

# Journal of the Mississippi Academy of Sciences

Volume 52

October 2007

Number 4



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*The Journal of the Mississippi Academy of Sciences* (ISSN 0076-9436) is published in January (annual meeting abstracts), April, July, and October, by the Mississippi Academy of Sciences. Members of the Academy receive the journal as part of their regular (non-student) membership. Inquiries regarding subscriptions, availability of back issues, and address changes should be addressed to The Mississippi Academy of Sciences, Post Office Box 55907, Jackson, MS 39296-5709, telephone 601-977-0627, or email-msacad@bellsouth.net.

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# **CHALLENGES OF COLLECTING SURVEY DATA ON THE MISSISSIPPI GULF COAST AFTER HURRICANE KATRINA: AN IN-DEPTH INTERVIEW STUDY OF SURVEY TEAM MEMBERS**

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## **ABSTRACT**

The purpose of this paper is to offer a brief description of the unique context faced by a team of researchers collecting survey data on the Mississippi Gulf Coast four months after Hurricane Katrina (see Swanson et. al. this issue for more information on the larger study). Based on in-depth interviews with survey team members, we discuss several challenges faced during data collection: locating subjects, soliciting subjects' participation, and collecting completed surveys. We conclude by discussing the methodological implications of these challenges.

## **INTRODUCTION**

Although studies of disasters and their aftermath usually include a discussion of methods and data, few studies have examined the actual process of gathering data after a disaster (for an exception see Killian 1956/2005). In the area of disaster research, there is a growing focus on methodology. Researchers recognize that the context of a disaster and its aftermath can pose unique methodological challenges to a study. For instance, the difficulty of recruiting subjects and guaranteeing the safety of data collectors may be heightened (Knack et. al., 2006). As a recently edited volume on the methods of disaster research notes, although the actual methods used by disaster researchers are not unique, their application in the field needs to be better studied and understood (Stallings, 2002).

The purpose of this paper is to offer a brief description of the unique context faced by a team of researchers collecting survey data on the Mississippi

Gulf Coast four months after Hurricane Katrina. The NSF-funded study had two objectives:

- (1) to gather pre- and post-Katrina information on housing and population; and
- (2) to distribute to coastal residents a self-administered, 115-item questionnaire to collect retrospective information on the roles that social and kinship networks played in sustaining a respondent's well-being after Hurricane Katrina (see Swanson et. al. this volume for specific information on the NSF-funded study and preliminary analysis of results).

Over a one-week period in early January 2006, the team of researchers went door-to-door handing out questionnaires and arranging with respondents a time to return for the completed questionnaire. In doing so,

they had to 1) locate subjects on designated blocks and 2) gain subject's consent to participate. Both of these activities posed unique challenges to team members as described below.

## **METHODS**

The data discussed in this paper were collected via in-depth interviews conducted by the two authors with eighteen members of the NSF-funded research team after the primary data collection period for the NSF-funded study was over. This interview study was designed to better understand the subjective experiences and challenges faced by the survey team members who gathered data in a disaster context. The NSF-study research team consisted of twenty-one researchers, two of whom were the authors of this paper. After receiving IRB approval, the two authors approached the other nineteen team members by phone or in-person requesting permission to interview them about their experiences in the field during data collection period of the NSF-funded study. Of these nineteen team members, only one could not be scheduled for an interview. All interviews with NSF-study research team members who agreed to participate took place between late January and March 2006. Depending on the team member's location, the interviews were either done in person or by phone. This paper also draws on the ethnographic observations of the authors, both of whom were members of the research team.

## **CHALLENGES OF DATA COLLECTION**

Although the following list of challenges is not exhaustive, it does encompass some of the major issues

with which the research team had to deal.

***Locating Subjects.*** One unique challenge of doing a survey in a disaster zone is that the disaster often dramatically changes the landscape such that normal navigation and standardized procedures become problematic.

For example, team members were given a list of census blocks and instructed to systematically locate and give questionnaires to residents still residing in those blocks. First, arriving at the designated area was problematic in that the hurricane had destroyed one of the main arteries into the study area—parts of HWY 90 and the Bay of St. Louis bridge. As the project's "home base" was by necessity located in Biloxi, at one of the few hotels still operating, the drive to the Waveland/Bay St. Louis area took much longer than usual, leaving less time to canvass the blocks. Teams only went out during daylight hours due to safety concerns. Once in the study area, missing street signs and other landmarks made locating specific blocks in the study area difficult. Several team members reported relying on local residents to orient them. Team members might also finally locate a designated block only to find that no structures remained standing. Although some pre-canvassing of census blocks was done in November prior to the start of data collection in January, the short time frame to implementation of the NSF-study and the large number of census blocks in the sample made pre-canvassing every block unrealistic.

Second, if structures were found, canvassing a block and finding subjects could be problematic. Team members had to be constantly aware of hazardous field conditions—debris, ruptured gas lines, dogs, and insects, among others.

Often team members had to scout around houses or other properties to locate possible temporary housing such as FEMA trailers which were not always visible. The unusual experience of walking on foundations, peeking into windows for clues about whether a house was occupied, and the general need for a more vigorous “search” of the property to find trailers or tents introduced a heightened concern among the volunteers that they might be invading people’s privacy. Some team members suggested that this led them to experience emotional exhaustion and some distress<sup>(1)</sup>.

Team members were also instructed to call back to each potentially habitable house two additional times if subjects could not be initially located. Although standard procedure, team members acknowledged that a lot of time was spent going back to houses of unclear habitation status.

***Gaining Subjects’ Participation and Consent.*** Once subjects were located, team members had to solicit their participation in the survey. As Lindsay (2005: 120) argues, while this process is usually presented as objective and predetermined, in reality it is “shaped through interactions with participants in the field.” By January 2006, the relationship between coast residents and local, state, and national governments and organizations was becoming strained. Residents had filled out multiple forms for FEMA and their insurance companies for, in some cases, very little return. Several team members reported that residents seemed “formed-out” and were less likely to participate if they thought the survey was connected to the state or national government. Although the written protocol instructed the research team to simply introduce

themselves as representatives of the University of Mississippi, many team members found that additional clarification was needed to convince potential subjects that the team was not associated with any other state or federal agency. While most survey research precedes under the assumption that official sponsorship by the government increases survey participation, a context in which “officials” have been discredited may require more careful analysis of this assumption (Quarantelli 2002). On the other hand, team members also indicated that some individuals expressed gratitude that someone was listening to them. They may have seen the survey as an avenue to voice concerns they believed no one else was heeding.

One event that may have created more support for the survey was a WLOX TV news spot done on the project toward the middle of the week. Several team members reported that residents indicated having seen the spot and wanted to participate. At least one team member reported that one subject who had refused to participate the day before, changed his mind due to the TV spot. In a context where there is a high level of suspicion of people asking them to fill out forms, TV spots could help by clarifying researchers’ goals and affiliations even before they knock at the front door (for an alternative view see Quarantelli 2002).

Another barrier to gaining participation according to team members was that many residents indicated a lack of time to fill it out due to rebuilding. Most team members found that the original plan of locating subjects in the morning, handing out the questionnaire, and picking it up several hours later was not going to be feasible due to the length

of the survey itself (approximately one hour to complete) and the fact that residents had more pressing issues to address. However, they also found that if they arranged with a respondent to pick up the questionnaire the next day, giving them more time to fill it out, the respondent may or may not be there and may or may not have left the questionnaire in the designated spot. One team member gave a survey to a man whose home had been reduced to a slab. He told the team member that he would leave the completed survey on a chair sitting on the middle of the concrete foundation, but did not end up doing so. The physical destruction of the hurricane removed some of the “normal” places people might feel comfortable leaving a survey and made arrangements for retrieval complicated. One positive aspect of residents’ rebuilding, however, might be that more residents were home during the day light hours instead of at work.

Although team members were very cognizant of the need to get people to participate and to follow standardized procedures, they were also aware of the emotional, psychological, and physical issues with which coast residents were coping. Several team members reported not wanting to push subjects to participate given the scope of what they had already been through. Team members stated that they wanted to be as little of a burden as possible to residents, to not interrupt their work and add to their distress. Because of this they did not try to “press” or “convince” residents to participate after an initial refusal <sup>(2)</sup>. At the same time, some of the team members reported that building rapport required a careful negotiation of the assumption that surveyors should be completely objective, and value-neutral

observers. They explained that some of the coastal residents wanted to discuss controversial and pervasive political issues, especially the response of FEMA and insurance companies to the plight of residents affected by Katrina. Team members who obliged felt that it increased the likelihood that people would participate.

## CONCLUSIONS

Overall, team members reported that they felt they were fairly successful in locating subjects and gaining their participation. At the same time, the experience could be very frustrating and emotionally draining. They reported being careful to follow the standardized rules of the research project, while modifying the rules as needed <sup>(3)</sup>.

This study contributes to the small but growing literature on the process and context of collecting data after a disaster by suggesting several methodological areas that warrant consideration. It is important to understand in what ways the physical destruction of a landscape may require adjustments to sampling techniques. For example, if time does not allow more thorough scouting trips to the area to confirm where residents and houses still remain, research teams may need more training on how to find neighborhoods and streets no longer marked by street signs or other landmarks. It is also important to consider and investigate how this physical destruction impacts the physical and emotional experiences of research team members in such situations. Last, although it is often argued that potential subjects are willing to participate in research studies after a disaster (Quarantelli 2002; Bourque, Shoaf, and Nguyen 2002), it is important to further explore how disaster

conditions affect individuals' likelihood to participate in a survey and what techniques researchers actually use to gain informed consent and participation in these situations.

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## Footnotes

1. The subjective or emotional experience of the researcher is an issue usually glossed over or treated in discussions of "bias" in reports of survey and other "objective" research studies. For some exceptions, see Shumsky (1962), Glass and Frankiel (1968) and Lindsay (2005). As Glass and Frankiel (1968) note, "the notion that as researchers we can turn off our emotions...is a heritage which the social sciences have carried along from the physical sciences...it is a view which does not well agree with what we know of human behavior." (P. 78)
2. Quarantelli (2002), in his history of the Disaster Research Center (now at the University of Delaware), notes that decisions such as whether to press for a particular interview or to seek information about some sensitive topic were made in the field and based on the team's judgment of how pressing the subject would affect the team's reputation and ability to make future contacts (p. 109).
3. For example, although there was a written protocol that the principle investigators gave the team members to read to potential subjects, introducing the survey and requesting consent to participate, team members quickly learned that reading the protocol word by word was problematic. For example, one potential subject told a team member that she did not need to keep repeating the word "Katrina" as everyone knew what the name of the hurricane was.

# ASSESSING KATRINA'S DEMOGRAPHIC AND SOCIAL IMPACTS ON THE MISSISSIPPI GULF COAST.<sup>1</sup>

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## ABSTRACT

This paper provides results from a study funded by the National Science Foundation to examine the effects of Hurricane Katrina on an area of the Mississippi Gulf Coast immediately to the west and east of St. Louis Bay. This Study Area includes portions of three towns in Mississippi, Bay St. Louis, Waveland, and Pass Christian. Specifically, the paper describes selected housing, demographic, and social impacts of Katrina on the Study Area. In regard to housing and demographic effects, we find that 27% of the housing was destroyed in the Study Area and 47% significantly damaged. Related to the effects on housing, Katrina caused a 40% decline in the Study Area's household population. In regard to social effects, the results of one of our research hypotheses about the effect of social networks on the well-being of people show that social isolation significantly increases perceptions of disaster disturbance and decreases perceived rates of disaster relief. Recommendations (and potential implications for other areas affected by large-scale disasters) based on our results are provided, as well as descriptions of the Study Area, study design, and data collection procedures.

## INTRODUCTION

According to most measures, the landfall of Hurricane Katrina on the Gulf Coast on August 29th, 2005 represented the greatest natural disaster in American history. The geographic spread of the disaster stretched 90,000 square miles, roughly the size of Great Britain (Johnson, 2006). In human terms, at least 1,836 people lost their lives from Katrina (only 65 did so due to Hurricane Andrew in August of 1992 and 265 from Hurricane Camille in August of 1969). In economic terms, hundreds of thousands of Gulf Coast residents lost their homes and jobs. One authoritative source estimates economic losses at

\$81.2 billion in 2005 dollars (Johnson, 2006), nearly double the costs associated with the next most costly disaster, Hurricane Andrew (\$45 billion in 2005 dollars) and nine times more than Hurricane Camille (\$9 billion in 2005 dollars).

While the preceding numbers are staggering and likely in the general ballpark, they are only estimates. As such, they fall within the tradition of post disaster assessment in that estimates of damage and destruction are the norm (Johnson, 2006). Because of the ephemeral nature of the data and the high costs, it is not surprising that estimates rather than complete counts



are made in regard to the damage from hurricanes and other large scale disasters. However, as observed by Chang (1983), Dynes et al. (1987) and Smith and McCarty (1996), the lack of reliable data poses a major problem in measuring and evaluating the demographic and economic effects of major disasters such as hurricanes, floods, tornadoes, earthquakes, and volcanic eruptions. It is this problem that formed one of the two major objectives of the study we report on here

The other major objective of our study was to examine the effects of social networks in regard to mitigating the effects of a disaster for people. We followed this line of inquiry because social science research clearly shows the importance of social networks in many activities, including obtaining employment (Montgomery 1992), maintaining one's health (Haines and Hurlbert, 1992), building safer and healthier communities (Coleman 1990; Portes 1998; Putnam 2000) and in mitigating the effects of unexpected events such as hurricanes (Haines, Beggs, and Hurlbert, 2002; Haines, Hurlbert, and Beggs, 1999; Hurlbert, Haines, and Beggs, 2000; Hurlbert, Beggs, and Haines, 2005; Kirschenbaum, 2004). In designing our study, we built on this and other previous disaster-related research by measuring social networks before, during, and after Hurricane Katrina. Thus, we developed temporal measures of social networks and disaster effects using primary data of Hurricane Katrina survivors in our Study Area. Because of space limitations, we do not provide an exhaustive report on the results of this part of our study. However, we do give an idea of the effects of social networks

by examining one of the social network hypotheses we examined in our study:

A person embedded in a larger personal network group will perceive lower levels of disturbance in his or her economic, health, and social well-being than a person in a smaller personal group network, where "disturbance" refers to the difference between responses for "now" (four months after the hurricane) and those for "before" (before the hurricane).

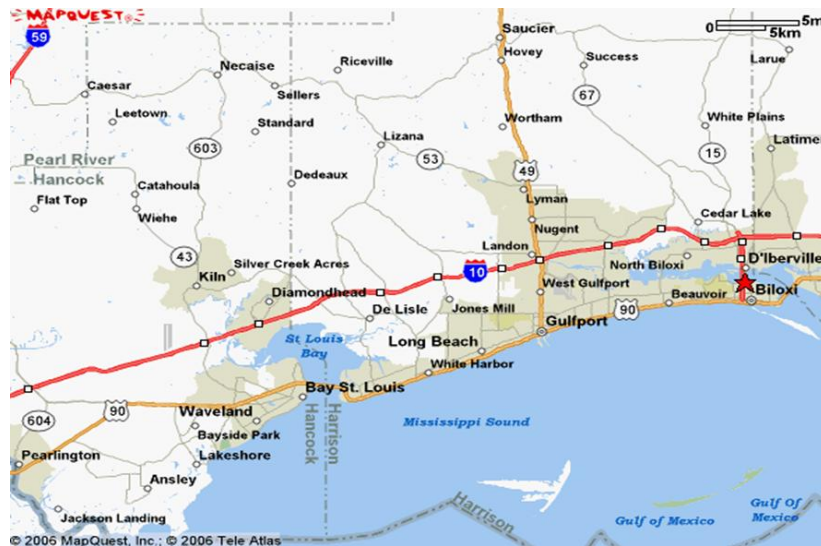
## DATA AND METHODS

As one of nine "social network" post-Katrina research projects funded by the National Science Foundation under the provisions of the SGER program,<sup>3</sup> the recipients of SGER Grant #0555136 (Swanson, Van Boening, and Forgette) received \$96,212 to conduct a study that:

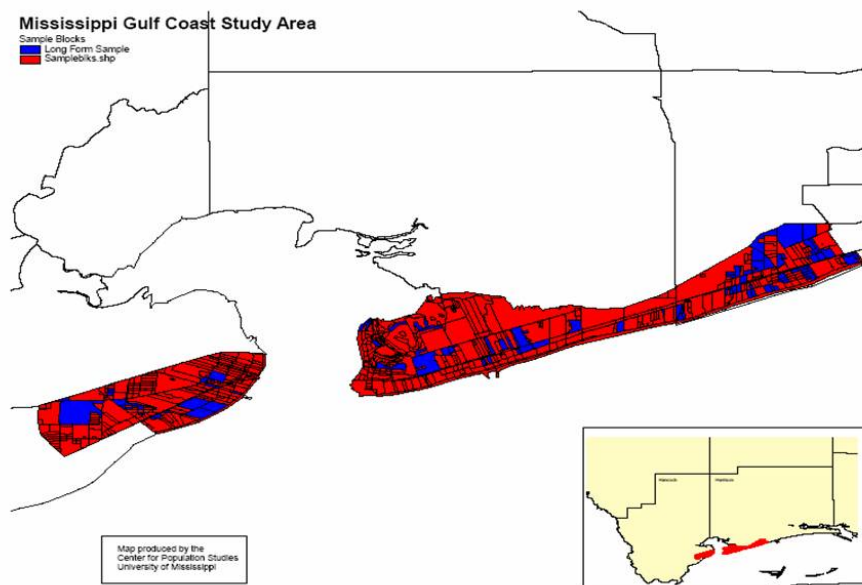
- (1) gathered pre- and post-Katrina information on housing and population from 573 targeted census blocks at the epicenter of Katrina's impact on the Mississippi gulf coast that the 2000 census showed as containing people (the "Short Form"); and
- (2) employed a random start, systematic selection, cluster sample targeting 126 of these 573 blocks for administration of a 115-item questionnaire (the "Long Form"), such that at least 350 completed questionnaires would be obtained. The Long Form was designed for several purposes, one of which was to collect retrospective information on the roles that social and kinship networks played in determining respondents' success (i.e., the capacity for respondents to sustain their physical and emotional well-being after Hurricane Katrina).

The geographic context in which our Study Area is found is provided in Exhibit 1 and the specific blocks are shown in Exhibit 2.

## EXHIBIT 1. THE STUDY AREA AND ITS GEOGRAPHIC CONTEXT



## EXHIBIT 2. THE STUDY AREA AND ITS TARGET BLOCKS



The primary data collection team included faculty and graduate students from the University of Mississippi, Mississippi State University, the University of Southern Mississippi, and the University of Tennessee Medical Center (Memphis), as well as several residents from the MS Gulf Coast. A secondary team was comprised of members of the geography division of the U.S. Census Bureau. This team geocoded selected sites and assisted with Short Form data collection. Collectively, the primary and secondary team members canvassed the Study Area to count and assess housing using the Short Form and to administer the Long Form Questionnaire.<sup>4</sup>

The collection of data entailed a number of operational challenges.<sup>5</sup> However, the team was successful in collecting Short Form data comprised of 10,547 completed surveys from 346 of the targeted 573 blocks and Long Form data comprised of 400 completed surveys from 71 blocks, 68 of which were from the 126 blocks targeted for Long Form data collection and three of which were from Short Form blocks erroneously canvassed.

The data collection process also captured information needed to provide a general assessment of survey data quality (American Association for Public Opinion Research, 2000; Dillman, 2000). Using these criteria, our assessment suggests that the data are of good quality.

#### **The Short Form**

The Short Form contained identifying information (housing unit sequence number, block, tract, and as much information on a street address as possible) and captured four pieces of information: structure type (single or multiple unit dwelling, trailer, mobile

home), whether it was permanent or temporary, its condition (habitable, heavily damaged, destroyed), and its occupancy status (occupied or vacant). The Short Form was approved for use by the Institutional Review Board of the University of Mississippi in the late fall of 2005. Short Form data were collected during two periods, January 8<sup>th</sup> to 15<sup>th</sup>, 2006 and March 10<sup>th</sup> to 19<sup>th</sup>, 2006, with the bulk of data being collected during the March 10<sup>th</sup> to 19<sup>th</sup> period.

The Short Form data (N=10,547) represent a complete enumeration of all housing in the 346 blocks, both permanent and temporary, as well as a determination of their condition (habitable, damaged, or destroyed) and occupancy status. These 346 blocks represent portions of two census tracts in Hancock County, MS (03010 and 03020) and four in Harrison County, MS (02700, 02800, 02900, & 0300), areas that were at the epicenter of Katrina's Landfall in Mississippi.

Because we used census definitions and conventions, the Short Form (and the corresponding control sheets for the Long Forms in a given block) allow for a direct comparison of our housing unit counts with Census 2000 housing unit counts on a block-by-block basis. From this we also can account for virtually all housing stock change between census 2000 (officially, the date is April 1<sup>st</sup>) and August 29<sup>th</sup>, 2005. This allows not only for a comparison of pre- and post-Katrina housing, but also pre-and post-Katrina household populations.

#### **The Long Form**

The Long Form was a self-administered questionnaire containing 115 items regarding sources, constraints, and assessments of Hurricane Katrina relief and recovery as well as basic

demographic information, the latter of which used census definitions and conventions in the same manner as the Short Form described earlier. It was approved by the Institutional Review Board (IRB) at the University of Mississippi in the late fall of 2005. Each block in the Long Form sample, had a Control Sheet corresponding to the items found in the Short Form. The Long Form was informally tested and revised nine times before a formal pre-test was done in the field. This field pre-test also allowed the study team to assess and refine protocols and procedures associated with the data collection effort.

The primary dependent variables that can be derived from questions in the Long Form are the differences in a survivor's responses of his or her economic, health and social well-being. To measure differences, respondents were asked to retrospectively and prospectively assess their satisfaction-levels in addition to stating their current perceptions.

The Long Form also contained a Post-Traumatic Stress Scale as well as items that allow us to control for other variables affecting post-disaster assessments. These variables include the level of property loss, access to insurance, the amount and sources of governmental relief (FEMA, National Guard, state and local emergency management), as well as ascribed (e.g., age, sex) and achieved characteristics (e.g., income, education).

Controlling for these alternative explanations, we could test many

specific hypotheses, one of which we present later in this paper.

As stated earlier, it was administered to a representative sample comprised of 126 targeted blocks of the total of 573 in the Study Area. Seventy one of these blocks were found to contain habitable housing. Team members went door-to-door handing out questionnaires and arranging with respondents a time to return for the completed questionnaire. A minimum of two callback attempts was made at each housing unit canvassed that potentially was occupied, including damaged permanent units and all temporary units.

The Long Form data were collected January 8<sup>th</sup> to 15<sup>th</sup>, 2006, with mail-out/mail-back callbacks collected from January 8<sup>th</sup> to February 15<sup>th</sup>. Four hundred completed Long Forms were obtained from canvassing and callbacks.

## **KATRINA'S HOUSING AND DEMOGRAPHIC IMPACTS**

As shown in Table 1.a, our data indicate that just before Katrina struck, there were 8,535 (permanent) housing units in the 346 blocks we canvassed, an increase of nearly 10% over the Census 2000 count of 7,793 (Table 1.b). Table 1.a also shows that of the 8,535 housing units, 2,227 (27%) were destroyed and 3,997 substantially damaged (47%), leaving 2,261 habitable (26%).<sup>6</sup> Table 1.c shows that 2,012 temporary units were in the Study Area after Katrina struck, of which 94% were occupied.<sup>7</sup>

**TABLE 1a. 2006 SPECIAL CENSUS DATA**

County/Tract	Total Housing Units (Permanent)	Habitable Permanent HUs	Occupied Habitable Permanent HUs	Damaged Permanent HUs	Occupied Damaged Permanent HUs	Destroyed Permanent HUs
Harrison/0027	2,035	1,331	1,198	651	103	53
Harrison/0028	698	53	46	232	20	413
Harrison,/0029	741	35	24	166	8	540
Harrison/0030	1,479	32	19	763	0	684
Hancock/0301	2,721	519	446	1,777	43	425
Hancock/0302	861	291	174	408	2	162
<b>GRAND TOTAL</b>	<b>8,535</b>	<b>2,261</b>	<b>1,907</b>	<b>3,997</b>	<b>176</b>	<b>2,277</b>

For definitions see endnote # 3.

**TABLE 1b.2000 DECENNIAL CENSUS DATA**

County/Tract	Total Housing Units (Permanent)	Occupied Housing Units (Permanent)	Vacant Housing Units (Permanent)
Harrison/0027	1,788	1,666	122
Harrison/0028	660	548	112
Harrison,/0029	670	353	317
Harrison/0030	1,361	1,086	275
Hancock/0301	2,528	2,177	351
Hancock/0302	786	656	130
<b>GRAND TOTAL</b>	<b>7,793</b>	<b>6,486</b>	<b>1,307</b>

For definitions, see endnote # 3.

**TABLE 1c. 2006 SPECIAL CENSUS DATA**

County/Tract	Temporary HUs	Occupied Temporary HUs	Total Occupied HUs (Perm & Temp.)
Harrison/0027	245	237	1,538
Harrison/0028	38	34	100
Harrison,/0029	29	26	58
Harrison/0030	425	422	441
Hancock/0301	805	745	1,234
Hancock/0302	470	436	612
<b>GRAND TOTAL</b>	<b>2,012</b>	<b>1,900</b>	<b>3,983</b>

For definitions, see endnote # 4.

There were approximately 16,540 people residing in 6,486 (occupied) permanent housing units in the 346 blocks as of Census 2000. Just prior to the impact of Katrina on August 29th, 2005, there were approximately 7,100 occupied permanent housing units (83% of the total number of permanent housing units) containing 18,105 people in these same 346 blocks. By January of 2006, we found approximately 10,950 people residing in 3,938 permanent and temporary housing units in these same 346 blocks. At the time of Census 2000 and just prior to when Katrina struck, the average number of persons per household (PPH) in the Study Area was 2.55. Subsequent to Katrina the PPH was 2.78. Thus, for the 346 blocks comprising our Study Area, Hurricane Katrina resulted in:

- (1) a decline of 7,155 for the household population – a 40% drop from the pre-Katrina household population of 18,105;<sup>8</sup> and
- (2) an increase of 0.23 persons per household– a 9% increase from the pre-Katrina PPH of 2.55.

Our estimates of the effects of Katrina on the household population in the Study Area are consistent with the special estimates of Hancock and Harrison counties that the Census Bureau released for January of 2006. These estimates were designed to show the impact of Katrina in the 117 counties designated by the Federal Emergency Management Agency (FEMA) as being eligible for individual and public assistance (U.S. Census Bureau, 2006). For Hancock County, the Census Bureau estimated that Katrina caused a 24% decline in the household population (As

of July 1<sup>st</sup>, 2005 the Census Bureau estimated the population of Hancock County to be 46,240 and for January of 2006, it estimated that the estimated the household population was 35,129) and for Harrison County, it estimated a 16.5% decline (As of July 1<sup>st</sup>, 2005 the Census Bureau estimated the population of Harrison County to be 186,530 and for January of 2006, it estimated that the household population was 155,817). We say that our numbers are consistent with the Census Bureau's because our Study Area is in the portions of Hancock and Harrison counties that received the brunt of Katrina's impact. As such, our estimate of a 40% decline in the household population for the Study Area is consistent with the Bureau's estimates of 24 and 16% declines for all of Hancock and Harrison counties, respectively.

### **THE EFFECT OF SOCIAL NETWORKS ON KATRINA'S IMPACT**

Beyond counts of housing and population, there is also the question of how an individual's economic, health, and social well-being is affected by a disaster such as Katrina. Why are some individuals better able than others to respond and recover in the immediate aftermath of major disasters? Does the economic, educational, racial or experiential (previous catastrophic event experiences) status of a particular refugee largely determine an individual's perceptions of relief and recovery?

To assist in answering these questions, we turned to Social Network Theory, which offers an interdisciplinary framework for understanding the health and resilience of communities (Coleman 1990; Portes 1998; Putnam 2000). Thus, in our research, we applied social

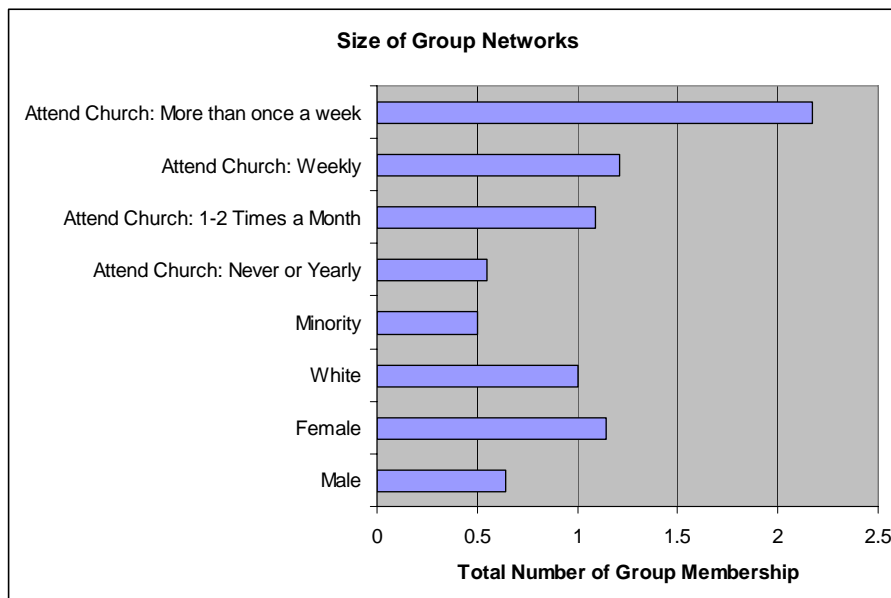
network theory to generate hypotheses addressing these questions. Our hypotheses were designed to clarify the conditions under which some individuals are better able to solve immediate problems presented by a natural disaster and to create a strong perception of eventual community recovery. We first examined the size and scope of the respondents' social networks and then analyzed whether or not being embedded in a social network affected the respondents' post-Katrina well-being.

Exhibit 3 shows that gender, race, and church attendance are correlated with the number of formal group network memberships. Females, whites and frequent church attendees average about twice as many formal group network memberships as males, minorities, and infrequent church

attendees, respectively. These respective differences were statistically significant ( $\alpha < .05$ ).

Exhibit 4 shows a second dimension of relative social isolation among Hurricane Katrina survivors: the average number of people in a personal group network by selected personal characteristics. As Exhibit 4 indicates, gender and employment are correlated with the size of a personal group network. Females and employed persons are in larger personal group networks than males and unemployed persons, respectively. Again, these respective differences were found to be statistically significant ( $\alpha < .05$ ). The difference between the white respondents and minority respondents is not statistically significant ( $\alpha = .083$ ).

**EXHIBIT 3. SIZE OF GROUP NETWORKS BY GENDER, RACE, AND CHURCH ATTENDANCE**



#### EXHIBIT 4. SIZE OF PERSONAL NETWORKS BY GENDER, RACE, AND EMPLOYMENT STATUS

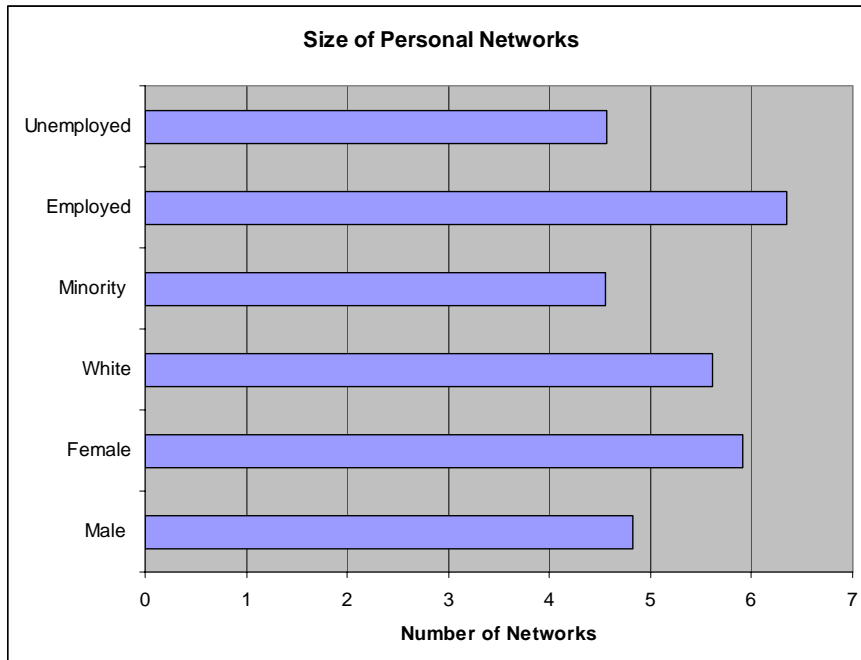


Exhibit 5 shows the general composition of these survivors' personal group networks. As it shows, about 90% of survivors' self-reported networks are "friends," "immediate family" or "extended family members."

As stated earlier, the specific hypothesis we report on here that a person embedded in a larger personal network group will perceive lower levels of disturbance in his or her economic, health, and social well-being than a person in a smaller personal group network. We examined this hypothesis using ordinary least-squares (OLS) multiple regression (Tabachnick and Fidell, 1996: 127-193). The results of our analysis are shown in Table 2. The dependent variables measure six types of disturbances perceived by respondents. These disturbances are in terms of their financial, economic, psychological, and

physical well-being, as well as their personal and professional relationships. For each of these six types of disturbances, we used our measure of the respondent's reported well-being or situation prior to Katrina and our measure of the respondent's reported well-being or situation after Katrina. Our measure of disturbance is the difference between the six sets of pre-Katrina and post-Katrina measures, respectively.

Looking at Table 2, what is the effect of personal group network size on survivors' perceptions of Hurricane Katrina's impact while controlling for the effects of other (independent) variables? Our results indicate strong support for the hypothesis that a person embedded in a larger personal network group (shown as "Personal Networks" in Table 2) will perceive lower levels of disturbance in his or her economic,



health, and social well-being than a person in a smaller personal group network. The Personal Networks coefficients are negative and statistically significant for financial, economic, psychological well-being, as well as that of professional relationships; there is no statistically significant effect of Personal Networks on physical well-being and on personal relationships.

Overall, Damage and Personal Networks are the most consistently

statistically significant of the independent variables across the six multiple regression models shown in Table 2. These two variables have the expected signs: Damage is positively associated with disturbance (more damage increases the disturbance) and Personal Networks is negatively associated with disturbance (larger personal group networks lessen the disturbance).

EXHIBIT 5. NETWORK COMPOSITION

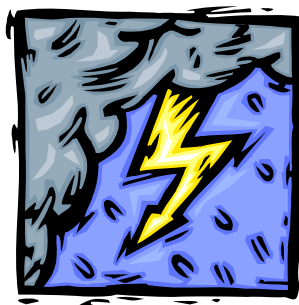
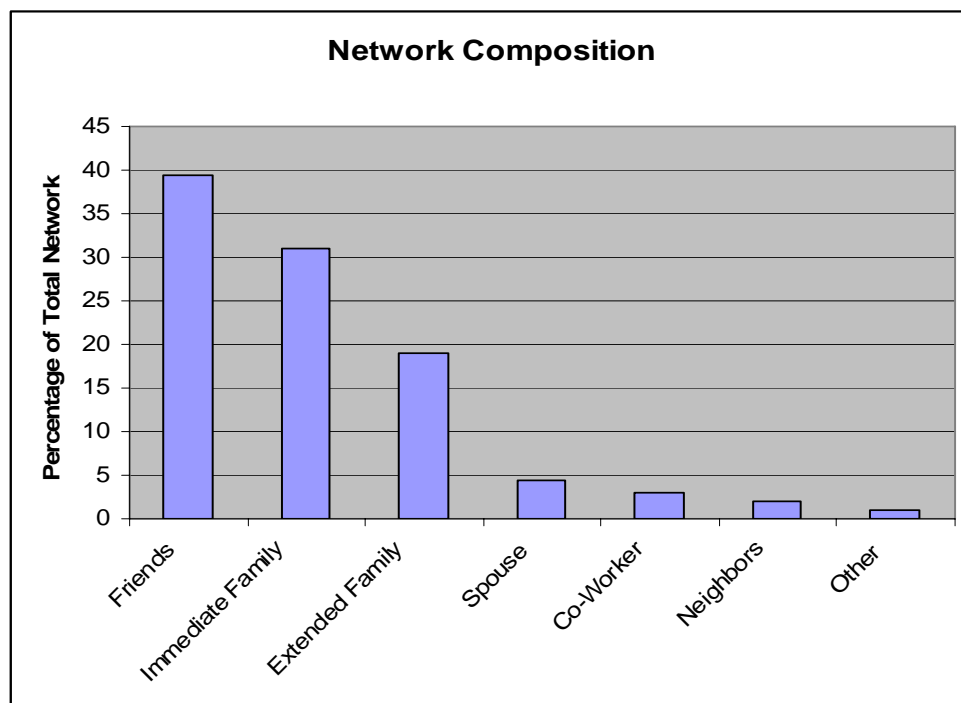


TABLE 2. RESULTS OF TEST OF THE HYPOTHESIS

<i>Disturbance (Dependent Variable)</i>	<i>Independent Variable</i>						<i>Model Characteristics</i>		
	<b>Damage</b>	<b>Insurance</b>	<b>Govt. Aid</b>	<b>Private Aid</b>	<b>Personal Networks</b>	<b>Injuries</b>	<b>Constant</b>	<b>R<sup>2</sup></b>	<b>N</b>
<b>Financial</b>	.484*** (.115)	.129 (.108)	.153 (.100)	-.065 (.076)	-.053** (.021)	----	-1.90*** (.393)	.07	335
<b>Economic</b>	.176* (.104)	.129 (.097)	.160* (.090)	-.055 (.070)	-.040** (.019)	----	-2.38*** (.352)	.03	332
<b>Psychological</b>	.208** (.099)	.088 (.091)	-.010 (.085)	-.068 (.065)	-.030* (.018)	----	-1.43*** (.339)	.02	335
<b>Physical</b>	.321*** (.092)	-.025 (.086)	.039 (.080)	-.058 (.061)	-.028 (.017)	.006 (.206)	-1.23*** (.397)	.05	335
<b>Personal Relationships</b>	.131 (.085)	-.078 (.080)	-.089 (.074)	-.045 (.056)	-.009 (.015)	----	-.431 (.289)	.02	338
<b>Professional Relationships</b>	.210** (.104)	-.036 (.097)	.020 (.089)	.003 (.069)	-.045** (.019)	----	-.819** (.358)	.03	287

The number in the upper part of each cell under the Independent Variables represents the OLS Multiple Regression coefficient for the Independent variable in question relative to the Disturbance in the same row. The number in parentheses in each of the same cells is the standard error associated with the coefficient. Statistical significance of each coefficient (or lack thereof) is shown by the number of asterisks, where: \*\*\* is statistically significant at the .01 level; \*\* is statistically significant at the .05 level; and \* is statistically significant at the .10 level. Lack of statistical significance is indicated by a lack of asterisks.

## DISCUSSION

What are the housing and demographic effects of a major disaster? Our research shows that they are substantial, with 27% of the pre-Katrina housing stock destroyed and 47% damaged, it is not surprising that we find a 40% decline in the Pre-Katrina household population. Neither should it be surprising that 48% of the occupied post-Katrina housing stock consisted of temporary units (Table 1.a and Table 1.b) and that there was a slight increase in the average number of persons per household after Katrina. Given the magnitude of these measurements, we concur with the recommendation by Henderson et al. (forthcoming) that methods need to be developed to quickly and accurately assess the TOTAL housing and demographic effects of large scale disasters like Hurricane Katrina, particularly at their epicenters.

What about social networks? Our results point toward a revised understanding of who is at-risk and who recovers from disasters. Vulnerable or at-risk populations are typically defined by personal or physical attributes that include an individual's socio-economic status, employment, disabilities, age, housing quality, availability of personal transportation (National Research Council, 2007). We find that social networks are an important part of a person's attributes that should be considered in better understanding who is at risk. Consequently, we suggest that the methods for identifying "at-risk and vulnerable" populations found in the National Research Council's 2007 report be extended to include community-based assessments of social networks. Understanding the spatial or geographic correlates of socially isolated disaster survivors may allow governmental and non-governmental emergency manage-

ment teams to better target relief and recovery efforts. Finally, we suggest that governmental emergency management needs to be sensitized to the importance of informal networks in ameliorating various types of disturbances associated with natural disasters, which suggests that they also play an important role in relief and recovery.

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(<http://www.census.gov/PressRelease/w/2005/katrina.htm>), last accessed June 2007).

## ENDNOTES

1. This material is based upon work supported by the National Science Foundation under Grant No. 0555136, awarded to the University of Mississippi (D. Swanson (Sociology & Anthropology), PI; Mark Van Boening (Economics) and Rich Forgette (Political Science), Co-PIs). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

2. David A. Swanson, Department of Sociology and Anthropology, University of Mississippi; Rich Forgette, Department of Political Science, University of Mississippi; Mark Van Boening, Department of Economics, University of Mississippi; Cliff Holley, Center for Population Studies, University of Mississippi; and Ann Marie Kinnell, Department of Anthropology and Sociology, University of Southern Mississippi

3. The Acronym “SGER” stands for “Small Grants for Exploratory Research.” Very soon after Katrina struck the Mississippi Gulf Coast, The National Science Foundation issued a call for “SGER” grants to assess its impact. There were nine SGER grants that used a social network perspective. The grantees using a social network perspective were assembled at an NSF-funded conference organized by RAND that took place in Arlington, Virginia August 17-18, 2006. Papers from this conference are forthcoming in a special issue of *Population Research and Policy Review* (volume 27, no. 6, December, 2008).

4. In addition to the authors, the study team included:

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Stefan Schulenberg, (Psychology Department, faculty)  
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Kirsten Dellinger (Sociology and Anthropology Department, faculty)  
Jeff Jackson (Sociology and Anthropology Department, faculty)  
Ed Sharpe (Sociology and Anthropology Department, adjunct faculty)  
Johnny Ducking (Economics Department, graduate student)  
Bryan Dettrey (Political Science Department, graduate student)  
Chrissy Glider (Economics Department, graduate student)  
Mike Hirschel (Psychology Department, graduate student)  
Gwen Wages (Sociology and Anthropology Department, graduate student)  
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Community

Mary Ellen Calvert (interviewer, Long Beach, MS; alumna of the University of Mississippi)  
Rita Swanson (Volunteer, first aid support for Field Work Team, Oxford, MS; RN, BSN, MSN)

Census Bureau Personnel (GPS recording of housing units and sites of housing units)

Greg Hanks (Team Leader)  
Steve Bainter  
Sharon Cochran  
Ross Davis  
Kevin Donnalley  
Jennifer Harrop  
Jennifer Holland  
John Kennedy

All primary study team members completed training models on gathering data from human subjects and were certified through their respective Institutional Review Boards. The secondary team

members completed similar training under the provisions of Title 13 as part of their normal work with the US Census Bureau. Training specific to the data collection (both the Short Form and the Long Form) was done at the University of Mississippi and Mississippi State University before the Pilot Study was done on January 7<sup>th</sup>, 2006. The Pilot Study also served as On-Job-Training and a final test of procedures and protocols. Data collection training included modules on dealing with a distressed population.

5. Operational challenges included, among others: (1) an extremely limited number of locations to use as a “home base,” which resulted in long driving times to the field and, in turn, limited the time available for team members to canvass blocks; (2) a lack of street signs and other landmarks to use to locate specific blocks in the study area; (3) hazardous field conditions – debris, ruptured gas lines, and insects; and (4) a lack of facilities for food, gas, and sanitation.

6. The definition of a housing unit follows that of the Census Bureau’s definition as used in the 2000 Decennial Census. However, the Census Bureau has no definition for a “damaged” or “destroyed” housing unit. Given the intent of our study, we needed such a definition. Therefore, we defined a “damaged housing unit as one that had received observable damage, but was still standing and appeared to be structurally sound. For example, a house with a blue tarp for a roof and all of the doors, windows, and interior walls missing was defined as damaged. A Destroyed house was one that was either completely gone (e.g., only a slab remained) or sustained structural damage (e.g., supporting beams for the roof had collapsed, a wall was caved in). In cases where it was difficult to distinguish whether a house was damaged or destroyed, we classified it as damaged.

7. The Census Bureau does not distinguish between a temporary and permanent housing unit. Specifically, the Census Bureau defines a housing unit as a shelter intended for “separate use” by its occupants such that there is independent access to the outside and the shelter is not a group quarters (Swanson and Stephan, 2004: 762). Given the intent of our study we needed to identify temporary housing units. Therefore, we defined temporary housing units using the following protocol. First, we defined as temporary housing units, any non-permanent structure in which people were residing. This included tents, lean-to, campsites, motor vehicles, recreational vehicles, travel trailers, house trailers and mobile homes with their axles and wheels in place. The recreational vehicles, travel trailers, house trailers, and mobile homes classified as temporary housing units generally were on lots next to destroyed or damaged permanent housing units or in parks and usually were connected to power and other utilities. In such cases, even if they were not occupied, we counted them as temporary housing units. If we encountered tents, cars, and trucks that were not occupied, we did not count them as housing units. Similarly, if we encountered un-occupied recreational vehicles, travel trailers, house trailers, and mobile homes on sales lots we did not count them (these were usually either heavily damaged or destroyed anyway)

8. The household population is comprised of those who live in housing units (as opposed to those who are homeless or living in group quarters – prisons, long-term care hospitals, military barracks, and school and college dormitories (Swanson and Stephan, 2004: 762).

# **THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN THE RESILIENCE OF EDUCATIONAL INSTITUTIONS IN THE WAKE OF HURRICANE KATRINA**

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## **ABSTRACT**

In this paper we examine the role of information and communication technology in the resilience of two educational institutions in the wake of hurricane Katrina. More specifically, we primarily focus on trying to understand the roles played by ICT from the perspectives of the IT department, the registrar's office and instruction. Also some recommendations how universities can use ICT in disaster recovery are provided. We use case study method that is both qualitative and exploratory in nature. The theoretical framework is drawn from the concepts of business process re-design, IT capabilities, and intellectual capital. This paper draws on qualitative results from the data generated by interviews with the following: (1) a department chair or teaching professional; (2) a representatives of IT Administration; and (3) a representative of the registrar's office. The results document the significance of ICT in the survivability and resilience of these institutions after Katrina.

## **INTRODUCTION**

The fall semester began for many southern universities only one week before Hurricane Katrina struck the Gulf Coast on August 29, 2005. Hurricane Katrina caused massive damage and destruction along the coastlines of Louisiana, Mississippi, and Alabama. It is estimated that Katrina was responsible for \$81 billion in damages (Johnson, 2006). The storm caused not only property damage, power outages, and fuel shortages but killed at least 1,836 people (Johnson, 2006). So far, the storm has left many people homeless and families separated. Eighty percent of the city of New Orleans was flooded and over one million people from the Gulf Coast region were displaced. Among those displaced were over 50,000 students forced to evacuate

from the city's campuses. In this situation, every university in New Orleans closed its on-campus operations for the 2005 fall term.

The leadership of the universities in New Orleans was profoundly stressed in keeping their universities viable. Immediately after Katrina, the public was barred from returning to New Orleans by the National Guard and local officials. During this period, University of New Orleans's Chancellor Timothy Ryan made a special request to the Coast Guard to escort him onto the university's campus to retrieve certain very important items. The Coast Guard complied with the request and transported him to the campus via Coast Guard vessel and armed escorts. What was so important to the Chancellor that in the midst of one of the nation's greatest disasters that he felt compelled to make this

extraordinary visit to a university campus? The answer was that he needed to retrieve the university's computer servers and, of course, the extensive information about the university, its students, its faculty and its employees. Think of the personal and institutional damage that could occur if information about student records, faculty employment, and diplomas awarded were forever lost. The university, of course, did have IT back-up but it was located in another area of New Orleans that was not accessible at this time during the flooding. The servers were retrieved and relocated to Baton Rouge. The information was saved and the university began to reestablish itself by its web presence. Significantly, the university was able to make its mid-September payroll within two days of its standard payroll procedures. Clearly, modern information technology was playing a critical role in the survivability and resilience of the University of New Orleans.

Many disaster related studies have focused on reporting "bad news" such as financial losses, physical damages or negative impacts on mental or physical health (Freudenburg, 1997; Gill, 1998; Picou, Marshall, and Gill, 1997; Chappell et al, forthcoming). The study that we report here, however, might be interpreted as a success story for Information and Communication Technology (ICT) in that it is a case study that investigates the role that ICT played in mitigating the effects of Hurricane Katrina on two of the universities in New Orleans. Is it possible that information technology is so important in responding to disasters that it can be considered a new form of "intellectual capital" that transcends, or at least extends, the traditional capabilities of human, financial, and infrastructure capital?

In our case study, we primarily focus on trying to understand the roles - facilitating, enabling or IT-driven - played

by ICT from the perspectives of three important university activities: (1) technical support; (2) the registrar's office; and (3) instruction. As a secondary goal, we will elaborate on how universities can use ICT in disaster recovery - very little has been done on the effects of disasters on organizations and even less on institutions of learning.

This paper is divided into four parts. First, we offer a short review of Intellectual Capital and ICT-related models and theories. This serves as the analytic framework for our research. Second, we present our methodology and analysis. Third, the key results are provided. And finally, we discuss and summarize the results of our research and give some recommendations on how ICT can be used by organizations in disaster recovery.

## **INTELLECTUAL CAPITAL AND IT CAPABILITIES**

When we were planning this study, we hypothesized that intangible organizational assets would play a role in disaster recovery even though tangible organizational assets such as buildings and other infrastructure were damaged or destroyed. In fact, we anticipated that ICT would become even more important when physical infrastructure became unavailable or unusable. This line of reasoning stems, in part, from research reported by, among others, Beggs, Haines, and Hurlbert (1995), Lin, Cook, and Burt (2001). One way to think about intangible assets is in terms of *Intellectual Capital* (MERITUM, 2001; Sullivan, 1998). The concept of Intellectual Capital can be approached from the perspective of value creation or value extraction (Sullivan, 2000, 184). The value creation aspect points out the human effort in creating innovations, formulating and sharing knowledge. The typical activities in value creation are education, knowledge, innovations, building organizational

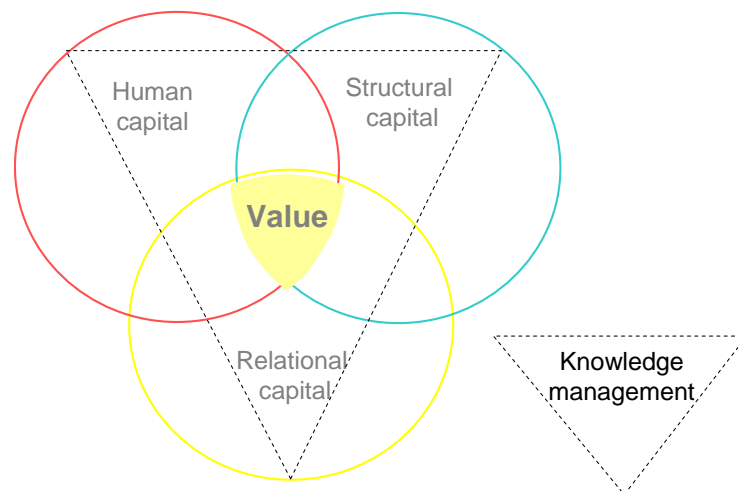


structures, the development of the interaction among customers, organizations, and individuals, and the management of values and organizational culture (Sullivan, 1998, 20). In this study, we use the value creation approach, where the primary objective is to improve the knowledge and skills of an organization's personnel. This is primarily accomplished through professional development. Typical activities include knowledge creation and sharing, learning, and organizational dynamics, and the development of information systems (Sullivan, 2000, 184).

Intellectual capital can be divided into three main dimensions (MERITUM, 2001): (1) human capital; (2) structural capital, and (3) relational capital. Human capital includes the competencies and capabilities of the personnel, their motivation, commitment and interaction. Structural capital consists mainly of organizational structures, processes, management, culture, values and information systems and other items related

to these. Conceivable features of relational capital are all the potential network related issues, like customers, partners, and other stakeholders. In our study, we view relational capital as consisting mainly of faculty and staff contacts with counterparts in other institutions via professional and other associations, alumni, and governmental bodies. Students can be viewed both as structural and relational capital. In our view, we examine them more from the perspective of relational capital.

It is useful to note that Saint-Onge also argues that value can be created only when all three forms of intellectual capital, human, structural, and relational are integrated (Edvinsson - Malone, 1997). In terms of such integration, the role of knowledge management can be thus seen as an integrating mechanism that pulls the three forms of intellectual capital into closer interaction with each other. Figure 1 describes this "value creation" process.



*Figure 1. MERITUM model of intangible assets and knowledge management (model was created by Saint-Onge, Armstrong, Petrash and Edvinsson and originally presented as value creation platform (Edvinsson and Malone, 1997))*

The role of ICT in mitigating the effects of a disaster can be approached in several ways. We can take the perspective of management, for example, or a more

technical approach, one based primarily on information technology (See Zmud, 1988; Schein, 1989; Sääksjärvi, 2000). Significantly common information

technology can be seen as an agent of empowerment in an organization. Thus, it has the capacity to be a vehicle for change in an organization's fundamental relationships with its stakeholders, both internal and external.

ICT can serve as an agent of empowerment through the different ways. It can be used to redesign organizational

functions and processes. Davenport (1990), for example, classifies these ways into three categories: (1) facilitating; (2) IT-enabled redesign; and (3) and IT-driven process redesign. Using this classification scheme, Hannus (1994) goes on to describe three different roles in business process re-design, which we use in our case study. Table 1 provides a description of these three roles.

**Table 1: Three roles of ICT modified from Hannus (1994)**

ROLE OF ICT	DESCRIPTION	LEVEL OF AMBITION
Facilitating role	ICT is utilized in implementing of the separately defined strategy	Improvement; the activity itself has not been questioned
Enabling role	The core processes are redesigned by utilizing innovatively the possibilities of ICT	Re-engineering
Driving role	Major changes in processes and mission on the basis of ICT	Rethinking / reinventing

Traditionally, information technology has been seen to have a facilitating role. The basic idea is that the functional needs of an organization, such as keeping student records and processing payrolls are first defined, so that the activities required to support these functional needs are then developed and implemented. One shortcoming of this approach is that it fails to recognize the reciprocal interaction among processes, which often serve as the potential enabling agents of ICT (Hannus, 2000, 109).

Bharadwaj (2000) defines the capability of information technology based on the definition of a resource-based view (RBV) by Barney (1991) as follows: "A firm's IT infrastructure, its human IT skills, and its ability to leverage IT for intangible benefits serve as firm-specific resources, which in combination create a firm-wide IT capability". These ideas are also similar to

those proposed by Langdon (2006). The IT infrastructure means the tangible resources consisting of the physical infrastructure components such as the computer and communication technologies and shareable technical platforms, and databases. Human IT-skills refer to the human resources comprising the technical and managerial skills. This definition is analogous to that of IC (Intellectual Capital) where St. Onge (Edvinsson and Malone, 1997) argues that value can be created only when all three forms of IC are integrated. The RBV theory, however, states that the resources and performance of a firm are linked in a way that the unique resources and skills are organization specific, valuable, and rare (Barney, 1991). Thus the combination of IT infrastructure, human IT skills, and the ability to leverage IT for intangible benefits creates the school-wide IT capability and

increases the performance as the dimension

interact. (See Fig. 2).

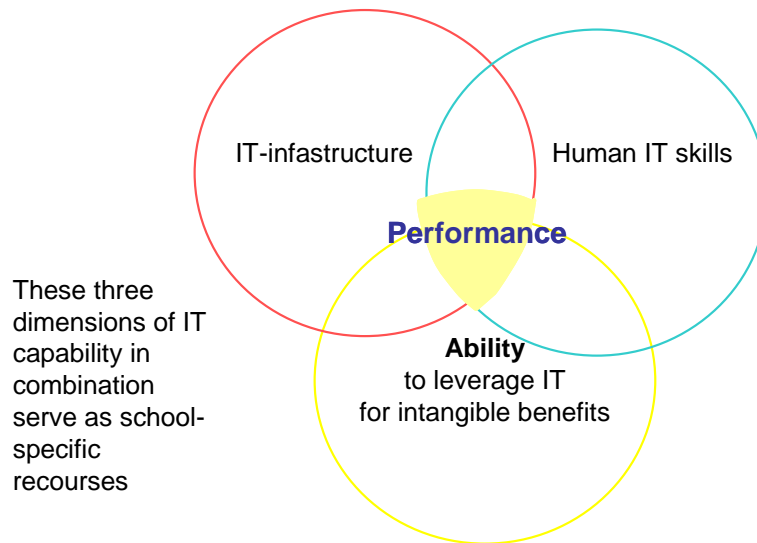


Figure 2. Visualization of a school-wide IT capability

## METHODS AND DATA

In our study, we use the case study method (Broder et al., 2003). This case study method has a long and rich history among institutions engaged in education, training and professional development. We selected the “historical narration form” of the case study method (see e.g. Patton and Swanson, 2003), which is well suited for our objectives. In our case study, we strategically selected two universities, “A” and “B,” which are of interest not only because of their unique features, but also for the potential of obtaining important knowledge about the “lessons learned”(Stake, 2000) in the aftermath of Katrina.

Our data were generated by interviews with the following: (1) a department chair or

teaching professional; (2) a representative of IT Administration; and (3) a representative of the registrar’s office. The interviews were done by telephone and conducted during June and July of 2006. The questions used in the interviews were common across each of the institutions but varied by type of representative. That is, the interview with a representative of IT administration was different than the interview with a representative of the registrar’s office, and both were different than the interview with a department chair or teaching professional. All interviews were semi structured and open-ended. Questionnaires were sent to respondents prior to the telephone interview. The interviews were recorded and transcribed. Table 2 provides a description of this process.

**Table 2. Background of the interviewed experts.**

<b>Background</b>	<b>Number of interviews</b>
<b>University A</b>	
- Chair of department	1
- Assistant professor	1
- Professor	1
- IT director	1
- Director of RO	1
<b>University B</b>	
- Chair of department	3
- IT professional	1
- Director of RO	1
<b>Total</b>	<b>10</b>

The data used in this study initially covered three educational institutions located in New Orleans. The first phase of data collection was the selection of the case organizations. The criteria for selection were that all these universities were located in the destroyed area and they both had different “survival” strategies. In the second phase a conference call with the representatives of each university was conducted in order to identify the most important things that they perceive as being the foundations for recovery from disaster. After that we designed and pre-tested questions. Three different sets of questions were created. Then we chose the interviewees one from IT and RO and three from instruction. The questionnaires were sent to respondents and phone interviews conducted. The interviews were recorded and transcribed. The analysis involved the classification of responses, first by themes and finally by activities. The third university was deleted from the study because we were unable to arrange interviews. The analysis is described in more detail in Appendix A.

University A was established in the mid 19th Century and is one of 28 Jesuit institutions of higher learning in the United States. Although a Jesuit university, it is open to students of all faiths and in its mission statement, welcomes students of diverse backgrounds. The leading academic areas of this institution are communications, music and religion and in the academic year prior to Katrina, it had a total enrollment of 5,900 students, of which 3,800 were undergraduates. The students come from all 50 states, the District of Columbia, Puerto Rico, and 46 foreign countries. Approximately 36 percent of the students were minority students.

University A was extremely fortunate in that it sustained only minor building damage. It also lost some video cameras, computers, and printers. More serious was the threat of losing lab contents and electronically-stored information due to the combined loss of power and air conditioning for a sustained period. In the biology department, for example, the loss of power and air conditioning was a catastrophe for lab contents such as frozen

tissues. However, even in the biology department very little electronically stored data were lost, which was the case for University A as a whole. E-mail and telephone service, and the student records system, for example, were operational about a week after the storm. More of a problem was the lack of electricity, which meant that electronically-stored data could not be accessed.

Although it sustained only minor damage to its buildings, the loss of power, other utilities, and the workforce needed to operate the university forced University A to close for the 2005 fall term. Many students did not attend school during the fall. The ones who did were spread over 500 different universities. The institution was re-opened in January and out of 5,644 students who had registered for the fall semester only 4,993 returned. The IT and registrar's offices did not lose many staff, but their workloads increased. This was particularly true for the Registrar's Office as it tried to track its students scattered across many universities. However, many departments lost faculty and like the students, not all returned for the spring term.

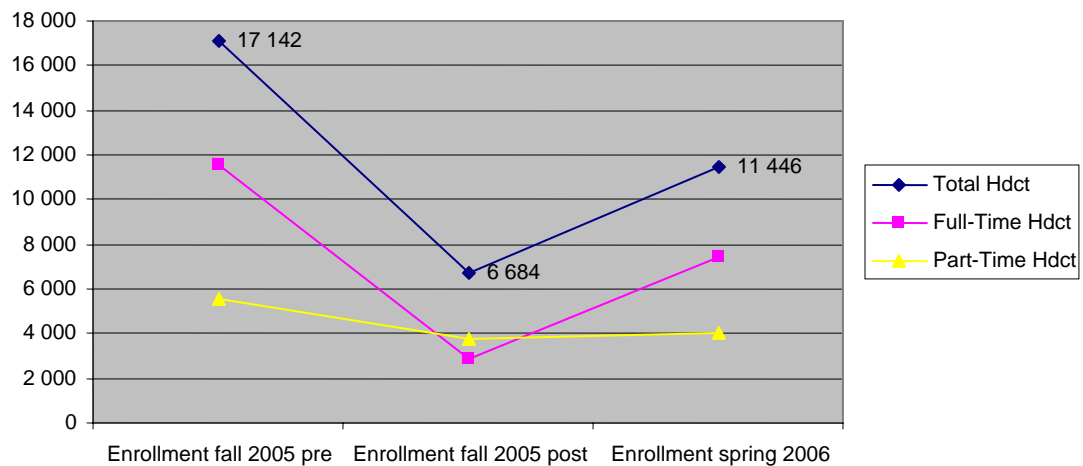
University B was established in 1956 as a metropolitan campus of the Louisiana State University System. Since the early 1970s it has also administered a large summer program in Europe. University B positions itself as "the urban research university of the state of Louisiana and provides essential support for the educational, economic, cultural, and social well being of the culturally rich and diverse New Orleans metropolitan area." University B had a total enrollment of over 17,000 students, most of whom were from the greater New Orleans area.

Unlike University A, University B suffered major damage to its buildings. For example, it still lacked functioning toilets in some buildings nearly a year after Katrina

struck. In addition, some buildings received interior water damage due to roof leaks, which ruined carpets and furniture, computers, video cameras, and printers. Many faculty members set up temporary offices on campus while the remainder worked largely from home. The following quote from the Registrar's Office describes the general situation across offices and departments even a year after Katrina: *"we're still living out of boxes because you can't just immediately unpack and put everything back together when you don't have as many employees as you used to have."*

University B lost some electronically-stored data. Notably, e-mails and data stored in personal computers at home. However, as was the case for University A, University B did not suffer major losses in its electronically-stored data. The Registrar's Office was working within four days of the storm, (although from a satellite office in Baton Rouge). The primary problem was the lack of electricity needed to access electronically-stored data. The power was brought back building by building and it took until December of 2005 before campus-wide power was restored. It is worth noting in this regard, that University B's IT Office did not lose any employees, but the loss of personnel in registrar's office and some academic departments was substantial. Re-designing activities and arranging online-courses resulted in a significant increase of workload.

Like University A, University B also had to close its on-campus operations for fall term 2005, but the teaching activities did not stop: 700 online courses and about 300 courses on satellite campuses in the area were offered. The campus re-opened in January. University B lost a significant number of students because of Katrina, but immediately began to recover (see Fig. 3)



Most of the general budget for the institutions comes from student tuition and state funding driven by enrollment. Due to the major decrease in enrollment, both University A and B were thrown into financial crisis, and many faculty and staff were terminated. As of the time of the writing of this report, some programs have been combined; while other departments and even some colleges have been completely eliminated.

## RESULTS

In this section we report what kind of roles IT departments had and what kind of roles ICT played in registration and instruction. We classified the roles according to Hannus (1994); facilitating, enabling, and IT-driven. We also tried to assess the IT capabilities and the changes or shifts in the intellectual capital of the organizations.

### FROM THE PERSPECTIVE OF INFORMATION TECHNOLOGY

Both universities already had information and information technology strategies in place that included disaster

recovery (DR) plans and “business continuation” (BC) plans. This phenomenon tends to be typical nowadays, but even for organizations with such plans an actual disaster results in plan revisions (Carpenter, 1993; Burke, 2005). For those organization lacking such a plan (e.g. Vijayaraman and Ramakrishna, 1993), recovery plans are often developed after their first experience with a disaster. For example, after 9/11/2001, financial firms were required by law to develop and implement a business continuation plan in the event of business disruptions (Burke, 2005). According to Carpenter (1993) the IT recovery plan encourages management to develop a total disaster recovery solution for the whole organization. The ICT acted hence in the role of a forerunner. The development of ICT recovery and continuation plans might serve as a model for these institutions to create a more strategic and comprehensive plan for the entire university.

University B’s representative describes the change as follows: “*In reality, I don’t think it’s changed that much, but they say that we will be up soon after a big storm.*” This sounds like the typical statement about recovery time in DR plans.

The recovery time in the business sector is in general 48 hours (Carpenter, 1993) or two business days. In educational settings this time may be longer. In our case study, the recovery time varied from 24 hours to some weeks depending on the department. The IT-person representing University A described what happened in more detail: *"we already had a disaster recovery plan before. And we tested and we used it during Katrina. But we've basically updated it and we found out some things that worked out and things that didn't work well. So we've made modifications to the plan to hopefully, if we ever have to use it again, it'll go a little bit smoother. The second thing that we're trying to do is we're trying to get this building to work by a generator."* This statement implicates that they tested, revised and upgraded their disaster recovery plan and did some physical investments such as generators in the infrastructure. Hence, IT acted mainly in the facilitating role. No radical changes have been made from the perspective of IT offices. They were primarily engaged in continuous improvement.

Both University A and B have information technology strategies in place. They already had backup-systems, secondary computer rooms, and disaster recovery plans, so essentially they were making minor changes in their existing plans. University B has taken extra steps to prepare for another disaster: *"but we also now have more than one way to get to the outside world, so to speak, on the network. So we always stay up, at least our major system stays up."* And *"If everything were washed away, we would still have a presence outside of New Orleans". We've actually changed the way we ship tapes now out of town, I mean out of the office, once a week and actually to another building every day, I'm not that concerned. Even if, like, we have a chemical spill or fire or*

*something, I think we're pretty safe it still takes a little bit of luck involved, I guess, but we're pretty safe. I think as safe as we can be."* Both organizations made incremental changes to their existing plans in such a manner that they enabled (or enhanced) their core processes rather than making radical changes.

As Katrina approached, neither institution implemented a plan for contacting students. Please recall that Katrina was not originally forecasted to strike New Orleans. However, the registration office in University B had created an emergency list of employees. This was originally intended for more typical and often individual emergencies, such as illness. She described the limitation of her emergency list: *"And it took me about ten days to track everyone down and part of that was because the area code 504, in terms of cell phones, was not operational."*

But in the aftermath of the hurricane many kinds of supporting roles became evident and the roles also changed and expanded. The nature of supporting depends on the department, as well on the characteristics of the informants. The IT offices were typically mediators; they were involved in communications with the various departments. A representative of IT in University A described their role *"And once we got our web server -- a secondary web server up our staff was updating the web server via what the president told us. So we were just trying to disseminate the information that somebody was giving us."* Traditionally, IT has a range of roles in redesign, as well as its usual service role. It provides the platform for information systems and is responsible for the continuity of the information system. But after Katrina there was a shift from the traditional role towards the role of end-user by disseminating the information that others gave them. In terms of operational

procedures, IT offices seemed to function very similar to pre-storm patterns, i.e., *“My particular office I don’t think is functioning much differently at all except for the fact that boxes are sitting in there that nobody’s undone. They don’t belong to us; they belong to somebody else in the building.”*

*Summa samarium*, both organizations already had the information and information technology strategies with their existing disaster recovery plans. They only tested, revised, and upgraded them. The biggest changes are that University A created a secondary email system (beyond the office) for faculty, staff and administrators - but not for students. The other typical change was the timeline and location of backup-systems. Third, they have prepared for IT resilience by providing generators for back-up power. In contrast, there was little or no alteration in the DR plan for computers or information systems. The role of IT department can be categorized as being a service provider, mediator, facilitator, and end-user. In addition it acted as a forerunner in a more abstract way for other disaster plans.

## **FROM THE PERSPECTIVE OF THE REGISTRAR**

The registrar’s offices offer an interesting perspective to this study. The policies and procedures at registration offices seem to have experienced major changes. Very soon after the storm they turned into virtual offices existing in cyberspace and using web-based Internet systems from different locations far away from their own campus. Thus the role of ICT was vital as it provided the means/tools to establish the virtual offices and create a presence outside the disaster area. ICT worked on the other hand in the role of a facilitator but it might be that it was also in the role of an enabler. ICT became a

powerful and innovative source for the registrar’s functions of the universities.

One phenomenon was the increased workload; University B lost numerous employees from its registrar’s office, while University A did not lose as many employees. Due to the lack of employees and the demands for new services, the registrars had to re-design their processes. Both institutions rapidly innovated: University B developed a new online system for registration. The students can now register themselves online and the program appears to be functioning better than their original system. They also rapidly transitioned from printed materials to online documents. A representative of registrar’s office in University B describes the improvement: *“In terms of things like print publications that related to registration like the class bulletins, that is all online now and there is no intention of going back to a hardcopy printed bulletin of any kind.”*

The changes at the registrar’s office A are also innovative and related to their information systems. They now do things that they had never thought of doing before. They have developed their policies and procedures in such a manner that they can either take or access their procedure manuals in case of evacuations. A variety of different types of reports are run and put on a drive and are then always ready to be relocated. They will have remote access to information for their currently enrolled students, their contact information, degrees and other major information. The level of ambition is judged to be high. For the registrar function, ICT is playing an important enabling role.

In addition to the improved resilience of student information, the universities have also improved access to other organizational data. Both have created emergency lists that include cell phone numbers and spouse’s cell phone numbers.



University A also requires everybody in its office to have a secondary e-mail address. In creating another e-mail address ICT has again provided a facilitating role and by improving communications in emergency situations, it works in an enabling role.

The registration offices also acted as a mediator. A representative of University B describes *"But that I did and, I mean, I had staff (in) Houston and Dallas and Oklahoma, Georgia, Tennessee. I mean, they went everywhere. So that was probably the biggest push."* IT played a major role in providing the communication linkage and facilitation of information exchange for a university that, in many respects, was operating in a virtual world.

The faculty, staff and students from University A were also widely dispersed after Katrina. However, there was substantial and parallel effort to establish face-to-face contact in addition to ICT communication. The representative of registrar's office A tells *"I think we handled it as best we could under the circumstances. We all had our phone numbers out there. I was receiving phone calls in South Carolina from students who were concerned or had special issues. We had phones set up in Houston where they could call in and speak with our vice president or a provost or even with some of their deans were there. So, maybe it wasn't face-to-face contact, we were easily accessible after about a week. As a matter of fact, our president, once things were up and running fairly smoothly, he started making visits to many of the cities that were housing so many of our students. He would do alumni visits and also those alumni organizations would bring in our students from those schools."* It looks like they really wanted to support and inform students very closely by hearing and visiting. Here ICT has no direct role yet in face-to-face contacts.

Both registrar offices made substantial changes in response to Katrina. They re-designed their service processes and in some cases created "mobile offices." There were divergence views on the persistence of innovation and change. When asked, "What is your office doing different now?": The director of the registrar's office of University A believed there was little change, *"we are functioning as if this never happened"* while the representative of University B maintained *"our office will never be back to what it was because of reductions in students, reductions in faculty."*

From a theoretical perspective, the roles played by ICT in registrar offices' activities are primarily facilitating and enabling. IT capabilities in both offices were good because of the flexible and integrated infrastructure so that both were able to add new applications in response to changing demands. In terms of intellectual capital, it seems that there is a shift from human capital to structural capital due to developing new information systems.

## **FROM THE PERSPECTIVE OF INSTRUCTION**

We were interested in how Katrina impacted teaching strategies, as well as learning and teaching quality. But especially we were interested what kind of role ICT played in instruction. These two organizations had markedly different strategies for instruction after the storm. University B turned very quickly to cyberspace and by October 10th was offering over 700 online courses. In addition, they offered about 300 courses at satellite campuses in the area. On the other hand, University A, offered no online courses, but instead was focusing on relocating their students to other universities. About 3,000 of their students

were attending about 500 different universities.

So the teaching strategy changed dramatically for University B. By spring semester both organizations were mainly back in classroom, but there was a dramatic shift in online course offerings in University B. Before Katrina the university had offered about five percent online courses. In the spring semester, after Katrina, online courses soared to about 30-35% of course offerings.

Many felt that there was diminished teaching effectiveness and learning quality because of the storm. The Chair of Communications in University A stated: *"I probably cut students slack that I normally wouldn't have done."* A professor at the same university noted: *"There's no doubt that everybody was severely traumatized, both the students as well as the faculty and staff."* The third teaching representative of University A emphasized psychological issues: *"Almost everybody found it to be a stressful semester in terms of stress levels of both the faculty, problems the universities were having fiscally and otherwise, and of course the problems with the students. So it was an overload semester. I think there was overall a lower level of performance. I certainly saw some of that in my courses. I heard my colleagues report some early in theirs."* Our respondents felt that the learning and teaching quality at University A was lower in spring semester after Katrina than that before.

According to a professor and chair at University A, the quality from the students' perspective is better due to smaller class sizes. He continues: *"This summer we're offering actually more courses than we offered last summer but that's just because I was asked to offer some additional courses. But I don't think it's significantly different."* The other professor and department chair reports: *"We're in a transition trying to*

*figure out exactly how large the school is going to be and how many faculty we need and stuff. But the quality of the teaching and learning itself has remained consistent."* A third respondent said: *"Well, I mean if we go to the spring semester, spring of '06, I would say we were back to normal as far as the types of courses we taught. We offered a few more Internet classes than we had in the past. But the majority of our classes were still classroom lecture seminar types of classes. Fall semester was an aberration. It was about 90 percent Internet classes. So I mean it was a big adjustment for everyone in the fall. But by the spring we were just about back to normal."* In interpreting these quotes, it appears that the professors interviewed in University A felt that the quality of learning and teaching remained constant or at least returned to the same level shortly after the storm.

Both universities were required "to do more with less." Almost everyone felt that their workload was increasing. The increasing workload resulted from a combination of many different factors. Many professors were teaching extra courses to "make up" for classes cancelled during the fall semester. The number of faculty and staff had decreased because of displacement, cancellation of programs and difficulty in retention of staff. Student revenue was down because of reduced enrollments, while course loads had increased because of reductions in staff. Pressures for downsizing were strong and constituted a substantial cost in faculty morale and cohesion.

The universities clearly relied on their websites as a primary means of conveying information to students, faculty, staff and other interested publics. E-mail and phone communications were also widely used to communicate and coordinate among the dispersed members of the universities. ICT played a profoundly

important facilitating role. It allowed faculty members to locate and contact student majors, minors and other advisees. Professors made themselves available through cell phones, e-mail and even home visits. One professor said that through his phone communication, he was able to reach about 75% of his major and minor students.

The answers to the question "*How is your department functioning differently now?*" vary a lot. Some respondents mention physical things such as the department is smaller because there are not as many faculty members and students. Some point out the psychological aspects like "*I would say the level of cohesion has it where it wasn't that before. But I think people often appreciate the contacts they have among colleagues because they're -- we were allowed for months so there were a lot of joyful and tearful reunions and that kind of stuff. It's very emotional stuff. And I think in a way that enhances cohesion among people.*" Some of them feel just uncertainty because they don't know how many students are going to be back and how many faculty members they are going to be able to recruit.

The most important role that ICT had in instruction was the IT-driven role evident in the increased offering of online courses. IT capacity was substantial for University B, in that they were able to leverage IT resources to provide a massive number of new online courses. In the case of University A, IT capacity was less of an issue because of a much different strategy of resilience - the placement of students in other universities and colleges. Human capital decreased dramatically in both universities, because they lost many experienced faculty members. Relational capital, in contrast, increased due to faculty and staff contacts with counterparts in other universities. But

because we examine the students more from the perspective of relational capital, it can be seen decreasing or staying equal.

## DISCUSSION AND RECOMMENDATIONS

The aim of this study was to try to investigate the roles played by ICT from the perspectives of three important university activities: (1) technical support; (2) the registrar's office; and (3) instruction. As a secondary goal, we wanted to elaborate how universities can use ICT in disaster recovery. The empirical part of the study comprised an analysis of data collected from two universities by phone interviews. We used the case study method and selected the form of the "historical narration." We approached the roles by using business process redesign, IT capabilities and intellectual capital theories.

According to the staff and faculty members interviewed, a major problem after Katrina was communication between students, faculty and staff. Both universities have since devoted considerable effort improving the resilience of their communication infrastructure and processes. Furthermore, the importance of functioning infrastructure arose, especially the reliability and availability of electrical power during emergencies. A third IT-specific challenge was to assure the continuation of IT functions, especially the protection of information through improved back-up security. Both universities had DR plans for their information and information technology. Rather than radically revising plans, both universities refined, modified and improved their existing documents. ICT was found to provide the three expected roles of facilitating, enabling, and driving. We also identified new or expanded roles

Table 3.

ROLE OF ICT	Organization A			Organization B		
Department/Activity	IT department	Registrar's office	Instruction	IT department	Registrar's office	Instruction
Facilitating <sup>+</sup>	x	x	x	x	x	x
Enabling <sup>+</sup>	x	x			x	
Driving <sup>+</sup>						x
Forerunner*	x			x		
Service provider*	x			x		
End user*	x			x		
Mediator*	x	x		x	x	

IT departments expanded their roles during Katrina to include more end-user and mediator functions, e.g., putting content on the web. Interestingly, some individuals expanded their traditional advising and instructional goals to include more IT activities. At one university response to Katrina resulted in increased expertise and capabilities for online education. IT capacities in both organizations were perceived to be resilient in that IT was seen as an important part of institutional survivability and recovery.

Disasters challenge society's capabilities for planning, mitigation, and response. It is also important to inform stakeholders before, during and after catastrophes about the organizations' plans response and activities. In our case studies, the educational institutions did not inform their students before Katrina, because they had not anticipated the nature of the storm. To get in touch with students during the catastrophe was nearly impossible. But very soon after the storm, it was possible to get in touch with the faculty largely through IT applications. Although this study is in many respects a success story for ICT, there are many things that could be done better. The challenges for response to disaster with the help of ICT might be categorized into the three "Cs" (1) Communication, to assure the

communication and knowledge sharing in all circumstances. (2) Continuation, to take care of the continuation of activities; and (3) capability, to offer an adaptive platform for new applications.

In terms of the first "C," communication, the primary challenge in responding to disaster is communication. In our study, the respondents recognized this and pointed out especially the importance of in-house communication. They reacted to this by creating an extra e-mail system and emergency lists. But the communication to wider audience is also important and more challenging. The following are recommendations from the ICT literature that seemed to have direct application to disaster situations such as Katrina:

- (a) Sharing and dissemination of information is both critical and problematic, beginning with whom to trust in unfamiliar settings (Manoj and Hubenko Baker, 2007). Thus these educational institutions should offer links to many trustworthy channels for more information.
- (b) The computer applications are often "heavy" and difficult to use. In addition, in case of disaster they are needed to use not so often. Hence the technology should be easy to use. Carver and Turoff (2007) point out the importance of simple interfaces

supported by technology, not driven by IT.

- (c) Online forums are already quite common and simple to use and include possibilities for interaction, so Palen, Hilz and Liu call for online forums supporting grassroots participation in emergency preparedness and response (2007). As these above mentioned things are solved, organizations could consider utilizing the more advanced and “heavier” ICT application such as
- (d) Decision support systems, which can be built on large databases or models or both. They can also simply search to organize and communicate results to differently skilled groups of decision makers as a goal to build a shared understanding (see French and Turoff, 2007).
- (e) Agent-based systems for disaster management, which are applications of agent technology, may be used to support many processes of the disaster management from preparation and mitigation to actual

response and recovery (see Fiedrich and Burghard, 2007).

- (f) ICT-based support for improvisation is also one possibility to facilitate emergent interoperability (Mendonça, Jefferson and Harrauld, 2007).

In terms of the second “C,” Continuation, the organizations have already prepared for the continuation of activities quite carefully revising their information, information technology strategies and recovery plans. The basic things, such as back-up systems and secondary computer rooms, they already had. They assured continuation providing their infrastructure supporting things such as generators. Could the next step in assuring continuation be the co-operation and networking with other institutions or companies?

The third “C” - capabilities - seems to be quite strong in both organizations. It tends that they already have an adaptive platform, which means a flexible and integrated infrastructure, for new applications. Table 4 describes these recommendations in more detail.

**Table 4. Recommendations**

1. Communication and knowledge sharing		2. Continuation		3. (IT) Capabilities	
<i>Multichannel and time critical</i>	<i>More Advanced</i>	<i>Physical</i>	<i>Networking with others</i>	<i>Physical</i>	<i>Human IT skills</i>
- E-mail (duplex) - STM messages to cell phones - Web - Radio - TV	- Decision support systems - Agent-based systems - ICT-based improvisation systems	- Backup systems - Fault tolerant computers - Infrastructure - Generators - etc.	- other institutions - partner companies	- Adaptive platform for new applications (flexible and integrated infrastructure)	- appropriate managerial and technical skills

The idea of intellectual capital would seem to have implications for the mitigation of the catastrophe so that an institution that scores high in intellectual capital (all three aspects, human, structural, and relational are

strong and well integrated) would be expected to recover from a disaster more

quickly and thoroughly than one that scored lower, all else equal. It is also argued that each company at each time has an emphasis

on a certain type of intangibles (human capital, structural capital, and relational capital), sometimes even neglecting others (Hussi and Ahonen, 2002). They propose that it is important to identify the primary intangibles and their current relationships with other dimensions of intangibles. Thus, one potential framework to study educational institutions' intangibles and the impacts of disaster on them could be the perspective of primary and secondary intangibles. Also Dynes (2002) calls on the need of these types of studies because social capital and other forms of intellectual capital have been largely overlooked by disaster researchers.

Because our work is both qualitative and exploratory, one of its primary accomplishments is likely to be the generation of testable hypotheses that it suggests. For example, one could derive from the Intellectual Capital perspective, the hypothesis that an institution that scores high in intellectual capital (all three aspects, human, structural, and relational are strong and well integrated) would be expected to recover from a disaster more quickly and thoroughly than one that scored lower, all else equal. Dynes (2002) cites the need of these types of hypotheses because social capital and other forms of intellectual capital have been largely overlooked by disaster researchers. Thus, we recommend that researchers consider not only the hypotheses that can be derived from this qualitative study, but what can be derived from others.

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## APPENDIX A

Phase 1	Selection of case organizations	Located in destroyed area Educational institutions Different strategies
Phase 2	Call conference with contact persons	General foundations and to single out the key “departments”
Phase 3	Design of questions and pre-tests	Three different sets of questions (IT Administration (IT), the registrar’s office (RO), and instruction)
Phase 4	Selection of interviewees	one from IT and RO and three from instruction
Phase 5	Sending the questionnaires to respondents and phone interviews	The interviews were recorded and transcribed. See table 2
Phase 6 a	<b>The data analysis</b> Case by case We tried to identify what has happened in each organization 1. Damages tangible, intangible 2. Changes in personnel in students 3. Changes in organizational structures 4. How well they are operating now	The choice of these areas was based on the concept of intellectual capital: We tried to classify tangible and intangible assets, how big the damages were and how much from the properties are functioning now (June, July 2005). We also tried to measure the organizations structural capital (information systems, organizational structure and culture, values, atmosphere) human capital (faculty and staff members, their motivation, commitment and interaction), and relational capital (students, their motivation, commitment and faculty and staff contacts with counterparts in other institution via professional and other associations, alumni, and governmental bodies).
Phase 6 b	By themes We tried to identify the themes as follows: 1. Changing Instruction 2. Increasing Workloads 3. Decreased number of students 4. The Chaos of Katrina 5. Technology as Diverse Communication 6. Waiting Atmosphere 7. Continuation of Different Research Activities 8. Re-design of Activities	Then combining the original themes, we created four main themes: - <i>Increasing Workload</i> - <i>Chaos</i> - <i>Technological Infrastructure</i> - <i>Human Dimensions of Disaster</i>
Phase 6 c	By activities We examined and reported what kind of role ICT have in - IT department - the registrar’s office - instruction	In categorizing roles we used suggestions of Davenport (1990); facilitating, enabling and IT-driven. But our analysis identified also other and expanded roles. Then we measured IT capabilities from the perspective of each activity and tried to measure intellectual capital.
Phase 6 d	Dropping the third organization off and writing the report once again.	Because we were not able to interview representatives of IT-administration and the registrar’s office, we dropped the third organization from this study.

# **COLLEGE STUDENTS' EXPERIENCES WITH HURRICANE KATRINA: A COMPARISON BETWEEN STUDENTS FROM MISSISSIPPI STATE UNIVERSITY AND THREE NEW ORLEANS UNIVERSITIES\***

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## **ABSTRACT**

When Hurricane Katrina struck the Mississippi/Louisiana Gulf Coast on August 29<sup>th</sup>, 2005, universities, colleges, and other campuses of higher education were among the many institutions that experienced severe disruption. New Orleans universities were forced to shut down for the Fall semester and many displaced college students enrolled at other colleges and universities throughout the nation. Mississippi institutions of higher education experienced less disruption, with those affected closing down for a week or less and most accepting some of New Orleans' displaced students. The college populations of New Orleans and Mississippi State University offered a unique research opportunity to gather comparative data from students who sustained both direct and indirect impacts from the Katrina disaster, as well as experienced the storm from different geographical locations. Utilizing data gathered from two web-based surveys administered during the first three months after the Katrina disaster, we analyze the comparative storm experiences of and impacts on students from Mississippi State University (N= 3,140) and three New Orleans universities (N= 7,100). Our findings show that compared to MSU students, New Orleans students experienced: (1) more fear and threat from the storm; (2) greater perceptions that the disaster was rooted in human or technological failure; (3) greater economic and personal loss; (4) less satisfaction with the response of disaster organizations; (5) less trust in institutions; and (6) higher levels of psychological stress. The overwhelming difference between the two groups attests to the severity of the Katrina catastrophe for students, particularly in New Orleans, and the need for universities to better prepare for future disasters.

## **INTRODUCTION**

On August 29<sup>th</sup>, 2005, Hurricane Katrina struck the Mississippi/Louisiana Gulf Coast as a Category 3 storm, creating one of the deadliest and most costly disasters in U.S. history. Packing winds of over 125 miles per hour with tidal surges ranging from 15 to 28 feet high, Katrina produced widespread physical devastation to some 90,000 square miles of the region and forced the evacuation of over one million Gulf Coast residents from their homes (Brinkley 2006). In the hurricane's aftermath, universities, colleges, and other

regional institutions of higher education were among the many institutions and organizations that experienced disruption. At least 30 college and university campuses sustained varying levels of storm damage and many experienced the collapse of their infrastructures and normal telecommunication systems (Chronicle of Higher Education 2005a). More than 95,000 administrators, faculty, staff, and students were displaced from their respective institutions and communities, including 50,000 students from New Orleans, resulting in the cancellation of scheduled classes

ranging from a few days to the entire academic year. Moreover, many of these campuses found themselves facing severe economic crises due to more than \$1.5 billion in infrastructure repairs, payroll outlays, and lost tuition funds, among other unanticipated costs (Cass 2005; Ferrell and Hoover 2005; Gill et al. 2006; Herbert 2005; Mangan 2005a).

Although Katrina severely affected higher education in the Gulf region (Lipka 2005), the psychosocial impacts and geophysical context of the catastrophe were significantly different for college students (and residents) of New Orleans than they were for students in Mississippi. The breaching of the New Orleans levee system that followed the storm, for example, flooded 80 percent of the city with as much as twelve feet of water in some areas. For weeks, New Orleans universities were without electrical power, water, phones, or other basic services. In response, these universities became “virtual” institutions existing in cyberspace through web-based internet systems located off-campus (Foster and Young 2005). Colleges across the U.S. responded to the catastrophe by announcing that they would open their admission doors to any student displaced by Katrina. With their wind and flood damaged campuses closed for the entire fall, 2005 semester, more than 18,000 New Orleans students relocated to some 1,017 new colleges and universities outside the Gulf Coast to enroll in classes (Ladd, Gill, and Marszalek 2007; Mangan 2005b).

Although the Pearl River Community College in Waveland, MS was completely destroyed and a few other small coastal campuses suffered damages that forced them to cancel classes for the first week of the semester (Chronicle of Higher Education 2005b), the vast majority of Mississippi college students experienced relatively indirect storm impacts from

Katrina and comparatively few were forced to evacuate their campus residences. Nevertheless, the state’s largest university campus, Mississippi State University (MSU) in Starkville, MS, while not heavily damaged by the storm, was located in the northern periphery of Mississippi counties that were declared disaster zones. Indeed, the path of the storm passed directly over Starkville with heavy rains and winds gusting to over 75 mph. Although MSU was closed for only two days, many students had immediate family, relatives, and friends living in severely impacted areas and some MSU students were in the coast area when the hurricane struck.

The college populations of New Orleans and Mississippi State University offered a unique research opportunity to gather comparative data from students who sustained both direct and indirect impacts from the Katrina disaster (Fee et al. 2006; Gill et al. 2006; Gill, Ladd, and Marszalek 2007; Ladd, Marszalek, and Gill 2006). Utilizing data gathered from two web-based surveys administered during the first three months after the Katrina disaster, we analyze the comparative storm experiences of and impacts on students from Mississippi State University (N= 3,140) and three New Orleans universities (N= 7,100). These two university samples represent over 10,000 students who initially experienced Hurricane Katrina from different geographical locations in the Gulf South. We conclude by suggesting some implications of our data for disaster research, as well as how universities can improve future disaster response and resilience.

## RESEARCH LITERATURE

Hurricanes and tropical storms are among the most prominent natural disasters that harm human populations, especially in coastal areas, and both their numbers and intensity have increased over the past decade

(Associated Press 2005b; Noji 1997). These trends resulted in 2005 becoming the busiest hurricane season on record, marked by 27 named storms and 15 hurricanes, three of which entered the Gulf of Mexico with Category 5 winds (Associated Press 2005a; Associated Press 2006). The first of these three storms, Hurricane Katrina, produced the largest hurricane disaster in U.S. history, causing over 1800 deaths, one million displaced residents, 260,000 homes destroyed, and approximately \$200 billion in estimated losses (Brinkley 2006). Physical recovery plans for portions of the devastated Gulf Coast are predicted to take at least a decade and two years after the disaster, tens of thousands of New Orleans residents remain displaced from their homes and neighborhoods (Alford 2006; Thomas 2005).

Because of their potential to generate traumatic physical and psychosocial impacts, including those associated with evacuation and relocation, disaster research on hurricanes has generated an extensive body of knowledge (see e.g. Adeola 1999; Baker 1991; Bateman and Edwards, 2002; Dash and Morrow 2001; Dow and Cutter 1998, 2000, 2002; Drabek 1986; 2000; Edwards 1998; 1999; Enarson and Morrow 1997; Fischer 1999; Franke and Simpson 2004; Gladwin and Peacock 1997; Howell 1998; Howell and Bonner 2005; Lindell and Prater 2003; Mittler 1997; Peacock and Girard 1997; Sattler et al. 2002; Tierney 1989; Van Willigen 2001; Waugh 1990; Whitehead et al. 2000; Wolshon et al. 2005). In particular, hurricanes have been shown to cause a wide array of negative psychophysiological responses ranging from fatigue, impaired concentration, and attention deficits, to depression, anxiety, substance abuse, and Post Traumatic Stress Disorder (PTSD) symptoms (Gillard and Paton 1999; Lindell and Prater 2003; Norris 2002; 2005; Norris et al. 2002; Perilla,

Norris and Lavizzo 2002). Prior to Katrina, for instance, Hurricane Andrew in 1992 was the second largest and most thoroughly researched disaster in U.S. history (Norris 2005). One such study conducted after Andrew found new onset psychiatric disorders in almost half the sample and about one-third were diagnosed with PTSD (David et al. 1996). Another study of those impacted by Andrew revealed that many victims sustained major levels of depression up to two years after the disaster (Norris et al. 1999). Even more moderate hurricanes like Hurricanes Hugo and Georges have been found to produce significant degrees of psychological distress, as well as adverse health impacts, for survivors who experience personal resource loss (Adeola 1999; Freedy et al. 1992).

Despite the increasing threats posed by natural and technological hazards for university campuses over the last decade (Federal Emergency Management Agency 2003), few researchers have studied the disaster-related experiences of college students in the aftermath of a regionally catastrophic hurricane (see e.g. Gutierrez, Hollister, and Beninati 2005; Pickens et al. 1995; Sattler et al. 2002; Van Willigen et al. 2005). Although such hazards rarely result in death and injury to students, hurricanes almost always create significant financial losses for universities and disrupt their institutional teaching, research, and service missions (FEMA 2003). For example, Gutierrez, Hollister, and Beninati (2005) studied college students in Central Florida impacted by Hurricanes Charley and Frances and reported that over 60 percent of students had moderate to extremely high levels of psychological stress, 50 percent suffered lost wages or income, and 65 percent sustained damage to their residences. Pickens et al. (1995) studied college students impacted by Hurricane Andrew in South Florida and found that

students who experienced the most severe impact damage from the storm reported the highest levels of stress, anxiety, and depressive symptoms. Sattler et al. (2002) surveyed college students in the U.S. Virgin Islands, Puerto Rico, Dominican Republic, and the United States affected by Hurricane Georges and found that differences in psychological stress were largely a function of their respective location, resource loss, and levels of social support.

In another study comparing the differential impacts of Hurricane Floyd on students and residents of the Greenville, NC university community, Van Willigen et al. (2005) found that students were less detrimentally affected than community residents but enjoyed greater levels of recovery assistance. Moreover, race, gender, and parenthood status had differential effects on the two populations. The authors suggest that students, by virtue of their socioeconomic resources and social roles, occupy a unique position within university communities which buffers them from many of the direct impacts of natural hazards.

Findings from these studies are consistent with those of other disasters. Disasters cause some degree of psychological stress among survivors and this varies by a host of psychological and sociodemographic characteristics, as well as location, physical damage, personal loss, social support networks, and other post-disaster recovery variables (see Riad and Norris 1996; Zhang et al. 2004).

Our research examines differences between college students from New Orleans universities and Mississippi State University (MSU) regarding their impacts surrounding Hurricane Katrina. Specifically, we compare students' storm experiences, resource loss, satisfaction with disaster response, trust in institutions, and psychological stress. Given the prolonged evacuation and closure of universities in

New Orleans, we generally hypothesize that students from New Orleans universities will have higher levels of disaster impacts than students from MSU. More importantly, such a comparison provides a benchmark for interpreting the severity of disaster impacts among New Orleans students, as well as better illustrates the range of impacts that university communities incurred from Katrina.

## RESEARCH METHODS

In the weeks following the Katrina disaster, a research team at the Social Science Research Center (SSRC) at Mississippi State University (MSU) was formed to study the effects of Hurricane Katrina on college students from Mississippi and New Orleans. This historic event provided a unique opportunity to study these respective student populations via the internet utilizing two web-based survey instruments designed specifically to measure student reactions and needs in the aftermath of the disaster. For the MSU study, we developed a 143-item questionnaire that focused on assessing storm and evacuation experiences, resource loss, satisfaction with the disaster response of government, media, social agencies, and the university, trust in institutions, levels of psychological stress, and other pertinent issues (Fee et al. 2006). For the New Orleans study, we developed a similar questionnaire composed of 77 items, many of which were specifically developed for students who were displaced from their New Orleans universities and relocated to hundreds of temporary campuses and homes across the country (Ladd, Marszalek, and Gill 2006; Ladd, Gill, and Marszalek 2007; Marszalek et al. 2006). Standard sociodemographic and educational status measures were also included on both instruments.

Approval to conduct our web-based survey of the student populations of MSU,

Loyola University New Orleans, University of New Orleans, and Xavier University of Louisiana was granted by each of the school's respective Institutional Review Boards in October and November of 2005. The three New Orleans universities were selected for the study because of their overall demographic representativeness of the city's college student population, as well as the access of the researchers to their university's student email records. The sampling frame for each of the four universities consisted of all the undergraduate and graduate students who had been officially enrolled for at least one class for the fall semester when Katrina struck on August, 29th, 2005. Prior to this date, MSU reported a fall enrollment of 15,889 students, Loyola University reported an enrollment of 5,644 students, Xavier University reported an enrollment of 4,190 students, and University of New Orleans (UNO) reported an enrollment of 17,251 students (Fee et al. 2006; Pope 2006).

University administrators at all four institutions provided us with a computer file listing all of their students' currently recorded email addresses as of October 1, 2005. For New Orleans students, this email file included their existing New Orleans university email accounts, a personal email account, and/or their newly reported email addresses from whatever college or university they were attending during the fall term. Many of these personal or new university email addresses were collected through the emergency remote websites of the New Orleans universities while their normal telecommunication systems were down due to storm damage and students were unable to access their regular university email accounts. Since we had no way of knowing which university or personal email address was most likely to reach the student in a timely fashion, (if at all), some students were automatically sent

more than one email message to each of their email accounts inviting them to participate in the survey. However, returned surveys were checked to ensure that no student returned more than one questionnaire. This email message described the purpose of the study, the informed consent statement, the research procedures used, the steps taken to protect the participants' privacy, and a faculty contact person from the research team if the student had questions or comments on the survey. Students who chose to participate in the study were instructed to click on the survey link and were directly connected from the email message to the web-based survey instrument contained in a separate software program.

Emails with a link to the web-based survey were sent to all four universities' students from the SSRC, beginning with MSU in early October, 2005 and then followed by Loyola University, Xavier University, and University of New Orleans students throughout the month of November, 2005. Emails were sent at different times for each university based on the dates we received IRB and administrative approval. The initial emails were mailed to 15,889 MSU student accounts, 7,574 Loyola student accounts, 7,091 Xavier student accounts, and 27,023 UNO student accounts. Following the initial email, two reminder emails were sent at one week intervals for those who had not yet responded to the study. All surveys were collected by December 16th. A total of 3,140 MSU students responded to the first survey (response rate= 20%) and 7,100 students from all three New Orleans universities responded to the second survey, resulting in an effective response rate of 38% (the official Pre-Katrina university enrollment figure of 27,085 students, divided by the 7,100 students who returned a useable survey). Overall, the sample characteristics

were roughly proportionate to the demographic profiles of each of the universities in general.

## FINDINGS

Our research findings focus on five areas: storm experiences; resource loss; satisfaction with response; trust in institutions; and psychological stress. In the following sections, we make t-test comparisons between New Orleans students and MSU students and describe general patterns in the data.

## Storm Experiences

Students were asked to rate their storm experiences on a scale from 1 to 10 (1 = low, 10 = high). Specifically, they were asked about the severity of the storm where they were located, how fearful they were, and how threatened they felt. In addition, students were asked the following: “On a scale of 0-10, to what extent do you believe the disaster was a natural event (0) or human/technological failure (10)?” Results are presented in Table 1.

Table 1. Perceptions of Storm Experiences among College Students from New Orleans Universities and Mississippi State University (mean scores)

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Storm Severity (Range = 0 – 10)	5.16	5.64	.000
Level of Fear (Range = 0 – 10)	5.58	4.44	.000
Level of Threat (Range = 0 – 10)	3.72	3.60	.008
Na-Tech (Range = 0 – 10)	5.41	3.16	.000

As expected, there were significant differences between students from New Orleans universities and MSU students. With regard to storm severity, however, MSU students experienced higher levels of severity than New Orleans students. Previous data analysis indicated that over 80 percent of MSU students were either on the MSU main campus or within a 50 mile radius of campus when the storm passed through Starkville (Fee et al. 2006; Gill et al. 2006). In contrast, the vast majority of New Orleans students (84%) evacuated to areas away from the storm’s path (Ladd, Marszalek, and Gill 2006). Compared to MSU students, New Orleans students were significantly more fearful and felt a higher level of threat, perhaps because they had

been uprooted from their social environment and community networks.

New Orleans students were more likely to define Katrina as a disaster with anthropogenic causes. In Mississippi, most damages were a direct cause of wind and storm surges. On the other hand, the massive flooding in New Orleans was caused by failures in the levee system that was supposedly designed to withstand a storm with the intensity of Katrina. Furthermore, the disaster in New Orleans was exacerbated by the mismanaged response by FEMA, and other federal, state, and local authorities (Brinkley 2006). Consequently, New Orleans’ students tended to view Katrina as a technological disaster, while MSU students tended to view

it as a natural disaster (see Ritchie et al. 2006).

### **Resource Loss**

Students were asked about economic and personal resource loss attributed to Katrina. In a series of yes/no questions (no = 0 and yes = 1), students reported on financial loss, loss of home/apartment,

vehicle loss, job loss, death of a relative/friend, and if a relative/friend was missing in the aftermath of the storm. The first four items represent economic losses and these items were summated into a scale. The last two items represent personal losses and were also summated into a scale (Table 2).

Table 2. Resource Losses Reported by College Students from New Orleans Universities and Mississippi State University (mean scores)

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Economic Loss Scale (Range = 0 – 3)	1.47	0.44	0.000
Personal Loss Scale (Range = 0 – 2)	0.42	0.08	0.000

Higher scores = greater loss

Results indicate that New Orleans college students experienced significantly higher economic and personal losses than MSU students. Indeed, Ladd, Marszalek, and Gill (2006) found that 85 percent of New Orleans students incurred financial losses and 81% had their residence damaged by the storm. Over one-fourth (26%) of New Orleans college students had a family member or close friend missing during or immediately after the disaster and almost one-tenth (9%) experienced the death of a relative or close friend.

### **Satisfaction with Response**

Students were asked to indicate their level of satisfaction with the disaster response of various officials, agencies, and organizations using a 5-point scale (1 = very satisfied and 5 = very dissatisfied). The results were divided into five summated scales: Federal Government Response (President Bush and FEMA); State/Local Government Response (each state's governor and local government officials); Media Response (national and local); Relief Organization Response (Red Cross, other charitable organizations, and local organizations); and University Response (administration and faculty).



Table 3. Response Satisfaction among College Students from New Orleans Universities and Mississippi State University (mean scores)\*

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Federal Gov. (Range = 2 – 10)	7.94	6.18	.000
State/Local Gov. (Range = 3 – 15)	10.02	8.46	.000
Media (Range = 2 – 10)	5.63	5.32	.000
Relief Groups (Range = 3 – 15)	6.38	5.17	.000
University (Range = 2 – 10)	5.04	3.73	.000

\* Higher means = less satisfaction

As indicated in Table 3, students from New Orleans universities were significantly less satisfied with the disaster response from all entities represented by the five scales. New Orleans college students were particularly dissatisfied with the response of the federal government and state/local government. Ladd, Marszalek, and Gill (2006) found that over two-thirds of New Orleans students were dissatisfied with the President of the U.S. (73%), FEMA (72%) and the governor of Louisiana (66%). Although both groups of students were generally satisfied with the response of relief groups and their respective universities,

there was a significant difference between MSU students and New Orleans students.

### **Trust in Institutions**

Trust in institutions was measured by asking students to indicate on a 4-point scale (1 = a great deal and 4 = not at all) how much they trusted various institutions and representatives of institutions. The following three scales were created: Federal Government (the US President, FEMA, and federal government); State/Local Government (state officials and local officials); and Media (national and local).

Table 4. Trust in Institutions among College Students from New Orleans Universities and Mississippi State University (mean scores)\*

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Federal Gov. (Range = 3 – 12)	8.66	6.56	0.000
State/Local Gov. (Range = 2 – 8)	5.31	3.77	0.000
Media (Range = 2 – 8)	4.67	4.29	0.000

\* Lower means = higher trust

As indicated in Table 4, New Orleans college students expressed significantly less trust in institutions than did MSU students. In particular, Ladd, Marszalek and Gill (2206) observed high levels of distrust of the federal government, including President Bush (67% distrust) and FEMA (62% distrust). Likewise, they found almost one-half of New Orleans college students expressed distrust for their state and local government, as well as the media.

### **Psychological Stress**

Psychological stress among college students was assessed using two standardized measures; the Impact of Event Scale (IES) and the General Health Questionnaire (GHQ).

#### ***Impact of Event Scale***

The IES (Horowitz 1974; Horowitz, Wilner, and Alvarez 1979) measures event-

specific psychological stress based on the rationale that highly stressful events are likely to produce high levels of recurring, unintentional, distressing feelings and thoughts (Intrusive Stress), as well as high levels of intentional efforts to suppress these feelings and avoid reminders of the event (Avoidance Behavior). The IES consists of 15 statements; seven measuring intrusive recollections (e.g., having dreams about it) and eight measuring avoidance behaviors (trying to avoid reminders of it). Responses are coded on a 4-point scale (not at all = 0, rarely = 1, sometimes = 3, and often = 5). Total scores range from 0-75 and subscale scores range from 0-35 for intrusive stress and 0-40 for avoidance behavior. The total IES serves as a proxy for Post Traumatic Stress Disorder (PTSD).

Table 5 IES Mean Scores among College Students from New Orleans Universities and Mississippi State University

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Total Scale (Range = 0 – 75)	28.49	12.21	.000
Intrusive Stress Subscale (Range = 0 – 35)	14.26	6.29	.000
Avoidance Behavior Subscale (Range = 0 – 40)	14.37	6.02	.000

Table 5 indicates significant differences between New Orleans college students and MSU students. Additional analysis revealed that 1401 (27%) of New Orleans university students were in the severe range on the IES (a score over 43) and another 26 percent were in the moderate range (26 - 43). The majority of MSU students (60%) were in the sub-clinical range (0 - 8) (Gill et al. 2006).

#### ***General Health Questionnaire***

The GHQ (Goldberg 1972) measures depression, social dysfunction, and loss of confidence in community settings and non-psychiatric clinical settings (e.g., primary care or general practice). The 12-item version of the GHQ was used with symptomatic responses coded as '1' and non-symptomatic responses coded as '0'. In this scoring scheme, total GHQ scores can

range from 0 to 12, with higher scores indicative of a greater likelihood of psychological distress. Subscale scores for social dysfunction range from 0 to 6, depression scores range from 0 to 4, and loss

of confidence scores range from 0 to 2 (see Graetz 1991). Scale and subscale scores were calculated and compared between New Orleans college students and MSU students.

Table 6 GHQ Mean Scores among College Students from New Orleans Universities and Mississippi State University

	New Orleans Universities	MSU	T-Test Sig. (one-tailed)
Total GHQ (Range = 0 – 12)	5.34	1.72	.000
Depression (Range = 0 – 4)	1.95	.52	.000
Social Dysfunction (Range = 0 – 6)	2.91	1.04	.000
Loss of Confidence (Range = 0 – 2)	.57	.16	.000

Table 6 indicates significant differences between New Orleans college students and MSU students on the GHQ and its subscales. Interestingly, New Orleans college students reported levels of depression and loss of confidence that were three times that of MSU students. Over one-third of the New Orleans students reported having 7 or more (out of 12) symptoms on the total GHQ scale. Almost one-fourth reported elevated symptoms of depression.

## DISCUSSION

Our research design functions as a type of sociological field experiment whereby we can measure and interpret the severity of social and psychological impacts from Hurricane Katrina. New Orleans university students constitute, in effect, the “experimental” group. Like many other residents in New Orleans and the Mississippi Gulf Coast, they bore the brunt of the disaster and experienced major upheaval and prolonged uncertainty regarding disaster recovery. In turn, MSU students serve as essentially a baseline

“control” group and point of comparison because all of these students were at least marginally affected by the disaster. As hypothesized, Hurricane Katrina caused significant negative impacts for New Orleans university students. T-test comparisons between the two groups indicated that New Orleans students experienced: (1) more fear (.000) and threat (.008) from the storm; (2) greater perceptions of human responsibility for the disaster (.000); (3) greater economic and personal loss (.000); (4) less satisfaction with disaster response (.000); (5) less trust in institutions (.000); and (6) higher levels of psychological stress (.000). The overwhelming and statistically significant difference between the two groups attests to the severity of the Katrina disaster, particularly in New Orleans.

Our findings are consistent with research literature on psychosocial impacts of disasters and substantiate recent conceptual developments in the field. Ritchie and Gill (2007) identified and incorporated several key disaster concepts

into a social capital framework. They argue that social capital can be diminished or 'spent' during a technological disaster, and concepts such as "corrosive community," "recreancy," and "collective trauma" are indicators of social capital loss. Specific to our findings, we observed indicators of recreancy, social capital loss, resource loss, and psychological stress. These concepts frame the remainder of our discussion.

Recreancy is defined by Freudenburg as "the failure of experts or specialized organizations to execute properly responsibilities to the broader collectivity with which they have been implicitly or explicitly entrusted" (2000:116). Recreancy is concerned with blame and when someone or some organization is held responsible for a disaster, there is a corresponding loss of trust—a cornerstone of social capital. Perceptions of recreancy can heighten feelings of anger, frustration, and betrayal, threaten ontological security, and contribute to psychological and emotional trauma.

Our findings indicate that New Orleans university students tended to perceive the disaster as a human/technological failure, rather than a natural disaster. In New Orleans, the Katrina disaster was a catastrophic flood. For many residents, the breaching of the levees represented a technological failure and inadequate responses to the disaster represented organizational failures. Both are indicative of recreancy.

The 'blame game' spawned by issues of recreancy diminishes social capital, particularly with respect to perceptions of organizational effectiveness in responding to the disaster and trust in organizations to do their jobs. Our findings indicate that New Orleans students were significantly dissatisfied with organizational responses to the disaster, particularly government responses at all levels. Dissatisfaction with disaster responses indicates a type of

recreancy; that is, many organizations did not do their jobs as well as expected. Likewise, our data show that these students expressed less trust in all levels of government; particularly FEMA and President Bush. Diminished trust reflects a loss of social capital. Moreover, we assume that most New Orleans university students experienced a net loss of social capital, despite the goodwill and assistance offered throughout the nation. Our qualitative analysis of the narrative accounts of New Orleans university students about the Katrina disaster supports this assumption (Ladd, Gill, and Marszalek 2007).

Hobfoll's (1988; 1989; 1991) conservation of resources (COR) model of stress posits that social and psychological stress is influenced by resource loss, threat of loss, or investment of resources without gain. Four categories of resources are found in the COR model: (1) objects (e.g., transportation, physical possessions); (2) conditions (e.g., a good marriage, time spent with loved ones); (3) personal characteristics (e.g., high self-esteem, sense of mastery, social competence); and (4) energies (e.g., money, knowledge). Rapid loss of high value resources produces traumatic stress (Hobfoll 1991). In general, resource loss from a natural disaster contributes to social and psychological stress (see Freedy et al. 1992).

Our findings reveal that New Orleans students experienced relatively high levels of economic and personal losses. Economic losses included financial and job loss (energies resources), and loss of home/apartment and vehicle loss (objects resources). Personal losses consisted of having a relative/friend missing or die during the storm (conditions resources). Our indicators cover a fraction of the resources that comprise our lives and undoubtedly, many other resources, including social capital, were drawn down, depleted, or lost.

Psychological stress is a typical reaction to disasters and our data supports this phenomenon. Three months after the hurricane, New Orleans students exhibited high levels of stress. Over one-fourth reported IES scores that placed them in the 'severe' diagnostic category and over one-third were symptomatic on the GHQ scale. Typically, psychological stress dissipates after a disaster. Literature on technological disasters, however, suggests that recreancy, prolonged social disruption, and loss of social capital can lead to chronic stress (e.g., see Gill and Picou 1998; Picou and Gill 1997; Ritchie 2004). Our data do not allow us to empirically examine this issue, but published accounts from the New Orleans *Times-Picayune*, as well as a number of studies, have found extensive levels of psychological and emotion distress among New Orleans' Katrina survivors, as well as increased alcohol and drug usage (see Gill, Ladd, and Marszalek, 2007; Rose 2005).

## CONCLUSIONS

These findings demonstrate that New Orleans university students experienced greater negative social and psychological impacts in the immediate aftermath of Hurricane Katrina than did students from Mississippi State University. These differential impacts between the two populations became further magnified in the coming months as many New Orleans students returned to find not only much of their flood-damaged city in ruins, but their universities grappling with infrastructure repairs, debt, reduced enrollments, and a host of future institutional uncertainties. Under administrative declarations of "financial exigency" or related degrees of fiscal emergency, all of the New Orleans universities in our sample (and others) began to initiate relatively draconian reductions in their operating and salary budgets over the spring and summer 2006 semesters.

Consequently, various degree programs and academic departments were discontinued, class offerings were reduced, assorted faculty and staff members were either furloughed or terminated, and student activities were cut. Amidst fears that even more stringent budget and program reductions might be forthcoming, a number of junior faculty left their positions for jobs at other institutions, older faculty members began to consider taking an early retirement, and students chose to transfer to other universities to continue their major field of study elsewhere (Ladd, Marszalek, and Gill 2006).

After experiencing the stress and collective trauma of being uprooted from their campus communities and forced to relocate to new universities and residences during the fall of 2005, many New Orleans students, upon returning to their university communities, continued to experience a prolonged series of secondary traumas regarding their lives and education that MSU students generally did not confront (Gill 2007). Assessing the devastation that the Katrina disaster visited upon the universities of New Orleans, a recent AAUP report described these events as constituting "undoubtedly the most serious disruption of American higher education in the nation's history" (American Association of University Professors 2007: 61). Nevertheless, in the overall range of impacts that they sustained, both MSU and New Orleans student populations can be seen as proxies for what large numbers of citizens in communities along the Mississippi/Louisiana Gulf Coast experienced in the aftermath of Hurricane Katrina.

Given the severity of Katrina's impacts and the potential for prolonged disruption from other natural and technological disasters, it is imperative that university communities, especially in the Gulf South, work to improve their

institutional preparedness and mitigation procedures in the face of these growing hazards. Indeed, recent disaster research has identified a broad range of vulnerabilities and contingencies that institutions of higher learning must address if they are to survive and rebound from future catastrophes (AAUP 2007; FEMA 2003). At the same time, research such as ours can also assist universities to become more resilient institutions in the aftermath of a disaster by improving their social support services to students who have been directly and indirectly impacted by the traumatic events surrounding hurricanes like Katrina (see Gill et al. 2006). Among other impacts, student survivors are especially likely to manifest impaired psychological and physical functioning, a generally diminished sense of well-being, and an increased use of mental and physical health care services. In addition, there are other issues that universities must prepare for regarding telecommunications and information-delivery systems, campus security, and shelter facilities, as well as counseling outreach programs, financial aid, and opportunities for students to participate in local disaster recovery efforts (Fee et al. 2006). Given these growing risks and challenges, social science researchers must pay greater attention to the impacts of disasters on university communities and how these events parallel other populations and institutions.

### **Acknowledgement**

An earlier version of this article was presented at the Mississippi Academy of Sciences conference, February 23-24, 2007, Starkville, MS. Major support for this project was provided by the Mississippi Agricultural and Forestry Experiment Station (MIS-605270) and the Social Science Research Center (SSRC) at Mississippi State University. Additional

support was provided by the SSRC's Societal Risk Unit and Decision Support Laboratory. The authors would like to acknowledge the contributions of Art Cosby, Virginia Fee, Dennis McSeveney, Elizabeth Wells-Parker, John Edwards, Angela Maggard, Katie Lynch; and Liesel Ritchie. This research was approved by Mississippi State University's Institutional Review Board (IRB #05-293).

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# HURRICANE KATRINA AS A NATURAL EXPERIMENT OF 'CREATIVE DESTRUCTION'

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## ABSTRACT

This article argues that Schumpeter's framework of "creative destruction" can, with minor modifications, be used to evaluate and interpret the regeneration and rebuilding process following Hurricane Katrina on the Mississippi Gulf Coast. The end result of this rebuilding has been the exclusion of the working class and poor from the coast, as concurrent agents force delays and erect bureaucratic barriers to rebuilding.

**Key words:** Evaluation, Schumpeter, Disaster Recovery, Mississippi Gulf Coast, concurrent objectives, exclusion.

## INTRODUCTION

Hurricane Katrina slammed into the Mississippi Gulf Coast on August 29, 2006. In coastal Harrison County, Mississippi, 62% of owner-occupied housing and 78% of renter-occupied housing were damaged (FEMA) [1].

Katrina was a natural disaster. It could not be prevented or controlled. But the response was anything but natural. The cumulative effect of the response was (to use a cliché) a perfect storm of concurrent interests. Mind you that each of these entities acted in their own economic and political self interests and there is no overt evidence of collusion. However their collective actions have radically changed the course of redevelopment for the Gulf Coast.

Nor is this the story of just one place. Neither this natural disaster, nor its long term effects, are unique to the Gulf Coast. The redevelopment lessons are applicable to every level of human

settlement, from towns to major metropolitan areas.

To evaluate and interpret this redevelopment process, I employ Schumpeter's term "creative destruction." Joseph Schumpeter first coined the term in his book *Capitalism, Socialism and Democracy* [2]. He used it to focus on and describe the process of industrial transformation that accompanies a radical innovation. Those innovations can range from the creation of new markets, the invention of new equipment or processes and new methods of transportation or communication.

In the context of this article, I am using the term creative destruction to describe the process of regeneration after a destructive event (e.g., hurricane, earthquake, massive urban renewal, etc.). This is more similar to Max Page's usage of the term in *The Creative Destruction of Manhattan, 1900-1940* [3].

This paper will evaluate how competing private and government interests, through their response, effectively delayed the rebuilding of home and businesses. Some 13 months, and more, after the storm, many homes and businesses remained empty shells. The result has been an economic and regulatory exclusion of previous residents and employees from the coastal area.

### **THE SITUATION 13 MONTHS AFTER THE STORM**

During an October 2006 trip to Harrison County, Mississippi, the hurricane's destruction was still evident. The housing photographs were taken in a residential neighborhood near Back Bay just south of I-10, while the business photographs were taken on US 90 just west of Biloxi, as depicted in Plate 1 "US 90 and I-10." In Plate 2 "Empty Slab with Sign", the only trace of the home is a wooden sign with the street address and name of the home insurance company. All debris has been removed from the site, leaving only a cement slab. In Plate 3 "Non-FEMA trailer on Slab", the residents continue to live at the site of their former house. We will return to the significance of the non-FEMA trailer later. In Plate 4 "Empty Sears", the building that the retail merchant Sears occupied on U.S. 90 facing the Gulf of Mexico remains an open shell.

### **AGENTS OF DELAY**

Although operating independently of each other, the slow response by private and government interests produced the same effects. Their technique of multiple delays cost time, money and lost opportunities. The major agents of delay were private insurance companies, the state of Mississippi and

the Federal Emergency Management Agency (FEMA).

The primary barrier to residential rebuilding was the time that it took for reimbursement of homeowner insurance and recovery of jobs. For the vast majority of families one third of their net worth is the equity in their home [4]. That equity was destroyed in the hurricane, and without prompt payouts from homeowner insurance companies to rebuild, families had to live off their savings. Further note that, following a disaster in which a home is destroyed, the mortgagee (homeowner) is required to continue to make monthly mortgage payments unless temporarily released from that obligation by the mortgage holder. But, 60% of families have only one month's of savings to pay bills and expenses. Even the next richest 20% have only 3-4 months of savings [5].

The second barrier to residential rebuilding was the refusal of home insurance companies to pay for water and flood damage associated with the hurricane. Most home insurance policies provide coverage for most perils (including wind) to the home. However, there is a specific exclusion for flood damage. The homeowner must purchase a separate flood damage policy. After the storm, insurance companies claimed that the bulk of the damage was due to water (driving rain and storm surge) and thus was not covered. In some cases, homeowners were offered the paltry sum of \$3,000 in exchange for signing waivers that their house was damaged by water and thus not a covered loss. The public outcry grew so large that the state of Mississippi's Attorney General filed legal suit against the insurance companies to force payments. The insurance companies won the initial suit and were not required to pay for damage

caused by water, although State Farm later went on to reach an agreement with the state of Mississippi in early 2007 [6].

As an aside, one controversy was the interpretation of whether or not homeowners should have purchased flood insurance. The federal agency FEMA is responsible for producing flood maps. Properties that fall within flood zones on these maps are required by the mortgage holder to purchase separate flood insurance. However, the Katrina experience demonstrated that these maps were inaccurate [7]. Many homes outside of the designated flood zone were damaged by water. Their purchase of flood insurance would have been optional, and some homeowners claim that insurance agents mislead them regarding the cost and necessity of purchasing optional flood insurance.

The third barrier to residential rebuilding was the lack of home insurance and the lack of affordable insurance. In the first case, many insurance companies stopped writing policies in coast areas [8,9]. In those areas where insurance was not available, the state of Mississippi had created a wind insurance pool, the insurer of last resort [10]. However, rates for this pool have recently risen by 90% for homeowners and 268% for businesses.

The state of Mississippi has been equally slow to support residential rebuilding. A state grant program for homeowners was announced in the Spring of 2006. The program drew more than 17,000 applications from homeowners. Incidentally, to be eligible the home had to be located outside of a flood zone. As of September 14, 2007, only 75 checks had been issued. After federal politicians (the source of the grant funding to the state) investigated, the rate of issuance went up

dramatically. Little more than two months later (November 17, 2006) more than 5,700 checks had been issued [11]. However, this was more than 14 months after Hurricane Katrina damaged or destroyed many of these homes.

Local communities also delayed residential rebuilding by delaying adoption of flood elevation for reconstruction. In the case of the city of Gulfport, it took the city more than a year to adopt elevations for construction. In some areas near the coast, buildings were required to be elevated to 18 and one half feet above sea level. The additional construction cost to elevate the structure will limit redevelopment.

Returning to the non-FEMA trailer in Plate 3. The reason that residents must live in their own private trailers is that FEMA regulations prohibit the placement of one of its more than 135,000 trailers in an existing flood zone. This unbending regulation does not recognize the fact that homes were destroyed and that people still need a place to live.

## **LESSONS FROM THE PROCESS**

More than one year after Hurricane Katrina destroyed much of the housing stock on the Gulf Coast, many homes are not rebuilt. A combination of delays, increased reconstruction cost and bureaucratic barriers have slowed the redevelopment process to a crawl for some. The destruction was provided by Hurricane Katrina. In mere hours it accomplished one the biggest feats of urban renewal. However the *process* of creative destruction, the regeneration that was expected, has not occurred for a number of reasons. Examining this response is informative in two respects. First, it indicates what will happen

following future natural and man-made disasters. Whether an earthquake, hurricane or dirty bomb, the same agents of delay will be involved. Apparently, their own economic and political interests are at odds with rapid recovery and full compensation.

The second insight is how the community must now change. This process is marked by an attitude of out with the old (i.e., low-value) and in with the new (read high value). Such redevelopment will come at the expense and exclusion of low-income residents

[12, 13]. Redevelopment along the coast will be more expensive. The only industry that has fully recovered is the casinos, a major source of state revenue and jobs in the area. Vacant land will be redeveloped with a higher density and cost, large apartment buildings and condominiums will make economic sense. This higher cost will force locals to move away from the Gulf Coast, while the vacuum will be filled by vacationers, retirees and others able to afford the suddenly higher cost of living in the area.

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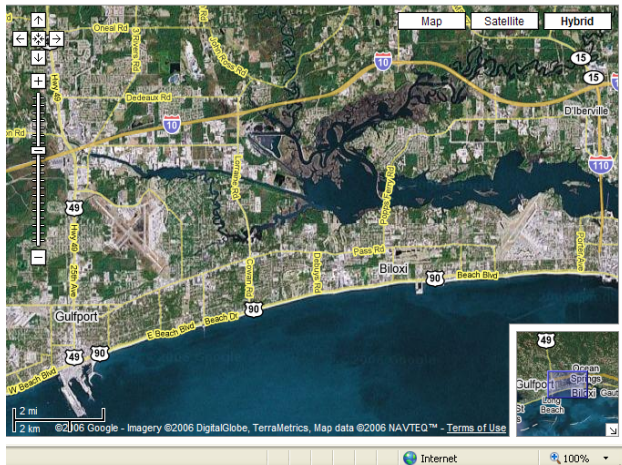
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**Plate 1.** US90 to I110



**Plate 2** Empty Slab with sign



Plate 3 Non Fema Trailer on Slab



Plate 4. Empty Sears



# LOOK FOR CHANGES TO OUR JOURNAL

## **MAS GOES PROFESSIONAL ON ABSTRACT SUBMISSION!!**

After many years of using a homemade system for abstract submission, the MAS has secured the assistance of a professional organization capable of handling any size meeting. While membership and preregistration will continue to use our old system, abstracts will be routed through Oxford Abstracts. You will notice a decidedly English tone in the grammar!

**All abstracts for the 2008 meeting should be submitted through the web site.**

**The presenter must be a member in good standing with 2008 dues paid or in the process of being paid. We will still accept PayPal for online payments, checks, or purchase orders.**

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# **WATER QUALITY STUDIES ON FRESHWATER BODIES IN NEW ORLEANS LOUISIANA ONE YEAR AFTER HURRICANE KATRINA**

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## **Abstract**

After Hurricane Katrina occurred on August 28 – 29, 2005, on the Gulf Coast, much of New Orleans was flooded. Freshwater bodies and drinking water in the affected areas were polluted with high levels of coliform bacteria, fungi, pesticides and toxic chemicals. Lake Pontchartrain and Mississippi River were said to be dump sites for pollutants in addition to the flooding. Flood water fouled with human and animal remains, sewage, heavy metals, petrochemicals and other hazardous substances were pumped into Lake Pontchartrain. This makes periodic monitoring of these large water bodies necessary to assess the level of contamination still existing as well as smaller bodies like ponds. The purpose of this study was to determine the quality of these water bodies after one year of the hurricane occurrence as well as Southern University, New Orleans (SUNO) Golf Course pond. Water samples were collected for two consecutive days from each of Lake Pontchartrain, Mississippi River and the Golf Course pond at SUNO and tested for contaminants. They were also tested for total coliform and *E. coli*. The results and analysis of the results show that over 50% of the chemical parameters tested failed to meet the Mississippi Water Quality Criteria and/or EPA standard and that the coliform and *E. coli* levels were below minimum concentration or negative. This shows that the water bodies were still chemically contaminated. It is recommended that periodic assessments be made on these water bodies to know whether the pollutants are clearing or increasing beyond human use.

## **INTRODUCTION**

The term water quality refers to the suitability of water for a particular purpose (Boyd, 2000). After Hurricane Katrina occurred on August 28 – 29, 2005, on the Gulf Coast, much of New Orleans was flooded. Freshwater bodies and drinking water in the affected areas were polluted with high levels of coliform bacteria, fungi, pesticides and toxic chemicals. Lake Pontchartrain and Mississippi River were said to be dump sites for pollutants in addition to the flooding. Floodwater fouled with human and animal remains or corpses,

sewage, heavy metals, petrochemicals and other hazardous substances were pumped into Lake Pontchartrain ([http://en.wikipedia.org/wiki/Lake\\_Pontchartrain](http://en.wikipedia.org/wiki/Lake_Pontchartrain)). This makes periodic monitoring of these large water bodies necessary to assess the level of contamination still existing as well as smaller bodies like ponds. Water quality can be closely linked to the surrounding environment and land use such as agriculture, urban and industrial development and recreation. Since water is used for many purposes, its quality deteriorates, causing serious concern in many nations including China and USA (Acholonu and Harris, 2006). Water quality

studies are important as there is much public apprehension about the effects of water pollution (Reen, 2001). The purpose of this study was to document the quality of water in the Mississippi River, Lake Pontchartrain and Southern University, New Orleans (SUNO) Golf Course pond (especially as SUNO was one of the sites badly flooded because of the hurricane) one year post the hurricane occurrence.

## MATERIALS AND METHODS

Water samples were collected at the depths of about one meter for two consecutive days in September 2006 from Lake Pontchartrain, Mississippi River, and the Golf Course pond at SUNO in clean plastic containers (water bottles) and transported to the laboratory at Alcorn State University (Figures (-11). In the laboratory, the LaMotte water pollution detection test

kits ordered from Carolina Biological Supply Company and the Dionex Chromatograph, equipment were used to perform various chemical pollution tests. The SHI model 89 hand held Dissolved Oxygen and Temperature meter was used to measure the dissolved oxygen. Fifteen different parameters were tested. To assess the bacterial content, coliforms and *Escherichia coli* tests were performed with Colilert which uses the patented Defined Substrate Technology (DST) to simultaneously detect total coliforms and *E. coli*. Colorless result means negative, yellow is coliform positive and yellow/fluorescent is *E. coli* positive. The test results were averaged, analyzed and compared with the Mississippi Water Quality Criteria (MSWQC) and /or Environmental Protection Agency (EPA) standard.



Figure 1. Map of United States of America showing the location of Louisiana

Map of Louisiana showing New Orleans, the site of the project



Figure 2. Map of Louisiana showing site of the Project in New Orleans.

**Figures 3-6 . Lake Pontchartrain showing students collecting water**



Figure 3



Figure 4



Figure 5



Figure 6

**Figures 7, 8 and 9. MS River showing students collecting water samples.**



Figure 7



Figure 8



Figure 9





Figure 10. Picture showing instructor, Dr. Alex Acholonu and some students at collection site, MS River.



Figure 11. Group picture of students that went on field trip to New Orleans. Background is Fats Domino's House destroyed by Hurricane Katrina

## RESULTS

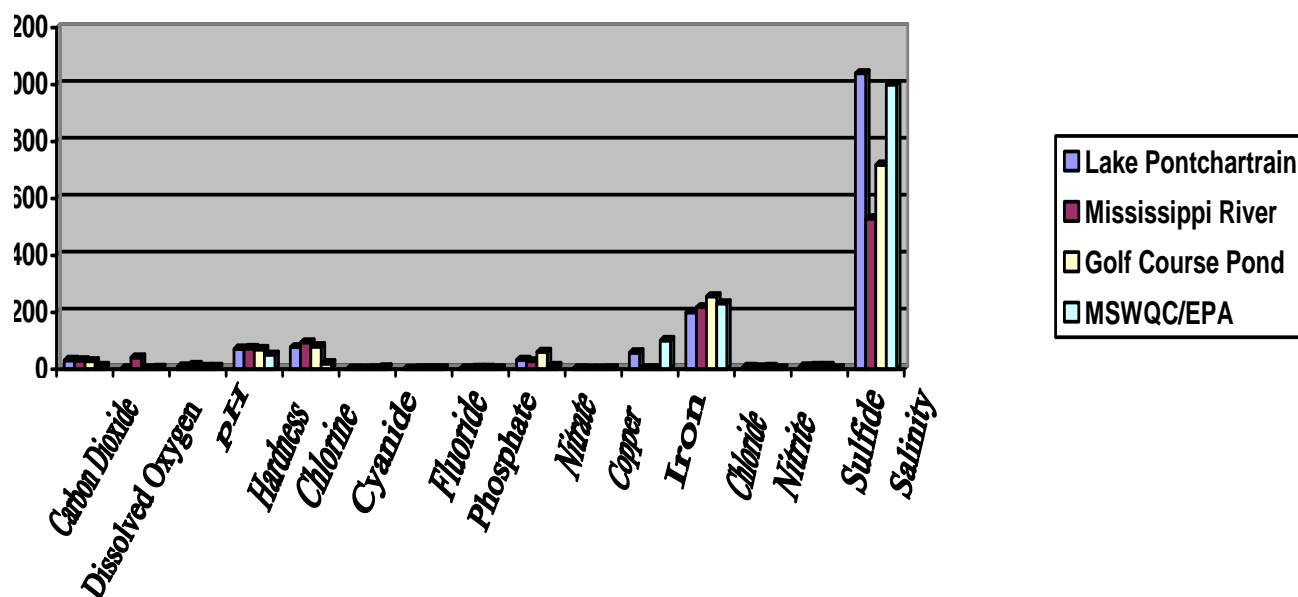
Lake Pontchartrain, Mississippi River and SUNO Golf Pond were tested for possible pollutants. The results of the tests are indicated in Table 1 and Figure 12. The coliform and *E. coli* levels registered were below minimum concentrations (colorless or negative).

**Table 1. Chemical Profile of Freshwater Bodies in New Orleans, LA and the Mississippi Water Quality Criteria/EPA (MSWQC/EPA) \***

	Lake Pontchartrain	MS River	Golf Course Pond	MSWQC/EPA
1. Carbon Dioxide	31	29	27	10
2. Dissolved Oxygen	1.3	40	1	4
3. pH	7.52	13	7	7
4. Hardness	71.04	72	69	50
5. Chlorine	76.4	93	79	19
6. Cyanide	0.2	0.63	0.8	5.2
7. Fluoride	0	0.8	1	2
8. Phosphate	2	3	2.5	2
9. Nitrate	32	27	60	10
10. Copper	1.25	0.6	0.6	1.3
11. Iron	57.75	2	0.73	100
12. Chloride	199	217	255	230
13. Nitrite	5.9	5	6	1
14. Sulfide	7.9	10	10	2
15. Salinity	1039	529	542	1000



Figure 12. Graph Showing the Results of the Water Quality Tests Carried Out on the 3 Freshwater Bodies in New Orleans, LA (All results in parts per million (ppm))



## DISCUSSION

The results and the analysis of the results show that the three water bodies did not completely meet the Water Quality Criteria of Mississippi and/or EPA standard. The following parameters tested, exceeded the Water Quality Criteria with respect to: (1.) **Lake Pontchartrain**: carbon dioxide (31/10), dissolved oxygen (1.3/4; i.e. lower than minimum required) pH (7.7/7), hardness (71.0/50), chlorine (76.4/19), nitrate (32/10), sulfide (7.9/2), nitrite (5.9/1). (2.) **Mississippi River**: carbon dioxide (25/10), dissolved oxygen (40/4), pH (13/7), hardness (72/50), chlorine (93/19), phosphate (3/2), nitrate (27/10), nitrite (5/1), sulfide (10/2). (3.) **Golf Course Pond**: carbon dioxide (27/10), dissolved oxygen (1/4; i.e. lower than minimum required), hardness (69/5), chlorine (79/19), phosphate (2.5/2), nitrate (60/10), chloride (255/230), nitrite (66/1), sulfide (10/2).

Based on the water quality parameters tested, over 50% of the test

results failed to meet the MS Water Quality Criteria and/or EPA standards. Also, the concentrations in parts per million (ppm), that exceeded the MSWQC/EPA standards are more than previously reported by Acholonu et al. (2000, 2006 ) and Hopkins and Acholonu ( 2005). This shows that the water bodies were still contaminated. It is recommended that periodic assessments be made on these water bodies to know whether the pollutants are clearing or increasing beyond human use. Water is the driver of nature and needs to be tested often (Smith and Smith 2001).

This study includes tests on coliform bacteria and *E. coli*. Acholonu and Harris (2006) in their comparative study on the water quality in China and Mississippi reported only on the chemical profile. They recommended that subsequent investigators should consider the determination of coliform bacteria in the China waters and had not included this in their previous studies hence, the inclusion of tests on

coliform bacteria and *E. coli* in this study. This was also included as it was stated that flood water fouled with human and animal remains and sewage were pumped into the Mississippi River and Lake Pontchartrain.

The salinity recorded for Lake Pontchartrain is not surprising. It ranged from 1010-1569 ppm and averaged 1039 ppm. It is called a brackish lake and the second largest salt-water lake in the United States (the first being the Great Salt Lake in Utah). The salinity fluctuates as it receives salt water from the Gulf of Mexico via Rigolets strait and freshwater from several rivers (e.g. Tangipahoa, Amite and Bogue Falaya Rivers) which thus make it an estuary. Also the Industrial Canal connects the Mississippi River with the lake at New Orleans. Bonnet Carré Spillway diverts water from the Mississippi into the lake during times of riverflooding

([http://en.wikipedia.org/wiki/Lake\\_Ponchartrain](http://en.wikipedia.org/wiki/Lake_Ponchartrain)).

## ACKNOWLEDGEMENTS

Grateful acknowledgement is paid to Dr. Yetunde Ogunkoya and Ms. Mary Richter, faculty and staff members of Southern University, New Orleans campus, who acted as consultants and collection guides in this study; to Dr. Alton Johnson, Associate Professor in the Department of Agriculture, Alcorn State University for allowing us the use his Chromatography equipment and Colilert for performing the coliform bacteria and *E. coli* tests. We are also grateful to the students who helped in running the tests, namely, Michelle Kinnard, Sherita White, Tandeka Phipps, and Tammy Williams. This study was supported by a grant from the Ecological Society of America (ESA).

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# A NOTE ON ADDITIONAL PLANTS FOUND AT SIXTEENTH SECTION (OSBORN) PRAIRIE.

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## ABSTRACT

*Andropogon gerardii* Vitman, *Arundinaria gigantea* (Walter), *Cacalia tuberosa* Nutt., *Erucastrum gallicum* (Wild.), *Eryngium yuccifolium* Michx., *Silphium trifoliatum* L. var. *latifolium* A. Gray., *Sorghastrum nutans* (L.), and *Tripsacum dactyloides* (L.) are reported as new records from the Sixteenth Section (Osborn) Prairie in Oktibbeha Co., Mississippi as a result of observations made from 2000 to 2005.

## INTRODUCTION

Leidolf and McDaniel (1998) reported 152 species of plants from Sixteen Section Prairie (also known as Osborn Prairie), a Black Belt Prairie remnant in Oktibbeha County, Mississippi (T19N R15E Sec. 16; 33°30'21"N 88°44'09"W). Their survey of 16.8 ha delineated three distinct plant communities: open prairie, prairie cedar woodland, and chalk outcrops, along a power-line right of way. Seven of these plants are listed as imperiled and four are under consideration for listing as imperiled in the state. Since that study, approximately 57 hectares of this remnant, including the Leidolf and McDaniel survey area, have been leased for 40 years from the Oktibbeha County Board of Education by "Friends of the Black Belt" in an effort to conserve this remnant. Osborn Prairie is one of the larger examples of protected Black Belt Prairie vegetation in Mississippi. It is frequently used as a study site for researchers as well as an "outdoor classroom" for the local public school district and various courses taught at Mississippi State University (Wiygul et al., 2003).

The open prairie habitat is significant in that it not only includes rare plant species, but also has several insect species populations that are disjunct from other populations in the Great Plains and other grasslands. These disjunct populations have been hypothesized to be the result of a grassland corridor that prehistorically connected the Black Belt and the Great Plains (Brown 2003). Pollen core studies for this area of the Southeast are not available to support the prehistoric presence of prairie in the Black Belt due to the lack of available sites with chronologically intact pollen preservation dating to this period (Peacock 1993; Sheehan 1982). However, a study of the macro-vertebrate fossil assemblage revealed a community of grazers, dominated by six species of *Equis* (Equidae), three of which are only known from the Black Belt and the Great Plains, and insect studies revealed the presence of an endemic, flightless ground beetle, *Cyclotrechelus hyperpiformis* Freitag (Coleoptera: Carabidae), whose most closely related species occurs in Texas and the Great Plains, and the local abundance of the moth, *Ceratonia hageni* Grt. Lepidoptera: Sphingidae), which is also locally common

in Kansas, Arkansas, Missouri, and Texas support Brown's (2003) hypothesis (Kaye, 1974 and Brown, 2003).

## METHODS

The plants reported here were detected in the open prairie habitat during the years 2000-2005 within the 57 ha currently leased by "Friends of the Black Belt" that includes the study area of Leidolf and McDainel. Voucher specimens have been placed in the Mississippi State Herbarium and the Cobb Institute of Archeology comparative collection. Nomenclature follows: Kartesz (1994).

## RESULTS AND DISCUSSION

New records for the open prairie habitat at Sixteenth Section include the grasses (Poaceae) *Andropogon gerardii* Vitman, *Sorghastrum nutans* (L.), *Arundinaria gigantea* (Walter) Muhl. and *Tripsacum dactyloides* (L.). Leidolf and McDaniel (1998) noted *A. gerardii* and *S. nutans* as being absent from the site and speculated that their absence was due to the lack of fire. Three small populations of *A. gerardii*, big bluestem, were located in this survey, with the largest covering an area 0.5 x 1.0 m. Three small populations of *S. nutans*, Indian grass, were discovered with the largest measuring one meter wide by three meters long. While another population consists of several scattered individuals on top of a hill along the power-line. *Sorghastrum nutans* hay was introduced to the site by Schawecker (2001) as part of an experiment at the site. His results indicated that this introduction was unsuccessful due

to various factors including a drought during the study period. It is possible that the *S. nutans* is present as a result of this introduction; however, none of the present populations are near the plots used in that study. *Arundinaria gigantea*, cane, is found bordering a creek that transects the prairie/power line near the north border of the site. The cane extends 5-10 meters from the stream bank into the open prairie. One clump of *Tripsacum dactyloides*, eastern gamma grass, was found in a prairie opening adjacent to the power line.

Additional non-grass plants found in the open prairie include *Silphium trifoliatum* L. var. *latifolium* A. Gray (Asteraceae), *Cacalia tuberosa* Nutt (Asteraceae), *Eryngium yuccifolium* Michx. (Apiaceae), and *Erucastrum gallicum* (Wild.) (Brassicaceae). A population of *Silphium trifoliatum* L. var. *latifolium*, whorled rosinweed, consisting of approximately 45 plants were found in several prairie openings, that were interspersed among areas of cedar woodland on the northeastern boundary of the study area. Several specimens of *Cacalia tuberosa*, Indian plantain, were found on the power-line right- of- way and in several of the prairie openings. A population of approximately 25 individuals of *Eryngium yuccifolium*, rattlesnake master plants, was discovered in a small prairie opening on the western edge of the property. Scattered individuals of *Erucastrum gallicum*, common dog mustard, were found growing mostly along the open prairie/chalk outcrop interface throughout the study area (See Table 1).

Table 1. Additional plants found in open prairie habitat at 16<sup>th</sup> Section Prairie.

<i>Arundinaria gigantea</i> (Walter), cane
<i>Andropogon gerardii</i> Vitman, big bluestem
<i>Cacalia tuberosa</i> Nutt., Indian plantain
<i>Erucastrum gallicum</i> (Wild.), common dog mustard
<i>Erygynum yuccafolium</i> Michx., rattlesnake master
<i>Silphium trifoliatum</i> L. var. <i>latifolium</i> A. Gray, whirled rosinweed
<i>Sorghastrum nutans</i> (L.), Indian grass
<i>Tripsacum dactyloides</i> (L.), Eastern gamma grass

## ACKNOWLEDGEMENTS

We thank Richard Brown and all of the “Friends of the Black Belt” who have put forth the effort to conserve the natural heritage of this region. We also thank John MacDonald for his effort in verifying several plant identifications. Thanks also goes to John Barone for his constructive comments on this manuscript.

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# ECOLOGICAL FOOTPRINT OF STUDENT POPULATION AND ITS USE IN POLICY ANALYSIS AT JACKSON STATE UNIVERSITY

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## ABSTRACT

Scientists continuously look for suitable indicators to measure the impact of humans on the ecosystem. Ideally, such indicators should also be suited as benchmarks for ascertaining the effects of administrative policies. One such indicator is the Ecological Footprint, which although it has a short history, has gained a widespread popularity. Since the first introduction of the Ecological Footprint, studies analyzing its impact on the ecosystem of nations, regions, or individuals have become widespread. The level of analysis has tended to shift toward institutions and, due to their role as opinion leaders, universities were the first to calculate the impact they have on nature. This study provides a complementary view by analyzing the Ecological Footprint of the student population at Jackson State University and the role that a possible campus policy may have in reducing it. It finds that the average Ecological Footprint of a student is lower than that of the average U.S. citizen by five acres. Our data suggests a policy that discourages freshmen and sophomore students from bringing their cars on campus would reduce the Ecological Footprint of the student population by about 4,000 acres or sixteen times the campus area. The study provides an example of how the Ecological Footprint can be used to plan for future campus development and create a campus that is aesthetically and ecologically balanced.

**Keywords:** ecological footprint, policies, sustainable development, Jackson State University

## INTRODUCTION

Accepted measuring tools that can shed light on the effect of humans on ecosystems are greatly needed in order to convince the public opinion for countermeasures. Several scholars have focused on designing and refining instruments and called them local sustainability indicators. However, while constructing such indicators became an industry unto itself, their effectiveness needs to be assessed and a different line of research addresses this task. The reasons, difficulties and possible outcomes of designing local sustainability indicators are discussed in detail by Rydin *et al.* (2003). These studies indicated the necessity of

using generally accepted indicators, whether perfect or not, in order to assure compatibility amongst the study results.

Due to the intricate patterns of trade that characterize the production-consumption cycle, the physical location of an individual does not correspond to the location of the resources consumed, and therefore, to their “ecological location” (Rees, 1996). The importance of trade and the difficulties it poses for calculating one’s impact on the ecosystem is highlighted in many methodological papers (Daniels, 2002, and Rydin *et al.*, 2003). However, the methods for treating these difficulties depend on the purpose of the study and therefore, on the

indicators used in assessment. Studies dealing with the impact of humans on the ecosystem may be classified in two broad categories. The first one is focusing on the global balance between consumption and sustainable production, and therefore concentrates more on the consumption side. If the researcher is interested in analyzing the impact of consumption on the global ecosystem, without paying attention to the locations where the impact is felt, the methodology applied will focus on the consumption patterns and the production process can be quantified with the help of global averages. It is sufficient to know the average world production of grains per hectare in order to calculate how many hectares an individual consumes annually at a certain location. However, if the researcher is more interested in the impact consumption has on a specific location, a second category of indicators is needed, which will focus on what is actually harvested at that particular location, without paying attention to where the products go.

The Ecological Footprint (EF) designed by William E. Rees (Rees 1992; 1996) is an example of the first type of indicators, which aimed at measuring the impact of humans on the planet (sustainability studies). The use of the EF and its adoption as a standard by local authorities and academia is unprecedented for any other such tool. Furthermore, its adoption continues at high rates, following the numerous studies pleading for its use as a standard in the field (Lewan and Simmons, 2001) and it appears to be the standard when it comes to studies analyzing the impact of institutions of higher learning on environment.

The EF is based on the "Carrying Capacity" concept which is defined as the maximum rates of resource harvesting and waste generation that can be sustained indefinitely without progressively impairing the productivity and functional integrity of

relevant ecosystems wherever the latter may be located (Rees, 1996). The main feature of this concept is its independence of any interpretable measurement unit such as currency or even purchasing power parity. Indeed, the hectare, which is the unit in which the carrying capacity and ecological footprint are expressed, has the same connotation and interpretation all over the world and this seems to make it the most reliable measure of this kind (Simmons and Chambers, 1998; Jorgenson, 2003). According to these concepts, each person consumes a certain amount of goods and services and produces a certain amount of wastes, and to each corresponds a certain area of land, which may be viewed as the area necessary to produce the goods and services consumed, as well as to assimilate and decompose in components usable by the nature of the wastes.

Numerous studies have calculated the EF of nations, communities, and individual institutions (Wright, 2002; Maltin and Starke, 2002). A study comparing the EF of the world's nations released recently reveals a worse than unpleasant picture (Venetoulis, 2004). According to the study, the sustainability mark was breached for the first time in the 1970s and the ecological deficit reached one acre per person in 2000.

The EF seems an easy to apply tool, however, it seems that results are less comparable than one would like to believe. According to Ventoulis et al. (2004), the EF of an average US citizen is 9.57 hectares. But according to other sources the EF of the average US citizen is about 1.03 hectares for food, 0.16 for degraded land, 0.64 for wood products and 0.67 for energy, amounting to about 1.83 hectares per capita, to which one may add 0.67 hectares, which represents the energy EF, for a total of 2.5 hectares (Palmer, 1999). Not only is there a difference between the two numbers, but one is four times the other.

While older studies focused on countries or larger areas, the research community has recently become interested in small communities or institutions. Methodologies and data that apply at cities, plants, universities and even household levels became easily available. Today, almost any interested individual or community can easily determine its impact on the ecosystem. Several organizations offer standardized tools for calculating EF either for downloading or on their website. The best known web site is the EF calculator that applies to individuals which is hosted by Earth Day Network (2004) and is based on the software created by the well-known organization, Redefining Progress (2004). The importance of universities as opinion leaders and early adopters of innovative scientific tools and technologies has been discussed and applied (Venetoulis, 2001; Wood and Lenzen, 2003). However, there are no studies that analyze the EF of students or groups of students within universities. Such a study is by no means a substitute for the analysis of the EF of the university as a whole, but a complementary approach that quantifies the personal consumption patterns of students, as the larger group of inhabitants of a university, and accordingly allows for analyzing the impact of policies that have certain groups of students as subjects.

In our EF study, we begin by quantifying the elements of consumption that characterize the majority of the population of study through a survey. The biocapacity conversion factors, used to account for the efficiency of conversion of raw materials to manufactured products and to secondary animal products, are applied to this data in order to obtain the EF of the sample (population). Previous studies worked with aggregated data, but non quantified consumption patterns with the help of surveys. Thus, this study differs from

previous research in two main ways. First, many studies addressing universities examined the footprint of the whole campus without assessing the individual patterns of consumption. While the methodology does provide a good estimate, it does not allow for easy quantification of the individual effects the population under study has on the environment. Indeed, in such studies the input consists of aggregate consumption data, which is difficult to allocate to the individuals that make up the population. Therefore, it is almost impossible to analyze the impact of different changes that may be the effect of policies. Secondly, this study uses a survey as means for quantifying consumption patterns of the population under study, which allows for a more in-depth analysis. The population of interest is students at Jackson State University, a medium sized southern university.

The objectives of this study are two fold: first is to analyze the Ecological Footprint of the student population, and second to analyze the impact on the EF of a possible administrative policy, the influence of automobile used by the freshmen and sophomore students. The study provides an example of how the EF can be used to plan for future campus development and create a campus aesthetically and ecologically balanced.

## **MATERIALS AND METHODS**

The instrument used in our study is a modified version of the widely used Footprint Survey. The survey was designed following the Tailored Design Method (Dillman, 2000), improved upon the principals of the Total Design Method, which recommended mechanically applying one set of survey procedures to all survey situations. All questionnaires were marked with an identification number in the upper right-hand corner of the back cover, which allowed identification of classification and



location of students (in-campus or out of campus). Questions to the similar topics (category of footprint) were presented together and questions about demographics were positioned at the beginning of the survey. The Footprint Survey was modified to address the specific population of students by two simple changes. First, the students were asked to refer to their residence on campus or in the city rather than their home residence. The second change was the inclusion of student classification in the survey. The surveys were randomly distributed in the JSU campus and the first author guided the students through the process of deciding which answer applied, in order to assure a uniform methodology. A number of 1,000 surveys were distributed, half to students living on campus and half to students living off campus. Out of the 600 collected surveys only 275 were usable (ones that have complete information), representing over 3.5 percent of the total population of about 7,800 students. The

Ecological footprint was calculated for each of the respondent and then statistical analysis was performed.

## RESULTS AND DISCUSSION

Table 1 presents JSU sample demographics. The sample seems to reasonably describe the population, particularly by classification. It is however; slightly unbalanced when it comes to sex since the sample is composed of over 55 percent males, whereas the total student body composed of only 37 percent males. The age distribution of the sample seems to mirror the student body well, with over 83 percent younger than thirty years old. The same seems to be true for the classification with the highest number of students being freshmen (over 33 percent) and sophomores (over 26 percent). Finally, about sixty percent of the students interviewed live on campus, giving a good break of the sample, which allows for comparison between the two groups.

**Table 1. JSU Sample Demographics**

Characteristic		No. Persons	Percentage	Percentage (Official JSU Records)
Age	16-30	229	83.27	79.9
	31-35	39	14.18	9.50
	36-50	7	02.55	10.6
Residence	On campus	164	59.64	34.0
	Out of campus	111	40.36	66.0
Sex	Male	152	55.27	36.9
	Female	123	44.73	63.1
Classification	Freshmen	92	33.45	27.7
	Sophomore	73	26.55	24.5
	Junior	43	15.64	14.9
	Senior	48	17.45	23.4
	Graduate	19	6.91	9.50

Table 2 shows some of the results of the survey. Only selected questions are

presented, which are the questions with weight in calculating the EF (the numbers

correspond to the numbers on the survey). Due to the characteristics of the sample, there were several questions that did not apply. Such questions were those regarding the motorbike transportation. This type of transportation is very rare in the south. Also, as expected, all respondents indicated their city to be of size between 100,001 and 1,000,000 (since the city of Jackson has about 350,000 people), while all respondents indicated the weather to be similar to the weather in Atlanta, as expected. One question that seems not to apply regarded whether each respondent's home has electricity. All respondents indicated that they have electricity, with only one indicating that her home has energy conservation efficient energy. Finally, out of the sample only twelve respondents indicated that they sometime use animal power to get around, while the large majority indicated they seldom do so.

According to the data, the median respondent age is between 16 and 20 years old. She/he eats animal-based products very often (eats meat daily), and between three quarters and half of the food eaten is processed, packaged and not locally grown. She/he generates as much waste as neighbors, shares her/his room with a roommate, and occupies a home between 500 and 1000 square feet. As expected, she/he lives in a multi-story apartment building with electricity. She/he does not use any public transportation or motorbikes, and travels an average of 100 to 200 miles each week. The respondent seldom uses animal power to move around, uses a bicycle, or walks and flies about 10-25 hours each year. Finally, she/he owns a car that gets between 25 to 35 miles per gallon and only occasionally shares the car with someone else.

**Table 2. Selected survey questions and their answers.**

Question	Categories	Answers	Percentage
# 7. Frequency animal based products eaten	Never	0	0.00
	Infrequently	1	0.36
	Occasionally	4	1.45
	Often	26	9.45
	Very often	101	36.72
	Almost always	143	52.00
# 8. Part of the food processed	Most	11	4.00
	Three quarters	124	45.12
	Half	120	43.63
	One quarter	20	7.27
	Very little	0	0.00
# 9. Waste generated compared with neighbors'	Much less	13	4.73
	About the same	258	93.80
	Much more	4	1.45
# 10. Number of people in the home	1	9	3.27

Question	Categories	Answers	Percentage
	2	201	73.09
	3	36	13.09
	4	19	6.91
	5	6	2.18
	6	2	0.73
	7	2	0.73
# 11. Home size (square feet)	2500	10	3.64
	1900-2500	19	6.90
	1500-1900	32	11.63
	1000-1500	57	20.72
	500-1000	2	0.73
	500 or less	155	56.38
# 12. Housing type	Free standing no running water	1	0.36
	Free standing and running water	44	16.00
	Apartment	173	62.91
	Row house	57	20.73
	Green-design	0	0.00
# 16. Distance by car each week (miles)	400	3	1.10
	300-400	10	3.64
	200-300	58	21.10
	100-200	184	66.90
	10-100	18	6.53
	0-10	2	0.73
# 18. Hours spent flying	100	2	0.73
	25	63	22.91
	10	86	31.23
	3	24	8.72
	0	100	36.77
# 21. Car gas mileage (miles/gallon)	50	0	0.00
	35-50	5	1.82
	25-35	155	56.37
	15-25	114	41.45

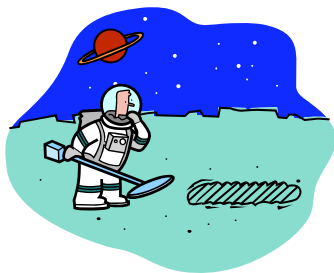
Question	Categories	Answers	Percentage
	<15	1	0.36
# 22. Car pooling frequency	Never	92	33.45
	25%	73	26.55
	50%	44	16.00
	75%	47	17.10
	Always	19	6.91

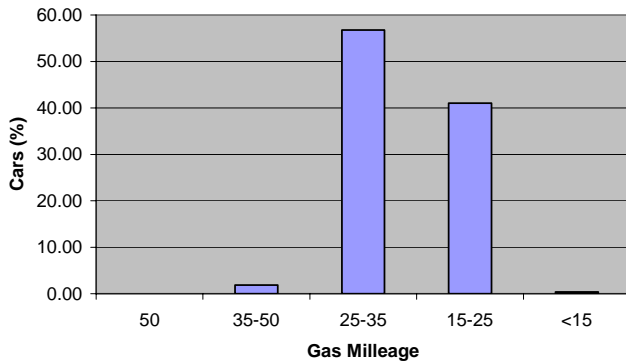
The two final indicators (the car gas mileage and car pooling frequency) are interesting to visualize, since one of the main purposes of the study is to analyze the influence of automobile use by the freshmen and sophomore students. Figure 1 shows the car gas mileage as indicated by the survey respondents. It is easy to observe that most cars used by the student population fall in the 15 to 25 and 25 to 35 miles per gallon range, which may probably corresponds with the usage patterns of all US residents of the same age.

The second interesting information from the car usage point of view would be the distance traveled by car (Figure 2). It can be easily observed that the largest number of students reported they travel a distance between 100 and 200 miles each week. This number will be important for calculating the average ecological footprint for the freshmen and sophomores

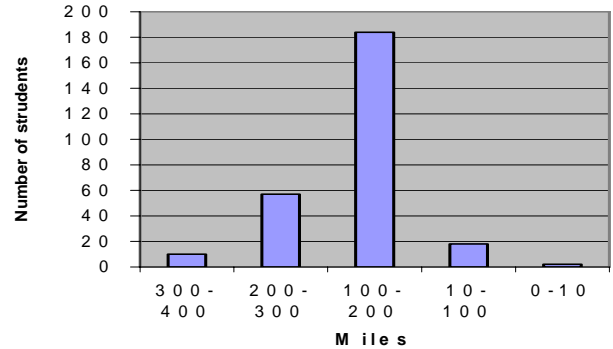
should a no car policy be adopted by the School Administration.

Descriptive statistics were generated for the ecological footprint of the 275 respondents. The respondent has a mean ecological footprint of 19 acres (Table 3), which would correspond to 4.3 planets needed to sustain the lifestyle. As expected this ecological footprint is lower (about 79 percent) than that of the average citizen, which is about 24 acres (Redefining Progress, 2004). Surprisingly enough however, the difference is not very large, and it seems to come mostly from the housing lifestyle. Indeed, students are expected to live in much smaller quarters than the rest of the population, at least during the school period. Table 3 presents the ecological footprint corresponding to the main four categories and, in comparison the alternative ecological footprint. Indeed, as expected, the larger proportion of the footprint accrues for food





**Fig 1** Distribution of JSU students' cars gas mileage



**Fig 2.** Miles traveled by car each week by JSU students.

**Table 3.** Mean (Standard Deviation) ecological footprint and alternative ecological footprint for JSU students

Category	EF of the student (SD)[Acres]	Alternative EF for student (SD) [Acres]
Food	5.7 (0.61)	6.2 (0.81)
Mobility	1.5 (0.45)	1.5 (0.62)
Shelter	5.7 (0.51)	1.7 (0.42)
Goods/Services	6.4 (1.10)	3.0 (0.37)
Total	19.0 (2.10)	12.0 (1.91)

While the calculations above were based on the assumption that the average respondent eats animal-based products very often and that three quarters of his/her food is processed, a significant portion of the sample indicated that they almost always eat animal-based products but also that half of the products they eat are processed. The difference that would arise from using these answers in the calculation would have no effect, as the total footprint remains the same. The ecological footprint of the total student population would then be  $7,800 \times 19 = 148,200$  acres.

A second calculation was made using the mode of the distribution for the different

answers, that is, the most often response was used in calculation and it is presented as the alternative ecological footprint. The difference is clear, with the total footprint of only 12 acres. As can be noticed in Table 3, the main difference appears for shelter and goods and services. Indeed, there is an apparent difference between the surface occupied by an apartment of 500 square feet and one of 750 square feet (between 500-1000).

A one-way analysis of variances (ANOVA) was performed to test if there is a significant difference in the EF among different classifications at JSU (table 4). Tukey (Tukey 1953) was used for mean separation

procedure. At the 5 percent level of significance, there was an overall significant difference among different classifications (p-value= 0.0001) with respect to the EF.

Table 5 presents the Ecological Footprint by classification. There were significant differences among different classifications except between graduates and freshman. As expected, the impact on the ecosystem tends to increase with the student's classification, as consumption also increases.

**Table 4. Analysis of Variance for Ecological footprint of JSU students by classification**

Source	DF	SS	MS	F	P-value
Total	274	4214.78			
Classification	4	1937.91	484.45	57.45	0.0001
Error	270	2276.87	8.43		

**Table 5. Ecological footprint (Acres) for JSU students by classification**

Classification	Mean (Standard deviation)
Graduates	19.85 (5.35) a
Seniors	19.38 (2.20) a
Juniors	17.18 (3.31) b
Sophomores	14.70 (2.59) c
Freshmen	12.81 (2.44) c

Means followed by different letter groupings are significantly different according to Tukey multiple comparison Test

### **Implications of a possible policy regarding the students' use of cars**

The majority of big city universities do not allow resident students to keep cars on campus for the duration of their freshman and sophomore year. In the 2003-2004 academic year, from a total of 2,334 students living on the JSU campus, 782 are freshmen and continuing freshmen and 468 sophomores, which represent about 54 % of the total student population. In order to analyze the impact on environment should such a policy be adopted, a profile of the students without a car was constructed and

the answers were run through the same program.

The main differences between the previous and the new consumption profile are that the distance reported by each student to be covered by means of car use was reduced to 0-10 miles, while the distance covered by public transportation was raised accordingly to 75-200 miles. As a result the questions regarding the car gas mileage and the car-pooling frequency have no relevance (Table 6). The main outcome of the policy is a decrease of the Ecological Footprint of about two acres per person, or about ten percent. Even if such a decrease

would not lead to saving the world, it would however provide the student population the opportunity to contribute to a more environmental friendly campus.

In terms of the total ecological footprint, the reduction would be proportional with the number of freshmen and sophomores that live on campus. According to the Jackson State Statistics (JSU, 2004) 2,028 students lived on campus in the 2003-2004 academic year. Therefore, the reduction in the ecological footprint corresponding to the student population would be of  $2,028 \times 2$  acres, that is, 4,056 acres or about 2.7 percent.

**Table 6. JSU campus no car policy ecological footprint.**

Category	Acres
Food	5.4
Mobility	0.5
Shelter	5.7
Goods/Services	5.7
Total	17

Finally, to help readers understand the results, it would be interesting to compare the different aggregate Ecological Footprints with the campus area. According to statistics, the main campus covers an area of about 250 acres (Mason, 2004). As such the aggregate Ecological Footprint of the student population would be about  $148,200/250$  or 593 times larger than the area actually covered by the campus. Furthermore, the change in the aggregate Ecological Footprint that would occur should the campus car policy be enforced would be a decrease of 4,056 acres, or about  $4,056/250$  or sixteen times the campus area. Indeed, the comparison of the Ecological Footprint with the campus area puts things in perspective. While the difference in the total EF due to the policy might not suggest a dramatic change, saving a surface equal to sixteen times the area of the campus can be considered a relatively important goal.

## CONCLUSIONS

Some of the institutions that may be characterized as highly concerned with their impact on the environment and therefore as early adopters of the Ecological Footprint methodology are universities. As such, there were several studies analyzing the impact on the environment of

several institutions. Less common however are studies that analyze the pattern of consumptions of students and the impact on environment of the student population itself. Such studies benefit the literature by allowing researchers to understand how the student population by itself affects the environment and therefore be able to compare the effects that different policies would have on exactly the impact on environment.

This study finds that for the population under study, the consumption pattern is relatively homogeneous, and that students do not seem to be concerned with the impact of their consumption patterns on the environment. Although the student population has an Ecological Footprint lower than that of the average US citizen, the difference comes mostly from the budget constraints associated with the student life and not due to any type of self restraint. Indeed, the main difference in the Ecological Footprint seems to come from the relatively small size of dwellings that are used by students. As such, the Ecological Footprint of the average student is 19 acres, while for the average citizen it is 24 acres. The study also illustrates the use of Ecological Footprint for policy analysis. It finds that, should freshmen and sophomores not be allowed to bring their cars in the campus, their ecological footprint would decrease by about two acres, which would lead to a total reduction of about 4,056 acres, or about sixteen times the campus area.

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# **INTRAOSSEOUS DENTAL IMPLANTS: THE RELATIONSHIP BETWEEN MORPHOLOGIC CONFIGURATION AND BIOLOGIC RESPONSE; THOUGHTS FOR CONSIDERATION**

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## **ABSTRACT**

Dental implants have long been utilized for the treatment of missing teeth. Archeological findings indicate that numerous ancient civilizations have implanted many materials (including teeth) as early as several centuries B.C. Among these are the ancient Greeks, Romans, Chinese, Egyptians, Mayans, Arabs, and Indians.

Today, implant placement is relatively common. Great strides have been made over the last century or so in biomaterials improvements, patient selection, as well as implant placement and loading techniques.

Still, the question of biologic “acceptance” or “rejection” of foreign materials remains an enigma to implant surgeons and dentists. Many recent improvements in design, materials selection, implant coatings, and placement techniques have been developed and improved on the “predictability” of a favorable outcome for dental implants. “Success rates” (however defined) are difficult to establish as practitioners and manufacturers alike are reluctant to discuss their “failures.” One practitioner may deem a one year retention a success while others may adopt a longer criteria such as 7 – 10 years. Also the question remains as to whether or not other factors besides the product itself, such as patient selection and compliance, placement technique, and loading may cloud the picture and thus adversely affect an otherwise successful case. We also have learned that location within the mouth and bone quality in the area of the implant. It appears safe to say that today’s implant placements are relatively (but not absolutely) successful and predictable.

This paper seeks to expand on one possible factor in modern dental implants which may be at least partially responsible for influencing the failure or success of the implant. While implants have been extensively studied from numerous angles, the design and shape of implants has received very little systematic attention. With further research into the relationship between the shape and configuration of implants and success or failure of same, a better understanding of this relationship should lead to principles of optimal configuration for implant design, and thus better success rates. Currently implant design appears to be driven largely by factors such as “marketing departments,” cost, and “user friendliness” issues rather than evidence based research.

**Keywords:** Endosseous, Coatings, Interface, Bone Resorption, Osseointegration, Biointegration  
Rejection, Loading, Bone Cement, Wolf’s Law

## **INTRODUCTION**

Restoring missing teeth has long been one of dentistry’s biggest challenges. Even before the advent of Pierre Fauchard’s development of the “modern” partial denture,

attempts were made to “graft” other person’s extracted teeth into the sockets left after a recipient’s tooth was avulsed or extracted. In fact, in the 16<sup>th</sup> century in many parts of Europe the poorest people often went to the dental practitioner and sold some of their teeth (usually

anterior, single rooted ones) to be immediately transplanted to someone (generally of wealth) whose corresponding tooth was just extracted and were willing to pay a donor for a “transplant.” Not much information is available regarding the length of retention of these transplants, but it seems safe to wager that success rates were low.

Later, the development of partial and full dentures as well as the fixed bridge provided better alternatives. Still, however, many persons did not like the idea of foreign materials such as dentures in their mouths and often found them unstable, thus intolerable and thus useless.

Today, the endosseous (also referred to as “intraosseous”) implant allows a dental appliance such as a crown, partial or full denture to be anchored securely to alveolar bone (by way of the implant), thus preventing many of the masticatory, speech, bone resorption, and esthetic problems often inherent in more traditional therapies. With these and other advantages, dental implants have virtually exploded in their application in dental practices worldwide.

## Definitions

- Endosseous (sometimes referred to as “intraosseous”) implants differ from subperiosteal and supraepiosteal implants in that while the latter are placed on the surface of alveolar bone, an endosseous implant is placed within the bone.
- Coatings are often placed on the surface of implant materials in hopes of enhancing their biocompatibility with bone and other tissues, and to promote osseointegration and biointegration.
- The interface is where the implant material meets the human tissue (generally bone).  
The reaction of the tissues at the interface to the implant largely determines the success or failure of the case.
- Bone resorption involves the “shrinking” and atrophy of bone which is not sufficiently and properly

stimulated or “stressed” frequently and with appropriate forces.

- Osseointegration is a term used to indicate that the tissues at the interface have grown to within about 100Å of the implant material. The case is generally viewed as a success when this occurs.
- Biointegration is similar to osseointegration except that when this condition exists, there is said to be essentially “no space” between the tissue and the implant. This represents the ultimate compatibility of the implant and surrounding tissues.
- Rejection is said to occur when the interface space is much over 100Å. The implant becomes loose and unattached sufficiently to the bone to be considered a “success.”
- Loading is the term used to indicate that a force (usually an occlusal one) is applied to an implant. In dental implants this most commonly occurs six to twelve weeks after placement to allow for a degree of healing and integration. Improper and premature loading is often cited as the major culprit in implant failures.
- Bone cements are available in which poly methyl methacrylate (PMMA) is often a major ingredient. Bone cement is often used in orthopedic applications to stabilize say a hip replacement implant so the implant can be loaded as early as the same or next day, thus allowing the patient to put force on the implant and begin to ambulate and “work” the joint. This is not done in dental implant placement. PMMA is also known to be rather cytotoxic, although it has been suggested from time to time that a mild “insult” to the bone may actually speed up its remodeling much the same way that calcium hydroxide is often placed by dentists in deep cavity preparations to stimulate the growth of reparative dentin.
- Wolf’s Law states that bone remodels itself in accordance with the forces

placed on it. In dentistry, orthodontic tooth movement is a good example of how direct pressure resorbs bone while pulling forces (via the periodontal ligaments) stimulate the deposition of new bone.

- Peri-implant bone loss refers to the loss of bone near the implant that usually occurs at or near the “coronal edge” soon after placement of the core receptacle. This process is poorly understood at this time.

## Historical Background

As was alluded to in the Abstract section, various forms of implantation have been with us since ancient times, perhaps as early as 1000 B.C. [1] Metals came into play as the implant material of choice in the last quarter of the 19<sup>th</sup> century. Originally gold, silver and even lead was used. While we shudder to think of lead in the body, it did exhibit some antibacterial properties and was more suitable than porcelains, wood, tin, or silver which were some of the other materials being tried at the time. Gold, while highly inert, was tried but with little success. Silver did not fair much better, perhaps due to corrosion. In at least one case, even precious stones were “implanted” in place of teeth (probably as a cosmetic show of wealth and power). [2]

It should be noted that “natural” biologic materials have been implanted into human jawbone for centuries. In parts of Europe during the 15<sup>th</sup> and 16<sup>th</sup> centuries it was not uncommon for a person who lost a tooth to pay money to some unfortunate soul to have their corresponding tooth extracted and immediately inserted into the empty socket of the recipient. Needless to say, most of these attempts were bound to early failure and rejection, but a few scattered accounts report “success” for up to several months. This author has been unable to uncover any historical mention of occlusal disharmony factors following such procedures, but it certainly is reasonable to assume that resultant occlusal disharmony occurred invariably.

A somewhat similar practice has been tried in more modern times, and is occasionally

conducted today. This is the practice of transplantation or autograft. It is sometimes employed for esthetic improvements in one’s “smile line,” or when two teeth have been transposed (“switched places”) congenitally. Success with this variant of dental implants has been very good especially when the teeth are relatively young and have large apices with excellent blood and nerve supplies. Results have also been good when endodontic treatment is required.

In 1947, Forginini, an Italian, concluded that a dental implant did not need to resemble a tooth root. [3] In 1962, Scialom, a Frenchman, advocated a “row of needles” (looking nothing like tooth roots) to support a prosthesis replacing multiple teeth.[4]

Probably the first form of dental implant since about 1950 and the emergence of modern dentistry was the so-called “blade” implant. These were considered endosseous (intraosseous) as they were placed into a slit which the dentist cut into the bone first. They were relatively common well past mid-1970’ and are still used by some dentists today as the implant design of choice.

Blade implants began to meet their demise after the proposals of a “tooth root implant” by Chercheve beginning in 1960. [5-8]

Up to this point, terms such as osseointegration and biointegration had never been used. When Schroeder introduced the concept of “functional ankylosis” in the 1960’s and 1970’s, the concept moved significantly closer to what we now refer to as osseointegration. [9] Osseointegration is said to have occurred when the recipient’s bone has grown “right up to” the implant and “accepts” it as natural without signs of any detectable inflammatory response or movement within the alveolus. The result is an implant that is “fused” with the host bone such that it becomes rigid and unmovable, and ultimately substitutes for the missing “tooth root.”

Perhaps the greatest recent advance has come from the work of Dr. Per-Ingvar Branemark, a Swedish orthopedic surgeon. In 1952, while experimenting with implanted devices in rabbit femurs, he discovered that after several months, the devices had become so integrated with the surrounding bone that the

expensive devices were virtually impossible to remove. Hence was born a new “rethinking” of the concepts that we now know as osseointegration. The company he formed, Nobel Biocare, has conducted and continues to conduct extensive and in-depth research into virtually all aspects of dental implants. Much has been learned about patient selection, bone quality, an implant’s location in the jaws, technique in placing the implant, the implant’s degree of biocompatibility with the host’s immune system, post placement illnesses and medications, healing time before loading, oral hygiene, and forces placed on the implant once it is loaded. Each of these factors has been researched rather extensively.

Patient selection involves both the patient himself, and also the operating dentist. The patient must have adequate levels of alveolar bone remaining and preferably the absence of greatly pneumaticized maxillary sinuses, or at least have sinuses that can be “lifted” and bone or bone augmentation procedures performed. Clearly too, the patient must have a means of paying for implants as they can be quite expensive. The patient’s attitudes toward dentistry and “foreign things in the mouth” plus his or her psychological frame of mind can also affect the overall outcome of a case. Fortunately, however, in most cases a potential implant candidate has experienced life with missing teeth for some time and has probably tried some prosthetic or restorative therapy alternative (many with numerous drawbacks), hence they will likely be more accepting of an implant supported replacement.

The “quality” of bone is equally a factor along with bone quantity in affecting the odds of success in a case. Lekholm and Zarb have proposed one system for classifying bone. [10] Type I bone is composed of homogeneous compact bone throughout the jaws. Type II bone has a core of dense trabecular bone surrounded by a thick layer of compact bone. Type III bone has only a very thin cortical plate surrounding a core of dense trabecular bone, and Type IV bone has a core of low-density trabecular bone with a thin cortical plate. Types I and II are the most favorable for implant success. Other researchers have proposed similar schemes for classifying bone quality.

Interestingly enough, Dao et al in 1993 and Köndell et al in 1988 demonstrated a lack of any direct correlation between age or sex and implant failure, but did note that osteoporosis occurs in females, over age 45, much more often than in males and when it did occur in females, it progressed much faster than in males. [11, 12] A higher quantity of bone also favors a successful implant outcome.

The location of an implant within the jaws is typically linked to varying rates of success or failure. Most literature suggests that mandibular implants have a slightly higher success rate than those placed in the maxilla by the same operator. The literature also tends to support the idea that success rates are generally better in the anterior zones of both jaws.

This is because of anatomical feature variations in the mouth and variations in bone quality as well as the location of certain anatomical structures such as nerves and sinuses. Of course, in the replacement of more than a single tooth, additional “gambles” may have to be taken with placement location in order to more properly distribute the occlusal loads.

The biocompatibility of the implant material itself has also been explored extensively. Spiekermann et al has classified all currently available implants from an immunologic standpoint into 4 groups. [13] The alloplastic materials [metals, materials of mineralogic origin, ceramics (in the broadest sense of the word) and plastic compounds] are one basic group. The metals range from pure titanium (99.9%), titanium alloys, tantalum, niobium, CrCoMo alloys, and implant-grade steel are examples. The ceramics include aluminum oxide ceramics (and may be monocrystalline or polycrystalline), calcium phosphate ceramics, hydroxyapatite ceramics, tricalcium phosphate ceramics, and glass ceramics. Interestingly, some of these have been tried in combination form. For example titanium has been used in conjunction with hydroxyapatite, tricalcium phosphate, aluminum oxide, etc. Generally speaking, the mechanical properties of metal tend to favor mechanical qualities (e.g. strength, rigidity, compression, tensile forces, and shear forces), while the biological qualities are favored more by the bioactive ceramics which appear to be kinder to

bone and soft tissues. Consequently, a metallic “core” is often coated with a more biocompatible outer surface. It is safe to say that a clear shift toward selecting titanium as a material of choice has been the most prominent trend since the 1970’s (along with “treatment” of the surfaces of implants with more biocompatible materials).

Closely related to the surface material’s biocompatibility is its texture. Titanium and other implant materials are often roughened to increase surface area in hopes of enhancing stability. Still others incorporate vents, vanes, fins, discs, etc., to also increase surface area and to enhance stability and retention. Sandblasting a surface can increase surface area by up to two or three times as much as a smooth one of identical gross dimensions. Some implant systems incorporate through and through holes in them to presumably encourage better stability as bone is presumed to grow into these spaces as healing occurs. Additionally, many systems offer implants in different lengths to take full advantage of the increased surface area, and quality and quantity of bone available. Current thinking holds that if bone conditions are favorable and permit it, the longer the implant the more stability due to greater surface area. The most predominant overall shape of implants today is a basic cylinder (often tapered) with a rounded “tip.”

The heterologous (xenogenic) materials, a second group, have a place in bone augmentation in implant surgery but are not generally used as implants themselves. Examples would be devitalized, deproteinized bone (Kiel bone chips, collagen, and gelatin).

Homologous (allogenic) materials constitute yet a third group. These are heretoplastic materials taken from one species and transferred to a different species. An example would be banked bone that that has been treated through lyophilization.

Spiekermann’s fourth group can be referred to as autologous (autogenous) materials. These are materials taken from one individual and implanted into that same individual. Examples would be the transplantation of impacted or transposed teeth, reimplantation of avulsed, intact teeth, and bone implants which are sometimes used in ridge augmentation

procedures (most often a rib or the crest of the pelvis).

Another group of factors that influence the success rates of implants relates to a patient’s psychological and physical health. Perhaps not the least in this group is aging. As noted earlier, osteoporosis (associated somewhat with aging) is a definite risk factor that cannot be altered, only perhaps retarded. Other factors such as medications (e.g. xerostomia inducing agents), metabolic and hematologic disorders such as clotting disorders and anemia may become morbidity factors for an implant patient. Certain collagen disorders, diabetes (especially type I), artificial heart valves, or patients at special risk for infection (e.g. immunosuppressive drugs) are contraindicated with implant patients. [14] From a mental health/behavioral consideration, a host of factors can compromise the prognosis for implants. Also many mental disorders are treated with antipsychotic medications many of which create xerostomia (dry mouth) which greatly increases the chance of implant failure. Various psychological/behavioral issues such as chemical dependence, depression, neuroses and psychoses can lead to poor compliance with not only systemic health issues, but poor oral hygiene and parafunctional habits such as bruxism. The initiation of smoking has been clearly linked to implant failure by a factor of about 2.5. [15, 16]

Much of what we know about techniques used in the placement of implants comes from proprietary research and as such, is made public only in the form of “recommendations” and often is used to promote specific products. Each company that manufactures implants, for example, promotes its own pre-drilling system that is unique to its own implant system and thus constitutes another way to sell products. Interestingly enough, dental implant systems differ from most other body implants in at least one significant way. Dental implant sites are prepared using an ultra slow drill (down to as few as 10 revolutions per minute) and many systems use copious irrigation while most orthopedic implants generally drill at much higher speeds. The slow rate of rotation of the dental drill seems to take the view that even slight elevations in the temperature at the

drill/bone interface will have a detrimental effect on healing and ultimate osseointegration.

Another technique factor that has helped in case selection and selecting the best sites for implants deals with various forms of imaging. The tomographic technique in x-rays, CT scans and magnetic resonance imaging (MRI) have been most useful in assessing bone quantity as well as bone quality. Recent advances enable the dentist to use information obtained from CT data to construct a three dimensional model of the jaws as an aid in implant placement site selection. [17] Many implant systems call for drill guides and sometimes systems employ custom templates to insure parallelism in drilling access holes for multiple implants.

Once placed, dental implants are rarely loaded immediately whereas with orthopedic implants (such as a knee or hip) are often loaded the same day or the next. This, in part, is due to the fact that most dental prostheses must be hand constructed in a dental lab which may take weeks. Also, many implant pioneers advocate a healing time of up to several months to allow the bone to “heal in” to the implant surface. As a result, each system has its own “healing cap” which goes over the implant immediately after it has been placed in bone but before it is sutured under the gingiva.

The one area of dental implants which has received the least scientific scrutiny is the effect of the shape and configuration of the implant body itself. Basically there are blade shapes (e.g. Biolog<sup>®</sup> and Oratron<sup>®</sup>) and cylindrical ones (e.g. TPS<sup>®</sup>, Lederman<sup>®</sup>, Brånemark<sup>®</sup>, ITI Bonefit<sup>®</sup>, IMZ<sup>®</sup>, Integral<sup>®</sup>, and Fralit<sup>®</sup>). The cylindrical shapes are often tapered (e.g. Fralit<sup>®</sup>) while others are straight (e.g. IMZ<sup>®</sup> and Integral<sup>®</sup>). Some have projecting “threads” or “vanes” (e.g. TPS<sup>®</sup>, Ledermann<sup>®</sup>, Brånemark<sup>®</sup>, ITI Bonefit<sup>®</sup>, and Fralit 2-step<sup>®</sup>). Each system has its own surface treatment also, but for this consideration these matters are considered under the subjects of interface and coatings.

Undoubtedly at the proprietary level, much research has focused on shape and configuration but little open research is available. It seems quite likely that marketing design and user friendly features are driving the shape and configuration as much as anything.

Clearly, all shapes have met with success as well as failures, but the question remains; can some configurations work better than others when it comes to dental type loading forces? And are some shapes and configurations more successful in certain locations within the mouth or perhaps better suited to different bone qualities? More research into these areas is badly needed.

## Modern Dental Implants

Fairly recently a much needed focus on dental implant design was published essentially raising the need for more evidence based consideration of the design and shape of the implant body. [18] This direction seems to offer considerable promise to reveal much about optimal implant selection for specific situations and locations within human jawbones. In a retrospective review of existing studies, for example, they noted a rise in failure rates of implants shorter than 10 mm in length. [19] Similarly, in a rabbit model based study, it was reported that better bone to implant contact occurred around screw-shaped implants than with “double cylinder” shaped and “T” shaped ones. It was also reported that the bond strength was increased when a rough implant surface was in contact with the bone rather than a smooth one.[20]

A recent trend has been to focus more attention to the role of chemical microbiological factors in osseointegration. This base of knowledge can only enhance our understanding of the role that implant configuration plays. Treating the prepared implant site with plasma rich proteins just prior to insertion of the implant has been suggested to be one factor in increasing the likelihood of host acceptance. Similarly, various growth factors are becoming the focus of numerous researchers, some in innovative ways. One example is the harvesting of live cells during the preparation of the implant site, enrichment of them with plasma rich proteins and then the treatment of the site and the implant itself prior to insertion. [21]

Still other researchers are focusing on ways to harvest and measure various crevicular fluids such as cytokines (generally) and interleukins (more specifically) as a way of monitoring the relative health or disease of an implant site once the implant has been placed.

[22] All of these trends strongly suggest that implants have gained a premier role in dentistry . It is suggested here that the much overlooked role of the shape and configuration of dental implants should be revisited systematically. We clearly know that size, shape, length, surface texture, and composition have something to do with implant outcomes, but just what is optimum for any given prospective implant site? At this juncture the practitioner is largely lacking a body of evidence based research.

## CONCLUSIONS

The purpose of this paper is to call attention to the fact that while implantology has made enormous strides, a potentially huge consideration has been largely ignored. Only recently have researchers began looking at factors such as the pitch on various screw type dental implants, the shape of the vane itself (e.g. square, round, v-shaped), the number of threads per centimeter, etc. The design of the implants on the market currently has been largely the product of the marketing divisions of supplying companies rather than systematic research. Clearly much of their focus is in providing a user friendly product to the practitioner (including start up costs of the initial placement kit) at a reasonable cost, but this is part of marketing and not focusing on thoroughly researched outcomes. The need for a body of evidence based implant knowledge is urgently needed.

Is there any one design shape that is optimal for all applications? It is clear that the answer is emphatically "no!" It is highly likely though that some designs are more suited for certain kinds of loading forces than others. We just haven't come to an agreement on what those are. With further research and review of existing data, we should begin to develop some principles to guide the practitioner in choosing the optimal design for a specific application.

Future implant research may involve animal model studies utilizing split-mouth techniques or human clinical studies under closely controlled and monitored conditions. It seems reasonable to expect that a closer research dialogue with other related fields, such as orthopedics, will lead us to faster and more economical answers. Figuratively speaking, we

have successfully launched the boat, but have we put the plug in the drain hole?

## ACKNOWLEDGEMENTS

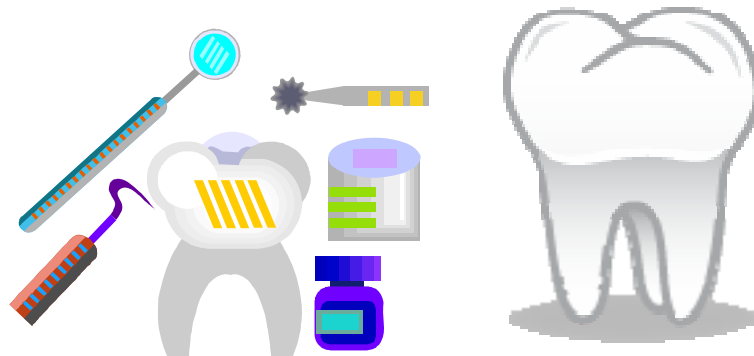
I wish to thank the Department of Diagnostic and Clinical Health Sciences of the School of Health Related Professions within the University of Mississippi Medical Center for their support and encouragement to pursue this review.

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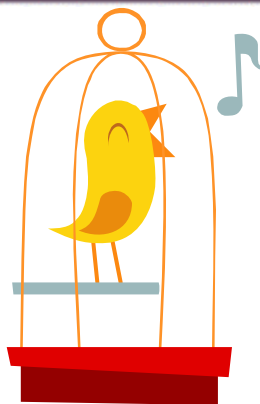
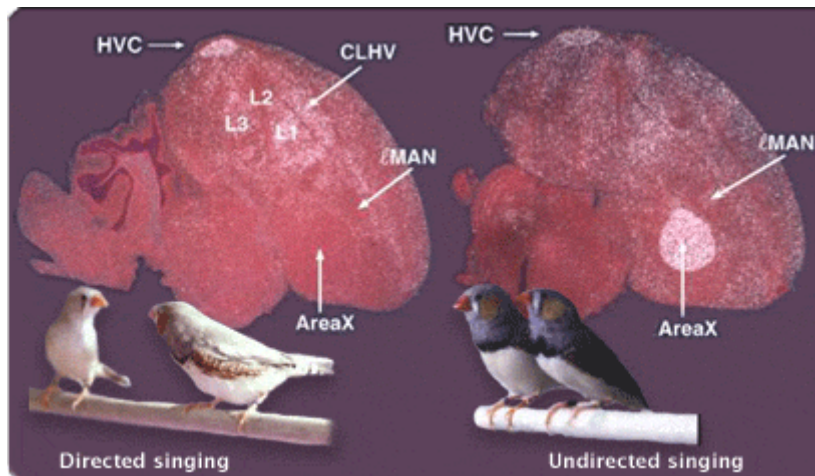
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