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ABSTRACT

This purpose of this research is to present a framework for the development of a spatial decisions support system (SDSS), utilizing geographic information systems (GIS), to identify Florida's *at-risk populations*, those that are likely to have special requirements for disaster management (DM) purposes. A coastal county in Florida is utilized as a case study in reference to the 2004 hurricane season. Florida provides an ideal case study as it has a large elderly population and an increasing number of *snowbirds*, elderly persons residing in Florida during the winter months leaving the state during the summer months. In addition to hurricane track files, spatial and non-spatial data from a variety of sources, including the U.S. Census, the Florida Geographic Data Library (FGDL), Florida Water Management Districts, County Health Departments, and the Comprehensive Assessment for Tracking Community Health (CATCH) data warehouse, will be utilized for model building and validation.

KEYWORDS

Geographic Information Systems (GIS), Spatial Decision Support Systems (DSS), Emergency Planning (EP), Disaster Management (DM).

INTRODUCTION

This purpose of this research is to present a framework for the development of spatial decisions support system (SDSS), utilizing geographic information systems (GIS), to identify Florida's *at-risk populations* (Batty & Densham, 1994). At-risk populations are those that are likely to have special requirements for disaster management (DM) purposes. Kreps (1991) defines disaster and emergency management as the "discipline and profession of applying science, technology, planning and management to deal with extreme events, that can injure or kill large numbers of people, cause extensive damage to property, and widespread disruption to society." Geographic information systems are "computer system(s) capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Practitioners also define a GIS as including the procedures, operating personnel, and spatial data that go into the system." (USGS 2004)

Recent events associated with the 2004 hurricane season in Florida and Hurricane Katrina in 2005 have demonstrated the need for identifying the location of at-risk populations for disaster management purposes. A recent study of an emergency management system, currently in use by a Florida County, which allows citizens to register as a *person with special needs*, reported that the time required to register and be accounted for in the system took between 6.5 and 18 days. In addition to this delay, lack of awareness of the system by citizens results in county officials not having systematic information regarding medical needs or locations of at-risk populations resulting in officials being unable to accommodate their needs in a reasonable manner in a disaster or emergency situation. (Hikmet & Kayhan 2006) Spatial decision support systems can provide an effective tool for improving and enhancing an organization's level of preparation for a disaster. (Cova, 1999)

The authors propose a research framework that brings together spatial and non-spatial data from a variety of sources, including the U.S. Census, the Florida Geographic Data Library (FGDL), Florida Water Management Districts, County Health Departments, and the Comprehensive Assessment for Tracking Community Health (CATCH) data warehouse for model building and validation. Over the past few years the authors have demonstrated an application of the CATCH data warehouse in another disaster management context, this being bioterrorism surveillance (Berndt et al, 2006a; Berndt et al, 2006b; Griffiths et al, 2006). This paper provides an overview of the CATCH Data Warehouse, discusses additional data sources, the 2004 hurricane season, presents the challenge of identifying At-Risk populations in Florida, overviews the emergency management process, then presents a framework and conclusions.

THE CATCH DATA WAREHOUSE

The Comprehensive Assessment for Tracking Community Health (CATCH) data warehouse, located at the University of South Florida, was initially developed in 1998. It integrates fine-grained event data such as vital statistics (birth and death records), hospital discharge data, and free-standing clinical data along with other detailed disease registries. The infrastructure also includes major healthcare coding systems, such as the International Classification of Disease (ICD), Common Procedure Terminology (CPT) and Diagnostic Related Group (DRG) coding systems to support analysis at varying levels of detail. In addition population data from the census, economic data and even commercial marketing data are added to the mix (Tremblay, 2006). This data can be aggregated at several spatial levels, such as ZIP code, community, and county. Data from the CATCH data warehouse should prove valuable for model building and validation purposes.

The CATCH community assessment methodology identifies both a rich collection of quantitative indicators and a framework for ranking healthcare problems to support policy formulation. The CATCH methodology has been applied to more than two-dozen counties throughout Florida, as well as selected applications in other states, with great success.

Additional Data

Additional data sources include the U.S. Census, the Florida Geographic Data Library (FGDL), Florida Water Management Districts, and county governments.

2004 HURRICANE SEASON

In 2004, the estimated cost of damage to the United States from hurricanes and tropical storms exceeded $42 billion. Thus, being the most costly hurricane season ever for the United States up to that point in time. The 1992 hurricane season, the year Hurricane Andrew impacted Florida, was the second most costly, at $35 billion. The Atlantic Basin had 15 tropical storms and 9 hurricanes, including 6 major hurricanes resulting in a more active season than average. An estimated one in five homes in Florida was damaged by hurricanes during August and September 2004, with 117 storm-related fatalities in Florida during that period. (NCDC 2004)

As can be seen in Figure 1, Florida was directly affected by four hurricanes ranked from two to four on the Saffir-Simpson Hurricane Scale (Charley, Francis, Ivan, and Jeanne) between August 13th and September 25th, 2004, no other state has been affected by four hurricanes in one season since 1886 when Texas was directly affected by four hurricanes. Hurricane tracks, wind speeds, and geographic extent of wind speeds are displayed in Figure 1. As can be seen, Hurricane Charley made landfall in South West Florida as a Category 4 Hurricane (131-155 mph winds) and maintained a Category 3 (110-130 mph winds) status midway through the state. Hurricane Charley was the strongest and costliest storm to hit the US since Hurricane Andrew in 1992. Charley caused approximately $14 billion in damage.

Hurricanes and tropical storms are routine occurrences in the southeast part of the US each year. Between 1991 and 2004, a total of 23 hurricanes struck the mainland US (NHCa 2006), eight of which were classified as "major" having a scale from three to five according to the Saffir-Simpson Hurricane Scale (NHCb 2006). In case of impending storms, counties that are in the path of hurricanes are responsible for evacuating thousands – sometimes millions – of citizens living in coastal, low-lying, or flood-prone areas and relocating them to temporary housing for several days or sometimes months at a time. In 2004, when three major hurricanes struck Florida, nine million Floridians were under evacuation recommendations at some point in time. Up to 350,000 of these were staying in nearly 370 inland storm shelters (Florida Cert 2004).

A UNIQUE CHALLENGE

The identification of at-risk populations is a particularly interesting and challenging problem in Florida for several reasons: (1) a large and rapidly growing population; (2) a large and rapidly growing elderly population, (3) a large and rapidly growing snowbird population (elderly residents that live in Florida during the winter months and return to their home state during the summer months); (4) a large and rapidly growing nursing home population; (5) a seasonal tourist population; and (6) large numbers of mobile and modular homes.

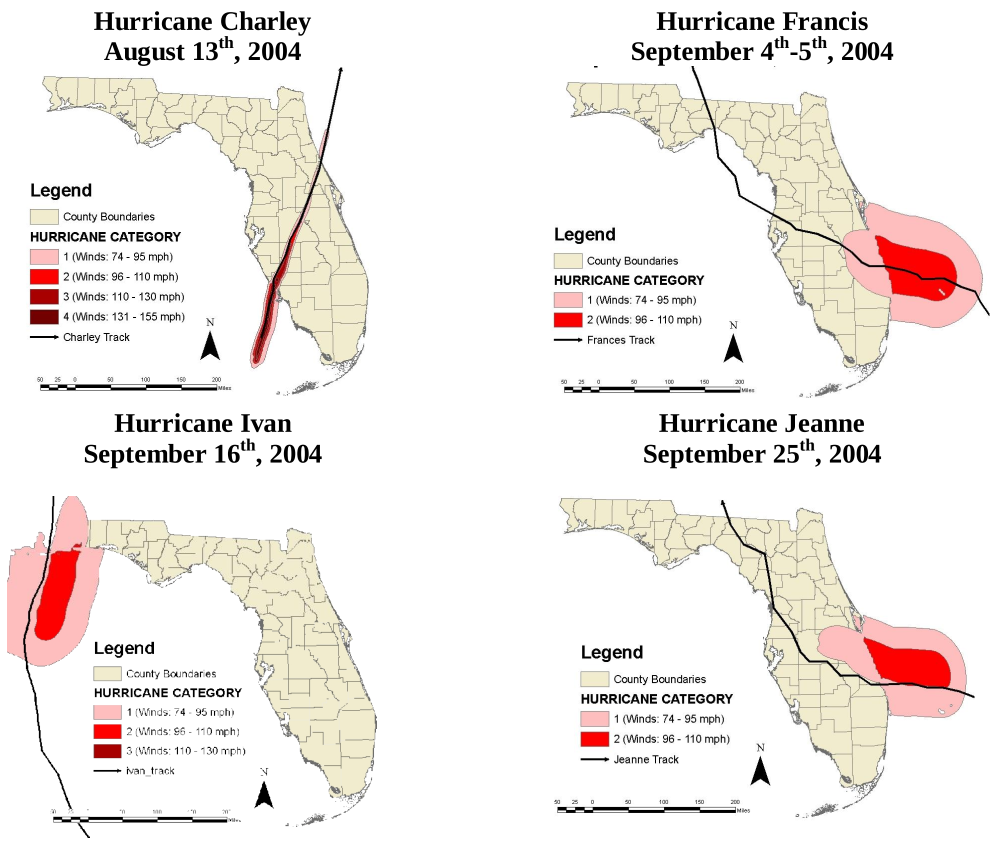


Figure 1. Florida's 2004 Hurricane Season's Major Hurricanes – Charley, Francis, Ivan and Jeanne

Florida's population increased by more than 700% from the years 1950 to 2000. Collier county Florida was the second fastest growing Metropolitan Statistical Areas (MSA) in the United States between 1990 and 2000. Florida is projected to overtake Texas as the third most populous state by the year 2011 and ranks above all other states in percentage of elderly. Florida is expected to remain the "oldest state" with more than 26% of it population projected to be over 65 by the year 2025. (Cambell, 1997) Florida's population growth isn't evenly distributed geographically with much of the growth being in coastal areas. Figure 2 displays the percentage of people over 50 years of age in Florida counties in the year 2000 which ranges from 21% to 55%. This is actually an underestimate since the US Census only counts residents of Florida and not snowbirds, those choosing to live in Florida for the winter months, while maintaining a residence in another state.

An additional challenge is that the US Census population counts can be a slightly misleading measure in a state where large numbers of tourists, sunbirds, and snowbirds temporarily reside in both the summer and winter months. For example, Monroe County, the county that encompasses the southwestern tip of Florida and the Florida Keys had an increase of 3.5 housing units for each person who became a resident of the county between 1990 and 2000. In addition, three counties in north Florida had housing unit to population growth rates approaching one house per person during the same time period. This reveals that population as a measure needs to be used cautiously. Snowbirds and vacationers are building homes but not becoming permanent residents of the State of Florida. Seasonal migration of the elderly becomes a particularly interesting problem when using population alone as a measure of risk. Smith and House (2005) found that "most migration statistics miss temporary moves such as daily commute to work, short business trips, vacations, and seasonal migration and these migrations have substantial impact on the resident populations of both sending and receiving communities." Again, this is where utilizing a healthcare data warehouse and knowing the locations of citizens who have recently been hospitalized for certain diagnosis codes has the potential to increase the validity of any model developed quite significantly.

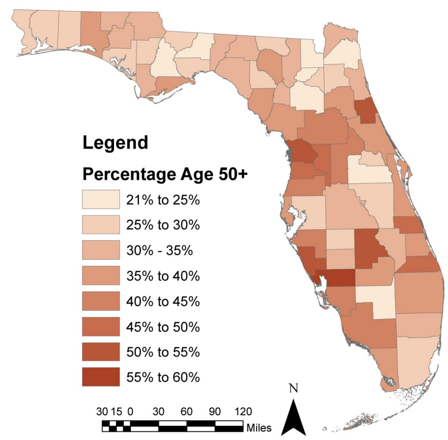
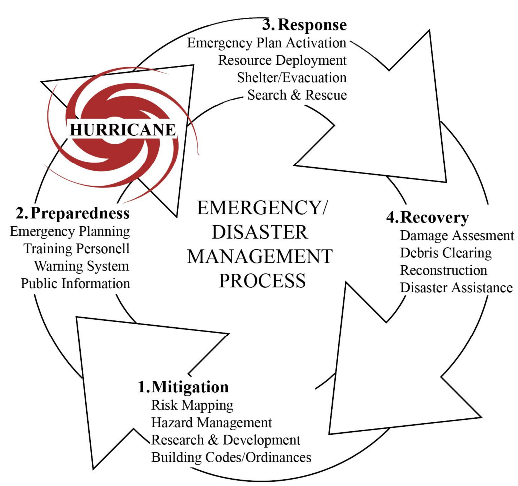


Figure 3: Percentage of the Population over the Age of 50 in the Year 2000

DISASTER AND EMERGENCY MANAGEMENT

Kreps (1991) defines disaster and emergency management as the "discipline and profession of applying science, technology, planning and management to deal with extreme events, that can injure or kill large numbers of people, cause extensive damage to property, and widespread disruption to society." There are four components that comprise the disaster and emergency management process: (1) mitigation; (2) preparedness; (3) response; and (4) recovery. As can be seen in Figure 6, geographic information systems (GIS) have the potential to play key roles in each of the four components.

In case of impending storms, county governments are responsible for evacuating thousands, and potentially millions, of citizens living in coastal, low-lying or flood-prone areas and relocating them to temporary housing for several days or even months at a time. In 2004, nearly nine million Floridians were under evacuation recommendations at some point during the year. Approximately 350,000 citizens were staying in nearly 370 inland storm shelters (Florida Cert 2004). In addition they have a role in each of the emergency management processes displayed in Figure 6.



Adapted from Cova (1999) & Christian (2004)

Figure 4: Emergency and Disaster Management Process, with examples where GIS has the potential to play a key role

FRAMEWORK & MODEL DEVELOPMENT

The model developed will be a significant modification of the Florida Department of Elderly Affairs (FDOEA) "Elder Needs Index". (FDOEA, 2004) The "Elder Needs Index" ranks geographical areas according to the characteristics of the resident elder population. The elements of the index include variables representing age, physical, mental, social and economic status. A general framework that will be utilized for model development purposes is displayed in Figure 3.

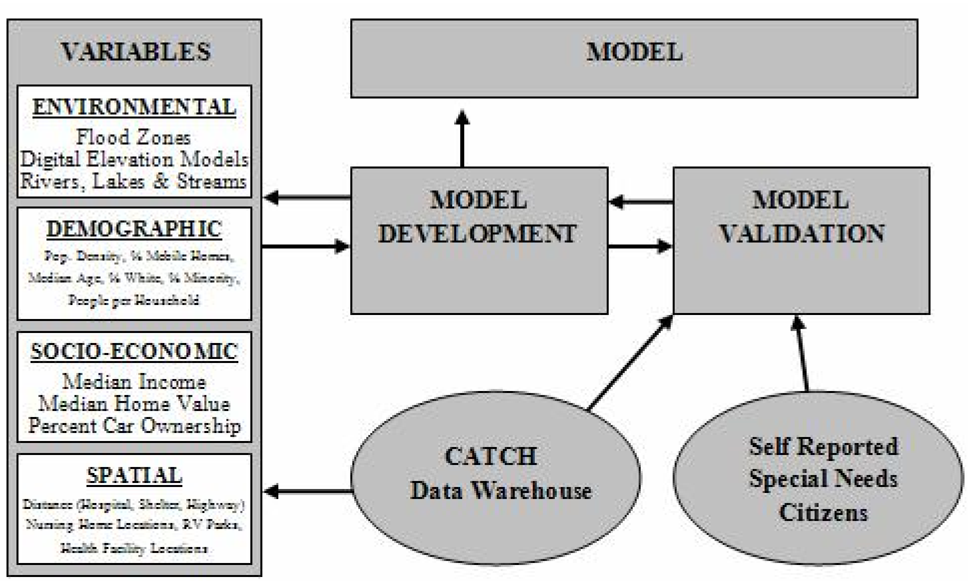


Figure 5: Framework for Identifying *At-Risk* Populations

CONCLUSION

The development of a model to identify at-risk populations in a state with an increasing percentage of elderly has the potential to save lives, reduce costs associated with disaster management, improve emergency response and provide vital information for emergency planning purposes. The 2004 hurricane season, Hurricane Katrina in 2005 and associated events in New Orleans have amplified the importance for the development of a spatial decisions support system (DSS) to aid in the identification of at-risk populations for disaster management purposes. This research is presented as a work in progress. Further development is currently underway.

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