

## Disaster Preparedness for Human Services A GIS Vulnerability Index

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### Abstract

In Florida's multiple-hurricane disaster of 2004, *local human service agencies* played a major role in response efforts. The disaster exposed the disproportionate disaster vulnerability of lower-income communities and their concentrated need for post-disaster assistance. The Lee County Department of Human Services has developed a predictive "Vulnerability Index" in GIS based on inputs of socio-economic factors such as income and housing tenure. Unlike forecasting tools that focus on natural conditions and physical infrastructure risk, this Index maps the geographic concentrations of *human* vulnerability and risks to the social infrastructure. Vulnerability indicators were selected, weighted for predictive value, and mapped for County subdivisions. The resulting Vulnerability map project will be demonstrated by overlaying the recorded geographic distribution of human service assistance (food, counseling, etc) in the 2004 disaster event. A positive correlation of concentrations will support the "Vulnerability Index" as a preparedness-planning tool.



Hurricane Charley, 2004 (NOAA<sup>1</sup>)

### Background and Rationale

Individuals and families in the general population suffering from inadequate incomes, unemployment or underemployment, disease, mental illness, development disabilities and physical disabilities, alcohol and substance abuse, victims of HIV/AIDs, as well as the oldest and youngest populations are vulnerable to all disruptions of daily life and are particularly vulnerable to the effects of major natural disasters. While this is intuitively clear, the 2004 hurricanes provided dramatic evidence of the results of this vulnerability. These disadvantaged populations are the clientele of community *Human Service* or *Social Service* agencies. In Lee County, Florida, The Department of Human Services (DHS) of the Lee County Board of County Commissioners administers programs supporting low-income and disadvantaged County residents in the areas of homelessness, health, HIV/AIDs, mental health, and substance abuse, housing, and neighborhood development.

## **Lee County Human Services in Disaster – Hurricane Charley, 2004**

The unprecedented scale and severity of the hurricane disaster in 2004 quickly absorbed the resources of the local first-responder agencies including Emergency Management, Police, Fire, and Red Cross. For weeks following the disaster, national television showed these agencies, as well as FEMA, National Guard and thousands of out-of-state public, nonprofit, and private workers carrying out the life-saving actions of disaster response. Less visible and less well known was the extensive involvement of local human service agencies. In the 2004 disaster, Lee County human service agencies found themselves in unexpected and demanding roles with critical responsibilities for the immediate disaster response and for the long-term recovery effort.

### **Human Services GIS in Disaster - the Immediate Response**

When Hurricane Charley struck Lee County in August 2004, the immediate impact was the loss of community support systems of all types from food, water, and gasoline to power, streetlights, and telephone communication. As the response teams assembled and out-of-state forces arrived, there was a great need for information, including a great need for geographic information on who had the greatest needs and where they were.

The Lee County Department of Human Services had GIS demographic mapping in place. (See *“Human Service Delivery with GIS”*, Proceedings, ESRI Intl. Conference, 2004) As a member of the Emergency Response Command, the Department was able to supply information and maps in order to direct relief supplies to areas of critical need. The Department was able to supply Human Services GIS maps, overlaid on recent aeriels, which served as a vital tool particularly for out-of-state teams with no knowledge of local terrain and access.

### **Human Services GIS in Disaster - the Long Term Recovery**

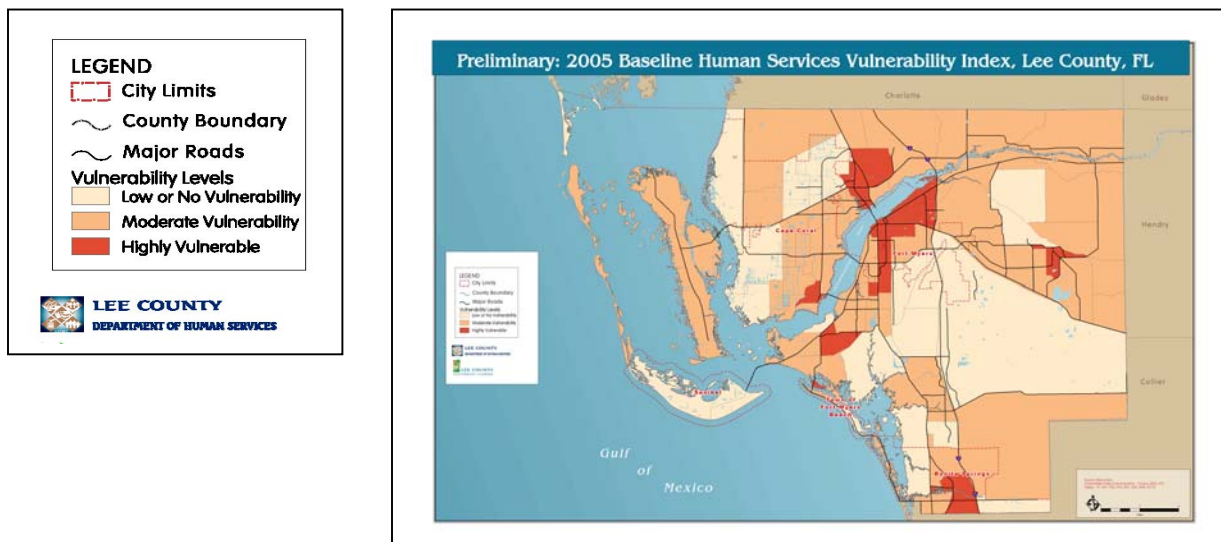
The long-term recovery effort continues one year later with thousands still in temporary housing or in dwellings with major damage remaining. The Department of Human Services has had much of its staff and resources refocused to disaster recovery for much of the year following the hurricane. The Department administers the *Long Term Recovery Committee*, which serves as a central focus for resources devoted to the continuing needs of the large population of local residents still dislocated and suffering from the hurricanes.

For the long-term effort, the Department has created map projects by geocoding response data from affected residents and structures and mating that data to post hurricane aerial photography. This tool has served door-to-door assessment teams and long-term assistance delivery. These maps are currently being utilized by the “New Blue” project, which is replacing the (blue) tarps, which still serve thousands of residents as temporary roofing at the advent of the 2005 hurricane season.

## Human Services GIS in Disaster Preparedness - The Vulnerability Index

Lee County and many other localities make use of GIS tools (such as the FEMA *HAZUS-MH* system) to analyze natural and physical features to predict disaster impacts to *structures* such as hospitals and homes and to *physical infrastructure* such as transportation, water supply, and energy systems. This priority planning focus on core physical infrastructure is appropriate; however, the 2004 hurricane demonstrated the value of planning and planning tools for *human services delivery*.

The Department is developing a GIS tool to support disaster preparedness and response in the area of *human services delivery* as a supplement to physical infrastructure planning. This tool grows out of the existing Department use of GIS to match human service assistance to geographic areas of highest need. The Human Services Vulnerability Index was conceived as an annually updated disaster preparedness tool to be made available to disaster response agencies. The 2005 Vulnerability Index is the initial project and will be the Baseline for future iterations.



**2005 Lee County Vulnerability Index<sup>2</sup>**

### 2005 Vulnerability Indicators

Income Vulnerability  
(2005 Weight = 1)  
Transportation Vulnerability  
(2005 Weight = 1)  
Employment Vulnerability  
(2005 Weight = 1)  
Physical Vulnerability  
(2005 Weight = 1)  
Transience  
(2005 Weight = 1)  
Population Density  
(2005 Weight = 1)

### Database

Adult Poverty/Census Tract  
(U.S. Census)  
“No Vehicle” response/CT  
(U.S. Census)  
Services Wages/CT  
(U.S. Census)  
Disabled over 65 or under 15/CT  
(U.S. Census)  
Length of tenure, English not 1<sup>st</sup>  
Language/CT (U.S. Census)  
Population/CT  
(U.S. Census)

### **The Vulnerability Index Continued**

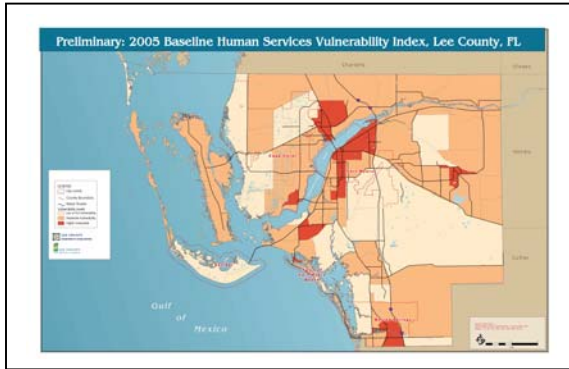
The Department of Human Services has selected a set of socio-economic indicators, which are intended to model *human services vulnerability*. Databases for the selected indicators were obtained from the County and Census sources. Where necessary, records were collated to constitute the indicator prior to being joined to the County Census Tract geography. GIS feature layers were developed for each of the individual vulnerability indicators and mapped to show the geographic distribution of that component. In compiling the composite index in 2005, each indicator was given equal weight. The final Vulnerability Index map was created by assembling a composite database for all indicators and symbolizing the census tracts with the highest proportion of the selected indicators. The 2006 Vulnerability Index will incorporate the weighting and refinement of the component indicators determined by analysis of the human service assistance deliveries to Hurricane Charley victims. (Assistance data compilation and analysis was not complete in time to refine the baseline indicators at the beginning of the 2005 hurricane season, however a graphic comparison of vulnerability prediction and preliminary delivery distribution is included below.)

### **Annual Implementation of the Human Services Vulnerability Index**

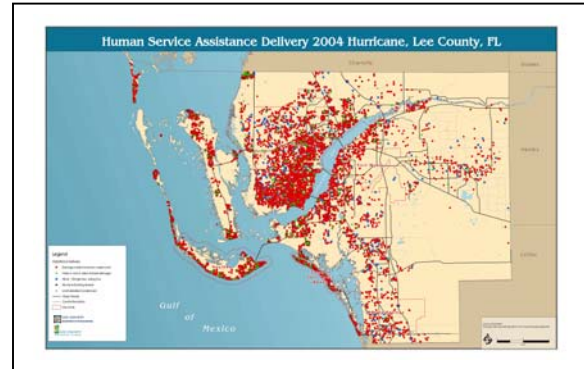
Each year, data updates for the Index component indicators will be obtained through commercial and public data services. Updated indicators will be weighted and compiled to compose the overall Vulnerability Index. The Index will be distributed to disaster response and recovery agencies for preparedness planning. At the Department of Human Services, the Index will be utilized to plan responses and locate service and supply distribution facilities. If a major natural disaster occurs at any time, the current Vulnerability Index GIS Map Project and its component indicator maps will be available for responders. The Department is formalizing the collection process for comprehensive assistance delivery data and refinements to the Index component indicators will be made as experience teaches. It is expected that the disaster Index will also serve as a model for *proactive* planning for human service delivery in non-disaster conditions.

## The 2004 Case Study

As noted previously, the collection and analysis of 2004 Hurricane human service assistance distribution patterns was not complete prior to the June 1 start of the 2005 hurricane season. A preliminary graphic analysis can be done by visually examining the 2005 Index and the preliminary 2004 human service assistance distribution pattern. This visual analysis suggests correlation between predicted and recorded patterns. This apparent correlation is being further investigated by studying correlations at selected census jurisdictions.



**Vulnerability Index Concentrations<sup>3</sup>**



**Hurricane Assistance Concentrations<sup>3</sup>**  
(Preliminary)

## Acknowledgements, End Notes, References, Author Information

The Lee County Board of Commissioners, County Administration, and in particular, Karen Hawes, Human Services Director, have given unqualified support for this human services expansion in GIS. Amy Hoyt, County GIS coordinator, was instrumental in initiating this effort and continues to provide regular support and direction.

One of the immediate challenges in analysis of the Vulnerability Index was the difficulty of collecting comprehensive human services assistance delivery data. Memoranda of agreement are being completed with all major assistance agencies to regularize the recording and collection of this data. The mapping process also showed the divergence between GIS displays of assistance deliveries in absolute terms and as normalized for population. The validation process for the Index will need to consider the implications of both views.

The footnotes associated with the graphics are as follows:

<sup>1</sup>(The hurricane track is a public domain graphic

from National Oceanic and Atmospheric Administration/Department of Commerce)

<sup>2</sup>(The Index Map graphic is simplified for clarity in the paper format. Additional information is available from the authors. Map was prepared from U.S. Census data in 2005)

<sup>3</sup>(The Assistance Pattern Map is preliminary and later iterations will be available from the authors. Map preparation was by Courtney Sullivan from assistance data collected by DHS)

The Lee County GIS system operates under licenses for ESRI ArcGIS, ArcIMS, and numerous extensions. Lee County authors can be contacted at [farisrl@leegov.com](mailto:farisrl@leegov.com), [jbizelli@leegov.com](mailto:jbizelli@leegov.com), and [hoytal@leegov.com](mailto:hoytal@leegov.com).

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