Leveraging Data Analytics and Scalable Information Technology Tools to Deliver a Culture of Care during an Emergent Natural Disaster

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ABSTRACT

Rice University's Culture of Care represents a commitment to ensuring that all are treated with respect, compassion, and deep care. Rice leveraged information technology (IT) to deliver its Culture of Care, in responding to Hurricane Harvey. IT tools were used to gather key information on Rice's over 12000 community members. These data were fused with structured university data, enabling data-driven disaster response, with actionable information pushed to local managers. Our successful communication and response programs were all driven by the data analyses.

Key Words: hurricane, disaster response, public health practice

INTRODUCTION
Place and Time
Hurricane Harvey was the most significant tropical cyclone rainfall event in US history, making landfall in Texas on August 26, 2017, and resulting in 300000 confirmed flooded structures.[1] During and following Hurricane Harvey, Rice University launched a data-driven disaster response effort to support the safety and recovery of the 12000 faculty, staff, and students that make up the Rice community.

Purpose
In 2010, the Rice University Dean of Undergraduates, John Hutchinson coined the term 'Culture of Care' to describe an environment where all community members are treated with respect, compassion, and deep care. Since then, Culture of Care has been embraced by the entire university community as a core value. Rice's goal throughout this data-driven response effort was to continue to deliver on its Culture of Care in responding to Hurricane Harvey. Using a rapid data-driven decision-making process, based on limited, but high-resolution information gathering, led to a well-calibrated response. That response: (1) addressed the real needs of our community; (2) efficiently allocated finite resources; and (3) implemented real-time response programs within three days of Harvey making landfall.

METHODS
Immediately after Harvey made landfall, the university launched a multiday data gathering, analysis, and reporting effort broken into four primary thrusts: data collection, data fusion, data analysis, and communications and outreach.

Data Collection
Rice community members were asked to complete a 90-second needs assessment, regardless of whether they had experienced damage. In addition to collecting residential address, the needs assessment asked whether the respondent had: children in the house, power, internet connectivity, housing damage, or vehicular damage. Rice implemented three additional targeted surveys: a housing matching tool, a childcare survey, and a carpooling matching tool.

Data Fusion
Many analyses were only possible when survey results were combined with existing static, and structured, university datasets. The survey data were fused with human resources data (part-time/full-time, hourly/salaried, emergency contact information, etc.), on-campus location of employment, and the registrar's data on who was teaching every course offered during the Fall 2017 semester.

Data Analysis
The Harvey Analytics Response Team (HART) used modern IT tools, including: ArcGIS, Pandas, R Studio, Jupyter, Slack, and Box to conduct:

1. *Response Rate Analysis*: Needs assessment response rates, disaggregated to local management units.

2. *Course Impact Analysis*: Impact of Hurricane Harvey on teaching faculty and enrolled students at Rice University.
3. *Local Management Unit Status Updates*: Daily reports delivered to local managers on those who had (a) reported some kind of issue (e.g., home flooding, vehicle damage, evacuation), (b) reported no issues, and (c) not yet responded.
4. *Geospatial Analysis*: geographical visualization of Hurricane Harvey's impact, and real-time updates on those affected by evacuation orders.

Communication and Outreach

The core of the outreach efforts was a central website that hosted the surveys and thrice-daily updates on university status. A phone bank was created, staffed by bilingual student volunteers. Volunteers focused on gathering responses to the needs assessment from members of the Rice community that had not yet responded, and sending relief teams to help. In total, more than 1800 students volunteered on relief teams throughout Houston.

RESULTS

7276 Needs Assessment responses were received out of 12127 total members of the Rice community, a 79% response rate, given that the ~2926 students and staff who lived on campus were specifically instructed not to respond to the survey. See Figure 1.

Insight #1: Uneven Survey Participation

A high response rate to the needs assessment was crucial to planning Rice's response to Harvey. We operated on the principle of collecting data centrally and then pushing them locally.

Initial response rates were significantly lower among hourly employees. The phone bank was used to call hourly employees who had not yet responded. As a result, response rates for the administration unit, which contains the majority of hourly staff, rapidly increased from 22.5% after the first day to a final response rate of 71.3%.

Insight #2: Keep Faculty, Staff, and Students out of Closed Buildings

The fused datasets allowed us to link faculty, graduate students, staff, and undergraduate students to the locations on campus where they worked. We posted status reports on buildings and individual floors and laboratories generated by Facilities. These 'eyes in the field' reports on the central website reassured community members and kept them out of closed buildings.

Insight #3: Home Displacement

The Housing Matching Tool collected information on people who were offering, or in need of, temporary housing. All requests for temporary housing were fulfilled, and to our knowledge, no members of the Rice community spent time in any of Houston's shelters. This approach built a deeper sense of community at Rice, and preserved the scarce city shelter resources for those most in need. The needs assessment data also provided the basis for a grant and loan program created for Rice community members dealing with home and vehicle damage.

Insight #4: Need for Responsive Intelligence

As rain continued to fall in Houston, areas experiencing flooding changed rapidly. For example, on September 1, 2017, the City of Houston issued a mandatory evacuation order due to reservoirs that were over capacity. Geospatial tools enabled quick identification of members of the Rice community impacted, as well as their status as reported in the needs assessment. We generated a visual map and summary reports on the community members affected (see Figure 2), prioritizing outreach to these individuals as their circumstances rapidly changed.

Insight #5: Child Care

Multiple school districts announced that all schools would close for at least the week following Harvey. Rice's response was three-fold: (1) Encourage people to handle childcare needs through community ties; (2) ask departments to handle childcare locally, using university spaces with required supervision by adults trained on Rice's standard 'working with minors' guidelines; and (3) stand up of a small childcare facility supported by an external contractor for parents unable to make other arrangements.

Insight #6: Vehicle Damage

The university needed strategies for getting people to work and to class. The carpooling matching tool was created to collect both requests for, and offers of, rides to campus. Like the housing matching tool, those able to provide rides were matched with those needing rides, informed by location.

Insight #7: Teaching Faculty were Impacted

The list of faculty reporting housing or vehicle damage, along with those who had not responded at all to the needs assessment, was intersected with course information from the registrar. This information was put into tailored reports for local managers. As a result, all but two sections of one course resumed on September 5, 2017, with either the original instructor or through 'lean-in' from a departmental colleague.

Insight #8: Regular Communication is Key

On August 27, 2017, we began a process of issuing emergency updates three times per day at about the same time each day, to create a clear expectation that the latest information would be forthcoming at known times. A rapid feedback loop between communication, services, and policy was very important for maintaining the confidence of the community. One email

FIGURE 1

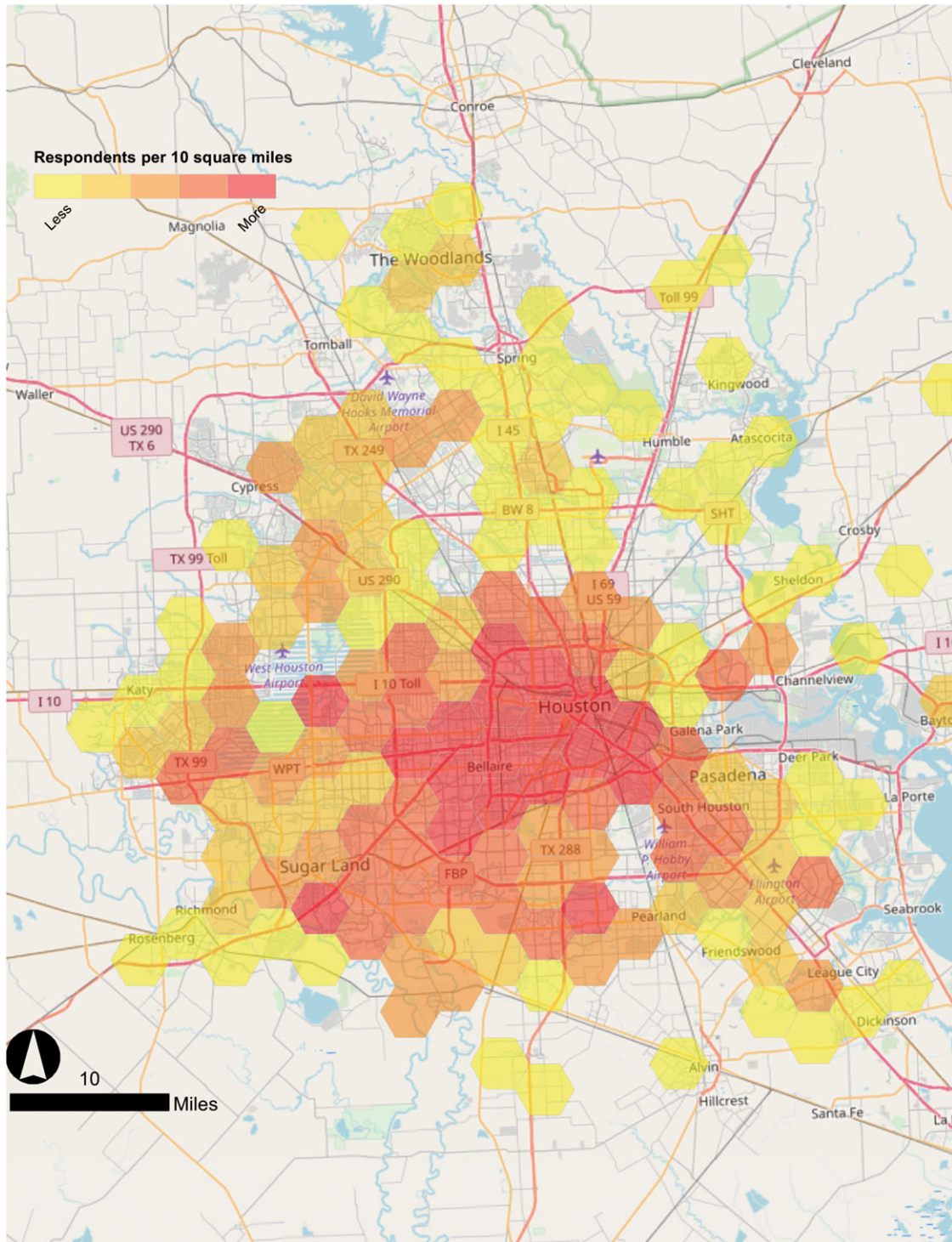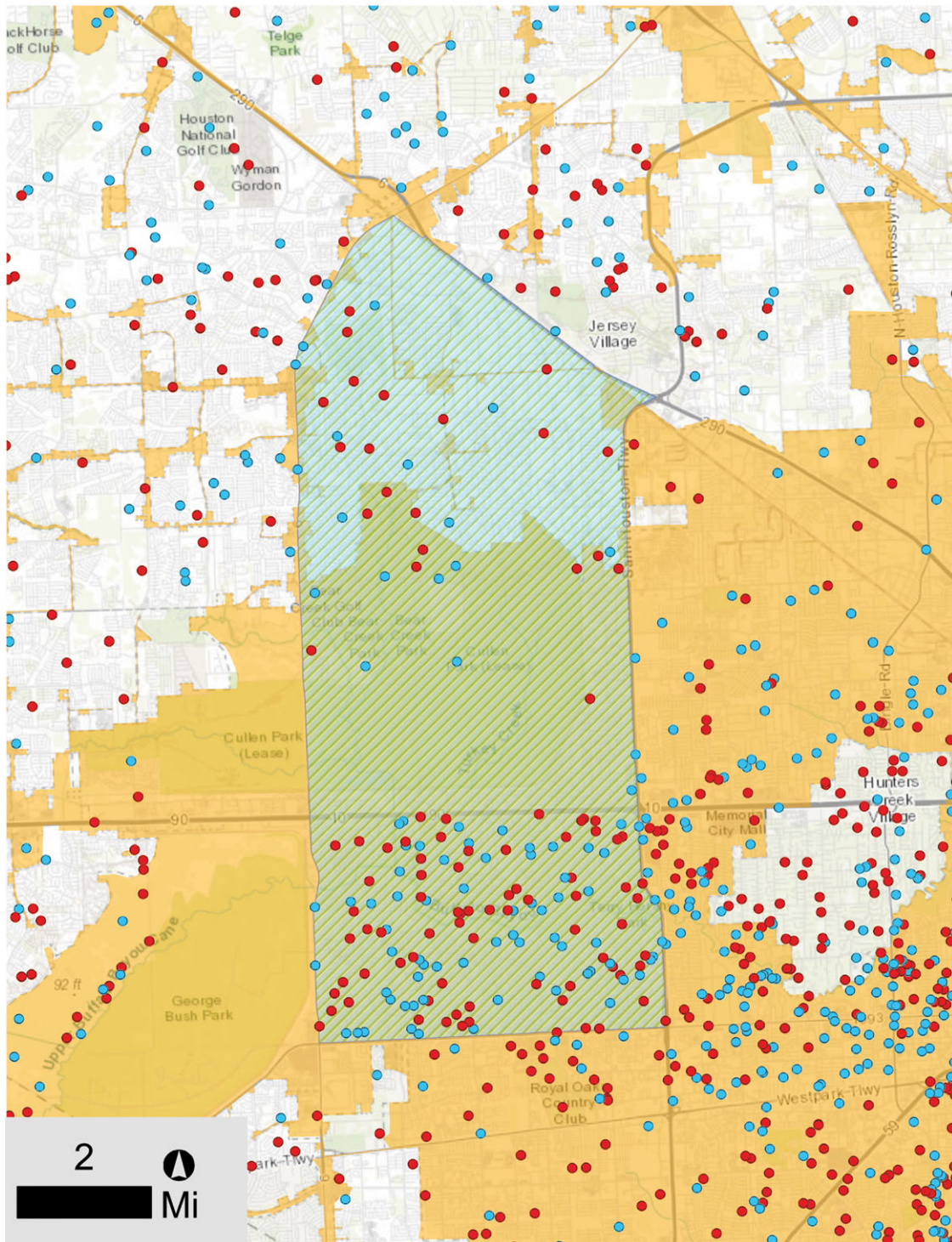Geographic distribution of responses to the Needs Assessment.

FIGURE 2

Area covered by a mandatory evacuation order issued by the City of Houston on September 1, 2017.

Located immediately east of the Addicks-Barker Reservoirs, this evacuation area is ~5 miles east-west by ~12 miles north-south. Green stripes indicate the mandatory evacuation area; orange indicates areas that lie within the City of Houston boundaries; white indicates areas that lie in Harris County, where Houston is located. Blue dots represent Rice community members who had already responded to the Needs Assessment, and red dots indicate those who had not yet responded.

to the crisis management team post-hurricane expressed: "The updates were personal and that's what made them special." Interestingly, only a limited slice of communication was directed at individuals, but the fact that the community-wide messages spoke to the circumstances that community members were experiencing made the updates feel personal.

DISCUSSION

This technology-centric response has only become possible within the last few years, as web and analytics technologies have evolved, and their integration into organizations and our society has improved.

While we now have a set of tools ready to deploy in future natural disasters, we are still working to address problems with institutional data systems that were identified during the hurricane. The improved business intelligence enabled by these tools helps in non-disaster situations as well.

We believe our four-step workflow of (1) data collection, (2) data fusion, (3) data analysis, and (4) communications and outreach is flexible and general enough to be applied at other institutions during natural disasters. Below, we enumerate suggested preparation for each step of the workflow:

1. *Data Collection*: Identify the channels through which you are and are not prepared to automatically and manually contact members of the organization. Identify how they might bias your sampling of the organization.
2. *Data Fusion*: Identify the static datasets available and how they can be centralized. Pay attention to datasets that allow you to localize and contact members of the organization. Preemptively centralize identified datasets.
3. *Data Analysis*: Identify who in the organization has the requisite analytical skills. You may also explore automated business intelligence and visualization solutions.
4. *Communications & Outreach*: Prepare and communicate a centralized website to be used in disaster response scenarios. Identify channels for communicating with your entire organization. Ensure you have contact information for sub-organizational leads and communicate the expectation of local action to them.

We acknowledge that the success of our approach was dependent on the ability of Rice community members to access either internet or cellular services. In the face of natural or manmade disasters that wipe out both types of services, the approach we took would have had to be substantially modified. In many ways, our communication strategy was successful because of existing goodwill between centralized and local units. As is often the case, some of the most important things one does in an emergency are a culmination of everything done in the three years leading to the emergency. A reservoir of goodwill and trust is invaluable in these circumstances. Rice's Culture of Care is designed to build that reservoir.

CONCLUSIONS

Our approach emphasized development and deployment of IT-based tools to support decision-making during and after Hurricane Harvey. Of importance, however, was the emphasis on rapid collection of a small set of the most critical data. Good communication was the bedrock of our efforts to deliver Rice's Culture of Care.

About the Authors

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