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Measuring Successful Disaster Recovery

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Disaster recovery involves a delicate balance between mitigating risks posed by future hazards and acquiescing to the desire of the community to return to normal. Even the best plans and policies put forth under such conditions often do not address all factors that are critical for successful recovery. If there are no plans, it becomes much more difficult to assess a community's recovery progress over time. In communities lacking robust planning capacity, metrics that characterize a community's baseline and post-disaster status may serve as a roadmap to inform the best use of limited resources and focus energy and attention where it is most needed. To assist with this, a disaster recovery tracking tool comprised of 79 metrics was developed and tested to determine if it could be used to characterize recovery progress, identify problems with recovery, and support proactive recovery planning to improve future recovery and resilience.

Keywords: disaster recovery, metrics, natural hazards, longitudinal assessment

Measuring Successful Disaster Recovery

What is a "successful disaster recovery" and how do we know if it has been achieved? While these are fundamental questions, we currently do not have an empirically-derived means to assess if they have occurred. This identification and validation of standards and metrics for assessing the effectiveness of recovery efforts has been identified as a major challenge by the National Academies of Sciences (National Research Council 2015). Both practitioners and researchers need longitudinal, systematically collected, shared data on recovery to improve recovery planning, and subsequently, community resilience to future disasters. As one approach to address this need, a disaster recovery tracking tool was developed by the University of North Carolina's Coastal Hazards Center of Excellence. The web-based tool, available at trackyourrecovery.org, provides 79 metrics, organized within 4 themes and 10 focus areas, for tracking recovery progress. Themes, focus areas, and metrics, generally aligned with the National Disaster Recovery Framework's (NDRF) recovery support functions and core capabilities, were identified as part of an 18-month long process that included a literature review, recovery plan review, case studies, key informant interviews, and focus groups (Dwyer and Horney 2014; Horney et al. 2016). The metrics are intended to assist communities in developing a strong factual foundation before the occurrence of a disruptive event and providing a starting point for high quality recovery and recovery planning.

Disaster recovery can generally be defined as "the differential process of restoring, rebuilding, and reshaping the physical, social, economic, and natural environment through pre-event planning and post-event actions" (Smith and Wenger 2007). Recovery from disasters is one of the five mission areas of the Federal Emergency Management Agency's (FEMA) National Planning Frameworks, along with prevention, protection, mitigation, and response (U.S. Department of Homeland Security 2015c). Specifically, the NDRF provides a context for how the "whole community," including nongovernmental organizations and other community-based groups, such as community foundations and long-term recovery committees, can work together to restore and revitalize communities after disasters (Smith 2011; Smith and Birkland 2012). Working together, a whole community approach to recovery has the potential to build a set of adaptive capacity and community resilience to future disasters (Norris et al. 2008). A resilient community can end the recovery process with more resources, competence, and connectedness than it had before the disaster (Saul and Landau 2004), and may ultimately recover from future disasters so effectively that recovery is no longer a prelude to a future disaster, since systems will have the intrinsic capacity to adapt to hazards (Manyena 2006).

Although disaster recovery planning is recommended to occur before the onset of a catastrophic event, recovery plans are generally developed in the wake of a disaster (Topping and Schwab 2014). Post-disaster recovery plans are likely developed under conditions of high uncertainty, with decisions made with little time for prolonged deliberation (Olshansky and Johnson 2010). Given the complexities governing community recovery planning, it is not surprising that this phase of the disaster management cycle is the least-understood, because conventional planning practices that deal with shaping community growth and development are not fully suited for dealing with decision making under conditions of high uncertainty (Topping and Schwab 2014; Berke and Lyles 2013). To support the development of high-quality, pre-disaster recovery plans, practitioners need useful and validated metrics to measure and monitor how well their community is recovering from a disaster over time. Ideally, these metrics are part of a pre-disaster recovery plan that includes each of the main planning principles (e.g. goals, fact base, and policies) and has been developed with input from local stakeholders and adopted by a proactive governmental organization with resources dedicated for implementation, monitoring, and evaluation. However, relatively few communities in high risk areas such as the U.S. Atlantic and Gulf Coasts have stand-alone pre-disaster recovery plans, and many lack the capacity to develop one of high quality (Berke et al. 2014). Without effective pre-disaster recovery planning, existing data and information may not be leveraged effectively to inform decision-making during recovery (Spiekermann et al. 2015).

To further explore the usefulness of the metrics in characterizing disaster recovery progress in impacted communities, we gathered baseline and post-disaster data for six disasters that affected communities in Texas between 2008 and 2013.

METHODS

Study Sites

The six disasters included in this study were selected using the following criteria: 1) variation in disaster type and community context for improved generalizability of findings; 2) variation in stages of the recovery process to help understand appropriate time frames for measurement of various metrics; and 3) the ability to control for state-level effects and more effectively isolate and study local response and recovery measures. The type and magnitude of these disasters varied, and cases include two rural counties, two small towns, and two cities with variations in racial and ethnic compositions and socio-economic characteristics (Figure 1).

Metrics and Data Collection

Baseline data was considered to be any information available prior to the occurrence of the disaster, while current status data was information reported following a disaster event. By its nature, the "current status" is continuous, may change depending on the amount of time that has passed since the event, and can be collected at multiple points of time to determine trends in community recovery. The 79 metrics in the disaster recovery tracking tool were used to document baseline pre-disaster conditions and ongoing (current) post-disaster recovery status for each of the six disasters. The focus areas and associated metrics included in each theme provide a multi-faceted perspective of the unique dynamics of each disaster recovery.

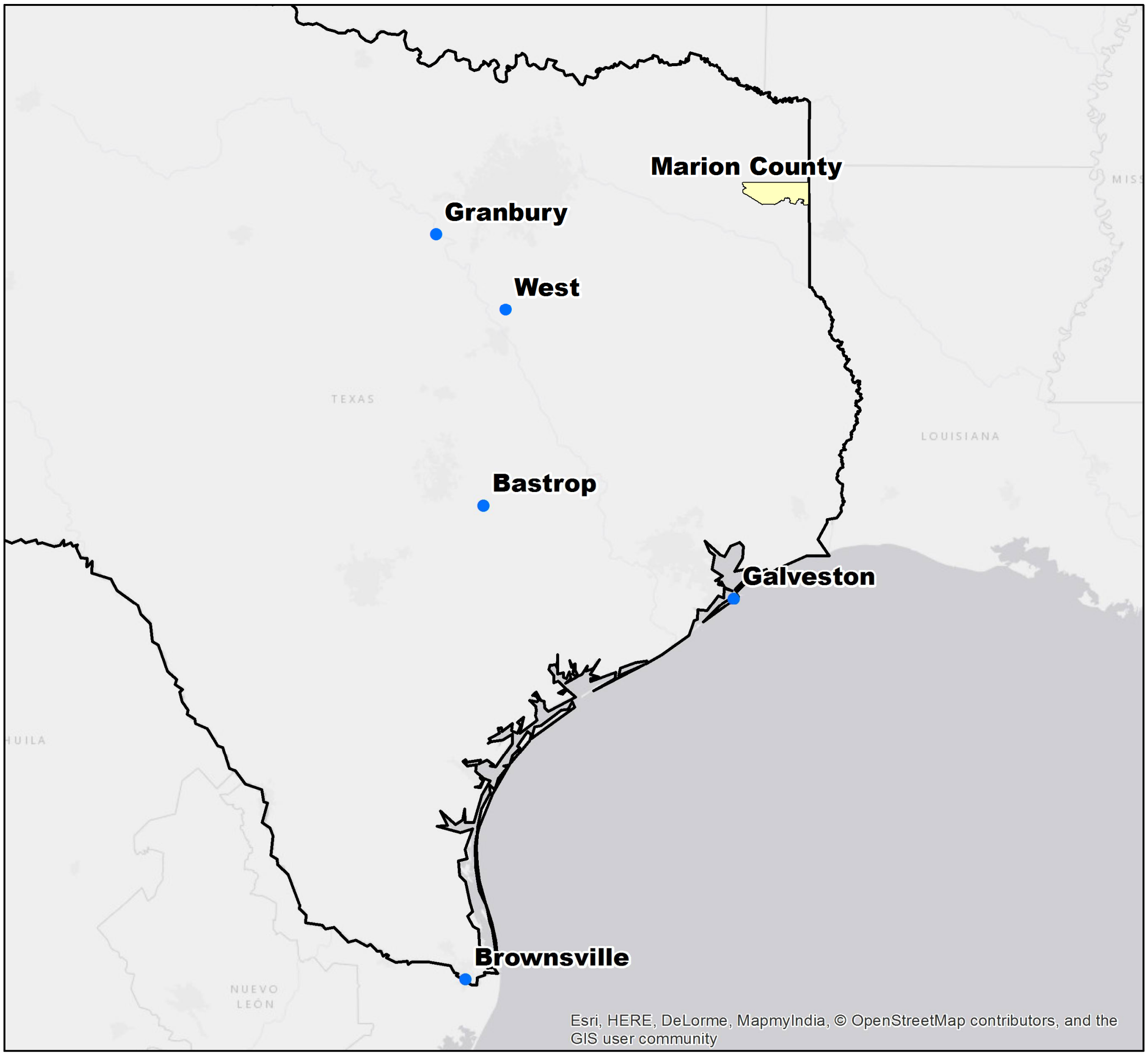

Figure 1. Map of Six Disaster Case Study Locations, Texas, United States

To gather baseline data for the six disasters, the team first collected and examined existing planning documents for each community including comprehensive/master plans, historic preservation plans, FEMA disaster declarations and assistance data (dollar amounts are adjusted annually based on the Consumer Price Index), economic development plans, strategic plans, and hazard mitigation plans. Information sources used to populate baseline data included local planning documents, the community or county's municipal website, local Chambers of Commerce, academic studies, media reports, and the U.S. Census (e.g., the American Community Survey and the Survey of Business Owners). When identified, baseline data for a recovery metric was recorded both within an Excel spreadsheet and in the online disaster recovery tracking tool, along with the data source. The data used to retrospectively estimate the baseline condition varied with the occurrence date of the disaster and the reporting of publically available data (i.e. reporting years for the U.S. decennial census and the American Community Survey).

Current status data was gathered using a variety of sources as well. When available, the most recent U.S. Census data (American Community Survey 5 year estimates, 2009-2013) were used to populate metrics. Empirical data sourced from electronic media reports and internet databases was derived using a three-step method described by Chang et al. (2009). Relevant non-academic articles were located and compiled from online databases and search engines using combined inquiries of Boolean search terms (e.g., recovery, rebuilding, restoration, funding, shelter, and housing) and disaster descriptors. Content analysis was subsequently performed to identify available current status data; identified metrics and source data were recorded in an Excel spreadsheet and transcribed in the disaster recovery tracking tool. Finally, the collected information was reviewed for completeness and a final media search was performed in an attempt to address notable gaps.

RESULTS

Although a large number of sources were reviewed in an attempt to populate the 79 metrics, our searches failed to produce a complete dataset for any of the six disasters. The completion rates for baseline and current status metrics collected in each case study are shown in Table 1. The average rate of completion for baseline metrics was 27.6% (n=21.8) with a range of 16.5% (n=13) to 49.4% (n=39). The overall current status completion mean was slightly lower at 23.0% (n=18.2) with a range of 20.3% (n=16) to 25.3% (n=20). Data was most frequently found for metrics in the households (baseline = 25%; current status = 65%) and population characteristics (baseline = 30%; current status = 92%) focus areas. No data was found for the metrics in the cultural sites and resources or natural resources focus areas.

Table 1. Completion rates of baseline and current status metrics collected by disaster

Disaster	Baseline Metrics % (N)[a]	Current Status Metrics % (N)[a]
Granbury, TX, Tornado (May 05, 2013)	49.4 (39)	21.5 (17)
West, TX, Fertilizer Plant Explosion (April 17, 2013)	16.5 (13)	20.3 (16)
Bastrop County, TX, Wildfires (September 4, 2011)	27.8 (22)	25.3 (20)
Marion County, TX, Wildfires (August 30, 2011)	25.3 (20)	24.1 (19)
Galveston, TX, Hurricane Ike (September 13, 2008)	25.3 (20)	22.8 (18)
Brownsville, TX, Hurricane Dolly (July 23, 2008)	21.5 (17)	24.1 (19)
Mean	27.6 (21.8)	23.0 (18.2)

[a] Completion rates were calculated by dividing the number of metrics for which data could be located from the total number of metrics evaluated (N=79).

Granbury, Texas Tornado

On May 15, 2013, the city of Granbury, Texas experienced an outbreak of severe weather with nineteen tornadoes, including one EF-4 and one EF-3. As a result of this event, 171 residential structures were severely damaged or destroyed and 513 homes were affected. In total, 54 individuals were injured and six residents of the Rancho Brazos subdivision died (National Climatic Data Center (NCDC) 2013).

Nearly half of the target baseline metrics were identified for Granbury (n=39, 49.4%), which was the highest completion rate of all case studies. Current status metrics were not as readily available, though 21.5% (n=17) were fulfilled. Much of this data was gathered from an ongoing, in-depth study of the community's recovery, conducted by the Texas A&M Hazard Reduction and Recovery Center (HRRC; 2014). Granbury possessed many publically available planning documents, which represented a notable contrast to many of the other communities, where data was generally more difficult to uncover. The population of Granbury increased between 2010 (n=7,978) and 2014 (n=8,266), though the city remained the second smallest of the areas included in this study. In the same period, unemployment rates increased from 3.4% to 7.9%, though the population living in poverty decreased from 10.8% to 9.7%. Nearly all (97.5%) of the small businesses located in Granbury during the tornado were impacted. Despite $250 million in economic losses, the community did not receive any federal disaster assistance.

West, Texas Explosion

The fire and subsequent fertilizer plant explosion in West, Texas on April 17, 2013 damaged approximately 350 homes, 142 of which were destroyed (Clements 2013). Approximately 210 individuals were injured and 15 people died as a result of this disaster (National Institute for Occupational Safety and Health 2014; American Red Cross 2014). Due to the explosion, an emergency was declared for McLennan County on April 19, 2013 (FEMA 2015f). Although the initial request for a major disaster declaration (submitted May 16, 2013) was denied (FEMA 2015e), a major disaster was declared (EM-3663) in McLennan County on August 2, 2013 following an appeal (FEMA 2015j). A major disaster declaration gives the federal government the authority to provide financial assistance to state and local governments, families and individuals, and certain nonprofit organizations.

The completion rates for baseline metrics (n=13, 16.5%) and current status metrics (n=16, 20.3%) were the lowest of all case studies. While the availability of the current status data was limited by the recent date of this disaster, this would not explain the scarcity of baseline metrics. This case was notable in that the West Foundation was created four months after the disaster to coordinate financing of long-term recovery efforts. The damages sustained by surrounding homes and businesses from this disaster were estimated to be more than $100 million (WJLA 2013). West is also unique given the relatively concentrated area of disaster impact and the limited types of federal disaster relief. Media reports indicated residents' frustration with a perceived slow pace of recovery in the city; responsibility for these lags was often assigned to inexperienced local non-profits managing the financial distributions to those in need (Thompson 2014). Significant challenges noted by Frank Patterson, Emergency Manager for McLennan County and Waco City, included lack of coordination among first responders, insufficient communication between command staff and federal agencies, delayed inclusion of public health officials, and inadequate media relations and control (FEMA 2015b).

Bastrop, Texas Wildfires

The Bastrop County, Texas fire, which ignited on September 4, 2011, was the most destructive wildland urban interface wildfire in Texas history. Exacerbated by prolonged conditions of drought, unusually high temperatures, and the windy remnants of Tropical Storm Lee, this wildfire ultimately burned 34,068 acres of land and destroyed 1,669 homes and 40 industrial buildings (NCDC 2011; Nielsen-Gammon 2011; Jackson 2015; Office of the State Climatologist 2013). Additionally, two lives were lost as a result of this wildfire (NCDC 2011). A fire management assistance declaration was made on September 4, 2011 (FEMA 2015c) and a major disaster declaration (FM-2958) was approved on September 9, 2011 for Bastrop County (FEMA 2015j).

The current status metric completion rate for this area was the highest of all case studies (n=20, 25.3%) and the baseline rate was the second only to Granbury, TX at 27.8% (n=22). Bastrop County is a suburb of Austin, Texas, and has a relatively high median income compared to other areas impacted by wildfires during the summer of 2011. In 2013, 14.1% of residents were classified as living in poverty and 7.7% were unemployed. The estimated losses in 2011 were $325 million and disaster assistance exceeded $120 million in 2015. To mitigate the risk of future wildfires, the Bastrop County Office of Emergency Management has initiated a fuel reduction project with an estimated cost of $3.7 million (U.S. Department of Homeland Security 2015b). Additional assistance from the Bastrop County Long Term Recovery Team has included screening for benefit eligibility, counseling, dissemination of information, and case-management (U.S. Department of Homeland Security 2015a)

Marion County, Texas Wildfires

From September 13, 2011, to September 18, 2011, the rural area of Marion County, Texas, was afflicted by a wildfire. While no injuries or deaths were attributed to this event, 2,695 acres of land were burned and 2 homes were destroyed (NCDC 2011). The Marion County wildfire was a subset of a larger event referred to as the Texas Bear Creek Fire, which received a fire management assistance declaration on September 6, 2011 (FEMA

2015d). A fire management assistance declaration provides funds to assist with ongoing fire management to control wildland fires before they become major disasters.

Approximately one quarter of the target baseline (n=20, 25.3%) and current status metrics (n=19, 24.1%) were identified for this area. Current status metrics from 2013 indicate that the population size (n=10,439) and the percentage of the population living in poverty (8.6%) decreased from baseline levels reported in 2010 (10,546 and 23.2%, respectively). Although over 800 businesses closed as a result of this disaster, the unemployment rate decreased from 11.0% in 2011 to 8.6% in 2013. The estimated disaster assistance received was greater than $120 million in 2015; however, the Marion County fire data highlights a key challenge of utilizing FEMA disaster declaration data for research purposes, which is typically distributed by disaster. As Marion County was only one of thirteen counties included in the disaster declaration (FEMA-4029-DR), it is difficult to discern the exact distribution of FEMA funding in each county since totals for individual and public assistance are reported in aggregate, which may skew results.

Galveston, Texas Hurricane Ike

Hurricane Ike made landfall near the urban cluster of Galveston, Texas on September 13, 2008 as a category 2 storm on the Saffir-Simpson scale and a wind speed of nearly 110 mph (95 kt) (Berg 2009). Approximately 17,000 homes in Galveston City were damaged, with estimated repair costs ranging from $135 million to $850 million (Urban Land Institute 2009). Using active mortality surveillance, Zane and others (2011) identified 74 deaths in Texas that were directly, indirectly, or possibly attributable to Ike, 17 of which occurred within Galveston County. An emergency declaration was made on September 10, 2008 (FEMA 2015i), which was followed by a major disaster declaration on September 13, 2008 (FEMA 2015h). The Galveston Community Recovery Committee, composed of over 300 residents, was established the following month by the Galveston City Council to develop a long-term recovery plan; on April 9, 2009, a final plan was completed and approved (Urban Land Institute 2009).

The completion rates of baseline and current metrics identified for Galveston were 25.3% (n=20) and 22.8% (n=18), respectively. The estimated population in 2008 was 52,821, 23.9% of whom were classified as living in poverty. Comparisons between baseline (2008) and current status data (2013) indicate a reduction in population size (n=48,352) coinciding with a 1.1% increase in the poverty and a 4.0% increase in unemployment. The economic losses resulting from Hurricane Ike were estimated at $30 billion (FEMA 2008). Despite the large amount of disaster assistance received (>$4.5 billion as of 2015), Galveston continues to struggle with some indicators of recovery, including increasing poverty and unemployment, as well as a loss of approximately 10% of the total population, many of them low-income minorities (Van Zandt and Peacock 2012; Van Zandt et al. 2012) .

Brownsville, Texas Hurricane Dolly

Hurricane Dolly made landfall in the Lower Rio Grande Valley near Brownsville, Texas, in July 2008, as the second named storm of the hurricane season. Some affected areas in the region received up to 18 inches of rain. Total damage estimates to households and businesses were difficult to obtain. A major disaster declaration was made on July 24, 2008 (FEMA 2015g).

The respective completion rates of baseline and current status metrics for Brownsville were 21.5% (n=17) and 24.1% (n=19). The 2013 current status metrics of population (175,210), unemployment (10.2%) and population living in poverty (34.5%) were increases from baseline data collected in 2008. Substantial economic losses were recognized in the agricultural sector, with the loss of cotton and sorghum likely exceeding $1 billion. Despite a lack of data on housing metrics, Brownsville is especially notable in that housing recovery from Hurricane Dolly was still being discussed in the national media as late as 2015, as the first homes built under the community's Rio Grande Valley Rapid Housing Recovery Pilot Program (RAPIDO), a local organization aimed to serve disadvantaged residents, for housing recovery were completed (Simone 2015). Additionally, Brownsville is likely the community with the least capacity to plan for a successful or high-quality recovery due to limited resources and high levels of poverty, unemployment, and socially vulnerable populations (Peacock et al. 2011; Ruin et al. 2008).

DISCUSSIONS

Using both the results of the data collection for the six Texas disasters, other existing research, and the subject matter expertise of the team, this research attempted to answer a number of questions and evaluate the ability of the proposed recovery metrics to fill gaps in what is currently understood about how disaster recovery is approached and how it unfolds.

Using Metrics to Characterize Recovery Progress

The concentration of vulnerable groups within a community may influence post-disaster recovery and resilience (Wickes et al. 2015). Individual-level metrics can be used to identify vulnerable groups in disaster-affected communities, which can aid in developing effective strategies to address inequitable needs. In the present study, the U.S. Census and other sources of regularly collected and reported information proved to be reliable sources of population and housing data for each of the six communities evaluated. The use of longitudinal data is especially important when evaluating the social impacts of disasters, as these can arise over an extended period (Lindell and Prater 2003). While not static across all disasters, there are a number of cases where metrics can help identify and isolate factors in a community. For example, current status metrics gathered in 2013 for Brownsville, Texas indicate that a third (35.7%) of the population had limited English-speaking abilities. This knowledge could be interpreted by local governing bodies to imply that information related to disaster recovery should be presented in multi-lingual formats.

Individual-level metrics collected at multiple points in time can provide a robust picture of how disaster recovery is unfolding in a community (Dwyer and Horney 2014). For example, data for the metric "disaster displaced individuals" can be collected over a number of points in time to determine whether displaced individuals have returned to the community, if they remain displaced, or if they have chosen not to return to the community. Many other metrics can be used in a similar manner.

Using Metrics to Detect Problems with Recovery

Although extensive time and effort went into the collection of data for each of the 79 metrics across the six disasters, there are still many gaps in available data. Previous pilot tests of the metrics in four communities impacted by Hurricane Sandy suggest a certain degree of difficulty inherent in obtaining measurements for many of the metrics in our dataset without having both close linkages with local subject matter experts if available (i.e., some small jurisdictions may have only a part-time emergency manager and no recovery staff) and strong inter-organizational coordination in the subject communities. It is possible that additional data was available for other metrics but that the research team was unable to access it because it was only locally available (e.g., part of an unpublished After Action Review or unpublished internal reports held by non-profit organizations). A lack of publically available data and documentation may indicate a systemic planning issue in a community, as the recovery research literature strongly supports the critical importance of public participation and engagement across a broad network that extends well beyond the public sector (Smith 2011). Additional research into the role of local knowledge might provide a better understanding of whether a practitioner working within their own community would have more success populating the recovery metrics.

The magnitude of a disaster, along with the size of the community impacted, affects the potential usefulness of the metrics in a number of ways. First, a smaller scale disaster may not result in significant changes in large, publically available data sets, making it more difficult to both assess recovery in that area as well as eliminate any confounding factors. For instance, it is difficult to fully assign any changes in the metric "total population" in Granbury to the EF-4 tornado that occurred in 2013. In these cases, it might be more useful to use local household surveys to collect data instead of relying on large datasets. However, the size, and associated capacity, of the community also plays a role in the usefulness of the metrics. Both large and small communities face challenges in terms of data collection. A small community might not have the means to collect the data necessary to fully evaluate recovery progress but may be able to address these gaps through strong inter-organizational coordination; a larger community may find it difficult to obtain some of the finer-grained, small scale data needed to evaluate some metrics, but may be able to partner with local community agencies or non-profits to gather data from their constituents. State policies may also play a role, although in this case is should be non-differential since all case study locations were in the State of Texas, which has relatively low levels of staff capacity and no mandate for local planning (Berke et al. 2012; Kang et al. 2010).

The size of a disaster impacts the usefulness of the metrics in other ways as well. A larger disaster of greater magnitude will likely be reported on and tracked more intently than a smaller event. This may lead to a greater amount of publically available information that can be used to populate the metrics, contributing to their greater overall usefulness. Based on the data collected for this project, it appears that the size of a community does not necessarily correspond to the speed or quality of community recovery following a natural disaster. For example, in 2008, two major hurricanes - Dolly and Ike - made landfall in Brownsville, Texas, and Galveston, Texas. There were many differences between these two storms and communities, including spatial size, population size, vulnerable populations, capacity for organizing and planning, property values, and the magnitude of impacts caused by Ike (a Category 2 hurricane) and Dolly (a Category 1 hurricane). Galveston also received significantly more disaster assistance than Brownsville ($4.5 billion versus $165 million). One might expect that, based on these differences, recovery progress in a well-equipped city like Galveston would proceed much more quickly than in a low-resource community like Brownsville. However, seven years later, neither community has managed to replace all of the housing damaged or destroyed in the storm. These findings could be explained in terms of impact ratio, defined as the extent of damage sustained divided by the resources possessed by a community to respond (Lindell and Prater 2003). Greater insight into the specific factors affecting recovery and subsequent resilience to future disasters can be gained through analysis of the compiled metrics gathered for both communities. Educational attainment, household access to vehicles and telephones, and the relative proportions of insured, elderly, disabled, and non-native English speaking residents have been associated with higher levels of disaster resilience (Cutter et al. 2010). In 2008, the proportion of the Brownsville population (25 years and older) with a high school level education was 58.5%, which was 21.0% lower than in Galveston City (79.5%). The proportions of elderly (≥65 years) residents were similar (9.1% in Brownsville and 12.9% in Galveston), though Brownsville had more linguistically isolated residents (25.8%) than Galveston (6.6%). This example illustrates the implicit variation in factors affecting the continuum of recovery in a community and the importance of engaging local practitioners in tracking data to evaluate progress and identify potential problem areas.

Data regarding disaster impacts on infrastructure, disaster-displaced individuals, and business recovery was often missing. For example, data for baseline metrics related to “net gain/loss for businesses” and “return of client/customer base” in the business and economy focus area were missing across all disasters. This may be in part due to a focus on business continuity and preparedness planning for businesses by groups such as the U.S. Small Business Administration. While these results may challenge the usefulness of the metrics, data that are consistently missing for certain focus areas may also signal that critical factors for successful community recovery are not being addressed. These gaps can point to areas of existing or continuing vulnerability or to areas where recovery is lagging, depending on whether data are being collected prior to a disaster or after one has already occurred. This information (or lack thereof) provides a unique opportunity for practitioners and other decision-makers to better understand the most pressing needs of their community to prioritize planning, spending, and other assistance strategies (e.g., policy change, training, new programs).

Gaps in data identified as part of this project may be due to a number of factors including: relatively weak planning capacity at the state level in Texas (e.g., total number of staff devoted to hazard mitigation and number of staff per capita), no state recovery planning mandate for local planning, and a low level of investment in local technical assistance efforts aimed at planning (e.g., workshops, peer review of local plans, data for plan making) (Berke et al. 2012; Brody et al. 2010; Smith et al. 2013). Additionally, Texas counties have very limited planning authority (Peacock and Husein 2011). Land use planning can reduce the vulnerability of communities to hazards by limiting development in susceptible areas (Lindell and Prater 2003) and foster more rapid recovery following disasters (Burby et al. 2000); however, the culture of land use planning is weak in Texas. While not helpful to our data collection process, these state-specific factors allow for some inferences to be made regarding the connection between high quality local planning and state-level capacity-building efforts. The notable lack of land use and pre-disaster disaster recovery plans suggests that there may be gaps in both direction-setting planning principles (e.g., goals, fact base, and policy) and action-oriented planning principles (e.g., inter-organizational coordination, participation, and implementation).

Planning in the post-disaster environment involves a delicate balance between mitigating the risk posed by future hazards and acquiescing to the desire of the community to return to normalcy. The conflict between these needs contributes to the volatile environment in which post-disaster recovery often takes place (Smith 2011). Without prior planning and consideration, communities may lack knowledge related to federal aid programs and subsequently face additional challenges and delays in procuring funding (Mulcaire and Overington 2013). Even the best plans and policies put forth under such conditions, not surprisingly, often do not address all the factors that are critical for successful recovery. If there are no plans, it becomes much more difficult to assess a community's progress over time. In communities lacking robust planning experience or capacity, the recovery metrics may serve as a roadmap helping to inform the best use of limited resources and focusing energy and attention where it is most needed.

Using Metrics to Support Proactive Recovery Planning

Good disaster recovery should support improvements in mitigation planning, preparedness, and the development of interventions that will contribute to enhanced disaster resilience in the future. Although major gaps in data were noted in this study, adoption of metrics of some type could encourage a community to think about what needs to be addressed to both prepare for a potential disaster as well as to foster greater accountability and transparency during the process of community recovery. For example, anecdotal information gathered from the media indicates that residents of Marion County felt that more recovery resources were being diverted to more populous neighboring communities and that little information about their community's plight was being spread by the media (WBTV, 2011). Such concerns could be assuaged through the measurement and communication of metrics related to disaster assistance allocations.

Metrics can also provide emergency managers and other practitioners with data that can be used to identify populations that may have been left behind during recovery (e.g. local business owners, disaster displaced individuals) and that require further support related to long-term recovery. For example, populations with high public transit ridership and low household car access may need rapid remediation of public transportation infrastructure and services. Further, re-establishment of child day care, after-school, and teen programs would be particularly relevant to populations with a high proportion of households headed by single parents or dual career parents (Enarson, Fothergill, and Peek 2007). Metrics such as these could aid in the development of targeted recovery programs (Runyan 2006). By utilizing the recovery metrics to guide the development of strong plan fact bases, it may even be possible to support a shift at the federal level towards more proactive planning for disaster recovery. Support might include funding for recovery planning, increased staffing to address identified needs, or changes in policy to better address identified gaps in assistance.

Quantifiable recovery metrics can support and build the capacity of local practitioners by providing the basis for informed decision making during recovery. For example, nearly all of the small businesses in Granbury, Texas, were impacted by the tornado. Small business owners faced a number of barriers to recovery, including a lack of pre-disaster planning, limited available capital, and cash flow interruptions, which may be compounded by damaged or inadequate infrastructure (Runyan 2006). Therefore, concerted efforts to encourage planning to mitigate future disaster impacts could benefit both small business owners and the local economy. Capacity building, particularly at the local level, is a major focus of the NDRF, which has been recognized for potentially improving long-term community recovery outcomes by supporting the development and implementation of a community roadmap for a safer and more resilient future (Jordon 2013; Peacock et al. 2008). Further, greater involvement could be achieved through the identification and support of community organizations that could provide additional resources for individual-level recovery.

Summary

When taken as a whole, the challenges in collecting data to fully populate the proposed metrics suggest three areas for future research that could be helpful to disaster recovery practitioners: 1) identifying and quantifying specific benefits that accrue from using data to develop a high-quality pre-disaster recovery plan; 2) preparing practitioners at the federal, state, and local level to collect data before and after disasters as part of building community capacity; and 3) the need for a set of relevant and available metrics that can be used to incorporate a broader perspective of community recovery into recovery programs and policies. Understanding that some types of data are difficult to find, and that local officials have a limited amount of time to focus on recovery planning, a practitioner reference guide that includes 15 key metrics has been developed to assist users with deciding which metrics to prioritize and how to begin collecting data that can be used to update plans or begin the process of developing a fact base for a pre-disaster recovery plan (Table 2). The selected metrics included in the reference guide have been specifically chosen to help practitioners develop a strong factual foundation for their community before the occurrence of a disruptive event. The reference provides a jumping-off point for practitioners to evaluate whether critical information is being collected and assessed within their own communities. Taking into account varying community capacities, the 15 metrics in the reference have been designed to be flexible, but collecting baseline and post-disaster data on all 15 should provide a fairly complete picture of the community's recovery trajectory.

To control for state-level variation in data availability and other factors, this research was limited to six case study communities to the state of Texas. It is worth investigating the availability of data in other states, particularly those with planning mandates, to determine if data is more or less available in other places. As researchers, the team undertaking this study lacked any intimate knowledge about the communities under investigation. An unanswered question remains as to whether a practitioner working in their own community would have more success populating the 79 recovery metrics, which was one reason for the development of the 15 metric practitioner reference. This question could be addressed by: 1) embedding a researcher in the community to work with local partners to obtain data for the metrics or, 2) partnering with local communities to have them work to populate the metrics on their own as part of a pilot study. This work is planned as part of a new project funded by the Department of Homeland Security's Office of University Programs, the Coastal Resilience Center of Excellence. As discussed previously, a strong fact base is one indicator of a high quality recovery or hazard mitigation plan. The metrics presented here can be used as a checklist or road map for a community to develop

Table 2. Practitioner Reference

Metric	Focus Area	Data Collection	Notes
Total businesses located in the Central Business District	Business and Economy	Local: Chamber of Commerce or Office of Economic Development	Private businesses are important to a community's overall economic well-being. They also have critical roles to play during the disaster recovery period. An accurate and ongoing inventory of community businesses will help gauge economic recovery and can help to identify needed resources and assistance in the event of a disaster.
Economic output	Business and Economy	Local/State: Office of Economic Development, State tax records	Economic output can be used as a proxy to measure a community's ongoing economic recovery following a disaster.
Net business loss/gain	Business and Economy	Local: Chamber of Commerce or Office of Economic Development	Communities often lose businesses in the wake of a disaster but, often, they gain new businesses as well. Knowing the number of existing businesses prior to a disaster helps to evaluate a loss or gain of businesses during the recovery period.
Social networks and community facilities	Communities and Social Services	Local/Regional: Develop a database of schools, public facilities, religious/spiritual facilities	The re-opening of community facilities may indicate the repair and restoration of community social networks. It will be difficult to assess the status of these facilities in the absence of a thorough database of existing facilities. Social networks and community facilities can also help fill resource gaps in the post-disaster period. A database can help identify and obtain needed resources during recovery.
Community health care facilities	Communities and Social Services	Local/Regional: Develop a database of all community health care providers	Health care providers provide critical services to community residents. They may also be able to help close resource gaps in the post-disaster period, particularly if there are emerging disease risks. A database can help identify these providers to direct residents to care and to obtain needed resources in the ongoing recovery period.
Mean/median household income	Households	Federal: US Census	Household income data can be a proxy measurement of community economic health. Tracking income trends can help identify unusual trends that may signal unanticipated recovery outcomes.
Median home value	Households	Federal: US Census	Tracking home values can help identify recovery trajectories related to homeownership and construction.
Abandoned housing units	Households	Federal: US Census; or Local: Informal windshield surveys	Accurate data on abandoned housing units, pre-disaster, may help to assess the number of structures that have been abandoned due to a disruptive event.
Total population	Population Characteristics	Federal: US Census	A comparison of pre- and post-disaster population data can help to identify the effect a disaster has had on a community's population and to identify whether residents are leaving, returning, or both.
Unemployment rate	Population Characteristics	Federal: US Census	Job opportunities are a critical component of a community's economic health. Changes in the unemployment rate (either positive or negative) can help identify disaster-related effects on employment.

Metric	Focus Area	Data Collection	Notes
Cultural and heritage sites	Cultural Sites and Resources	Local/Regional: Develop a database of important cultural and heritage sites, and their current condition	Restoration of important cultural and heritage sites is critical to repairing social networks and community identity. Developing a database of these sites and resources, including their condition, before a disaster will contribute to repairs being made in a timely manner, post-disaster.
School enrollment	Public Sector Recovery	Local: Enrollment data for local schools	Accurate enrollment data for local schools helps to assess whether there has been a net gain or loss of families following a disaster. Obtaining this data before a disaster helps to evaluate whether changes in enrollment have occurred due to a disruptive event. Ongoing monitoring of this data can detect positive or negative changes in enrollment as recovery progresses.
Roadways and bridges	Public Buildings and Infrastructure	Local: Inventory of all roads and bridges in community, and their current condition	A thorough inventory, including condition, of local roads and bridges will help with a post-disaster damage assessment to help gauge physical progress during recovery. An inventory can also help identify vulnerable infrastructure.
Critical infrastructure	Public Buildings and Infrastructure	Local: Inventory of all critical infrastructure in community, such as utilities, water treatment, storm water, pipelines, and more	A thorough inventory, including condition, of critical infrastructure will help with a post-disaster damage assessments to help gauge physical progress during recovery. An inventory can also help identify vulnerable infrastructure.
Natural resource areas	Natural Resources	Local/Regional/State: Inventory or database of all natural resource areas and their condition	Natural resource areas are critical to both a community's economy, including tourism, and identity. Natural resources also perform important environmental services that may help protect a community from further damage and disaster.

a robust fact base or as a means to assess community capacity that needs to be addressed through planning efforts. It would then be possible to assess the overall quality of these plans, using existing plan quality protocols, to determine if using the metrics to guide plan development results in better outcomes. In addition, these metrics could reduce the time required to develop estimates for federal assistance applications.

CONCLUSIONS

Despite the extensive effort that went into collecting data for the disaster recovery metrics, and the implied importance of the metrics as supported by the academic planning literature, it often proved difficult to obtain the data needed to craft a full picture of the recovery experience of the communities under investigation. A number of possible explanations were discussed, including the amount of time that has passed since the disasters selected for this case study, the lack of publically available data, and a relatively weak planning paradigm in the state where the study communities are located. However, there are other possible explanations for gaps that are more closely related to the nature of disaster recovery legislation and funding at the federal, state, and local levels. The NDRF addresses the need for better pre-disaster planning by highlighting the importance of planning for recovery before disaster strikes, as well as focusing on organizational and leadership elements that are critical to a successful recovery. Specifically, the NDRF intends to address the lack of pre-recovery disaster planning at state and local levels, the need for capacity-building initiatives at the local level, the importance of strong coordinated leadership, and the growing disconnect between the various federal recovery programs and between state/local and federal recovery efforts (FEMA 2011). In addition to policy-based changes, FEMA is working to better prepare practitioners, including emergency managers, city managers, planners, and other individuals critical to community recovery, by offering professional development training courses and toolkits.

Among the first things we need to do is to educate local, state and federal officials about the value of collecting data before and after disasters as part of an ongoing planning process. While metrics such as the condition of housing stock and infrastructure and the closing of shelters are fairly obvious indicators of progress towards recovery, disaster recovery often takes place within an evolving spectrum involving a multitude of factors and players. The set of metrics presented here provides a validated starting point for incorporating a broader perspective of community recovery into federal, state, and local disaster-related programs and policies. In addition to the great need for increased community capacity for recovery planning, there is a demonstrated need for validated metrics to gauge progress, or lack thereof, along the continuum of recovery. As discussed previously, the majority of the recovery literature has focused on disaster-specific case studies and little data is available to compare recovery outcomes across different types of disasters, in different locations, at different time points. This project is intended to contribute to a growing body of research supporting the development of standardized metrics that can be utilized to assess recovery progress. It is hoped that the data and analysis generated and shared through these efforts could ultimately contribute to improved community resilience to future disasters, supporting to the greater protection of property, the environment, and, most importantly, lives.

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