large-scale vulnerability assessments for natural hazards. Natural Hazards 47:143–155 o Social Vulnerability to Environmental Hazards (Cutter, Boruff and Shirley)

- Social vulnerability and the natural and built environment: a model of flood casualities in Texas (Zahran, Brody, Peacock, Vedlitz and Grover) Resiliency and sustainability research o Disasters by Design (Mileti)
- Godschalk, David R., 2003 Urban Hazard Mitigation: Creating Resilient Cities. Natural Hazards Review, Vol. 4, No. 3, August 1. Recovery
- Hurricane Andrew (Peacock, Gladwin and Morrow)
  Olshanky, R.B., & Johnson, L.A. (2010). Clear as mud: planning for the rebuilding of new orleans.. Chicago, IL: American Planning Association Planner's Press.
- Deyle, R., Eadie, C., Schwab, J., Smith, R., & Topping, K. (1998). Planning for post-disaster recovery and reconstruction (pas 483/484). Chicago, IL: APA Planning Advisory Committee.

Emergency planning

- Emergency planning(Perry and Lindell)

Natural resource management

VI. Organizations and Associations

- Multi-hazards
  - FEMA Mitigation
  - APA Growing Smart
  - IBHS (Institute for Business and Home Safety)
  - National Institute of Building Sciences Multihazard Mitigation Council
  - USGS Hazards
  - International Strategy for Disaster Reduction
- Earthquake
  - Building Seismic Safety Council(BSSC)
  - Earthquake Engineering Research Institute (EERI)
    Hurricane, Wind
  - Wind Science and Engineering Research Center, Texas Tech University
    HazNet:
    The National Sea Grant Network Web Site for Coastal Natural Hazards Information.
- Flood
  - Association of State Floodplain Managers (ASFPM)
- Fire Color Country Interagency Fire Management Area
  - The Fire Safe Council
    Firewise Communities
  - National Interagency fire Center
    National Database of State and Local Wildfire Hazard Mitigation
  - Programs
    - National Fire Protection
- Association Research Institute
  - Hazard Reduction and Recovery Center, Texas A&M University

- Natural Hazards Center, University of Colorado at Boulder
- Disaster Research Center, University of Delaware
- Hazards & Vulnerability Research Institute, University of South Carolina

Task 3: Assess the local, state and federal resources available for mitigation, preparedness, response and recovery from coastal natural hazards and evaluate their application to the TCMP.

Task Description: Regardless of whether one is a period of declining or expanding funding from federal, state, or local sources, the funding of activities to address hazard impacts or potential impacts will often require the creative use of a host of funding resources, many of which might not appear to be particularly relevant at first glance. For example, low-income housing is often the most susceptible to hurricane hazards, yet targeting a program to directly address these issues can be difficult. However, using local housing authority and energy efficiency funding, some local communities have been able to match State funding and provide shutters for low-income elderly homeowners. The focus of this task will identify local, state, and federal resources that might be employed to meet mitigation, preparedness, response, and recovery needs stemming from coastal hazards.

This task includes the following objectives:

a. During interviewing as part of earlier phases local officials will be asked about innovative funding sources that can be utilized to enhance local mitigation, preparedness, response and recovery.

b. The natural hazard literature, particularly the literature with a more applied focus, and the internet will be searched in order to identify potential resources that might be brought to bear on these issues.

c. Sources will be identified and narrative discussions evaluating their potential utility will be provided on a web site devoted to identifying potential resources.

Deliverable(s):
Updates provided in progress reports.

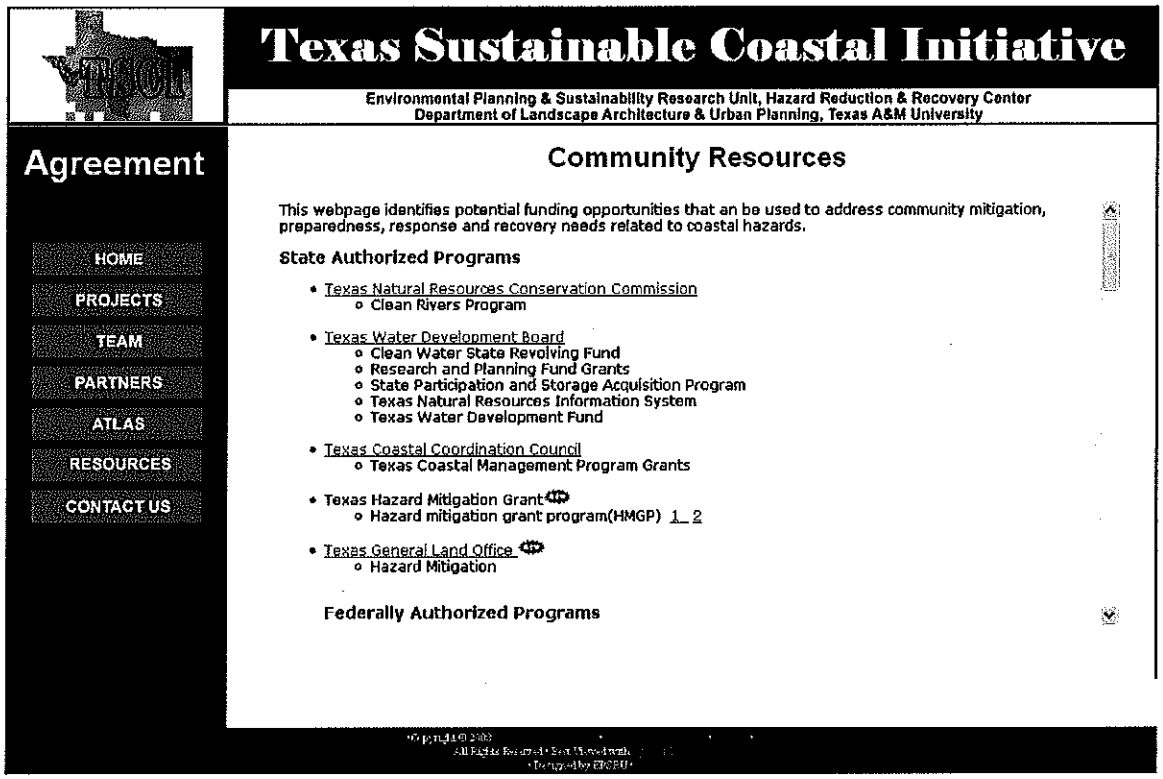


Figure 4. Community Resources Webpage

Figure 4, above, displays the community resource webpage that was initially launched in November of 2008. It is accessible by selecting or clicking on the hot link off the Community Resources webpage (see Figure 2). The actual website is now located on both the TAMU (http://coastalatlas.tamu.edu/community.htm) and TAMUG (http://coastalatlas.tamug.edu/community.htm) websites. It is frequently updated and its links are checked for accuracy. The community resource page lists over 80 State and Federal websites that provide information on different types of resources that can be utilized to improve and develop mitigation policies and, most importantly, fund and implement potential mitigation actions. The complete listing of resource hot links is as follows:

State Authorized Programs

- Texas Natural Resources Conservation Commission
  - Clean Rivers Program
- Texas Water Development Board
  - Clean Water State Revolving Fund
  - Research and Planning Fund Grants
  - State Participation and Storage Acquisition Program
  - Texas Natural Resources Information System
  - Texas Water Development Fund

- Texas Coastal Coordination Council
  - Texas Coastal Management Program Grants
- Texas Hazard Mitigation Grant
  - Hazard mitigation grant program(HMGP) 1 2
- Texas General Land Office
  - Hazard Mitigation

Federally Authorized Programs

- Department of Agriculture, Natural Resources Conservation Service
  - Emergency Watershed Protection Program
  - Watershed Protection and Flood Prevention Program
  - Watershed Surveys and Planning
  - Wetlands Reserve Program
    http://www.nrcs.usda.gov/programs/watershed/index.html
    http://www.nrcs.usda.gov/programs/wrp/
- Department of Housing and Urban Development
    - Disaster Relief/Urgent Needs Fund
    - Texas Community Development Program
    - Community Development Block Grant (CDBG)
  - Environmental Protection Agency
    - Drinking Water State Revolving Funds
    - Nonpoint Source Grant Program
    - Water Protection Coordination Grants to States
    - Water Quality Cooperative Agreements
    - Watershed Initiative Grants
    - Wetlands Grants
  - Federal Corporation for National and Community Service, Special Volunteer Programs and the Retired and Senior Volunteer Program o

Department of Homeland Security

Citizens Corp

http://www.dhs. gov/xopnbiz/grants/
http://www.dhs. gov/xgovt/grants/index. shtm
http://www.grants.gov/
http://www.dhs.gov/xlibrary/assets/OfB_CDFA_Crosswalk.pdf

- All-Hazards Emergency Operational Planning
- Antiterrorism and Emergency Assistance Program
- Assistance to Firefighters Grant
- Buffer Zone Protection Program
- Chemical Stockpile Emergency Preparedness Program
- Community Assistance Program, State Support Services Element (CAP-SSSE)
- Citizens Corp
- Community Emergency Response Teams (CERT)
- Community Disaster Loans
- Competitive Training Grants Program

- Cooperating Technical Partners
- COPS Interoperable Communications Technology Program
- Disaster Preparedness Improvement Gant (DPIG)
- Emergency Food and Shelter Program
- Emergency Operations Center Funding
- Emergency Management Performance Grant
- Fire Management Assistance Grant Program
- First Responder Counter-Terrorism Training Assistance
- Flood Hazard Mapping Program
- Flood Mitigation Assistance Grant Program
- Flood Recovery Mapping
- Hazard Mitigation Grant Program (HMGP)
- Hazardous Materials Assistance Program
- Hazardous Materials Emergency Preparedness Training and Planning
- Hurricane Local Grant Program
- Infrastructure Protection Program (IPP)Law Enforcement Terrorism Prevention Programs
- Individual Assistance Program
- Map Modernization Management Support
- National Dam Safety Program
- National Earthquake Hazard Reduction Program
- National Flood Insurance Program
- National Urban Search and Rescue (US & R) Response System
- Pre-Disaster Mitigation Grant Program (PDM)
- Public Assistance Grant Program
- Preparedness Grant Fund
- Repetitive Flood Claims Program (RFC)
- Regional Catastrophic Preparedness Grant program -- http://www.fema gov/government/grant/rcp/index. shtm
- Section 406 Hazard Mitigation Grant Program
- Severe Repetitive Loss (SRL)
- State Homeland Security Program
- State and Local Domestic Preparedness Training Program
- Superfund Amendments and Reauthorization Act o

Small Business Administration

- Small Business Administration Disaster Assistant Program
- Pre-Disaster Mitigation Loan Program

o U.S. Army Corps of Engineers

Useful Government Links

Programs

Planner's Study Aids

- Aquatic Ecosystem Restoration http://www.usace.army.mil/CECW/PPA http://www.usace.army.mil/CECW/PlanningCOP/Documents/library/pgms/pgl97-05.pdf
- Aquatic Habitat and Wetlands

        - Beach Erosion and Coastal Projects
        - Clearing and Snagging Projects
        - Emergency Advance Measures for Flood Prevention
        - Emergency Rehabilitation of Flood Control Works or Federally Authorized Coastal Protection Works
        - Emergency Streambank and Shoreline Protection
        - Floodplain Management Services
        - Nonstructural Alternatives to Structural Rehabilitation of Damaged Flood Control Works
        - National Flood Risk Management Program
        - Planning Assistance to States
        - Small Ecosystem Restoration
        - Small Flood Control Projects
    - Community Capacity Development Office (CCDO), Office of Justice Programs (OJP), U.S. Department of Justice
        - Operation Weed and Seed
    - Department of Health and Human Services
        - Public Health Emergency Preparedness
        - Bioterrorism Training and Curriculum Development

Tasks 4 and 5:

Both Tasks 4 and 5 deal with assembling various forms of data, such as mapping or spatial data and utilizing these data to create, populate and improve the platform for their usage to help Texas coastal communities and various stakeholders communities and stakeholders in their planning activities. Indeed the primary activity required by these tasks was development and maintenance of a website to display data and tools that will enable the public to gain access to these data in a user friendly website environment. Over the course of this multi-year project the website developed for this purpose is called the Coastal Planning Atlas and is now hosted at both the main TAMU campus in College Station (coastalatlas.tamu.edu) and in Galveston (coastalatlas.tamug.edu). Given the similarities between these two tasks, the accomplishments for each will be discussed together. The following will briefly outline the tasks and subtasks associated with each. This will be followed by a discussion of the accomplishments for both tasks and their subtasks during phase 3.

Task 4: Evaluate the geographic relationship between current CMP boundaries and project impacts from various categories of hurricanes based on the latest coastal study area maps.

Task 4 Description: Task 4 is developing procedures for spatially displaying and analyzing the mosaic of coastal management and planning regimes in conjunction with coastal management program boundaries and physical hazard vulnerabilities. The goal is to provide insights with respect to the spatial distribution of quality management and contiguous (or noncontiguous) consistency and compatibility in management in order to

identify weaknesses in broader coastal management issues. In a very real sense, the focus of this task will be a spatial analysis of coastal management vulnerability – an analysis of vulnerabilities emerging due to management deficiencies or inconsistencies.

This task includes the following objectives:

a. Continue assembling physical hazard analyses related to coastal natural hazards (surge maps, inland flooding maps, flood plain maps, and wind field maps).
b. Continue assembling and integrating coastal management and policy boundary files.
c. Continue development and refinement of methodologies for displaying general policies based on quality and area of implementation.
d. Begin spatial analysis of these data and where necessary develop methodological tools to display these data and the results from the analyses.
e. Begin the development of a web based system for making the findings available to prospective users.
f. Make data – non-proprietary data- available to users and enhance uploading of data to site by users.

Deliverable(s): Updates provided in progress reports

Task 5: Assess the physical and social vulnerabilities of coastal populations to facilitate planning and policy development related to hazard mitigation and response.

Task 5 Description: A critical element in the determining "management vulnerabilities" and hazard mitigation plans and planning along with building codes is an assessment of the physical and social vulnerabilities of a coastal population. Task 5 therefore is important for the other tasks to be undertaken as part of the larger project and will provide a usable set of products for end users making decisions related to hazard management planning and policy development.

This task includes the following objectives:

a. Most if not all of data needs for this project should have been met by Year 3, however additional data may be needed to compile and added as it becomes available.
b. Continue spatial analysis and finalize methodologies for identifying socially vulnerable populations.
c. Update and compete development of a web based system for making the findings available to prospective users.
d. Begin the process of including temporal and spatial assessments of social vulnerability utilizing historical census data.
e. Assess and begin if possible the temporal assessment of physical vulnerabilities.

Deliverable(s):

1 Preliminary report on spatial and temporal dimensions of population vulnerabilities. (SEE APPENDIX 2 for this report)

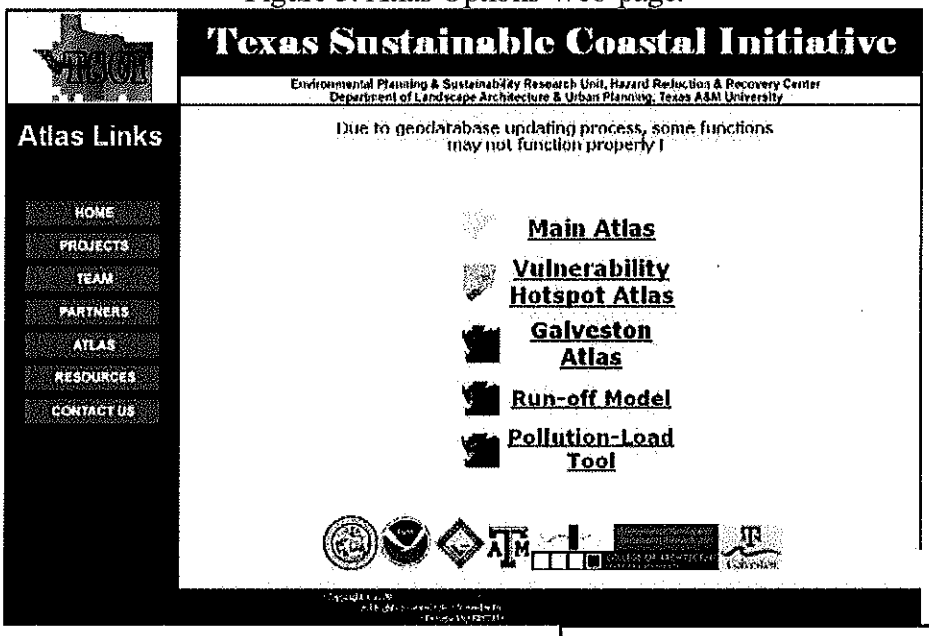
2. updates provided in progress reports. The Coastal Atlas website will be updated and improved. Updates will be provided in quarterly reports.

In sum, both Tasks 4 and 5 include collecting data (primarily and secondary data), continue creatively evolving a website that will allow for the mapping of these data and the development of tools to utilize these data. While Task 4 focuses on hazard data and policy data, Task 5 includes additional hazard data, data on physical hazards and, most importantly this year data for establishing and measuring population social vulnerabilities. Both tasks address continuing to spatially analyzing these data and developing methodological tools for displaying the data and results and providing a web based system whereby prospective users can make use of the data and their results. The additional major task for this phase was to undertake the writing of a report utilizing the data collected to spatially analyze population social vulnerabilities of coastal counties, focusing on the CMZ. The following offers some of the highlights of the website, its data, and its tools.

I. Website options and enhancements:

Phase 3 of the Status and Trends project has seen major improvements to the Coastal Atlas Website. We have continued to modify the look, feel, and content of the Coastal Planning Atlas by improving data layers, displays and tools. New servers have been brought on line at Texas A&M Galveston that have greatly enhanced the capabilities of the website. Indeed, the website is hosted in both locations: coastalatlas.tamu.edu and coastalatlas.tamug.edu. We have gone from principally three (3) websites to offering five (5) different Atlas websites delivering a variety of data and tools targeting particular areas or analysis themes in an easily accessible manner with a host of tools to allow for visualization of the data and data analysis.

Figure 5. Atlas Options Web-page.



The principle access point for the website is through http://coastalatlas.tamu.edu or http://coastalatlas.tamug.edu pictured in Figure 1 (see above). The user clicks on the

"Atlas" button on the left hand side of the webpage. Once that button is clicked, the Atlas-options webpage (see Figure 5) opens offering 5 different Atlas web-pages or entry portals. The *Main Atlas* offers a host of data for all coastal counties, the *vulnerability Hotspot Atlas* offers pre-analyzed and configured data layers to enable users to undertake both physical, social, and environmental vulnerability and sustainability analysis, the *Galveston Atlas* provides very rich and refined data at a high resolution for the Galveston County, the *Run-off Model* features a unique what if approach that allows the user to understand the consequences, in terms of potential flooding runoff, for different types of development, and the final website is the *pollution-load tool* (which is actually prepared as part of phase 4 and will not be discussed further in this report). The following will provide a brief tour of these first four atlas pages.

Access to the main atlas webpage can be gained by simply clicking on the "Main Atlas" hotlink in the center of the Atlas Options Webpage. Figure 6 displays a visual representation of the main atlas page. This webpage now displays 18 different categories of data layers including administrative boundary layers, transportation, topography, ecological data, and natural hazards data layers to name a few. In total, the Main Atlas webpage provides 98 different data layers in a fully operative Geographical Information Systems format. The entire detailed listing of these 98 data layers can be found in Table 1.

Figure 6. The Main Atlas Page

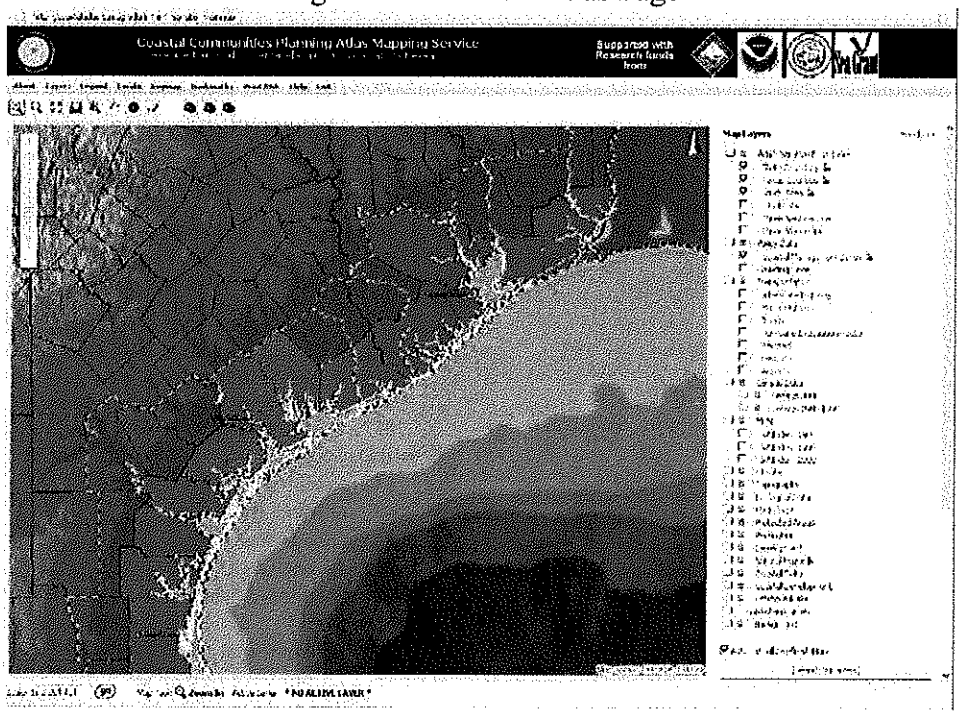


Table 1. A Detailed Listing of Data Layers Available Through the Main Atlas Webpage.

Administrative boundaries
1. State boundary
2. Texas Counties
3. Study Area
4. City Limits
5. Three Nautical line
6. Three Marine line
7. Study Area County Labels

Policy Data
8. Building Code
9. Coastal Management Zone

Transportation
10. Interstate Highway
11. Major Highway
12. Roads
13. Hurricane Evacuation Route
14. Railroad
15. Heliports
16. Airports

Census Data
17. County Population (2000)
18. Census Tract Population (2000)
19. Block Group Population (2000)
20. Block Population (2000)

Census 1980-1990
21. County Population Growth Rate
22. Census Tract Population Growth Rate
23. Block Group Growth Rate

MEND (Mitigation and Engagement Need Index)
24. SV_Index1980
25. SV_Index1990
26. SV_Index2000

Climate
27. Rainfall

Topography
28. Elevation

Ecological Data
29. Eco-Regions
30. Vegetation
31. Seagrass
32. Washover Areas

Hydrology
33. Hydrological Units
34. Rivers and Streams
35. Lakes and Reservoirs

Protected Areas
36. Federal Lands
37. National Parks
38. State Parks
39. Wildlife Refuge
40. Marine Sanctuaries
41. Audubon Sanctuaries
42. Coastal Preserves
43. Burn Exclusion Zone
44. Habitat Priority Areas
45. Wetland Inventory Data
46. Historic Places (National Register)
47. Species
48. Rookery
49. Hard Reefs
50. Open gulf

Recreation
51. County and City Parks
52. Beach Access
53. Marinas
54. Boat Ramps

Development
55. Census county Property Values (2000)
56. Census Tracts Property Values (2000)
57. Census Block Groups Property Values (2000)
58. Populated Places
59. Dams
60. Wetland Permits

Natural Hazards
61. Hurricane Surge Zones Category 1
62. Hurricane Surge Zones Category 2
63. Hurricane Surge Zones Category 3
64. Hurricane Surge Zones Category 4
65. Hurricane Surge Zones Category 5
66. Hurricane Risk Zones Category 1
67. Hurricane Risk Zones, Category 2
68. Hurricane Risk Zones, Category 3
69. Hurricane Risk Zones, Category 4
70. Hurricane Risk Zones, Category 5
71. Hurricane Tracks
72. Hazard Events (1960-2005)
73. FEMA Flood Zones (FEMA Flooding Risk)
74. Fire Risk Zones
75. Earthquake Risk Zone

Coastal Data
76. Coastal Topography
77. Bathymetry Points
78. Bathymetry Lines (Bathymetry contours)
79. Sea Floor Features
80. Detailed Shoreline
81. Ship Channel
82. Ship Fairway
83. Coast Guard

Coastal Development
84. Resource Management codes
85. Offshore Blocks
86. Oil and Gas Leases
87. Oil and Gas Units
88. Oil and Gas Platforms

Offshore Risks
89. Environmental Sensitivity Index
90. Erosion Areas (Erosion)
91. Tidal Influence (Tidal Influence Zone)
92. Coastal Barriers
93. Dredged Sites

Galveston Parcels
94. Parcels_2005

Background
95. Texas Image
96. Background
97. Water
98. Mexico

The websites have full set of operative GIS tools that are located in the upper left hand corner, just above the map itself. These tools are available in all three of the Atlas webpages (Main, Hotspot, and Galveston). The buttons in the grey bar offer tools that, for the most part, provide information regarding the current map. Activating or selecting one of these tools results in the information appearing in the left frame of the atlas screen. For example, clicking the "Layers" button results in the 18 categories (or 98 detailed categories) of data layer options appearing in this frame, which allows the user to active specific data layers for presentation. Furthermore, of one clicks on the "Legend" button, a legend will appear in the left frame providing the user with information regarding the data currently being displayed in the map frame. One can also select the "Print PDF" button to obtain a hardcopy of the current map. There is also a set of quick tools including: zoom in (+), zoom out (-) query tool (*i*), and a tool to move the map (the hand symbol).

There are more advanced tools that can be opened in the red, green, and blue tool box icons. The red tool box contains tools to save current work, email the results, upload or download data, as well as a tool that allows the user to use additional visualization tools such as "Virtual earth," or "Google earth" to obtain a visual picture of a mapped location. This tool box also contains tools to get measurements and add captions to a map. The green tool box contains a number of mark-up tools. These tools allow one to draw on or add additional information to a map. For example one can draw dots, add lines, add geo-referenced lines or points, draw polygons, move mark-up symbols, and add labels. These are all tools that should be particularly useful when conducting workshops or planning charrettes. During these events participants can display a variety of attributes and then use markup tools to discuss "what if" scenarios and ask questions like: What if land-use patterns are changed in 'this' area? What wetland areas might be impacted? How would the look of our community change?

The final tool box, the blue tool box, contains additional query tools where by one can select and create complex sets of queries where by one can use attribute tables to select and combine data to answer questions. There is also a fully function tutorial that can be executed to provide more information about how to use the full GIS capabilities built into the system by Geocortex® and ArcIMS ® We will be converting away from these in the very near future.

The following are some examples of simple maps that display some of the data available in the Main Atlas web page. The first map, Figure 7, is a very simple map of hurricane surge zones with the Coastal Management Zone boundary file overlaying these zones for the northeastern part of the Texas coast. The surge zones range from those associated with a category 1 storm in red, category 2 in dark orange, category 3 in dark yellow (slightly darker than the county background color), category 4 in pink and, lastly category 5 storm in light pink. This is an interesting map because it clearly shows many surge risk areas extend well beyond the CMZ. This may well be a good argument for extending the CMZ further inland in many areas, because these are coastal areas subject to coastal storm surge. Furthermore, it should also be clear that substantially all areas within the CMZ are highly vulnerable to surge.

Figure 7. Main Atlas with Surge Zones and CMZ layers active.

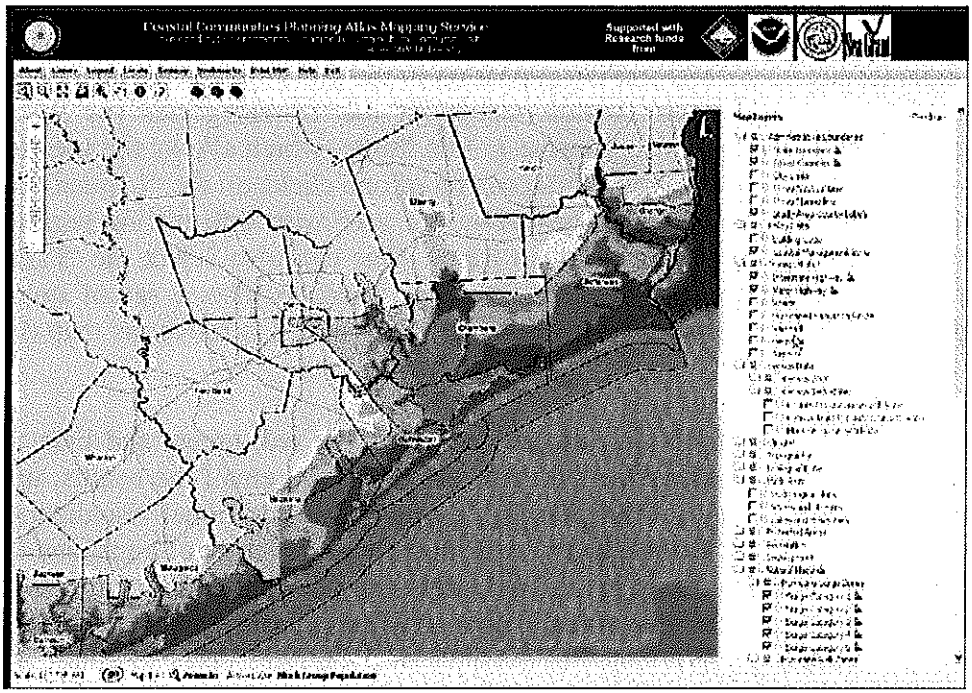


Figure 8. More Elaborate map of Corpus Christi & Port Aransas Areas.

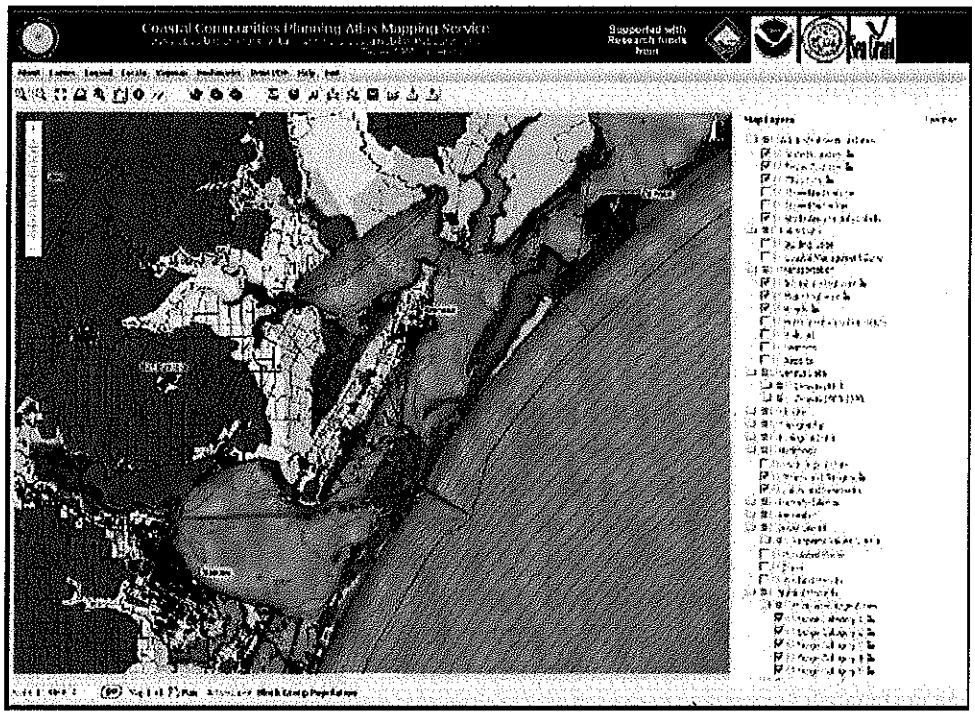
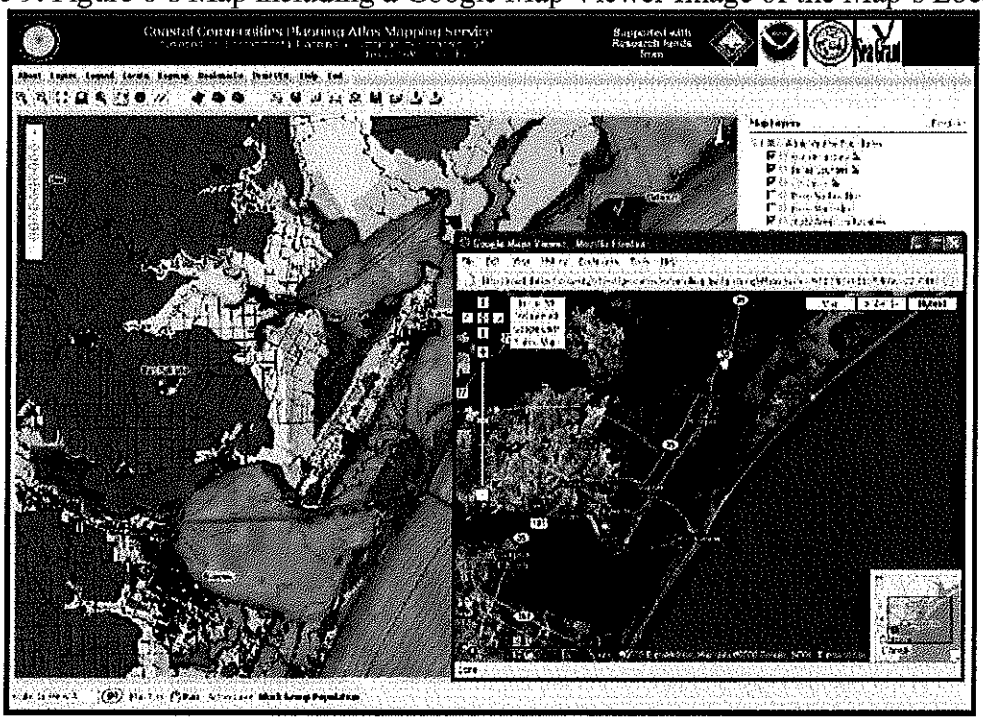


Figure 8 offers a bit more elaborate map of the Corpus Christi and Port Aransas area. This map includes bathometry data and road/highway data along with the surge zone data

from category 1 through 5. Of course, one can zoom all the way into a much higher resolution to capture surge zones relative to specific roads and neighborhoods. In addition, as shown in Figure 9, by activating the external map visualization tool, the user can bring up a virtual map of any location, geo-referenced to the map being developed within the Atlas. Here, a Google-map has been activated to actually display a picture of this location.

Figure 9. Figure 8's Map including a Google Map Viewer Image of the Map's Location



In addition to the 98 layers discussed above as part of the main atlas webpage, the hotspot webpage contains 73 layers of data. The vulnerability hotspot page is accessed from the Atlas options page (see Figure 6). This page provides more detailed data associated with counties in the northeastern portion of the Texas coast. Many of these data have been processed with respect to the county or municipality to allow for county and city planners, emergency management officials, stakeholders, or just the general public to undertake analysis that is relevant for their particular area of interest. These include ecosystem criticality measures that assess how critical ecosystem areas (defined by county area, census tract area, and census block area) are under stress due to development. Land-use changes over decades. Social vulnerability analysis utilized census data at the block level to identify areas containing populations likely to have difficulty preparing for and responding to environmental hazards and disasters, can also be undertaken with this website. A full discussion of this type of analysis is presented in the detailed report on social vulnerability and the Coastal Atlas that can be found in Appendix 2. These data have also been analytically combined so that one may examine areas with particular types of needs (child care, elder care, public transportation, housing recovery, and overall social vulnerability hotspots) at the municipality or county level. Finally there are basic economic analyses, based on Location Quotient Analysis, included

at the county level as well. The full list of data available for the hotspot webpage is listed in Table 2. However it should also be noted that we have added social vulnerability analysis – termed MEND – analysis to the main atlas page. Indeed these data will provide assessment of changes in social vulnerability using the 1980, 1990 and 2000 census data. The report on Social Vulnerability in Appendix 2 discusses this analysis.

Table 2. Data Available on the Hotspot Website.

Political & Administrative Boundaries
1. 2000 Census Count
2. 2000 Census Tracts
3. 2000 Census Block Groups
4. 2000 Blocks
5. Focus Texas Counties
6. Non-Coastal Counties
7. City Limits
8. Building Codes

Transportation
9. Interstate Highway
10. Major Highway
11. Hazardous Cargo Routes
12. Hurricane Evacuation Routes

Demographic Data (Census 2000)
13. County
14. Census Tracts
15. Census Block Groups
16. Census Blocks Natural

Hazards: Hurricane Surge Zones
17. Category 1 Surge Zone
18. Category 2 Surge Zone
19. Category 3 Surge Zone
20. Category 4 Surge Zone
21. Category 5 Surge Zone

Natural Hazards: Hurricane Risk Zones
22. Risk Zone A
23. Risk Zone B
24. Risk Zone C

Natural Hazards: Hurricane Tracks
25. Hurricane Tracks (1851-2005)

Natural Hazards: Flooding
26. FEMA Flood plains

Ecosystem Critically Measures (ECM)
27. ECM County
28. ECM Census Tract
29. ECM Block Group
30. ECM Block

Social Vulnerability Assessment: Base Characteristics
31. Population < 5 years
32. Single Parent Households with Children
33. Population Age > 65 years
34. Population Age > 65 years below Poverty Line
35. Workers using Public Transportation
36. Households without Vehicle
37. Occupied Housing Units
38. Renters
39. Race (non-White)
40. Persons in Group Quarters
41. Housing Units > 20 years
42. Mobile Homes
43. Persons in Poverty
44. Occupied Housing Units without phone
45. Education less than HS for Age > 25 years
46. Unemployed (Age > 16 years)
47. Population speaking English not well/not at all (Age>5years)

Social Vulnerability Assessment: Indexes (Block Groups regional comparisons)
48. Child Care Needs
49. Elderly Care Needs
50. Transportation Needs
51. Recovery Needs
52. Capacity Building Needs
53. Raw total Social Vulnerability Index (SVI)
54. Weighted SVI

Social Vulnerability Assessment: Block Group County Comparison using SVI
55. Orange County
56. Newton County
57. Liberty County
58. Jefferson County
59. Jasper County
60. Harris County
61. Hardin County
62. Galveston County
63. Fort Bend County
64. Chambers County
65. Brazoria County
66. Construction
67. Others

Location Quotient Analysis
68. Natural Resources and Mining
69. Construction
70. Other

Land Cover Data
71. Land Use 1996
72. Land Use 2001
73. Land Use 2005

Figure 10 displays a map of areas (census block groups) in Galveston that are socially vulnerable when it comes to transportation needs, in that the darker areas have higher proportions of households without vehicles and in which workers are more likely to depend on some form of public transportation to get back and forth from work. These areas can therefore be expected to have individuals and households that will find it more difficult to evacuate for hurricanes.

Figure 10. Transportation Dependent Areas in the City of Galveston.

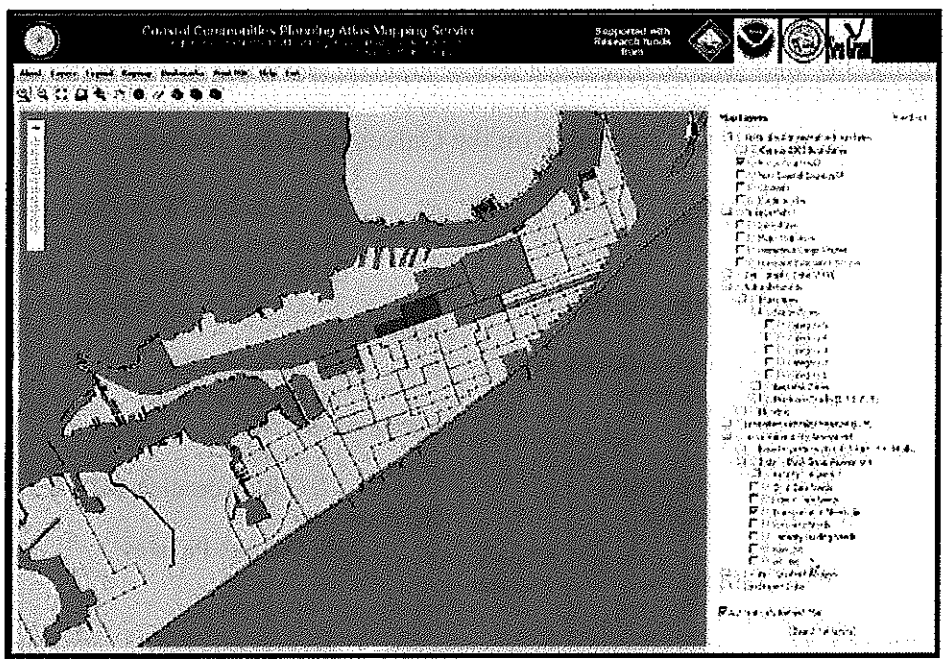
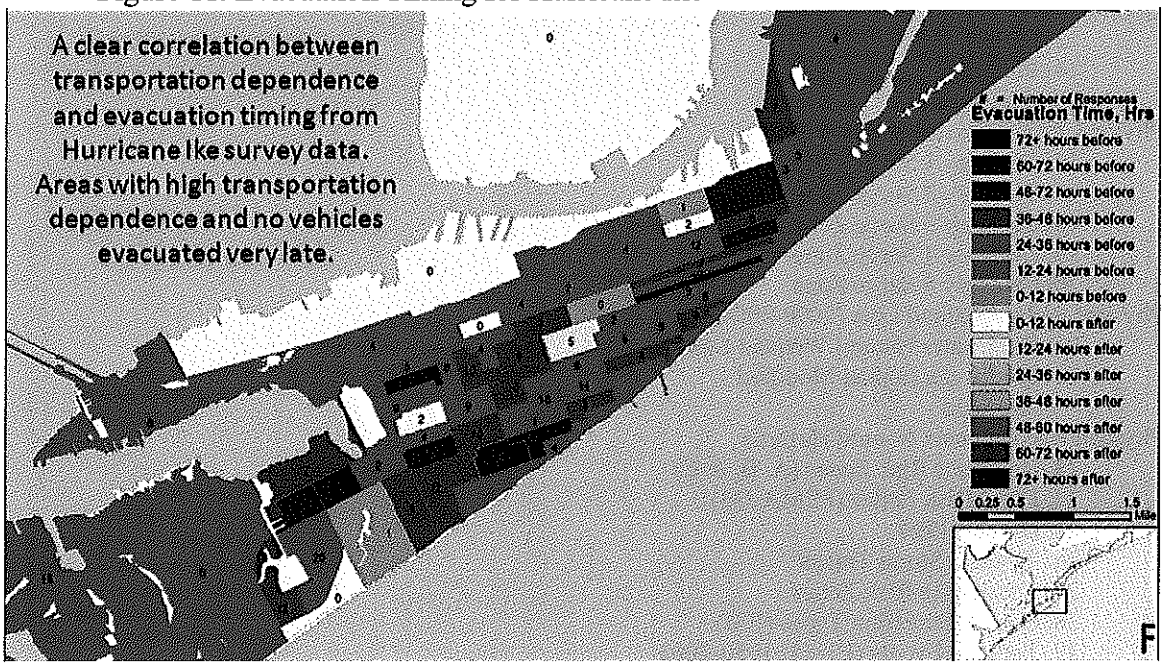


Figure 11. Evacuation Timing for Hurricane Ike



It is interesting to contrast the image in Figure 10 with that of Figure 11, which displays the evacuation timing of households from a survey of a random sample of households conducted after hurricane Ike. These data have been aggregated (averaged) to the block group and the averages have then be categorized ranges of evacuation timing periods. This procedure results in often very small numbers of observations (the numbers embedded in each block group polygon) being averaged, however it does provide a means of looking for patterns of evacuation. It should be clear that areas with higher proportions of households that were transportation dependent were more likely to evacuate between 12 to 24 hours before the storm. In other words these households left very late in the evacuation period. This analysis was pushed much further in the report on social vulnerability that will be discussed below and can be found in Appendix 2.

Table 3. Data Available on the Galveston Atlas Website.

Administrative Districts Boundaries
1. County
2. City
3. Water Control and Improvement Districts (WCIDs)
4. Municipal Utility Districts (MUDs)
5. Independent School Districts (ISDs)
6. Drainage Districts
7. Emergency (police, fire, EMS) Service Networks (ESNs)
8. College Boundaries
9. Navigational Districts

Census 2000 Data
10. Census Tracts
11. Census Block Groups
12. Census Blocks

Development
13. Streets
14. Railroads
15. Landmarks

Physical Risks: Hurricane Surge Zones
16. Category 1 Surge Zone
17. Category 2 Surge Zone
18. Category 3 Surge Zone
19. Category 4 Surge Zone
20. Category 5 Surge Zone

Physical Risks: Wetland Loss (2000-2004)
21. Freshwater Natural Wetland Loss
22. Freshwater human Modified Wetland

Physical Risks: Others Natural Hazards
23. Hurricane Risk Zones (A, B, & C)
24. Flood Risk Zones (FEMA-Q3)
25. Flood – 1994
26. Tropical Storm Tracks
27. Subsidence Risk Zones
28. Coastal Shoreline Types (ESI)
29. Tornado Events (F3-F5) 1950-2003
30. Hazardous Waste Sites 2004
31. Flood Events 1993-2003
32. Drought Events 1994-2003
33. Coastal Erosion Rates (Ft per year)

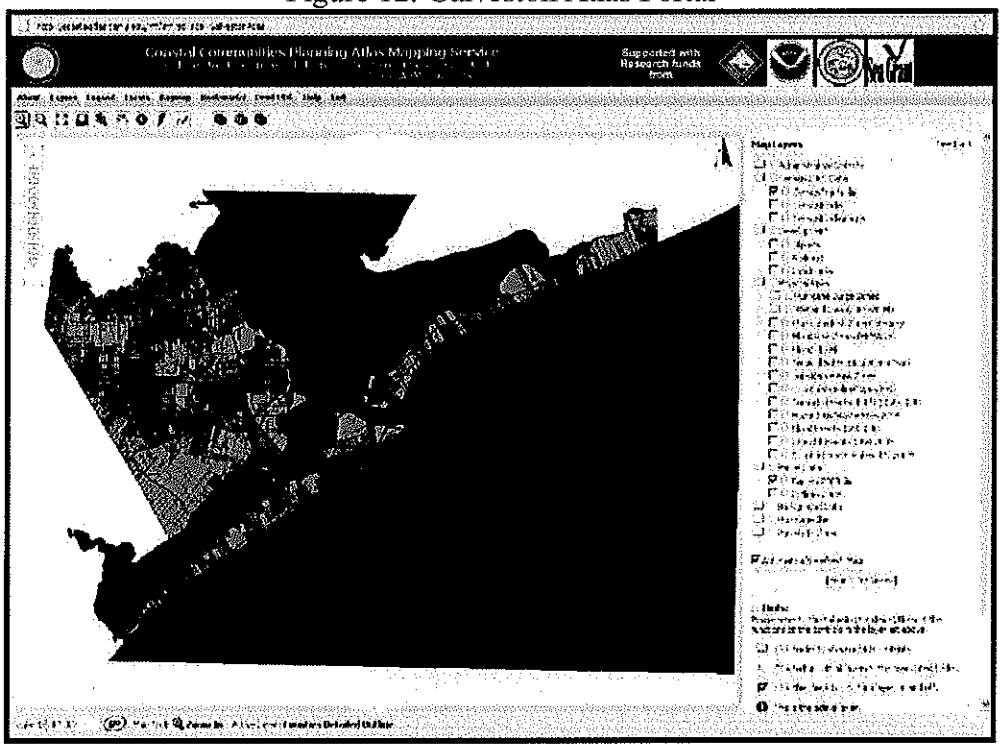
Parcel Data
34. Parcels 2008
35. Lot Lines 2008

Background Data
36. Water
37. County detailed Outline

Hurricane Ike
38. Damage Pictures

The Galveston Atlas provides very detailed data on Galveston proper that allows users to undertake analyses at a much finer resolution. The Galveston Atlas provides users with 38 different data layers. The foundation of these layers is the parcel data for Galveston County which provides data on each individual property parcel for the entire county. In addition to the parcel data, some of the other data layers include layers for Water Control and Improvement Districts (WCIDs), Municipal Utility Districts (MUDs), Independent School districts and Emergency Service Networks. A complete listing of the data layers can be found in Table 3 (above). Figure 12 displays the main website for the Galveston Atlas that is reached by clicking the hotlink in the Atlas Options webpage (see Figure 5).

Figure 12. Galveston Atlas Portal



Figures 13 and 14 offer two examples of the types of maps and analysis that can be undertaken with data layers available at Galveston Atlas website. Figure 13 displays the property parcel level data for a section of the City of Galveston near the port area, just south of Pelican Island, which is just barely indicated by the sliver of green just north of the port waterway, and extending south from the Strand area to near the sea wall. The northern area near the port was the area that received the most extensive flooding from the surge that accompanied Hurricane Ike. Overlaid on the parcels are the surge zones for Category 1 and Category 2 hurricanes. While one must be cautious about interpreting the precise boundaries of the surge risk areas, since they are only approximate and not designed for this fine of a resolution, one can clearly get an indication of the areas of Galveston City proper that are more subject to surge damage than others. The much narrower band of surge areas to the south reflect the protection of

the sea-wall and the fact that the elevation of the island increases markedly as one moves toward the sea-wall due to the filling of this area following the great Hurricane of 1900.

Figure 13. Cat 1 & 2 Surge Zones Over Galveston City Parcel Data

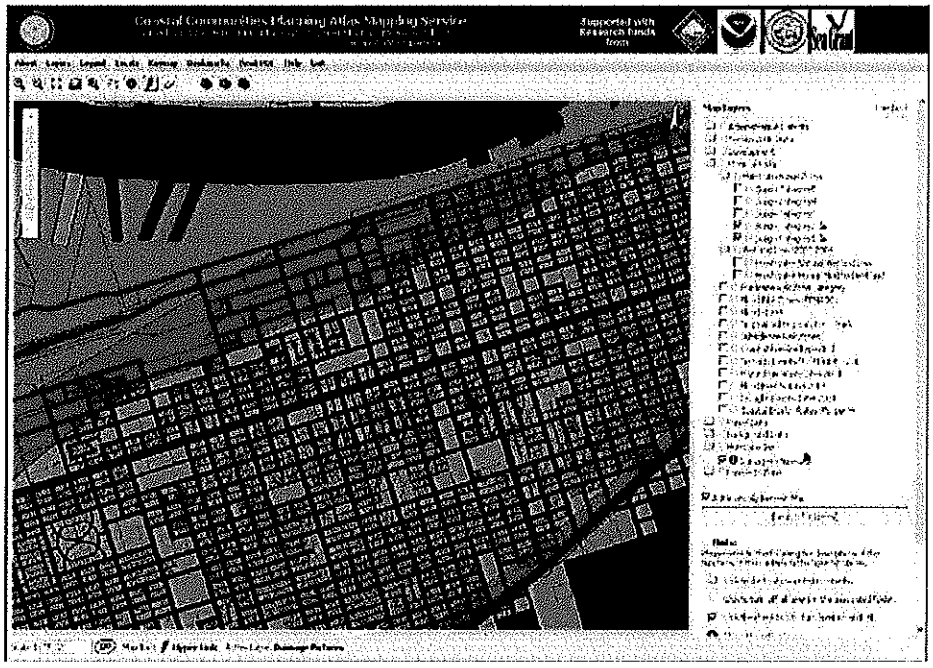


Figure 14. Cat 2 Surge Zones over Galveston Parcel Data on the Island's West End

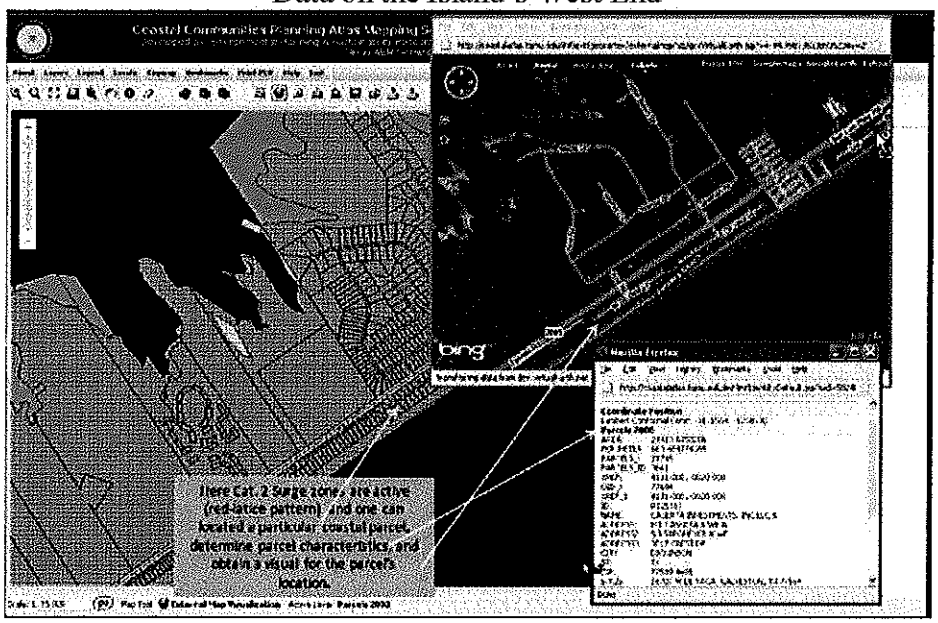
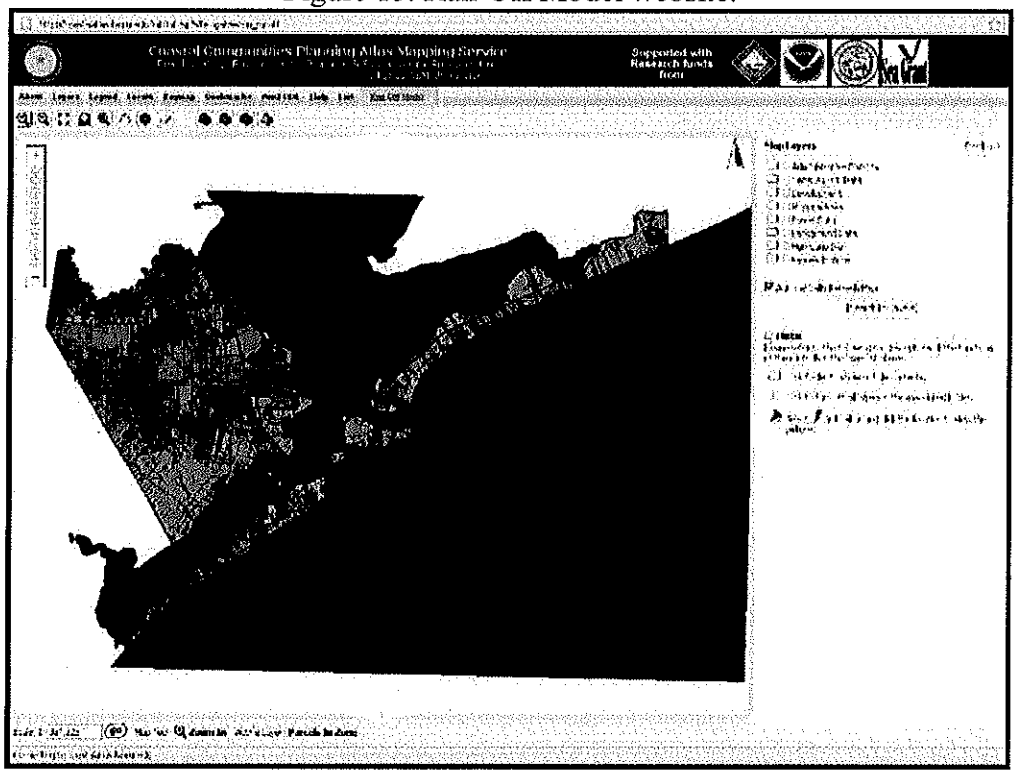


Figure 14 provides yet another example of the functionality of the Galveston Atlas website. Here parcel data from the west end of the island, near the community of Jamaica Beach, have a category 2 storm surge layer active. This representation clearly shows that

all properties in this area are subject to major surge flooding under normal category two event. Furthermore, this example indicates how a user can obtain specific information regarding a given parcel and also obtain a visual representation of the location being mapped. Here, instead of using Google Map, a Virtual Earth tool is employed. These examples, make it clear how these finer resolution data can more clearly help planners, emergency managers, and, perhaps most importantly, the public understand how potentially vulnerable they are coastal hazards.

A final component of the Coastal Atlas is a "what if" scenario tools for Galveston County that enables a user to project the consequences of development for storm water runoff. This is the most interactive and predictive component of the Atlas system because a user can change existing land use at the parcel level based on a development scenario and then receive a graphical and statistical output of the impacts at the landscape level. To reach this tool, the user simply clicks on the "Run-off Model" hotlink on the main atlas link webpage (see Figure 5). After clicking the hotlink the Run-off Model webpage (http://coastalatlas.tamu.edu/imf/imf.jsp?site=galveston_runoff) can be reached. This webpage is show in Figure 15.

Figure 15. Run-Off Model website.

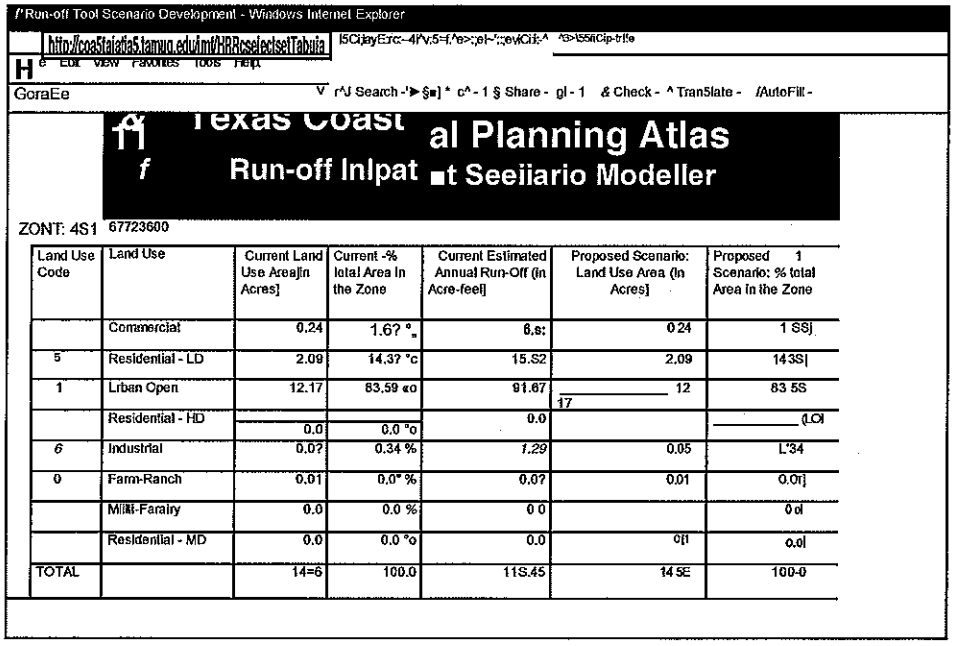


Under the stormwater runoff model, the system calculates percentage change in acre-feet of surface runoff within a Census Tract. For example, using the yellow toolbox, a user can select multiple parcels for which the Atlas will calculate stormwater runoff and potential flooding based on existing land use within the chosen zone. A user can then change the percentages of land use based on a hypothesized development scheme (e.g.

80% urban open to 80% single-family residential) to estimate the change in surface runoff within the zone (Census Tract).

Figure 16. Selected parcels

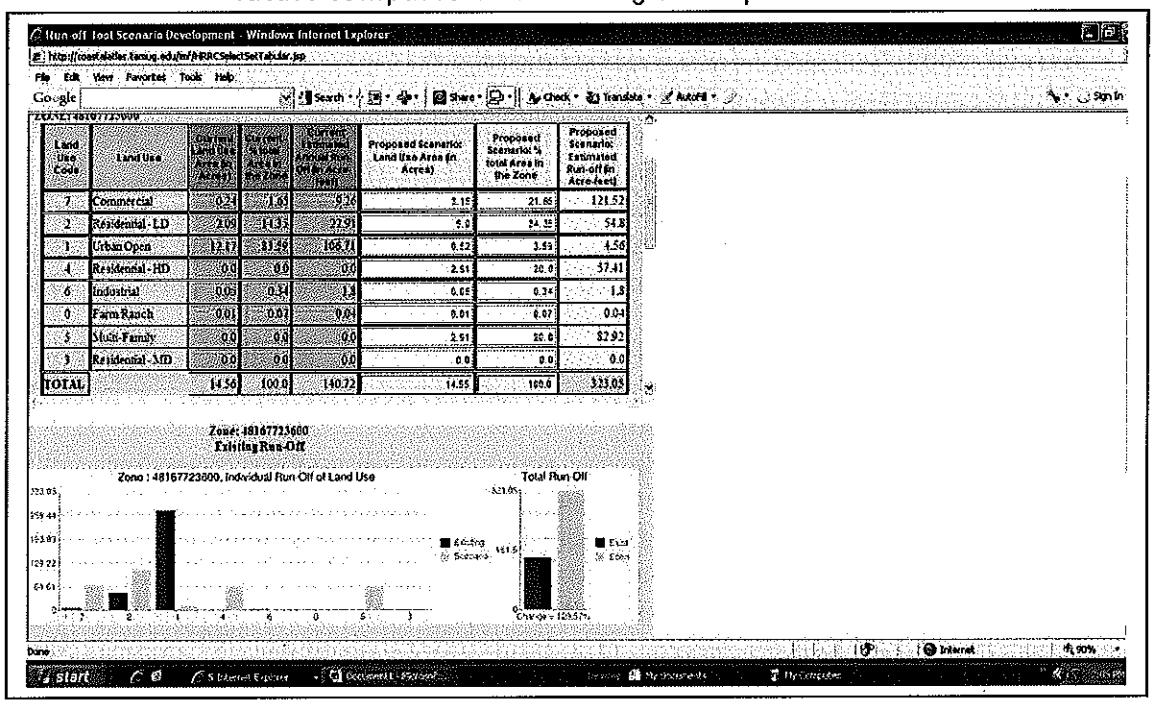
Figure 17. Calculated runoff within Census Tract Zone



An illustration of a runoff scenario is given in Figures 16 through 18. Figure 16 shows 166 parcels in Galveston County selected for analysis (outlined in yellow). The system then calculates runoff in acre-feet based on existing land use for the selected parcels within the designated zone, which in this case is a Census Tract, as shown in Figure 17. Figure 18 illustrates the changes a user could make under the proposed scenario column (outlined in red) in the land use table. In this case, the 84% Urban Open land use is largely re-distributed to commercial, residential (high and low density), and multi-family categories. Finally, the bar chart in Figure 18 shows the consequences of the proposed

development in terms of surface water runoff. The red bars represent the existing land use scenario and the yellow bars indicate the proposed development. In this case, the proposal would generate an estimated 129% increase in total runoff, which could exacerbate area-wide flooding.

Figure 18: Changed percentage of land use within zone and predicted runoff for future compared with existing development scenario.



In sum, activities associated with Tasks 4 and 5 have produced an ever improving multifunctional website that offers coastal planners, emergency managers, stakeholder and the public access four different Atlas websites. The main coastal atlas website contains over 98 data layers for all coastal counties in Texas, the vulnerability hotspot website contains 73 data layers on the 11 northeastern coastal counties, and the Galveston Atlas contains nearly 40 data layers with the foundational layer being all property parcel data for the entire county, and finally the run-off tool allows users to assess "what-if" scenarios to examine the consequences of changing development patterns in Galveston. Each of these websites provides a fully functional web-based GIS environment that can be used to facilitate planning activities with respect to a coastal hazards, ecosystem characteristics, and physical and social vulnerability analysis.

II Website outreach and training activities.

The website has been presented and training exercises have been undertaken in a number of venues and locations. The following provides a partial listing of these activities with information on who did the presentation or training along with some indication of the number of participants.

Presentations:

1. April 3, 2009: Atlas Presentation to the Department of Landscape Architecture and Urban Planning's Master of Urban Planning and Landscape Architecture Advisory Committees. (Peacock) [n = 14]
2. April 23, 2009: Preliminary Findings from the Community Recovery and Resilience Project. Presentation to MARS 689 (Coastal Marine Sciences) class, TAMU-Galveston. (Van Zandt). [n = 20]
3. June 24, 2009: Evacuation Effectiveness: meeting the Unique Challenges of Low-Income Households. Presentation to the Safe Homes for All: Leadership Forum. Washington D.C. with Jay Baker, FSU. Introduced and employed the Coastal Atlas to show vulnerable areas along the Texas Coast. (Peacock) [n = 50]
4. June 25th 2009: Toward a Resiliency and Vulnerability Observatory Network: RAVON. Presentation at the United States Geological Survey Headquarters, Reston Virginia. Introduced and used the Coastal Atlas as part of this presentation. (Peacock) [n = 24]
5. July 14, 2009: Advancing Coastal Community Resiliency. Resiliency Workshop, Omni Interlocken Resort, Broomfield, Colorado. Used the coastal atlas as part of this presentation. (Peacock) [n = 40]
6. July 19 2009: The Need for Resiliency and Vulnerability Observatory Network: RAVON. Presentation to the International Research Committee on Disasters Researchers' Meeting, Omni Interlocken Resort, Broomfield, Colorado. Use the Coastal Atlas as part of this presentation. (Peacock) [n = 46]
7. September 22, 2009: Applications of the Texas Coastal Communities Planning Atlas: Proactive Decision Making in a Web GIS Environment. 8th Annual Sea Grant Researchers Conference. TX A&M-Galveston, Galveston, TX. (Brody) [n = 25]
8. September 23, 2009: Toward Sustainable Urban Systems: Natural Hazards, Vulnerability, and Resiliency. Presentation to the National Academies' of Science, Second Sustainability Research and Development Forum. National Academies Headquarters, Washington DC. (used Atlas to display wetland permits and Ike's path). (Peacock) [n = 57]
9. October 1, 2009: Examining the Willingness of Americans to Alter Behavior to Mitigate Climate Change. ACSP Annual Conference. Crystal City, VA. (Brody) [n = 30]
10. October 4, 2009: Housing Inequalities and Social Vulnerability: Findings from 2008's Hurricane Ike. Presented at the Association of Collegiate Schools of Planning, Crystal City, VA. (Van Zandt). [n = 18]
11. October 8, 2009: Lessons on Disaster Impact and Recovery: housing and Businesses. Presentation to Recovery session at TEXAS APA. Galveston Texas. Presentation with Yu Xaio. Used Atlas to show SV mapping and compared to our survey results. (Peacock) [n = 35]
12. October 8, 2009: Examining the Effectiveness of Flood Reduction Strategies. Presentation to Texas APA. Galveston Texas. (Brody) [n = 10]
13. October 9, 2009: Housing Recovery After Hurricane Ike: Dislocation and Early Rebuilding. Presented at the Texas Chapter of the American Planning Association Annual Conference, Galveston, TX. (Van Zandt). [n = 25]

14. October 22, 2009: Galveston as a Living Laboratory for the Study of Community Resilience and Recovery. Presented at Beijing University, China. (Van Zandt) [n = 45]
15. October 22, 2009: Disasters, Vulnerability, and Resiliency: and emerging Consensus in the Research Community. Presented at Beijing University, China. (Peacock) [n = 45]
16. November 6, 2009. "Hands-on Introduction to GIS Concepts", Presented to six Bryan High School pre-IB Geography Classes, Bryan, TX. (Wunneburger). [n = 132]
17. November 18, 2009: The Coastal Planning Atlas. GIS-Day at TAMU. Coastal Atlas presented as part of the student presentations. (Graduate Students). [n = 50]
18. January 15th 2010: The Need for a Resiliency and Vulnerability Observatory Network. Presentation at FEMA/DHS headquarters in Washington DC. Use the Atlas in this presentation as well. (Peacock) [n = 4]
19. February 22, 2010: Enhancing Community Resiliency by Addressing Social Vulnerability" Presentation to Land Development MSLD671 (Sustainable Land Development) & MARS689. (Peacock) [n = 22]
20. April 1, 2010: Toward a Resiliency and Vulnerability Observatory Network." Presentation to the Subcommittee for Disaster Reduction (SDR), President's National Science and Technology Council, White House Conference Center, Washington DC. (Peacock and Berke) [n = 12]
21. April 20, 2010: "GIS Visualization and Web Applications" Presentation to PLAN 625 (Geographical Information Systems in Landscape Architecture and Urban Planning) class. Texas A&M University – College Station. (Wunneburger) [n = 22]
22. May 8, 2010, "An interactive GIS Based Planning Atlas for Hazard Planning" Presentation to the National Center for Disaster Reduction, Taipei, Taiwan. (Peacock) [n = 6]
23. May 26, 2010, "Social Vulnerability and the Texas Coast: Extending the Notion of Vulnerability to Promote Resilient Coastal Communities" Presentation to the 2010 Coastal Resiliency Symposium Agenda, Rice University, Houston, Texas. (Peacock) [n = 250].

Training activities:

1. January – May 2009: LDEV 671 (Sustainable Land Development) at Texas A&M College Station. Atlas used extensively in Brody's class training students on the use and technical aspects of the Atlas. TRAINING [n=43].
2. August – December 2009: PLAN 641 (Problems of Environmental Planning Administration) and MARS 689 (Coastal Environmental Planning) at Texas A&M College Station and Galveston. Atlas used extensively in Brody's class training students on the use and technical aspects of the Atlas. TRAINING [n = 22]
3. October 9, 2009: A Coastal Communities Planning Atlas for Decision Makers and Local Residents. TX-APA Conference. Galveston, TX. (Brody) TRAINING. [n = 8]

4. January – May 2010: PLAN 613 (Planning Methods II). The Atlas was used in that class which had 27 students. TRAINING. [n = 27] (Van Zandt)
5. January – May 2010: PLAN 663 (Applied Planning II). The Atlas was employed to generate recommendations as part of the Galveston Comprehensive Planning Process and as part of the development of the new Galveston Land-use Map. TRAINING. [n = 21] (Van Zandt/Peacock)
6. January – May 2010: MSLD 671 (Sustainable Land Development) & MARS 689 (Coastal Sustainability and Resiliency) at Texas A&M College Station and Galveston. Atlas used extensively in Brody's class. TRAINING [n=19].
7. March 31, 2010: Hazard Mitigation, Social Vulnerability and the Texas Coast: Planning for Resilient Coastal Communities" Presentation and training to the Texas VISTA annual meeting, Austin Texas. (Peacock) TRAINING[n = 22]
8. March 31, 2010. Coastal Atlas Online Training Workshop to Sea Grant Extension Agents, TX Sea Grant. (Brody) TRAINING. [n = 15]
9. April 21, 2010: Texas Coastal Communities Planning Atlas Training, Galveston Area GIS Consortium, Galveston TX. (Brody). TRAINING[n = 18]

III. Preliminary report on spatial and temporal dimensions of population vulnerabilities.

As part of Phase 2 a major report entitled, The ***Status and Trends of Coastal Hazard Exposure and Mitigation Policies for the Texas Coast: The Mitigation Policy Mosaic of Coastal Texas*** was written. That report was a major assessment of the vulnerability of coastal counties both with respect to their areas and populations, paying particular attention to CMZ areas, when considering likely hazard impacts and the mitigation policies in place to address these vulnerabilities. Likely hazard impacts were assessed by utilizing surge, flooding, and wind risk maps in combination with the population data that have all be assembled for the Coastal Planning Atlas. The final major activity of Task 5 during phase 3 was to undertake additional analysis of the spatial and temporal dimensions of population vulnerability. In a very real sense, this report is a complement of the previous report, because it examines the status and trends of the social vulnerabilities of Texas's coastal population, with a primary focus on the CMZ. That report is entitled: ***The Status and Trends of Population Social Vulnerabilities along the Texas Coast with special attention to the Coastal Management Zone and Hurricane Ike: The Coastal Planning Atlas and Social Vulnerability Mapping Tools*** and appears in full in Appendix 2.

Task 6: Survey of planners and managers in local Jurisdictions.

Task Description: Assess the perception and adoption of hazard mitigation policies and actions by the planners and managers in local jurisdictions and the adoption of hazard mitigation technologies (e.g., hurricane shutters) and planning by households so that effective and targeted educational programs and policies can be developed at both the community and household level.

Much like the problems with the lack of firm information related hazard mitigation and broader land use planning policies, almost nothing is known about the awareness, perception, and adoption of mitigation strategies by members of the planning and management community in local jurisdictions and by households residing in Texas counties subject to coastal natural hazards. Furthermore, nothing is known about general coastal hazard risk perception or responsiveness to incentives that may promote adoption and strengthen any form of public information, education, and outreach plans. While the elite survey will provide detailed information related to hazard mitigation planning, in Texas, all planning is ultimately a local phenomena. Hence there is a need to conduct systematic sample of planners and managers in specific local jurisdictions in order to truly understand the nature of mitigation planning in coastal areas. The purpose of this task will be to collect random samples of planners and households in order to facilitate and enhance the development of public outreach programs to enhance coastal management planning.

This task will include the following objects for this year:
a. Develop data collection instruments for the planning and management communities in local jurisdictions.
b. Development of a survey strategy, sampling frames, and procedures for the planner/manager community
c. Undertaking the planner and manager survey.
d. Begin the development of data collection instruments and survey strategy for a household survey.[4]

Deliverable(s):
1. Final planner/manager survey instruments. (SEE APPENDIX 3)
2. Report on survey strategy and sampling plan. (SEE APPENDIX 4)
3. Preliminary report on planner/manager survey. (SEE APPENDIX 5)
4. Updates as part of progress reports

The following provides a brief description of the activities undertaken for this task during Phase 3 and the deliverables:

I. The survey instrument

During Phase 3 a planner/manager survey instrument was developed to capture information on the types of hazard mitigation policies, broader land use policies and education programs that might be adopted by jurisdictions. The survey is divided into 6 sections designed to collect information on the following topics:

- *Section I: General Land use policies and issues:* This section asks some general questions about the jurisdiction and land-use planning issues.

[4] In March of 2010 the task of undertaking the household survey was made moot due to budget cuts to Phase 4 and 5 resulting in the dropping of the possibility of undertaking a survey of households in the CMZ.

- *Section II. Policy:* This section asks about specific policies or actions that a jurisdiction may employ in their general planning strategy or for specific hazard mitigation planning. These policies and actions include zoning, land use regulations, environmental impact etc.
- *Section III: Hazard Experience:* This section asks the respondent to roughly assess about how much damage or how likely their jurisdiction will be impacted by different types of hazards.
- *Section IV: Jurisdictional Capacities and Resources*: This section's questions ask about the capacities and resources of the respondents jurisdiction has or might employ for undertaking hazard mitigation planning activities.
- *Section V. Coordination, Cooperation, and Involvement:* This is the second to the last section and asks questions about coordination and cooperation within the respondent's jurisdiction as well as between their jurisdiction and others.
- *Section VI. Information on Your Jurisdiction:* The final section gather general information about the jurisdiction.

As noted above the complete full survey instrument can be found in Appendix 3.

II. The Survey strategy and sampling plan

The following describes the sampling plan and survey strategy employed by the survey. This report also appears at Appendix 4.

The primary goal of this survey was to obtain a clearer picture of the variety and nature of hazard mitigation policies adopted and implemented by coastal jurisdictions in Texas. The survey methodology was originally conceived of as being a random sample of planners and managers throughout the coastal region. However after thinking through the issues, the survey strategy was modified.

The major difficulty in seeking to understand what types of hazard mitigation policies and tools are adopted and implemented by coastal jurisdictions in Texas is the complete lack of systematic and reliable information on the subject. While many states have adopted and mandate a statewide building code and also mandate comprehensive planning activities, sometimes including specific hazard mitigation requirements, by their counties and municipalities, such is not the case in Texas. In states with such mandates, there is usually a state agency that has all the information one might be interested in about the kinds of policies adopted by local counties and municipalities, but this again is not the case in Texas.

Some might be surprised to know that there is a statewide building code promulgated by the Texas Department of Insurance. However, local municipalities are essentially free to adopt or not adopt that code and counties do not have the legal right to officially adopt and enforce building codes.[5] Furthermore counties are severely limited when it comes to

[5] The TDOI has no reliable information regarding which municipalities have or have not adopted the building code

land use and development control policies. Indeed, municipalities are the only entities in Texas with home rule. In other words, to the extent that mitigation policies, particularly land use policies and building codes, can be adopted and enforced in Texas, that action must be taken by municipalities. This is not to say that counties do not engage in some forms of mitigation policy development and implementation, it only means that counties are going to be limited in what they can undertake. Unfortunately, there is no one single source that one can contact to find out what types of hazard mitigation policies have been adopted by municipalities and counties. The simple fact is that local municipalities are free to adopt or not adopt mitigation policies as they see fit, there are no state mandates. Similarly, counties can also adopt and implement mitigation policies as well, however, they are constrained regarding what they can actually enforce.[6]

If then the goal is to establish a baseline for the types of policies that are adopted by coastal jurisdictions and how widely they are employed, one must go to the source – the local jurisdiction itself. If that is the goal, it makes little sense to undertake a random sample of planners and managers throughout the coast. Rather, it makes better sense to consider using planners and managers as knowledgeable informants and systematically sample them based on their location within an official agency or organization of a coastal jurisdiction that has been selected or sampled.

Thus our sampling strategy changed markedly from one of conducting a simple random sample of coastal planners and managers, to one of first systematically identifying coastal jurisdictions that should be sampled and then identifying planners, managers and other knowledge potential informants to survey.

Jurisdiction selection: First it was decided to survey both counties and municipalities. The selection of municipalities was obvious, since municipalities in Texas have home rule and therefore are legally capable of enacting and enforcing land-use policies and building codes that are so critical for hazard mitigation. It was also decided to survey counties because counties do undertake flood plain management policies. The next issue concerned the size of the community to be surveyed. In the past many planning surveys have chosen to focus on only relatively large communities with populations of 50,000 or more. Again, however, since municipalities of any size are the backbone of land-use planning in Texas, we decided to attempt to survey any officially designated and state recognized municipality. The last issue was of course the location of our targeted jurisdictions. The first and obvious decision was to include all counties that were fully or partially within the CMZ and all municipalities within that region. To better insure that our sample would be sufficiently large and would allow for comparison between communities within and outside the CMZ it was decided to include first and second tier counties and some third tier counties. Based on these parameters, the initial sample frame

[6] Some counties, for example, "adopt" the State's Building code, but they have no legal ability to adopt that code.

for this region included 255 local jurisdictions composed of 215 cities and 40 counties for which we were able to find administrative contact information[7].

Informant selection: The second step in identifying the sample frame consisted of identifying the local informant that would be contacted to provide information about the jurisdiction's mitigation policies. The critical goal here was to find an individual involved in city or county government that would be knowledgeable about various forms of mitigation policies related to land use, development and environmental controls and building code regulations. Our primary targeted individuals were city planners and county judges. However, in the event that these individuals were not available or identifiable other targeted individuals included city managers, building inspectors, flood administrators and even local mayors. The task was made more difficult by the fact that we were dealing with city and county governments of great variety and capacity. While some were extensive local governments with planning departments, building and zoning departments, etc., others were very simple operations with only a few staff or employees. The development of our sample frame required extensive investigative work via such sources as the web, the city/county data book, and even simple telephone conversations with multiple contacts. In the final analysis a sampling frame was developed that consisted of 326 individuals to capture information on the 255 jurisdictions. Clearly, in many cases there were multiple respondents, this was done to ensure coverage.

Surveying strategy: There are a variety of approaches that could be employed to actually implement the survey including mailed surveys, telephone surveys, face-to-face surveys and, more recently, internet surveys. There are advantages and disadvantages with respect to each approach. For example, face to face surveys have major advantages in that the survey can be rather complex, but nevertheless manageable, since it will be implemented by a trained interviewer. However, these would be very expensive to implement, particularly when trying to cover over 255 places in Texas. It was decided to employ an internet survey in this case. An internet survey was feasible because we were soliciting information from professional individuals that were likely to have access to the internet, indeed in almost all cases we had extensive contact information on the informants, having talked with many of them as part of the investigations to determine the best individual to contact in these jurisdictions. Indeed, for many individuals we had their names, addresses, phone numbers, and email addresses. The survey was planned and implemented utilizing Dillman's (2007) three-tiered approach for internet surveys.

References: Dillman, D. 2007. *Mail and Internet Surveys: The Tailored Design Method.* Wiley: New York.

III: Preliminary findings

The following offers a very brief discussion of the preliminary findings. A more complete report on the survey and some findings in Appendix 5.

[7] There were a number of communities for which there were no websites, phone numbers or even elected officials that could be identified and contacted.

Building codes and standards: The results with respect to building codes were not entirely surprising. We were delighted to find that nearly 26% had adopted the 2009 IRC/IBC code sanctioned by Texas Department of Insurance, with an additional 35.5% having adopted the 2006 IRC/IBC code and 17% using the 2003 IRC/IBC code. What was a little disconcerting was that 8 communities or 8.6% of the sampled communities had adopted no building code and 5 or 5.4% of the sample were still using the old southern building code (SBC).

Land Use regulations: Table 1 presents the findings with respect to land use regulations within jurisdictions. Specifically respondents were asked about 7 different types of land use regulations. These include: 1) residential subdivision ordinances, 2) planned unit development, 3) special overlay districts, 4) agricultural or open space zoning, 5) performance zoning, 6) hazard setback ordinance and 7) storm water retention requirements. With respect to each respondents were asked to identify to what extent their jurisdiction makes use of each form of land use regulation on a scale from 1 to 4, where 1 is not at all, 2 is to a small extent, 3 is to some extent and 4 is very great extent. If their jurisdiction did not have the capacity or ability to regulate land use using one of these tools they were ask to indicate this by checking a "not within this jurisdiction's authority" option.

As can be seen in Table 4, residential subdivision ordnances are clearly the most popular form of land use regulation among the jurisdictions were nearly 66% report using them. The second most popular approach is hazard setbacks (40.4%) and storm water retention requirements (36%). Interestingly very few jurisdictions report using more incentive based and flexible policies such as performance zoning or planned unit developments. It is also interesting to note that agricultural or open space zoning is relatively rarely implemented policy.

Table 4: Land use regulations

Land Use Regulations	Not within Jurisdiction	Not at all	small extent	some extent	very great extent	Total
1. Residential subdivision ordinance	6	8	4	21	75	114
	5.26%	7.02%	3.51%	18.42%	65.79%	100.00%
2. Planned unit development	9	30	27	17	31	114
	7.89%	26.32%	23.68%	14.91%	27.19%	100.00%
3. Special overlay districts	13	49	14	26	12	114
	11.40%	42.98%	12.28%	22.81%	10.53%	100.00%
4. Agricultural or open space zoning	11	50	20	17	16	114
	9.65%	43.86%	17.54%	14.91%	14.04%	100.00%
5. Performance Zoning	12	69	15	12	6.0	114
	10.53%	60.53%	13.16%	10.53%	5.26%	100.00%
6. Hazard setback ordinance	7	32	7	22	46	114
	6.14%	28.07%	6.14%	19.30%	40.35%	100.00%

7. Storm water retention requirements	7	18	24	24	41	114
	6.14%	15.79%	21.05%	21.05%	35.96%	100.00%

Table 5 presents the data on the use of regulations to limit development within a jurisdiction. On the whole, one is struck by the overwhelming sense that these regulations are not very extensively used by any of the sample jurisdictions. Indeed, the vast majority of jurisdictions report not having the ability to regulate on these issues or simply not employing them at all. The only development limitation regulation employed to at least some if not to a very great extent was the use of environmental impact assessment where 25.4% report using them to some extent and an additional 20.2% reporting using them to a very great extent.

Table 2. Limited Development Regulations

Limit development	Not within Jurisdiction	Not at all	a small extent	to some extent	very great extent	Total
Environmental impact Assessment	5	26	31	29	23	114
	4.39%	22.81%	27.19%	25.44%	20.18%	100.00%
Limitation of shoreline development to water-dependent uses	27	54	12	10	11	114
	23.68%	47.37%	10.53%	8.77%	9.65%	100.00%
Restrictions on shoreline armoring	30	53	13	8	10	114
	26.32%	46.49%	11.40%	7.02%	8.77%	100.00%
Restriction on dredging /filling	24	41	12	18	19	114
	21.05%	35.96%	10.53%	15.79%	16.67%	100.00%

Summary

These two tables provide only a very brief picture of some of the data and ultimate findings that will be yielded by the survey. The report on preliminary results of this survey, found in Appendix 5, provides more detailed information about the survey, the sample of jurisdictions, and response rates. Future reports will provide more detail information on the survey results themselves. These will be forthcoming as part of Phase 4 of this project.

Appendix 1.

The Elite Survey Report:
A Report on the Perception of State, County, and Local Officials Regarding the State of Texas Mitigation Plan, Coastal Management Program and the Promotion of Mitigation Efforts in the Texas Coastal Management Zone

The Elite Survey Report:
A Report on the Perception of State, County, and Local Officials Regarding the State of Texas Hazard Mitigation Plan, Coastal Management Program and the Promotion of Mitigation Efforts in the Texas Coastal Management Zone

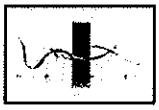
by

Walter Gillis Peacock, Rahmawati Husein, Gabriel R. Burns,
Tommy Kennedy, Jung Eun Kang, and Carla Prater

A Report Prepared for the
Texas General Land Office
and
The National Oceanic and Atmospheric Administration
Under GLO Contract No. 09-045-000-3362

This investigation was funded by a grant from the National Oceanic and Atmospheric Administration administered by the Texas General Land Office. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

Hazard Reduction and Recovery Center
College of Architecture
Texas A&M University
TAMU 3731
College Station, Texas 77843



List of Acronyms

CCC – Coastal Coordinating Council

CEPRA – Coastal Erosion Planning and Response Act

CMP – (Texas) Coastal Management Program

CIAP – Coastal Impact and Assistance Program

FEMA – Federal Emergency Management Agency

TDEM or DEM – Governor's Division of Emergency Management

GIS – Geographic Information Systems

HRRC – Hazard Reduction and Recovery Center

IBC – International Building Codes

IRC – International Residential Codes

NFIP – National Flood Insurance Program

SHMP – State of Texas Hazard Mitigation Plan

TCMC – Texas Coastal and Marine Council

TDI – Texas Department of Insurance

GLO – Texas General Land Office

TMP – Texas Hazard Mitigation Plan

TWIA – Texas Wind Insurance Agency

The Elite Survey Report:
A Report on the Perception of State, County, and Local Officials regarding the State of Texas Mitigation Plan, Coastal Management Program and the Promotion of Mitigation Efforts in the Texas Coastal Management Zone.

Walter Gillis Peacock, Rahmawati Husein, Gabriel R. Burns,
Tommy Kennedy, Jung Eun Kang, and Carla Prater

1. Introduction

As part of the Status and Trends project a purposive elite survey was initiated during the first year and completed during the second year. The goal of this survey is not to gain data on a representative sample of leaders at the state, county and local levels in order to have findings that are necessarily representative of that "population." Rather, the goal of this survey is to gain detailed information and individual insights regarding the State of Texas Hazard Mitigation Plan (SHMP), the Coastal Management Program (CMP), and general issues concerned with and surrounding mitigation planning along the Texas coast. More specifically the objectives of this project is to interview government officials, planning leaders and other stakeholder to ascertain their perceptions and knowledge of the CMP, the SHMP and mitigation issues along the Texas coast. Secondly, this survey sought to assess general perception of these individuals with respect to hazard mitigation policies and actions that might be taken by planners and emergency managers in local jurisdictions and how the GLO might enhance and encourage the knowledge and adoption of mitigation policies and actions.

The insights gained from these interviews will serve a variety of purposes. First, they will provide project staff with an understanding of the complexities of mitigation issues in Texas, with an emphasis on the coast and coastal hazards. Simply stated the whole issue of mitigation in Texas is highly complex because there are, in general, few comprehensive integrated planning mandates or building code policies that can be found in other states. For example, there is no statewide building code. While the Texas Department of Insurance (TDI) does adopt a building code and does seek to strengthen and update that code, there is no mandate or at least enforceable mandate to ensure that it will be adopted by local municipalities or counties. In addition, there is no statewide mandate requiring for comprehensive planning by local municipalities or counties. Furthermore, there are very limited planning activities that can take place at the county, state, or regional level. "Home rule" is only granted to local municipalities; hence, the majority of planning activities in terms of zoning, land-use regulation, building codes, etc. must take place at the municipal or city level of government. To the extent that other forms of planning occur, such as mitigation planning, it is because of cooperative agreements or incentives based on federal and sometimes state dollars. Hence, by interviewing knowledgeable leaders and individuals, project staff can gain a more comprehensive picture of the complex processes involved in mitigation planning in the state and can better comprehend the complexity of mitigation planning processes in general.

A second purpose that the insights gained from these interviews might serve is to provide useful information on the part of knowledgeable individuals related to the

SHMP, the CMP, and how they might promote mitigation planning in the coastal management zone. However, the perspectives and insights gained from this survey activity must be utilized with caution. As will be addressed below, this research activity is primarily a qualitative approach to data collection. As such, the goal is to gain rich highly detailed information from key informants, not to gain general information that is necessarily representative of the population of all leaders at the state, county and local levels, nor all emergency management or other planning personnel.

A final important purpose for undertaking these interviews is to provide project staff with critical information from knowledgeable individuals regarding important state and local mitigation policies and actions being currently undertaken or considered. This information will greatly facilitate future data collection activities that will be undertaken as part of the larger project. Specifically this information will provide important information about local mitigation actions and policies and about how best to ask future questions, particularly on more structured surveys that will be based on some form of random sampling. These surveys are likely to be self-administered mailed surveys or structured telephone interviews. In such cases it is critical to know how to ask the question such that potential respondents will understand what you are asking and provide you with useful responses.

2. Study Methodology, Key Informants, and Targeted Area.

The principle strategy employed in this study was the qualitative interviewing of key informants. This strategy could more technically be termed as semi-structured interviews of a sample of key informants initially selected as positional leaders and then supplemented by informants selected using a snowballing technique. Semi-structured interviews were employed to better insure that highly detailed information, much of which might not have been initially anticipated, could be collected. A semi-structured instrument provided interviewers with an initial set of questions and topics to be covered, however interviewers were free to deviate from the initial questions as informants provided additional more detailed information based upon their individual knowledge, experience, and expertise. The initial sampling frame for this survey was based on positional leaders. In other words, the first phase of this survey targeted individuals who were holding particular positions within state, county and local governmental departments and agencies. The targeted individuals are those holding positions with the GLO, the Texas Department of Insurance (TDI), the Texas Wind Insurance Association (TWIA), The Texas Division of Emergency Management (TDEM or DEM), and individuals holding key positions in county and municipal emergency management departments, planning departments, building departments, flood plain managers, county judges, etc. As part of the interview, interviewees were often asked if there were other individuals (reputational or influential leaders) that should be interviewed. By using this snowballing technique, we were able to get a good purposive sample of individuals who were likely to know about or be involved with mitigation activities.

The primary target area for this study, particularly with respect to the selection of county and municipal key informants was Galveston, Brazoria, and Harris County areas within the coastal management zone (see figure 1). Within these counties, specific types

of individuals were targeted, in part because of their location on involvement with areas in the coastal management zone, their coastal risk profile, and also because of community involvement in municipal, county, or regional mitigation planning activities.

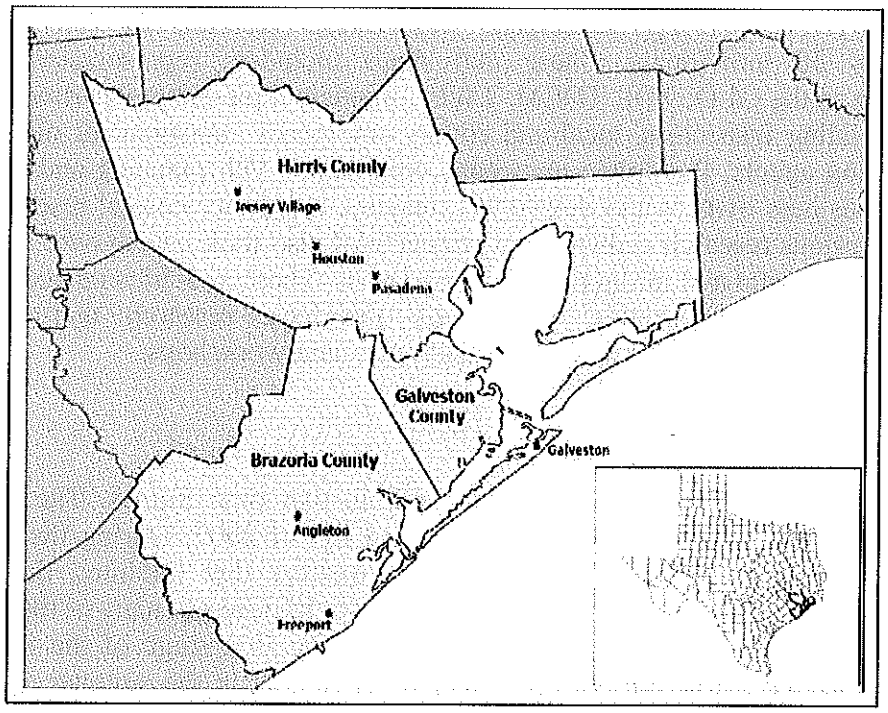


Figure 1. Targeted Area for County and local Informants

In addition to the semi-structured interviews with a purpose sample of key informants, the second methodology employed in this study was *participant observation.* Participant observation is a qualitative data collection method whereby researchers participate or take part in ongoing community or area activities. By participating in these activities the researcher can observe and informally interview participating individuals, gaining rich qualitative information of the particular actions being undertaken, obtain reports from participants concerning their perception and thoughts about the activity, observe interactions among participants, and grasp what types of activities and conversations are actually being undertaken. Project staff participated in a variety of activities generally associated with local mitigation planning, environmental planning, coastal management, community planning charrettes, and coastal research/practitioners workshops. When participating in these activities, participants knew that researchers were from the Hazard Reduction and Recovery Center and undertaking research on coastal mitigation planning. Interviewing during these activities was much more informal and free flowing in comparison to the semi-structured interviews conducted with key informants during a face-to-face interview sessions. However, many of the same topics were covered, particularly if they were germane to the activities at hand. More importantly, participation in these activities were often particularly advantageous, because they not only provided accesses to individuals that may have been part of our

original sampling frame, but also to representatives of key stakeholders such as local business owners, developers, as well as contractors supporting local efforts in mitigation activities.

The implementation of the semi-structured interviews with key informants and informal interviews during participant observation resulted in interviews with approximately 50 individuals. These individuals included: representatives of state agencies such as the GLO, TDI, TDEM, TWIA, municipal planning department officials, municipal building inspectors, local and county emergency management officials, Sea-Grant extension agents, floodplain managers, contractors with planning and engineering firms, local business owners and developers, mayors, university coastal researchers, and directors of various research centers. The project staff also took part in over 15 activities associated with coastal and mitigation planning issues. These activities ranged from local community planning charrettes, stakeholder meetings, research and practitioner workshops, and various coastal planning conferences and workshops.

3. Interviewing Time Frame.

The semi-structured interview process was split in two time frames. The first set of interviews was conducted during the summer and fall of 2007. During the first set of interviews there were two instances of severe weather that inhibited the interview process, Tropical Storm Erin and Hurricane Humberto. In general, many of the interviews with state agency representatives took place during the first stage of the interviewing process. The second set of interviews conducted beginning in the summer of 2008 and extending into early 2009. During the second set of interviews the Texas Coast had 3 major storm events, Hurricane Dolly, Tropical Storm Edouard and Hurricane Ike. In the case of Hurricane Ike the damage was so severe in the study sites that the scheduling of interviews became nearly impossible at times. Participant observation activities were undertaken from the summer of 2007 through early 2009.

4. The Semi-Structured Survey Instrument.

As discussed above, the interview instrument utilized for this survey was a semi-structured interview schedule. A structured interview protocol demands that the questions be read as written and in the order specified, without deviation. However, a semi-structured interview protocol is more of a guide to the interview regarding the types of questions that should be asked and the types of information that should, where possible, be collected. In other words, using a semi-structured protocol the interview is a more fluid and open process, with the interviewers having a set of questions to guide their interactions in terms of content and order. The interviewer allows the interviewee to answer the questions as they see fit in a more open fashion and the interviewer is allowed to ask follow-up questions or prompts to gain additional information. If the interviewee appears to be particularly knowledgeable or concerned about a particular topic or issue, they can be encouraged to elaborate on these points, providing far more detail than might

be normally elicited or even anticipated. The order the interview questioning takes is open, because the goal is to acquire as much in-depth information as the interviewee can provide given their experiences and expertise. Finally, if the interviewee has limited or no knowledge regarding particular points or issues, the interview is free to move quickly over those points, or even skip sections that may be of no relevance to the interviewee. Given the nature of the instrument, it could be utilized both in the face-to-face interviewing process and as a general guide during participant observation activities.

The semi-structured interview instrument was designed to gather information on the Texas Coastal Management Program (TCMP), various TCMP policies and funding streams, as well as the Texas General Land Office (GLO); 2) the State of Texas Mitigation Plan (SHMP), 3) Local Mitigation Plans, 4) local community and county mitigation policies, actions and incentives, and other forms of planning tools, 5) building codes, and 5) wind and flood insurance. The final section was a handout that explained the Coastal Planning Atlas, an online GIS planning support system that acts as a proactive device to identify, visualize, and predict the impacts of future growth along the coast. The coastal planning atlas is being developed as part of this overall project. The complete interview instrument is provided in Appendix A.

5. The Interview Process:

The exact nature of the interview process depended on whether it was part of a more formal face-to-face interview or if it took place as part of a participant observation activity. With respect to the more formal face-to-face interviews, interviewees were, as mentioned above, selected because of their formal position in state or local agencies or because they had been referred to during a previous interview. Initial contacts were often made through email. The survey team identified themselves as researchers with the Texas A&M's Hazard Reduction and Recovery Center (HRRC) working on a project funded by the Texas General Land Office. After making initial contact the survey team moved to phone conversation where they further explained the purpose of their research and their desire to set up an interview to ask questions related to coastal hazard mitigation. There were occasions when no response was received from email. In these cases, the team waited three days after sending an email before making a phone call to contact the potential interviewee. If no email information was available, contact was initiated via telephone from the start. After contact was made, meetings were arranged to begin the interview. A number of times the interview instrument was sent prior to the meeting so that the interviewee might have time to review the document. Generally interviews were conducted in a place designated by the interviewee to make the process as comfortable as possible. At the conclusion of all interviews the survey team often left a copy of the interview protocol. A copy was left with the interviewee to review and if they later felt that they had inadequately answered a particular question or if they remembered additional information after the survey team left, they could notify the team and provide additional information.

3. Findings

As might be expected, the conversations during participant observation activities and during the semi-structure interview were often quite wide ranging and the particular topics covered were highly dependent upon the relative expertise and experience of the individuals involved as well as the context. In analyzing the information gathered during this research activity the goal was to bring forward important insights, issues, and themes that emerged. Before beginning this discussion, the caveat that these findings were again gained from a purpose sample and participant observation in a select number of workshops and community activities, and not a random sample of stakeholders must be kept in mind. This means that findings may well not hold for more representative sample, but they do provide us with detailed information upon which future actions might be undertaken, with caution.

The following highlights issues that emerged from the data collection activities and have been organized into issues and themes related to a) state level agencies; b) county and local emergency management and managers, c) local planners and related local agencies, d) mitigation planning activities and mitigation actions, and finally, e) constraints on mitigation planning activities.

3a. Issues related to state level agencies.

The following are some of the issues that emerged from interviews with individuals working in state agencies associated with coastal hazards and hazard mitigation. Some of the following are simply points of information related to the operation of these agencies, while others are relevant in that they address or highlight points of commonality among agency missions and hence opportunities to coordinate activities.

- The relationship between the Texas General Land Office (GLO) and the Division of Emergency Management (DEM) through changes in the 2007 State of Texas Mitigation Plan in which the GLO will be playing an active role in working with mitigation planning activities should enhance the working relationship between the two and should also help ensure greater consistency between the State of Texas Mitigation Plan (SHMP) and Coastal Management Program (CMP) activities.
- In the words of a key official with the Texas Division of Emergency Management (TDEM), the best possible outcome related to mitigation in the coastal zone is to "minimize coastal development to reduce cost of response, evacuation, and public sheltering." This clearly suggests the implementation of effective mitigation planning will help insure that development and subsequently people are not located in coastal high hazard zones.
- In addition, the same official from the TDEM noted that, if development must or simply does occur, then that development must be "floodplain and wind-code compliant to reduce cost of public sheltering" and subsequent response and recovery efforts. This statement was given in the context of promoting effective building codes related to wind and flooding, but was also coupled with programs and policies that promote open green space,

provide for setbacks, storm surge flow-through of ground level parking, cluster developments, and other forms of effective land-use planning policies.

Several individuals either mentioned or, when the issue was introduced, expressed the opinion that the inclusion of a representative from the Governor's Division of Emergency Management on the Coastal Coordinating Council may well help insure greater coordination and more concerted action between the TDEM and the GLO actions, particularly with respect to the SHMP and the CMP.

There is a good deal of commonality in goals between the Texas Department of Insurance (TDI) and the GLO and its CMP because they both are concerned with reducing losses related to coastal hazards although the TDI is much more focused on wind hazard, because flood hazards are covered by the National Flood Insurance Program (NFIP). This commonality in mission could have implications for joint efforts to better model and assess coastal wind hazards along the Texas Coast and for the CMP consistency reviews.

The Texas Windstorm Insurance Association (TWIA) is the insurer of last resort for Texas homeowners that are seeking wind coverage, which is generally not covered by homeowner policies along the coast. The TWIA's exposure to property losses is rising exponentially along the Texas Coast as insurers refuse to underwrite wind hazard insurance following the hurricanes and tropical storms of the 2005 (Rita), 2007 (Erin and Humberto), and 2008 (Dolly, Edouard, and Ike).

The TDI is making a concerted effort to constantly improve coastal building codes through material testing and the adoption of new International Residential and Building Codes (IRC/IBC) building codes with "stronger" Texas amendments. For example, the new IRC/IBC 2006 was adopted. Yet there is little knowledge of the adoption of these codes by local municipalities. The TDI performs an informal survey of municipalities, but does not systematically collect these data.

While local communities in the coastal zone, first tier counties, are required to adopt the TDI sanctioned code, there is no enforcement or way to enforce this mandate.

It is interesting to note that the Texas Coastal and Marine Council (TCMC), the precursor to the Coastal Coordinating Council (CCC), drafted a model minimum hurricane resistant building standard for the Texas Gulf coast in 1976. Clearly there a history of common interests and missions between the TDI and the CMP.

The insurance market in Texas has a tripartite structure consisting of the: 1) voluntary market made up of licensed private sector insurers, 2) involuntary market made up of the TWIA (the insurer of "last resort") and 3) the surplus market made up of insurers who are not licensed in the state but can sell insurance without any restrictions.

- Local municipalities often do not inspect residential or other built structures for wind related hazards. Any inspection related to wind, for example, roof inspections, is undertaken by the TDI if at all.
- Many insurers including the TWIA require roof inspection and a windstorm certification of compliance (WPI-8) indicating that the roof has been inspected by a certified state inspector/engineer and found to be in compliance before wind coverage will be issued.

As is reflect in the above, there are points of common interest and commonalities in missions between the TDI, TDEM, GLO, as well as the TWIA. In a state that does not legally mandate comprehensive planning, particularly as it relates to coastal hazard mitigation, or a statewide building code, it is important, indeed critical, for agencies active in this area to work together, pool limited resources, and facilitate concerted actions on this important issue. Coordination and the pooling of resources can be particularly important when the onus of planning falls on often small coastal communities that simply do not have the personnel, expertise, or resources to devote to these important activities. There are of course a variety of mechanisms that might be employed to insure more coordinated action. One obvious action that might be taken is to include membership from DEM, TDI, and perhaps even TWIA on the Coastal Coordinating Council (CCC). Membership of these entities on the CCC might better ensure overall coordination of activities of these agencies as they focus on coastal issues, particularly those addressing coastal hazards and hazard mitigation.

Another mechanism to insure increased coordination might be to undertake joint programs and activities, such as is occurring with joint efforts between TDEM and the GLO on coastal mitigation planning efforts. These might be extended to include the TDI and TWIA as well. In addition, to the extent that it is possible, developing programs to incentivize the adoption of stronger building codes, land-use planning, zoning that reflects hazard exposure, and similar types of policies that have hazard mitigation potential. Other potential joint project might be related to technical assistance programs, training programs for local communities and the development of mitigation technical tools. An example of the latter might be the development of a scientifically valid high resolution mapping tools for wind hazard. Such a tool would identify in high resolution, such as at the census block or block-group, the probability and hence, the risk of hazards winds of particular magnitudes. This tool should be available to the public and local governments to facilitate mitigation planning decisions related to coastal development, building codes, etc. In other words, this tool would become a critical element in hazard mitigation planning actions and policies. Such a tool could also be the first step in developing a public insurance rating model, to empirically validate rate changes by insurers throughout the coast, as well as establishing TWIA rating structures.

3b. Issues related to emergency managers and mitigation planning:

The following section addresses a host of issues related to emergency management, emergency managers, and the relationship between and among emergency

mangers and local planners. These primarily focus of these findings is on county and local emergency managers and management agencies/organizations.

- Emergency management is much more focused on emergency and response activities, with little time, energy or commitment for mitigation and recovery planning. In many cases emergency managers do not deal with mitigation plans directly and often define mitigation issues as separate from their activities.
- In spite of the above statement and seemingly inconsistent with it, emergency management personnel were often found to be the "designated" participants in local hazard mitigation planning activities. In other words, while they perceive of themselves as focused on emergency and response activities, they are often called upon to work with mitigation planning. The result is that there is a tendency for local mitigation planning activities and proposed mitigation actions to focus more on emergency management and response issues, rather on mitigation issues (see Peacock et al 2009).
- Some emergency managers attended training/school held by FEMA once or twice a year. However, most of that training is based on response and, to a limited extent, recovery and little attention to mitigation strategies.
- For the most part city and county emergency management offices have very small staffs. In some cases the emergency manager is a part-time or volunteer position. The staffs that are associated with them have limited training in mitigation and in come cases are mainly clerical assistance personnel.
- To the extent that mitigation is discussed, the solutions are often in terms of technical solutions, such as beach nourishment or re-nourishment, but rarely are issues like land use planning, zoning, and other forms of mitigation policies.
- The perception of all emergency managers is they have some form of coordination authority in their respective county especially in regard to evacuation and emergency response. However, there are some cases where the coordination is based on very little contact among participating agencies and municipalities. Unfortunately, there are sometimes ill feelings expressed about the competency of other emergency personnel which prevent stronger communication.
- Emergency management offices often provide preparedness material such as brochures, leaflets and flyers and they also support educational awareness activities. This material generally focuses only for emergency preparedness and response, such as steps a household could take before and after a disaster event. This literature rarely addresses mitigation or long-term recovery issues.
- There appear to be regular meetings between certain city emergency managers and county emergency managers. In these meetings, joint resolutions have been drafted for evacuation procedures and special group needs.

- Emergency management personnel often speak of good communication between municipal planners and emergency management, but this communication seem to be more related to emergency and response, with little communication or joint activities related to mitigation and mitigation planning.
- Most city emergency management personnel have little knowledge of the CMP or work with the GLO. However, as will be seen below, the counties and planning agencies are more likely to know about the CMP and be currently working with the GLO or have worked with them in the past.
- Municipal emergency management, generally hold that their own emergency management strategies and activities come first, but they do appreciate and believe that it is very important to have communication between their operations and county level to increase cooperative efforts.
- Surprisingly, while there is general knowledge of the existence of the SHMP, some emergency management personnel have limited knowledge of the actual plan and how it addresses local issues.

On the whole, the picture that emerges from interviews with local emergency management and managers is one of individuals that are much more focused on the tasks of emergency response and preparation, but not on long term recovery or mitigation issues. Mitigation and recovery efforts are more likely to be seen as in the realm of planning, not emergency management. Nevertheless, local emergency managers are often the same individuals that are called upon to participate in local mitigation planning efforts. There is communication between emergency management and planning, but little in the way of joint work on hazard mitigation. There are clear needs to facilitate education, training and support activities to emergency managers on mitigation and long-term recovery. Indeed, local emergency managers are often working with limited resources and time; hence, they tend to focus on the immediate short term issues, rather than longer term mitigation issues.

3c. Issues related to planners and planning related personnel and agencies.

The following are issues that emerged related to planners and planning agencies and personnel. The terms "planners" and "planning agencies" are broadly defined here to include all individuals and agencies addressing planning and management policies at the local or county level. Hence, this includes planners, floodplain managers, building code and permitting personnel, etc. These are however confined to individuals working for municipal or county governments. The following are some of the key issues that emerged:

- Planning staffs appear to have good general knowledge of the GLO and are often working quite closely with them on a variety of funding programs and permitting activities. The knowledge of the CMP is for the most part confined to funding programs related to beach re-nourishment activities, public access support, signage, and public education materials.

As noted above, there seems to be a rather clear differentiation between planning and emergence management activities at the local levels. In general, emergency management personnel appear to be less familiar with the CMP or the GLO, particularly with respect to mitigation.

While there appears to be good general knowledge of the CMP and the GLO, there is often limited knowledge of the SHMP and how it might be incorporated into on-going community planning activities.

Similarly, recovery planning, as a part of a mitigation plan or a stand along plan, is rarely discuss, particularly as it relates to opportunities to significantly improve a community's mitigation status and potentially improve, protect, and reclaim ecological resources such as wetlands.

Mitigation does not appear to be completely understood, nor is the relationship between normal development or planning activities and mitigation clearly recognized. Planning agencies are often attempting policy changes and planning actions that do have both positive and negative consequences for mitigation; they are simply not viewed as "mitigation" actions. Nevertheless, to the extent that "mitigation" of potential losses to coastal hazards is not explicitly addressed in many ongoing development strategies is a point of concern.

There may be a whole host of policies related to historic dwellings, special zoning areas, etc. that can enhance or sometimes thwart mitigation. For example, modifications to a home above 50% of the value of the structure can require the complete retrofitting of the home to meet new building code standards. This can have negative consequences on low valued homes or on fixed income households that cannot afford bring a home up to code. In the case of the former even seemingly minor mitigation retrofitting can trigger the 50% rule because of low property (just the structure) values.

This does not mean that mitigation related actions should be reduced, rather it means that there is a need for flexibility, incentives, and perhaps even public assistance to insure that needed maintenance/improvements are not ignored and the resulting mitigation actions not taken.

Mitigation plans are addressed by many agencies such as Planning, Public Works, City Manager, Commission or councils (at the municipal and county level), Floodplain Administration office, and Emergency Management.

City and county planners have projects that directly and/or indirectly work with the GLO. Some city and county planners and administrators have a long standing working relationship with the GLO.

Many programs have been funded through 306, 309 and 6217 both at the county level and the city level. However, it is mostly the counties who participate in projects funded by CEPRA, CMP and CIAP.

Cities and Counties have some regulations related to mitigation such as park ordinance, sand dune law, and flood prone areas. These are very limited at the county level, usually focusing on flood plain management. However on the issue of regulating ecologically sensitive areas such as wetlands there is a lack of knowledge on how to integrate these natural resource areas into their mitigation strategy.

- There is an understanding, on the part of some planners, that mitigation actions can take many forms that allow appropriate and responsible development while protecting life, property and the environment. In a few municipalities, there are attempts to strengthen mitigation planning are by putting an element of mitigation into their comprehensive plans. Some municipalities also have relatively strong building codes and seek to ensure that residential structures obtain windstorm certificates during the construction process.
- There is increasing interest and use of GIS to support mitigation planning and provide more information to individuals, groups and other agencies within local jurisdictions. Some planning agencies and departments have budgets to support GIS and hire qualified GIS technicians. However, the extent to which this is wide spread is difficult to determine from the current survey. It appears that the use of GIS is higher among planning offices than among emergency management offices.
- Building officials are very aware of building code issues and the importance of coastal setbacks for mitigation purposes. They also appear to be knowledgeable about the CMP and GLO.
- There is considerable concern about debris removal, which is seemingly considered a mitigation activity.
- There are novel programs in the State to help provide immediate access to "recovery" dollars on behalf of municipalities – particularly with respect to debris removal. These funds that can be made readily available (advanced) to local municipalities and later paid back from federal recovery funding. It is hoped, that such programs can jumpstart the recovery process after a disaster.
- When the relevance of mitigation planning is evident, planners often discuss the lack of "political will" on the part of elected officials to undertake comprehensive planning and land use regulation. The short term decision horizon displayed by local officials, particularly when policies are perceived as going against local development interests, can make it difficult to propose long run mitigation polices related to land use planning, environmental protection, zoning, etc.

In general, planners and planning agencies often have good knowledge of the coastal management program and work with the GLO. However, there is often a failure to see how effective mitigation planning might be incorporated into a community's on going planning efforts. It should be noted that planners and planning agencies often have limited resources and expertise to be able to fully integrate mitigation planning into their on going activities. They are extremely open to the use of GIS applications and tools, but again, often lack the resources to make this happen. Furthermore, planners and planning departments are more often than not in reactive rather than proactive mode. In other words, they are often reacting to changes in their communities, rather than having the ability to work with local community constituencies

and stakeholders to shape community change and development trajectories. Of course, the lack of political will issue was often mentioned by a variety of respondents. This continues to point to the need to enhance education of stakeholders and elected officials to the benefits of comprehensive mitigation planning wrapped around concepts like smart growth and community disaster resilience.

3d. Mitigation Planning Processes and Action

The following represent a set of general issues and observations that emerged from the interviewing and participant observation that relate more directly to mitigation planning and processes.

- Mitigation planning and plans are often developed with the assistance of outside consulting firms with little or no knowledge of local situations. In these situations outside contractors and firms must depend upon local involvement to provide local knowledge and input. Unfortunately, in the case of the development of a county mitigation plan, rarely were emergency managers from various municipalities within the county involved in the planning stages or implementation process. Even more limited is the participation by local planning personnel in the development, evaluation, and implementation of the mitigation planning process and plan.
- Local participation is often difficult to ensure, particularly from the general public and even by some planning departments. As a consequence contractors are left with little local input and the resulting plans are very formulaic.
- Contractors often seek to work one-on-one with stakeholders to better insure their understanding of mitigation and how to develop measureable mitigation actions, but time and expenses can make this difficult particularly if there is not community buy in and commitment to the process.
- Participation by local municipalities in county and regional mitigation planning efforts appears to be limited and uneven.
- Many mitigation action plans still focus on structural mitigation, meaning that the actions are related to projects like constructing and renovating drainage systems, channel maintenance, sewage systems, storm water management, elevating roads, and retrofitting public and private buildings.
- There is little understanding of "soft" mitigation strategies such as the use of zoning and building codes to prevent infrastructure damage. In particular, there is often little discussion, understand, or knowledge of a host of planning related strategies that can be employed such as: overlay zoning, performance zoning, density bonuses, infill/community redevelopment policies, conservation easements and setbacks, land banking, real estate disclosures, etc.
- There are a few examples of potential overlap between the municipal and county/regional mitigation planning, with some cities having independent

mitigation planning efforts and plans while at the same time being located in counties or regions with existing mitigation plans. These plans may not reflect coordination between municipal and county or regional mitigation plan efforts. This is not necessarily a negative, however to the extent that planning efforts are mutually supportive and cooperative, both plans may be strengthened and consistent mitigation actions undertaken.

- There is little understanding of the differences between 1) hazard exposure, 2) social and physical vulnerability, and 3) risk analysis. Furthermore, contractors and others working with local communities do little to clarify the issue and rarely engage in full risk analysis. While hazard exposure is concerned with areas subject to natural hazard impacts and vulnerability is related to the susceptibly of the built environment or natural environment and the population to damage, injury, or death due to hazard impacts, risk is associated with assessing the probability of impact and damage due to different levels of impact. Unfortunately, risk analysis is often too expensive to undertake within local mitigation planning efforts.
- Rarely do mitigation strategies deal with or address the full spectrum of "special needs" or socially vulnerable populations. When asked about special needs or socially vulnerable populations, most emergency managers describe elderly and the mentally incompetent. A complete understanding of factors that shape and identify socially vulnerable populations is generally lacking and is rarely included in mitigation planning efforts.
- The relationship between mitigation and environmental management, resource preservation and reclamation, and, as mentioned above, general development is often missing. If the issue of mitigation planning is properly understood as a critical component of these other important issues, it may be possible to attract and increase stakeholder involvement in the process, and thereby strengthen the final product.
- There is little recognition that recovery planning, as part of mitigation planning, can be an important tool for addressing past development problems. Through policies such as land banks, damage-building acquisition, development rights acquisition, damaged and abandoned properties can be converted to more appropriate land-uses, shifting development away from high hazard areas. These policies can be more easily implemented and funded in the aftermath of disaster when communities often have the political will to propose and pass these policies and recovery dollars, particularly mitigation funding from the Federal government can be employed to fund these initiatives.

These issues and insights above provide a wealth of opportunities for the GLO and its agency partners; unfortunately many of these are not easily met. There clearly is a need for education regarding the broad nature of mitigation issues and the great variety of mitigation actions that might be proposed or developed. This is particularly evident with respect to the variety of mitigation planning efforts and policies that might be

implemented. Broad based education programs, while good, may not insure broad based stakeholder understanding of mitigation planning issues. Perhaps targeted education programs would better enhance mitigation planning. In other words, education of emergency management, planners, floodplain managers, coastal planners, and elected officials might enhance the process. Given the long history of emphasis on structural mitigation strategies, such as sea walls, levies, and beach nourishment, participants in mitigation efforts are quick to identify these as likely solutions to hazard mitigation. Unfortunately there is little knowledge regarding soft mitigation policies that can be equally as effective. The development of model plans or planning tools might also facilitate the process by offering local municipalities tools to help martial stakeholder support for why mitigation actions should be undertaken and once actions are proposed, there might be off the shelf examples to guide in the development of these policies. In addition, the development of scientifically valid tools to not only map hazard risk, vulnerability, and exposure, but also help local communities visualize the nature of their risk may well help in the process. Working with grassroots organizations that are natural allies to mitigation planning can also expand the stakeholder base and, perhaps, foster increasing involvement.

4. Summary and Recommendations

Reviewing the issues and insights gained from this research it is perhaps difficult to not be somewhat discouraged when it comes to addressing mitigation issues along the Texas Coast. There are so many constraints to developing effective mitigation planning. Some of these constraints include: 1) the lack of comprehensive planning mandates, 2) the lack of a mandated statewide building code, 3) limited planning potential at the county level of government and at regional levels as well, 4) potential and actual divisions among and between emergency management and planners, 5) a lack of financial resources, technical skill, and human resources at so many critical points, but particularly at the local community level where most effective planning activities can be undertaken and 6) sometimes a lack of coordinated mitigation efforts.

However, there are also many positive points to build on. First, there are large numbers of dedicated individuals throughout coastal counties and the coastal management zone, particularly in the target counties where much of the interviewing took place, that firmly believe in mitigation and mitigation issues. They may not all agree on the solutions or actions that should be taken, but they do agree that something must be done to address the ever-increasing vulnerability of the Texas coast. Second, there are also many dedicated individuals at state, county, and local levels that recognize the nature of the problems facing the Texas coast and that hazard mitigation is a prime factor in moving us toward a solution. Furthermore, as discussed above, there are already beginning stages of cooperative and coordinated action between the TDEM and GLO with respect to mitigation planning, and there is the potential of increasing that coordination with the TDI and TWIA. In addition, recent events related to Rita and Ike have provided an important window of opportunity that can perhaps motivate municipalities and various stakeholders toward greater participation in broader mitigation activities at the state, regional, county and local level.

Perhaps the best strategy is to build on the strengths that are already evident and by building on these strengths seek to develop a more comprehensive and integrated program promoting coastal hazard mitigation through the TSMP and the CMP. Some of the actions that might be recommended are as follows:

7. *Build on current cooperation and seek to enhance future coordination:* In a sense the first steps have already been taken with cooperation between the GLO and TDEM focusing on mitigation planning efforts. However, future cooperative efforts among GLO, TDEM, and TDI should be explored. One important step that should be considered is expanding membership on the CCC for TDEM and, perhaps even, the TDI should be considered. Clearly there are commonalities in the missions of these agencies and there is a strong possibility of enhancing synergies through coordinating efforts through the CCC.
8. *Targeted Education and Training programs:* Education programs are often mentioned as a solution to enhancing mitigation, however it might be more strategically sound to target those education programs focusing on local emergency management and planning officials. The goal would be to increase the understanding of broad based mitigation approaches, policies, and actions that can be undertaken. Here again, coordination among agencies will be important. In particular, it makes since for TDEM and the GLO to coordinate efforts. Furthermore, when developing these programs it may well make sense to work with professional emergency management organizations, the Texas Chapter of the American Planning Association, and various state universities that have planning and coastal management programs. These programs should focus on broad based mitigation planning including "soft" mitigation strategies such as: overlay zoning, performance zoning, density bonuses, infill/community redevelopment policies, conservation easements and setbacks, land banking, real estate disclosures, etc. In addition, as noted above, there is little recognition that recovery planning, as part of mitigation planning, can be an important tool for addressing past development problems. Hence education programs might address topics such as land banks, damage-building acquisition, and development rights acquisition as tools that can, in the aftermath of a disaster, promote the conversion of damaged and abandoned properties to more appropriate land-uses, shifting development away from high hazard areas.
9. *Developing policy and planning templates:* In addition to education programs, the development of policy and planning templates might well be a logical next step to promote the adoption of mitigation policies. For example, as part of the Texas Chapter of the American Planning Association's list-serve one constantly encounters local planners asking for examples of ordinances and plans that can be employed as models in their own community. These examples are important, not only because they make it easier for a community considering an ordinance to develop its own, but also because these examples have often withstood legal challenges thus better insuring effective policy and ordinance development.
10. *Providing Strategic Tools and Technical Assistance:* It is clear that many local communities (as well as counties) lack the tools and technical knowledge to engage in the critical elements of hazard mitigation planning: hazard

Identification, vulnerability assessment, and risk analysis. This is particularly the case with the latter. Investment in hazard risk assessment tools, such as the wind risk assessment tools discussed above, might well be a sound investment toward helping coastal communities better understand their risk. The GLO and TDEM have already developed some of these tools and have sought to develop and make available to the public a variety of data sets to help in hazard identification and risk. Perhaps the TDI might be an additional partner in these efforts, working with the GLO and TDEM to enhance the development of tools and databases related to wind risk, as well as higher resolution flooding and surge mapping tools. Of course the development of tools and technical capacities must be coupled with the creation of additional tools and technologies that can integrate data, model output and enhance the ability of local communities, grassroots organizations, stakeholders, and ultimately the public to visualize the problems they face and potential solutions.

11. *Enhancing visualization and data integration tools:* Community planning and emergency management agencies, stakeholders, and the public must have access to tools that can enable them to better visualize and integrate data necessary to not only understand and analyze their current mitigation status, but also to envision their future under a variety of different scenarios. If tools are only left in the hands of a few, then the hopes of widening access and increasing community involvement in coastal planning in general and hazard mitigation planning in particular is doomed. This is particularly important the case of Texas, where planning can most effectively be undertake at the local municipality level. The efforts being undertaken as part of this project to develop a coastal community planning atlas is an important step in the direction of creating web-based visualization and data integration tools that be easily accessed by the broader public. However, as important as this effort is at providing as a test of concept, enhancing and maintaining this tool or developing the next generation of tools that can be easily accessed must be considered.
12. *Promoting involvement and increasing stakeholder involvement:* Mitigation planning must be seen as part of the larger solution for developing resilient and sustainable coastal communities in Texas. If disaster mitigation planning is seen as part of a portfolio of related issues for developing resilient communities, then the stakeholder base will be increased and, perhaps, involvement also enhanced. This should be part of the targeted education and training programs mentioned above, but also part of a targeted public education program as well. Specifically these programs can be designed to place hazard mitigation into a large context of environmental sustainably, climate change and variability, sea-level rise, and other issues of critical importance to coastal counties in general and coastal communities in particular. These programs should work through and in conjunction with local elementary, middle, and high schools and local community colleges and universities.

Appendix 2:

The Status and Trends of Population Social Vulnerabilities along the Texas Coast with special attention to the Coastal Management Zone and Hurricane Ike: The Coastal Planning Atlas and Social Vulnerability Mapping Tools

The Status and Trends of Population Social Vulnerabilities along the Texas Coast with special attention to the Coastal Management Zone and Hurricane Ike: The Coastal Planning Atlas and Social Vulnerability Mapping Tools

Walter Gillis Peacock, Himanshu Grover, Joseph Mayunga,
Shannon Van Zandt, Samuel D. Brody and Hee Ju Kim

I. Introduction

Disasters like hurricane Ike, as well as storms that have struck Texas in the past, such as Allison, Katrina, and Rita, are generally referred to as "natural" disasters. Rather than being wholly "natural," however, these disasters result from the interaction among biophysical systems, human systems, and their built environment. Indeed, the emerging scientific consensus is that the damage incurred—in both human and financial terms—is largely due to human action or, more often, inaction (Mileti 1999). As we have shown in earlier reports from the Status and Trends to Coastal Hazards Project, many of Texas's coastal communities, as with much of the United States, continue to develop and expand into high hazard wind and surge areas along the coast, contributing to increased hazard exposure (Peacock et al. 2010). This expansion often results in the destruction of environmental resources such as wetlands and barrier islands that can reduce losses. In other words, many of our coastal communities in Texas are becoming ever more *vulnerable* to "natural" hazards while simultaneously becoming less disaster *resilient*. This report takes the assessment of the growth and expansion of Texas's population into high risk coastal areas a step further by considering the social and economic characteristics of this expanding population.

When disaster strikes, its impact is not merely a function of its characteristics such as its magnitude and the location where it strikes. For example, like most communities Galveston is composed of many unique neighborhoods and places. Some of its neighborhoods are composed of beautiful homes whose occupants lives are characterized in terms of relative wealth, leisure, and privilege while other neighborhoods have run down homes and are plagued by poverty, crime, and unemployment. Development patterns that are all too often characterized by sprawl, concentrated poverty and segregation shape our communities' urban environments in ways that separate and often isolate vulnerable populations in a manner such that poor and rich, Black, White and Hispanic, owners and renters, primary residents and vacationers are separated from one another in clusters and pockets across the Island. In a disaster event like Ike, the socio-economic geography of our communities can interacts with the physical geography to expose vulnerable populations to greater impact. Lower-income populations often live in low-lying areas and in lower-quality homes that are at greater risk. Furthermore, vulnerable populations are less likely to have access to both information and resources that would allow them to anticipate and respond to a real or perceived threat, yet they are more often than not the groups who most need to heed warnings to evacuate or seek shelter.

Appendix 2:

The Status and Trends of Population Social Vulnerabilities along the Texas Coast with special attention to the Coastal Management Zone and Hurricane Ike: The Coastal Planning Atlas and Social Vulnerability Mapping Tools

The Status and Trends of Population Social Vulnerabilities along the Texas Coast with special attention to the Coastal Management Zone and Hurricane Ike: The Coastal Planning Atlas and Social Vulnerability Mapping Tools

Walter Gillis Peacock, Himanshu Grover, Joseph Mayunga,
Shannon Van Zandt, Samuel D. Brody and Hee Ju Kim

I. Introduction

Disasters like hurricane Ike, as well as storms that have struck Texas in the past, such as Allison, Katrina, and Rita, are generally referred to as "natural" disasters. Rather than being wholly "natural," however, these disasters result from the interaction among biophysical systems, human systems, and their built environment. Indeed, the emerging scientific consensus is that the damage incurred—in both human and financial terms—is largely due to human action or, more often, inaction (Mileti 1999). As we have shown in earlier reports from the Status and Trends to Coastal Hazards Project, many of Texas's coastal communities, as with much of the United States, continue to develop and expand into high hazard wind and surge areas along the coast, contributing to increased hazard exposure (Peacock et al. 2010). This expansion often results in the destruction of environmental resources such as wetlands and barrier islands that can reduce losses. In other words, many of our coastal communities in Texas are becoming ever more *vulnerable* to "natural" hazards while simultaneously becoming less disaster *resilient.* This report takes the assessment of the growth and expansion of Texas's population into high risk coastal areas a step further by considering the social and economic characteristics of this expanding population.

When disaster strikes, its impact is not merely a function of its characteristics such as its magnitude and the location where it strikes. For example, like most communities Galveston is composed of many unique neighborhoods and places. Some of its neighborhoods are composed of beautiful homes whose occupants lives are characterized in terms of relative wealth, leisure, and privilege while other neighborhoods have run down homes and are plagued by poverty, crime, and unemployment. Development patterns that are all too often characterized by sprawl, concentrated poverty and segregation shape our communities' urban environments in ways that separate and often isolate vulnerable populations in a manner such that poor and rich, Black, White and Hispanic, owners and renters, primary residents and vacationers are separated from one another in clusters and pockets across the Island. In a disaster event like Ike, the socio-economic geography of our communities can interacts with the physical geography to expose vulnerable populations to greater impact. Lower-income populations often live in low-lying areas and in lower-quality homes that are at greater risk. Furthermore, vulnerable populations are less likely to have access to both information and resources that would allow them to anticipate and respond to a real or perceived threat, yet they are more often than not the groups who most need to heed warnings to evacuate or seek shelter.

Community vulnerability, in its broadest sense, describes the susceptibility of a community or, importantly, its constituent parts to the harmful impacts of disasters. Variation in existing vulnerabilities influences the exposure of households, businesses, and communities to effects of natural hazards as well as the capacity and resources available to respond to and recover from disasters. In other words, storms like Ike were and are not "equal impact" events—they affect different groups, sub-populations and neighborhoods in different ways. While some can easily anticipate and respond to hazard threats by putting up hurricane shutters or evacuating to relatives and friends further inland, others find it more difficult if not impossible. And then, in the aftermath of a devastating disaster, recovery can be highly uneven, with some parts of a community recovering relatively more quickly as insurance companies respond more readily, expediting their abilities hire contractors or builders to have their homes repaired or rebuilt, while others neighborhoods lag behind. The uneven nature of recovery can jeopardize the overall vitality and resiliency of a community and bring into question its future.

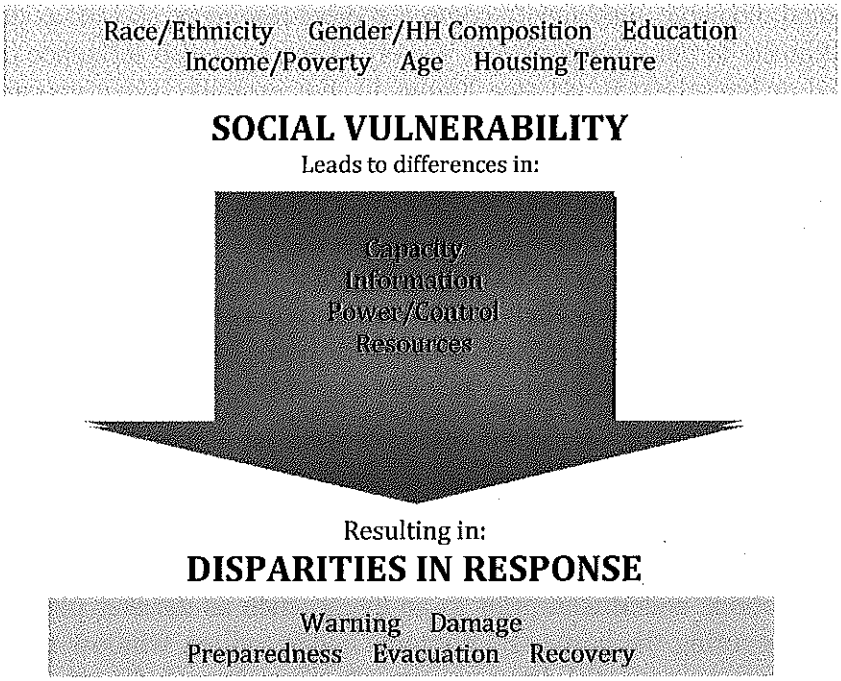
This report provide an expanded view of community vulnerability, focusing on how social and economic factors influence the ability of coastal communities and their populations (individuals and households) to anticipate, respond, resist, and recover from disasters. It will first present a discussion of the literature on social vulnerability and discuss previous findings showing how social vulnerability can shape disaster response. We then present the approach for measuring, assessing and mapping social vulnerability along the Texas coast using the Texas Coastal Community Planning Atlas[8]. Employing data from the Atlas, we also discuss the status and trends in social vulnerability from 1980 through 2000 focusing on areas within the coastal management zone (CMZ). Finally, using data from Galveston, we will examine patterns of social vulnerability prior to Ike and show how these pre-existing patterns are related to differential response to warning, impact, access to recovery resources, and the initial stages of recovery. We conclude that undertaking a spatial analysis of social vulnerability should be a critical element in emergency and hazard management, hazard mitigation and disaster recovery planning. Our findings suggest that social vulnerability analysis can help communities reduce losses, enhance response and recovery and thereby strengthen community resilience.

II. Social vulnerability (SV)

Vulnerability has become a central yet evolving concept in hazard analysis and research (White, Kates and Burton 2001:86; NRC 2006; Naudé, Santos-Paulino and McGillivary 2009). When considering natural hazards, vulnerability generally refers to susceptibility or potential for experiencing the harmful impacts of a hazard event (Cutter 1996; Mitchell 1989). The foundation of vulnerability analysis, a hazards assessment, generally focuses on a community's exposure to hazard agents such as floods, surge, wave action, or winds (Deyle et al. 1998; NRC 2006:72-3). Such assessments identify the potential exposure of populations, businesses, and the built environment (housing, infrastructure, critical facilities, and so on). Also important

are the physical characteristics of the built environment such as wind design features of buildings, the height of structures relative to potential floods, as well as natural and engineered environmental features such as wetlands, dams, levees or sea walls, because these can modify vulnerabilities and concomitant risk. As disaster and hazard researchers critically examined the nature and distribution of disaster impacts and the factors shaping the variability in exposure and access to technology that can mitigate impacts (i.e., shutters, impact resistant glazing etc.), it became clear that more than just more than just hazard exposure and the built and natural environment were also shaping vulnerability. A new perspective began to emerge suggesting that social structures and processes also shape vulnerability; hence, the term social vulnerability (SV).[9]

Figure 1. Conceptual model of how vulnerabilities lead to disparities in disaster response.



Social vulnerability is defined by Blaikie, Cannon, Davis, and Wisner (1994:9) as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard." A SV perspective focuses attention on the characteristics and diversity of populations in terms of broader social, cultural, and economic factors that shape abilities to anticipate future events, respond to warnings, and to cope with and recover from disaster impacts. While the SV literature continues to grow, it has examined a variety of hazard and disaster contexts identifying dimensions of social vulnerability related to race/ethnicity (Bolin 1986; Bolin and Bolton 1986; Perry and Mushkatel 1986; Peacock et al. 1997; Bolin and Stanford 1998; Fothergill, Maestas, and Darlington

[9] Similar lines of thought were evident in what has been termed the Environmental Justice research (e.g., Bullard1990; Bryant and Mohai 1992; Pastor, Bullard, Boyce, Fothergill, Morello-Frosch and Wright 2006).

1999; Lindell and Perry 2004; Zhang and Peacock 2010), income and poverty (Peacock et al. 1997; Dash et al. 1997; Fothergill and Peek 2004), gender (Enarson and Morrow 1997; Enarson and Morrow 1998; Fothergill 1999) as well as a host of other factors such as age, education, religion, social isolation, housing tenure, etc. Very often, these factors are present in combinations (both poor and Black, for example), which can exacerbate vulnerability (Morrow 1999). Conceptually, this perspective is presented in Figure 1, where preexisting social vulnerability factors shape access to information and resources and hence shape disaster response.

Policies and practices related to disaster response often assume that all residents of an area have the same information as well as the same resources and ability to act upon that information. Further, they assume that all residents will react in the same way. Social vulnerability factors, however, can shape and influence access to and knowledge of resources (physical, financial, and social), control of these resources, as well as perceived or real power within the larger community or society. They may also influence the capacity of the individual or household to act (see Figure 1). For example, some research suggests that African-Americans often rely on informal social networks rather than media or government to obtain information about threats or hazards (Perry and Lindell 1991; Morrow 1997). Even if a resident has the same information, he or she may not have the capacity (a car, for example) to evacuate in a timely manner. Renters are typically more mobile or transient and may not have local family connections to facilitate evacuation or sheltering, while owners are more likely to have such resources, but also are more place-bound, in that they often express concerns about their homes and contents. As a result of these differences, responses to disasters may be quite disparate.

The following offers a brief review of the research literature illustrating how dimensions of SV are related to household and individual response to critical disaster stages: a) preparedness, b) warning, c) evacuation, d) casualties and damage, e) reconstruction and recovery and f) mitigation.[10]

a. Preparedness: Actions undertaken prior to an event, such as disaster planning, having supplies on hand, securing the home and contents and installing window protection that can reduce or eliminate potential impacts are all examples of disaster preparedness. Interestingly, despite the general finding that minority status and lower-income is associated with higher risk perceptions for natural and technological hazards (Flynn, Slovic, and Mertz 1994; Vaughn and Nordenstam 1991; Vaugh and Seifert 1992; Turner, Nigg and Paz 1986; Lindell and Prater 2000; Peacock, Brody, and Highfield 2005), on the whole minorities and low income households display lower levels of preparedness. With respect to earthquake preparation, a number of researchers found preparation less common among minorities than whites (Turner et al. 1986, Farley 1998, Edwards 1993, Mileti and Darlington 1997). Similar findings are reported for Black households with respect to hurricane preparation supplies (Norris et al. 1999) and Morrow and Enarson

[10] The this typology and the following discussion draws heavily from two excellent reviews of the disaster and hazards literature related to race/ethnicity (Fothergill, Maestas, and Darlington 1999) and poverty (Fothergill and Peek 2004).

(1996) noted that prior to Hurricane Andrew poor women in public housing heard warnings and wanted to prepare, but simply lacked the economic resources for supplies. Even among homeowners Florida, both low-income and Black households were less likely to have code-compliant hurricane shutters to protect their homes from hurricanes. These findings are not completely consistent across hazards or regions, where, for example, some researchers found no racial/ethnic variations with respect to flood preparation (Lindell et al. 1980, Ives and Rurseth 1983) and with hurricane preparedness in Miami (Gladwin and Peacock 1997). On the whole however, the literature suggests somewhat higher vulnerabilities for lower-income and minority households with respect to disaster preparation.

b. Warning: Disaster warning processes begin with receiving and then believing a warning, where source credibility and conformation can be critical, and hopefully ends with undertaking protective action such as evacuating (Lindell and Perry 2004). Although findings are not always consistent, the general pattern suggests that race/ethnicity, income and other SV factors can be important. For example, researchers found that among Hispanics in general (Mexican-Americans in particular) and Blacks, social networks and relatives are more important for relaying warning and disaster information (Perry and Mushkatel 1986; Phillips and Ephraim 1992; Perry and Nelson 1991; Blanchard-Boehm; Morrow 1997). Similarly, research suggests that Anglos are more likely to report the authorities and the media as most credible when compared to minorities that tend to pick social networks as most credible (Perry and Lindell 1991, Lindell and Perry 1992). Interestingly, Perry and Lindell (1991) found that Whites were somewhat less likely to require message confirmation, which is consistent with conclusions by Perry and Mushkatel (1986) that Whites more strongly believe warnings than do either Blacks or Mexican-Americans. These findings suggest that minorities may experience potential delays in receiving and confirming warning messages since they display greater dependence on informal social and familial networks.

c. Evacuation: Research on evacuation is somewhat equivocal, but on the whole it suggests that minorities, lower-income groups, and aged are less likely to respond to warnings. Early research found that minorities and lower-income populations fail to comply with warnings (Moore 1958; Sims & Bauman 1972). Lindell, Perry and Greene (1980) examining flooding response found that Mexican Americans were less likely to evacuate and Drabek and Boggs (1986) found that Mexican-American households were more dependent on extended family ties to facilitate evacuation. On the other hand, Perry and Lindell (1991), examining flooding and hazards material spills, report limited to non-significant ethnic variations in evacuation. Gladwin and Peacock (1997) however, found that low-income and black households were less likely to evacuate prior to Hurricane Andrew. They speculate that this is due in part to a lack of resources, particularly private vehicles, ineffective public transportation options, and few refuge options outside evacuation zones. Morrow and Enarson (1996) and Morrow (1997) found that prior to Hurricane Andrew poor women and others in public housing lacked transportation, forcing many to walk or hitchhike in order to evacuate. Similarly, Enarson (1999) found that the homeless, unemployed and lower-income women were less able to evacuate in

response to Red River Valley flood warnings. These findings are consistent with the failures of many poorer and minority households to evacuate New Orleans in response to Katrina. Lindell and Perry (2004:90) also suggest that income and education might have consequences for evacuation in response to warning, "due to restricted material resources, knowledge, and skill."

d. Casualties and damage: Research examining variations in casualties and damage suggests that minorities and low-income groups are much more likely to be disproportionately impacted and hence more vulnerable to flooding. In one of the earliest studies examining casualties due Hurricane Audrey, Bates et al., (1963) found significantly higher death rates among Blacks (322 per 1000) compared to Whites (38 per 1000). Bolin and Bolton (1986) reported that following the Paris tornado, Black respondents were significantly more likely to report friends being injured (19.6% to 9.9%) and killed (31.1% vs. 17.5%) when compared to Whites. Rossi et al. (1983) examined injuries due to various disasters from 1970 through 1980, and found that lower income areas experienced significantly higher injuries, particularly when examining floods and earthquakes. Aguirre (1988) similarly found that the poor had higher injury and deaths following a Texas tornado in 1987. More recently, Zahran and his colleagues (2008) found that counties with higher concentrations of socially vulnerable populations, defined by race, poverty and income, had higher flood casualty rates from 1997 – 2001 in Texas.

The research on damage and losses due to disasters suggests that minorities and lower-income households suffer disproportionately. In large measure this appears to be due to trickle down housing processes in the United States whereby the poor and minorities are often allocated to older and poorer quality housing, often segregated into less desirable and potentially more risky neighborhoods and areas (Foley 1980; Bolin 1986; Bolin and Bolton 1986; Logan and Molotch 1987; Greene 1992; Massey and Denton 1993; Phillips 1993; Phillips and Ephraim 1992; Peacock and Girard 1997; Charles 2003; Peacock, Dash, and Yang 2006; Van Zandt 2007). Bolin and Bolton (1986), for example, found that minorities and low income households suffered disproportionate losses from both tornados and earthquakes (see also, Bolin 1986, Bolin and Stanford 1991 and 1998). Fothergill and Peek (2004), citing data from the U.S. Department of Commerce, noted that nearly 40% of all tornado fatalities occur among mobile home residents, which are more likely to be occupied by low-income households. Peacock and Girard (1997) found that, once housing type is controlled, income variations become non-significant, and yet both black and Hispanic household suffered higher levels of damage when compared to Anglos in Hurricane Andrew (see also Zhang and Peacock 2010). The findings with respect to flooding are not as consistent. Indeed, Brody and his colleagues (2007), examining damage losses due to flooding in Texas coastal counties from 1997-2001 found that a county's median household income was not related to total property losses.

e. Reconstruction and Recovery: The literature suggests that minorities, low- income households, and even female- headed households can be at a disadvantage in part because of low language skills and education when it comes to qualifying for

and negotiating the process of obtaining public financial resources such as SBA loans or minimum housing assistance (Phillips 1993; Bolin 1985; Bolin and Stanford 1990; Morrow 1997; Morrow and Enarson 1997). Furthermore, racial/ethnic groups are often excluded from community post-disaster planning and recovery activities because they have less economic power and political representation (Bolin and Bolton 1983; Quarantelli 1985; Tierney 1989; Phillips 1993; Morrow 1997; Morrow and Peacock 1997; Prater and Lindell 2000). Research further suggest that poorer households and neighborhoods often fall far short of receiving necessary aid to jump start the recovery process(Rubin 1985; Bolin and Stanford 1991; Phillips 1993; Berke et al. 1993; Bolin and Stanford 1991; Dash et al. 1997), particularly when it comes to qualifying for SBA loans and private insurance settlements necessary for housing recovery.

Research has shown that low-income and minority homeowners are much more likely to fail to qualify for government-backed SBA loans (Bolin 1982; Drabek and Key 1984; Quarantelli 1982; Bolin and Bolton 1986; Bolin 1986; Bolin 1993b; Bolin and Stanford 1998a and b), although more recent research suggests that ethnic/racial variations may no longer be significant (Galindo 2007). While early research found that low-income and minority households were more likely to be without insurance (Moore et al. 1963 and 1964; Cochrane 1975; Drabek and Key 1984), later research suggests more parity in holding insurance policies, but that poor and minority households were more likely to report settlements failing to meet repair and reconstruction costs (Bolin 1982; Bolin and Bolton 1986). Peacock and Girard (1997) found a similar pattern in Miami-Dade County following Hurricane Andrew where both Black and Hispanic households were more likely to report insufficient insurance settlements for repairs and reconstruction. Further analysis suggested that this was a function of the insurance company. Specifically, large national insurance companies that were more likely to provide adequate settlements had systematically failed to underwrite insurance in minority, and particularly Black, neighborhoods. The literature also suggests that rental housing is slower to recover, which makes it more difficult for minority and low-income households to find post-disaster housing and return to their pre-disaster communities, often extending the recovery process (Quarantelli 1982; Comerio 1998; Comerio et al. 1994; Bolin 1986, 1993b; Bolin and Stanford 1998a and 1998b; Morrow and Peacock 1997). Indeed, in one of the few longitudinal studies of housing recovery following a major natural disaster, Hurricane Andrew in Miami-Dade county, Zhang and Peacock (2010) found that housing in predominantly minority (Black and Hispanic) neighborhoods as well as rental housing, was much slower to recover.

f. Hazard Mitigation: Hazard mitigation generally refers to actions undertaken prior to a disaster that act as protection against disaster impacts passively (Lindell Prater and Perry 2010). In other words, these are actions that once taken help reduce impact, lessen the consequences of impacts, but do not necessarily need to be undertaken at the time of an event. Past literature referred to mitigation actions as hazard adjustments. These adjustments range, at the community level, from major structural adjustments such as building dams and levees, to land use regulations, building codes, and education programs. At the individual or household level these adjustments could be installing hurricane shutters or impact resistant windows in hurricane risk areas, elevating homes

hurricane surge or inland flooding risk areas, to strapping water-heaters and bookshelves to the walls in earthquake areas.

The literature on mitigation and hazard adjustments at the household level is often associated with a number of SV factors. For example, researchers have found that income is positively associated with the ability to undertake a variety of adjustments (Edwards 1993; Russell et al. 1995; Lindell and Prater 2000). Peacock (2003), found that high income households were much more likely to have hurricane shutters installed on their homes and were also more likely to have more complete protection for their home (i.e., their home's envelope) when considering windows, garage doors, sliding glass doors, etc. However, Lindell and Perry (2000) have noted, the results have been somewhat inconsistent across all types of adjustments. Peacock (2003) suggests, these inconsistencies could be a function of the variability in the types of adjustments considered. Often times researchers have constructed hazard adjustment indices that include relatively large proportions of low investment items such as flashlights, batteries or simply attending meetings. When considering such low investment items it, perhaps is not surprising that income has little in the way of consequences. However, when considering adjustments that will demand significant capital outlays, like shutters, new roofs, elevating home etc. higher income households will have more disposable income and potential accesses to credit to make these rather substantial investments.

Researchers have also found that race and ethnicity have consequences for hazard mitigation adjustments (Edwards 1993; Mileti and Darlington 1997). Indeed, Peacock (2003) in his research on homeowners in Florida also found that Black households, when compared to Anglo households and after controlling for a host of other factors, were less likely to have quality shutter systems and envelope coverage. The author suggested that the reasons for these differentials were due, in part, to racial and ethnic variations to credit and capital. For example, research on home ownership and access to loans suggests significant ethnic variations, with minorities particularly Blacks having significantly lower access to these scarce resources Squires and Velez 1987; Horton 1992; Alba and Logan 1992; Massey and Denton 1993; Oliver and Shapiro 1997) and when they do, payments and interest rates are often higher. The implication is that minorities, particularly Black households will have reduced access to the capital resources necessary to make home improvements and retrofits. It is also interesting to note that Peguero (2006) has found significant ethnic differentials, particularly with respect to Latino households, in sources of information related to mitigation. Specifically he found that Latino homeowners in Florida tend to rely most on friends and family, and less on governmental or official sources.

On the whole, then, the literature suggests that SV factors can be important determinants of vulnerability and hence should be considered when undertaking disaster planning related to warning, response, impact, recovery and mitigation. Further, and importantly, socially vulnerable populations are not evenly distributed throughout communities. Instead, they tend to be clustered into particular locations or neighborhoods. On one hand, such clustering exacerbates the impact of disasters; on the other hand, it may also make it possible for public officials to address such disparate outcomes through spatially-targeted efforts both prior to and after a disaster. In the next section, we explore the use

of a spatial decision-making tool to both identify and address the needs of socially vulnerable populations.

III. Social Vulnerability Mapping: The Coastal Planning Atlas Approach

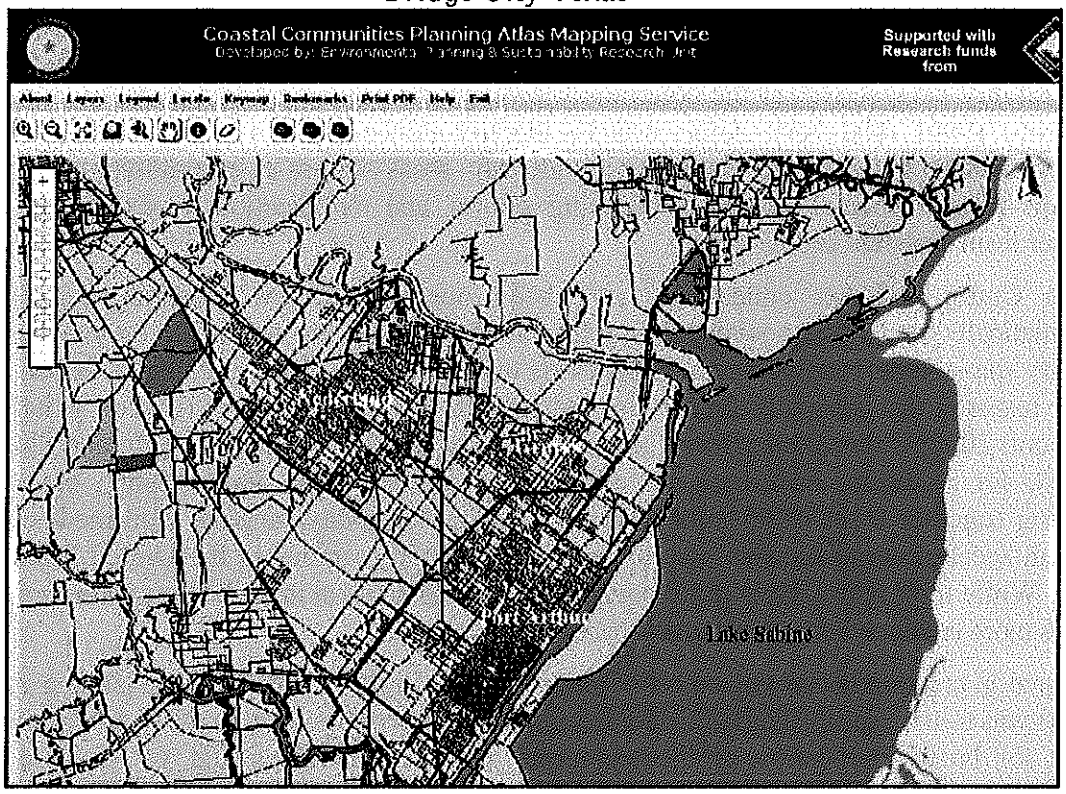
While the above discussions on social vulnerability clearly suggest that a host of factors from age, to income and even minority status can indeed be important when seeking to understand and predict the variability in the abilities of populations to anticipate, respond and recover from disasters, the inclusion of these factors into community planning and vulnerability analysis has been slow to develop. Indeed, it was not until nearly the turn of the century that researchers began to call for the systematic application of social vulnerability perspectives at the community level to develop social vulnerability mapping (Morrow 1999). The basic logic was to identify concentrations of populations with particular SV characteristics in order to identify areas within a community that will perhaps require special attention, planning efforts, and mobilization to respond to and recover from disasters and hazards.

Susan Cutter and her colleagues have been one of the few research groups to systematically undertake social vulnerability mapping utilizing a variety approaches to identify spatial units ranging from census tracts to counties and states, seeking to extend and apply research that generally focuses on individuals or household level (Cutter, Mitchell, and Scott 2000; Cutter 2001; Boruff, Emrich and Cutter 2005). Cutter, Boruff, and Shirley (2003), for example, undertook an extensive analysis of the vulnerability literature drawing together a set of 85 indicators of social vulnerability ranging from median age through social security receipts per capita for over 3,000 counties in the United States in 1990. While their approach is quite comprehensive and national in scale, the approach taken here is more conducive for community-based planning.

Our goal in creating social vulnerability mapping tools in the Texas Coastal Planning Atlas (CPA) was to use readily available data from secondary sources such as the U.S. Census, to allow for broad application of the technique to all communities and yet provide for sufficiently fine resolution that planners and emergency managers might easily identify and potentially target more or less homogeneous pockets of socially vulnerable populations. The logical census areal units (and data) that might be employed to map parts of a community were census blocks, block-groups, or tracts. Tracts are the largest areal unit that might be possibly employed. They are designated by the census to have relatively stable boundary over several census decades. Their boundaries often follow more or less recognizable physical features of a community and generally contain between 1000 to 8000 individuals. Tracts have a major advantage of offering rich social and economic data to measure dimensions of SV. However, relatively speaking they also tend to be quite large, often times encompassing multiple neighborhoods and even smaller communities. Because they are so large they can be quite heterogeneous and fail to capture neighborhoods that are natural areas to organize and work with for planners and emergence managers. Census blocks, on the other hand are quite small and homogeneous, and generally capture quite refined areas much like blocks within communities. Unfortunately since they are so small, and individuals can be more

easily identified, the US Census provides only minimum data for blocks and these data are far too limited to capture many SV dimensions. Block-groups offered a viable compromise in that they fall between tracts and blocks, offer relatively refined data relevant for measuring various dimensions of SV, and yet are also sufficiently small in spatial scale that they often matched more or less homogeneous neighborhoods.

Figure 2. Census Blocks in Port Arthur, Groves, Nederland and Bridge City Texas



These distinctions can be readily seen in the maps provide in Figures 1, 2 and 3 which are of the Texas side of Lake Sabine with the city of Port Arthur on the west side of the lake, Groves Texas just to the north of Port Arthur, with Nederland, Port Neches, and Central Gardens to the north west of Port Arthur. Figure 1 displays a map of census blocks, which are so refined that they clearly identify individual blocks within these cities. They would be ideal to use for SV mapping because they are so small that one could get a very clear picture of the individuals residing in these blocks. However, it is precisely because of this fact that they may contain so few individuals and households that the US Census does not release much in the way of detail data on the individuals and households in these units. For example, data on the numbers of individuals, household and basic racial information is often the best that is obtainable, although even here, in very small blocks even racial information might be withheld. The bottom line is that the data available for these census units is

far too limited for use when seeking to identify socially vulnerable individuals or households.

Figure 3. Census Tracts in Port Arthur, Groves, Nederland and Bridge City Texas

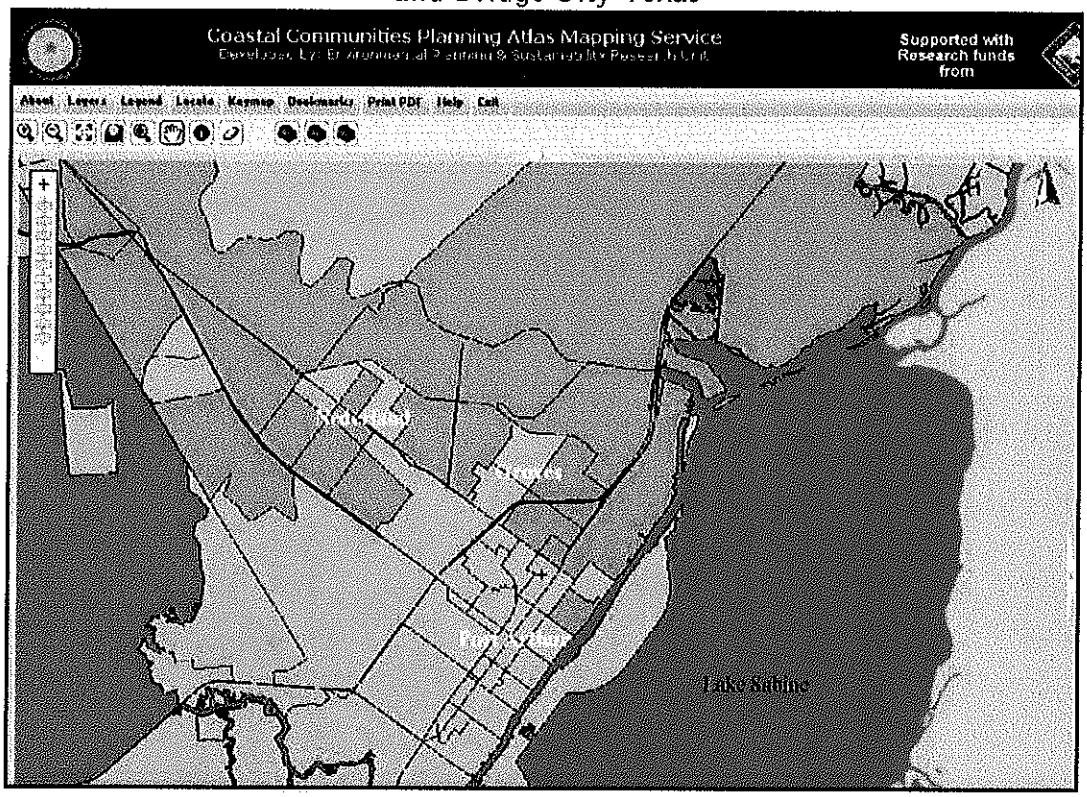


Figure 3, above, displays a map of census tracts for the same area. While these census areal units would provide very rich data upon which to base the SV measures, these spatial boundaries are rather large. Port Arthur is reduced to a relatively small number of census tracts, but even more dramatic are the consequences for Nederlands and Groves which are reduced to very few unrecognizable geometries that encompass multiple neighborhoods. These relatively large areas, besides not capturing recognizable neighborhoods are often quite heterogeneous in terms of population and housing characteristics. As a result these units can make it very difficult for planners and emergency managers to utilize the information to shape policies and actions to better respond to disaster threats.

Figure 4, on the other hand, displays census block group boundaries, again for the same area. These represent our compromise spatial unit upon which to base our SV maps. As we will shortly see the census provides rather refined and relatively rich data for these spatial areas that will allow for good definition of SV characteristics. Equally important, these spatial boundaries while not perfect, often demarcate neighborhood areas or parts of neighborhoods that are easily recognizable to local planners, emergence managers, and citizens themselves. This can therefore facilitate effective development of policies and the targeting of programs to address hazards and disaster response. The extent to which

they reflect actual neighborhood boundaries can greatly enhance the ability to work with local neighborhood organizations, businesses, churches, neighborhood associations, and other civic organizations to organize the neighborhood.

Figure 4. Census Block Groups in Port Arthur, Groves, Nederland and Bridge City Texas

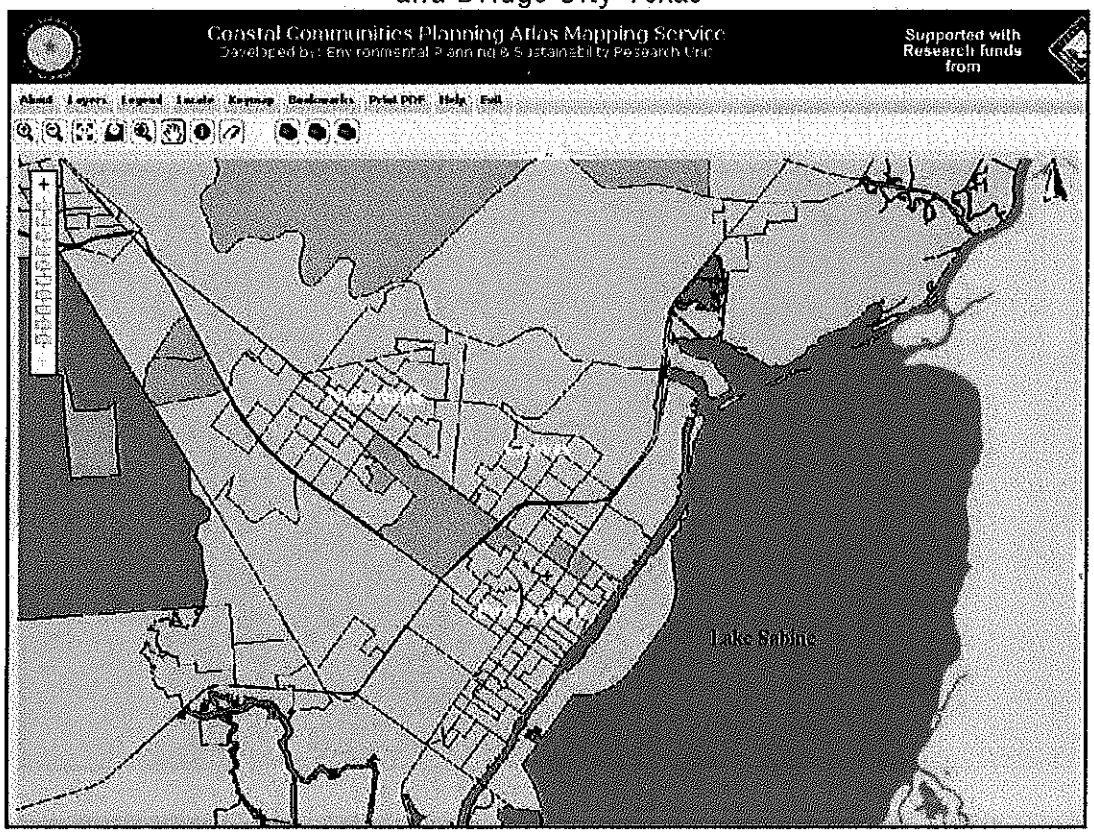
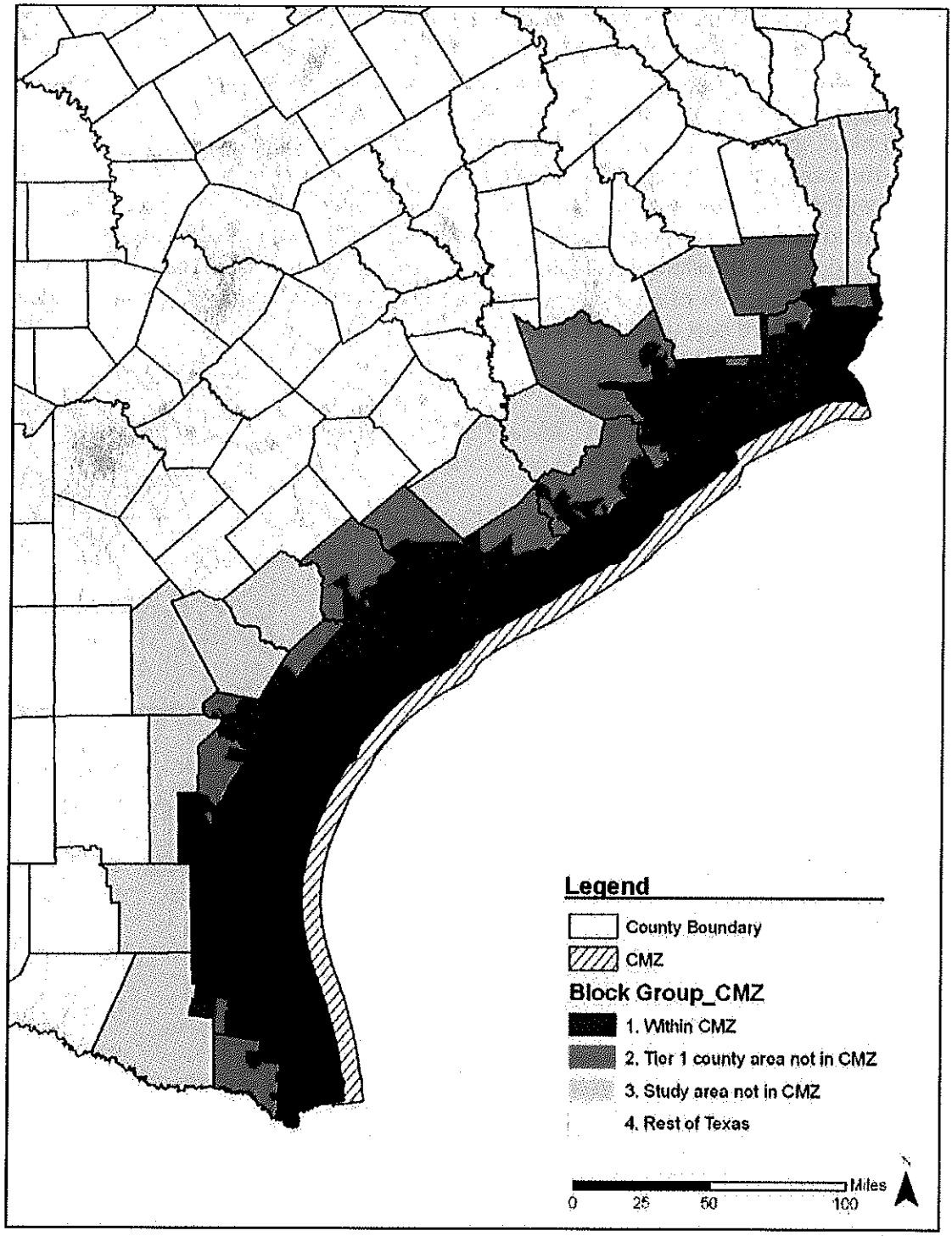


Figure 5. Coastal Atlas Counties, CMZ boundary and Block Groups



The coastal atlas has data on the 3993 census block groups located in the first two layers of counties of the Texas coast. At times we will utilize and present all of these data, however, for much of this report we will focus on areas within the coastal management zone. Specifically, we have identified 1,322 census block groups located either wholly (100%) or partly (minimum of 10%) within the Texas's CMZ. Figure 5 displays a map of

the first two tiers of coastal counties that are part of the Coastal Planning Atlas. These counties are displayed in blue (dark, medium, and light). The Coastal Management Zone Boundary is marked in red on this map and all block groups that are included in our analysis as CMZ block groups are indicated in dark blue. As is apparent from the map some of these block groups extend beyond the CMZ boundary. More often than not, these are rural block groups that are sparsely populated and hence quite large. Unfortunately, it is often the case that the population concentrations for many of these block groups are actually within that part of block group that is within the CMZ. To better insure that population concentrations that are actually within the CMZ are included in our analysis, we employed a 10% threshold for inclusion in our sample as a CMZ block group. In other words, if more than 10% of a block group's physical area fell within the CMZ, the block group was considered part of the CMZ.

Table 1. Social Vulnerability Indicators and 2nd and 3rd Order SV Measures

Base Social Vulnerability Indicators (percentages)	2nd Order	3rd Order
1. Single parent households with children/Total Households 2. Population 5 or below/Total Population	Potential Child care Needs	Socially Vulnerable Hotspot
3. Population 65 or above/Total Population 4. Population 65 or above & below poverty/Pop. 65 or above	Potential Elder Care Needs	
5. Workers using public transportation/Civilian pop. 16+ and employed 6. Occupied housing units without a vehicle/Occupied housing units (HUs)	Potential Trans. needs	
7. Occupied Housing units/Total housing units 8. Persons in renter occupied housing units/Total occupied housing units 9. Non-white population/Total population 10. Population in group quarters/Total population 11. Housing units built 20 years ago/Total housing Units 12. Mobile Homes/Total housing units 13. Persons in poverty/Total population	Potential Housing Needs (Temporary Shelter and housing recovery)	
14. Occupied housing units without a telephone/Total occupied HUs 15. Population above 25 with less than high school/Total pop above 25 16. Population 16+ in labor force and unemployed/Pop in Labor force 16+ 17. Population above 5 that speak English not well or not at all/Pop > 5	Potential Civic Capacity needs	

The selection of SV indictors was guided by the literature on social vulnerability, some of which was discussed above, and, of course, was contingent on the data available from the US Census and attached to block groups that most closely captured attributes discussed in the literature. Table 1 displays the 17 base or 1st order indicators utilized to identify socially vulnerable populations. The indicators include a range of factors related to household structure (single parent households with children), age (children at or below 5, individuals ≥65, and individuals ≥65 living in poverty), transportation dependence (reliance on public transportation or households not having a car), housing

characteristics (occupancy, mobile homes, group quarters), minority status (non-white population), poverty (population below the poverty level), educational status (individuals 25 or older without a high school diploma or equivalent), employment status (unemployment) and English language competency (individuals ≥5 not speaking English well or at all). Each of these indicators was transformed into a proportion[11] (ranging from 0 to 1) by dividing it by an appropriate base to facilitate their comparability across block-groups. In each case, the closer to one (1) a block group's proportion, the higher the concentration of vulnerability.[12] These 1st order SV indicators capture important dimensions of social vulnerability, which is, by its nature multi-dimensional (Morrow 1999). An additional advantage of having these 17 basic or 1st order SV measures available to process and map at the local level is that planners can more easily identify and perhaps focus on particular types of policies and programs to address specific dimensions of vulnerabilities given particular hazard risks. Examples might be programs targeting non-English speaking populations or elderly populations to enhance their compliance with evacuation orders. Furthermore, there are a host of many different types of funding and assistance programs at the Federal, State and local level that might be available to address different types of community needs, some of which are related to addressing hazard/disaster needs. By identifying those focused areas within a community, planners can use these funding streams more effectively and efficiency to address the unique needs of their community's population.

These basic indicators can in turn be combined to form 2nd order SV measures indicating special needs that are germane during emergency response, disaster recovery, or even when considering mitigation programs. In this case 2nd order measures were created to identify areas with higher potential for child care needs both before and after a disaster event, elder needs for evacuation and during the emergency response and long term recovery period, transportation needs particularly for hurricane and other types of emergency evacuation, housing needs or more specifically temporary shelter and housing recovery needs after a disaster, and civic capacity needs that can be particularly important during preparation, response, recovery, and mitigation. Any number of 2nd order SV measures might be created, depending upon the particular focus or emergency functions of interest. Adding or averaging proportions across block-groups can create these composite scores. In this case we have computed average proportions.

Finally, all 17 indicators can be combined to form a composite Social Vulnerability composite index. To compute this measure we again simply averaged the 17 SV indicators with the resulting index offering a general measure of relatively high or low levels of social vulnerability. By focusing on the upper end of this composite index, planners and emergency managers can quickly identify a community's

[11] These proportions can, of course, be converted to percentages by simply multiplying them by 100.
[12] The exception to this rule might be occupied housing units. In this case the higher the proportion occupied housing units, the few the housing units that might be available for households in a block-group to occupy if their unit is damage, hence the more housing vulnerable.

hotspots or concentrations of higher levels of social vulnerability within and across block-groups. Of course, it is possible that a block-group may have very high proportions of socially vulnerable populations, say that over 80% of their population is elderly or non-white minorities, but there are very few actual people living in the block group itself. Block groups are constructed by the US Census to capture the population of individuals residing in these areas which generally range between a few hundred to several thousands.[13] To correct variability in population, a "weighted" SV measure can be calculated in which the score is either weighted based on a population size or density in the block-group. In this way, a block-group that has a high SV score and has a relatively large population or is very densely populated will score higher than one with a similar SV score but sparsely populated.

Table 2. Descriptive Statistics for 2000 Social Vulnerability Indicators, 2nd and 3rd Order *SV* Measures

Social Vulnerability Indicator, 2nd, or 3rd Order Measure	Mean	Median	Std.	Min.	Max.
1. Single Parent Households	10.69	9.43	7.80	0.00	63.67
2. Population ≤ 5 years	9.02	8.98	3.88	0.00	28.75
2nd Order: Potential child care needs	9.85	9.23	5.06	0.00	40.88
3. Population ≥ 65 years	11.43	10.08	6.96	0.00	52.42
4. Elders in Poverty	14.30	10.33	15.14	0.00	100.00
2nd Order: Potential elder care needs	12.86	11.69	8.14	0.00	54.62
5. Transportation dep. employees.	2.08	0.00	4.83	0.00	51.12
6. Housing units without auto	10.28	6.90	10.62	0.00	69.73
2nd Order: Potential transportation needs	6.18	3.92	7.04	0.00	58.82
7. Occupied housing units	89.00	91.73	11.17	0.00	100.00
8. Population in rental housing	35.13	30.91	22.77	0.00	100.00
9. Non-white population	53.97	53.25	30.95	0.00	100.00
10. Population in group-quarters	2.20	0.00	9.86	0.00	100.00
11. Housing over 20 years old	72.33	80.43	25.53	0.00	100.00
12. Mobile homes	6.46	0.20	11.59	0.00	81.61
13. Population in poverty	18.61	15.67	14.19	0.00	88.21
2nd Order: Potential housing needs	39.67	40.10	9.39	10.00	65.78
14. Housing units without phones	4.60	3.06	5.29	0.00	41.18
15. Pop. ≥ 25 w/o HS. diploma	30.50	27.00	19.45	0.00	100.00
16. Population ≥ 16 unemployed	8.90	7.08	7.57	0.00	100.00
17. Pop. not speaking English well	8.46	4.08	10.16	0.00	48.78
2nd Order: Potential civil capacity needs	13.12	11.13	8.79	0.00	42.09
Social Vulnerability	22.82	22.33	6.92	5.88	48.60

The data utilized in this report were drawn from the 1980, 1990, and 2000 U.S. Census data. A primary focus of this report will be to examine not only levels or current status of social vulnerability as measured by the 2000 census data, but to also examine changes

[13]The block groups for the first two tiers of states along the Texas coast have an average population of 1,614 individuals.

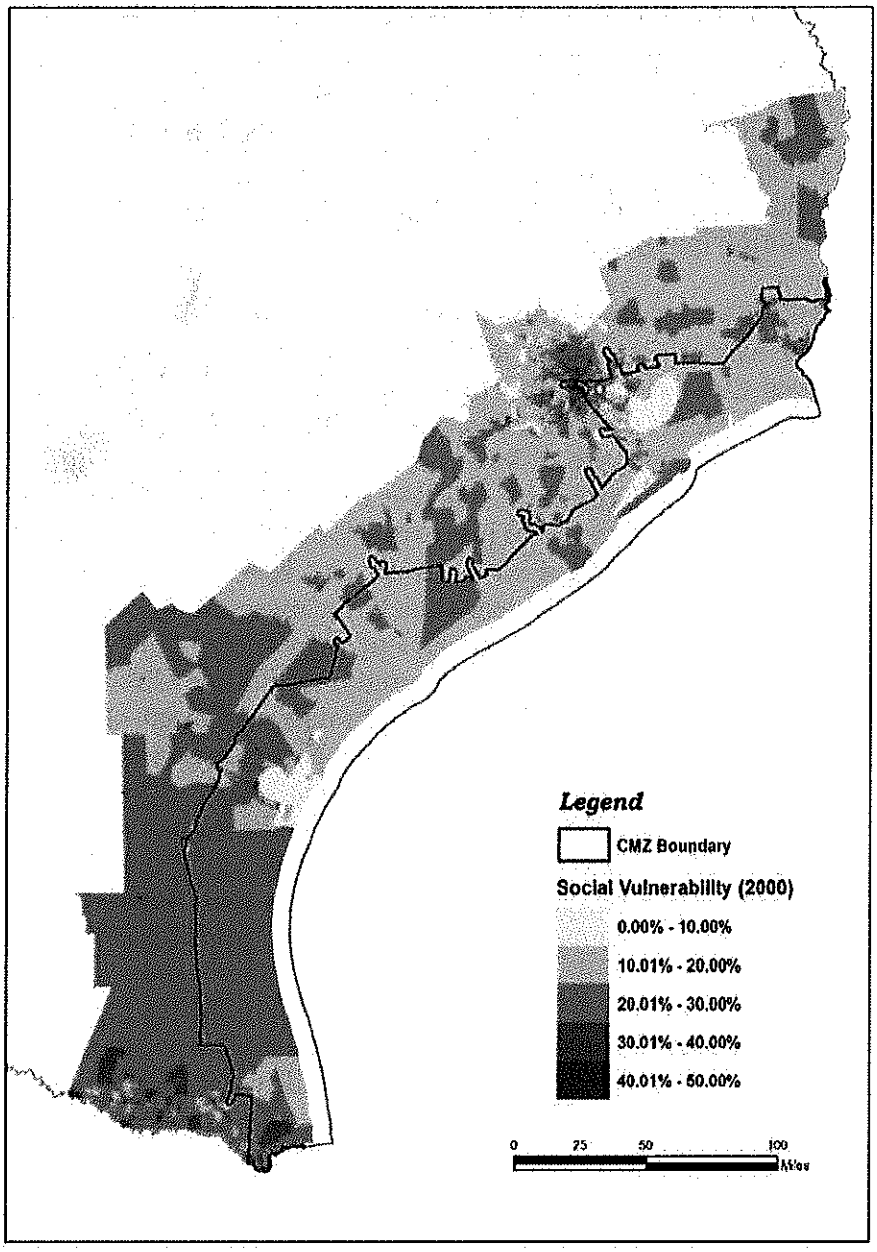
and trends over this time period. We will begin our discussion however by focusing on the 2000 census data as an assessment of current status. Table 2 displays the descriptive statistics for each of the 17 SV 1st order indicators, each of the five (5) second order SV measures and the total SV composite index for the 1,322 census block groups located in Texas's CMZ. Each second order SV measure is presented below its basic constituent indicators and is shaded in light orange. The final row in the table, this time shaded in a slightly darker orange, presents the statistics on the overall SV index that combines by averaging all 17 indicators. To ease in presentation, all proportions have been changed to percentages (by multiplying by 100).

The basic SV indicators represent proportions, or in presentation, percentages, so the mean represents the average percentage across the 1,322 block groups in the Texas CMZ. For example, among CMZ block groups the average percentage of their households that are single parent households with children was 10.69%, with a median of 9.43%. The minimum percentage of these types of households across these block groups was 0, with a maximum of nearly 64%. There are a number of other descriptive statistics that are worth noting in this table. An average of just over 14% of all elders in these block groups are living below poverty levels. These block groups also have on average 10.28% of their households reporting not having their own vehicle for transportation and in at least one block group that percentage reaches nearly 70% of all occupied housing units. It is also very interesting to note that on average block-groups within the CMZ have populations that are nearly 54% non-white, with some block-groups composed of 100% non-white populations. As we will see below, this represents the changing population demographics of Texas. The average proportion of individuals living below poverty in CMZ block groups was 18.6%, with a high of 88.2%. The average proportion of populations over 25 without a high school degree was 30.5%, with a median value of 27%. Furthermore, while the average percentage of block group populations over 5 not speaking English well or at all was only 8.46%, the maximum for at least one was nearly 48.8%.

As can be easily seen in this table, the second order SV measures capture the average percentage across their component set of indicators. The final row presents the total SV measure or index, suggesting that the average vulnerability on a 100 point scale for the 1322 block groups located in the coastal management zone is nearly 23, based on this assessment of 17 indicators. Figure 6 offers a coastal wide map of the SV index results for 2000. This maps suggest that areas along the southern most coast of Texas have higher concentrations of vulnerable populations. Interestingly, the upper coast, while displaying some areas with relatively low levels of SV, also contain pockets of higher levels of SV.

As mentioned above, the 1st and 2nd order SV measures can be thought of as indicators of different dimensions of social vulnerability measured on, in this case, a scale that runs from 0 to 100. The overall SV index, on the other hand, yields a relatively coarse and quick assessment of levels of vulnerability considering multiple dimensions simultaneously. Before touching on various interpretations of these measures, we continue with our general assessment of SV by examining of trends among the 1,322 CMS block groups.

Figure 6. Social Vulnerability Measure for the Texas Coast.



IV. Social Vulnerability Trends in the Coastal Management Zone

In this section we turn our attention to the patterns of social vulnerability from 1980 through 2000. Tables 3, 4, and 5 present the average vulnerability levels for the 17 1st order indicators, the five 2nd order measures, and for the overall SV composite index. In each case the average for the 1,322 CMZ block groups are presented for data from the 1980, 1990, and 2000 US Census. In addition, differences between 1980 and 1990, 1990 and 2000, and 1980 and 2000 were computed and average difference scores are presented in the final three columns for each of these periods respectively. These differences are

computed by subtracting the later percentage from the earlier percentage. Hence, negative values indicate that levels of SV are getting worse meaning increased in levels of social vulnerability, while positive differences suggest things are getting better meaning reductions in social vulnerability. Finally, each of these differences scores was tested to see if they were statistically significant from zero, implying no change. The results from these tests are also indicated with respect to each difference score.

Table 3: Average CMZ block group percentages and difference scores for 1980, 1990, and 2000 Child Care, Elder Care, and Transportation Needs.

Baseline Social Variables	Mean	Difference in Percentages#		
1. Single Parent Households	%'s	1980-1990	1990-2000	1980-2000
1980	6.77	-2.21**		
1990	8.98		-1.70**	
2000	10.69			-3.92**
2. Children five or below				
1980	10.33	0.99**		
1990	9.35		0.33**	
2000	9.02			1.32**
2nd Order: Child Care Needs				
1980	8.55	-0.61**		
1990	9.17		-0.69**	
2000	9.85			-1.30**
3. Elders (65+)				
1980	8.27	-2.28**		
1990	10.55		-0.89**	
2000	11.43			-3.17**
4. Elders living in poverty				
1980	9.47	-8.66**		
1990	18.13		3.83**	
2000	14.30			-4.83**
2nd Order: Elder Care Needs				
1980	8.87	-5.47**		
1990	14.34		1.47**	
2000	12.86			-4.00**
5. Labor force transportation. Dependent				
1980	1.78	1.47**		
1990	0.31		-1.77**	
2000	2.08			-0.30**
6. Households without a private vehicle				
1980	8.64	-2.10**		
1990	10.74		0.45*	
2000	10.28			-1.65**
2nd Order: Transportation Needs				
1980	5.21	-0.32***		
1990	5.53		-0.66**	
2000	6.18			-0.97**

statistical tests were all paired t-tests; * two tailed p<.05; ** two tailed p<.01;

Rather than discussing each of the 17 different SV indicators separately, followed by five (5) second order SV measures, and ending with a discussion of overall SV index trends, the following discussion will be structured on the basis of the 2nd order SV measures. In other words, each of the five (5) 2nd order SV measures – *potential child care needs, elder care needs, transportation needs, housing needs*, and *civil capacity needs* – along with their specific 1st order component indicators will be discussed. This in turn will be followed by the presentation of the overall SV index. Our discussion begins with *potential child care needs.*

1. Potential Child Care Needs: The percentage of single parent households with children increased throughout the period, beginning with an average across CMZ block groups of 6.77% in 1980, increasing to 8.98% in 1990 and finishing at 10.69% in 2000. Overall then, between 1980 and 2000 the average percentage of single parent households with children increased by nearly 4% points, which was statistically significant, suggesting increasing vulnerabilities on average across CMZ block groups. The average percentage of block group populations five years old or below --indicating very young and vulnerable children -- actually declined throughout the period. In 1980, on average just over 10% of block group populations were in this very young age group. However that percentage declined to just over 9% in 2000, yielding a net and statistically significant reduction over the period of 1.32%. While the average percentage of younger children did fall throughout this period, these reductions were offset by the increasing percentages of single parent households with children, resulting in an overall increase in potential child care needs from 1980 (8.55%) to 2000 (9.85%), yielding a negative change over that period of 1.3%, suggesting increasing vulnerabilities.

2. Potential Elder Care Needs: The trends for elders, elders in poverty and potential elder care needs are also presented in Table 3. As one might expect, given the general aging of the US population, the average proportions of elders, individuals 65 or older, in CMZ block groups generally increased throughout the period. In 1980 the average percentage was 8.27%, but that grew to 10.5% in 1990 and still further to 11.43% in 2000. The difference between the 1980 and 2000 proportion was a statistically significant -3.17%. This suggests increasing social vulnerabilities. The results with respect to elders living in poverty suggest some improvement between 1990 and 2000, however the net for the entire period suggest a net increase in SV. In 1980 on average 9.47% of elders in CMZ block groups were living below poverty levels. This average is nearly double by 1990 to just over 18%, but fortunately fell back to 14.3% in 2000. Nevertheless, on the whole the average difference between 1990 and 2000 percentages of block group elders residing in poverty was negative (-4.83%) suggesting an overall increase in social vulnerability with respect to this dimension. Overall then, the 2nd order elder care need measure, given the increase in percentages of elder populations and elders living below the poverty level, increased from 8.9% in 1980 to 12.9% in 2000, resulting in a negative change of 4

percentage points, suggests increasing vulnerabilities with respect to elders over the period.

3. Potential Transportation Needs: Evacuation in particular, whether related to natural hazard or technical hazard events is dependent upon households and individuals to transport themselves out of the danger zone. Individuals or households without private transportation are at a distinct disadvantage when it comes to responding to evacuation "orders." Transportation can also be important for facilitating pre-event preparation and post event response. The trends with respect to transportation, like those for elders living in poverty, were not consistent, but the net differences again suggest increasing vulnerabilities. The average percentage of block group employed labor force dependent on public transportation actually declined precipitously between 1980 and 1990, moving from 1.8% to only .3% respectively. However this percentage also rose markedly by 2000 to 2.1%. The net effect was a small, but nevertheless significant, difference between 1980 and 2000 of -.3%, suggesting a slight increase in vulnerabilities. Interestingly the average percentage of households without private transportation was 8.6% in 1980, rose to 10.7% in 1990, and fell back slightly to 10.3%, resulting in a net difference between 1980 and 2000 of a significant -1.65%. The consequence of these two negative trends, results in an overall negative and statistically significant trend for transportation needs of just about -1%, suggesting that overall there is a slight increase in transportation vulnerabilities across CMZ block groups.

4. Housing Needs: Table 4 presents the seven (7) individual SV indicators and overall 2nd order measure related to potential housing needs. Housing needs indictors were selected because the literature suggest that they are related to emergency shelter and temporary and permanent housing needs following a disaster. The first indicator, occupied housing units, provides an indicator for potential surplus housing units that might, if occupied housing is damaged, provide for permanent or temporary housing needs after a disaster. In 1980 the average occupancy rate for CMZ block groups was nearly 90.2%, suggesting very little surplus housing. In 1990 the occupancy rate decreased to 86.3%, and then rose to 89% by 2000. Overall then, there was a slight, but significant, increase in surplus housing over the period, suggesting a potential reduction in housing need vulnerability. Unfortunately this was the only indicator that showed a net positive trend over this period.

The literature suggests that rental housing units are much slower to come on line after a disaster due to delayed rebuilding and repairs processes (c.f. Peacock, Dash and Zhang 2006; Zhang and Peacock 2010). These delays result in higher levels of population displacement after an event and slower recovery trends these for neighborhoods and communities. Hence, the higher the proportion of rental population, the higher the potential levels of temporary and long-term housing needs. In 1980 the average block group percentage of rental households was 34.7% that rose in 1990 to 36.6%, and then fell back slightly to 35.1%. The net change from 1980 to 2000 was not statistically significant. Essentially the overall average percentage of rental housing -- representing an average of slightly over one third of all housing – among CMZ block groups remained unchanged from 1980 to 2000.

Table 4: Average CMZ block group percentages and difference scores for 1980, 1990, and 2000 Housing Needs.

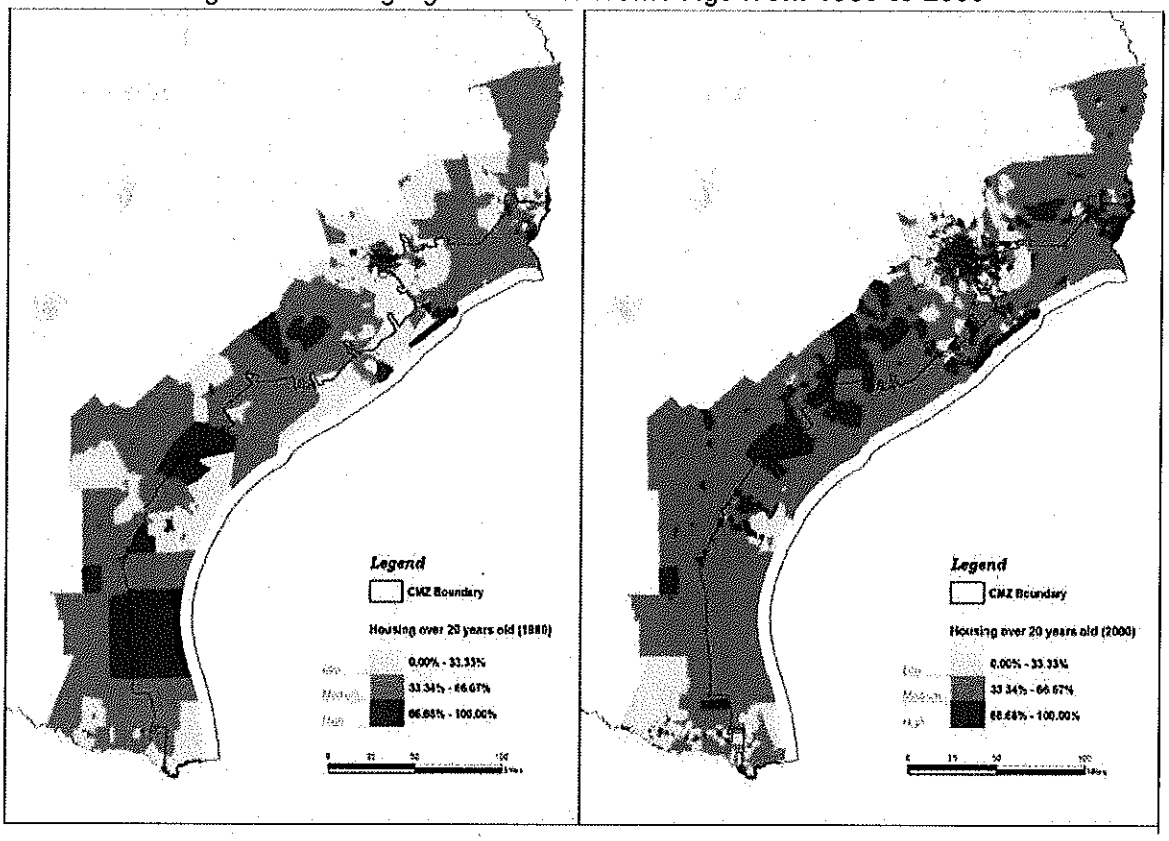
Baseline Social Variables	Average	Difference in Proportions#		
7. Occupied housing units				
1980	90.17	3.91**		
1990	86.26		-2.74**	
2000	89.00			1.17**
8. Households renting their residence				
1980	34.66	-1.96**		
1990	36.63		1.50**	
2000	35.13			-0.46
9. Non-white population				
1980	38.28	-7.12**		
1990	45.40		-8.56**	
2000	53.97			-15.69**
10. Population living in group quarters				
1980	1.22	-0.69**		
1990	1.91		-0.29	
2000	2.20			-0.98**
11. Housing over 20 years old				
1980	48.26	-10.30**		
1990	58.56		-13.78**	
2000	72.33			-24.08**
12. Mobile homes				
1980	5.34	-1.02**		
1990	6.36		-0.10	
2000	6.46			-1.12**
13. Population living in poverty				
1980	13.99	-6.65**		
1990	20.64		2.03**	
2000	18.61			-4.63**
2nd Order: Housing Needs				
1980	33.13	-3.41**		
1990	36.54		-3.13**	
2000	39.67			-6.54**

note all paired t-tests; * two tailed p<.05; ** two tailed p<.01; neg. values=more vulnerable; pos. values=less vulnerable

As discussed above, non-White populations are particularly sensitive to housing problems in the aftermath of natural disasters (Peacock, Dash, and Yang, 2006). The literature suggests that these populations are much more likely to be living in substandard housing and that housing is much more likely to be damaged in a disaster. Furthermore, non-White populations are more likely to have significantly reduced housing options when their homes are damage. Hence they are much more likely to need emergency shelter, temporary housing, and to have greater difficulty establishing permanent housing after an event. In 1980 the average proportion of non-White populations across CMZ block groups was 38.3%, rose to 45.4% in 1990, and rose again to nearly 54% by 2000. This represents an average net increase in non-White populations of nearly 16%. This trend clearly suggests higher levels of social vulnerable populations within CMZ block groups throughout this period.

Populations in group quarters are generally individuals not related to each other residing together in both institutionalized and not institutionalized settings including jails, halfway houses, nursing homes, religious group quarters, college dormitories, etc. Often times, in these situations, special care is needed for evacuation and sheltering before and after an event. Furthermore, if housing is damage, the former occupants or their institutional guardians must make arrangements for temporary and, ultimately permanent housing. In 1980 the block group average for populations residing in group housing situations was 1.2%, that increased to 1.9% in 1990, and to 2.2% in 2000. The difference between 1980 and 2000 was approximately -1%, a statistically significant difference, implying increased vulnerability.

Figure 7. Changing Pattern of Home Age from 1980 to 2000



Housing quality and standards can have important consequences for disaster damage and hence both temporary and permanent housing needs after a disaster. The State of Texas has invested, through the Texas Department of Insurance (TDOI), to upgrade and improve building codes in Texas, particularly with respect to wind standards. While Texas coastal communities have not been as quick to adopt these new standards as many would like, we have seen the slow improvement through time of building codes and standards as communities moved from the old southern building code to more recent versions of the International Building Code recommended by the TDOI. Furthermore, as one might expect some housing, for example site built housing, is more resistant to wind and flooding damage, than less permanent housing like mobile homes. To capture the

relative vulnerabilities due these quality issues we have employed two measures: the percent of buildings over 20 years old and the percent of housing units that are mobile homes. In both case we can see trends toward higher vulnerabilities for housing in the CMZ. In 1980, on average 48.3% of housing was older than 20 years old in CMZ block groups. That percentage increased substantially to 58.6% in 1990, and 72.3% in 2000. These dramatic shifts can be easily seen in Figure 7 which clearly suggest average home age is increasing within the CMZ from 1980 to 2000. Indeed, the difference between 1980 and 2000 was -24.1% representing a significant increase in vulnerabilities. These changing patterns of housing age from 1980 to 2000 can be seen visually in Figure 7 above. While the average percentage of mobile homes was only 5.34% in 1980, it did increase to 6.46% by 2000, again increasing the average vulnerability for block groups in the CMZ.

The final housing needs indicator is the percent of a block group's population below poverty levels. The literature clearly suggest that poverty not only has consequences for anticipating and coping with natural hazards, but most importantly for housing, relative damage levels, and difficulty finding post disaster temporary and permanent housing (cf. Fothergill and Peek 2004, Peacock, Dash and Yang 2006). In 1980 an average of nearly 14% of block group populations were below poverty levels. In 1990 the average rose to 20.6%, but fortunately fell back slightly to 18.6% by 2000. Nevertheless, the net average difference between 1980 and 2000 was a negative 4.63. Again this was a significant increase in the levels of social vulnerability, related to poverty across CMZ block groups.

On the whole then, for 6 of the 7 housing needs indicators the net trend was toward increasing social vulnerability. It should not be surprising then that the combined SV measure for *potential housing needs* shows a consistent and significant increase between 1980, 1990 and 2000. Indeed the net difference between 1980, at 33.13%, and 2000, at 39.67%, is a significant -6.54%. This negative value, again suggests that social vulnerabilities with respect to housing has increased on average across all blocks within the CMZ.

5. Civil Capacity: The final set of SV 1st order or basic indicators and their 2nd order measure seeks to capture the *civic capacity needs* of a block group's population. One of the often cited critiques of vulnerability analysis is that these analyses fails to address the inherent capacities of even the most vulnerable communities to martial their limited social, human, and economic capital resources to address hazard risks and disaster impacts. In an attempt to address this critique, our approach seeks to directly address these capital features of a block group's population. The ability to share information and communicate with others, particularly those within ones social network can be extremely important for the dissemination of warning and mitigation information, as discussed above. To partially capture this ability we include a measure of the percent of a block group's households without telephones. In 1980 the average percentage of households without access to a phone was 10.56% and that percentage increase to 10.79% in 1990. However, by 2000 this percentage fell markedly to only 4.6%, probably due to the proliferation of relatively low coast cellular phone technologies. Indeed, the difference between the percent of households without phone access between 1980 and 2000 was

+6.04 percentage points suggesting increasing capacities to communicate among family, friends and associated networks, resulting in an overall decline in social vulnerability.

Table 5: Average CMZ block group percentages and difference scores for 1980, 1990, and 2000 Housing Needs.

Baseline Social Variables	Ave.	Difference in Proportions#		
14. Households without a telephone				
1980	10.65	-0.15		
1990	10.79		0.23**	
2000	4.60			6.04**
15. Population over 25 w/o high school degree				
1980	40.00	5.84**		
1990	34.16		3.66**	
2000	30.50			9.50**
16. Labor force unemployed				
1980	5.21	-3.74**		
1990	8.94		0.05	
2000	8.90			-3.69**
17. Population over 5 not speaking English well				
1980	2.59	-3.85**		
1990	6.44		-2.02**	
2000	8.46			-5.87**
2nd Order: Civic Capacity needs				
1980	14.61	-0.47**		
1990	15.09		1.97**	
2000	13.12			1.50**
3rd Order: Social Vulnerability				
1980	19.74	-2.27**		
1990	22.01		-0.81**	
2000	22.82			-3.08**

note all paired t-tests; * two tailed p<.05; ** two tailed p<.01; negative = more vulnerable; positive = less vulnerable

A similar pattern emerges when examining the average percentages of individuals over 25 without a high school diploma or equivalent, a measure of the community's human capital. In 1980 the average percentage was 40%, but by 1990 that percentage fell to 34.2% and it fell even further by 2000 to 30.5%. Between 1980 and 2000 then, there was a vast and significant improvement of 9.5 percentages points. In other words, the average the human capital assets – measured in terms of achieving a high school diploma -- of CMZ block groups increased. As a consequence, their relative social vulnerability actually fell during the period of 1980 through 2000.

The patterns with respect to the last two civic capacity need measures – unemployment and English competency – unfortunately do not exhibit the same trends as the first two indicators. In 1980 the average unemployment rate across CMZ block groups was 5.21%, in 1990 the rate increased to 8.9% and it remained essential unchanged by 2000. The net trend between 1980 and 2000 was therefore a significant increase in unemployment of 3.69 percentage points, suggesting less economic capital assets, in the form of wages and

salaries, for populations to draw upon. Similarly, in 1980 only 2.59% of the population over 5 did not speak English well or at all, in 1990 that percentage rose to 6.44% and by 2000 it rose still higher, finishing at 8.46%. Thus, with respect to English language competency, on average, CMZ block groups actually experienced a significant reduction in competency of -5.87 percentage points, suggesting an increase social vulnerability over the period. These changing vulnerability patterns are quite pronounced and can easily be seen in Figure 8. The CMZ block groups have substantially change between 1980 and 2000, with many block groups now having substantial percentages of individuals with limited English speaking competency. Despite these trends with respect to unemployment and language competency, the overall civic capacity levels actually improve.

Figure 8. Changing Patterns of English Language Competency: 1980 to 2000.

With respect to civic capacity, we see two very different trends, while fewer households are without a phone and more adults have a high school degree or equivalent, unemployment rates have increased and so has the proportion of the population without English speaking competency. On the whole, the 2nd order civic capacity needs measure actually deceases over the period moving to 13.12% in 2000 from 14.6% in 1980, resulting in a significant, 1.5 percenage point, improvement and a reduction in *civic capacity needs*.

6. Overall Social Vulnerability: Despite the reduction in SV with respect to *civil capacity needs*, and reductions in 5 of the 17 SV indicators during the period of 1980 to 2000, on the whole the average level of *Social Vulnerability* as measured by the SV composite

index has actually grown for block groups within the coastal management zone. The bottom most sections of Table 5 present the summary statistics for the overall *SV index,* which again is the average for all 17 1st order SV indicators. In general, the SV level was 19.7% in 1980, rose to just over 22% in 1990, and then finished the period at 22.8%. The net difference score between 1980 and 2000 was -3.1%, which again is statistically significant and indicates an increase in overall average levels of *social vulnerability* across all CMZ block groups.

It must be remembered the general *SV composite index* is more of a coarse and relatively quick assessment across all of the 17 indicators or dimensions of vulnerability. So for planners and emergency managers, this measure provides a general assessment of SV levels and an indication of areas likely to have concentrations of highly vulnerable populations. Regardless of which SV measure is employed, there is no magic number or level, beyond which one can easily suggest that the population of a given block groups "is" or "is not" socially vulnerable. Rather these are relative indicators. They assess a particular characteristics, dimension, or set of characteristics of a block group's population. When applied to a region, like the coastal management zone, they provide a picture of a region's block groups in terms of the ability of their population's to respond, anticipate, and recover from a natural disaster or hazard threat. Any level of SV should be of some concern for planners and emergency managers, in that it suggests that components of their community's population may have difficulty responding to hazard threats and recovering from disasters. Furthermore, relatively higher levels of SV suggest the need for special attention and perhaps working on particular policies, activities, education programs or other organizational responses to help those areas or neighborhoods to better respond and meet future hazard events.

As it stands now, with respect to our measurement and the simple analysis strategy we have undertaken here, we can see that, with respect to 17 separate indicators of SV, populations within the 1,322 coastal management zone block groups are becoming more vulnerable with respect to 12 of the 17 different SV indictors. Specifically, we see that on average block group population have higher percentages of single parent households, elder populations, elder populations living in poverty, labor force dependent on public transportation, households without private transportation, households renting, non-white populations, populations in group quarters, populations living in older housing and mobile homes, individuals livinb below poverty, unemployed and populations not speaking English well. On the whole, it is important to note that we do see some improvement in overall civic capacities of these populations. Nevertheless, we also see trends suggesting greater hazard and disaster needs with respect to transportation, housing, and child and elder care needs. These are important trends for hazard planning and emergency management in Texas.

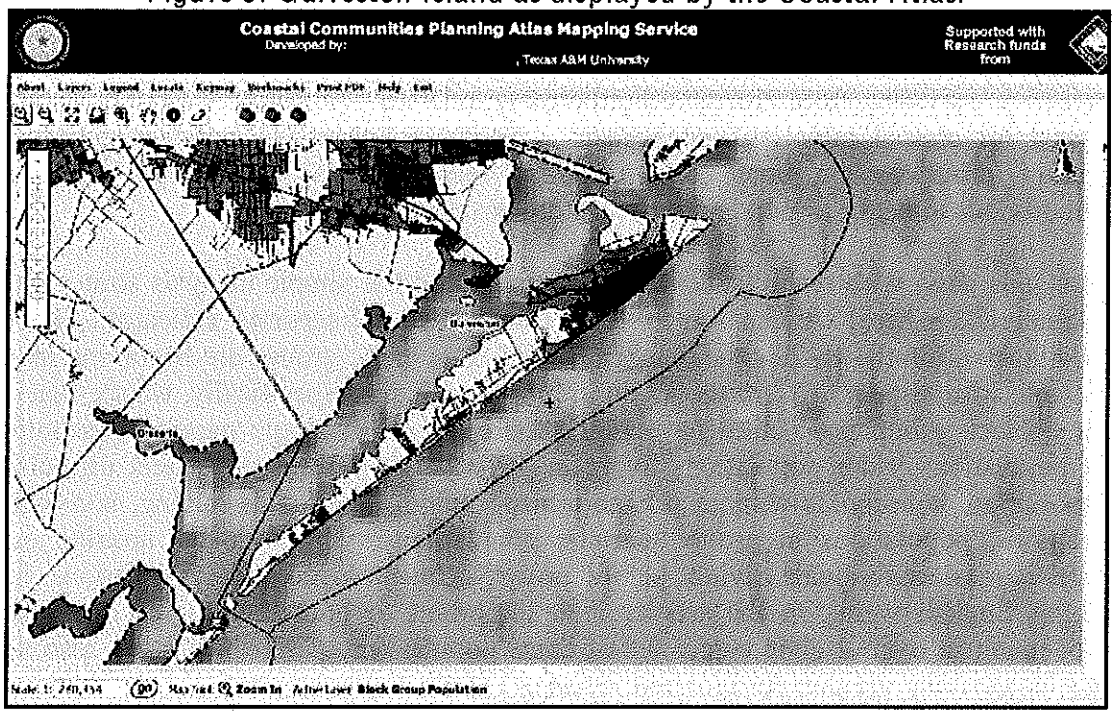
Having examined the logic behind social vulnerability mapping, discussed the methods and details followed in creating the SV mapping approach adopted and utilized in the *coastal planning atlas*, and discussed the status and trends in dimensions and overall levels of SV for the Texas coast, focusing on the CMZ, we now turn out attention to a brief assessment of the relevance of social vulnerability mapping for hazard and disaster

issues in Texas. Specifically, we will utilize the example of hurricane Ike, how people responded to the threat it posed by evacuating and Ike's impact on Galveston and the recovery process for this assessment. But before doing that, the following section provides a brief discussion of Galveston, some examples of SV maps for the island, and Hurricane Ike.

V. Galveston and Social Vulnerability

Galveston is one of the most urbanized barrier islands in the United States (see Figure 9). Although the City's population is declining only in part because of the hurricane (just under 50,000 following Hurricane Ike), growth in the region has been rapid. The Island itself has a dense urban core on the east end of the island, where 89 percent of the population lived in 2000. The sprawling west end of the Island is home to the remaining 11 percent of the population and one additional smaller incorporated community, Jamaica Beach. In addition to much higher population densities, the urban core also has higher occupancy rates (85 percent, compared to 47 percent on the West End), and higher home ownership rates (60 percent, compared to 46 percent on the West End).

Figure 9: Galveston Island as displayed by the Coastal Atlas.



Not surprisingly, given that Galveston is a barrier island, the Island is highly vulnerable to coastal hazards like hurricanes. Figure 10, for example, zooms in on the urban core of Galveston City and displays surge zones for category 1 (red), 2 (orange), and 3 (blue) hurricanes. When Hurricane Ike passed over the Island, as can be seen in Figure 11, the urban core was protected from powerful surge flows and destructive wave action coming from the ocean side by Galveston's famous seawall constructed after the 1900 storm. Nevertheless, given the circulation of the storm, which was counter clockwise, the storm

pushed part of its storm surge onto the island from the backside. As a consequence, the surge entered the urban core from the bay side, flooding many areas designated as category 1 and 2, as well as substantial proportions of category 3 areas. Category 1 and 2 areas are substantially lower and thus homes and businesses structures in those areas were subject to extensive flood waters prior to the storm passing over the Island and extending for many hours after it passed.

Figure 10. Category 1, 2 & 3 Hurricane Surge Areas

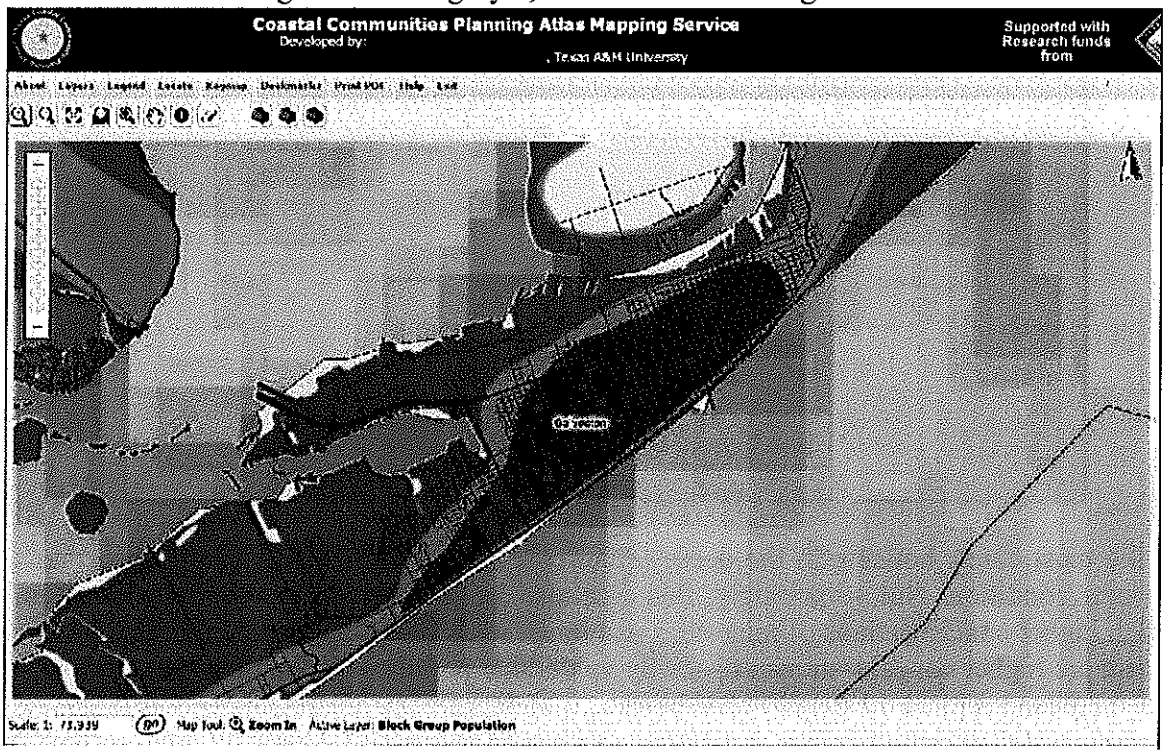
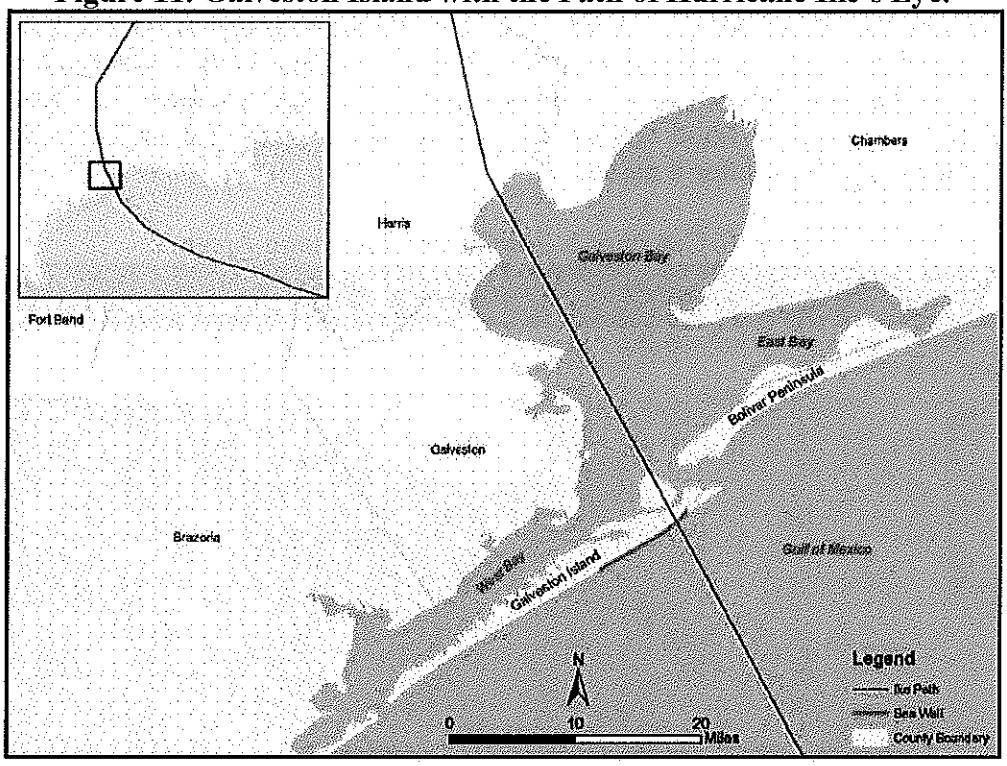
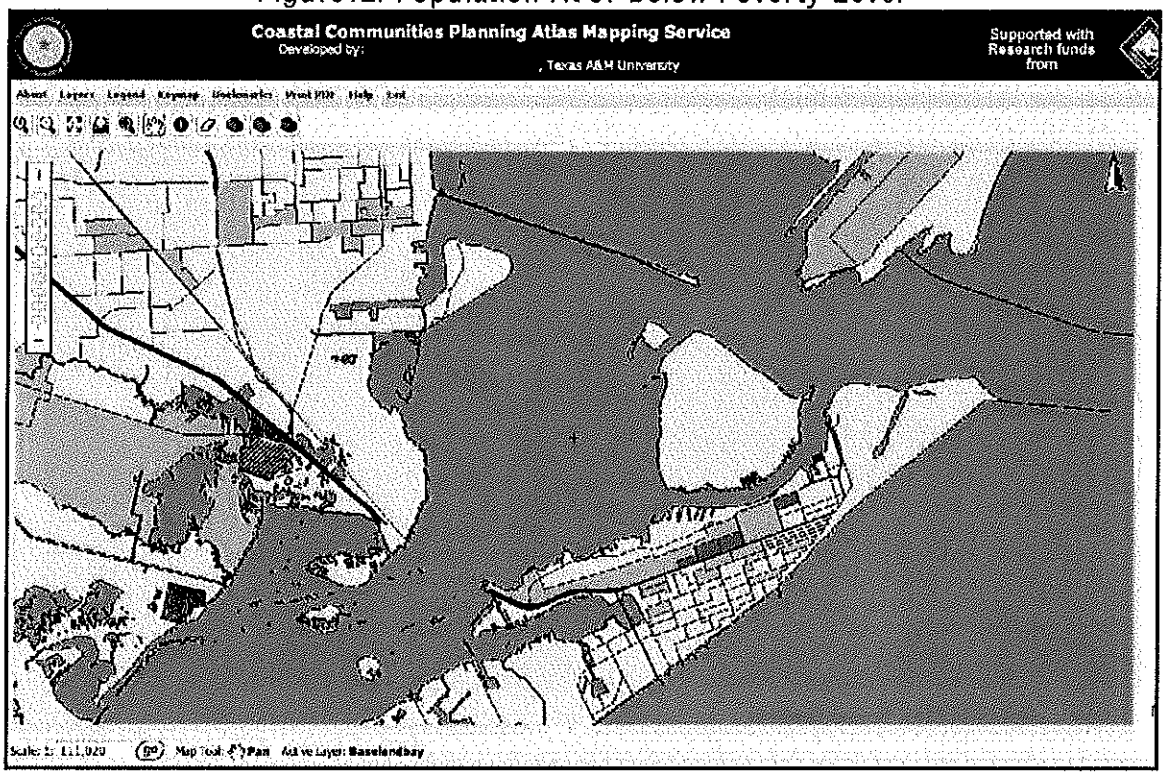


Figure 11. Galveston Island with the Path of Hurricane Ike's Eye.



Like most cities, housing in the dense urban core is much older and generally in much poorer condition. Not surprisingly, this area also has a much more diverse population, with higher concentrations of minorities and households living in poverty. In other words, there are higher concentrations of socially vulnerable populations found in the urban core of the Island. Figure 12 displays SV block group data for the Island, as well as mainland sections of Galveston County, indicating concentrations of individuals living at or below the poverty line. As can be seen in this figure, there are a number of block-groups that have relatively high concentrations of individuals living below the poverty line that, as seen in Figure 12, are also located in areas vulnerable to surge inundation.

Figure12: Population At or Below Poverty Level



The real benefit of tools like the *coastal planning atlas* for planning purposes and for helping citizen better understand their risk, is being able to identify areas that are ***both*** physically and socially vulnerable by overlapping these data. This also allows the identification of critically vulnerable areas and hence important targets for the focus of emergency management and mitigation activities. Figure 13, for example, displays areas with high concentrations of non-white populations that are also subject to category 1 and 2 storm surge. In light of the literature that suggest that these populations are less trusting of authorities when it comes to heeding warning, and are more dependent on social networks, local emergency management and planning officials might develop special relationships with churches and civic organizations in these areas to better insure that when official warning are released, these organizations can reinforce the warnings through informal networks, thereby enhancing timely compliance.

Figure 13. Non-White Population Concentration and Category 1 & 2 Surge Zones

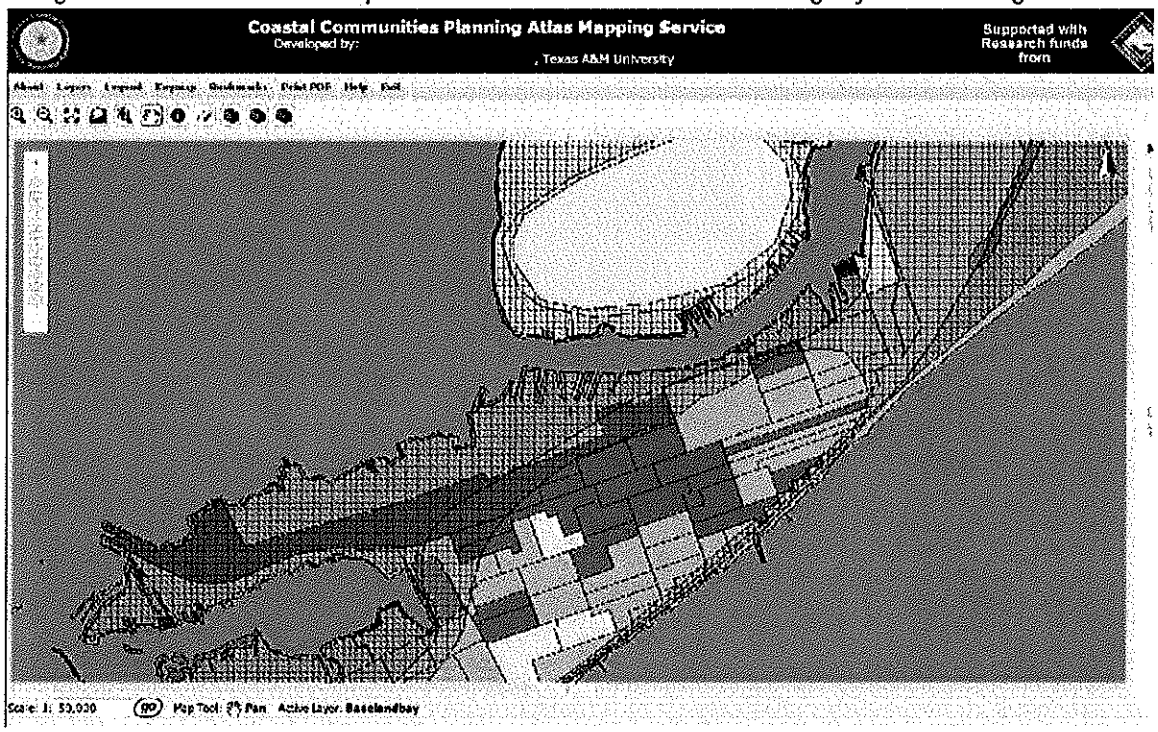


Figure 14. Weighted SV Composite measure and Category 1 & 2 Surge Zones

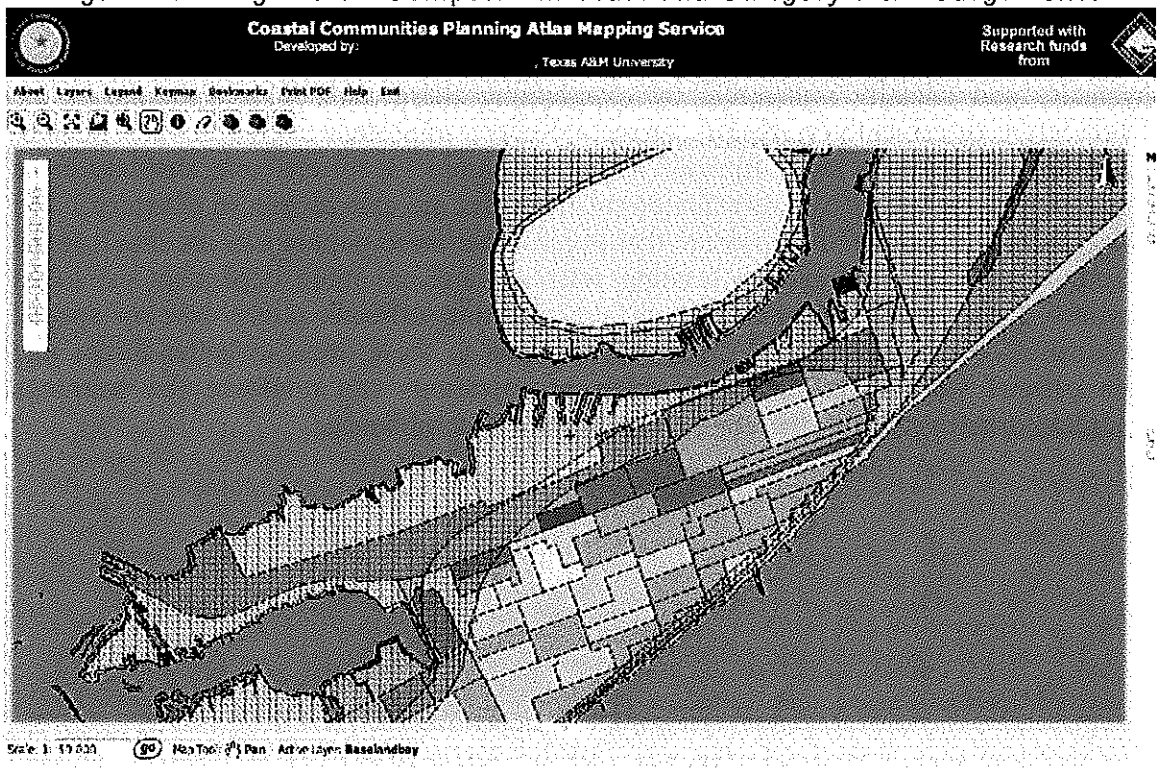


Figure 14 displays the SV composite measure, which in this case has also been weighted by population densities in Galveston County, overlaid with category 1 and 2 surge zones.

As discussed above, the SV measure is particularly useful for quickly identifying areas that have concentrations of socially vulnerable populations. In this case the additional weighting also helps to identify areas with high population concentrations as well. The areas that are darker orange will be areas that urban search and rescue as well as emergency health officials will want to quickly visit after a disaster to determine if there are stranded individuals or individuals needing special medical attention.

VI. Findings from the Hurricane Ike Research

Hurricane Ike provides an opportunity to assess how well the mapping of social vulnerability characteristics in the Coastal Atlas can assist local emergency management and planning departments to identify areas such as neighborhoods containing households and individuals that will have greater difficulty responding to and recovering from similar disaster events. In this section, we present examples of how social vulnerability characteristics are related to the response, impact, access to recovery resources, and the initial stages of the recovery process. In undertaking this assessment, we must be careful to acknowledge that every disaster event and the community impacted will have their own unique qualities. Consequently, this does not necessarily represent a critical test of the utility of social vulnerability mapping as a tool for planning. Nevertheless, we should generally expect to find patterns that are consistent with the research literature on SV. In this case we will use data collected from both primary and secondary sources in the months immediately after the storm to see if the patterns anticipated by the literature and identified by the SV mapping approch hold.

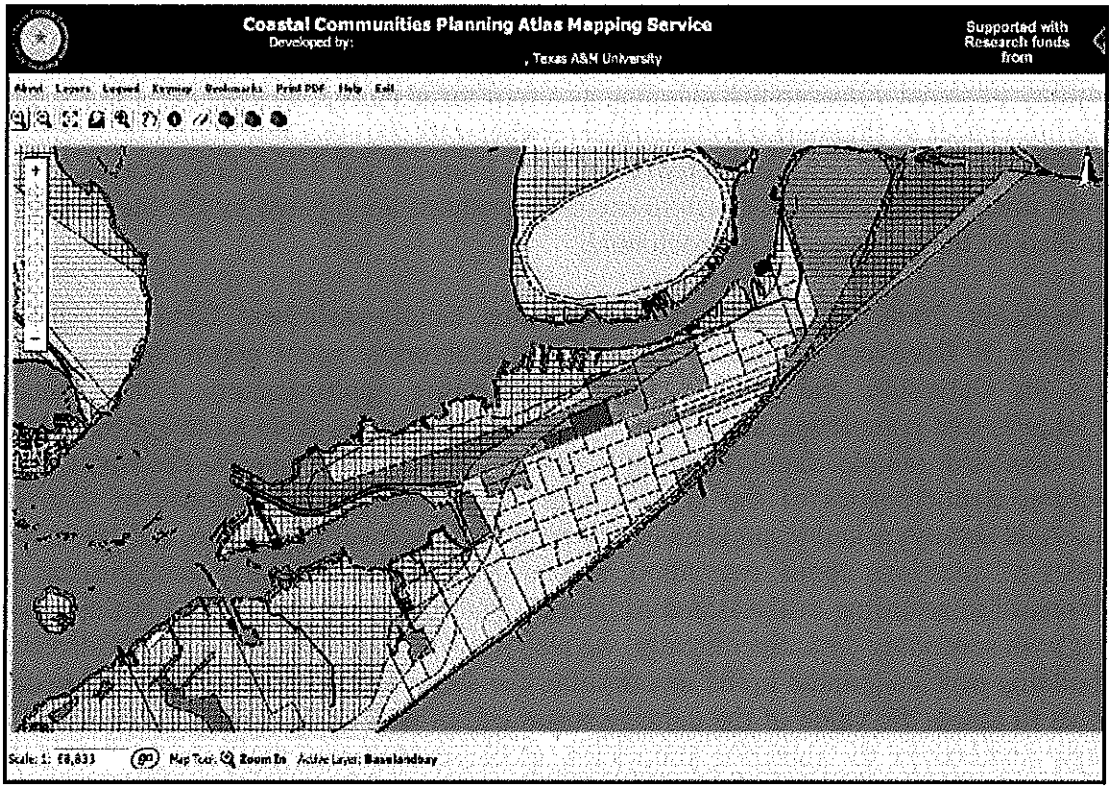
In December 2008, eighteen students and four faculty members from the Hazard Reduction & Recovery Center at Texas A&M University spent approximately 2,000 hours on Galveston and Bolivar Islands, collecting approximately 1,500 damage assessments and completing more than 550 household surveys from a random sample of 1500 detached (single family) housing units. Damage assessments determined the structural characteristics of the housing unit as well as visible evidence of damage. Household surveys asked respondents to assess their own level of damage, and also asked a series of questions about evacuation, recovery resources, and early decision-making with regard to returning to the Island to rebuild. These data will be utilized in this report along with secondary data. Specifically, we also draw on data from the City of Galveston on building permits granted in the months after the storm and tax assessments. These data help us to assess the value of the damage sustained, as well as the timing and volume of repairs undertaken to impacted properties. Because these permits are geocoded by property ID number, we are able to match them to our primary datasets, as well as assess variation by spatial location.

Together, these data give a fairly comprehensive view of the response from residents of detached, generally speaking single family, housing units to the Hurricane. Unfortunately, these data do not include residents of multi-family structures, which are home to a population that is likely to be particularly vulnerable, since they are almost exclusively renters. Along with the vulnerabilities associated with renting discussed earlier, renters are also more likely to be non-white and poor, which likely exacerbates

their vulnerability. As a result, these findings likely underestimate the true incidence and consequences of social vulnerability among Galveston residents.

There are a variety of approaches that could be used to assess the correspondence or relationships between SV measures and response, impact and recovery outcomes. A simple but limited approach might be to compare SV maps to outcome maps and look for commonalities in patterns. For example, Figure 15 displays the 2nd order SV measure for *transportation needs*, identifying block-group concentrations of households without access to their own vehicles and with workers dependent upon public transportation. Figure 16 displays average evacuation times by block group for the same area. It would be anticipated that areas with high concentrations of individuals and households with transportation issues would have greater difficulty evacuating and hence leave later in the process.

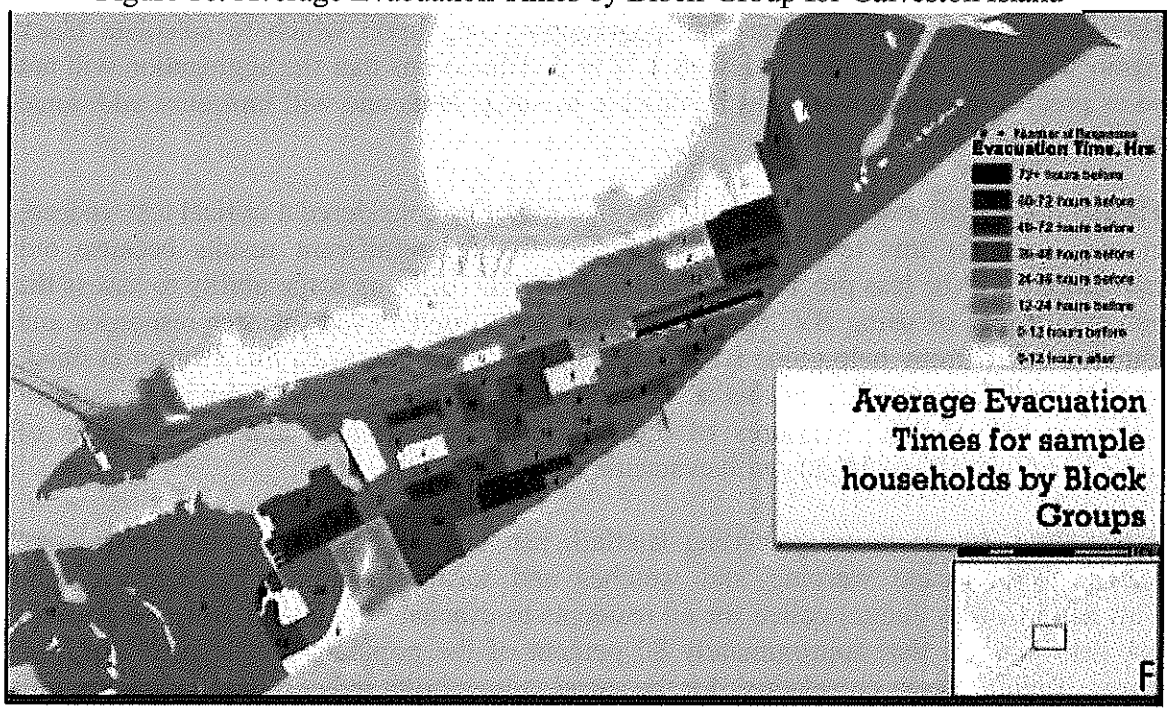
Figure 15. Block Groups with High Transportation Needs & Category 1 & 2 Surge Zones



By comparing the two maps, a general overall pattern of correspondence between high transportation needs and late evacuation times can be roughly seen. This pattern is most clearly evident if one notes that areas in darker pink colors in Figure 15, indicating higher transportation need concentrations and hence transportationally challenged populations, are also the same areas in Figure 16 that have lighter blue colors indicating that they were on average later to evacuate in response to warnings and official evacuation calls. This pattern suggests that households without access to private transportation do seem to be related to later neighborhood evacuation times. Hence, focusing planning activities to

ensure that populations without their own transportation have a way of evacuating earlier could well reduce the vulnerability of these populations.

Figure 16. Average Evacuation Times by Block-Group for Galveston Island



While assessments based on the comparisons of maps offer a visual method of determining correspondence, they are also highly dependent upon the patterns evident for a few block-groups and not the overall pattern displayed across all block group observations. In other words, they are too subject to perceptual biases. As a consequence, a more robust yet simple statistical technique will be employed. To assess the relationship between social vulnerability characteristics and hurricane response, impact and recovery, we use simple correlations. As discussed above, the SV indicators are based on 2000 U.S. Census data measured at the block group level. While hurricane response, impact and recovery are measured at the individual household or housing unit level, they too can be aggregated to the block group level by calculating appropriate summary statistics. These assessments, then, will be based on the correlations between these two sets of measures at the block-group level for Galveston Island.

Before proceeding, it is necessary to offer again a cautions statement about this analysis. As noted above, each disaster and community is unique, hence in a very real sense this is simply a case study as to whether or not we see relationships between SV measures and selected disaster response and impact assessments gained from data collected following hurricane Ike. In addition, as noted above, we will be aggregating individual level data from our surveys and secondary sources to the block group level to undertake the analysis. Aggregation of these data to the block group is not without problems. Most of our data come from a random sample of 1500 single family structures that was not designed to ensure equal or representative sampling of homes or households within block groups. As a result, some block groups will have more sampled homes/households than

others and these single family sampled might better capture the nature of housing and households within some block groups better than others. Indeed, a closer examination of Figure 16 actually shows the number of households providing data on evacuation times for that each block group in that map. While some block groups have 10, 12, or even 20+ observations upon which to base an aggregation (i.e., upon which to calculate block group statistics), others have as few as 1, 2 or 3. This means that the aggregation will not be as precise or representative as is possible in many cases and will introduce additional random noise into our analysis.

The net effect will mean that this analysis should not be considered a critical test. Indeed, in many respect this test is stacked against finding significant results because our estimations will be less precise. Nevertheless, they do offer us some ability to assess the potential utility of using SV mapping approaches to understand disaster responses and impacts, and thereby help guide hazard and disaster planning. With this caution in mind, we now turn our attention to this assessment of the relationship between aggregate SV measures and various measures of disaster response, damage, and initial levels of recovery. Our analysis begins with evacuation.

Evacuation: In the hours preceding landfall, residents received continual information related to hurricane warning and watches and local emergency management (the Galveston County Judge) called for all residents to evacuate the Island. Most responded; our data indicate that approximately 80 percent of the population evacuated from the Island. Table 2 shows correlations for the social vulnerability indices, base indicators, and second order indices with the percent of sampled block-group households that evacuated and the average block group evacuation time measured in terms of how many hours before landfall households evacuated. In general our expectations, based on the literature, will be that areas with higher concentrations of socially vulnerable populations will show lower rates of evacuation and when they do evacuate, the expectation will be that they will have later evacuation times. The findings in Table 6 are generally consistent with the SV expectations. Here we see that the composite SV measure is negatively associated with evacuation, indicating that areas with highly vulnerable households saw relatively lower evacuation rates and the average evacuation times for those that did evacuate were later or closer to actual landfall.

Table 6. Correlations between SV indicators and Evacuation Response Data

	Evacuated	Evacuation time
SV Composite Measure	-0.2463**	-0.2909**
1st Order or Base Indicators		
Percent Single parent households with children	-0.3021**	-0.1618
Percent population 65 or older	0.1124	-0.1557
Percent Elders below poverty level	-0.0900	-0.0686
Percent employed dependent on public transportation	-0.1961*	-0.1893*
Percent occupied housing units without a vehicle	-0.2380**	-0.1763*
Percent population in renter occupied housing units	-0.3776**	-0.2499**

Percent non-white population	-0.2231**	-0.2532**
Percent pop. group housing	-0.2041**	-0.0348
Persons in poverty	-0.2265**	-0.2244**
Percent occupied housing units without a telephone	-0.1284	-0.1591
Percent population 25 or older w/o high school	-0.1641	-0.1330
Percent labor force unemployed for age above 16	-0.0679	-0.2303**
Percent 5 or older not speaking English well or not at all	-0.1016	0.018
2nd Order Indices		
Public transportation needs	-0.2492**	-0.1962*
Civic capacity	-0.1670*	-0.1838*

Note: * indicates one-tail p≤.1; ** one-tail p≤.05.

Base level indicators help us understand the contributors to this overall relationship. Results indicate that neighborhoods with higher percentages of single parent households, renters, households in poverty, and non-white households experienced lower evacuation rates. Not surprisingly, areas with higher concentrations of households without a vehicle and with workers dependent upon public transportation also saw lower evacuation rates. Many of these same vulnerabilities were associated with later evacuation times. Specifically, neighborhoods with higher proportions of renters, households in poverty, and minorities were more likely to have gotten off the island closer to the arrival time of the storm, which greatly jeopardized their evacuation, since water began creeping on the Island well in advance of the storm's impact, cutting off many evacuation routes. In addition, areas with higher percentages of occupied housing without vehicles and with workers dependent on public transportation left later as well, although these coefficients were only marginally significant.

These second order measures are useful from a planning and management perspective, as they relate to different types of assistance, funding sources, or needed improvements. They also capture the compounding effects of dimensions of SV that can exacerbate abilities of individuals and households in an area to respond to disaster threats. In this case, two 2nd order indicators are examined: transportation needs and civic capacity needs. The former is associated with household ability to evacuate, which as noted above is highly dependent upon privately owned transportation. The latter, composed as it is of measures related to communication, education, employment, and language skills, assesses the neighborhood's human capital. In this case a lack of transportation is a clear and significant obstacle to evacuating—neighborhoods with high proportions of households without access to private transportation and dependent on public transportation off the Island (which is quite limited in the first place) had lower evacuation rates and, while only marginally significant, these areas had later average evacuation times. Similarly, areas with higher civic capacity needs saw lower evacuation rates and later evacuation times, although again, these correlations are only marginally significant.

Damage: The most visibly devastating impact of the storm is the damage to physical structures; in particular, homes. As with most hurricanes, the damage comes in two

forms: wind and water. In Galveston Island's case, the wind damage was fairly minor and limited. The real damage came from the storm surge, which washed back across the Island from the Bay side. As a consequence, the surge that impacted most of the Island's urban core was not the powerful Gulf surge seen on the Bolivar Peninsula, nor was it accompanied by the damaging effects of wave action that destroyed homes and scoured away whole structures and their foundations. Rather it was characterized by slow rising waters as the Bay crept on to the Island into the urban core area, filling the city with water. As a consequence, it was somewhat difficult to assess water damage from outside the home.

In Table 7, different measures of damage are employed. The first, overall damage, relies on an assessment by field researchers of visible external damage to the structure. The second and third columns rely on assessments by the survey respondents (household occupants) themselves, of overall damage and of internal damage that would may have been visible to the field researcher. All three of these measures generally assess the relative extent or percent of damage suffered by the home externally and internally. The last two columns are based on the assessed "improved" (the value of the building on the property) property values for 2008 and 2009. The 2008 property assessment reflected the property's structure or home value prior to the hurricane and the 2009 reflected the value of the damaged structure. We computed the absolute loss in the structures value and the percentage loss in the structure. With respect to all of these measures, averages were computed for all surveyed or, in the case of the property value data, for all single family homes in each block group to give an overall damage assessment for the block group or neighborhood. Given the SV research which generally finds that socially vulnerable populations experience greater *relative* losses but lower *absolute* losses, our expectations are that areas with higher concentrations of SV should be positively associated with the relative damage measures (the 1st, 3rd, and 5th columns), but be negatively associated with absolute loss (the 4th column).

Table 7. Correlations between SV indicators and Damage Data

	Overall damage	Self-assessment of overall damage	Self-assessment of Internal Damage	Absolute value loss	Percent value loss
SV Composite Index	-.0277	-0.1213	-0.0039	-0.3274*	0.1368
1st Order or Base Indicators					
Percent population 65 or older	-.0599	.0588	.0688	-.1086	-.0446
Percent Elders below poverty level	-.0789	-.1630	-.0602	-.2892*	-.0035
Percent pop. in renter occupied HUs	-.0085	-.1293	-.0601	.0757	.0661
Percent non-white population	.0516	-.0977	-.0083	-.2761*	.2548*
Housing units built 20 years ago	-.1934	-.1525	-.0314	-.4407*	-.0376
Percent mobile homes	.2615*	.2091	.1848	-.0757	.5611
Persons in poverty	-.1243	-.1130	-.0312	-.2044	.1057
Per. occupied HUs without a telephone	.0131	-.0442	-.0316	-.3520*	-.0348
Per. pop. 25 or older w/o high school	.0393	-.1881	-.0908	-.5208*	.0263
Per. labor force unemployed	-.0597	.0355	.1097	-.2088	.0479

Percent ≥5 yrs. w/o English competency	.1426	-.1597	-.0487	-.2705*	.0723
2nd Order Indices					
Shelter and housing recovery needs	-.0355	-.1124	.0107	-0.2352*	0.1516
Civic capacity	.0375	-.1409	-.0335	-0.5039*	0.0391

** two-tailed p≤ 0.05.

The first three columns displaying the relationships between the SV measures and interviewer and respondent relative damage measures, shows only one statistically significant relationship. That is the relationship between the percent of a block group's housing that is mobile homes and the overall damage assessment by the interviewer (.2615). When examining the last column, which also reflects a relative damage measure, we again find only one statistically significant and positive correlation. That correlation (.2548) was between relative loss in home values and the percent non-white population in a block groups The significant positive correlation suggests that block groups with higher proportion of minorities suffered greater relative damage, which is consistent with SV expectations. On the whole then, rather than finding the significant and positive associations expected, there were only two significant correlations, one for percent mobile homes and the other for percent non-white populations. It should also be noted that there were no significant correlations for the 2nd and 3rd order composite SV measures.

While the findings with respect to relative loss were, with the exception of two correlations, not consistent with our expectations, those with respect to absolute loss were. The relationships between absolute loss (column 4) and many of the SV generally show the expected pattern in that blocks with higher levels of SV suffered lower amounts of absolute (dollar) damage. In some sense, these findings are not all that surprising. Higher concentrations of SV generally imply less affluent neighborhoods and housing, hence there is simply less value to lose in the first place. Specifically we find significant and negative correlations between the absolute loss measure and elders in poverty, non-white population, housing units over 20 years old, housing unites without a phone, populations over 25 without a high school diploma, and low English competency. In addition, the overall composite SV index and 2nd order measures for housing needs and civic capacity needs all showed significant negative correlations.

On the whole then, the results are somewhat disappointing. With the exception of the two significant correlations associated with the relative loss measures and the consistent of significant negative correlations with respect to absolute loss, the results for Hurricane Ike suggest that the relationship between neighborhood SV and damage was not as consistent with the expectations of the literature. This finding may well suggest that, at least with respect to damage, SV analysis is of limited utility. However, this non-finding may also be a function of the unique characteristics of Ike and Galveston in general. More specifically, this result maybe a function of the particular nature of Ike – an extensive but gradual surge flooding event from its bayside with very limited wind damage and in nature of development on barrier islands, confounding the relationship physical vulnerability and real estate amenity.

Often times the literature finding a relationship between SV and relative damage is base on earthquake and wind related events in which poor quality housing, generally occupied by SV populations, are shaken apart or picked apart by winds. Furthermore, the work on floods generally is associated with inland communities where low-lying, flood prone areas have poor land values and more typically the sites for low-income housing and households. In the case of Ike however, we have an slow rising surge event impacting essentially all of the urban core, home to 85% of the island's inhabitants – both rich and poor, minority and majority, etc. – as well as housing of the relatively affluent on the west end with its outstanding view and proximity to a beach and bay. These latter homes may be at great physical risk, but their owners have very little social vulnerability, not only because these homes are often vacation homes and not primary residences, but more importantly because these households typically have very good access to resources—social, physical, and financial—to help them avoid lasting impacts from the storm. Thus, the nature of this event and Galveston's unique characteristics may well account for the lack of relationships between the SV measures and most damage measures. Another important factor is that this analysis is simply looking for the bivariate relationship between SV and relative damage, which is perhaps a more complex matter.

It is worth noting that more elaborate multivariate analysis conducted with the survey data and predicting the first relative measure of damage use in column one of table 7, does find the expected positive effect of various measures of social vulnerability. Specifically, Highfield, Peacock, and Van Zandt (2011), develop a multivariate model that sought to predict relative structural damage using a series of variable capturing a home's exposure to the flooding/surge hazard, the structures features, and its neighborhood's SV characteristics. The specific variables utilized to capture these different sets of factors were as follows: a structures relative exposure to flooding/surge hazard was based on its distance from the water (bay or gulf), how close it was behind the Galveston's famous sea wall, its location in flood zones, and the actual water inundation level at a structure's location; the structure's features included how high it had been elevated and its age, as a proxy for building code quality; and finally social vulnerability measures included the percent Black and Hispanic population is the home's block group and how economically affluent the home's block group as assessed by the average home value. Not unexpectedly a home's hazard exposure and its structural features were statistically significant determinants of relative damage, working as one would have expected. Nevertheless, the social vulnerability characteristics were also statistically significant determinants as well, even after controlling for these other factors. Specifically, homes in progressively more Black and Hispanic neighborhoods (i.e., with higher percentages of these non-white populations) suffered disproportionally higher levels of relative damage and homes in more affluent neighborhoods suffered less relative damage. These findings suggest that SV is important, however given the complexities of the determinants of damage due to Ike's surge flooding, the simple bivariate relationship, reflected by a correlation coefficient, was obscured.

Recovery Resources: Given that damage was widespread and affected households in neighborhoods of all income levels and race/ethnicities, one might hope that recovery and recovery resources would also be fairly even and widespread. In this section, we explore

the relationship between social vulnerability and recovery resources. While households may have access to a variety of resources for recovery after a disaster, insurance is perhaps the most commonly accessed. In addition to these private resources, additional public funds are poured into a community in the days and weeks after a disaster. In this analysis we will consider each category of resources separately.

Private recovery funds: First, we examine private recovery resources in the form of whether respondents had insurance (both owners and renters), as well as whether they had flood insurance, and, finally, whether they received a settlement. Again, as with other analyses, the individual household responses have been aggregated by computing the appropriate proportions or percentages within the block group that had various forms of insurance and received settlements. The general expectations are that neighborhoods with high SV would have lower access to these private resources and have fewer settlements.

Table 8 presents the correlation coefficients. The correlations with the composite social vulnerability index show strong negative associations with having had either home insurance or renters insurance. These correlations indicate that households in neighborhoods with generally high levels of overall social vulnerability are less likely to have either home owners or renter's insurance. While the signs for the correlations with flood insurance and having reached a settlement are negative, they are not statistically significant.

Table 8. Correlations between SV indicators and Insurance coverage/settlements

	Home Insurance	Flood Insurance	Renters Insurance	Received Settlement
SV Composite Index	-0.2720*	-0.1602	-0.3262*	-0.0990
1st Order of Base Indicators				
Percent Single parent households with children	.0390	-.1690	.0021	.0659
Percent population 65 or older	-.4202**	-.0512	-.1737	-.3368**
Percent Elders below poverty level	.0361	-.0891	.0486	-.0651
Percent occupied HUss without a vehicle	-.3270**	-.0727	-.3364**	-.1298
Percent pop. in renter occupied HUs	-.2045	.0868	-.3012**	.0550
Percent non-white population	-.2441**	-.2505**	-.3086**	-.0976
Housing units built 20 years ago	-.1358	-.1833	-.2778**	-.1454
Persons in poverty	-.0753	.0028	-.2219*	-.0027
Per. occupied HUs without a telephone	.0190	.0155	-.2216	-.0697
Per. pop. 25 or older w/o high school	-.3405**	-.2235**	-.3338**	-.2406**
Per. labor force unemployed	-.0262	.0151	-.2336**	-.0034
Percent ≥5 yrs. w/o English competency	-.3480**	-.1536	-.0034	-.1137
2nd Order Indices				
Shelter and housing recovery needs	-.2367**	-.1609	-.3493**	-.0490
Civic capacity needs	-.2772**	-.1526	-.3145**	-.1767*

Source: U.S. Census; HRRC survey; Coastal-planning atlas; * tail p≤.1; ** one-tail p≤.05.

A closer look at the base indicators suggests that neighborhoods with higher proportions of elderly, nonwhite, and low education households have a greater proportion of homeowners that are likely to be without home insurance. It may be useful to note that only homeowners with federally backed mortgages are required to carry home insurance; after homes are paid off, owners may opt to drop homeowner's insurance. For this reason, it is not surprising to see that neighborhoods with higher percentages of elderly, who are often on fixed incomes, have lower homeowners' insurance rates. Similar patterns are evident for rental insurance. By far the most disturbing finding, given the nature of this disaster, is the result for flood insurance. Neighborhoods with high proportions of minorities and those with higher proportions of adult individuals not completing high school have lower percentages with flood insurance. These findings suggest that these socially vulnerable neighborhoods in particular will be slower to recover because of a lack of private recovery resources.

The 2nd order SV indices for housing needs and civic capacity are also negatively associated with homeowner's and renter's insurance. Specifically, neighborhoods with higher shelter and housing recovery needs have lower rates of homeowners insurance and particularly renter's insurance, suggesting a disturbing lack of access to this important resource for recovery capital. The SV measure for Civic capacity needs is also highly negatively correlated with a lack of insurance. Since civic capacity includes potentially other types of nonfinancial resources, such as access to information and perhaps social support, this association could aggravate the lack of financial resources to slow or even prohibit recovery in these neighborhoods.

It is particularly significant to note that some areas of high SV are also reporting higher levels of failing to have an insurance settlement, which can significantly delay recovery and reconstruction for households with insurance in the first place. Specifically neighborhoods with high levels of elderly have lower proportions reporting insurance settlements. Additionally, neighborhoods with high levels of adults without a high school degree are also less likely to have received a settlement. This may be associated with greater difficulty filing claims or pursuing denied claims among this less-educated population. Regardless not having a settlement, will delay the recovery process. There is also a marginally significant, negative relationship between the 2nd order measure for civic capacity needs and having received an insurance settlement.

On the whole, the findings with respect to insurance and insurance settlements suggest that many vulnerable neighborhoods have lower access to these important sources of recovery funds, in part because of lower proportions that have insurance in the first place whether considering homeowners, renters, or most importantly, flood insurance. Furthermore, even among those that have insurance, settlements are reported at lower rates for high SV areas.

Public recovery funds: We next consider the availability and use of common public resources for recovery aid. There are a variety of forms of more "public" aid with FEMA and SBA as the most recognized. Assistance from FEMA generally comes in the form of

grants for living expenses, housing assistance, and minimum home repairs to help families through emergency periods, displacement due to home damage, or to make emergency repairs to their homes. These funds are generally seen as minimal and limited, acting as a safety net for those without resources, either chronically or temporarily. Major assistance to homeowners to help rebuild or repair damage when private funds are not available comes in the form of low interest loans from the Small Business Administration (SBA). These are loans, however, and not grants; hence, they are awarded based on the likelihood that individual can repay the loan.

As part of the household survey, respondents were asked whether they applied for assistance from FEMA, SBA, or both and whether or not they had received any funding from either of these sources. Table 9 displays the correlations between the SV measures and the percentages of respondents within each neighborhood that applied for FEMA assistance, SBA low-interest loans, as well as whether any funds were received from either of these sources. While the literature suggests that there can be variations in household applications and receipt of IFG and SBA funding, the examinations of the general trends across neighborhoods suggests that, as intended, FEMA grant programs go to areas with higher SV (minority and lower income areas) while SBA low interest loans funding tends to be in more affluent areas (Kamel and Loukaitou-Sideris 2004). In light of these findings, the expectations would be that higher levels of SV should be positively associated with applications to FEMA, while SBA applications should be negatively associated with SV indicators. Unfortunately, since the receipt of funding could be from either FEMA or SBA, the expectation is indeterminate and hence the findings will be considered more exploratory.

Table 9. Public Recovery Funds and Social Vulnerability Indicators.

	Apply to FEMA	Apply to SBA	Receive funding from either FEMA or SBA
SV Composite Index	.2718**	-.1817	.1538
Base Indicators			
Single parent households with children	.3016**	-.0636	.1826
Elders with age above 65	-.0231	-.2790**	-.0025
Elders with age above 65 are below poverty level	.0860	-.1744	.2217*
Occupied housing units without a vehicle	.2901**	-.2828**	.2116*
Persons in renter occupied housing units	.2341*	.0013	.1958
Race/ethnicity (non-white population)	.1827	-.0567	.0420
Housing units built 20 years ago	.0754	-.2542**	-.0996*
Persons in poverty	.2417*	-.2255*	.1845
Occupied housing units without a telephone	.2393**	-.0884	.0013
Educational attainment less than high school	.0363	-.1184	.1345
Labor force unemployed for age above 16	.2949**	-.1441	.0507
Speak English not well or not at all	-.0137	-.0445	-.0126
2nd Order Indices			
Shelter and housing recovery needs	.2694**	-.1186	.1190
Civic capacity	.1677	-.1444	.0908

Source: U.S. Census; HRRC survey; **two-tailed p≤ 0.05; * two tailed p ≤0.10

The findings are generally consistent with the expectations in that neighborhoods with higher SV indicators also had higher proportions reporting applying for FEMA assistance, yet lower proportions applying for SBA loans In terms of the general composite SV measure, we find that households in more socially vulnerable neighborhoods, are more likely to apply for FEMA assistance. Similarly, neighborhoods with higher proportions of single parent households, households without a car, renters, living in poverty, homes without phones, and unemployed apply to FEMA only. The 2nd order index, reflecting higher proportions likely to be in need of shelter and housing recovery assistance also was positively associated with higher levels of FEMA applications. It should however be noted that FEMA aid is not designed for, nor is it sufficient to undertake anything more than minimal emergency repairs to a home.

On the other hand, the relationship between socially vulnerable households and applying for SBA loans is negative, despite what we have already seen as low access to homeowner and flood insurance, indicating that higher concentrations of socially vulnerable households have relatively lower applications to these sources. More specifically, significant negative correlations are found for areas with high proportions of individuals living in poverty, older homes, or homes without vehicles, as well as combinations of elderly or elderly living in poverty. Again, these findings are not too surprising because applications for an SBA low-interest loan suggests the ability to repay that loan, which will be much more difficult in poorer areas and for older individuals who are reluctant to incur higher levels of debt at their age or financial status.

Interestingly, only areas with higher proportions of poor elderly and households without cars show relatively higher proportions that received some form of aid from these sources, although the correlations are only marginally significant. While it is impossible, given the nature of the information collected, to be clear which form of assistance was received; one might deduce given the nature of high SV areas that this is more likely to be aid in the form of grants from FEMA and not SBA loans. To the extent that this is the case, these findings in conjunction with the negative relationships between these two SV indicators and insurance, suggest that more public sources are indeed filtering into areas that are lacking recovery resources from insurance. However, only a very small slice of SV neighborhoods appear to be actually receiving such assistance at rates greater than the rest of socially vulnerable neighborhoods.

Public resources for recovery are expected to be a safety net for households who do not have any or adequate private resources (primarily insurance and savings) for recovery. It should also be noted that this safety net is minimal and not designed to replace funding from private sources nor is it designed to repair homes. Minimal home repair is just that, designed to put a tarp on a damaged roof, not replace the roof, until other funding is available. They are income-qualified programs that should be targeted to those households most in need of such assistance. This is clearly the public perception of these programs, which explains the moderately strong relationships with application rates for FEMA assistance and negative relationships with SBA applications in highly vulnerable

areas. That we do not see higher positive relationship for receipt for a broader spectrum of socially vulnerable areas suggests that these programs may have gaps in their ability to target at-risk neighborhoods.

Recovery: Recovery is signified by building activity—home owners, business owners, and residents undertaking repairs to their damaged homes or businesses, or rebuilding on their lots after homes have been destroyed. In Table 10, we examine the relationship between social vulnerability and indicators of early recovery activities. Specifically, we look at the proportion of households in neighborhoods that have undertaken significant repairs, as reported in our household survey conducted several months after the hurricane, as well as the percent of housing units in the neighborhood that have not yet received permits for reconstruction, and the average number of months before the first permit was granted for each neighborhood. These latter indicators were created using data from the City of Galveston's building permit system. The overall SV expectations are that neighborhoods with high SV levels should be negatively associated with the proportion of significant repairs started in the area, positively associated with higher proportion of properties not having permits to start major rebuilding and repair efforts and positively associated with the average number of months before the first single family permit issues for major repairs or rebuilding indicating greater delays in recovery efforts.

Table 10. Housing recovery indicators and Social Vulnerability Indicators

	Undertaken Significant Repairs	Percent not having received permits	Average months to first permit
SV Composite Index	-.1854*	.2718**	.2063**
Base Indicators			
Single parent households with children	-.0798	.0331	-.0365
Percent population 65 or older	.1741	.0469	.1657*
Percent Elders below poverty level	-.0644	.1630*	.0706
Occupied housing units without a vehicle	.0005	.1137	.1174
Percent population in renter occupied HUs	-.0780	-.0026	.0809
Percent non-white population	-.2442**	.3353**	.2072**
Housing units built 20 years ago	-.2851**	.4937**	.2947**
Persons in poverty	.1274	.0569	.0024
Per. occupied HUs without a telephone	-.1708*	.1529	.1302
Per. pop. 25 or older w/o high school	-.2841**	.4199**	.3894**
Per, labor force unemployed for age above 16	.0124	.1503	.0418
Percent ≥5 yrs. w/o English competency	-.1692*	.1379	.1545
2nd Order Indices			
Shelter and housing recovery needs	-.2154**	.2695**	.1801*
Civic capacity	-.2327**	.3533**	.2990**

Source: U.S. Census; HRRC, City of Galveston building permits, and Coastal Planning Atlas; **two-tailed p≤ 0.05; * two tailed p ≤0.10

Beginning first with measures from the survey data found in the first column, we see that there is a marginally significant negative correlation between sampled households

reporting starting significant repairs and the composite SV index suggesting that highly vulnerable neighborhoods show lower rates of undertaking significant repairs. Furthermore, and more importantly, there are a number of highly significant relationships with the 1st and 2nd order measures. Specifically, neighborhoods with higher proportions of minorities, neighborhoods with older housing stock, and those with lower adult educational attainment are less likely to have begun undertaking significant repairs. While only marginally significant, we also see that neighborhoods with higher percentages of individuals not speaking English well display lower levels undertaken significant repairs. Also as anticipated, neighborhoods with higher shelter and housing recovery needs and those with higher civic capacities needs are less likely to have begun significant repairs.

Interestingly, when employing permitting data that canvases all block group structures and not just relatively small sample of single family home within neighborhoods, the general pattern is replicated and in some cases appears stronger. Starting with the results in column 2, for the proportion of structures within a neighborhood that have not been permitted for repairs, we see a fairly strong and significant association with the composite social vulnerability index. The same base indicators—nonwhite population, low education levels, older housing stock, and while only marginally significant, areas with higher percentages of elders living in poverty are positively associated with larger percentages not having received permits. With respect to the 2nd order SV measures, we also see that those areas with high shelter and housing recovery needs and high civic capacity needs have larger proportions of structures that have not obtained permits to begin rebuilding or repairing homes. These findings are all consistent with the SV expectations.

In the third column, we look at average time to first permit—a variable which indicates how quickly households were able to begin undertaking repairs and rebuilding. We see that the overall social vulnerability index is positively associated with the number of months before the first permit was applied for suggesting that socially vulnerable neighborhoods are taking significantly longer on average to even begin repairs and rebuilding. The correlations with the base indicators suggest that areas with higher percentages of non-Whites, older housing, and populations with low levels of education are all later, on average, before the first permits are being pulled for rebuilding and repair work. With respect to the 2nd order SV measures, we find that areas with high civic capacity needs and, all be it marginally significant, areas with high housing needs were also later, on average, in pulling initial permits for rebuilding/reconstruction efforts.

The findings with respect to the early stages of recovery clearly suggest that more vulnerable neighborhoods – those that are older and those that are composed of greater percentages of minorities and those with higher percentages of adults without a high school degree – are certainly rebuilding and recovering at a slower pace. The literature suggests that they may well be less likely to ever recover. In some cases, these neighborhoods may become targets for redevelopment—meaning the properties are demolished and replaced with different uses— for higher-income housing or nonresidential uses, for example (Yang and Peacock 2010). In cases like this,

communities may see an overall loss of affordable housing, and may displace original residents, perhaps permanently.

Summary: The overall conclusions from examining the utility of the *Coastal Planning Atlas's* strategy for measuring and mapping socially vulnerable block groups (neighborhoods), at least with respect to Galveston's Hurricane Ike experience has been, on the whole, positive. The use of 1st, 2nd, and 3rd order SV measures was show to be of utility when assessing response to warning, in the sense of evacuation rates and timing, when assessing access to recovery resources including various forms of insurance and public resources, and finally, and most importantly, when assessing various forms early recovery and rebuilding. The one area that was less than satisfactory was in the area of flooding damage due to Ike, where there were only a few indicators that appears to work in identifying relative losses as opposed to absolute losses. However, neighborhood SV measures did perform as expected in more complex multivariate analysis predicting relative losses. On the whole, the use of the Atlas's SV strategy and mapping tools can be utilized by coastal community planners and emergency managers to effectively identify areas within their own communities which, due to their social vulnerability characteristics, are going to have lower levels, capacities and abilities to, in the words of Blakie et al (1994:9), "anticipate, cope with, resist and recover from the impacts of a natural hazards." It therefore is incumbent, particularly given the status and trends toward greater levels of social vulnerability within the Texas coastal management zone, for planners and emergency managers to utilize such tools to address this issue of growing concern.

VII. Comprehensive Disaster Mitigation and Recovery Planning for Resilience.

Resilience implies the ability to resist or absorb impacts and rapidly bounce back from those impacts. In the case of natural disasters and social systems, this implies the ability and capacity to prepare, respond, withstand the disaster impacts without major damage, and most importantly, to bounce back from the impact sustained. But when addressing communities, the picture is often far more complex because communities are composed of networks of businesses, governmental organizations, and most importantly, households and families living in areas that make up a complex mosaic of socially-defined neighborhoods. These neighborhoods are not the same, nor are they equal opportunity venues. They can be as different as night and day in terms of their socio-economic composition, the quality and types of housing, and their access and ability to mobilize resources when "bad" things happen. In a very real sense, social vulnerability mapping reveals disparities that make a difference when it comes to the capacity of residents and households to respond, mobilize resources, and bounce back from natural or other types of disasters.

This report has discussed one research-based approach that identifies those social, economic, and cultural factors that have been seen to be relevant to decision-making and behavior in responses to disaster. Furthermore, we have utilized census data at the lowest level of aggregation that still provides a wealth of information related to vulnerability, but

does so at a unit of aggregation likely to be more parsimonious with neighborhoods: census block groups. These units also have an advantage is that they are workable in the context of planning policies, actions and programs. In other words, community planners, emergency management personnel, and civic leaders can utilize such information to identify neighborhoods where they can work with local civic organizations, target education programs, locate emergency shelters, and coordinate evacuation pick-ups, etc. to better meet the needs of these populations.

The approach presented does appear as an effective method of identifying target areas likely to experience particular problems when addressing hazard risk and disaster response, impacts and recovery. Comparing needs predicted by the Coastal Atlas to actual needs expressed after Hurricane Ike, this tool did indeed identify neighborhoods that failed to heed or were slower to respond to calls for evacuation, that had lower levels of private and public resources, particularly resources necessary for rebuilding, repairs, and ultimately recovery. And finally, this approach identified neighborhoods that were on the slow track to recovery and at jeopardy of failing in that pursuit. These failures have consequences not only for the households in those areas, but for the community as a whole, because these become areas at risk of cycling down to become pockets of economic and social despair that can threaten the overall resilience of the community, particularly if they spread.

In short, indicators of social vulnerability did make a difference. The neighborhood disparities identified by SV mapping did identify neighborhoods that were quite different in their abilities to respond to Hurricane Ike and bounce back from its impacts. This suggests that using social vulnerability mapping in conjunction with hazard map and physical vulnerability mapping can greatly facilitate community planning for disaster response, recovery, and mitigation. With this approach we can better plan for and monitor our community vulnerabilities and thereby develop more comprehensive planning approaches that can enhance long term community resiliency. Furthermore, in light of the current status and trends with respect to social vulnerability, it is critical that we employ social vulnerability analysis as a critical element in community and hazard planning.

VII. References

Aguirre, B.E. 1988. The Lack of Warnings before the Saragosa Tornado. *International Journal of Mass Emergencies and Disasters* 6: 65-74.

Alba, R. D., and Logan, J. R. ~1992!. "Assimilation and stratification inthe homeownership patterns of racial and ethnic groups." *International Migration Review,* 26(4), 1314–1341.

Bates, F. L., Fogleman, C. W., Parenton, V. J., Pittman, R. H., and Travy, G. S. 1962. *The Social and Psychological Consequences of a Natural Disaster: A Longitudinal Study of Hurricane Audrey.* Washington D.C.: National Academy of Sciences – National Research Council, Publication 1081.

Berke, P.R., J. Kartez and D. Wenger. 1993. Recovery after Disaster: Achieving Sustainable Development, Mitigation and Equity. *Disasters* 17(2): 93-109.

Blaikie, P. Cannon, T. Davis, I. and Wisner, B. 1994. *At Risk: Natural Hazards, People's Vulnerability and Disasters.* London: Routledge.

Blanchard-Boehm, R.D. 1998. Understanding public response to increased risk from natural hazards: Application of the Hazards Risk Communication Framework. *International Journal of Mass Emergencies and Disasters* 16 (3), 247–78.

Bolin, R. 1985. Disasters and long-term recovery policy: a focus on housing and families. *Policy Studies Review,* 4: 709-15.

Bolin, R. 1986. Disaster impact and recovery: A comparison of black and white victims, *International Journal of Mass Emergencies and Disasters (IJMED),* 4: 35-50.

Bolin, R. 1993b. Post-earthquake shelter and housing: Research findings and policy implications. Pp. 107-131 in Monograph 5: *Socioeconomic Impacts,* K.J. Tierney and J.M. Nigg, eds. Monograph prepared for the 1993 National Earthquake Conference. Memphis, TN: Central U.S. Earthquake Consortium.

Bolin, R. and Bolton, P. 1986. *Race, religion, and ethnicity in disaster recovery.* Program on environment and behavior, Monograph # 42. Colorado: Institute of Behavioral Science, University of Colorado.

Bolin, R. and Stanford, L. 1991. Shelter, Housing and Recovery: A Comparison of U.S. Disaster. *Disasters,* 15: 24-34.

Bolin, R. and Stanford, L. 1998a. The Northridge earthquake: Community-based approaches to unmet recovery needs. *Disasters,* 22*:* 21-38.

Bolin, R. and Stanford, L. 1998b. *The Northridge Earthquake: Vulnerability and Disaster.* London and New York: Routledge.

Boruff, B.J., C. Emrich, and S. L. Cutter. 2005. Erosion Hazard Vulnerability of US Coastal Counties. *Journal of Coastal Research* 21(5):932-942.

Brody, S.D., Zahran, S., Maghelal, P., Grover, H., and Highfield, W. 2007. The rising costs of floods: Examining the impact of planning and development decisions on property damage in Florida. *Journal of the American Planning Association* 73(3): 330-345.

Charles, C.Z. 2003. The dynamics of Racial Residential Segregation. *Annual Review of Sociology.* 29: 167-207.

Cochrane, H.C. 1975. *Natural Hazards and Their Distributive Effects.* Boulder, CO: Institute of Behavioral Sciences.

Comerio, M.C. 1998. *Disaster hits home: New policy for urban housing recovery.* Berkeley: University of California Press.

Comerio, M.C., Landis, J.D., and Rofe, Y. 1994, *Post-Disaster Residential Rebuilding.* Working Paper 608. Berkeley, CA: University of California, Institute of Urban and Regional Development.

Cutter, Susan L. 1996. Vulnerability to Environmental Hazards. *Progress in Human Geography,* 20(4):529-539.

Cutter, S.L. 2001. American hazardscapes: *The regionalization of hazards and disasters.* Washington, DC: The Joseph Henry Press.

Cutter, S.L., B.J. Boruff, and W.L. Shirley. 2003. Social Vulnerability to Environmental Hazards. *Social Science Quarterly* 84: 242-261.

Cutter, S. L., J. T. Mitchell, and M. S. Scott. 2000. Revealing the vulnerability of people and places: A case study of Georgetown county, South Carolina. Annals of the Association of American Geographers 90 (4): 713–37.

Dash, N., Peacock, W.G. and Morrow, B. 1997. And the Poor Get Poorer: A Neglected Black Community. Pp 206-225 in W.G. Peacock, B.H. Morrow, and H. Gladwin, *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster.* London: Routledge.

Deyle, R.E., S.P. French, R. B. Olshansky, and R.G. Paterson. 1998. Hazard Assessment: The Factual Basis of Planning and Mitigation. In Burby, R.J. (ed.) *Cooperating with nature: confronting natural hazards with land use planning.* Washington, DC: Joseph Henry Press.

Drabek, T.E. and Boggs, K. 1968. Families in Disaster: Reactions and Relatives. *Journal of Marriage and the Family* 30 (August): 443-451.

Drabek, T.E. and Key, W.H. 1984. *Conquering disaster: family recovery and long-term consequences.* New York: Irvington Publishers.

Edwards, M.L. 1993. Social Location and Self Protective Behavior. *International journal of Mass Emergencies and Disasters*, 11:293-304.

Enarson, Elaine. 1999. "Violence Against Women in Disasters: A Study of Domestic Violence Programs in the US and Canada." Violence Against Women 5 (7): 742-768.

Enarson, E. and Morrow, B.H. 1997. A Gendered Perspective: The Voices of Women. Pp 116-140 in Peacock, Morrow, and Gladwin *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters.* London: Routledge

Enarson, E. and B.H. Morrow (eds.) 1998. *The Gendered Terrain of Disaster: through Women's Eyes.* Praeger, Westport.

Farley, Reynolds. 1998. "Comments on Racial and Ethnic Discrimination in American Economic Life." Presentation at the Urban Institute. Washington, DC.

Flynn, J., P. Slovic and C. Mertz. 1994. Gender, Race, and Perception of Environmental Health Risks. *Risk Analysis* 14(6): 1101-08.

Foley, D.L. 1980. The Sociology of Housing. *Annual Review of Sociology.* 6:457-78.

Fothergill, A., E. Maestras, and J.D. Darlington. 1999. Race Ethnicity and Disasters in the U.S.: A Review of the Literature. *Disasters* 23(2):156-173.

Fothergill, A. and L. A. Peek. 2004. Poverty and Disasters in the United States: A Review of Recent Sociological Findings. *Natural Hazards* 32(1): 89-110.

Galindo, K.B. 2007. Variation in Disaster Aid Acquisition among ethnic groups in a Rural Community. Dissertation. College Station Texas: Texas A&M University.

Gladwin, H. and W.G. Peacock. 1997. Warning and Evacuation: A Night for Hard Houses. In W.G. Peacock, B.H. Morrow and H. Gladwin (eds.) *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters.* Routledge, London.

Greene, M.: 1992, Housing recovery and reconstruction: Lessons from recent urban earthquakes, In: *Proceedings of the 3rd U.S./Japan Workshop on Urban Earthquakes*, Oakland, CA: Earthquake Engineering Research Institute (EERI) Publication No. 93-B.

Highfield, W.E., W.G. Peacock, and S. Van Zandt. 2011. Determinants & Characteristics of Damage in Single Family Island Households from Hurricane Ike. Proceeding of the 2011 NSF Engineering Research and Innovation Conference, Atlanta, Georgia.

Horton, H. D. 1992. "Race and wealth: a demographic analysis of black home-ownership." *Sociological Inquire,* 62(4), 480–489.

Ives, S.M. and O.J. Furseth (1983) Immediate Response to Headwater Flooding in Charlotte, North Carolina. *Environment and Behavior* 15(4): 512–25.

Kamel, N.M.O. and A. Loukaitou-Sideris. 2004. Residential Assistance and Recovery Following the Northridge Earthquake. *Urban Studies* 41(3): 533-562.

Lindell et al 1980

Lindell, M. K., and Perry, R. W. (1992). *Behavioral foundations of community emergency planning*, Hemisphere, Washington, D.C., Lindell, M.K. and R.W. Perry. 2004. *Communicating Environmental Risk in Multi-Ethnic Communities. Thousand Oaks, CA: Sage Publications.*

Lindell, M.K., R.W. Perry and M.R. Greene (1980) Race and Disaster Warning Response. Research paper. Battelle Human Affairs Research Center.

Lindell, M. K., and Prater, C. S. (2000). "Household adoption of seismic hazard adjustments: A comparison of residents in two states." Int. J. Mass Emergencies Disasters,18, 317–338.

Logan, J.R. and Molotch, H.L. 1987. *Urban Fortunes: The Political Economy of Place.* Berkeley, CA: University of California Press.

Massey, D.D. and Denton, N.A. 1993. *American Apartheid : Segregation and the Making of the Underclass.* Cambridge, MA: Harvard University Press.

Mileti, D. 1999. *Disasters by Design.* New York: Joseph Henry Press.

Mileti, D.S. and J.D. Darlington 1997. The Role of Searching in Shaping Reactions to Earthquake Risk Information. Social Problems 44(1): 89-103.

Mitchell, J.K., ed. 1989. *The Long Road to Recovery: Community Response to Industrial Disaster.* Tokyo: United Nations University Press.

Moore, H.E. 1958. *Tornadoes over Texas.* University of Texas Press, Austin.

Moore, H.E. and Bates, F.L., Layman, M.V. and Parenton, V.J. 1963. *Before the Wind: A study of the Response to Hurricane Carla.* Washington D.C.: National Academy of Sciences/National Research Council.

Moore, H.E. et al. 1964. *...and the Winds Blew.* Austin TX: The Hogg Foundation for Mental Health.

Morrow, B.H. 1997. Stretching the Bonds: the Families of Andrew. Pp 141-170 in Peacock, Morrow, and Gladwin *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters.* London: Routledge.

Morrow, B.H. 1999. Identifying and Mapping Community Vulnerability. *Disasters* 23(1): 1-18.

Morrow, B.H. and Peacock, W.G. 1997. Disasters and Social Change: Hurricane Andrew and the Reshaping of Miami? Pp 226-242 in Peacock, Morrow and Gladwin. *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters.* London: Routledge.

Morrow, B.H. and E. Enarson, 1996. Hurricane Andrew Through Women's Eyes: Issues and Recommendation. *International Journal of Mass Emergencies and Disasters* 14(1): 1-22.

Norris, F.H, J.L Perilla, J.K. Riad, K. Kaniasty, and E.A. Lavizzo. 1999. Stability and change in stress, resources, and psychological distress following natural disasters: Findings from Hurricane Andrew. *Anxiety, Stress, and Coping* 12(4): 363-396.

National Research Council. 2006. *Facing Hazards and Disasters: Understanding Human Dimensions,* Washington D.C.: The National Academies Press.

Nuade, W., A. Santos-Paulino, and M. McGillivray. 2009. Measuring Vulnerability: An Overview and Introduction. *Oxford Development Studies* 37(3): 183-191.

Peacock, W.G., B.H. Morrow, and H. Gladwin. 1997. *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters.* Miami: Laboratory for Social and Behavioral Research, Florida International University.

Peacock, W.G., S. D. Brody, and W. Highfield. 2005. "Hurricane risk perceptions among Florida's single family homeowners" *Landscape and Urban Planning.* 73:120-35.

Peacock, W.G., N. Dash, and Y. Zhang. 2006. Shelter and Housing Recovery following Disaster. Pp 258-274, in *The Handbook of Disaster Research,* edited by Havidan Rodriguez, E. L. Quarantelli, and Russell Dynes. New York: Springer.

Peacock, W.G. and Ragsdale, A.K. 1997. Social Systems, Ecological Networks and Disasters: Toward a Socio-political Ecology of Disasters. Pp 20-35 in W.G. Peacock, B.H. Morrow, and H. Gladwin, *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters.* London: Rutledge.

Peacock, W.G. and Girard, C. 1997. Ethnic and Racial Inequalities in Hurricane Damage and Insurance Settlements. Pp. 171-90 in W.G. Peacock, B.H. Morrow and H. Gladwin, *Hurricane Andrew: Ethnicity Gender and the Sociology of Disasters.* London: Rutledge.

Peacock past GLO project results...

Peguero, A.A. 2006. Latino Disaster Vulnerability: The Dissemination of Hurricane Mitigation Information Among Florida's Homeowners. Hispanic Journal of

Behavioral Sciences 25(1): 5-: Perry, R.W., and A. H. Mushkatel. 1986. *Minority Citizens in Disasters.* University of Georgia Press, Athens.

Perry, R.W. and M.K. Lindell. 1991. The Effects of Ethnicity on Evacuation Decision-Making. *International Journal of Mass Emergencies and Disaster*s 9(1): 47-68.

Perry, R.W. and L. Nelson. 1991. Ethnicity and hazard information dissemination. *Environmental Management* 15(4):581-587.

Phillips, B.D. 1993. Culture diversity in disasters: sheltering, housing and long-term recovery. *International Journal of Mass Emergencies and Disasters* (IJMED). 11: 99-110.

Phillips, B.D. and M. Ephraim. 1992. *Living in the Aftermath: Blaming Processes in the Loma Prieta Earthquake.* Working Paper No. 80. Natural Hazards Research and Application Information Center. University of Colorado, Boulder.

Prater, C.S. and Lindell, M.K. 2000. Politics of Hazard Mitigation. *Natural Hazard Review* 1: 73-82.

Oliver, M. L., and Shapiro, T. M. 1997. *Black wealth/white wealth: A new perspective on racial inequality*, Routledge, New York.

Quarantelli, E.L.1982. General and Particular Observations on Sheltering and Housing in American Disasters. *Disasters*, 6: 277-81.

Quarantelli, E.L.1995. Patterns of shelter and housing in US disasters. *Disaster Prevention and Management*, 4: 43-53.

Rossi, P. H.,Wright, J. D.,Weber-Burdin, E., and Pereira, J.: 1983, *Victims of the Environment: Loss from Natural Hazards in the United States, 1970-1980*, Plenum Press, New York.

Rubin, C. B. 1985. The community recovery process in the United States after a major disaster. *International Journal of Mass Emergencies and Disasters*, 3: 9-28.

Russell, L., Goltz, J. D., and Bourque, L. B. ~1995!. "Preparedness and hazard mitigation actions before and after two earthquakes." *Environment and Behavior*, 27, 744–770.

Sims, J. and Bauman, D. 1972 The Tornado Threat: Coping Styles of the North and the South. Science, 176:1386-92.

Squires, G. D., and Velez, W. 1987. "Insurance redlining and the transformation of an urban metropolis." *Urban Affair Q.*, 23(1), 63–83.

Tierney, K. J. 1989. Improving theory and research in hazard mitigation: Political economy and organizational perspectives. *International Journal of Mass Emergencies and Disasters*, 7: 367-396.

Turner, R.H., J.M. Nigg, and D. Paz. 1986. *Waiting for Disaster: Earthquake Watch in California.* University of California Press, Berkeley.

Van Zandt, S. 2007. Racial/Ethnic Differences in Housing Outcomes for First-Time, Low-Income Home Buyers. *Housing Policy Debate* 18(2): 431-474.

Vaughn, E. and Nordenstam, B. 1991. The Perception of Environmental Risk Among Ethnically Diverse Groups. Journal of Cross-Cultural Psychology, 22:29-60.

Vaughn E. and Seifert, M. 1992. Variability in the Framing of Risk Issues. Journal of Social Issues, 48:118-35.

White, G. F., R. W. Kates, and I. Burton. 2001. Knowing better and losing even more: The Use of Knowledge in Hazards Management. *Environmental Hazards* 3:81-92.

Zahran, S., Brody, S.D., Peacock, W.G., and Vedlitz, A., Grover, H. (2008). Social vulnerabitliy and the Natural and Built Environment: A model of Flood Casualties in Texas 1997-2001. *Disasters* 32(4).

Zhang, Yang and Walter Gillis Peacock. 2010. Planning for Housing Recovery? Lessons Learned from Hurricane Andrew. *Journal of the American Planning Association*, 76(1):5-24.

Appendix 3.

TEXAS COASTAL HAZARD MITIGATION POLICY SURVEY INSTRUMENT

TEXAS COASTAL HAZARD MITIGATION POLICY SURVEY

HAZARD REDUCTION & RECOVERY CENTER
TEXAS A&M UNIVERSITY

2010

The purpose of this survey is to gather information about the types of hazard mitigation policies and actions coastal jurisdictions (e.g., municipalities and counties) in Texas are employing to help reduce their vulnerability to natural disasters such as hurricanes and coastal flooding. Hazard mitigation refers to actions taken to reduce future disaster impacts. Often this is interpreted as structural actions like levees, dykes, or flood control infrastructure. However, the primary focus of this survey is on more "non-structural" mitigation practices often associated with general community planning efforts such as promoting development in non-hazard areas, building codes that are appropriate for high wind risks, involvement in the National Flood Insurance Program, and promoting community awareness. Since our focus is on these planning efforts, questions will be asked about general municipal/county planning as well as planning focused on mitigation.

The individual information we gather will remain confidential, however the broader findings and patterns will be examined and shared with you and other participants so that we all can better understand what types of actions and policies are being employed by jurisdictions along the Texas Coast. We hope that this information will better help all of us make our communities more resilient.

Please answer the following questions to the best of your ability. Most of the questions are factual with the goal of simply collecting the most reliable and accurate information as possible. So, if you need to consult with co-workers regarding some of these questions, please feel free to do so.

Throughout the survey, the questions are being asked with respect to "your jurisdiction." If you are a city official, this refers to your city or municipality. If you are a county official, this refers to the county itself and unincorporated areas under its jurisdiction, not to the cities that may reside in your county.

Overall there are 31 questions. It should take you about 20-25 minutes to complete the survey.
We appreciate your time and efforts at completing this survey.

If you have questions, please contact Ama Husein at 210.204.0029 or amahusein@tamu.edu or Dr. Walter Gillis Peacock at 979.845.7813 or peacock@tamu.edu. If you send an email, please put "Survey Question" in the subject line.

Section I.

The following section asks some general questions about your jurisdiction and some land-use planning issues.

1. To what extent are each of the following issues considered to be high priorities in your jurisdiction?	Not Important at all	Somewhat Important	Important	Very Important
a. Economic Development				
b. Land Use				
c. Housing				
d. Infrastructure (e.g., water, sewer, electric power				
e. Environmental protection				
f. Disaster reduction				
g. Transportation				
h. Recreation				

2. Does your jurisdiction have a comprehensive or general plan?
   a. Yes b. No

3. Does your jurisdiction have it own hazard mitigation plan (not a emergency preparedness plan) or is it participating as part of a county or regional hazard mitigation plan? NOTE: If you have more than one, please select all that is applied.
   a. No
   b. Yes, stand alone hazard mitigation plan (or hazard mitigation action plan)
   c. Yes, part of regional (multi-jurisdictional) hazard mitigation plan (or hazard mitigation action plan)
   d. Yes, others _____

4. Does your jurisdiction have zoning ordinances?
   a. Yes b. No

5. Does your jurisdiction have a building code and if yes, what type of code has been adopted?
   a. No
   b. Yes, 2009 IRC/IBC
   c. Yes, 2006 IRC/IBC
   d. Yes, 2003 IRC/IBC
   e. Yes, 2000 IRC/IBC
   f. Yes, SBC
   g. Yes, Others _____

Section II. Policy

Questions 6-14 ask about specific policies or actions that jurisdictions may employ in their general planning strategy or for specific hazard mitigation planning. Please indicate how extensively your jurisdiction employs each on the scale ranging from (not at all) through (to a very great extent) with a (√) or (X). If your jurisdiction does not have the authority (as may be the case for counties) to use a particular policy or action, simple select the response indicating that fact. We are aware that many jurisdictions may not employ all of the strategies mentioned below, but to get a clear picture of what is being used, we need to gather information on all of them.

6. To what extent are each of the following issues considered to be high priorities in your jurisdiction?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Residential Subdivision Ordinances					
b. Planned unit development					
c. Special overlay districts					
d. Agricultural or open space zoning					
e. Performance zoning					
f. Hazard setback ordinances (shoreline, flood plain)					
g. Storm water retention requirements					
h. Environmental impact assessment requirements					
i. Limitation of shoreline development to water-dependent uses					
j. Restrictions on shoreline armoring (e.g., levees, seawalls)					
k. Restrictions on dredging/filling					
l. Dune protection regulations					
m. Wetlands protection regulations					
n. Coastal vegetation protection regulations					
o. Requirements for habitat protection/restoration					

7. To what extent has your jurisdiction used the following building standards?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Special local standards for wind hazard resistance for new home construction (e.g. hurricane straps, impact resistant windows, reinforced garage doors)					
b. Special local standards for flooding hazards for new home construction (e.g. home elevation, flood vents, shields)					
c. Special local hazard retrofit standards for existing buildings					
d. pecial local utility codes (e.g., raised meters, raised air-conditioner platforms)					

8. To what extent has your jurisdiction used the following property acquisition programs?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Fee simple purchase of undeveloped lands in environmentally sensitive/hazardous areas					
b. Acquisition of development rights or easements in environmentally sensitive/hazardous areas					
c. Relocating existing buildings from environmentally sensitive/hazardous areas					

9. To what extent has your jurisdiction used the following incentive tools?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Transfer of development rights from environmentally sensitive/hazardous areas					
b. Density bonuses in environmentally sensitive/hazardous areas					
c. Clustered development in environmentally sensitive/hazardous areas					
d. Participation in the National Flood Insurance Program (NFIP)					
e. Participation in the FEMA community rating system (CRS)					

10. To what extent has your jurisdiction used the following financial tools?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Lower tax rates for preserving environmentally sensitive/hazardous areas as open space or limited development intensity					
b. Special tax assessment for districts for environmentally sensitive/hazardous areas					
c. Impact fees or special assessments for development of environmentally sensitive/hazardous areas					

11. To what extent has your jurisdiction used the following information dissemination strategies?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Public education for hazard mitigation (e.g., brochures, posters, public service announcements)					
b. Citizen involvement in hazard mitigation planning (e.g., public hearings, meetings with community groups)					
c. Seminars on hazard mitigation practices for					

developers and builders					
d. Hazard disclosure requirements in real estate transactions					
e. Hazard zone signs					

12. To what extent has your jurisdiction used the following	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Requirements for locating public facilities and infrastructure in less environmentally sensitive/hazardous areas (e.g., capital improvement plans)					
b. Requirements for locating critical private facilities and infrastructure in less environmentally sensitive/hazardous areas					
c. Using municipal service areas to limit development in environmentally sensitive/hazardous areas					

13. To what extent has your jurisdiction used the following private-public sector initiatives?	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Land trusts for environmentally sensitive/hazardous areas					
b. Public-private partnerships for environmentally sensitive/hazardous areas					

14. To what extent have geologists, engineers, and other professionals been employed or worked for your jurisdiction to:	Not at all	A Small extent	To Some extent	Very great extent	Not Within this jurisdiction's authority
a. Identify suitable building sites in hazard prone areas					
b. Develop special building techniques for hazard prone areas					
c. Conduct windstorm/roof inspection					

Section III: Hazard Experience

The next two questions ask you to roughly assess about how much damage or how likely your jurisdiction will be impacted by different types of hazards. We realize that you may not be a trained specialist when it comes to these hazards, but we are simply asking you to give your best judgment or assessment. Also, some jurisdictions may not be at risk to some of these hazards, in those cases, simply answer "never."

15. In the past 10 years, how much damage has your jurisdiction experienced from:	Never	Slight	Moderate	Major
a. Flood				
b. Coastal storms (including hurricanes)				
c. Tornados				
d. Hail				
e. Excessive heat				
f. Drought				
g. Wildfires				
h. Thunderstorms				
i. Coastal Erosion				
j. Technical hazards (e.g., industrial disaster, dam/levee failure, etc.)				
k. Subsidence				
l. Sea-level rise				
m. Others (please specify):				

16. In the next 10 years, to what extent do you thing the following hazards impact your jurisdiction?	Not at all	Not Very Likely	Somewhat Likely	Very Likely
i. Flood				
j. Coastal storms (including hurricanes)				
k. Tornados				
l. Hail				
m. Excessive heat				
n. Drought				
o. Wildfires				
p. Thunderstorms				
q. Coastal Erosion				
r. Technical hazards (e.g., industrial disaster, dam/levee failure, etc.)				
s. Subsidence				
t. Sea-level rise				

u. Others (please specify):

Section IV: Jurisdictional Capacities and Resources

The following questions ask about the capacities and resources your jurisdiction has or might employ for undertaking hazard mitigation planning activities.

17. How would you rate the capacity of your jurisdiction to undertake hazard mitigation planning in the following areas?	Poor	Fair	Good	Very Good	Excellent
a. Budget adequacy					
b. In-house technical expertise (e.g., GIS, water/storm water engineer, building inspector)					
c. Access to senior appointed and elected officials					
d. Enforcement authority					
e. Business communities (e.g., chambers of commerce, small businesses)					

18. Please indicate the general support for hazard mitigation planning exhibited by the following groups in your jurisdiction:	Poor	Fair	Good	Very Good	Excellent
a. Elected officials					
b. Jurisdiction's staff as a whole					
c. Jurisdiction's planning staff/personnel					
d. Jurisdiction's emergency management staff/personnel					
e. Business communities (e.g., chambers of commerce, small businesses)					
f. Special districts (e.g., independent school district, utility district)					
g. Citizens/general population					

19. Rate the frequency with which any jurisdictional staff/personnel have been able to attend the following training opportunities addressing hazard mitigation issues with the past 3 years.	Not at all	A Small extent	To Some extent	Very great extent
a. Training by FEMA				
b. Technical training for computer programs (e.g. HAZUS, GIS, etc.)				
c. Training by professional association (e.g., American Planning Association, Texas Planning Association, National Emergency Management Association)				
d. Other (please specify):				

20. Please rate the degree to which your jurisdiction has used each of the following financial resources for funding hazard mitigation actions and/or for disaster recovery efforts.	Not at all	A Small extent	To Some extent	Very great extent
a. Community Development Block Grants (CDBG)				
b. Texas Coastal Management Program Grants (GLO)				
c. Section 406 Hazard Mitigation Grant Program				
d. Small Business Administration Disaster Assistant Program				
e. Pre-Disaster Mitigation Loan Program				
f. Local jurisdictional funds				
g. Other (please specify):				

21. Please rate the degree to which your jurisdiction uses each of the following data sources in map or digital form for general or hazard mitigation planning.		Not at all	A Small extent	To Some extent	Very great extent
a.	Aerial photos/satellite images				
b.	Topographical maps				
c.	Jurisdictional land use maps or parcel data				
d.	Risk area or hazard zone data (e.g., flood, surge, wind-field)				
e.	Sensitive environmental area location maps				
f.	U.S. Census data				
g.	Population projections from State Demographer or Texas Water Development Board				
h.	Economic data (e.g., sales, number of employees)				
i.	HAZUS program or output-estimates from that program				
j.	Coastal Planning Atlas (coastalatlas.tamu.edu)				
k.	Other (please specify):				

Section V. Coordination, Cooperation, and Involvement

We are nearly finished. This is the second to the last section, which asks questions about coordination and cooperation within your jurisdiction as well as between your jurisdiction and others.

22. To what extent have the following individuals or departments been involved in your jurisdiction's hazard mitigation planning?		Not at all	A Small extent	To Some extent	Very great extent	Group/Department Not Present In Jurisdiction
a.	Elected officials					
b.	City Manager (or City Manager in County)					
c.	Public Works/Engineering					
d.	Planning/Community Development					
e.	Economic Development					
f.	Building Department					
g.	Emergency Management					
h.	Environmental Services					
i.	City/County Attorney's Office					
j.	County Judge					
k.	Housing Department/Authority					
l.	Flood administrator					
m.	Parks/Recreational Department					

23. To what extent have the following individuals or departments been involved in your jurisdiction's hazard mitigation planning?		Not at all	A Small extent	To Some extent	Very great extent
a.	Texas Department of Housing and Community Affairs (TDHCA)				
b.	Texas Commission on Environmental Quality (TCEQ)				
c.	Texas Department of Transportation (TxDOT)				
d.	Texas Water Development Board (TWDB)				
e.	Texas State Soil and Water Conservation Board (TSSWCB)				
f.	Texas Parks and Wildlife Department (TPWD)				
g.	Texas General Land Office (GLO)				
h.	Texas Division of Emergency Management (TDEM)				
i.	Texas Department of Rural Affairs (TDRA)				
j.	Regional Council of Government (COG)				
k.	Federal Emergency Management Agency (FEMA)				
l.	Other (please specify):				

24. Has your jurisdiction worked with or coordinated with other jurisdictions in your area on hazard mitigation planning issues?

a. Yes b. No

25. Does your jurisdiction have any type of agreements like MOUs or joint aid agreements with the following groups for hazard mitigation planning, or disaster response/recovery efforts?		Yes	No
a.	Schools/educational institution		
b.	Utilities (e.g., electric power, natural gas, telecommunication)		
c.	Health service institution (e.g., hospital, clinic)		
d.	Professional associations (e.g., builders, engineers, planners)		
e.	Non-profit organization (e.g., Red Cross, Habitat for Humanity, neighborhood)		
f.	Church or faith-based organization		
g.	Financial institution (e.g., bank, savings, loan associations, insurance)		
h.	Hospitality facilities (e.g. hotel/motel, nursery homes)		
i.	Other (please specify):		

26. How would you characterize the support the following stakeholders have for general planning activities undertaken by your jurisdiction?

	Strongly Opposed	Opposed	Neutral	Supportive	Strongly Supportive	Group(s) Not Present In Jurisdiction
a. Developers/Realtors						
b. Property/land owners						
c. Hospital/medical industry						
d. Utilities (e.g., electric power, natural gas, telecommunications)						
e. Financial industry (e.g., insurance, banks, mortgage companies)						
f. Minority organizations						
g. News media						
h. Neighborhood associations						
i. Environmental groups						
j. Religious groups						
k. Other (please specify):						

Section VI. Final Information on Your Jurisdiction

The following four final questions simple asks about your jurisdiction.

27. How many staff members in your jurisdiction are involved in hazard mitigation planning?

28. Please indicate the amount of time per year each of these staff members are is involved in hazard mitigation activities. (For example if you have 4 people involved in hazard mitigation activities, 2 for about 50% of their time and 2 for about 10% of their time enter 2 by 26%-50% and 2 by 0%-10%). Each field must have a response, even if it is 0.

a. 0 % to 20 %	
b. 21 % to 40 %	
c. 41 % to 60 %	
d. 61 % to 80 %	

e. 81 %to 100%

29. Please estimate the approximate annual budget your jurisdiction dedicates to hazard mitigation planning:
    a. $0–$5,000
    b. $5,001–$10,000
    c. $10,001–$20,000
    d. $20,001–$50,000
    e. $50,001–$100,000
    f. $100,001–$300,000
    g. $300,001 or greater

30. Name of your jurisdiction (city or county name):

31. Your job title (e.g. city planner, floodplain administrator):

Appendix 4.

The Sampling plan and Survey Strategy for the Hazard Mitigation Policy Adoption and Implementation Survey of Local Jurisdictions along the Texas Coast.

The Sampling plan and Survey Strategy for the Hazard Mitigation Policy Adoption and Implementation Survey of Local Jurisdictions along the Texas Coast.

Walter Gillis Peacock and Rahmawati Husein

The primary goal of this survey was to obtain a clearer picture of the variety and nature of hazard mitigation policies adopted and implemented by coastal jurisdictions in Texas. The survey methodology was originally conceived of as being a random sample of planners and managers throughout the coastal region. However after thinking through the issues, the survey strategy was modified.

The major difficulties in seeking to understand what types of hazard mitigation policies and tools are adopted and implemented by coastal jurisdictions in Texas is the complete lack of systematic and reliable information on the subject. While many states have adopted and mandate a statewide building code and also mandate comprehensive planning activities, sometimes including specific hazard mitigation requirements, by their counties and municipalities, such is not the case in Texas. In states with such mandates, there is usually a state agency that has all the information one might be interested in about the kinds of policies adopted by local counties and municipalities, but this again is not the case in Texas.

Some might be surprised to know that there is a statewide building code promulgated by the Texas Department of Insurance. However, local municipalities are essentially free to adopt or not adopt that code and counties do not have the legal right to officially adopt and enforce building codes.[14] Furthermore counties are severely limited when it comes to land use and development control policies. Indeed, municipalities are the only entities in Texas with home rule. In other words, to the extent that mitigation policies, particularly land use policies and building codes, can be adopted and enforced in Texas, that action must be taken by municipalities. This is not to say that counties do not engage in some

[14]The TDOI has no reliable information regarding which municipalities have or have not adopted the building code

forms of mitigation policy development and implementation, it only means that counties are going to be limited in what they can undertake. Unfortunately, there is no one single source that one can contact to find out what types of hazard mitigation policies have been adopted by municipalities and counties. The simple fact is that local municipalities are free to adopt or not adopt mitigation policies as they see fit, there are no state mandates. Similarly, counties can also adopt and implement mitigation policies as well, however, they are constrained regarding what they can actually enforce.[15]

If then the goal is to establish a baseline for the types of policies that are adopted by coastal jurisdictions and how widely they are employed, one must go to the source – the local jurisdiction itself. If that is the goal, it makes little sense to undertake a random sample of planners and managers throughout the coast. Rather, it makes better sense to consider using planners and managers as knowledgeable informants and systematically sample them based on their location within an official agency or organization of a coastal jurisdiction that has been selected or sampled.

Thus our sampling strategy changed markedly from one of conducting a simple random sample of coastal planners and managers, to one of first systematically identifying coastal jurisdictions that should be sampled and then identifying planners, managers and other knowledge potential informants to survey.

Jurisdiction selection: First it was decided to survey both counties and municipalities. The selection of municipalities was obvious, since municipalities in Texas have home rule and therefore are legally capable of enacting and enforcing land-use policies and building codes that are so critical for hazard mitigation. It was also decided to survey counties because counties do undertake flood plain management policies. The next issue concerned the size of the community to be surveyed. In the past many planning surveys have chosen to focus on only relatively large communities with populations of 50 thousand or more. Again, however, since municipalities of any size are the backbone of land-use planning in Texas, we decided to attempt to survey any officially designated and

[15]Some counties, for example, "adopt" the State's Building code, but they have no legal ability to adopt that code.

state recognized municipality. The last issue was of course the location of our targeted jurisdictions. The first and obvious decision was to include all counties that were fully or partially within the CMZ and all municipalities within that region. To better insure that our sample would be sufficiently large and would allow for comparison between communities within and outside the CMZ it was decided to include first and second tier counties and some third tier counties. Based on these parameters, the initial sample frame for this region included 255 local jurisdictions composed of 215 cities and 40 counties for which we were able to find administrative contact information[16].

Informant selection: The second step in identifying the sample frame consisted of identifying the local informant that would be contacted to provide information about the jurisdiction's mitigation policies. The critical goal here was to find an individual involved in city or county government that would be knowledge about various forms of mitigation policies related to land use, development and environmental controls and building code regulations. Our primary targeted individuals were city planners and county judges. However, in the event that these individuals were not available or identifiable other targeted individuals included city managers, building inspectors, flood administrators and even local mayors. The task was made more difficult by the fact that we were dealing with city and county governments of great variety and capacity. While some were extensive local governments with planning departments, building and zoning departments, etc., others were very simple operations with only a few staff or employees. The development of our sample frame required extensive investigative work via such sources as the web, the city/county data book, and even simple telephone conversations with multiple contacts. In the final analysis a sampling frame was developed that consisted of 326 individuals to capture information on the 255 jurisdictions. Clearly, in many cases there were multiple respondents, this was done to ensure coverage.

Surveying strategy: There are a variety of approaches that could be employed to actually implement the survey including mailed surveys, telephone surveys, face-to-face surveys and, more recently, internet surveys. There are advantages and disadvantages with respect

[16]There were a number of communities for which there were no websites, phone numbers or even elected officials that could be identified and contacted.

to each approach. For example, face to face surveys have major advantages in that the survey can be rather complex, but nevertheless manageable, since it will be implemented by a trained interviewer. However, these would be very expensive to implement, particularly when trying to cover over 255 places in Texas. It was decided to employ an internet survey in this case. An internet survey was feasible because we were soliciting information from professional individuals that were likely to have access to the internet, indeed in almost all cases we had extensive contact information on the informants, having talked with many of them as part of the investigations to determine the best individual to contact in these jurisdictions. Indeed, for many individuals we had their names, addresses, phone numbers, and email addresses. It was planned to implement the survey Dillman's three tiered approach for internet surveys (2007).

References:

Dillman, D. 2007. *Mail and Internet Surveys: The Tailored Design Method.* Wiley: New York.

Appendix 5 The Hazard Mitigation Policy Adoption and Implementation Survey of Local Jurisdictions: A Preliminary Survey Report

The Hazard Mitigation Policy Adoption and Implementation Survey of Local Jurisdictions:
A Preliminary Survey Report

Rahmawati Husein and Walter Gillis Peacock

Introduction

The primary goal of this survey was to obtain accurate and valid information on the types and variety of mitigation policies used by local jurisdictions in coastal Texas, with a primary emphasis on jurisdictions within the coastal management zone. Unfortunately in Texas there is little knowledge regarding the nature of mitigation policies actually utilized by municipalities and counties to address coastal hazard issues, nor is there any comparative data on what jurisdictions within the coastal management zone are doing relative to others along the coast. As a consequence it was decided to undertake primary data collection on coastal management and hazard mitigation issues to establish a baseline. This report offers a very preliminary glimps into some of the characteristics and findings of our survey.

Sample selection

The primary focus of this study is on cities and counties along the Texas coast which are vulnerable to a variety of coastal hazards. This study includes not only areas within the Coastal Management Zone of Texas, but also includes jurisdictions intersecting fourth-order hydrological units (as define by the USGS) within 100 miles of the Texas coastline. In total a sample frame was developed to survey 255 local jurisdictions consisting of 215 cities and 40 counties for which it was possible to gain administrative contact information. The final sample frame for this research consisted of a listing of potentially knowledgeable informants, holding key administrative positions, within each jurisdiction that can provide information about their jurisdiction. The primary targets for informants included a municipality's leading planner or a county's judge. Unfortunately, not all municipalities had planning agencies and often they lacked any form of planning staff. In these situations other informants were identified including individuals like city managers, building officials, flood managers or administrators and even, when necessary, city mayors or their key staff. The goal was to contact and ultimately obtain an informant who was knowledgeable about the adoption and

implementation of land use and development regulations. The process of developing the sample frame of key jurisdictional administrative officials, including their contact information required considerable time because there is considerable heterogeneity in local jurisdictions in terms of their size and complexity. The final sampling frame consisted of 326 possible informants for the 255 jurisdictions

The survey instrument consisted of a self-administered web-based questionnaire, distributed from the summer through fall of 2010, with some stragglers even participating during the first part of 2011. Potential respondents, many of whom had been contacted during the development of the sampling frame itself, were contacted again via email with a link to the survey's website and a specific code allowing them to access and complete the survey. Survey implementation followed the Dillman's three-tiered approach for internet survey (Dillman 2007). The initial survey distribution was followed with a reminder letter sent to the respondent's email addresses after one month. If no response was received after two months, emails and cover letters with the link to the survey were resent. Follow-up reminders were sent via email and even by phone calls. When necessary paper copies of the survey instruments were mailed along with addressed and stamped return envelopes. In total respondents in 8 jurisdictions were sent the survey in paper format because they did not have email or internet contact information. In total 129 responses were obtained although some represented double responses for a specific jurisdictions. As a result there were 117 responses for the 255 jurisdictions consisting of 93 cities and 24 counties that responded the survey, yielding an overall response rate of 46%. Figure 1 provides a bar graph for the numbers of surveys solicited and the completed survey returned for cities, counties, as well as a combined total. Figure 1. City and County completed survey

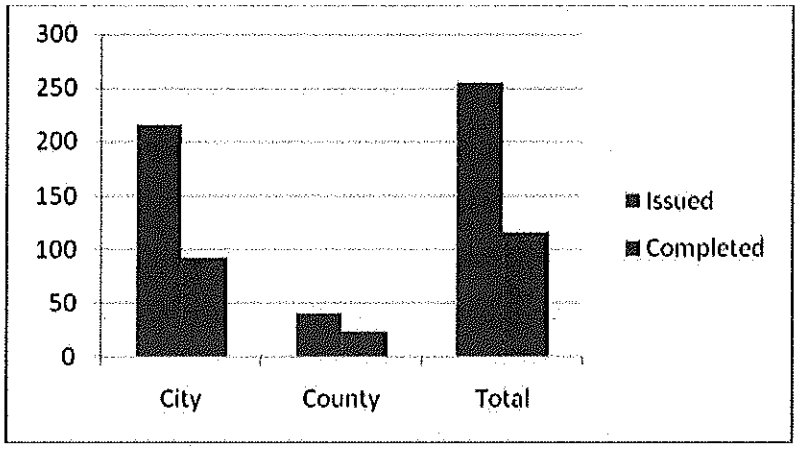
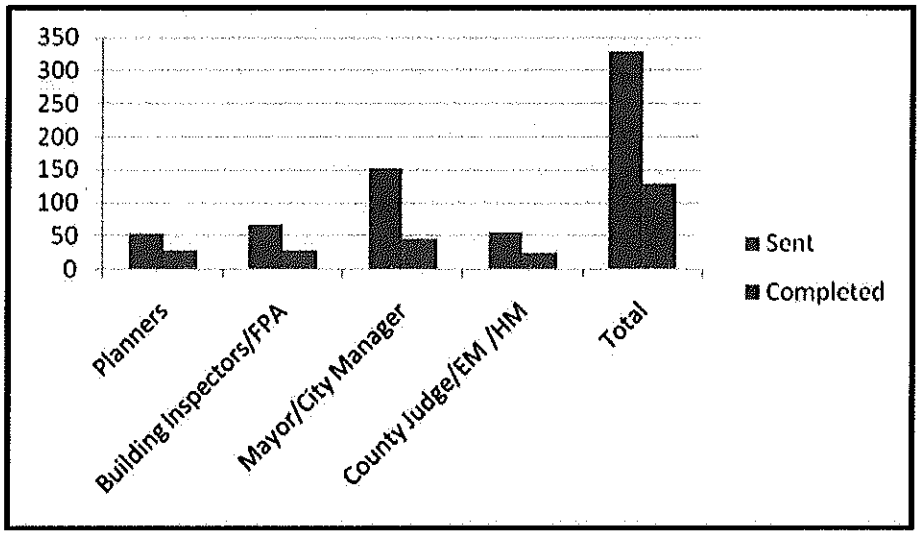


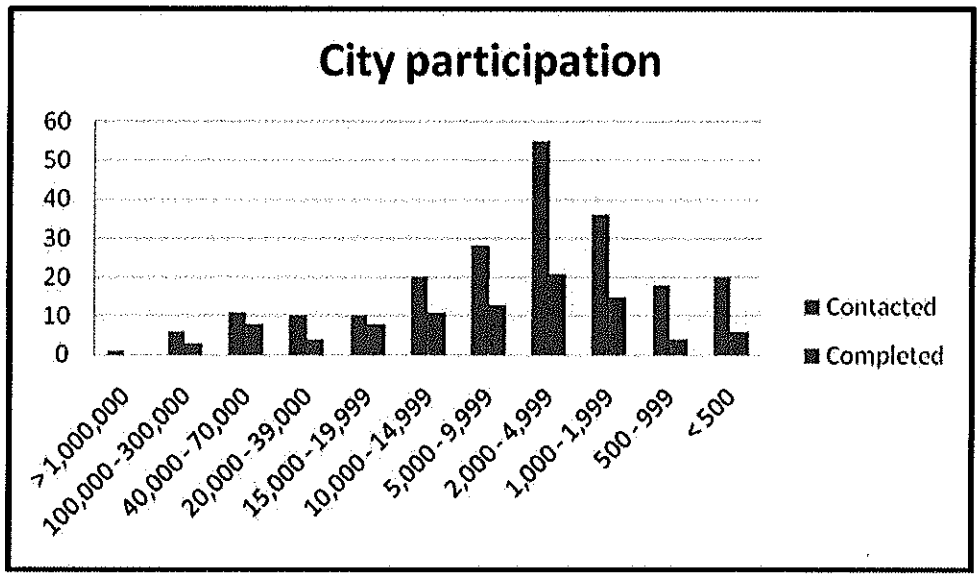
Figure 2 displays the frequencies and responses from different types of officials contacted to complete the survey. These officials included: planners, building officials or flood plain managers, mayors or city managers, and county judges or emergency or hazard management officials. As can be seen from the graph, while planners were our original target informants for municipalities, we often had to resort to building officials and even city managers or mayors in many communities. Indeed city managers and mayors were by far the largest group we ended up contacting. Planners were by far the most responsive of our contacts, with 54.7% responding, followed by county judges or emergency or hazard management officials at 44.6%, building officials and flood plain managers at 42.6%, and finally mayors and city managers at 30.3%.

Figure 2: Types of officials contacted and response rates



Finally, Figure 3 presents the response frequencies for different sizes of cities, when only considering the municipalities include in our sample. Often when these types of surveys are undertaken nationally the focus is generally on cities of 50 thousand individuals or larger. However, given the fact that municipalities in Texas are the only political entities with home rule and therefore empowered to enact, implement, and enforce land use, development control and building code policies that are so important for hazard mitigation, we decide to include the full range of cities in our sample. In a very real sense, cities represent the backbone for hazard mitigation policies in the State of Texas. As can be seen by examining the data presented in this graph, the largest category of municipalities in out sample were those with populations that fell into the 2,000 to 4,999 range. Our response rates across these ranges were generally in the forty to fifty percent range. On the whole the ranges were generally higher in the larger communities; indeed the lowest response rates were for communities of less than 1000 individuals.

Figure 2. Response base on city population



The survey

Hazard mitigation is generally divided into two forms: structural and non structural. Structural mitigation includes what are generally large public infrastructural projects such as the construction of dams, levees, and sea-walls. Non-structural form of mitigation, on the other hand, generally refers to the implementation of policies and

education programs that promote mitigation. Development regulations and land use management policies are seen by the literature as being crucial non-structural strategies for promoting hazard mitigation at the local level. These approaches offer obvious ways to avoid many natural disasters (Hyndman & Hyndman, 2006) and are important tools for reducing impacts and disaster losses in natural disaster (Burby, et.al, 2000).

Generally, development regulation and land use management are carried out through land use planning activities. Conceptually, these strategies seek to adjust human activities by encouraging appropriate development in relatively safe areas and discouraging development in hazard prone areas. Furthermore, these polices seek to promote proper development and building that is consistent with the hazard exposures and threats to an area. So for example building codes will specify appropriate roof styles, construction techniques, and materials that are consistent with the wind risks of a particular area. There are a host of different types of policies that can be enacted some of which seek to simply regulate activites through zoning and development restrictions, while others seek to encourage and promote mitigation through various incentives.

For the purposes of this survey we have attempted to gather information on the full range of land use and development strategies and policies that have hazard mitigation potential, either directly or indirectly. Furthermore we sought to include policies that are both regulatory in nature and others that seek to incentivize mitigation actions. The following are some of the types of data collected by the survey.

1. Land use and development regulations including: a). residential subdivision ordinances, b) planned unit development, c) special overlay districts, d) agricultural or open space zoning, e) performance zoning, f) hazard setback ordinance and g) storm water retention requirements
2. Limit development policies and regulations including: a) environmental impact assessments, b) limitation of shoreline development to water-dependent uses, c) restrictions on shoreline armoring and d) restriction on dredging/filling.
3. Natural resource protection policies including: a) dune protection, b) wetland protection, c) coastal vegetation protection, d) habitat protection/restoration and e) protected areas

4. Building standard including: a) building code and types, b) wind hazard resistance standards, c) flood hazard standards, d). retrofitting standard for existing building, e). special utility codes.
5. Property acquisition programs including: a) fee simple purchases of undeveloped lands, b) acquisition of development and easements, and c) relocation of existing structures out of hazardous areas.
6. Incentives approaches including: a) transfer of development rights from environmentally sensitive/hazardous areas, b) density bonuses in environmentally/hazardous areas, c) clustered development in environmentally sensitive/hazardous areas, d) participation in the National Flood Insurance Program (NFIP), and e) participation in the FEMA community rating system (CRS)
7. Public education/awareness programs including: a) public education for hazard mitigation, b) citizen involvement in hazard mitigation planning, c) seminar on hazard mitigation practices for developers and builders, d) hazard disclosure, and e) hazard zone signage.
8. Financial tools including: a) lower tax rates, b) special tax assessment , c) impact fees or special assessments
9. Critical public & private facilities policies including: a) requirements for locating public facilities and infrastructure, b) requirements for locating critical private facilities and infrastructure, c) using municipal service areas to limit development
10. Private-public sector initiatives including: a) land trusts, and b) public-private partnerships.
11. Employment of geologists, engineers, and other professionals for mitigation planning including: a) identify suitable building sites, b) develop special building techniques, and c) conduct windstorm/roof inspection

In addition to the above items a variety of questions were also asked about the characteristics of the jurisdiction and the extent to which various constituencies and stakeholders were involved in mitigation and overall planning activities.

Preliminary results

We are currently undertaking a comprehensive the analysis of the data that have been collected. The following give a very limited example of some of our findings thus far. Specifically we will briefly discuss the findings with respect to land use regulations and policies to limit development.

Building codes and standards: The results with respect to building codes were not entirely surprising. We were delighted to find that nearly 26% had adopted the 2009 IRC/IBC code sanctioned by Texas Department of Insurance, with an additional 35.5% having adopted the 2006 IRC/IBC code and 17% using the 2003 IRC/IBC code. What was a little disconcerting was that 8 communities or 8.6% of the sampled communities had adopted no building code and 5 or 5.4% of the sample were still using the old southern building code (SBC).

Land Use regulations: Table 1 presents the findings with respect to land use regulations within jurisdictions. Specifically respondents were asked about 7 different types of land use regulations. These include: 1) residential subdivision ordinances, 2) planned unit development, 3) special overlay districts, 4) agricultural or open space zoning, 5) performance zoning, 6) hazard setback ordinance and 7) storm water retention requirements. With respect to each respondents were asked to identify to what extent their jurisdiction makes use of each form of land use regulation on a scale from 1 to 4, where 1 is not at all, 2 is to a small extent, 3 is to some extent and 4 is very great extent. If their jurisdiction did not have the capacity or ability to regulate land use using one of these tools they were ask to indicate this by checking a "not within this jurisdiction's authority" option.

As can be seen in Table 1, residential subdivision ordnances are clearly the most popular form of land use regulation among the jurisdictions were nearly 66% report using them. The second most popular approach is hazard setbacks (40.4%) and storm water retention requirements (36%). Interestingly very few jurisdictions report using more incentive based and flexible policies such as performance zoning or planned unit developments. It is also interesting to note that agricultural or open space zoning is relatively rarely implemented policy.

Table 1: Land use regulations

Land Use Regulations	Not within Jurisdiction	Not at all	small extent	some extent	very great extent	Total
1. Residential subdivision ordinance	6	8	4	21	75	114
	5.26%	7.02%	3.51%	18.42%	65.79%	100.00%
2. Planned unit development	9	30	27	17	31	114
	7.89%	26.32%	23.68%	14.91%	27.19%	100.00%
3. Special overlay districts	13	49	14	26	12	114
	11.40%	42.98%	12.28%	22.81%	10.53%	100.00%
4. Agricultural or open space zoning	11	50	20	17	16	114
	9.65%	43.86%	17.54%	14.91%	14.04%	100.00%
5. Performance Zoning	12	69	15	12	6.0	114
	10.53%	60.53%	13.16%	10.53%	5.26%	100.00%
6. Hazard setback ordinance	7	32	7	22	46	114
	6.14%	28.07%	6.14%	19.30%	40.35%	100.00%
7. Storm water retention requirements	7	18	24	24	41	114
	6.14%	15.79%	21.05%	21.05%	35.96%	100.00%

Table 2 presents the data on the use of regulations to limit development within a jurisdiction. On the whole, one is struck by the overwhelming sense that these regulations are not very extensively used by any of the sample jurisdictions. Indeed, the vast majority of jurisdiction report not having the ability to regulate on these issues or simply not employing them at all. The only development limitation regulation employed to at least some if not to a very great extent was the use of environmental impact assessment where 25.4% report using them to some extent and an additional 20.2% reporting using them to a very great extent.

Table 2. Limited Development Regulations

Limit development	Not within Jurisdiction	Not at all	a small extent	to some extent	very great extent	Total
Environmental impact Assessment	5	26	31	29	23	114
	4.39%	22.81%	27.19%	25.44%	20.18%	100.00%
Limitation of shoreline development to water-dependent uses	27	54	12	10	11	114
	23.68%	47.37%	10.53%	8.77%	9.65%	100.00%
Restrictions on shoreline armoring	30	53	13	8	10	114
	26.32%	46.49%	11.40%	7.02%	8.77%	100.00%

Restriction on dredging /filling	24	41	12	18	19	114
	21.05%	35.96%	10.53%	15.79%	16.67%	100.00%

Summary

While this report provides more detail on the nature of the jurisdictions sampled by this survey and the response rates, it only provides a very brief and preliminary taste for the types of data and findings the survey will yield. We will continue to develop this analysis further and provide a full report on the survey results as part of Phase 4 activities.

References

Burby, R. J., R. E. Deyle, et al. (2000). "Creating hazard resilient communities through land-use planning." Natural Hazards Review 1: 99.

Dillman, D. 2007. *Mail and Internet Surveys: The Tailored Design Method.* Wiley: New York.

Hyndman, D., & Hynmand. D. (2006). "Natural hazard and Disaster", 2mnd edition. California: Brooks/Cole