The Florida Geographer

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Editor: Kevin Archer, Ph.D.
Managing Editor: Kris Bezdecny, M.A.

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Articles

From the Editor

The Florida Geographer is the official publication of the Florida Society of Geographers and is distributed free to members of the society. It is a statewide journal with coverage of social and physical geographical topics. Most articles are related to the state, or feature Florida figures as an important component.

Papers are welcomed from all who feel they have research worthy of dissemination. Authors should not be dissuaded from submitting articles for review because of format considerations. It is requested that authors follow the following guidelines when submitting their manuscripts:

- All manuscripts should be sent in electronic form. Text should be submitted as a Microsoft Word document (*.doc) or as a rich text file (*.rtf). Authors should submit the final copy on an IBM compatible disk, a CD, or emailed to the editor.
- Figures and maps, if submitted separately from the text, should be sent as a JPEG (*.jpg) or graphical image file (*.gif). Tables may also be submitted in Excel or Quattro Pro format. Please note that all images will be printed in black and white, and as such should be sent as either black and white or gray-scale images. Please include the figure (table) number, title, and source .
- It is the author's responsibility to ensure that none of the materials used in the paper are copyright-protected.
- Headings, paragraphs, and references should be consistent in their style.
- Please use in-text citations; footnotes will not be accepted. Endnotes should only be used sparingly.

Please send manuscripts, comments, or questions to:
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The Florida Society of Geographers was chartered in 1964 as a non-profit organization for the purpose of furthering professionalism in geography through application of geographic techniques in all areas of education, government, and business.

The Society supports these objectives by promoting acquaintance and discussion among its members and with scholars and practitioners in related fields by stimulating research and field investigation, by encouraging publication of scholarly studies, and by performing services to aid the advancement of its members and the field of geography in Florida.

Since 1996 the Florida Geographical Alliance, whose mission is to support geographical education in grades K through 12, has paid for the publication and distribution of *The Florida Geographer*. All members of the Alliance receive the journal, and articles related to geographical education are enthusiastically encouraged.

The Society holds meetings once a year, usually in February. At this meeting, papers are presented and matters of mutual concern are discussed. Meetings are held in different parts of the state always include field trips to allow participants to gain first-hand knowledge through field experience. This year's conference will be held February 17-19, 2006 in St. Petersburg, Florida.

The Florida Geographer (ISSN 0739-0041) is published annually, normally in the fall.

Persons interested in membership in the Florida Society of Geographers should contact:

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Regular membership is $15 per calendar year; student membership is $7.50. Membership includes a subscription to this journal.

"The Do's and Don'ts of Humanitarian Supplies Management." Pan American Health Organization. World Health Organization. 20 Oct. 2004 <http://www.paho.org/english/ped/te_supp.htm>.

"What is PAHO?" Pan American Health Organization. World Health Organization. 9 Nov. 2005
< http://www.paho.org/english/paho/What-PAHO.htm>.

Note to Readers

I am pleased to present the most recent edition of the Florida Geographer. For this run, good strides have been made toward my original goals for the journal. Although some kinks remain in the process---as authors of the current volume will attest---this edition includes manuscripts which were fully double-blind, peer-reviewed. For this, I appreciate all the efforts put forth both by the reviewers I called upon for the task and by the authors who revised their submissions accordingly. I think that the quality of the resulting text clearly underscores the worth of moving in this direction. It certainly bodes well for the future of the journal in this respect.

Here, I once again put out a call for manuscripts dealing not only with Florida topics but with those concerning the greater region, including the Caribbean basin. It is certainly not my intention to attempt to replicate the *Southeastern Geographer*, but I think that broadening the topical horizon a bit just may hasten both more manuscript submissions as well as a wider interest in the research that Florida geographers (and their friends elsewhere) are currently undertaking. I also would like to see more submissions by authors at the K-12 level of education either dealing with pedagogical issues specifically or actual research undertaken, field-based or otherwise. Again, I am willing to entertain submissions that may not fit the full manuscript format such as shorter notes, lesson plans, experiential comments, book reviews, etc., as long as a case is made that such information is pertinent to the concerns of Florida geographers.

Finally, I would like to thank my managing editor, Ms. Kris Bezdecny, now a Ph.D. student here at the University of South Florida, for her continuingly fine efforts in seeing that this journal actually is published. She certainly keeps the press trains running on time and thus has been quite instrumental to the production of the final product.

Kevin Archer, Ph.D.

In Memorandum:
Richard Zeller

Richard (Dick) Zeller served as a member of the Florida Society of Geographers (FSG) executive board as the Secretary/Treasurer and was also a significant contributor to FSG for over 25 years. Born August 2, 1948, Dick was one of four siblings born and raised in Fairview Park, Ohio, which is a suburb of Cleveland. Dick received his Ph.D. from Ohio State University and then taught in the Department of Geography at Florida State University from 1980-1986. Dick was employed with the state of Florida's Department of Highway Safety and Motor Vehicles until he passed away on April 4, 2005. Dick touched the lives of not only FSG members, but also his co-workers and the people at the social service agency where he volunteered with the Lutheran Social Services of North Florida. He was an enthusiastic sports fan, and especially followed the Penn State teams, especially football. He will be missed greatly.

needs and proper donation strategies has helped expedite disaster recovery in Peru and other countries. In 2003, Peru and 29 other countries with the support of the United Nations helped establish the International Center for El Niño Phenomenon Research in Guayaquil, Ecuador. With the assistance of organizations such as PAHO in place to help countries cope with disaster and the increasing availability of technology and excellent methodologies, Peru will be better prepared for El Niño in the 21st century.

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Lama, Abraham. "El Niño's Other Threat- Mud Damage to Dams." Inter Press Service 30 Sept. 2002. LexisNexus. 5 Oct. 2004.

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of actually receiving supplies, this sometimes presents itself as a daunting task. Upon first hearing of a disaster, many times the amount of donations is overwhelming for the country in need or a non-governmental organization (NGO). Since a massive amount of donations may flow into a country during a disaster, PAHO has developed a classification system called SUMA that categorizes donations into ten groups, including medicines, food and beverages, water, etc. From these ten categories, each package of donations is assigned a level of priority. Priority 1 refers to items that should be distributed immediately. Priority 2 refers to non-urgent items that may be used in later phases of relief. Priority 3 refers to non-priority items that have "no foreseeable use or benefit" ("The Do's and Don'ts of Humanitarian Supplies Management").

Equally important to knowing what to donate and how, people should be aware of things that they should not donate. Items that people should avoid for the purpose of donating are: used clothing, household foods, household medicines and prescriptions, blood and blood derivatives, or anything not requested by the affected country. Also, people should not send medical or paramedical personnel or teams to a disaster site since local health personnel are already able to care for disaster victims ("International Health Relief Assistance").

Conclusion

Peru is a country that faces consistent environmental, economic, and societal hardships due to El Niño. The '97-'98 El Niño was one of the worst in this century, an occurrence marked by massive damage to infrastructure and substantial loss of life. The rains attributed to El Niño poured down on Peru vehemently, erupting in flash floods, mudslides, and avalanches. Because Peru has been subject to the worst that El Niño can bring, the coastal South American country has made a conscious effort to combat the effects of the climatic phenomenon by improving prediction methods, monitoring, and disaster mitigation. The Pan American Health Organization has also aided Peru greatly in its endeavor to assist Latin American countries, integrating technology and sound methodology to better coordinate disaster relief efforts. PAHO's guide for the rapid assessment of

In Memorandum:
Robert Fuson

Robert H. Fuson, First President of the Florida Society of Geographers

Robert (Bob) Henderson Fuson, PhD, Professor Emeritus of Geography at the University of South Florida, died October 22, 2004, in Temple Terrace, Florida.

Dr. Fuson, 77, was one of the world's most foremost scholars on Christopher Columbus and a cultural geographer specializing in Latin America. He was also responsible for landmark research about the Mayan civilization and their use of the compass to establish astronomically relevant ceremonial sites.

Author of numerous books, one of Dr. Fuson's most acclaimed was the *Log of Christopher Columbus* that received the Book of the Year award from the Library Journal and the Montroll Special Award from the New York Academy of Science. He has been a resource on Columbus for researchers, educators and the media throughout the world, including appearances on Good Morning America and the A&E Biography series. He also wrote *Legendary Islands of the Ocean Sea* and *Ponce de Leon and the Spanish Discovery of Puerto Rico*. Among his several geography textbooks is *Fundamental Place-Name Geography*, now in it's 9th edition. Dr. Fuson was a charter faculty at the University of South Florida in Tampa, Florida and served as Chairman of the Geography Department for many years.

Born in Bloomington, Indiana, Dr. Fuson received degrees from Indiana University and Florida State University prior to completing his PhD from Louisiana State University.

He was a founding member and first president of the Florida Society of Geographers, and a member of the American Society of Geographers, the Society for the History of Discoveries and Phi Kappa Phi Honor Society.

An Army and Navy veteran of World War II, Dr. Fuson was a lieutenant in the Air Force Reserves during the Korean War and was an intelligence analyst in Washington, DC.

Hurricane Charley and Changing Vulnerability: An Analysis of Spatial and Temporal Changes

Burrell Montz, Valerie Blackman, and Leyla Halupke

Introduction

Vulnerability has been a concern of hazards researchers and emergency managers for some time, as they seek to understand the patterns, dynamics, and implications of populations and areas at risk. Identifying particularly vulnerable locations and populations can facilitate emergency responses and can help set priorities for longer term recovery. While areas at risk can be identified based on topographic and locational factors, the geophysical characteristics of events can vary significantly over time and from place to place. The situation becomes much more complicated when characteristics and patterns of vulnerable populations are included, but it is these populations that are the primary concern in evacuation, response, and recovery efforts.

While much attention has been given in the literature to concepts of vulnerability (Blaikie et al, 1994; Hewitt, 1997) and to various factors that serve to define or determine levels of vulnerability (Cutter et al., 2000 and Chakraborty et al., 2005), uncertainty remains as to how the influencing variables play out over the short and long terms. Vulnerability changes over time, in part because of the changing geophysical environment, but mostly as a result of demographic trends and socio-economic influences. Thus, it is useful to evaluate changes in vulnerability at a location to further our understanding of the extent to which vulnerability is increasing.

The research presented here looks at changing vulnerability by focusing on those counties in Florida most significantly affected by Hurricane Charley in 2004. The extensive damage wrought by

Burrell Montz is Professor of Geography and Environmental Studies at Binghamton University. Valerie Blackman is a graduate student in the Department of Geological Sciences and Environmental Studies and Leyla Halupke is a student in the Masters of Public Administration Program at Binghamton University.

dengue outbreaks. However, such diseases are commonplace after an El Niño, especially since disaster areas are prone to be hotbeds for infection.

Disaster Relief Techniques

PAHO also assists countries through another critical aspect of disaster mitigation, effective aid and donation methodology. PAHO suggests that following a disaster, one interested in making donations or providing some sort of aid should consult with the health disaster coordinator of a given country charged with the duty of determining health needs. Another suggestion made, and one perhaps widely overlooked by people wishing to make some contribution to the effort, is to "donate cash or credit directly to the national health authorities, to international agencies, or channel it through well-established private agencies" ("International Health Relief Assistance"). A point also worth considering is that people who are willing to donate their time and/or money to a disaster relief effort should assist countries during the "preparedness, rehabilitation, and reconstruction phases." All too often people help out when the immediate emergency is apparent, but then the country exhausts its resources and requires additional aid as the disaster relief phases progress and aid and donations stop coming in. Lastly, PAHO urges the coordination of "independent assessment teams or fact-finding missions with those of the affected country and other agencies" ("International Health Relief Assistance").

Delving further down into disaster relief literature, PAHO provides clear guidelines for dispatching and receiving donations in a section on the organization's website called "The Do's and Don'ts of Humanitarian Supplies Management." Some of the key points to remember when donating supplies are: use strong packing materials, make a list of the contents, make each box easy enough for one person to carry, separate donations by category, label multiple consignments as part of a series, with the name, address, and telephone number of the consignee, and inform consignees about the dispatch of every single shipment. PAHO suggests that when considering donating used medical equipment, new equipment, tents, and vaccines, one should consult with the Ministry of Health or PAHO/WHO. In terms

In addition to providing humanitarian assistance, PAHO organizes training programs for officials from Latin American countries to better prepare them for disaster mitigation. One of the essential factors for successful disaster mitigation stressed by members of PAHO is called rapid needs assessment. The first detail outlined in PAHO's website emphasizes that "Immediately following a disaster, the needs of the population must be assessed as part of the comprehensive approach that the responsible national authorities employ to the overall situation" ("Rapid Needs Assessment"). This kind of large-scale assessment must be hierarchized into three main areas. The first and most important area of concern is to assess the quality of life of the victims. This translates into seeking out the status of communication systems, infrastructure, population and geographic region affected, transportation, basic services, and food availability. The next area of concern is to assess the scope of the damage by determining the death toll, how many people have been reported missing, how many people have been injured, the current status of health facilities, urgent needs, and local resources. Finally, secondary health hazards need to be assessed. These hazards occur as the indirect result of a disaster and might not be detected as quickly as the need for medical supplies or food, but they are also very important.

When one thinks of an El Niño, images of rains and flooding or drought and fires (depending upon the Southern Oscillation Index of a given country) are conjured. Rarely do people associate contaminated water or malaria or dengue fever with an El Niño, but all of these aftermath effects pose certain threats to the livelihood of a population affected by the phenomenon. Mudslides, for example, can cause the accumulation of mud to occur in irrigation systems needed for crops to thrive or in reservoirs and dams, creating a harmful buildup of sediment in places needed for clean drinking water. Pedro Luque, an agronomist, describes the underestimated effect that mud can have; "The floods are catastrophic and have an immediate spectacular effect, but sedimentation is a hidden, progressive threat that generally goes unattended" ("El Niño's Other Threat…"). Also, people do not necessarily consider that the standing water created by the torrential rains associated with an El Niño instigates malaria and

Charley speaks to the high vulnerability levels of this area, yet the damage was not the result of flooding, as is usually the case in hurricanes. With Charley, a particularly fast-moving storm, winds caused the most damage throughout the state. Thus, housing type is an important determinant, along with other more traditional factors that serve to define vulnerability, such as age and mobility of the population. Given this, the research questions addressed here are:

1. What factors can be used to understand Florida's vulnerability to hurricanes?
2. How have these factors changed over time?
3. How do these factors vary over space?

Understanding Vulnerability

While socio-economic vulnerability has been defined in a variety of ways in the literature, there is considerable agreement on those population characteristics that contribute to high levels. Factors such as age, mobility, and income have been cited often along with the geophysical characteristics of one's location (Mejia-Navarro et al., 1994; Clark et al., 1999; Montz and Tobin, 2003). While much work has been done on defining vulnerability and documenting spatial differences (Hodgson and Palm, 1992; Montz and Tobin, 1998), much less has been undertaken on monitoring changes over time. Part of this is due to difficulties in reaching agreement on what should be used as indicators of vulnerability (King, 2001), as well as problems associated with finding measurable variables that can be traced reliably over time at an appropriate scale. Indeed, spatial variations in geo-physical risk, in exposure to hazard, and in dwelling type have confounded results (Montz and Tobin 1998; Cutter et al. 2000; Chakraborty et al., 2005).

The dynamic nature of vulnerability centers on three factors: the geophysical environment, the built environment, and characteristics of the population that make various segments more and less vulnerable. Even if we assume the physical environment is not changing, elements of the other two can significantly affect vulnerability and its changes over time. In Florida, population numbers are increas-

ing and the proportion of the population that is retired is also growing. Research on the elderly has often focused on their responses to disasters (Bolin and Klenow, 1982-83; Ellen 2001; Thomas and Soliman, 2002; Sanders, et al. 2003), but the results do not provide definitive conclusions. Some studies indicate that the elderly have remarkably successful coping strategies, while others suggest that the elderly are more vulnerable. Nonetheless, as more move to hurricane prone regions, vulnerability increases. It is also well recognized that the structural soundness of homes can increase or decrease vulnerability, with manufactured homes being particularly susceptible to damage (Cutter et al., 2000; Chakraborty et al., 2005). Thus, documentation of changing vulnerability over time can help in the development of dynamic responses.

This project addresses changing vulnerability as it has occurred in the seventeen counties most directly and severely affected by Hurricane Charley. With the research questions detailed earlier as the main focus, Florida's hurricane history is presented and then spatial and temporal patterns of factors associated with vulnerability are analyzed

The Study Area

Up until 1950 when the population was just under 3 million people, Florida had the smallest population of any southern state. At present, with a population of almost 18 million, it ranks as the state with the largest population in the Southeast, and the fourth largest in the United States. The seventeen counties on which this research is centered are diverse in terms of population characteristics (Figure 1). The population ranges from 10,576 (Glades County) to 896,344 (Orange County), all counties having experienced population growth since 1990 (Table 1). DeSoto, Glades, Hardee, and Highlands all have the lowest median household incomes, just over $30,000 while Collier and Seminole have the highest, in excess of $48,000 (U.S. Census Bureau, 2004). These characteristics suggest that vulnerability varies throughout the region under study.

Florida's proximity to the Gulf of Mexico, the Caribbean Sea, and the mid-latitude Atlantic Ocean places it in the path of storm sys-

ing $1.2 billion in estimated losses in its wake ("Balance of Harshest El Niño"; "El Niño's Other Threat…").

PAHO and Disaster Mitigation

In order to combat the effects of El Niño, Peru and other countries in South America decided to band together. The '97-'98 El Niño marked the first time that certain Latin American countries developed comprehensive prevention and disaster mitigation programs. To achieve this, countries established Internet-based diagnostic and response-oriented communications. The Pan-American Health Organization (PAHO), an arm of the World Health Organization, has aided greatly in coordinating disaster relief efforts among countries. PAHO has helped facilitate countries' exchange of information regarding damages and needs and has utilized the Internet as a conduit through which countries can access up-to-date information about El Niño. Unfortunately, due to the lack of technological infrastructure in Latin American countries Internet access is not readily available to everyone, even for disaster relief ("El Niño Phenomenon").

For the past one hundred years, the Pan American Health Organization has served the Western Hemisphere through implementing relief strategies, providing health care to the less fortunate, disseminating crucial information, and offer technical assistance. Recognized as a Regional Office of the Americas for the World Health Organization, PAHO also functions as the only major non-governmental health organization for the Inter-American System. PAHO's mission is "to strengthen national and local health systems and improve the health of the peoples of the Americas, in collaboration with Ministries of Health, other government and international agencies, nongovernmental organizations, universities, social security agencies, community groups, and many others" ("What is PAHO?"). PAHO has acted as the preeminent international public health agency in the Americas since 1902, unifying its member countries under the umbrella of a common interest in promoting the health of its citizens. This agency is also unique in that it addresses health issues at all levels, from assisting volunteers deployed in a disaster-stricken country distribute supplies to aiding governments coordinate relief efforts.

turns). Additionally, the very thermocline that brought cool waters conducive to anchovy fishing takes a dive deeper into the Pacific, revealing perilous warmer waters. Finally, the trade winds and equatorial easterlies that formerly deflected wind away from South America are weakened, leaving the coast more susceptible to convection and an extension of warm water emanating from the Gulfo de Guayaquil, known as a warm "finger." These relatively abrupt changes in the climate proved particularly traumatic for Peru during the '97-'98 El Niño, a point I will explore in the next section.

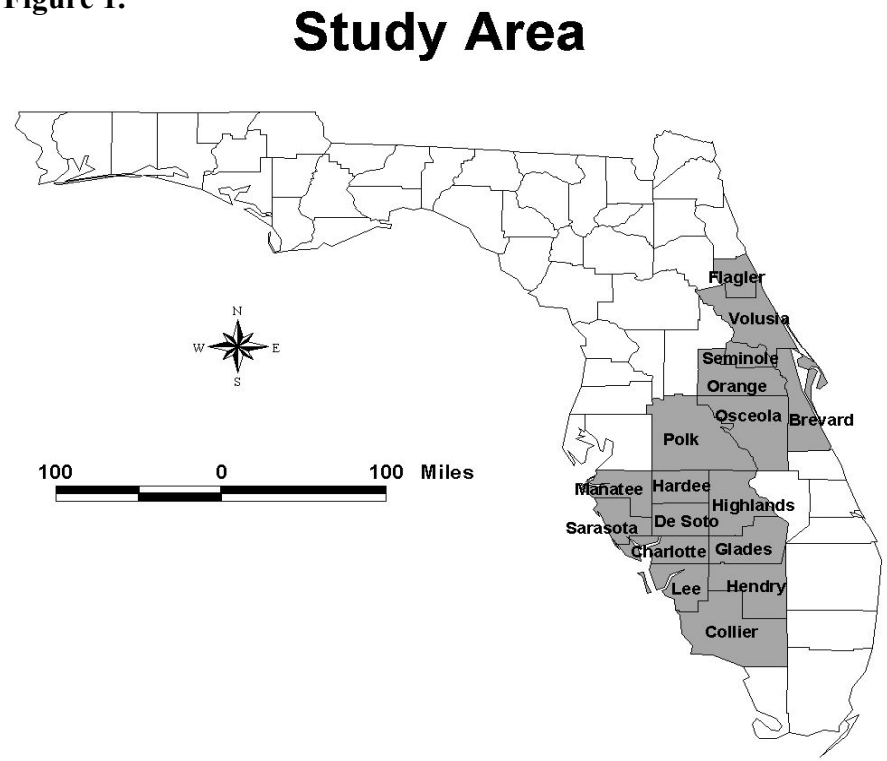
Description

The '97-'98 El Niño is widely regarded as "the weather event of the century" (El Niño to Continue Wreaking Havoc…"). For Peru, this meant enduring a substantially devastating version of El Niño. During the '97-'98 El Niño, Peru felt the heat from an anomalous 1.7-5.3°C rise in sea-surface temperatures (SSTs) which severely impaired its fishing industry that thrives off of cold-water watch such as anchovy. However, perhaps the most volatile factor of the '97-'98 El Niño came in the form of alarmingly high amounts of rainfall. Northern and central Peru as well as low-lying areas along the Andes Mountains incurred the greatest losses of life and damage to infrastructure and farmland due to flash flooding, mudslides, and avalanches.

Flooding in Peru

With regards to the damage caused by floods brought on by El Niño, the numbers are staggering. In terms of infrastructural and agricultural losses, 28,000 homes were demolished, 200,000 hectares of farmland were adversely affected, 3,000 hectares of crops were totally lost, 6,353 kilometers of roads were damaged, 883 kilometers of roads were destroyed, 59 bridges were swept away, and 125 kilometers of railway lines were torn up. To add a human component to the devastation, 40,000 people were left homeless and over 300 people died as a result of the symptoms of El Niño experienced by Peru. Overall, the '97-'98 El Niño ravaged the Peruvian countryside, leav-

Figure 1.



tems that are born in these warm bodies of water. Indeed, some 86 hurricanes and 73 tropical storms made landfall in Florida between 1901 and 2002 (Winsberg et al., no date). Losses and deaths to major hurricanes vary significantly. The data in Table 2 show the impacts of those hurricanes that affected areas that were hit by Charley in 2004. These data indicate that losses have been high. However, a major hurricane has not hit the area since 1960, but population has grown significantly in this region, suggesting an increase in vulnerability, despite these experiences.

Hurricane Donna was the most recent event to strike the region of Florida that Charley affected in 2004. Donna was among the longest and strongest hurricanes in recorded United States history with sustained hurricane winds maintained throughout the track from Florida all the way into New England. This Category 5 hurricane

Table 1. Population Characteristics of the Study Area

County	Land area, sq. mi.	2000 Population	Percent change, 1990-2000	Number of housing units	Median household income	% below poverty level
Brevard	1,018	476,230	19.4	231,644	$40,099	9.5
Charlotte	694	141,627	27.0	83,413	$36,379	8.2
Collier	2,025	251,377	65.3	160,844	$48,289	10.3
De Soto	637	32,209	25.0	13,819	$30,714	23.6
Flagler	485	49,832	73.6	27,722	$40,214	8.7
Glades	774	10,576	39.3	5,821	$30,774	15.2
Hardee	637	26,938	38.2	9,892	$30,183	24.6
Hendry	1,153	36,210	40.5	12,412	$33,592	24.1
Highlands	1,028	87,366	27.7	49,691	$30,160	15.2
Lee	804	440,888	31.6	265,989	$40,319	9.7
Manatee	741	264,002	24.7	146,211	$38,673	10.1
Orange	907	896,344	32.2	383,331	$41,311	12.1
Osceola	1,322	172,493	60.1	82,666	$38,214	11.5
Polk	1,874	483,924	19.4	235,776	$36,036	12.9
Sarasota	572	325,957	17.3	190,724	$41,957	7.8
Seminole	308	365,196	27.0	156,221	$49,326	7.4
Volusia	1,103	443,343	19.6	219,845	$35,219	11.6

with maximum sustained winds of up to 160 miles per hour caused thirteen deaths and 305 million dollars in damage as the system moved through Florida, after making landfall in Naples.

On August 9, 2004, Hurricane Charley originated as a Tropical Depression moving quickly across the Caribbean while strengthening (Table 3). It passed just south of Jamaica about two days after it became a hurricane. Charley made landfall in Cuba and then turned toward the northeast. The system accelerated toward the southwest coast of Florida, rapidly becoming more intense, from a Category 2 to a Category 4, just prior to landfall. The storm had been predicted to make landfall in Tampa Bay, so preparations were focused there, and 3 million people were evacuated. However, Hurri-

Here Comes the Rain Again:

Flooding and Disaster Mitigation in Peru, A Case Study from the 1997-1998 El Niño

Josh Gellers

Background

Peru, the country responsible for giving El Niño its name, suffers from massive flooding, mudslides, and even avalanches as a direct result of the catastrophic climatological phenomenon. While the effects of El Niño on Peru can be simply observed by reading the international section of a newspaper every four to seven years, the depth of the impact that El Niño makes goes much further than body counts or dollar signs. Therefore, in order to establish a deeper understanding of El Niño's march on Peru, I present this case study examination of the 1997-1998 El Niño, with a particular emphasis on flooding and disaster mitigation.

Before engaging El Niño from a country-centric standpoint, it is prudent to look at how El Niño affects the entire western coast of South America. Under normal conditions, a circular loop of convection called a Walker Cell governs precipitation in the Pacific Ocean. The thermocline (level at which the ocean temperature is 20°C) slopes sharply from the eastern Pacific to the western side, leaving cooler waters off the western coast of South America. Finally, southeast trade winds push air masses away from the coast, keeping some convective forces at bay.

During an El Niño, this carefully orchestrated system is thrown for a tailspin. When this phenomenon takes place, the Walker cell is disrupted, usually marked by a splicing of that cell which then churns convective activity in the center of the Pacific along the Inter Tropical Convergence Zone (ITCZ) and drops off right onto the western coast of South America ("Atmosphere," El Niño: The Child Re-

Josh Gellers is an undergraduate student in the Department of Geography at the University of Florida, and winner of the 2005 Florida Society of Geographers Undergraduate Student Honors competition

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Table 2. Major Hurricanes Affecting Study Area

Year	Mo/Day	Name	Deaths in FL	Damage in FL	Landfall
1910	11-Oct.	1910	11	0.5 million	Fort Myers
1921	25-Oct.	1921	6	1 million	Tampa
1926	18-Sept.	1926	243	112 million	Miami & Fort Myers
1928	16-Sept.	1928	1836	26 million	West Palm Beach
1933	4-Sept.	1933	2	4.1 million	West Palm Beach
1944	19-Oct.	1944	18	60 million	Sarasota
1945	15-Sept.	1945	4	54 million	Miami
1947	17-Sept.	1947	17	32 million	Fort Lauderdale & Naples
1948	21-Sept.	1948	3	17.5 million	Everglades City & Clewiston
1949	26-Aug.	1949	2	45 million	West Palm Beach
1950	5-Sept.	Easy	2	3.3 million	Cedar Key
1950	18-Oct.	King	3	28 million	Miami
1960	10-Sept.	Donna	13	305 million	Naples

Source: www.wunderground.com

Table 3. Charley's Progression through Storm Stages

Date	Storm Category
8/9/04	Tropical depression
8/10/04	Tropical storm
8/11/04	Category 1 hurricane
8/12/04	Category 2 hurricane
8/13/04	Category 4 hurricane
8/14/04	Category 1 hurricane
8/14/04	Tropical storm
8/15/04	Tropical depression

Source: www.wunderground.com

cane Charley suddenly turned toward the Fort Myers-Port Charlotte area and made landfall there on August 13.

Charley had sustained winds estimated at 145 mph, which made it a Category 4 storm. Floods associated with hurricanes are usually the worst danger, but this was not the case with Hurricane Charley, which moved much too fast for any large amount of rain to fall at a given location. Although this was a short-lived system due to its high speed, a swath of damage was seen through Florida as the storm traveled northeast across the central Florida Peninsula, knocking over trees and power-lines, and ripping homes away from their original spots.

As the most powerful storm to hit since 1960, Charley was directly responsible for ten deaths in the United States, nine of them in Florida. Insured damages are estimated at $6.755 billion in Florida (Insurance Information Institute, 2004). It is difficult to sort out the amount of public disaster aid that came to Florida as a result of Hurricane Charley because of the subsequent events. However, all tolled, at least $3.3 billion in federal disaster aid was allotted to Florida counties during the 2004 hurricane season. Every county in the state was declared a disaster area following Hurricane Charley, though the categories of assistance differ. It is the seventeen counties that were designated to receive all categories of individual and public assistance that are the subject of this project.

Methods

In order to address the research questions, longitudinal census data were obtained for a set of variables, chosen based on their anticipated contributions to explaining differences in vulnerability in Florida (Table 4). Since the counties vary so much in population size and other characteristics, the percent change in variables was used to illustrate temporal and spatial patterns. Two time periods were employed, where possible. The first, 1970 to 2000, provided a means of evaluating changing vulnerability since the last major hurricane struck the area. The second, 1990-2000, allowed for analysis of more recent demographic changes. All data were obtained from the United States Census Bureau (US Census Bureau, 2004) and were mapped

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their own socio-spatial constructions embedded within geographies of social and economic justice.

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Table 4. Variables Used For Analysis

Variable	Years Available
Total population	1970, 1980, 1990, 2000
Total White population	1970, 1980, 1990, 2000
Total Black population	1970, 1980, 1990, 2000
Total Hispanic population	1970, 1980, 1990, 2000
Population below poverty level, by race	1990, 2000
Total female heads of household	1970, 1980, 1990, 2000
Number of mobile homes	1970, 1980, 1990, 2000
Population 65 and over	1970, 1980, 1990, 2000
Population 5 and under	1970, 1980, 1990, 2000

using ArcView; natural breaks were chosen to determine the categories of change. Individual variables were mapped to provide a means of evaluating spatial and temporal differences. Three examples, total population, population 65 years of age and older, and mobile homes, are presented here.

In order to understand overall change in vulnerability, composite maps were created for both time periods. The data in these maps were derived from the categorizations in the individual maps. Specifically, the lowest category for each variable was assigned a 1, the second lowest a 2, and so on, to the highest (5). These numbers were summed for each county and then categorized from lowest to greatest change (increase) in vulnerability. The resulting maps allow for analysis of vulnerability as a composite of contributing factors. Unlike other studies of vulnerability, however, the approach here does not attempt to rank or weigh variables. Each is considered equally.

Results

The population of the Southeastern United States has increased dramatically in recent decades, and the counties most affected by Hurricane Charley are no exception. Indeed, as shown on

Figure 2.

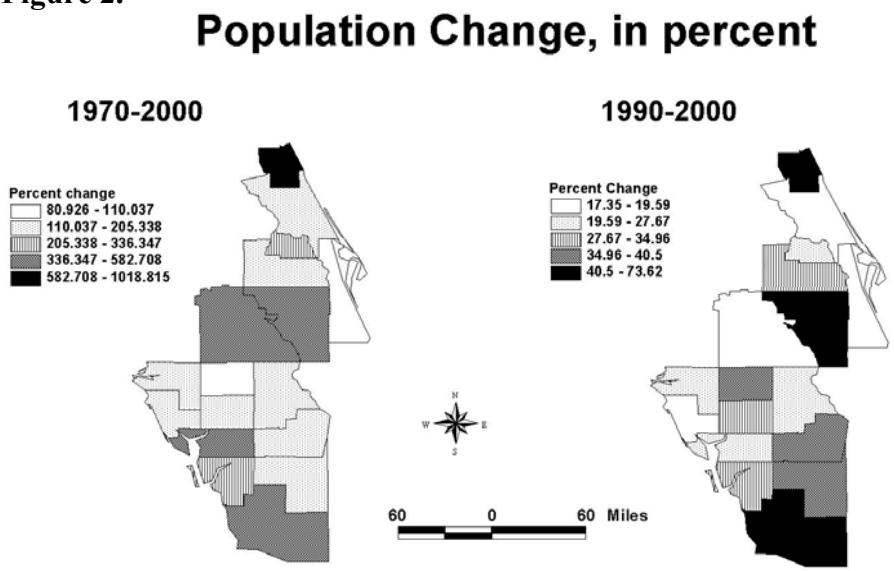


Figure 2, only two counties in the study area experienced population growth rates of less than 110 percent between 1970 and 2000, and one, Flagler, experienced growth in excess of 500 percent, going from some 4,400 people in 1970 to more than 49,000 in 2000. There is no spatial pattern evident in this growth as coastal counties experienced similar rates to non-coastal counties. These growth rates clearly illustrate that more people are at risk, no matter what other characteristics they might have.

Of particular concern to this work is the more recent population growth (1990-2000) that has brought people with little or no experience to hurricane prone regions. Three counties, Collier, Osceola, and Flagler, experienced growth rates in excess of 40 percent and all but four had population increases in excess of 20 percent. The sheer numbers are clearly of concern when one considers vulnerability of an area. However, it is specific characteristics of that population that serve to define changes in vulnerability more accurately.

As might be expected, the percent change in the population 65 years of age and older is large (Figure 3). Flagler and Collier counties, in the extreme north and south of the study area respectively,

nationalism and racism. These international boundary crossings protested by the Klan threaten their sense of collective identity, as they struggle to maintain nativist social borders defined by 'whiteness'. The ORION Ku Klux Klan's racist agenda and ideologies look inward and demand purity while reacting with hate to the new global scales of social production and reproduction. Institutions of global scope embed themselves in everyday life, producing a sense of loss of local control where pre-modern constructs of Klan identity are seriously threatened.

In a very geographical sense, the post-modern era of globalization gives rise to ever increasing border crossings that manifest themselves through increasing demands for low cost migrant farm labor. Reactions of hate groups such as the Ku Klux Klan can be seen as a marker of racist ideology as a reaction to such border crossings. As globalization continues to initiate economic dominance through political and social influences, it plays an important role in shaping personal identity and social relations, where racism continues to be embedded in personal life politics. These identities are inextricably intertwined with capitalistic pressures toward personal advantage and materialism, and are actualized through a reflexively ordered environment that links personal identity to systems of global scope (Giddens, 1991). The presence of foreign born Hispanic migrant farm labor in Immokalee is but one example of how these personal identities are played out through discourses of hate and discrimination which are masked by economic protectionism. The reality of global capitalism continues to increase the demand for low paying, unskilled, foreign labor pools. In the case of the ORION Knights of the Ku Klux Klan, these demands created a localized response couched in hyper-nationalism and racism. Legitimizing job protectionism through othering immigrant workers as "unclean, non-white criminals" remains a viable weapon in the arsenal of hate and discrimination employed by various "anti-immigration" groups throughout the nation. Justification of these spaces of hate are also played out and justified through group alliances that expand outward into wider geographical fields. This illustrates the continuing need for proactive movements such as immigrant labor rights to combat these racialized spaces by using

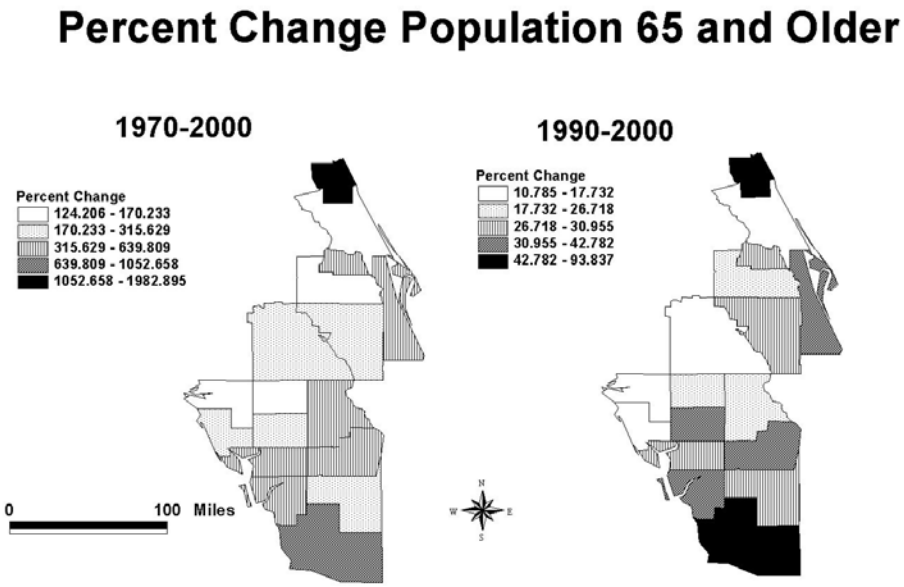
than 50 counter-demonstrators took up Turner's chant — "Arrest the illegals! Arrest the illegals!" — They waved hand-painted signs toward the immigrant rights rally: "Illegal Invasion," "Mine the Mexican Border," "No!!! Minority White America," "I Never Asked for Diversity." The Center for Immigration Studies (CIS) also met the immigration activists in Miami, and demanded federal officials arrest all undocumented workers. The California Coalition for Immigration Reform insisted the protesters were criminals, had no rights, and had to be deported immediately. In Chicago, members of the white supremacist Council of Conservative Citizens joined together with the Neo-Nazi "White Revolution", holding signs that said "No More Free Rides - No more Welfare - No More Stolen Jobs". And in Atlanta, D.A. King of the Georgia Coalition for Immigration Reduction had a similar reaction after protesting a Freedom Ride stop outside Atlanta: "I got the sense that I had left the country of my birth and been transported to some Mexican village, completely taken over by an angry, barely restrained mob. My first act on a safe return home was to take a shower." (Southern Poverty Law Center, 2003).

In order to maintain the 'purity' of whiteness, racist groups feel a need to defend themselves in relationship to 'the other'. These social constructions of 'us' versus 'them' materialize out of a desire to distinguish what is 'good, normal and pure' (and hence white), in relationship to what is bad, abnormal, and impure'(non-white). In this case, what is established as abnormal (the other) are Hispanic immigrant workers, defined by white supremacists as being 'dirty, criminal, or diseased'. Thus, these coalitions of white racists not only invoked a larger geographical field by banding together to counter demonstrate, but their targets were those "others" that would threaten "their" economic space. The rights of white nationalists help construct their 'whiteness' by "othering" the freedom riders as "dirty criminals" that were illegally taking jobs meant for Americans.

Conclusion

The reality of migrant farm labor in Immokalee is but one example of how new and modern global demands for international divisions of labor can create a localized response that is rooted in hyper-

Figure 3.

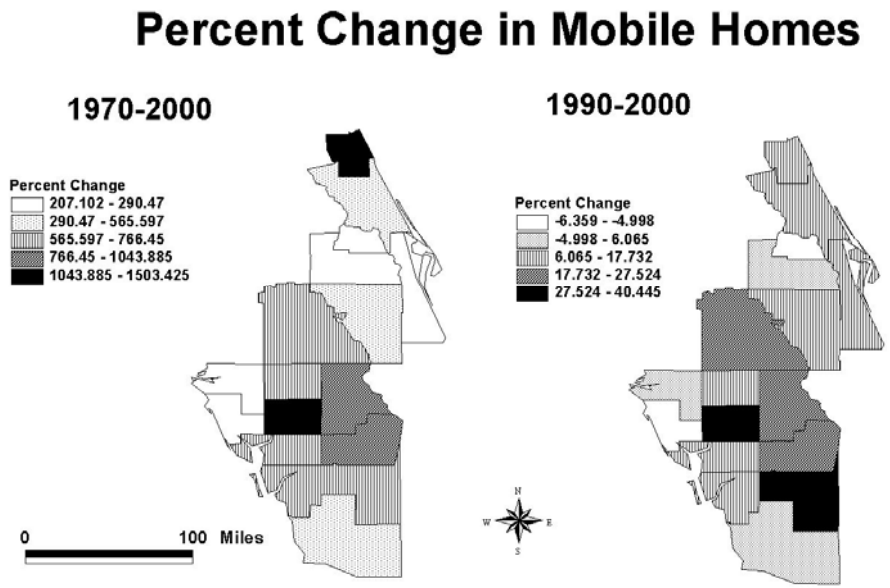


stand out for having experienced the greatest increases in both time periods. However, between 1970 and 2000, all counties increased at rates in excess of 100 percent. The rate of growth was much less between 1990 and 2000, but each county continues to see a greater proportion of elderly residents, whether on the coast or in the interior.

Comparison of Figures 2 and 3 suggests that those counties with the greatest population increases are also seeing increases in vulnerable populations. However, for the three counties experiencing the greatest rates of growth between 1990 and 2000 (Collier, Osceola, and Flagler), the rate of increase in the elderly population is slightly greater than that of the population as a whole. Thus, the population in these counties is aging.

Given the damage wrought by Hurricane Charley to manufactured homes, mobile homes are a major concern to understanding changing vulnerability. The maps in Figure 4 depict changes in the proportion of mobile homes as part of the housing stock. No county experienced less than a 200 percent increase in the proportion of mo-

Figure 4.



bile homes between 1970 and 2000, with DeSoto and Flagler counties showing the greatest increases, greater than 1000 percent. Most of the growth in this time period was in the central part of the study area, including a few coastal counties. By the period 1990 – 2000, the rate of increase in mobile homes had lessened somewhat, with several counties seeing decreases. Again, the greatest increases are in the central part of the study area and in non-coastal counties. Under a "normal" hurricane scenario, this pattern makes sense wherein the proportion of mobile homes is decreasing or experiencing smaller increases in the more vulnerable coastal counties.

Clearly, vulnerability has increased throughout the study area, both over the longer term and the shorter term, as shown by the individual variables discussed above. While these are critical to understanding the dynamic nature of vulnerability and to developing emergency management priorities for various locations, it is also important to consider the overall temporal and spatial changes. Figure 5 presents the composite for 1970 to 2000. Not surprisingly, the entire area is characterized by increased vulnerability since the last major hurricane

mize local power and sovereignty. This "jumping of scale" is generally viewed as a political strategy for dealing with the forces that originate from varying scales of power. Places such as Immokalee struggle to negotiate extra-local forces, often global in nature, in order to establish some sort of control over how those forces will effect the locale, which then become "spaces of engagement" (Cox, 1998; Gallaher, 2004). A protest by the Klan in Immokalee is just one example of how a local place struggles with outside forces that have created a need for cheap foreign farm labor, and are deemed a threat by the Klan.

However, this "jumping of scale" is not created in a vacuum. Using various scales to legitimize a particular movement is not only used for transgressive purposes (such as hate and racism), but is also part of a progressive strategy designed to legitimate calls for human rights and social justice, creating a socio-spatial power struggle between competing actors (Castells, 1997). For example, the migrant farm worker's rights rally in Immokalee was but one stop along a nationwide tour that was sponsored by the Immigrant Workers Freedom Ride Coalition . The coalition sponsored a "Freedom Ride", inspired by the 1961 Freedom Rides for black civil rights. They made more than 100 stops in small towns and big cities across America to promote their reform agenda: greater workplace protections, reunification of immigrant families, and a "road to citizenship" for America's estimated 8 to 10 million undocumented workers (Immigrant Workers Coalition). The ride culminated in a rally at Liberty State Park in New Jersey, within the shadow of the Statue of Liberty, perhaps the best known icon in the world for immigration.

Along the way, however, a variety of white supremacist hate groups took part in counterdemonstrations, picking up the same key message the local Ku Klux Klan in Immokalee had invoked: That immigrants are wrecking the economy and "stealing" jobs from U.S. citizens. The racist Klan rhetoric in Immokalee was also invoked by the likes of Hal Turner, a well known New Jersey white supremacist who called the freedom riders "slime, filth, criminals, enemy invaders, mongrels and savages who have slithered their way into this country from every cesspool Third world nation on Earth." As more

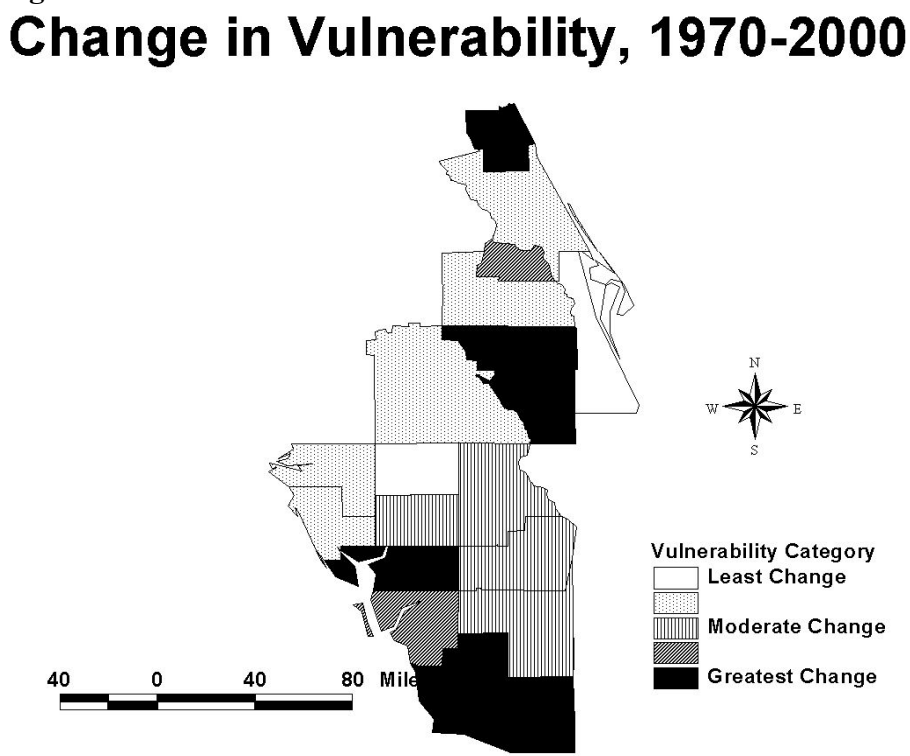
ogy can thus be seen through a geography of racism. These geographies are detected through a textual reading of the ORION Klan's goals as stated in their website: 'White brothers and sisters are united in a *common cause';* the struggle for 'the *common* welfare and the greater good and general betterment of *our* people'; and the 'fight for the very survival of *our* race, *our* culture, and *our* religion (emphasis added).' All of these statements imply ownership and separation of white space. Invoking the "other" as a "pot of multi-cultural foolishness" implies a direct threat to ownership and control of this white space. Thus the perceptions that migrant farm worker "terrorists" are invading the spaces of Immokalee.

'White' identity is heightened for racial hate groups such as the Klan, because they see it as a marker of racial victimization rather than racial dominance. The racial self-consciousness of white supremacists grows out of the notion that whites have endured oppression in the past and present (Blee, 2004). Examples of such feelings are invoked throughout the ORION Klan creed, as they feel a need to 'defend white Christendom against the onslaughts of anti-Christian, multi-cultural, race-mixing Babylon'. In this sense, they are threatened and victimized by the fear that whites are in danger of 'throwing away their heritage and birthright'. Rural tradition, memories of past glories, and attempts to halt change are closely held, pre-modern Klan ideals that are threatened by the economic insecurities of globalization. These so called 'threats' lead to the kind of Klan protests in Immokalee that are cloaked in rights of local economic sovereignty constructed by race and culture.

Legitimizing the Movement through Geographical Scale

Increasingly, the couching of local economic power within discourses of hyper-nationalism relies on larger scales for legitimization (Gallaher, 2000). The ORION Klan protest was a local manifestation of much larger anti-immigration rhetoric that was rooted in alliances with other white supremacist groups nationwide. Thus the protest in Immokalee transcended geographical scale beyond the local to the nation-state. In this sense, the ORION Klan used extra-local anti-immigration rhetoric to justify their position locally and to legititi-

Figure 5.

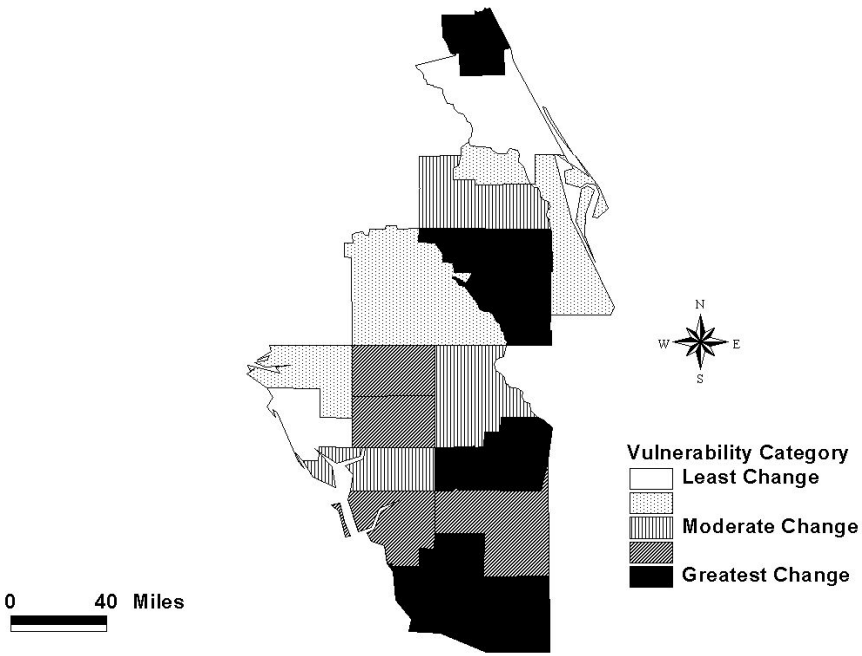


struck with the southern portion of the study area experiencing the greatest overall increase. Of those counties in the top two categories, most are coastal. However, it is also important to note that four coastal counties are also in the categories of least change. This does not necessarily mean that they are not characterized by high levels of vulnerability. All of these counties have experienced increases in population since 1970, but there apparently has not been a disproportionate increase in vulnerable populations. The same cannot be said for Collier, Lee, and Charlotte counties, the three southern counties in the highest categories of increase.

More recent changes in vulnerability can be seen in Figure 6. Although the percentages of change are much less than over the 40 year period presented above (see Figures 2, 3, and 4 for examples of differences), spatial patterns are evident. The entire southern portion

Figure 6.

Change in Vulnerability, 1990-2000



of the study area has experienced a greater increase in vulnerability than has the northern portion. Flagler and Osceola counties, the two counties that experienced the greatest population increases between 1990 and 2000, stand out as exceptions in the northern part of the study area. In contrast, DeSoto, Glades, Hardee, and Hendry Counties experienced among the greatest increases in vulnerability and have the highest poverty rates in the study area. Thus, the composite view is important to understanding fully the nature of the temporal and spatial changes that have been mapped.

Discussion

The data presented here suggest that vulnerability, at least as measured by these variables, has increased throughout the study area. The patterns vary depending on the characteristic mapped, but overall

out fliers saying "STOP Immigration and keep Americans working" (Naples Daily News, 2003).

Social Constructions and Geographies of Hate

The spaces of white, racist identity articulated by the ORION Knights in Immokalee are constructed by both race and class relations, which is often expressed at the scale of the nation-state in the form of intense nativism. This core identity is a common thread that binds white racists together. Oftentimes, these racialized constructions rely on and react to various struggles for social justice created to counter the identity politics of whiteness that perpetuate domination and oppression, and which justify exclusion (Lipsitz, 1998). The Coalition of Immokalee Workers represents such a struggle for social justice through advocating for immigrant Hispanic labor rights. In part, reactions of the Klan in Immokalee can be seen as a local manifestation of race and class construction embedded in the rhetoric of "jobs for Americans". Calls for local labor rights from the Coalition of Immokalee Workers creates more spatial visibility for the plight of immigrant farm workers, hence racist identity constructions perpetuated by the ORION Klan have a clear (and local) target.

ORION stands for "Our Race is Our Nation", and a visit to their website (www.orionknights.com, n.d.) reveals a historical paradigm as a white racist history, where universal religious beliefs were linked with racial constructions, and sovereignty was associated with early European (and white) Christianity. This was a period when culture was embedded in the glories of the church and the king, and political conflict was framed in religious terms (Taylor, 1999; Bonnett, 2000). By invoking "Our Race is Our Nation" as a "defense of White Christendom", the racist ideology emanating from the ORION Klan is a pre-modern reaction to a globalized political-economy, where borders and nation-states are continually transgressed by international pools of labor and capital., and in which the spaces of Immokalee represent a materialization of such border 'transgressions'.

To become a white racist, it is also necessary to identify with whites as a racial collective by drawing sharp socio-cultural boundaries between the white race and other races (Blee, 2004). Klan ideol-

compact by heavy reliance on non-American unskilled farm labor helps explain the Klan's reactions to the "others" that are taking away jobs meant for "Americans" (Silver & Slater, 1999; Flint, 2001). Political and economic realities of globalization have allowed corporations to tap low-cost labor across national borders through a vision of global free trade. Situating race within this broader political-economic global restructuring provides insight into what sort of "problem" immigrant workers in Immokalee pose to the Klan.

Immokalee is Florida's largest migrant farm worker community, located in Collier County, about 30 miles from Naples (map 1). The community is split, roughly, along the following ethnic/national origin lines: 50% Mexican, 30% Guatemalan, 10% Haitian, and 10% other mainly Central American nationalities. Virtually all workers are transitory, spending 8-9 months picking produce to be sold on the national and international market, and then migrating north during the summer to do similar work. The work itself is exhausting, and is paid in piece work: At the going rate of 45 cents a bucket, laborers must fill 125 buckets (about 2 tons of tomatoes) just to earn $56 in a day. Some workers eventually do go on to work in other jobs in the area, mostly low income and low skilled occupations in the service and building construction trades (Coalition of Immokalee Workers, n.d.). As such, Immokalee is truly representative of a place that plays a crucial role in the exploiting of foreign workers that plays out across twenty-first Century capitalist global space.

Members of the Ku Klux Klan appeared in Immokalee to protest a migrant farm workers rights rally, sponsored by the Coalition of Immokalee Farmworkers (CIW). The coalition was formed in the early 1990's, in part as a response to the repressive working conditions inflicted on workers in the tomato fields and orange groves of Southwest Florida. Since then, the Coalition has grown into a 2,700 member organization with a staff of eight, educating migrant farm workers of their rights, and organizing labor actions. The local Klan group is associated with the Florida realm of the O.R.I.O.N. Knights of the Ku Klux Klan, based in Lake Placid, FL. They waved Confederate and American flags, and held signs saying "Stop Non-White Immigration" and "Illegal Immigrants Equal Terrorists". They also handed

there is increased population and disproportional increases in the factors considered here. For instance, in both time periods, the increase in percent of the population age 65 and older is higher in the coastal counties of Charlotte, Collier, Flagler, Lee, and Brevard counties than is the percent change in the total population.

While the number and proportional growth rate of mobile homes was large during the period 1970-2000, this growth was much less in the 1990 to 2000 period. Indeed, some counties saw decreases or very small increases in the percent of homes that are classified as mobile homes. Of these, several are coastal. On the other hand, the coastal counties of Flagler, Volusia, Brevard, Charlotte and Lee experienced at least a 6 percent increase in mobile homes. However, it is the continuing increase in the number of mobile homes in the non-coastal counties that is notable. Under ordinary circumstances, locating mobile homes away from coasts makes sense as these are homes that are affordable both as second homes and as primary residences for those with fewer assets. The overlap between those counties with large proportional increases in populations below the poverty level and those with larger rates of increase in mobile homes reflects this. The relationship is less clear when comparing the maps of those 65 and older with mobile homes, and additional work is required to sort this out.

The composite maps suggest that proportion of the population defined as having relatively higher levels of vulnerability is increasing over time, sometimes at very large rates. While spatial patterns are not entirely obvious with the individual variables, the composite maps present interesting trends. Vulnerability is increasing throughout the study area. Certainly, it is increasing at different rates for different variables, but the overall trend is one of higher proportions of the population at risk. Yet, the increases are not spatially uniform. Some counties have experienced large increases in vulnerability but others have not. Both the variables that contribute to these increases as well as the overall picture should be of concern to emergency managers, as they develop plans and set priorities for the next hurricane. Hurricane Charley made it clear that evaluating vulnerability in coastal counties is not sufficient. The changes seen throughout this

study area suggest that a broader spatial view of vulnerability is needed. That Charley moved quickly through coastal and non-coastal areas indicates that the locations and characteristics of vulnerable populations (as defined by socio-economic factors and not geophysical ones) must be known for appropriate and efficient planning, preparation, and recovery efforts.

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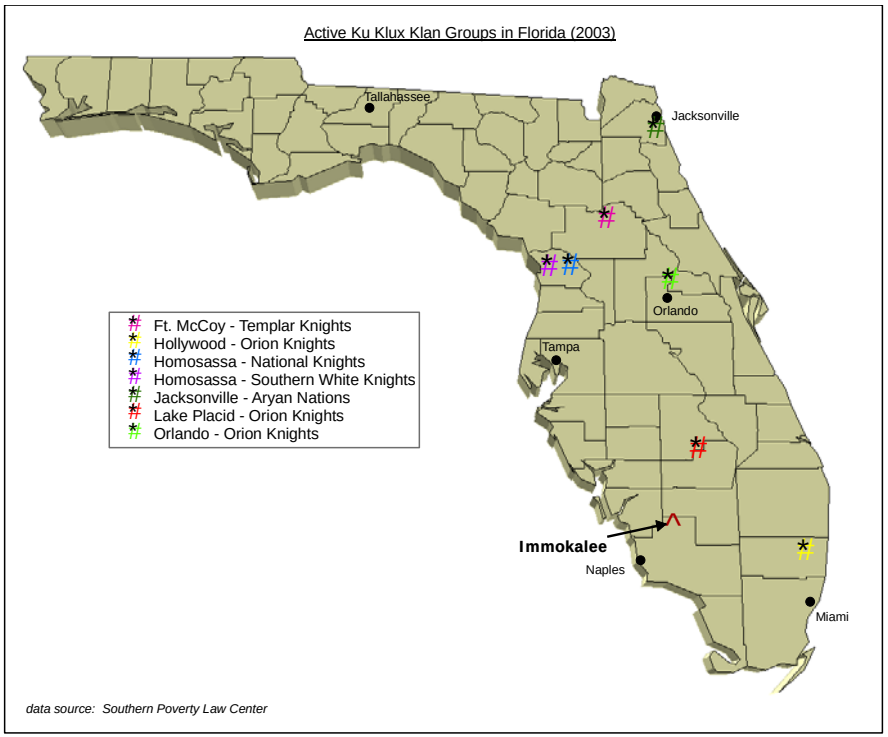
Map 1.



Global Change, Local Anxieties

As America enters a new phase of international globalization, it has produced a paradox, where the spatial dimensions of late American hegemony call for a need to construct a national economic base while simultaneously creating a contradictory need to diminish the importance of national borders, particularly for unskilled farm labor. This dilemma is part of the framework in the twenty-first Century that provides fuel to the established fires of American nativism, which continues today as a prime ideology of the Ku Klux Klan (Flint, 2004, Southern Poverty Law Center, 1991). Previous American hegemonic cycles have always favored a territorial defined social compact that favors white, skilled workers over non-skilled workers and people of color within the American economy. Disruption of this

"hooded hoodlums and sheeted jerks." The Klan's power was particularly strong in Orange County, where its ranks included prominent lawmen, businessmen, and elected officials: Sheriff Dave Starr was a known Klansmen, as were a county commissioner and the city manager of Winter Park. Apopka and Winter Garden were particularly infested: Apopka's police chief, constable and night patrolman all belonged, as did one constable and the justice of the peace in Winter Garden. One businessman estimated that 75 percent of Apopka's male population belonged.

During the 1950's suburbia became the domestic landscape of new consumer society (Taylor, 1999). In the fashion of previous American hegemonic influences, it was a way of life to be emulated, with its image being broadcast across the world through television and cinema. The suburb was a way of life that epitomized consumerism based on Fordist wages and a gendered division of labor. Suburbia was the image and reality of American prime modernity, as the white middle class was re-establishing a sense of collective identity within the bucolic suburban setting. The message of exclusion of minorities and the "others" that lived in the city disseminated by the Klan in the 1920's became part of the suburban lifestyle that defined American modernity at the time. The message was clear: Blacks and other minorities were not welcome in these suburban white spaces (Flint, 2004).

During the 1950's in Florida, the Klan was at a crossroads. Harry T. Moore's Progressive Voters' League had registered 100,000 new black voters in the Democratic Party; NAACP branches were challenging Jim Crow ordinances over the use of public golf courses, swimming pools, and libraries; and the Florida Legislature passed an anti-mask ordinance by an overwhelming margin. The Klan responded with a rash of cross burnings and floggings from the Florida Panhandle to Miami. Florida Klan groups began trying to roll back this progress with so many bombings, or attempted bombings, that the northern press dubbed it "The Florida Terror." Into the 1960's, Florida remained a Klan stronghold, particularly in the Jacksonville area (Public Broadcasting Service, 2001).

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takeover by the Roman Catholic Church reflected fears of a loss of sovereignty. The rapid global changes, with America at the helm of cultural and economic influence, was seen as a direct threat to the "traditional American Lifestyle", and the Klan's supporters saw the organization as a tool to conduct "social surgery" and save America (Flint, 2001).

Specific targets of Klan activity in the 1930's began to expand outward. Anti-Catholicism, anti-immigration, attacks upon the role of the automobile in immoral behavior, and prohibition were political attempts to stop social change. Industry and the city were geographic manifestations of these fears, as people in rural areas where the Klan was most active perceived a loss of citizen status. This rural/urban conflict epitomized a new 'American way of Life' that associated urbanization with progress and change. The Klan was seen as a bulwark against "the anarchy" that seemed to be destroying the settled and traditional ways of village life in the days of bootlegging, prohibition, 'city immorality', broadcasts by the radio and cinema, and the immoral evils of the automobile, called 'a house of prostitution on wheels' by some. Hence the basis of Klan activity was also a local reaction to changing urban/rural geographies associated with economic, cultural, and political changes that established new modes of 'The modern American way of life' (Flint, 2001).

Florida had an estimated 30,000 Klan members during this period, in which Jacksonville, Miami, Orlando, and Tampa were strongholds. Although Florida Klansmen continued to terrorize African Americans, they expanded their targets to include union organizers, particularly in the citrus belt from Orlando to Tampa. During the 1940's, a Florida Klan revival was initiated by Dr. Samuel Green, an Atlanta doctor, who formed the Association of Georgia Klan, which quickly spread to Florida and at least six other states. On election night of 1948, the Florida Klan paraded from Lake County to Wildwood, marching through several African American neighborhoods, to show support for Dixiecrat presidential candidate Strom Thurmond and attempt to intimidate black voters. In January 1949, Klansmen held a motorcade through Tallahassee, where newly- inaugurated governor Fuller Warren, a former Klansmen himself, denounced them as

creased dramatically in the 1920's, peaking at about four million members.

From the 1920's and onward into the new millennium, Ku Klux Klan activities and acts of protest motivated by hate can be linked to various stages in America's dominant role as purveyor of cultural, economic, and political influence across the globe. These protests are played out through space and time, and provide insight into how members of the Klan express their local dissatisfaction with these global hegemonic influences. With each succeeding phase in America's geo-political and economic discourse, new American 'ways of life' took shape, and continued to further marginalize pre-modern traditional ways of life that provoked violent, racist, and xenophobic reaction. As a result of these various stages of American hegemony, Klan activities began taking on different roles and targeted new victims. As such, new "geographies of hate" were formed as they played out across various landscapes at various times. For example, the Klan's mission expanded from an almost exclusive anti-black message in the early twentieth century, to pro-American, anti-Catholic, and anti-Semitic rhetoric by the end of the 1920's. The Klan also began an all-encompassing moral crusade attacking bootleggers, adulterers, corrupt businessmen, and just about anybody deemed to be acting outside of community norms. Women comprised about half the membership in some states (Flint, 2001).

The rise in Klan membership during the 1920's coincides with the end of World War I, as American social, economic, and cultural power began to coalesce and take shape as a prime 'global' modernity, in which American influences fundamentally altered the social relations of production and reproduction across the globe (Taylor, 1999). New methods of capitalist production took the form of Fordism, and new global political considerations took form in debates surrounding the League of Nations and isolationism. Economic growth that spurred immigration unsettled many Americans; and fears of 'immoral behavior' reflected massive cultural changes. Perhaps most influential to activities of the Klan during this time was the rise of American international presence that produced a reaction of isolationism. Cries of "one hundred percent Americanism" and fears of a

A Methodology for Delineating a Primary Service Area for Recreational Boaters Using a Public Access Ramp: A Case Study of Cockroach Bay

Timothy Fik, Charles Sidman, Bill Sargent, and Robert Swett

Introduction

The delineation of a market service area for recreational boaters using a given public access ramp is essential to answer the question of where boaters come and examine the extent to which there is variability in the geographic distribution of use intensity within a ramp's market area. This paper presents a methodology for identifying and mapping the ***primary service area*** (PSA) of a public access ramp – the predominant market area from which ramp patrons are drawn – by taking into account directional variability and the distance-decay properties of ramp use. This involves the identification of the market boundary of the PSA; something that is known to vary by location and direction.

Conventional approaches to delineating market service trade areas include radial ring-based studies, drive-time analyses, and the use of gravity models. **Radial ring studies** are performed by evaluating various market demographics, using census information aggregated to tract, block, or block-group level; identifying those areas that fit a pre-selected profile and fall within a pre-defined radial distance from a given location. This approach commonly depicts service/trade areas as circular, and typically does not consider the behavioral, spatial, or physical conditions that can promote or restrict patronage in various directions (Thrall and McMullen, 2000; Thrall, 2002). Variability in the spatial distribution and density of prospective patrons, their willingness to travel, the tyranny of distance and separation, lo-

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cation accessibility as defined in terms of the transportation infrastructure, and the physical characteristics of the coastline can all play important roles in influencing the size and shape of market service areas. These considerations are widely overlooked in radial ring studies, as is the fact that accessibility to a given a site will vary across a region (or ring) in accordance with population density and the physical layout of the road network and related capacity and travel constraints. **Drive-time analyses** delineate market service areas based on geographic locations that fall within pre-defined travel times to a given site (Thrall et al., 2002). This method, however, does not account for variability in willingness-to-travel, consumer preference, knowledge and experience, perceptions, and spatial-use patterns that are affected by competition and/or intervening opportunities from alternative sites that are deemed as substitutable from the perspective of patrons.

Gravity or 'spatial interaction' models have also been applied to delineate market service or trade areas (Fotheringham, 1981, 1983; Huff, 1964). Gravity frameworks assume that patrons are "distance minimizers", and that there is a distance-decay property to patronage with respect to a given site. In short, the farther prospective patrons reside from a particular site/location, the less likely those patrons are to visit or frequent that site/location. Gravity-type formulations, however, are more difficult to implement than the radial ring method or drive-time analyses within a Geographic Information System (GIS). Nonetheless, gravity models can be very effective in exposing directional trends in patronage and the spatial distribution of demand. Used in conjunction with pie-shaped wedges, sectors, or transects that extend outward from a central point or location (Thrall, 2002), the gravity model can be used to derive irregularly shaped market areas that capture directional differences in market share and geographic reach based on observed travel patterns and distance-decay properties.

The wedge-casting approach applied in this study has its roots in both the gravity model tradition and the retail market-area capture rate established by Applebaum (1965; 1966). Applebaum (1966) suggested that ***a primary service area encompass a geographic area***

job loss by "Americans". This economic polarization is in part a direct result of the globalization process that continues on into the new millennium, especially where large-scale migratory movements in search of work have profoundly affected social reproduction at the local level (Harvey, 1989; Gallaher, 2000). These economic frustrations, combined with a racist agenda can sometimes result in territorial conflicts that manifest themselves as a process of global space played out within a contested local landscape. Such was the case in Immokalee, Florida in September 2003, when members of the local Ku Klux Klan made an appearance to protest against the mostly Hispanic migrant farm workers that dominate the local labor force. I will begin this discussion by placing the activities of the Ku Klux Klan within a general geo-historical context, including a review of other geographer's work on linking globalization processes and identity to spaces of hate and racism. I will then illustrate how transnational flows of immigrant farm labor (a seemingly permanent fixture of the late stages of capitalism) are linked with the spaces of Immokalee, Florida in the context of the rhetoric of the local Ku Klux Klan. In demonstrating how modern global hegemonic processes are used to contest this Florida landscape, I will discuss the role of geographical scale, and how it is used to establish the collective identity of both the local Klan and the local immigrant farm labor rights group, formed to challenge domination and oppression of farm workers in the region.

A Twentieth Century Geohistorical Interpretation of the Klan

The 20th century Klan claims its revival in 1915, beginning with an event atop Stone Mountain in Georgia, coinciding with the 50th anniversary of the end of the civil war. Klan members proposed a large-scale relief sculpture atop Stone Mountain, of a group of hooded reconstruction-era Klansmen, to remind Southerners of the debt they owed "to the Ku Klux Klan which saved us from Negro domination and carpet bag rule". Geographies of memory sought to glorify the Confederate cause, legitimating a related narrative of intolerance through public iconography (Medlicott, 2004). The twentieth century Klan was not just a feature of Southern life, however, as strongholds were common outside southern states. Membership in-

Globalization, Identity, and the Florida Realm of the ORION Knights of the Ku Klux Klan:
Landscapes of Resistance in Immokalee, Florida

Thomas Chapman

As places across the globe have become increasingly interconnected, people are experiencing a 'speeding up' of the pace of life, in which barriers in space are rapidly broken down by a globalizing economy. There is a feeling that the world is shrinking, and even that it will collapse in upon us (Harvey, 1989). This process and their associated feelings are not new, but are deeply embedded in the history of capitalism and the relentless drive towards newer and newer modernities. In the twenty-first Century, these dualities of time and space seem to have taken on a new 'hyper-urgency' in overcoming spatial barriers and accelerating the pace of economic and social life. This compression of time and space can indeed instill a sense of incoherence, where a 'crisis of identity' has created a profound sense of disconnectedness between the global and the local (Gallaher, 2000). These feelings are especially threatening to those involved in racialist movements, where people build trenches of resistance on behalf of God, nation, and race, and in which they feel they are under assault from these techno-economic global processes that are beyond their local control (Castells, 1997; Gallaher, 2000; Flint, 2004).

Even as people realize the interdependent nature of their world, they are unable to feel an active agent in it. Interconnectedness of places is undeniable, yet simultaneously uncontrollable, and therefore somewhat mysterious (Gallaher, 2000). This phenomena, which scholars see as beginning in the 1970's, has resulted in the re-emergence of hate group activity, primarily as a response to threats of

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that accounts for between approximately 75 and 80 percent of the users or consumers within that market. This market capture rate will be used as a benchmark to assess the validity of a primary service area generated from the gravity model. A series of gravity models will be run to estimate direction-specific distance-decay parameters and corresponding threshold travel distances.

The Data

Ramp patron data for N=31 ramps in the Tampa and Sarasota Bay area were collected as part of a unified two-year effort initiated by the Florida Fish and Wildlife Conservation Commission's Fish Wildlife Research Institute (FWRI) and Florida Sea Grant. The underlying objective of this data collection effort was to determine where boaters travel from in order to access ramps, as well as other information including where they travel to on the water (favorite destinations) and on-water travel routes. During 2003 and 2004, personnel from FWRI, FSG, and Hillsborough County visited area ramps and collected 6,088 unique license tag numbers (FL tags, excluding repeat visitors) from tow vehicles/trailers in ramp parking lots. License tag information was compared to the state's Vessel/Vehicle Title Registration System (VTRS), maintained by the Florida Department of Highway Safety and Motor Vehicles, yielding a subset of N=3,089 name and address matches.

Approximately 51 percent of the trailer license numbers observed at the ramps did not have a corresponding VTRS name and address match. The high rate of unmatched records can be partially explained by fact that many boaters requested that the DHSMV not make their personal information available to the public. Boater names and mailing addresses were used to conduct a mail survey questionnaire and for determining the location coordinates of name/addressed matched users. The {x,y} coordinates {longitude, latitude} for geo-coded observations were then compiled as a GIS point/data layer and mapped.

For this analysis, only the sample data for ramp patrons of Cockroach Bay were utilized. This sample was combined with a supplementary database of Cockroach Bay ramp patrons from a study

conducted by FWRI in 2004. The combined databases yielded a sample of n=504 geo-coded/address mapped observations of ramp patrons that launched a boat from Cockroach Bay during the 2003 and 2004 boating seasons.

Delineation of a Primary Service Area: A wedge-casting approach

A wedge-casting approach is used to delineate the primary service area (PSA) of the public access ramp located at Cockroach Bay. The method employed in this analysis is similar to the one used by *EdgeMap* GIS for the delineation of a market service area (see Thrall and Casey, 2002; Thrall, et al. 2002). The approach adopted in this paper, however, is more modeling oriented. As with all gravity-type formulations, it is assumed that use-intensity declines with increasing distance from a given ramp; i.e., that there is a distance-decay characteristic to ramp patronage. Furthermore, it is expected that the rate of decline and the subsequent "reach" of a ramp (and its draw) will vary depending on geographic location and direction. Directional variability in ramp use may be attributable to many factors including (a) variations in accessibility related to the location of the ramp relative to the spatial distribution of boaters; (b) established patterns of use and user preferences; (c) the physical features of the study region and coastline and the ease at which a ramp (and/or preferred on-water destinations) are accessible from various locations or launch sites; and (d) the layout of the regional transportation network along which boaters must travel to access various ramps.

To capture directional variability in ramp use intensity, point distributions of ramp patrons were mapped using latitude and longitude coordinates for geo-coded observations from the aforementioned sample. A series of wedges, centered about each ramp, was drawn within the GIS at equally spaced intervals of 15 degrees (i.e., from 0 to 360 degrees) to cover all of the possible land-based origins of boaters that were observed using the ramp (see Figure 1). Grid cells of a fixed and predetermined size were superimposed over the study region. Distance estimates, in miles, were then calculated between the centroid of each grid cell and the boat ramp. Note that distance estimates may also be obtained using travel mileage or travel times to the

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the page. In this manner, a sample size evenly divisible by four would have yielded an equal distribution of each survey type had a survey been correctly completed each time the page was visited. In reality, the distribution was nearly equal with 54 correctly completed type *a* surveys, and 51 type *b*, *c*, and *d* surveys.

3. In this study, communications is considered a group separate from social sciences because it is a separate college at the university. Social science refers to majors belonging to the College of Social Sciences. The author has assigned no other meaning to this division.

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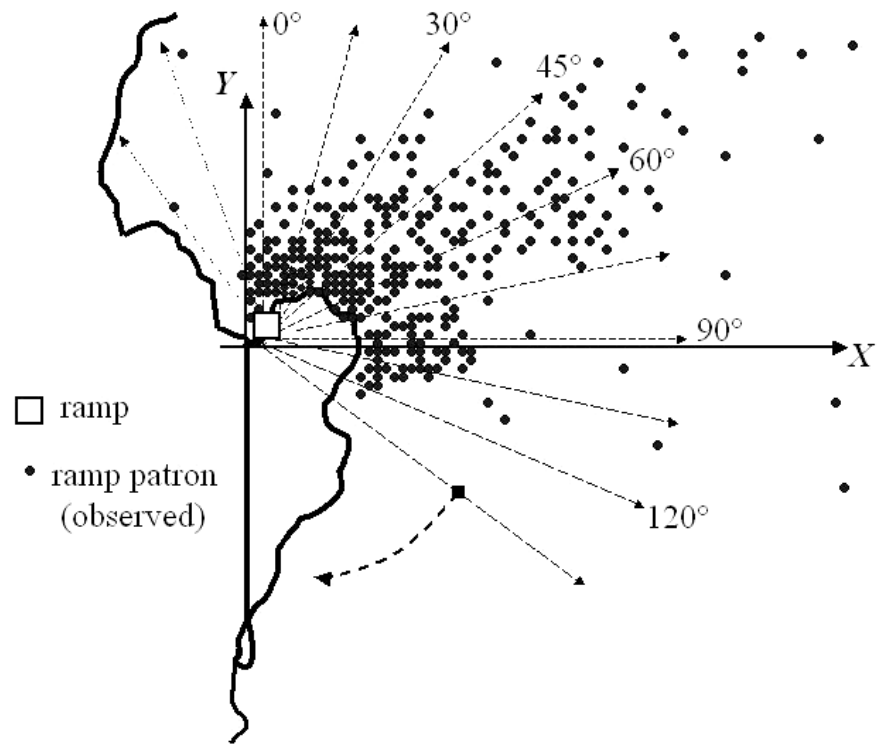
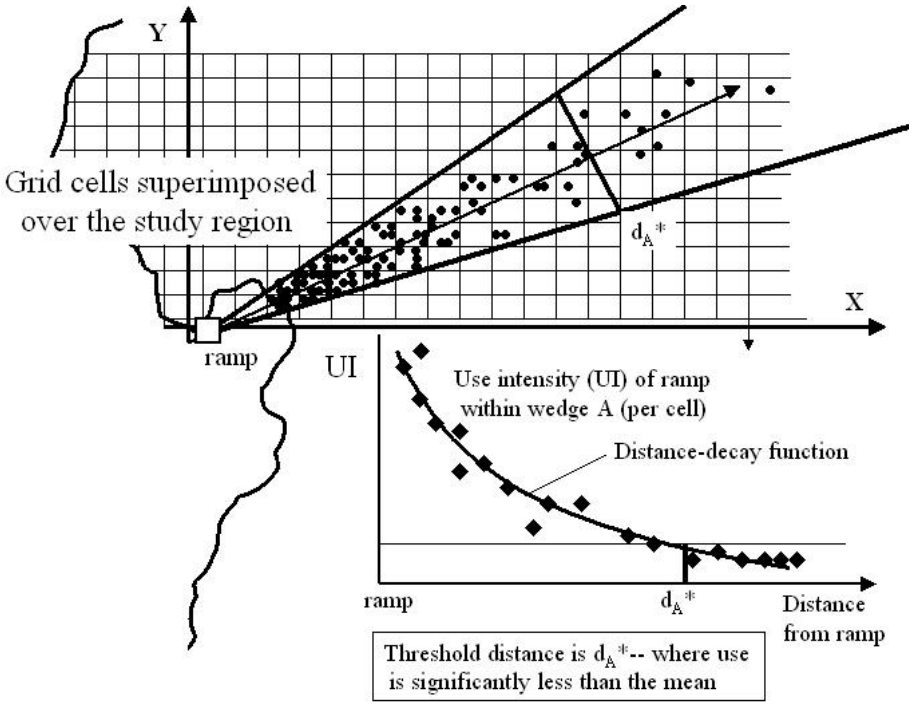
Figure 1. Wedge-casting method using 15 degree slices.



ramp assuming the shortest route along a superimposed transportation network. Use-intensity per unit area (UI) was measured simply by summing the number of geo-coded ramp patrons observed within each grid cell. Only cells with non-zero entries (i.e., with at least one geo-coded ramp patron address) were used in this analysis. Some wedges were also combined to side-step problems associated with limited sample size.

Wedge casting allows for the extraction of statistically derived wedge-specific estimates of threshold distance. Threshold distance may be defined as the distance from a ramp that marks the outer boundary of the primary service area for a given wedge (or along a transect) – the distance from a ramp at which ramp patronage falls to a level that is significantly below the average within a wedge (see Figure 2). Note that (a) the size of the grid cells, (b) the chosen angle

Figure 2. Estimation of threshold distance using a distance-decay function.



or wedge size, and (c) the orientation of wedges (via rotation of the axes) can be altered to allow sensitivity testing of threshold distance estimates. A grid cell size of 2.5 square miles was used in this analysis, given that it produced a distribution of values that ranged from a minimum of 0 to a maximum of 14 ramp patrons/points per cell from the sample data. This provided an adequate number of non-zero cell entries (and degrees of freedom) to allow estimation of the distance-decay function. The total number of non-zero entry cells equaled 272, with an average (median) patron/point count of approximately 2.4 (2.0) patrons/points per cell.

A threshold distance (d*) can be identified for each wedge, where at some distance (d), d > d*, use intensity (UI) falls to a value that is significantly less than the "mean use intensity" (UI_m) observed within a j-th wedge. To find the threshold distance, set use-intensity

meant for public consumption. More research is needed to determine if this perception holds true for the general population. If color enhancement does make a hurricane appear more threatening, this fact has implications for risk communication. When action such as evacuation is encouraged, weather broadcasters should emphasize the danger of the hurricane by showing enhanced images (which many currently do). When action is to be discouraged, however, weather broadcasters should take the time to carefully explain what the colors in the image mean and show the visible image as well.

Gamson and Modigliani (1989, in Stallings, 1990) stated that the role of news organizations is neither trivial nor decisive in the social construction of risk. Television remains an important if not the major source of information for people about weather, and especially severe weather. As part of the weather segment of the news, or as a large part of weather updates on the *Weather Channel*, satellite images do play a role in shaping public perception of threat. While there a multitude of factors determine what actions individuals take during severe weather, one should take great care to understand the influence (however small) that satellite images have in shaping perception of the hazard.

Notes

1. This is not the original web address. As a result of the change in location, the survey is no longer operational. Respondents were directed to a screen on which they could click a button to take the survey. The respondents would not have seen that there were four types of surveys. This is not the original web address. As a result of the change in location, the survey is no longer operational. Respondents were directed to a screen on which they could click a button to take the survey. The respondents would not have seen that there were four types of surveys.
2. Part of the html script for the survey included a function that allowed each of the four survey types to be called up randomly without replacement until each type had been viewed. This process would then be repeated for as long as people continued to visit

eral population in the region for a number of reasons. Firstly, people with more to lose in severe weather situations should have a greater desire to seek information about how they or their property might be affected since the relevance for this group is greater. Secondly, the average age of respondents to this survey was 21.3 years. The average age of the television news viewer is considerably older than 21. In future research on this topic, a random sample of the population affected by hurricanes should be obtained.

While the use of students was a limitation in this study, there is no reason to believe that the general public would be less influenced by image type or hurricane category. Just over half the students who responded to the survey had taken a map-reading class in the past. This may have been an advantage in interpreting the image for a handful of the respondents. So, while the public may have more experience with television news and weather, that experience does not automatically suggest that they better understand the images they view on television.

Other questions may be raised by this research. One may wonder, for instance, whether the effect of the color enhancement on threat perception is significant enough to stimulate some behavioral response. In this study, it did not. Respondents receiving the enhanced image were not significantly more likely to leave their homes ($t_{205} = 1.25$, $p > .1$), leave the area ($t_{205} = -.90$, $p > .1$), or even make other preparations ($t_{205} = -1.08$, $p > .1$). The category of the hurricane in the survey received did translate to differences in behavioral action taken in two of the three responses. While those receiving information about category four hurricanes were not significantly more likely to leave their homes ($t_{205} = .60$, $p > .1$), they were significantly more likely to leave the area ($t_{205} = -4.17$, $p = .000$). There is also suggestive evidence that the hurricane category in the survey led to differences in whether respondents would make other preparations ($t_{205} = -1.93$, $p = .06$).

Conclusions

This study did demonstrate the need to consider the influence that color enhancement has on weather images when these images are

equal to the lower limit of the (1-a) x 100% confidence interval for mean use intensity within the wedge and solve for d*, where a is a chosen significance level (in this analysis a = .01, implying a 99% confidence level). The distance-decay property of ramp patronage can be expressed as a negative-exponential function, with use-intensity (UI) defined as a decreasing function of distance (d):

$$\begin{aligned} UI &= f\,(d) \\ &= \theta \cdot \exp^{\beta(d)} \mu, \end{aligned} \qquad (1)$$

and E(ß) < 0 (i.e., there is a negative distance-decay parameter). The estimation procedure involves a semi-logarithmic transformation of (1), yielding

$$Ln\,(UI) = Ln\,(\theta) + \beta\,(d) + \varepsilon, \qquad (2)$$

where Ln(θ) is a constant term, ß is the "friction-of-distance" parameter (with the expectation that ß will be less than zero), and ε = Ln(μ) – a random, log-normal error term. Estimates for the model's constant term and the distance-decay parameter (θ*, ß*) may be found by using ordinary Least Squares regression under the usual limiting assumptions. Note that estimation of the constant term requires recovering the "anti-log" of Ln(θ), where exp(Ln θ) = θ*. Hence, once parameter estimates are recovered, estimated use-intensity UI_o at a given distance d_o (where $d_o < d_{max}$) may be defined as

$$UI_o = \theta^* \cdot e^{\beta^*(d_o)} \qquad (3)$$

and d_{max} is the observed "outer range" -- the greatest distance from which a patron is observed using a given ramp. A threshold distance (d*) can then be identified for each wedge, where at distances d > d* use intensity will fall to a value that is significantly less than the "mean use intensity" (UI_m) observed within that wedge. To find the threshold distance, set use-intensity equal to the lower limit of the (1-α) x 100% confidence interval for mean use intensity and solve for d*.

Thus, we may define $UI^* = \theta^* \cdot e^{\beta^*(d^*)}$, where

$$UI^* = UI_m - \{ t_{\alpha/2} \cdot (\sigma^* / \sqrt{n}) \} \qquad (4)$$

for a chosen α value, standard deviation estimate σ*, and sample size n – defined as the number of cells with non-zero observations/point totals within a given wedge. Equations (3) and (4) are then used to solve for the threshold distances associated each wedge, thereby revealing a geographic representation of PSA.

Logarithmic transformation and algebraic manipulation of equation (3) yields $\text{Ln}(UI^* / \theta^*) = \beta^* (d^*)$. Hence, a wedge-specific threshold distance estimate d* may be found for any set of estimated values associated with a j-th wedge $\{UI^*, \theta^*, \beta^*\}_j$, where

$$d^* = \text{Ln} \{ [UI_m - t_{\alpha/2} \cdot (\sigma^* / \sqrt{n})] / \theta^* \} / \beta^*$$

$$= \text{Ln} \{ UI^* / \theta^* \} / \beta^*. \qquad (5)$$

If $UI^* < 1.0$, then set $UI^* = 1$ to solve for d* -- the distance where use intensity UI falls to 1.0 ramp patrons per cell using the estimated distance-decay function parameters.

Should the regression model fail to produce a distance-decay parameter estimate ß* that is significantly different from zero (i.e., if one fails to reject the null hypothesis that ß*=0) then a reasonable estimate of d* must be found. This can be achieved by calculating either the median distance value (d_{median}) or the upper value of the confidence interval for the median distance value. The use of the median distance value provides a useful alternative when the distance-decay function cannot be estimated due to problems associated with (a) small sample size or limited degrees of freedom; (b) zero variance in use-intensity values within a given wedge or sector; and (c) poor fit due to the presence of "outliers" or extreme observations.

Another option is to combine wedges, should the spread of points be similar in a given direction over a broader range or reference angle. Combining wedges is useful in helping to overcome problems of small sample size (and limited degrees of freedom), yet it provides

Table 3. The four hypotheses and their test results.

	Description	Status	F (degrees of freedom)	*p*-value
Hypothesis 1a	IR perceived more threatening	Inconclusive	$3.11_{(1, 201)}$	.079
Hypothesis 1b	IR described more negatively	Not Confirmed	$.176_{(1, 203)}$	.675
Hypothesis 2a	Category 4 more threatening	Confirmed	$46.29_{(1, 201)}$	.000
Hypothesis 2b	Category 4 described more negatively	Confirmed	$11.01_{(1, 203)}$	.001

dents' levels of attentiveness had an influence on their perception of the hurricane. The results of the analysis suggest that it did not. The fact that attentiveness was not found to influence the amount of threat perceived or the negative description of the images could demonstrate that one's rating of the importance of weather information in general does not apply during cases of severe weather. During such events, attentiveness is likely to be already heightened. Several respondents in the focus group, who would have been described as weather non-attentive, discussed the desire to view severe weather as an event. Perhaps a more adequate measure of attitude could have been devised to take this desire into account. It is also possible that a more appropriate attitude to measure would have been the predisposition to feel threatened in less intense situations. In future research, this variable should be considered.

A major limitation to this study, which may have impacted the results, was the use of students as the respondents. Students might not be the best indicator of public perception of hurricanes. As a group, students do not own property and would not have the same decisions to make during a hurricane. The researcher was surprised at the number of students who did view television news or the *Weather Channel* during the tropical storm and hurricane situations in the survey. She also feels that this number would be higher among the gen-

= .000).

A covariance analysis was run to determine if the attitudinal factor attentiveness had any influence on responses on threat perception or negative description. When controlling for attentiveness, however, all results remained the same. Thus, while attentiveness may have some influence on perception of threat and negative description, it is not statistically significant.

Discussion

Hypothesis 1a proposed that color enhanced images would be perceived as more threatening than unenhanced visible images. The analysis was performed using the constructed variable, threat perception, to determine whether this was the case. The analysis suggested that due to factors associated with the placement and use of colors in the image as discussed previously, a color enhanced IR image would be perceived as more threatening than a similar un-enhanced visible image. While the color-enhanced image was perceived as more threatening, it was not described more negatively. Hypothesis 1b was not confirmed. A significant difference was not detected between images received in their negative description. A possible explanation for this lies in the selection of the nine descriptors. The focus group discussion provided the basis for selection of these descriptors. Other words might have been more appropriate for the images they were meant to describe.

Hypothesis 2a stated that the category four hurricane should be perceived as more threatening than the category two hurricane. The analysis of variance confirmed this hypothesis regarding the influence of strength of the hazard on the amount of threat perceived. One would expect this to be the case. Hypothesis 2b was also confirmed. The analysis suggested that category four hurricanes were also described significantly more negatively than category two hurricanes, confounding the earlier suggestion that selection of descriptor was inappropriate. See Table 3 for a summary of hypotheses and results.

Given the results of the focus group discussions, a final non-directional research question was raised to determine whether respon-

Table 1. Regression Results for Cockroach Bay: estimated distance-decay parameters (β*) and estimated threshold distances (d*).

wedge(s)/degrees		**distance-decay β***	(prob.)	threshold distance d*	cells	points	d.f.
1	0-15°	na		25.22**	18	21	--
2	**15-30°**	**-.03309**	**(.0256)**	**33.60**	**25**	**37**	**22**
3	**30-45°**	**-.03035**	**(.0441)**	**31.38**	**41**	**100**	**38**
4	**45-60°**	**-.01634**	**(.0003)**	**43.76**	**76**	**182**	**73**
5	**60-75°**	**-.01440**	**(.0442)**	**47.32**	**48**	**84**	**45**
6	**75-90°**	**-.04346**	**(.0004)**	**50.51**	**19**	**33**	**16**
7-8	**90-120°**	**-.01505**	**(.0741)**	**50.41**	**13**	**17**	**10**
9-12	120-180°	na		11.38**	6	7	--
13-14	180-210°	na		8.26**	12	12	--
15-18	210-270°	na		--	0	0	--
19-22	270-330°	na		12.11**	7	3	--
23-24	330-360°	na		27.17**	7	8	--

*Note: Estimated threshold distances shown in miles; six of the 12 regression runs produced significant results at the 90% confidence level or higher (shown in bold, with probability estimates in parentheses); r-square values ranged from .11 to .40; na – means not applicable; ** "fail to reject" H_o: $\beta = 0$ at 90% confidence, with d* estimates based on observed median distance value within wedge/sector.*

less accurate results when estimating direction-specific threshold distances.

Once wedge-specific threshold distance estimates are compiled, the general shape of the PSA will be revealed. This same procedure can then be applied to all ramps in a given study area using a hypothetical or "average" launch location (based on the average {x,y} coordinates for all ramps in the study region) and the observed point distribution of the origins of ramp patrons observed launching from those ramps. This analysis will reveal a regional service area (RSA) – the predominant regional market area that represents the locations from which ramp patrons are drawn taking into account variations in the directional orientation of travel patterns and estimated distance-decay parameters. Mapping the RSA will allow an individual ramp's market draw potential to be compared to the draw potential of all ramps in the study region.

The Results

The regression results for Cockroach Bay are shown in Table 1. In cases were a fairly large number of non-zero entry cells were available, the model did quite well in terms of producing a statistically significant estimates of the distance-decay parameters and threshold distances. Note that the regression models for wedges 2 through 7-8 yielded probability values < .10 for β*. Notice also that some of the 15-degree wedges were combined to increase the number of cells where point densities were low. In these cases, estimates of threshold distance were based on the median travel distance value. The outer boundary of the primary service area for Cockroach Bay is shown in Figure 3.

Note that this modeling approach did quite well in terms of estimating threshold distances and capturing areas with the highest density of points (areas where ramp use intensity is high based on the observed point distribution). This is especially true for the wedges associated with ramp patrons located along the northern, northeastern, and eastern sections of the service area. The wedges along the southwest, however, seem to be over-estimated. This is undoubtedly tied to a relative small sample size and the presence of distant or outlying points. All in all, the wedge-casting approach provided an adequate representation of the PSA for Cockroach Bay. Points/patrons that are located beyond the outer boundary of the PSA, but within the state or region, may be thought of as being part of the ramp's "secondary service area" (SSA). Note that the PSA for Cockroach Bay accounted for roughly 77% of its ramp patrons; a value that is acceptable in terms of Applebaum's targeted market capture rate for a PSA.

A similar regression-based approach was taken to delineate the regional service area (RSA) using the entire point distribution for all N=31 ramps in the Tampa Bay and Sarasota Bay regions. The results are based on the average launch location (from ramp coordinates) and the entire sample point distribution of ramp patrons in sample. The average ramp location is the representative geographic center from which a typical boater would launch (hypothetically), and the RSA represents the primary service area for all ramps within the

Hypothesis 1a. Color enhanced images will be perceived as significantly more threatening than unenhanced visible images.

Hypothesis 1b. Color enhanced images will be described significantly more negatively than unenhanced visible images.

Hypothesis 2a. The category four hurricane will be perceived as significantly more threatening than the category two hurricane.

And

Hypothesis 2b. The category four hurricane will be described significantly more negatively than the category two hurricane.

Analysis of variance was then utilized to determine if the strength of the hurricane (category two or four) and the type of image received (enhanced IR or unenhanced visible) led to the same amount of threat perceived and the same level of negative description. This analysis used the new variables *threat perception* and *negative description*. The results of these tests indicated that those students receiving category four hurricane information perceived significantly more threat than those receiving category two hurricane information ($F_{1,\ 201} = 46.29$, $p = .000$). Similarly, those receiving category four hurricane information described the images significantly more negatively than those receiving a category two hurricane ($F_{1,\ 203} = 11.01$, $p = .001$).

The difference in perceived threat between those who received color-enhanced IR images and those who received unenhanced visible images approached significance ($F_{1,\ 201} = 3.11$, $p = .079$). No significant difference was found, however, between IR and visible images in terms of being negatively described ($F_{1,\ 203} = .176$, $p > .1$). The category four IR image was described significantly more negatively than both of the category two images ($F_{3,\ 201} = 3.91$, $p = .01$). The category by image by threat perception analysis mirrored the category by threat analysis. In other words, no significant difference was found in category by image, but significant difference was found in both images per category ($F_{3,\ 199} = 16.78$, p

and other storms the respondent may have experienced) most respondents (from 64.7% to 73.4%) reported viewing local television news and the *Weather Channel*. Respondents were not asked whether they would view television news or the *Weather Channel* during the hypothetical event.

Reliability Analysis

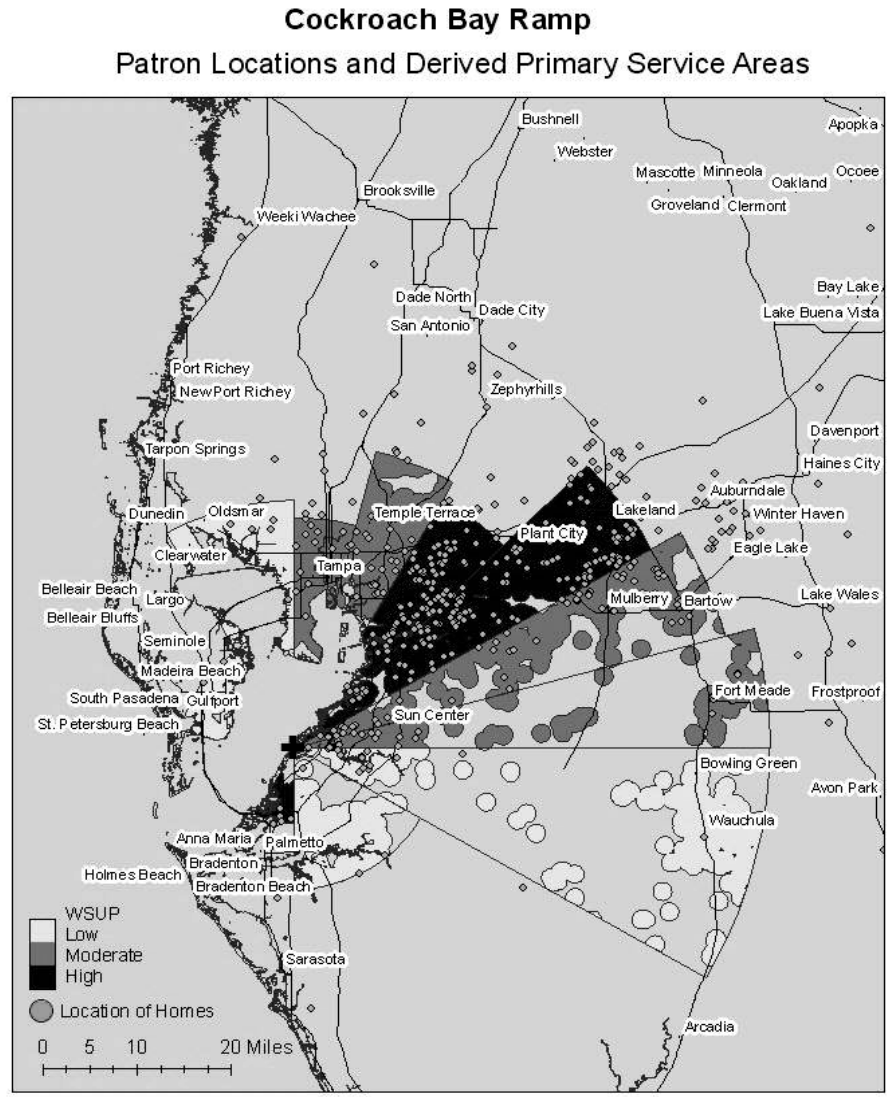
Nine items attempted to measure the respondents' weather "attentiveness." Attentiveness was a construct operationalized as the sum of five of the attitudinal variables (interested in weather, informed about weather, considers weather daily, considers weather when making future plans, and fascinated with hurricanes), which were chosen through a reliability analysis using Cronbach's alpha (alpha = .6806). These questions dealt with the importance that students placed on weather knowledge, and an interest in hurricanes.

Six items were also combined using Cronbach's alpha for each of the four survey types (alpha = .8877, .8877, .8145, and .7991 for survey a through d respectively) to create the new variable *threat perception*. These six items relating to the perceived characteristics of the hurricane were intensity, damage potential, impact on oneself, impact on the coast, probability of landfall, and concern. Finally, this same technique was used to select the four most appropriate descriptors for the image students received. From the list of nine words, "bothersome," "horrible," "scary" and "worrisome" had the highest alpha values for survey types a through d (alpha = .7637, .7851, .8430 and .5519 respectively). These four descriptors were thus combined to create the new variable *negative description*.

Analysis of Variance

Prior to the analysis of variance, it became clear that the initial two hypotheses, which dealt primarily with the first variable *threat perception,* needed to be expanded to account for the addition of the second variable *negative description*. Since these two variables would remain distinct throughout the remainder of the analysis, the initial hypotheses were rewritten as follows.

Figure 3. The Primary Service Area (PSA) for the Cockroach Bay ramp.



Tampa Bay and Sarasota Bay boating regions.

The general outline of the RSA is shown in Figure 4. Note that the RSA retains a shape that is similar to that of the PSA for

Figure 4. The Regional Service Area (RSA) for N=31 public access ramps in the Tampa and Sarasota Bay area.

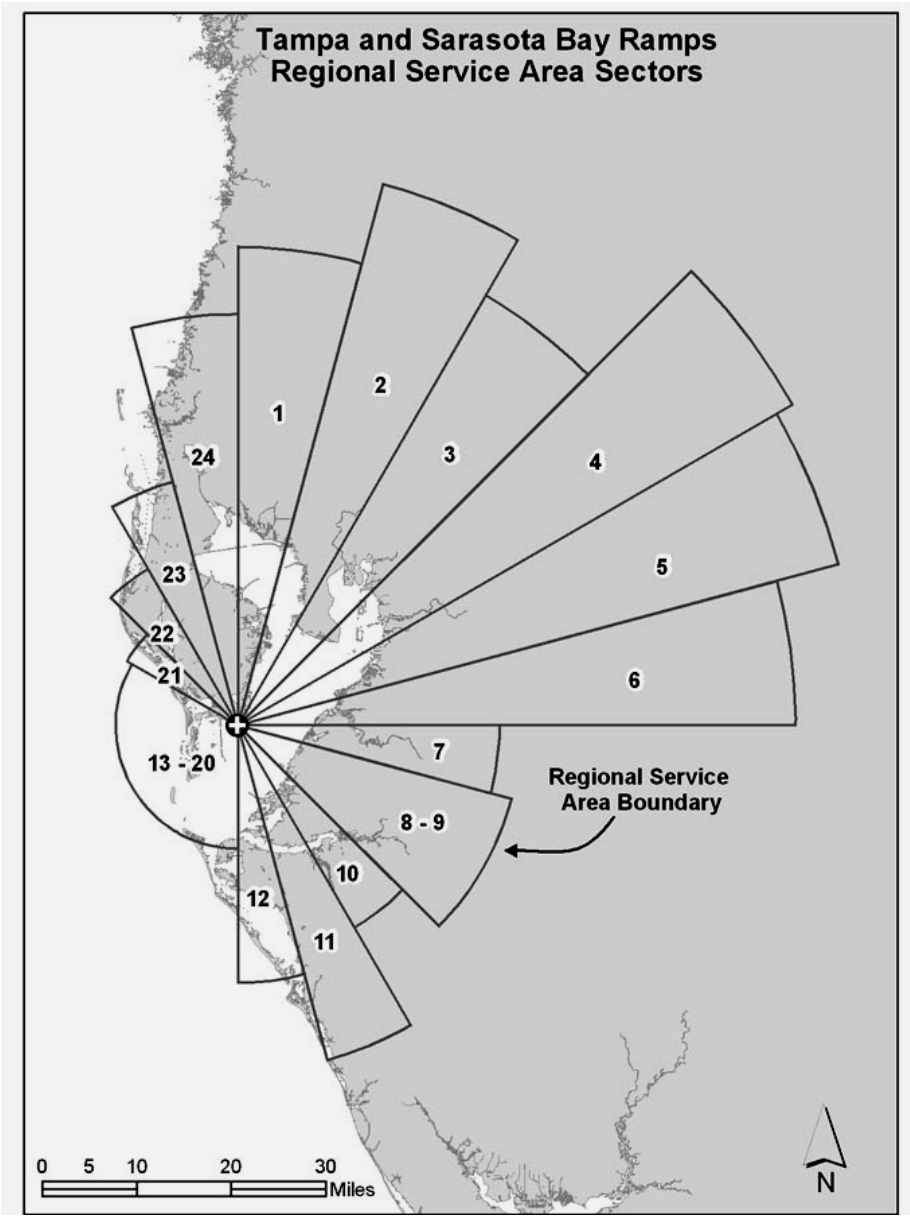


Table 2. Viewing behavior. The table shows how frequently respondents view weather on television and where they get most of their weather information.

I watch the Weather Channel…

Always	Often	Sometimes	Rarely	Never
10.6% (22)	32.4% (67)	30.4% (63)	20.3% (42)	4.8% (10)

I watch the weather segment of my local news…

Always	Often	Sometimes	Rarely	Never
14% (29)	37.7% (78)	27.5% (57)	10.1% (21)	9.3% (19)

I get much of my weather information from…(percent replying "yes")

Weather Channel	TV News	Internet	Friends & Family	Radio	Newspaper	Other
70.5% (146)	65.7% (136)	45.4% (94)	48.8% (101)	38.2% (79)	23.7% (49)	6.3% (13)

Viewed the following during other tropical events…(percent replying "yes")

Weather Channel	Local Television News
On average 67.5% or 140 per storm	On average 68.4% or 142 per storm

1). An overwhelming majority (81.6%) called Florida their "home state," although twenty-two states, one territory and two foreign countries were represented, and a majority majored in either a social science field (23.2%) or communications field (38.6%).[3] The mean age of respondents was 21.3 years old (standard deviation, 4.09) with a range of 18 to 57. 83.6% (173) of respondents were 22 years old or younger. Additionally, many students had taken classes in one of the subject areas listed above (e.g. map reading, 51.7%).

A plurality of respondents (37.7%) watched local television weather "often" or "sometimes" (27.5%), and watched the *Weather Channel* "often" (32.4%) or "sometimes" (30.4%) (See Table 2). The most common source of information about weather for respondents was the *Weather Channel* with 70.5% replying "yes" they watched the *Weather Channel.* Local television news was viewed by 65.7%. During the actual events (Hurricane Gordon, Tropical Storm Helene,

Table 1. Sample characteristics. Respondents who completed the survey were predominantly female, from Florida, between the ages of 20-21 and Communications majors.

Sex	**Male**	**Female**
	37.6% (77)	62.4% (128)

Home state	**Florida**	**Northeast**	**Southeast U.S.** (Not including FL)	**Other U.S.**	**Non-U.S.**
	81.6% (169)	7.2% (15)	4.3% (9)	4.3% (9)	1.4% (3)

Major (coded)	**Communications**	**Social Science**	**Business**	**Physical/Natural Sciences**	**Other**
	38.6% (80)	23.2% (48)	13% (27)	5.3% (11)	18.2% (37)

Age	**18-19**	**20-21**	**22-23**	**24 and over**
	26.1% (54)	45.9% (95)	15.5% (32)	12.3% (23)

Class Experience	**Map Reading**	**Map Making**	**Hazards**	**Other Weather Class**
	51.7% yes (107)	14% yes (29)	29.5% yes (61)	35.7% yes (74)

tion-seeking habits, and prior class experience in weather, natural hazards or map making/reading.

Survey Results

Sample Characteristics

Of the 254 students who gave their permission to take part in the project, 210 actually completed the survey, of which 207 were used. Three were discarded because they appeared to be duplicates. Of those respondents completing the survey who answered the question, 62.4% (128) were female and 37.6% (77) were male (See Table

Cockroach Bay, particularly for wedges along the northern and western portions of the study region. The RSA, however, extends farther out (as would be expected), especially along the northeastern sectors of the study area. This is no surprise given that the locations associated with this area contain the largest number of VTRS boats per unit area. Note that the estimated regional service area (RSA) accounted for approximately 79% of all ramp patrons in the sample. Statistical results for both the PSA and RSA yielded market capture rates that were in line with criterion established by Applebaum.

Draw Potential and Use Intensity

A ramp's draw potential (RDP) may be found by comparing the size of the PSA (coverage in square miles) to the size of the RSA. The RDP essentially describes the geographic "reach" or draw of a given PSA using the RSA as a benchmark. The greater the area associated with a PSA, the greater the geographic reach of the ramp's service area when compared to the reach all ramps within the study region. RDP can be thought of as a measure of relative spatial coverage of a ramp's predominant market area, and to what extent it might be localized or regionalized. It can be used to identify ramps that draw users from proximate versus more distant locations. The RDP for Cockroach Bay is approximately .47 (or 1,249sq. mi. / 2,686sq. mi.). This reveals that the PSA for Cockroach bay is roughly half of the size of the RSA, suggesting that it draws from a fairly large geographic area.

Ramp patrons in each wedge of the PSA are known to contribute to a ramp's use. Hence, a wedge-specific user potential (WSUP) index may also be calculated. For an i-th ramp or PSA, let p_{ij} denote the number of observed geo-coded points/patrons in wedge j, and let A_{ij} denote the total area within wedge j that is known to contain a boating population (prospective ramp users). The boat/boater "supply area" of a wedge can be defined as the geographic area where VTRS records are observed for trailer-able boats (i.e., boats less than 26 feet in length), excluding areas where such boats/boaters do not reside, based on the geo-coded address information from Flor-

ida's VTRS and "buffered" areas that encompass the boating population.

A wedge-specific user-potential (WSUP) index for an i-th PSA and a j-th wedge may be defined as:

$$WSUP_{ij} = \{ [p_{ij} / \sum_{j=1}^{m_j} p_{ij}] / [A_{ij} / \sum_{j=1}^{m_j} A_{ij}] \},$$

where p_{ij} is the number of patrons observed in a j-th wedge, A_{ij} is the total area within a j-th wedge associated with VTRS boats, and m_j is the total number of wedges/sectors that define an i-th PSA. Note that this index is similar in design to a "location quotient" in terms of its structure. It is a ratio of ratios, an index that contrasts the percentage of points found within a wedge to the percentage of boating area from which patrons are likely to be drawn. Unlike the location quotient, the WSUP index is a use-intensity measure that highlights the proportion of users associated with a given wedge (on a per unit area basis) taking into account only those areas in which there is a resident boating population as established from VTRS records. In other words, the WSUP index is a relative measure of inter-wedge use variability that highlights the degree to which ramp patrons located within a given wedge account for ramp use controlling for the uneven density and distribution of the boating population within the PSA itself.

WSUP index values for the Cockroach Bay ramp are highlighted in Figure 3 (see shaded wedges). The values are broken down into three categories: low, medium, and high use-intensity based on equal intervals. WSUP values ranged from a minimum of approximately 1.5 to an observed maximum value of approximately 6. Notice that the big contributors to ramp use are associated with the northeasterly wedges. It is no surprise that these wedges run along the western side of Florida's I-4 and major transportation corridors as they make their way toward the Tampa Bay area. Notice also that ramp use intensity as measured by the WSUP index is shown to decline with increasing distance from the major transportation corridors. This pattern is also consistent with the spatial distribution of VTRS boats and the high density of boats/boaters located along areas that

Figure 3. Enhanced IR satellite image. Half of the respondents received this infrared image (in color on the webpage), and were told it was either a category 2 or a category 4 hurricane. No information was provided about what the colors indicated. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/IR_Hur.jpg.

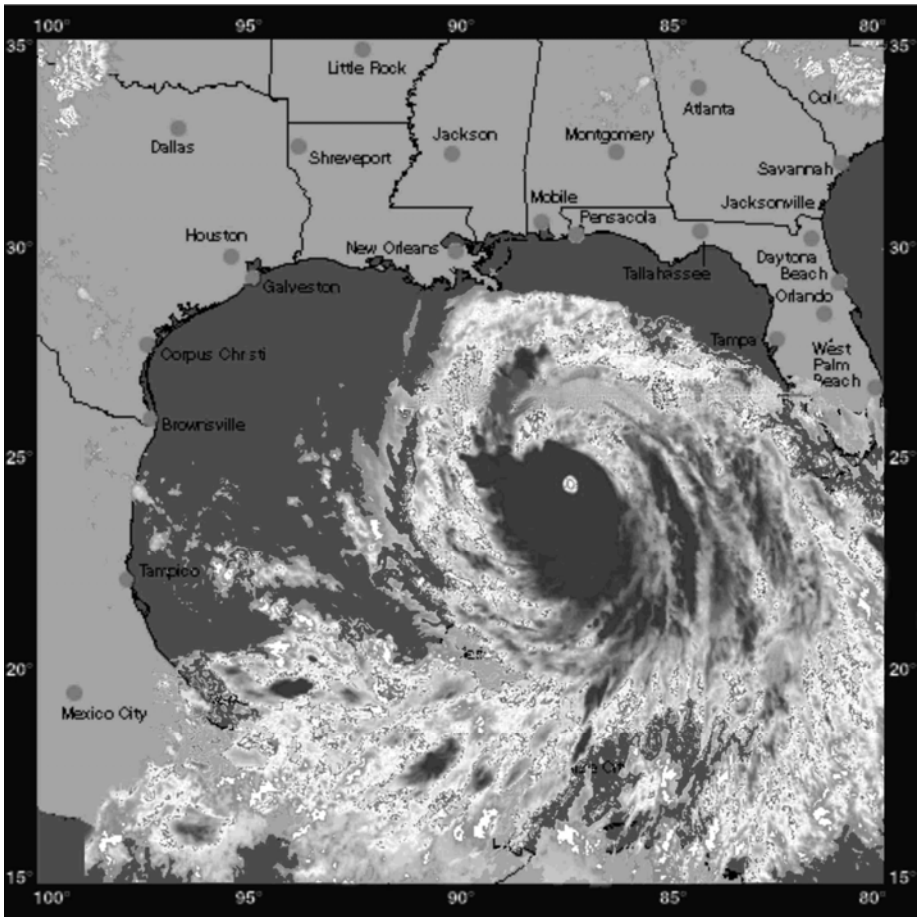
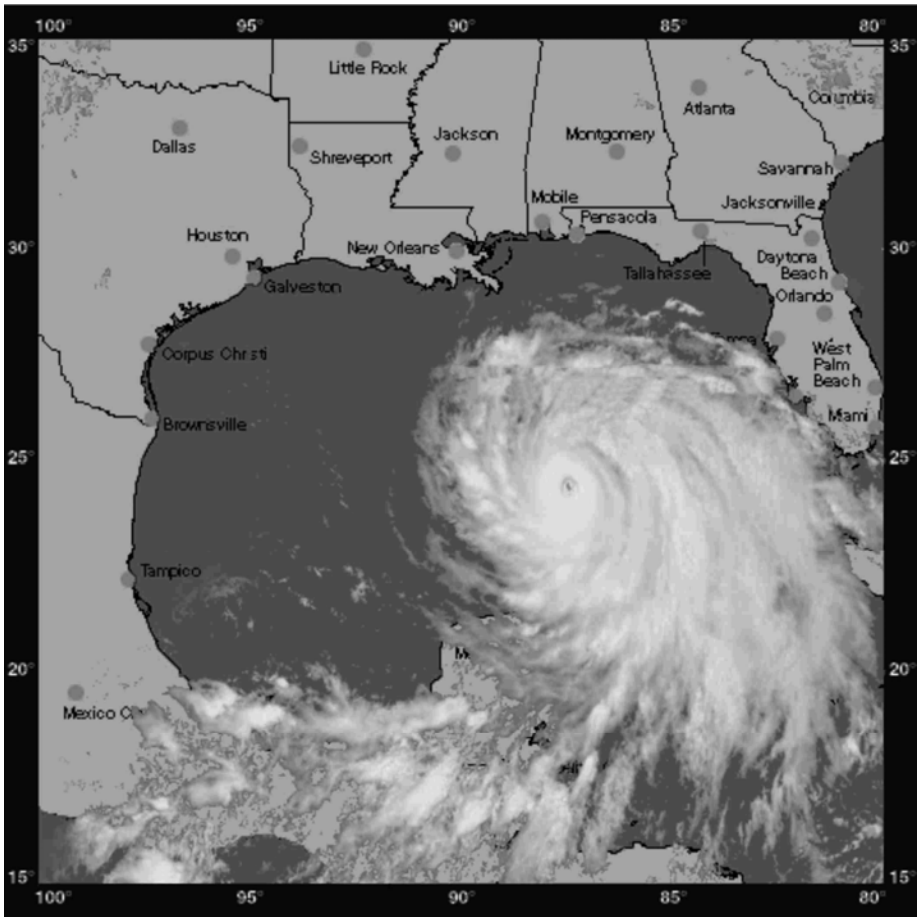


Figure 2. Visible, unenhanced satellite image. Half of the respondents received this visible image (with base map and ocean in color), and were told it was either a category 2 or a category 4 hurricane. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/VIS_Hur.jpg.



run parallel to the transportation arteries found within the study region. This suggests that the geography of VTRS boats and the regional transportation network play important roles in influencing the demand for the public access ramp located at Cockroach Bay.

In order to better reflect the geographic area from which boaters are drawn to a given ramp, the PSA may be "fine-tuned" in accordance with the observed use intensity values that are found within the PSA and the use intensity found outside the PSA. In short, the PSA may be optimized to better reflect the spatial distribution of use intensity. This can be accomplished by applying a cell-based procedure (post PSA estimation), deleting cells within the PSA with use intensity values that fall significantly below the average value and augmenting the PSA to have it include cells in the secondary service area where use intensity is not significantly different from that which is observed with the PSA itself. This would require evaluation of the underlying trend surface of ramp use (i.e., modeling use probabilities) and a cell-based demand analysis. Directions for future research also include a complimentary water-side analysis to uncover the spatial distribution of on-water destinations that are associated with particular ramps to test the hypothesis that boaters are "distance minimizers" with respect to favored on-water destinations (i.e., boaters choose ramps that are both close to home and close to their favorite on-water site).

Concluding Remarks

The wedge-casting approach for estimating a ramp's PSA and the accompanying descriptive indices offer tremendous potential for highlighting spatial patterns of ramp use intensity. Future applications must involve large sample sizes (where the sample size exceeds, say, 1000 observed ramp patrons per public access ramp) to ensure adequate representation of the spatial distribution of demand. The analysis in this paper may be expanded to generate *probability estimates* that represent the likelihood of ramp use from various locations within the study region. In addition, inspection of favored on-water destinations may shed light on the patterns of ramp use and what estuarine areas users are likely to impact once boaters launch from a

given ramp. Moreover, the methods applied in this study could be useful in helping to locate additional public access ramps within the study region (based on existing and/or projected demand, the distance-decay properties of ramp patronage, use intensity measures, and VTRS information). The empirical findings in this study are consistent with results from a previous boater survey in the Tampa and Sarasota Bay area (Sidman, et. al 2004), in which boaters were characterized as "distance minimizers" with respect to ramp choice. The ramp-use patterns for Cockroach Bay also reveal a primary service area with use intensities and an outer boundary that is highly influenced by the regional transportation system and the spatial distribution of registered boats.

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Section Two presented respondents with a hypothetical hurricane scenario and sought to measure the amount of threat they perceived from the information they were given. Before completing the remaining questions, respondents were asked to read a paragraph describing a hypothetical hurricane situation. All surveys included this brief descriptive paragraph about the hurricane along with an image showing the forecast track. This image (Figure 1) contained a map of the Gulf of Mexico with the surrounding states and the probable track of hypothetical Hurricane Zeke. Close to half of the respondents would receive information about a category two hurricane while the remaining respondents would receive information about a category four hurricane. The first image remained the same for each respondent. The descriptive paragraph varied slightly according to the severity of the hypothetical hurricane. The second image respondents viewed in Section Two contained the same base map, but had a hurricane satellite image (from the National Climate Data Center's Historical Significant Events Imagery archive) superimposed upon it. Roughly half of the surveys would contain a visible satellite image in which the hurricane appeared in gray-scale (Figure 2), while the remaining surveys would contain a color-enhanced IR image (Figure 3). Thus the respondents could have received one of four possible survey versions henceforth referred to as surveys *a* through *d.* These versions combined the two image types with the two hurricane categories. Ideally, these four versions would be divided equally among the respondents.[2]

The purpose of Section Two was to determine whether the image that respondents received had any influence on the rating students assigned to questions measuring threat. Threat was measured by respondents' ratings of a series of factors based on two of the four characteristics of threat—severity and certainty—which, according to Lindell and Perry (1992), influence an individual's motivation to respond. Other questions asked respondents to rate the images they received based on the appropriateness of the nine descriptors and then to decide what actions would be necessary if the hypothetical hurricane had been a real event. Finally, respondents were asked demographic questions as well as questions pertaining to weather informa-

Figure 1. Forecast track map. All survey participants were shown this image (in color) of hypothetical Hurricane Zeke located in the Gulf of Mexico, forecast to make landfall in Florida. The dark shading along the coast indicates a hurricane warning, while the light shading indicates a hurricane watch in effect. The survey contained a statement explaining what these colors meant along with the image. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/watch_warn.jpg.

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These specific words were selected from the larger list of forty-five because participants used these words most frequently to describe something positive, negative and annoying. Finally, participants agreed that the hurricane images to be included in the survey indeed appeared realistic. One participant also confirmed the researcher's early hypothesis that color enhancement increases the level of threat perceived with a shout of "Wow that looks really bad!" when shown the color-enhanced IR image.

Survey

The preliminary survey instrument was then modified given the results of the focus groups. To obtain a sample for this project, students were recruited to participate from seven classes offered by the communications and the geography departments at a large state-funded institution in Florida. One of these classes was taken by students of all majors; predominantly communication and geography majors took the remaining six classes. A total of 254 students were recruited and gave their permission to take part in the survey. Once consent was obtained, students were directed to the researcher's website (*http://www.msstate.edu/courses/kms5/hurricane.html*)[1] to complete the survey online. Students could visit the site either by typing in the address in the top of their browser or by clicking on a link sent to them via e-mail.

The survey consisted of twenty-five questions arranged into two general sections. Section One attempted to create a profile of the respondents' attitude towards weather and past behavior during hurricanes. Some of these statements reflected the attitudes that emerged during the focus group discussions. Questions one through nine asked respondents to respond to statements about their attitudes towards weather using a Likert scale. For instance, one of the statements read, "I believe it is important to be informed about the weather." Questions ten through thirteen asked respondents about their actions taken during two tropical systems that made landfall in Florida during September and October 2000, and during other hurricanes by which they were affected.

cussion time of two hours was divided into three parts. The first part of the discussion focused on weather; initially weather in general and then severe weather specifically. During the second part of the focus group discussion, participants were given a list of forty-five words. They were told to group these words together as they saw fit. Next, participants were asked to think of these words in terms of their ability to describe something negative. This enabled the researcher to see how such words could be used to describe a hurricane image. Finally, participants were given the opportunity to examine several satellite images of hurricanes, both IR and visible. Participants were then asked for their opinions and first impressions of these images so the researcher could determine whether the images were indeed realistic representations of a hurricane.

The focus group discussions resulted in several important outcomes. The discussion forced the researcher to modify several questions on the preliminary survey dealing with attitudinal variables to account for a range of attitudes towards weather that emerged in the focus group participants classified as "attentiveness" to "non-attentiveness." These attitudes can be conceptualized as the degree of importance and dependence one placed upon weather, as well as the level of interest one had in severe weather. Those participants in the focus groups who showed a low level of weather attentiveness had little experience viewing weather graphics on television. For example, some did not know the difference between the radar images shown on the *Weather Channel* and the satellite images shown to them during the focus group. This lack of basic satellite image understanding led to the following research question, as well as the consideration of attentiveness as a variable in the survey.

> *Research Question: What influence, if any, will the respondents' level of weather attentiveness have on their perception of the hurricane image in the survey?*

Focus group discussion also led to the creation of a smaller list of descriptive words. The nine words chosen—*attractive, boring, bothersome, confusing, horrible, peaceful, scary, vibrant* and *worrisome*—were used on the survey to represent the degree to which the image respondents received was positive, negative or annoying.

Issues on the Use of Variogram-Based Feature Vectors in Content Based Image Retrieval

Zhixiao Xie and Fang Qiu

Introduction

Content Based Image Retrieval (CBIR) intends to objectively and efficiently retrieve interested images or image segments (pixel blocks) from a large-volume image database based on the content similarity between a query icon (or sample image) and database images (or image segments). CBIR was originated from computer vision and database community (Flickner et al., 1995; Pentland et al., 1996; Smith and Chang, 1996) and has been gradually accepted by GIScientists for geographic image database applications (Ma and Manjunath, 1996; Bruns and Egenhofer, 1996; Sheikholeslami et al., 1999; Agouris et al., 1999; Stefanidis et al., 2002; Bian, 2003; Bian and Xie, 2004).

To geographers, image retrieval is a reversal to image classification in regard to operational process since image retrieval starts with a content description and then identifies locations that contain the content. Image classification, on the other hand, begins with a study area and then identifies contents within the area. One key component in CBIR is to represent the semantic content of an image segment, often through a numeric index vector (called feature vector), with each element being a measurement of a visual property, such as color, texture, shape and so on. To represent the important spatial structure information within geographic images, approaches based on variogram has recently been adopted for CBIR (Huang et al., 1999; Aksoy and Haralick, 2000; Bian and Xie, 2004). While the concept of variogram

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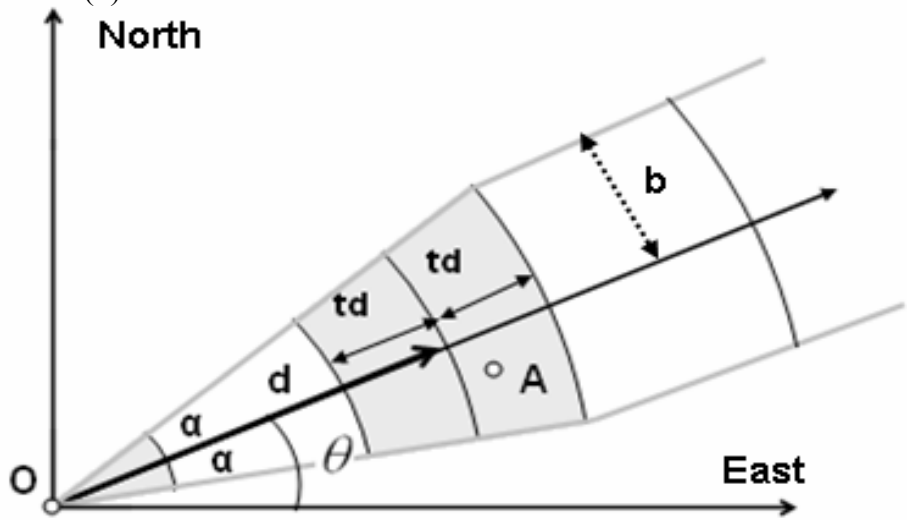
Figure 1. Illustrate how to determine whether two sample points (O, A) are location pairs separated by a lag *d* along a direction θ, defined by a distance tolerance (*td*), a direction tolerance (α), and a bandwidth (*b*).



is not new, some important aspects require further study to ensure these approaches be properly applied in CBIR. This paper examines several issues in this regard.

Variogram

Variogram is a key concept underlying a set of spatial interpolation approaches called Kriging in geostatistics (Issaks and Srivastava, 1989). Like many spatial interpolation methods, the objective of Kriging is to interpolate a continuous surface from a limited number of sample points. In an image, the pixel centers are normally regarded as the nominal sample point locations. It is from these sample points that empirical variograms are constructed and used for subsequent inference.

A variogram (or more formally, semi-variogram) is a plot of semi-variance vs. lag distances, where the spatial continuity or the association between semi-variances and the lag distances is explicitly presented. The association may show directional difference, representing

of the risk. Sandman et al. (1998) state that the effectiveness of risk explanations should not be studied without considering the size of the risk. Often literature offering explanations of public behavior or perception includes cases with more than one level of severity (Sandman et al., 1998 and Baker, 1995). This study therefore included two levels of severity, a category two hurricane and a category four hurricane. Intuitively, events with a greater degree of severity will be perceived as more threatening. This leads to the second hypothesis.

> *Hypothesis 2: The category four hurricane will be perceived as more threatening than the category two hurricane.*

Methodology

To examine these hypotheses, a survey instrument was created that would measure a respondent's perceptions of a hypothetical hurricane. Participants would be given one of four survey types based on the level of severity (category two or four), and type of image (color enhanced IR or unenhanced visible). Before administering the survey, however, the researcher believed it best to ascertain that the questions to be asked on the survey actually measured what variables they intended to measure. To accomplish this, a series of focus groups was run using undergraduate students. Using the results of the focus group discussion, a final survey was created and administered. Undergraduate students were used in the focus group because they would comprise the sample used in the survey research.

Focus group

The purpose of the focus group was to create a better survey instrument. Beyond that broad purpose, however, the two focus group discussions had three primary goals: (1) to acquire a better sense of what attitudes might be present in the study population that might predispose respondents to perceive more or less threat regardless of the level of severity or image shown; (2) to analyze the list of descriptive words the researcher planned to use in the survey as well as the types of question planned; and (3) to evaluate the images created for the survey. With these goals in mind, each focus group's dis-

on a blue background, such as many television stations do, could cause the image to stand out more when viewed quickly due to figure-ground relationship and the advancing properties of the colors in the image compared to the retreating colors of the base map. Compared to the IR image, the visible satellite image composed of white and gray is more difficult to differentiate from the blue background and may not provoke the same amount of attention.

The combined interaction of several of the display characteristics in the IR image that are not present in the visible image provide reason to suggest that color-enhanced IR images will be perceived as more threatening than unenhanced visible images. This is due to the IR image's use of colors that suggest danger, its more pronounced figure-ground effect, and its juxtaposition of advancing warm reds against a cool blue background. These factors present in the enhanced IR image and not the unenhanced visible image lead to the first hypothesis.

Hypothesis 1: Color enhanced images will be perceived as more threatening than unenhanced visible images.

The Influence of Storm Characteristics

One must also consider the characteristics of the storm itself when attempting to determine how different images influence perception. Literature on what factors of the storm itself influence threat perception helped in the creation of the survey used in the study. After examining previous research, Lindell and Perry (1992, p. 149) concluded that public perception of natural hazards could be organized into four categories: "characteristics of the hazardous agent, characteristics of impact, perceived personal consequences and affective reactions to the hazard." They also found that much of the literature supports four predominant characteristics of threat, which influence individual's motivation to respond: severity, certainty, immediacy and duration of impact (Lindell & Perry, 1992). These factors were considered along with the image characteristics in the attempt to measure respondents' perceptions of the hypothetical hurricane threat.

One of the characteristics, severity, takes into account the size

spatial continuity anisotropy, and the anisotropy can be characterized by the differences of variograms along different directions. In geostatistics, a semi-variance $\gamma(h)$ is commonly calculated as the average of the squared difference of values of a variable at paired locations separated by a lag distance h, and along a specific direction θ (Eq. (1)).

$$\gamma(h) = \frac{1}{2N}\sum\left(V_s - V_{s+h}\right)^2 \tag{1}$$

where, V_s and V_{s+h} are the values of a variable at two locations separated by a lag distance h; N is the number of such location pairs. To construct a useful variogram, a sufficient number of sample location pairs for each lag distance are required, since too few pairs may give a variogram too erratic to serve as a useful description (Issaks and Srivastava, 1989). However, in many cases, sample location pairs may not be separated exactly by a distance used for a lag and along a direction needed in the variogram plot. Therefore, a tolerance for distance (td) and a tolerance for direction (α) are often used to determine whether two (set of) sample locations could be paired for a lag (Fig. 1). For example, although OA is not exactly separated by a lag distance d, along a direction θ, OA is still considered as a location pair separated by a lag distance d, because A falls within the area defined by distance and directional tolerances. Obviously, the areas defined by tolerances for two neighboring directions may overlap, causing some location pairs to be used for more than one direction, which will possibly blur some directional differences (Deutsch and Journel, 1997). Therefore the overlap should be carefully reduced. Further, a bandwidth b may be applied as well to further decrease the blurring effects (Fig. 1).

In Kriging, after the empirical variograms have been calculated from sample locations, they are usually fitted with theoretical models, most commonly spherical, exponential or Gaussian. These theoretical models are later used to derive the weights of sample locations for interpolating values at un-sampled locations. However, application of variograms in CBIR is somehow different.

Variograms applied in CBIR

Variograms have been used to capture textual information for CBIR (Huang et al., 1999; Aksoy and Haralick, 2000; Xie, 2004) and for remote sensed image classification (Curran, 1988; Miranda et al., 1992; Lark, 1996; St-Onge and Cavayas, 1995; Wallace et al., 2000, Carr, 2002; Jensen, 2004). An intuitive approach for adopting variograms in these contexts is to use the key parameters of the theoretic variogram models, such as nugget, range and sill, as the texture and structure descriptors. Although this approach was applied in image classification (St-Onge and Cavayas, 1995; Wallace et al., 2000), it is considered not applicable in CBIR at present, because a CBIR requires a highly automated process, while it is still not reliable to automatically fit empirical semivariograms with theoretical models (Atkinson and Lewis 2000).

A more feasible approach in CBIR up to now is to bypass the curve fitting bottleneck and construct feature vectors with elements being a set of semi-variances, calculated from a set of selected lags and directions. For example, Aksoy and Haralick (2000) compute the gray level variances for 5 different distances and 4 directions, and an image is represented with a vector of 20 variances (their research is not strictly variogram-based, but closely related). Huang et al. (1999) use color correlogram to capture the spatial correlation of color pairs over certain distances. Algorithms for effectively dealing with rotated or flipped spatial anisotropy phenomena, which are common rather than accidental in geographic images, are proposed by Xie (2004). However a couple of issues should be paid more attention in using this approach as discussed below.

The determination of location pairs

First, when calculating semivariances, it is essential to determine appropriate location pairs, which are separated by a lag distance and along a direction in an image segment. If a feature vector needs to characterize the spatial continuity anisotropy commonly existing in geographic images, the semivarainces should be calculated along sufficient number of directions. Further, geographic images may capture similar geographic entities at different orientations or the entities may be rotated/flipped relative to each other in different images (Fig. 2).

ground relationship explains why when one looks at a map of North America one sees the continent as separate from the ocean. Experiments using figure-ground relationship have demonstrated that search time for a target on a display is shorter when the target images are placed on dissimilar or no backgrounds, but that search time increases when backgrounds are similar to the targets (Carter, 1982). Furthermore, since visual search of a display is completed through a number of fixations, modeling of this process indicates that extraction of information from the image is improved when the figure is conspicuous (Dobson, 1985). Thus, objects that stand apart from their backgrounds are processed more efficiently.

Closely related to the concept of figure-ground relationship is the notion that some colors appear to retreat while others appear to advance (Robinson et al., 1995). Saturated, high value reds, oranges and yellows are more likely to be seen as the figure on a map due to their advancing appearance. Low value, or less saturated greens, blues, browns and grays on the other hand are more likely to be viewed as background due to their retreating nature (Robinson et al., 1995). This process is in part due to a physiological phenomenon causing light rays entering the eye to be refracted in an inverse proportion to their wavelengths (Robinson et al., 1995). Also responsible are the red cones in the eye, because they are more numerous than green or blue cones.

Several of the concepts discussed above provide a framework for one to question the influence of weather images that assign false colors to various phenomena on perception. The enhanced IR satellite image, for instance, uses highly saturated warm colors such as reds and yellows to highlight areas in the cloud mass where cloud top temperatures are coldest. The unenhanced visible image, however, uses a gray scale to show differences in cloud thickness. Color enhancement could have profound effects on perception of the IR image by the untrained observer, especially when compared to an unenhanced visible image. The use of colors that normally connote danger or caution, such as in the enhanced IR image, could immediately suggest to the observer that they are viewing a dangerous situation, even if no danger exists. Also, placing an enhanced satellite image

fected by the proximity of another color. This occurs because one color's value (brightness) when surrounded by another will shift in value to enhance the contrast (Mersey, 1990). For instance, when gray is surrounded by green, the gray appears reddish, but when surrounded by blue, the gray appears yellowish (Slocum, 1999).

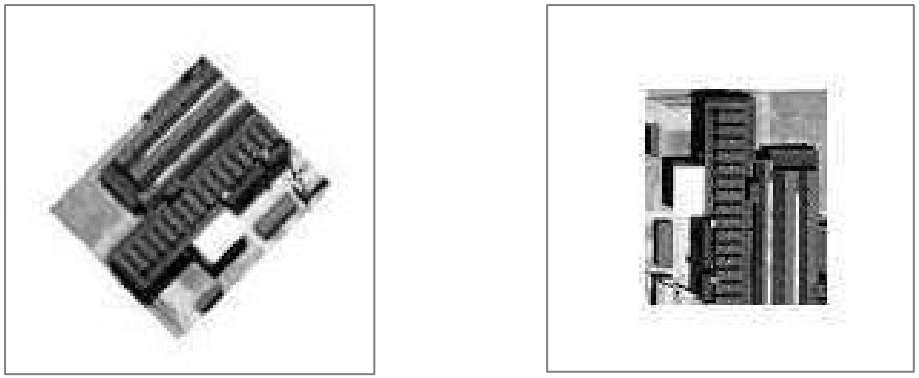
When adding color to a display, one should also consider the conventions and cultural connotations associated with colors. For instance, there is a strong convention in map making and interpretation that dark equals more of something, or a higher magnitude, while light equals less magnitude; "the darker, the more" according to Mersey (1990, p. 1). Other conventions exist dealing with color's role as a landscape metaphor. These associations include green with vegetation, blue with water, and yellow with a desert environment (Monmonier, 1991).

Furthermore, colors may have certain cultural associations. Red may be used to denote warnings, for example, while yellow and green denote caution and safety respectively (Hoffman et al., 1993). Also, there are powerful associations of blue with cold and red with hot (Monmonier, 1991). Little is know about subjective reactions to color on maps besides standard conventions which include the association of red with "fire," "warning," "heat" and so on (Monmonier, 1991, p. 153). Although not necessarily negative, color connotations can work to a display's disadvantage if not used properly. Monmonier (1999, p.136) discusses this issue as it pertains to the assignment of false colors to weather images. He states that,

> Electronic image processing, which can sharpen details and assign colors to non-visible wavelengths, confers artistic license either to highlight noteworthy differences in the data, or to exploit cultural associations of navy blue with water and green or brown with land. This power to radiation intensities and estimated quantities like precipitable moisture can help readers either use the map key to decode conditions at specific places…or dramatically reify storms and their surroundings.

The concept of a figure-ground relationship is another basic cartographic principle that should be considered when creating a map or weather image. Similarly saturated colors are usually grouped together as either background, or theme (Robinson et al., 1995). Figure-

Figure 2. Illustration of the common situation that similar geographic objects in images are oriented differently.



In order to reach a rotation/flip invariant comparison (Xie, 2004), it is essential that the same set of lag distances be used for different directions.

As a common sense, pixels are arranged in a regular spatial grid in an image, and it is not a challenge for appropriate pair location determination if only horizontal and vertical directions, (i.e. 0 ° and 90°) are considered. If we assume the pixel size is fixed and denote it as one unit, for either horizontal or vertical direction, a set of lag distances can be easily selected at the integer number of such units, *k,* (*k* ranges from 1 unit to one thirds or a half of the segment size). By selecting lags in such a way, it is guaranteed that a sufficient number of location pairs will be available. Moreover, no tolerances are necessary since the lags cover the exact distances between pixel centers, and the exact samples locations and values are used.

Unfortunately, we need more than these two directions in many cases, and issues may arise when dealing with diagonal (45° and 135°) and other directions such as 22.5° and so on. Along diagonal directions, the distance between two pixel centers is $\sqrt{2}k$ units. It means that a common set of lag distances along diagonal directions and horizontal / vertical directions are not readily available given the existing sample locations. A tolerance on lag distance may have to be used when determining location pairs if we want to use the same set

of lags (k units) as those readily available along horizontal /vertical directions. A directional tolerance is not necessary because a lag tolerance is enough for producing sufficient pairs. In fact, this can also avoid blurring directional differences due to unnecessary directional tolerances. To ensure each sample location (a pixel center) have a meaningful corresponding location for any lag distance (k units), the lag tolerance should be $\frac{1}{2}\sqrt{2}$ units, which is the largest distance from an un-sampled location to a sample location (pixel center). In cases when two candidate sample locations are within the tolerance range, it is preferable to pick the one closer to the location with exact lag distance.

For other directions other than diagonal, horizontal, and vertical, both a directional tolerance and lag distance tolerance are needed since very rarely can we find sufficient location pairs if only a lag distance tolerance is used. Many software packages are available for calculating variograms by setting directional/lag distance tolerances, such as VARIOWIN (Pannatier, 1996), GSLIB (Deutsch, and Journel, 1997), and the Geostatistical Analyst Extension in ArcGIS by ESRI. However, an unanswered yet important question is what tolerances are reasonable for extracting variogrms along arbitrary directions in images. In geostatistics, the principle for setting directional tolerance is to use as small an angular tolerance as possible to limit the blurring anisotropy effect that results from combining pairs from different directions (Issaks and Srivastava, 1989). As illustrated in Fig. 3, for any direction, an angular tolerance of 22.5° should be sufficient since a sample location (pixel center) can definitely be found within the area defined by such a directional tolerance for any lag distance. To minimize blurring further, a bandwidth (b) should be set at $\frac{1}{2}\sqrt{2}$ units, because this is half the maximum distance between two neighboring pixels ($\sqrt{2}$ units) and at least one sample location can be found for any lags (k units). For the similar reason, the lag distance tolerance can also be set at $\frac{1}{2}\sqrt{2}$ units.

however, recommendations dealt primarily with notions such as the use of hue for qualitative differences and the use of lightness for quantitative differences (Brewer, 1994). Most of these recommendations had also been made with the printed map in mind. With the advancement of computer cartography, however, it became necessary to set guidelines that extended beyond the recommendations for the printed map. In 1993, the American Meteorological Society's Interactive Information and Processing Systems (IIPS) Subcommittee for Color Guidelines created a list of recommendations for color weather features. These guidelines included such recommendations as blue to denote cold fronts, and green to denote the occurrence of precipitation (IIPS, 1993). Even with such guidelines established, adding color to a display has certain impacts on the reader or viewer that require careful consideration by the image creator.

Monmonier (1991, p.147) stated, "Color is a cartographic quagmire." Colors help to make a map (as well as a weather image) more attractive, but can also be deceptive. The use of color on a map or image can have both positive and negative effects on the ability for one to "read" it. It is easier to search a display for colors than symbols, and it is easier to count colored targets than those varying only in size or value (gray tone) (Hoffman et al., 1993). This is due to color's ability to be retrieved rapidly from memory, as well as its ability to be distinguished by that part of vision consisting of both rods and cones together, which provides lower resolution sight, and where form is indistinct (Carter, 1982). It is also possible to discern more different hues in a display than various degrees of lightness or value of a gray scale (Mersey, 1990).

A potential negative aspect of the use of color in a map is that sequences of varying hues (the property of a color by which one commonly recognizes it-- red, green and purple for instance, as defined by its wavelength) have no single consistent ordering (Monmonier, 1991). For this reason, hue is not usually used to portray quantitative differences on a map. It is often used to denote qualitative differences, however, which are not ordered. Another problem with color is that of simultaneous contrast (Slocum, 1999). Simultaneous contrast is a phenomenon in which the appearance of one color is af-

these weather images may have on peoples' perceptions, which become the realities they use to make decisions about the risk involved in a severe-weather event.

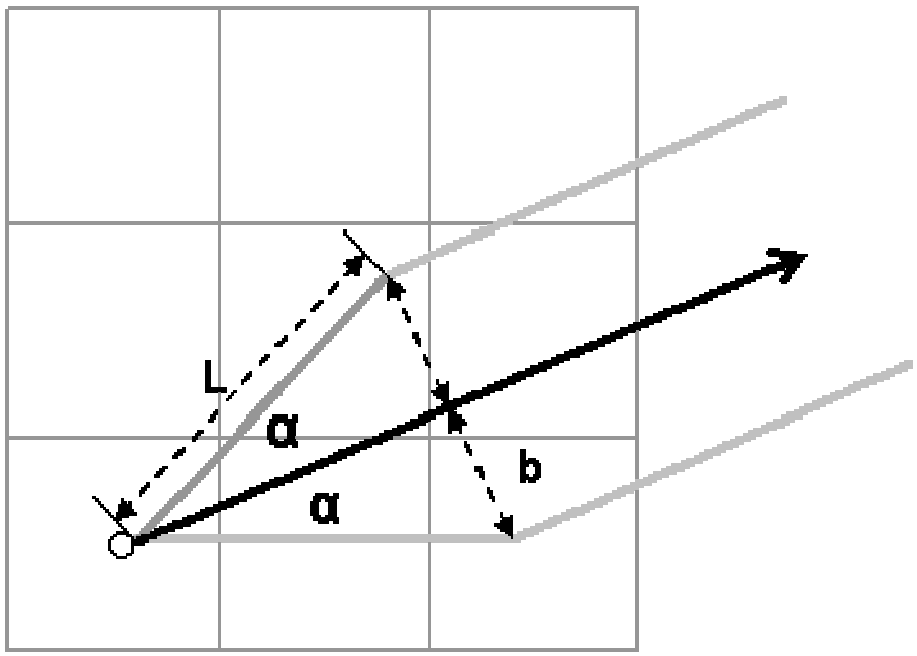
A potential problem in the use of weather imagery during severe weather is that little is known about the influence these graphics have in shaping perception and encouraging or discouraging action. The purpose of this study is to examine one type of image common to newscasts during a hurricane: satellite imagery. Infrared (IR) satellite imagery is often color enhanced to better show differences in cloud top temperature (Conway et al., 1997). Color codes for satellite enhancements are not typically provided during the weather segment of the news, however. Without provision of such a color code, one should not assume the audience has adequate knowledge about the enhancement to understand the images. This possible lack of understanding among viewers as to what the various colors mean combined with several display characteristics of the images themselves could lead to color enhanced satellite images having a different influence on perception than unenhanced IR images or visible images which show cloud thickness, and are not enhanced. Therefore, this study examines this possible difference through the use of a hypothetical hurricane situation. Before discussing the research however, it is important to establish a familiarity with some of the display characteristics of weather images, and how they might factor in shaping perception.

The Influence of Color in Weather Displays

Many of the elements responsible for the way one interprets a map are also applicable in weather displays. Weather displays such as the satellite image are in fact just one type of representation of the world (for a discussion of this, see Monmonier, 1999). For this reason, weather display characteristics will be examined through a cartographic lens. Additionally, this study focuses only on the use of color in the satellite image, although other factors might also prove important.

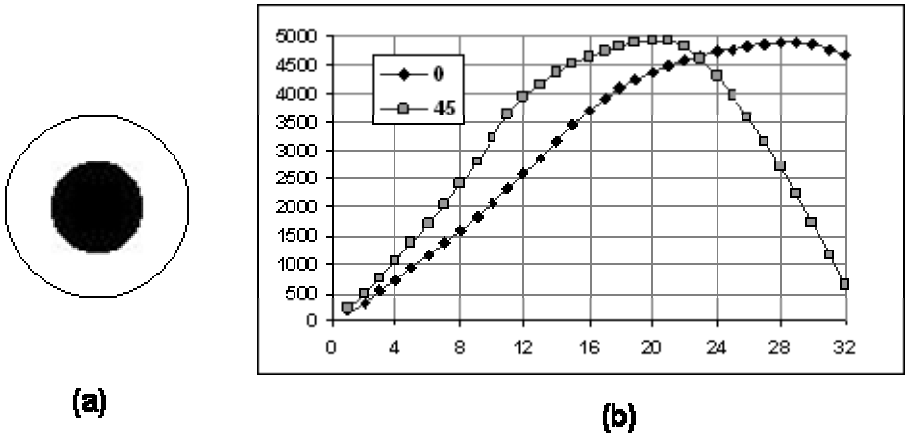
Recommendations on the appropriate use of color have had a long history in cartography (Brewer, 1994). Throughout this history,

Figure 3. An illustration of the distance tolerance (*td*), directional tolerance (α), and bandwidth to be used for determining location pairs along directions other than horizontal, vertical and diagonal. Specifically, $\alpha = 22.5°$, $td = b = \frac{\sqrt{2}}{2}$ units, $L = \frac{b}{\sin(\alpha)} = \left(\frac{\sqrt{2}}{2}\right) \Big/ \sin(22.5°)$ units. L denotes when the bandwidth starts to play a role.



In the above discussions, we implicitly measure lags using Euclidean distance metric. This is necessary since variograms characterize spatial continuity, which states that things nearer in space tend to be more similar than those farther away from each other, and the concept of "near" or "far" should be measured with Euclidean distance in most cases. However, in some related applications (Huang et al., 1999; Aksoy and Haralick, 2000), a distance metric (Eq. (2)) has often been misused due to its implementation simplicity.

Figure 4. An image segment with isotropic spatial pattern (a), and the directional variograms (b) along two directions, 0° and 45°, using the $d = \max\{|r_1 - r_2|, |c_1 - c_2|\}$ as the distance metric for lags.



$$d = \max\{|r_1 - r_2|, |c_1 - c_2|\} \tag{2}$$

where, (r_1, c_1) and (r_2, c_2) are the rows and columns of two pixels.

Apparently in any non-horizontal and non-vertical directions, the distance between the two pixel centers are $\sqrt{(r_1 - r_2)^2 + (c_1 - c_2)^2}$ units in Euclidean distance, and $\sqrt{(r_1 - r_2)^2 + (c_1 - c_2)^2} > \max\{|r_1 - r_2|, |c_1 - c_2|\}$. As a result of using this distance metric (Eq. (2)), some semi-variances (or variances) in non-horizontal and non-vertical directions will be mistakenly associated with a shorter lag, as will inevitably distort the actual spatial continuity present in the image object.

Such distortions are illustrated in the two directional variograms in Fig. 4. These two variograms are computed based on the image segment in Fig. 4a, one along 0° direction and the other 45° (Fig. 4b). Although there exist no directional differences in spatial continuity in the original image object, the variogram curve along the 0° direction is completely different than that along the 45° direction when the lag

Enhancing Threat: Using Cartographic Principles to Explain Differences in Hurricane Threat Perception

Kathleen Sherman-Morris

Introduction

With local television stations in Florida sometimes providing over twenty-four hours of commercial-free coverage of hurricanes aimed at the state, residents are bombarded with images (Whitney, 2004). These images range from the almost-clichéd appearance of a rain-drenched reporter clutching a pole in one arm and a microphone in the other to an array of computer generated graphics delivered by the weathercaster.

Advancements in the ability to create and display weather graphics have made it possible for stations throughout the country to give the public live, up to the minute accounts and warnings during times of severe weather in ways that are visually appealing and eye-catching. News stations also routinely break into local programming to announce the threat of a tornado and show very detailed and colorful images that indicate where this tornado is, and where it is likely heading. Whether warning the audience of a tornado or hurricane, these graphics, as part of the message sent by the newscast, have a role in shaping the viewers' perceptions of the existing threat.

As part of the news, the images shown during the weather segment may have some role in shaping the audience's sense of reality. Stallings (1990, p. 87) states "journalists simultaneously create and perpetuate an image of reality when they assemble a news product." For this reason, and because people do turn to mass media in times of severe weather, it is important to understand the influence

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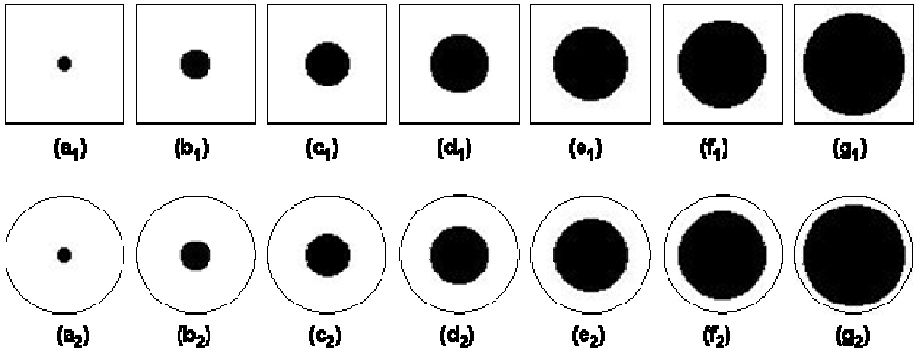
Figure 5. A series of image segments containing disc objects of varied sizes. The size of a pixel is 1 unit of distance and the diameters of the internal discs are 8, 16, 24, 32, 40, 48, 56 units for a_1 to g_1 and a_2 to g_2, respectively. 1) The size of all square segments is 64 by 64 units. 2) The diameter of all circle segments is 64 units.



is measured using the metric in Eq. (2). Consequently, Euclidean distance should always be adopted to measure lag distances to avoid directional distortion.

The image segment shape

In CBIR, an image is often subdivided into small image subsets, also referred to as image segments. The calculation of semi-variances is conducted for each image segment. A square shape is often chosen for convenience. However, the appropriateness of using the square shape has not been carefully examined or explicitly justified. In this section, we investigate the benefits and drawbacks of two different segment shapes, squares and circles.

To compare the different effects exerted by square and circle shaped image segments on the resulting variograms, two experiments are conducted based on hypothetical image segments. The first experiment involves the use of a series of discs of varied sizes centered in square (Fig. $5a_1$-g_1) and circle (Fig. $5a_2$-g_2) image segments. The use of discs is based on the consideration that a disc bears no directional differences in spatial continuity and exhibits spatial isotropy. In theory, the variograms derived from an image segment containing a disc should be the same or at least sufficiently close in all directions. An ideal image segment shape should be the one that faithfully char-

acterizes the spatial isotropy of a disc object.

The size of each square image segment in Fig. $5a_1$-g_1 is 64 by 64 units of distance (in Euclidian distance metric) and the diameter of each circle segment in Fig. $5a_2$-g_2 is 64 units. The diameters for the center discs are 8, 16, 24, 32, 40, 48, 56 units as shown in Fig. $5a_1$ to $5g_1$ and $5a_2$ to $5g_2$ respectively. In all the image segments, the DN value is 127 for the white pixels and 0 for the dark pixels.

For each of the image segments in Fig. 5, we calculate variograms along 8 directions, including 0°, 22.5°, 45°, 67.5°, 90°, 112.5°, 135°, and 157.5°, and at lags from 1 to 64 units . The resulted variograms from using the square segments and circle segments are shown in Fig. $6a_1$ to $6g_1$, and $6a_2$ to $6g_2$, respectively.

As shown in Fig. 6, no matter what image segment shape is adopted, variograms obtained from discs of varied sizes demonstrate similar overall patterns along the same direction, although the ranges and sills change with the size of the discs. However, the variograms along different directions become significantly dissimilar when the square segment (Fig. $6a_1$-g_1) is applied, no matter what size disc is contained. The variogram curves along diagonal directions (i.e. 45° and 135°) exhibit the largest deviations from those along horizontal and vertical directions (i.e. 0° and 90°), whereas the variogram curves along 22.5°, 67.5°, 112.5°, and 157.5° fall in between. In comparison, the circle segments produce almost identical variograms for all directions for each segment, though subtle discrepancies do exist (Fig. $6a_2$-g_2).

The second experiment assesses how the shape of an image segment affects the directional variograms for image segments containing an anisotropic object, a rectangle in this case. Unlike a disc, a rectangle exhibits directional differences in spatial continuity (i.e. spatial anisotropy). In order to assess the sensitivity of a variogram to the various rotated versions of an object, the same rectangle is oriented at two different angles (i.e. 0° and 45°), embedded within both the square and circle image segments. A segment shape is regarded as more appropriate if the variograms derived from the same object with different orientations are still sufficiently close with regard to the object directions.

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the ratios derived from the relative semi-variances but in greater detail.

The ratios derived from the absolute semi-variances are extremely high, around 120% for all lags (Fig. 11a). Conversely, the ratios derived from the relative semi-variances are less than 2% for most lags, about a quarter of the lags with a ratio between 2% and 6% (Fig.11b). Only a few lags have ratios larger than 6%, all of which are at extremely short lag distances. The large deviation of ratios at the short lags can be possibly attributed to nugget effects. Nevertheless, the relative variograms for the four image segments are very close, witnessing the ability of relative variograms to characterize equivalent spatial structure regardless of underlying DN value variation.

Conclusions

A series of experiments are conducted to investigate several important issues concerning the appropriate use of variogram-based feature vectors for CBIR. It is argued that except horizontal and vertical directions, lag tolerance and/or directional tolerance are needed to produce semivariances at the same set of lag distances as those readily available along horizontal and vertical directions. For diagonal directions, only a lag tolerance is needed. For other directions, a directional tolerance and a bandwidth should be also set. It is also emphasized that Euclidean distance should always be adopted to avoid adding false anisotropy information not inherent in image objects. The experiments also suggest that, although a square segment is often the convenient and common choice, a circle segment is more appropriate for characterizing the directional spatial continuity of an object contained within an image segment. In addition, relative variograms are more appropriate to represent spatial structure than absolute variograms. In conclusion, although variograms based feature vector can be valuable for characterizing texture and structure information, a proper use of variograms guided by the findings in this paper may better unleash the power of this technique and aid our understanding and interpretation of the results obtained.

Figure 6. The empirical variograms along 8 directions (0°, 22.5°, 45°, 67.5°, 90°, 112.5°, 135°, 157.5°, and the angle is measured counter-clockwise starting from due east), and at lags from 1 to 64 units of distance using both square segments (a_1-g_1), and circle segments (a_2-g_2).

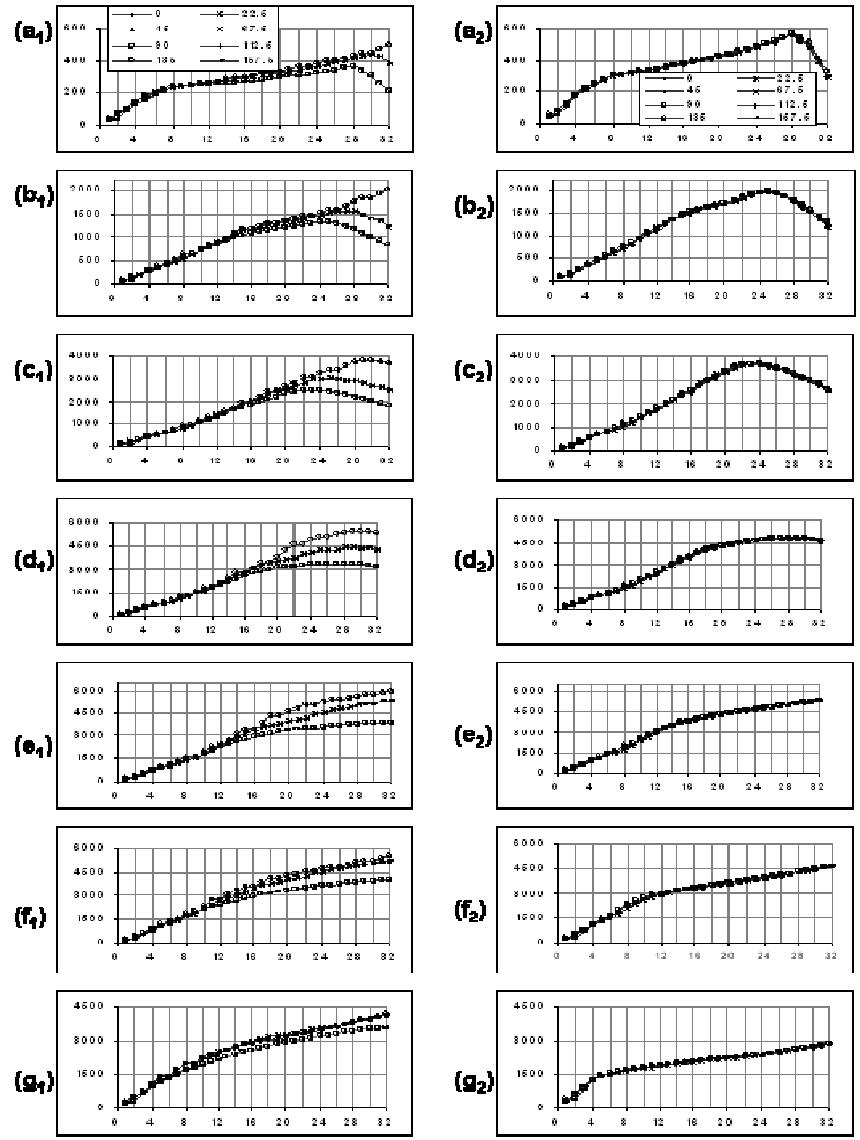
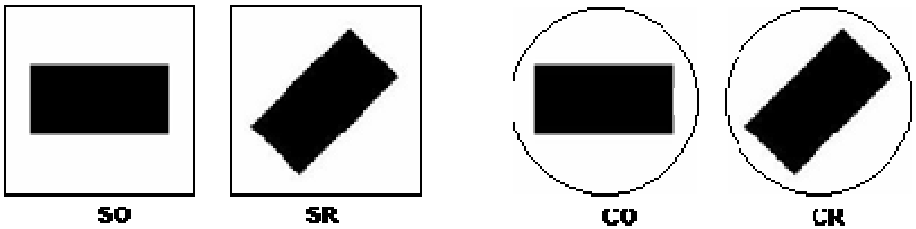


Figure 7. The same rectangle object within square image segments (SO, SR) and circle image segments (CO, CR). The rectangle objects in SO and CO are of original orientation (i.e. 0° rotation), while those in SR and CR are rotated at 45° counter clockwise.

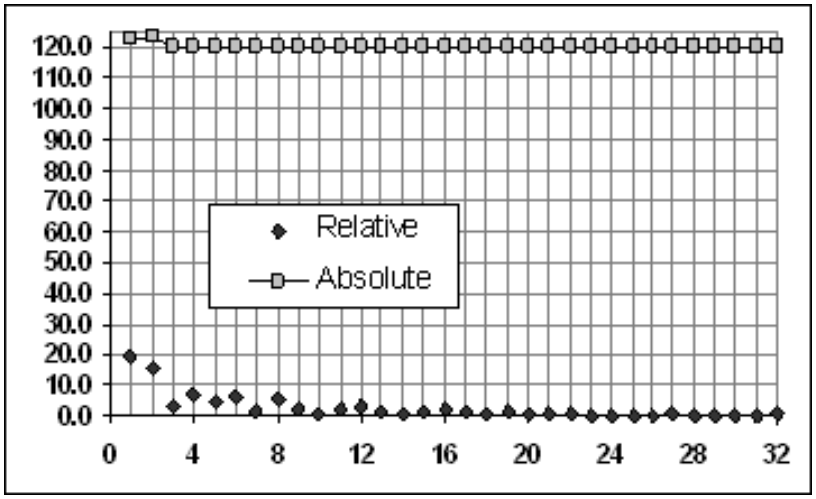


This experiment analyzes a set of 4 image segments, each containing the same 48 by 24 unit rectangle (Fig. 7). Again, the DN value for the white pixels is 127 and that for the dark pixels is 0. Two of the 4 segments are square-shaped with a dimension of 64 x 64 units (Fig. 7-SO and SR) and the other two are circle-shaped with a diameter of 64 units (Fig. 7-CO and CR). The rectangle objects in Fig 7-SO and CO are of original orientation (i.e. 0° rotation), while those in Fig 7-SR and CR are rotated at 45° counter clockwise.

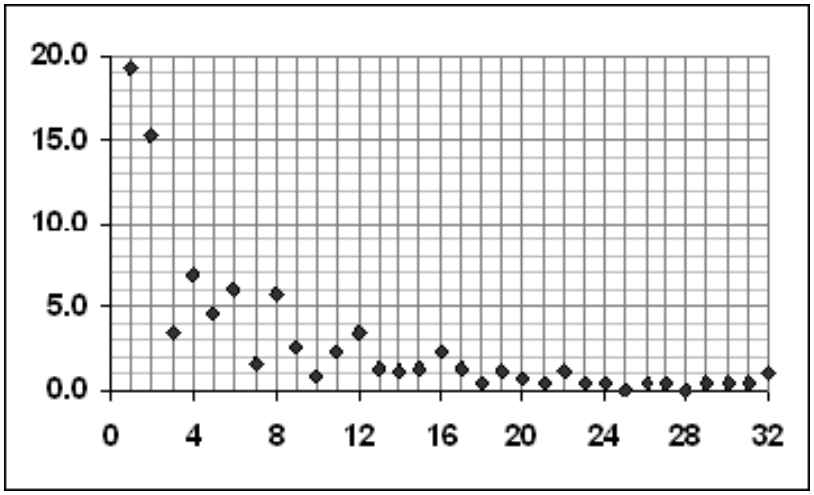
The resulted variograms for the image segments in Fig. 7-SO and SR are shown in Fig. 8a, and those for the image segments in Fig. 7-CO and CR are displayed in Fig. 8b. For the image segments in Fig. 7-SO and CO, five directional variograms at 0°, 22.5°, 45°, 67.5° and 90° of angles are produced. For those in Fig. 7-SR and CR, five corresponding directional variograms at 45°, 67.5°, 90°, 112.5° and 135° of angles are created, because the rectangle objects in these later two image segments are rotated 45°. When the square segments are used, the variograms for the two different object orientations (i.e. Fig 7-SO and SR) along the corresponding directions (e.g. 0° in SO and 45° in SR) are significantly different from each other (Fig. 8a). Conversely, variogram curves for the corresponding directions are almost identical when the circle segments are used (Fig. 8b).

A preliminary conclusion can be made based on above discussions. To describe spatial continuity, circle segments are able to truthfully characterize both isotropic and anisotropic continuity information of objects in the image segments, as illustrated in the two experiments.

Figure 11. The ratio (%) of standard deviation to mean of the semivariances of 4 image segments in Figure 9 along 8 directions and at each lag: (a) comparison of the ratios between the absolute and relative variograms; (b) the ratios of the relative variogram in detail.

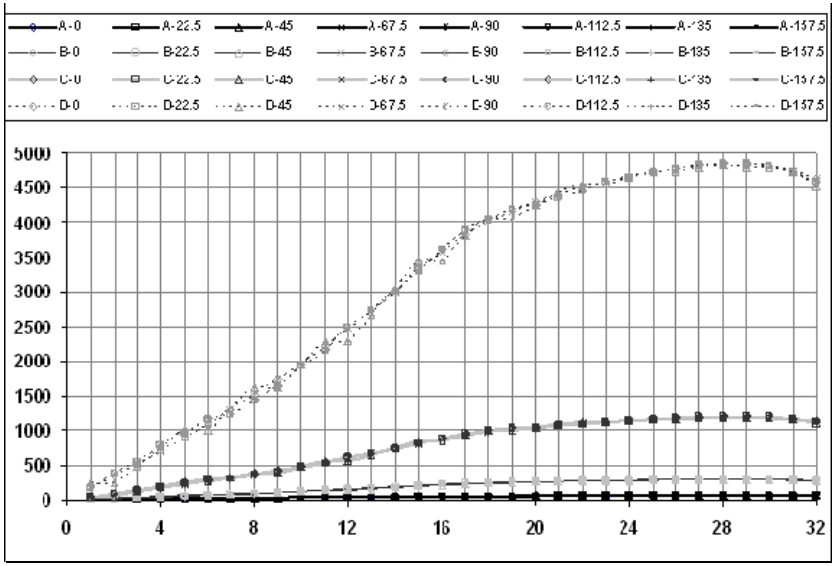


(a)



(b)

Figure 10. The absolute variograms (a) and relative variograms (b) for the image segments in Figure 9, where A-x, B-x, C-x, and D-x represent the directional variograms in x° direction for image segments in Fig. 9a-d respectively.



(a)

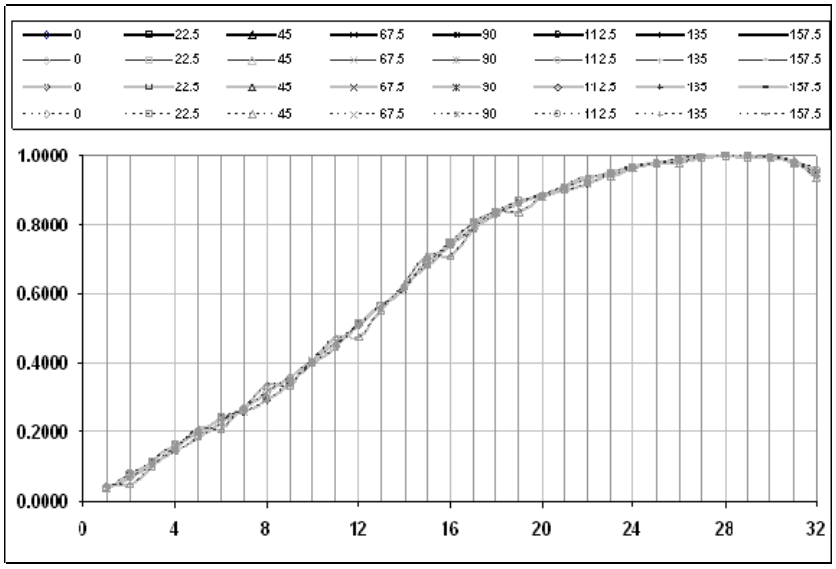
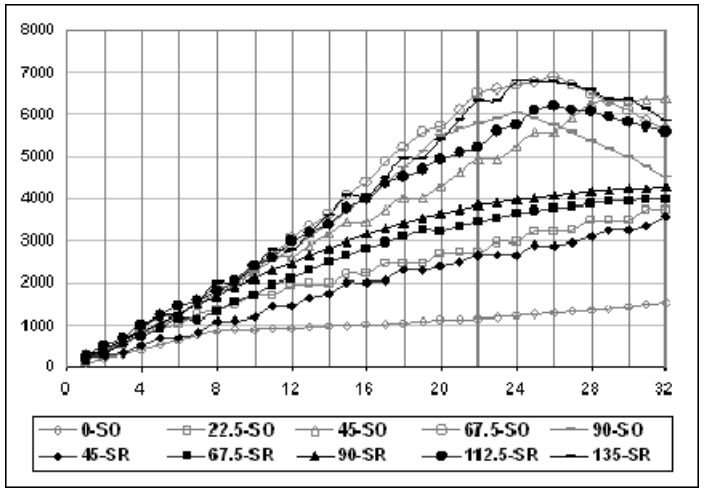
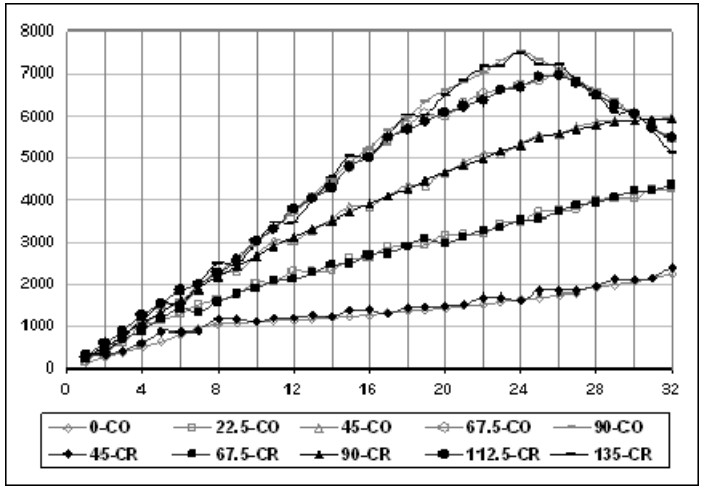


Figure 8. The directional variograms for the image segments in Figure 7. (a) Variograms for Fig. 7-SO and SR, where x-SO and x-SR denotes x° directional variogram for the image segments containing original and rotated objects respectively. (b) Variograms for Fig. 7-CO and CR, where x-CO and x-CR stands for x° directional variogram for the image segments containing original and rotated objects respectively.

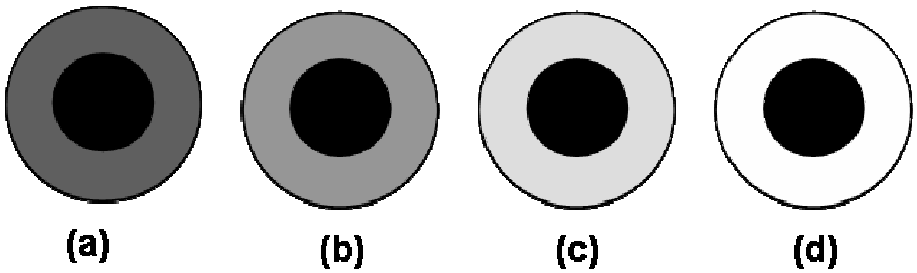


(a)



(b)

Figure 9. Four image segments with the same spatial structure, i.e. each containing a disc object of the same size (32 units in diameter). The DN values for all the dark pixels in the disc are 0. The DN values for the shaded pixels outside the disc vary from 15, 31, 63, and 127 for segments (a) to (d), respectively.



On the contrary, square segments may distort the spatial continuity of both isotropic and anisotropic image objects, due to the anisotropic nature of the square shape in itself. Other non-circle segments may also lead to similar distortions for the same reason. Therefore circle segments are believed by the authors to be more appropriate for deriving variograms from a remotely sensed image.

The relative semivariogram

All the variograms we have examined so far are absolute variograms, in which the actual semi-variances of the DN values are used to construct variogram curves. The absolute semivariances may depend on the mean of data values for that lag. In geostatistics, relative variograms are used to take account of the changing mean and to scale semivariances so that a clearer description of the spatial continuity can be produced (Isaaks and Srivastava, 1989). In this section, we evaluate whether relative variograms are a better alternative when spatial structure is of primary concern instead of DN value variances in CBIR.

To this end, we create a set of 4 circle image segments (64 units in diameter) with similar spatial structures, all containing an disc at the segment center with a diameter of 32 units (Fig. 9). Within each image segment, the DN value for the dark pixels of the internal discs is 0, but the DN value for the shaded pixels (ranging from dark gray to white) outside the internal disc varies from 15, 31, 63, to 127 as

shown in Fig. 9a-d respectively.

There are several types of relative variograms: local relative variograms, general relative variograms, and pairwise relative variograms. Both general and pariwise relative variograms can provide adequate display of spatial continuity (Isaaks and Srivastava, 1989). Detailed comparison of the two are beyond the scope of this paper and only pairwise relative variograms are used to present the concepts here.

The pairwise relative variogram adjusts the variogram calculation by a squared mean, and the adjustment is done separately for each pair of samples, as shown in Eq. (3).

$$\gamma(h) = \frac{1}{2N} \sum \frac{(V_s - V_{s+h})^2}{\left(\frac{(V_s + V_{s+h}}{2}\right)^2} \qquad (3)$$

where all the variables, including V_s and V_{s+h}, carry the same meaning as in Eq. (1).

For comparison purposes, we also calculate the absolute variograms for the 4 image segments in 8 directions, using Eq. (1). The resulted absolute and relative directional variograms are displayed in Fig. 10a and 10b respectively. The curves of the absolute variograms are dramatically different for the 4 image segments (Fig. 10a) with the semi-variance at the same lag increasing with the increasing DN values of the shaded pixels outside the internal disc (i.e. 15, 31, 63 and 127 respectively). In comparison, all the relative variograms are remarkably similar to each other as shown in the Fig. 10b, independent of the DN value variation.

To quantitatively document the differences between the set of absolute variograms and between the set of relative variograms, we further calculate the mean and the standard deviation of all the absolute and the relative semi-variances over each lag. The ratio (%) of the standard deviation to the mean is then derived in order to show the magnitude of overall deviation from the mean semi-variance at each lag. Fig. 11a displays the ratio values derived from both the absolute and relative semi-variances in the same plot. Fig. 11b presents only