

Developing indicators to measure post-disaster community recovery in the United States

Jennifer Horney, Caroline Dwyer, Meghan Aminto, Philip Berke, and Gavin Smith¹

Disaster recovery is a key capability of federal, state, and local government. To support this capability effectively practitioners need useful and validated metrics to document how well a community is recovering from a particular disaster. This study developed and categorised recovery indicators according to the Federal Emergency Management Agency (FEMA)'s Recovery Support Functions and Recovery Mission Area Core Capabilities through a literature review, an evaluation of the pre-disaster recovery plans for 87 coastal jurisdictions, and a case study of two communities (New Hanover County, North Carolina, and the City of Hoboken, New Jersey). Metrics identified in the literature were validated through the recovery plan review and the case study. The research team also identified sources for both baseline and current status data. Based on these findings, a user-friendly checklist for practitioners was established, which will be piloted with practice partners during a future disaster recovery initiative.

Keywords: disaster, metrics, recovery

Background

Although recovery from disasters is a key capability of federal, state, and local government, measurable, validated indicators of community recovery have not been developed as of this writing. To support this capability, practitioners at all levels need useful and validated metrics to gauge how well a community is recovering from a disaster over time (Smith and Wenger, 2007). This point is echoed within the hazards research community, which has made the case over the past decade for more systematic ways of measuring the disaster recovery process across events and over time (Chang and Miles, 2004; French, Feser, and Peacock, 2008). Since much prior recovery research has focused on case studies of single disasters and has not applied common measurements, the possibility of comparing the effects of different disasters and monitoring change over time is limited. Long-term coordinated research, with systematically collected and shared data, is needed to improve community resilience to future disasters (National Research Council, 2006, 2012; Peacock et al., 2008).

The development of indicators is based on a well-defined process, which typically is composed of three phases: (i) defining the objectives of the indicator; (ii) identifying a guiding framework; and (iii) selecting specific metrics on the basis of the consensus of experts (Joint Commission on Accreditation of Healthcare Organizations, 1990; Astleithner et al., 2004; Institute of Medicine Committee on the State of the USA

* Paper corrected on 1 June 2016 (after initial online publication on 14 March 2016) to amend the list of authors.

© 2016 The Author(s). *Disasters* © Overseas Development Institute, 2016

Published by John Wiley & Sons Ltd, 9600 Garsington Road, Oxford, OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

Health Indicators, 2009). The most valuable and defensible indicators are easy to appraise, are cost effective, and are useful for decision-making in policy, practice, or research settings. The development of community recovery indicators in this project followed three primary criteria, grounded in best practices documented in the published research literature (Astleithner et al., 2004; Institute of Medicine Committee on the State of the USA Health Indicators, 2009). First, it must be possible to measure and assess indicators repeatedly over time. When possible, there should be documented evidence that selected indicators are valid and reliable. Second, indicators should be variables that are sensitive to changes in community recovery status over time or within key demographic and geographic subpopulations, which allows for the exploration of interaction. Third, the effects of community- and individual-level experiences also should be considered concurrently. Metrics that meet these definitions have been applied previously in settings such as disaster medicine (Bayram, Zuabi, and Subbarao, 2011), environmental policy effectiveness (Clay, Kitts, and Pinto da Silva, 2014), and hazard mitigation (Frazier et al. 2013).

National recovery policy as a guiding framework

The identification of standards and metrics for evaluating the effectiveness of national mitigation and recovery efforts has been identified as a major challenge requiring federal investment (National Research Council, 2012). Based on the subject matter expertise of the research team and the guidance of practice partners at the Federal Emergency Management Agency (FEMA)'s Recovery Directorate, the indicators developed for this project are categorised according to FEMA's Recovery Support Functions (RSF) and Recovery Mission Area Core Capabilities as described in the National Preparedness Goal, developed under Presidential Policy Directive 8: National Preparedness (PPD-8) (Department of Homeland Security, 2011a). PPD-8 is an overarching policy initiative approved by the President of the United States calling for the whole community to work together to keep the country safe and resilient in the face of acts of terrorism, natural disasters, or pandemics. The RSFs and Core Capabilities were employed because they provide an effective coordinating structure for the principal functional areas of assistance usually needed by a community after a disaster (Smith and Wenger, 2007; Institute of Medicine Board on Health Sciences Policy, 2012; Kapucu, 2014). The use of federal recovery policy documents as a guide also supports comparability among communities and provides a context for actions to reduce further vulnerability and to build resiliency.

The RSFs were developed as a part of the 2011 National Disaster Recovery Framework (NDRF) to create a support and cooperation framework under which communities could work with the federal government during their disaster recovery efforts. Its six functions are: community planning and capacity building; economic recovery; health and social services recovery; housing recovery; infrastructure systems recovery; and natural and cultural resources recovery. The supporting documentation for each RSF outlines a coordinating agency, primary agencies, supporting organisations, mission, function, pre- and post-disaster responsibilities, and expected outcomes

(Department of Homeland Security, 2012). For instance, the housing recovery function is led by the US Department of Housing and Urban Development, with support from the Corporation for National and Community Service, Department of Commerce, Department of Energy, Environmental Protection Agency, Health and Human Services, Small Business Administration, US Access Board, Veterans Affairs, American Red Cross, and National Organizations Active in Disasters (Department of Homeland Security, 2011b).

The National Preparedness Goal defines 31 core capabilities that are necessary to achieve if the preparedness objective is to be met. Each Core Capability is grouped within one of five mission areas (prevention, protection, mitigation, response, and recovery). The Core Capabilities identified for inclusion in this study (that is, those falling within the Recovery Mission Area) are operational coordination and public information and warning. While other Core Capabilities are grouped within the Recovery Mission Area, they were already accounted for within the RSFs.

Literature review

Disaster recovery can be defined as ‘the 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, p. 237). In the aftermath of a disaster, officials face tremendous pressure to put things back to the way they were before the event. Recovery assistance programmes often focus on short-term relief, with less attention paid to opportunities to increase community and individual resilience to future disasters through a high-quality recovery process (Berke, Kartez, and Wenger, 1993; Peacock et al., 2008). Recovery activities also may be seen as consuming scarce resources and diverting attention away from other essential governmental functions (Comfort et al., 1999). This sense of urgency may lead local governments to make decisions in the short term that foreclose long-term options to reduce a community’s vulnerability to disasters, such as rebuilding houses in a flood-prone area. However, sustainable recovery should provide an opportunity to improve on, rather than recreate, pre-disaster vulnerabilities (Beatley, 1994; Mileti, 1999; Bean, 2002; Smith and Wenger, 2007).

A pre-disaster recovery plan based on careful deliberation of how a community should be redeveloped after a disaster is a logical first step towards supporting resilience under conditions of high uncertainty and rapid change. Recovery plans are based on the concepts of foresight, adaptation, and multiple possible futures in which communities not only evaluate alternatives for their time ahead, but also consider possibilities that they may not fully control (Schwab et al., 1998; Olshansky and Johnson, 2010; Berke et al., 2014). Flexible policies are then designed to anticipate possible change. Monitoring programmes based on measurable indicators of recovery are a critical component of recovery planning as they can be used to track the recovery status of communities and the performance of policies across events and over time.

While local adoption of pre-disaster recovery plans has been sporadic in most US states, a growing number of communities are adopting plans to guide the recovery process. During the past 15 years, for instance, approximately 80 per cent of the 203 local coastal governments in Florida have incorporated a recovery element in their comprehensive land use plan.² North Carolina's Coastal Area Management Act has required the adoption of recovery elements in land use plans in coastal counties since the late 1990s, and all 20 coastal counties and more than 60 per cent of the municipalities had included recovery elements in their plans by 2000 (North Carolina Division of Coastal Management, 2000). In Louisiana, stand-alone recovery plans were adopted voluntarily in 30 parishes affected by Hurricane Katrina of August 2005. Each parish plan outlines an overall vision for recovery, recovery goals, and specific projects for meeting those objectives (restoreyoureconomy.org, 2009). When Hurricanes Ike and Gustav struck Louisiana in 2008, the recovery procedures and redevelopment policies of the parish plans may have guided the recovery, although only piecemeal programme and process evaluations have been published to date (Chandra and Acosta, 2009; Acosta, Chandra, and Feeney, 2010; Miner et al., 2010). Recovery plans probably could be strengthened by the inclusion of standard metrics for measuring the progress of plan implementation and the quality of recovery efforts (Smith and Wenger, 2007; Berke et al., 2014).

Several researchers have examined the disaster recovery process and outcomes more generally, but most published research on recovery consists of single case studies or collections of several case studies (Rubin, 1985; Rubin and Popkin, 1991; Berke, Kartez, and Wenger, 1993; Berke and Beatley, 1997; Olshansky et al., 2008). As the adoption of most recovery plans has occurred recently, it is not yet clear from the literature how well they have been implemented or whether they have strengthened a community's resilience to disasters (Berke et al., 2014). As of early 2016, there is no consistent way to measure how these pre-disaster recovery plans are being implemented during post-disaster recovery and whether or not they are making a difference to either the quality or the pace of recovery. However, there is broad consensus that recent post-disaster recovery activities have underscored the need to shift from a top-down, technocratic model of pre-disaster planning and post-disaster recovery to a bottom-up approach that incorporates local knowledge and builds local capacity (Paton and Johnston, 2001; Ganapati and Ganapati, 2008; Olshansky et al., 2008).

The development of a robust set of recovery indicators, with associated quantifiable metrics, can address many of the gaps identified in the current literature, as well as support and build the capacity of local practitioners by improving pre-disaster recovery planning and providing data for decision-making during recovery. The proposed indicators could assist in the formation of a robust fact-base needed for the creation of a high-quality recovery plan in the future (Dash, Peacock, and Morrow, 1997; Schwab et al., 1998), as well as assist in the establishment and implementation of a roadmap for the recovery process (Government Accountability Office 2008). The tracking of recovery indicators over time also may provide the opportunity for practitioner collaboration across potentially isolated functions (such as emergency management and planning), and highlight areas where data are not currently available and engagement with additional partners is necessary for successful recovery.

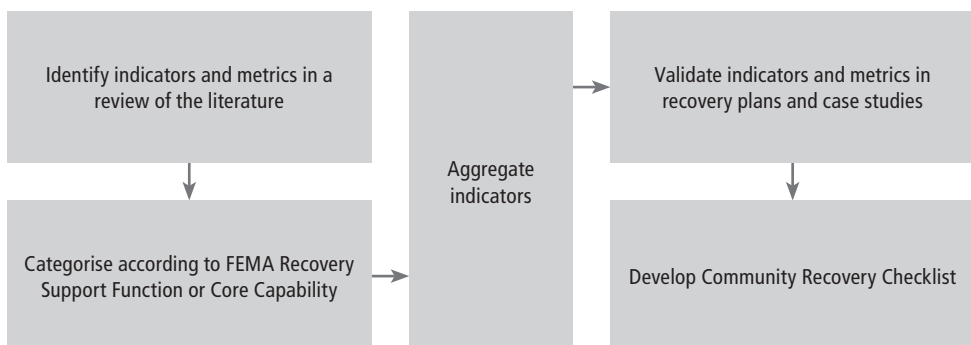
Methods

Developing the indicators

Potential indicators were identified initially through a systematic review of the literature and categorised by FEMA RSF or Core Capability. After aggregating the identified indicators, several methods were used to validate the final aggregated list, including a review of disaster recovery plans from coastal counties and municipalities and a case study of two communities recently affected by a disaster. The final product is the development of a Community Recovery Checklist for use by practitioners (see Figure 1).

A systematic review of post-disaster recovery literature was performed to identify research studies related to measuring the progress of recovery in order to extract potential recovery indicators and metrics. First, citations were obtained from the two most comprehensive sources published in the disaster recovery literature to date: *Developing a Management Framework for Local Disaster Recovery: A Study of the U.S. Disaster Recovery Management System and the Management Processes and Outcomes of Disaster Recovery in Three U.S. Cities* (Johnson, 2009); and *Planning for Post-Disaster Recovery: A Review of the U.S. Disaster Assistance Framework* (Smith, 2012). Second, a supplemental University of North Carolina at Chapel Hill (UNC) University Libraries Articles+ search was conducted using the following keywords: ‘disaster’; ‘recovery’; and ‘community’. In total, 98 peer-reviewed, scholarly articles published between 2008 and 2013 were retrieved from Johnson (2009), Smith (2012), and the library search. In addition, 15 conference papers published between 2006 and 2013 were retrieved by first searching conference citations found in Johnson (2009) and Smith (2012) and by conducting UNC Libraries Articles+ and Google Scholar searches related to disaster recovery-related conferences in the fields of emergency management, engineering, planning, and remote sensing. Articles from a special issue of the *International Journal of Emergency and Disasters* (Reiss, 2012) also were included. A total of 118 peer-reviewed publications and conference presentations were reviewed to determine if they incorporated recovery metrics or measures employed to gauge community recovery progress. Of these 118

Figure 1. Methods used in the development and validation of recovery indicators for the Community Recovery Checklist



Source: authors.

Table 1. Indicators identified in literature review, listed by RSF/Core Capability and recovery focus area

RSF/Core Capability	Recovery focus area	Total indicators (literature review)	Total indicators (recovery plan review)	Consolidated indicators
Community planning and capacity building	<ul style="list-style-type: none"> Disaster and recovery management 	104	51	8
Economic recovery	<ul style="list-style-type: none"> Business recovery and economic stabilisation Communities and social services Households Mobilisation of recovery funding Public buildings and infrastructure 	70	28	18
Health and social services recovery	<ul style="list-style-type: none"> Communities and social services Mobilisation of recovery funding Population characteristics 	70	17	13
Housing recovery	<ul style="list-style-type: none"> Households Mobilisation of recovery funding Population characteristics 	99	45	17
Infrastructure systems recovery	<ul style="list-style-type: none"> Disaster and recovery management Mobilisation of recovery funding Public buildings and infrastructure 	77	27	9
Natural and cultural resources recovery	<ul style="list-style-type: none"> Cultural sites and resources Disaster and recovery management Natural resources 	40	12	12
Public information and warning	<ul style="list-style-type: none"> Disaster and recovery management 	19	4	6
Operational coordination	<ul style="list-style-type: none"> Mobilisation of recovery funding Disaster and recovery management Public buildings and infrastructure 	43	20	7
Total		522	204	90

Source: authors.

publications and presentations, 57 (48.3 per cent) included recovery metrics or measures. The 57 sources represent various research methods, such as case studies, comparative case studies, longitudinal case studies, content analyses, and literature reviews. In addition, they represent multiple types of natural hazards, with hurricanes, tsunamis, and coastal storms being the most common ($n=19$), followed by earthquakes ($n=10$). The studies include disasters in multiple locations in the US ($n=38$), as well as major international disasters ($n=19$).³

For each of the sources, the type of paper (article or conference), year of publication, author, source publication, study area, study type, and study indicators were recorded, along with any measurements or metrics that were used. In total, 522 indicators were identified and categorised according to the primary RSF or Core Capability based on the descriptions given in the NDRF or the National Preparedness Goal (see Table 1) (Department of Homeland Security, 2011a, 2011c). The 522 indicators identified in the literature review were reviewed independently by two graduate students and consolidated through inductive reasoning to remove duplicates and to generate a more succinct and user-friendly list of 90 indicators. In addition, since recovery is highly outcome-focused, 10 focus areas were created to make the categories more goal-oriented (see Table 1).

Validating the indicators

As a first step in validating the indicators identified in the literature, disaster recovery plans, content-analysed for another project (Horney et al., 2009), were reviewed to determine whether or not these indicators have been used in practice. Recovery plans had been previously collected from 87 coastal counties and cities with a population of greater than 10,000 persons on the US Atlantic and Gulf Coasts between the States of Virginia and Louisiana. Recovery plans from the original sample of 87 were included in this study if they scored above the overall mean score in the original plan quality assessment study (Berke et al., 2014). The final sample ($n=26$) constituted 30 per cent of the plans from the original study. Of these 26 plans, only 15 contained indicators, including 13 from jurisdictions in Florida and 2 from North Carolina. A total of 204 indicators from these 15 plans were identified and categorised by RSF or Core Capability. Each of these plan-based indicators was able to be categorised within one of the 90 aggregate indicators, illustrating that all plan-based indicators validated the existing literature-based indicators (see Table 2). The plan-based indicators were then reviewed to spot potential metrics to be added to the list of possible measurements.

A retrospective review of two case study communities undergoing recovery from recent disasters was conducted to validate the indicators identified in the first phases of this project. The case studies highlight a community's potential use of the recovery indicators as a means to evaluate the success of recovery, using actual recovery experiences. The validation of the indicators through case studies may elucidate potential sources for gathering data on a community's ongoing post-disaster recovery,

as well as its pre-disaster baseline status. In addition, the case studies may help to demonstrate further how local planning can be used to fulfil national recovery priorities, as outlined in the RSFs and Core Capabilities.

Two jurisdictions, New Hanover County, North Carolina, and the City of Hoboken, New Jersey, were selected on the basis of meeting or exceeding the following conditions:

- the presence of a robust community fact-base within existing planning documents, necessary to assess thoroughly the community's pre-disaster baseline condition;
- the release of a federal disaster declaration within the past five years (preferably more recent), resulting in greater availability of online media resources and avoiding large gaps between baseline conditions and current status data; and
- the existence of recovery plans, emergency operations plans, or hazard mitigation plans for the communities under investigation, allowing for more thorough validation of the identified recovery indicators.

Hoboken was also selected to satisfy a request from funders at the Science and Technology Directorate of the Department of Homeland Security that one of the case studies include a community affected by Hurricane Sandy of late October/early November 2012.

Retrospective baseline data were gathered by examining pre-existing planning documents, including multi-jurisdictional hazard mitigation plans, recovery plans (when available), emergency operations plans, community comprehensive (or master) plans, and US Census information. When identified, a baseline condition for a recovery objective or activity was recorded along with the source of the data. Current status recovery data were gathered from electronic media reports and internet databases, using a search method described and validated by Chang, McDaniels, and Beaubien (2009). The method comprised three basic steps: (i) using an online database or search engine to gather relevant media articles via Boolean search terms; (ii) reading the gathered media reports and recording identified community recovery goals, and their current status, along with source data; and (iii) performing a final media search to address any gaps in the collected recovery data following the first two steps.

New Hanover County, North Carolina

New Hanover County, home to more than 200,000 residents (United States Census Bureau, 2014a), is located in southeast North Carolina, bordering the Atlantic Ocean. Vulnerability indices calculated for its 2010 Multi-Jurisdictional Hazard Mitigation Plan Update and used for the prioritisation of subsequent mitigation efforts reveal that New Hanover faces a high risk of the following natural hazards: flood; hurricane, nor'easter, tropical storm; sea-level rise; severe thunderstorm; storm surge; and wild-fire. The case study evaluation focuses on recovery from Hurricane Irene.

Hurricane Irene made landfall several times along the east coast of the US in late August 2011, causing more than USD 16 billion in damage to affected areas. The

storm made initial landfall in the US on the Outer Banks of North Carolina, just north of New Hanover County. A major disaster (DR-4019) was declared for a number of coastal counties in North Carolina, including New Hanover, on 31 August 2011 (Federal Emergency Management Agency, 2014). The documents used to determine New Hanover County's pre-disaster baseline condition include: the *New Hanover County North Carolina 2010 Multi-Jurisdictional Hazard Mitigation Plan Update* (September 2010); the *New Hanover County Emergency Operations Plan* (August 2011); the *Wilmington–New Hanover County 2006 CAMA Plan Update* (August 2006); and the US Census (2000 and 2010). Major media resources for current status data include the North Carolina Department of Public Safety's website and *Wilmington Star-News*.

Hoboken, New Jersey

More than 50,000 people (United States Census Bureau, 2014b) currently reside in Hoboken, New Jersey, located directly across the Hudson River from Manhattan (New York) and spanning two square miles within the boundaries of Hudson County. Hudson County's existing *Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan for the County of Hudson, Volumes I and II* (2008) identifies nine 'significant hazards of concern': coastal storm (hurricanes, nor'easters, tropical cyclones, tropical depressions, tropical storms); drought; earthquake; extreme temperatures; flooding; ground failure; severe storm (hail, thunderstorms, tornadoes, windstorms); severe winter storm (heavy snow, blizzards, ice storms); and wildfire (brush lands). The case study evaluation concentrates on Hoboken's continuing recovery following 'Superstorm Sandy'.

Hurricane Sandy developed late in the 2012 Atlantic tropical cyclone season, reaching a peak intensity of Category 3, before merging with a frontal system off the northeast coast of the US. Sandy was the second costliest hurricane on record, with damage estimated at nearly USD 70 billion (through to June 2013) (National Oceanic and Atmospheric Administration, 2012). A major disaster (DR-4086) was declared for all New Jersey counties on 30 October 2012 (Federal Emergency Management Agency, 2014). The documents used to determine Hoboken's pre-disaster baseline condition include: the *City of Hoboken Master Plan* (adopted in April 2004); the *City of Hoboken Reexamination Report 2010* (adopted in March 2011); the *Multi-Jurisdictional Pre-Disaster Mitigation All Hazards Plan for the County of Hudson, Volumes I and II* (September 2008); and the US Census (2000 and 2010). Major media resources used to determine current status conditions include *The New York Times* (website and archives), *The Hudson Reporter* (website and archives), and the NJ.com and the northjersey.com websites.

Baseline data

Given that the case study communities were selected based on the specific merits discussed above, including a rich community fact-base, pre-disaster baseline conditions for both of them were determined with relative ease. For New Hanover County,

Table 2. Recovery indicators identified by recovery plan review and case studies, listed by RSF/Core Capability and recovery focus area

RSF/Core Capability	Recovery focus area	Consolidated recovery indicators	Total indicators (recovery plan review)	Number of recovery indicators identified: Hoboken, NJ	Number of recovery indicators identified: New Hanover County, NC
Community planning and capacity building	<ul style="list-style-type: none"> Disaster and recovery management 	8	51	2	2
Economic recovery	<ul style="list-style-type: none"> Business recovery and economic stabilisation Communities and social services Households Mobilisation of recovery funding Public buildings and infrastructure 	18	28	11	12
Health and social services recovery	<ul style="list-style-type: none"> Communities and social services Mobilisation of recovery funding Population characteristics 	13	17	3	8
Housing recovery	<ul style="list-style-type: none"> Households Mobilisation of recovery funding Population characteristics 	17	45	9	12
Infrastructure systems recovery	<ul style="list-style-type: none"> Mobilisation of recovery funding Disaster and recovery management Public buildings and infrastructure 	9	27	7	5
Natural and cultural resources recovery	<ul style="list-style-type: none"> Cultural sites and resources Disaster and recovery management Natural resources 	12	12	5	4
Public information and warning	<ul style="list-style-type: none"> Disaster and recovery management 	7	4	2	3
Operational coordination	<ul style="list-style-type: none"> Disaster and recovery management Mobilisation of recovery funding Public buildings and infrastructure 	6	20	4	5
Total		90	204	43	51

NC, and Hoboken, NJ, baseline data were most available for indicators categorised in the economic recovery and housing recovery RSFs and the operational coordination Core Capability. Less information was available for indicators categorised in the natural and cultural resources RSF, with particular challenges pertaining to locating baseline data for indicators such as monitoring of ecosystem resiliency, rates of erosion, and land degradation.

Current status data

Current status information was available for many of the indicators, but those most represented in the available media were those categorised as economic recovery, housing recovery, and infrastructure systems recovery. Once again, the measures for the indicators categorised under the natural and cultural resources RSF were virtually absent in the available post-disaster media reports (see Table 2).

Developing a Community Recovery Checklist

During the validation of the literature review results with the recovery plan review and case studies, the number of indicators was aggregated down to 79 through the removal of duplicates. A Community Recovery Checklist (see Table 3) was created that included these indicators as well as potential metrics. All 79 aggregated indicators from the literature review were validated in the recovery plan review, while more than one-half were validated in the New Hanover County, NC (n=43, 54 per cent), and Hoboken, NJ (n=51, 65 per cent), case studies.

The Checklist was established with the intention of assisting practitioners, government agencies, and citizens in tracking recovery in their community following a disaster. To make it more effective, and to ensure further ease of use, the aggregate indicators developed in the first stages of this project were categorised into one of four themes (financial, process, social, and public sector) and operationalised in achievement-oriented focus areas. In addition, the validation process revealed potential sources of data for each metric, including the US Census, the US Department of Labor, locally developed planning documents, and published reports in both the peer-reviewed literature and the popular media. Suggested data sources are provided as part of the Checklist to assist users, along with suggested temporality of each metric. Since recoveries may follow different time trajectories, the Checklist is flexible and can accommodate baseline data and data collected at various points during the recovery (weekly, monthly, annually). Ideally, it could yield data for decision-making during recovery, a time when policymakers typically face tremendous pressure to take action that may foreclose on long-term opportunities to reduce vulnerability and to build resilience.

An internet-based version of the Community Recovery Checklist is available at communityrecoverytool.org. Additional usability testing and content validation of the Checklist also is under way (Dwyer and Horney, 2014).

Table 3. Community Recovery Checklist

FINANCIAL THEME	
This theme contains focus areas relating to the management of recovery funds and the restoration of the community's economic sector.	
Focus area: business recovery and economic stabilisation	
This focus area contains metrics capturing the status of local businesses, economic activity, and economic structure.	
Metric	Description
Total disaster-related business closures	The number of businesses within the geographic boundaries of the identified community that closed directly owing to the disaster.
Average level of business insurance	The average monetary value of insurance policies covering businesses for disaster-related damage.
Number of commercial bankruptcies	The number of businesses within the geographic boundaries of the identified community that have declared bankruptcy.
Economic output	The total taxable income generated by businesses within the geographic boundaries of the identified community.
Total businesses located in central business district	The number of businesses located within the community agreed upon central business district or economic centre.
Number of small businesses	The number of businesses that, by total employees, fall in the lower 50 per cent of all businesses within the geographic boundary of the identified community.
Number of large businesses	The number of businesses that, by total employees, fall in the upper 50 per cent of all businesses within the geographic boundary of the identified community.
Restoration of business supply lines	A measure of the system of organisations, people, activities, information, and resources involved in the movement of products and information.
Net business gain/loss	Total monetary value lost or gained as a direct result of disaster.
Economic structure (sector-share) in community	The distribution of businesses that share the same or related products or services.
Return of client/customer base	The restoration of clients and customers to local businesses.
Focus area: mobilisation of recovery funding	
This focus area contains metrics examining the amount of recovery-related funds (public and private) allocated and distributed.	
Metric	Description
Amount of FEMA funding distributed	Total FEMA dollars distributed through disaster recovery funds.
Amount of non-FEMA recovery funding distributed	Total non-FEMA dollars distributed through disaster recovery funds.
Amount of donations received	Dollars and other resources, such as food and supplies, dispersed by charitable organisations and as private gifts.
Amount of insurance payments received	Total dollars fully dispersed through insurance pay-outs.
Total funding used for permanent reconstruction projects	Total dollars used for permanent post-disaster reconstruction projects.

PROCESS THEME	
This theme contains a focus area relating to the quality of the disaster recovery process.	
Focus area: disaster and recovery management	
This focus area contains metrics quantifying and qualifying the processes of disaster recovery and disaster management. Many of the metrics concentrate on the planning process and whether or not recovery is being led by values reflected in existing plans. It also examines how well communities are capitalising on opportunities that disaster can create for incorporating hazard mitigation practices into the community's development framework, such as building codes and improved land use.	
Metric	Description
Number of hazard mitigation, emergency preparedness, and recovery public meetings held and number of public participants	Number of meetings conducted by the community, and attendance, as a means of enhancing future community hazard mitigation, emergency preparedness, and recovery efforts.
Disaster management plans (emergency preparedness/hazard mitigation/recovery) developed or updated post disaster	Attempts made by the community to leverage the disaster as a means of improving pre-disaster planning initiatives.
Plans (emergency preparedness/hazard mitigation/recovery) that address vulnerable populations (such as low-income persons, non-English speakers, and senior citizens)	Attempts made by the community to leverage the disaster as a means of improving pre-disaster planning initiatives specifically for traditionally under-served populations.
Improved community resiliency	Attempts made by the community to institute regulations that enhance disaster resiliency, including buyouts, elevation of buildings, improved land use protection measures, restoration/reconstruction of public works with increased resiliency, and strengthened building codes.
Outreach methods used to engage the public during disaster planning efforts (such as brochures, community surveys, dedicated website, print, radio, or television advertisements)	Variety of media used to engage the public in hazard mitigation planning, recovery planning, or disaster management (in general), such as brochures, flyers, radio, television, web surveys, and workshops.
Number of organisations involved in recovery and disaster management planning processes	Number of organisations involved in recovery and disaster management processes, including charities, community groups, religious entities, non-profit and non-governmental organisations, and school associations.
Government monitoring of progress towards recovery plan goals	The methods, if any, by which the aims of a local disaster recovery plan are being assessed.
Recovery plan used to initiate recommendations for the enactment or repeal of recovery procedures, or the extension of emergency resolutions, ordinances, and orders	The level to which an existing recovery plan is being followed, particularly any recommendations it contains on the extension and enforcement of emergency resolutions and development moratoria, if necessary.
Regulations implemented for priority resettlement areas	Regulations implemented to create and maintain post-disaster priority resettlement areas.
Discontinuation of building moratoria	Any post-disaster building moratoria put in place have been lifted.

SOCIAL THEME	
<p>This theme contains focus areas examining recovery at the individual and community level. It focuses on household recovery, the re-establishment of community services, the demographics of the population, and the availability of cultural resources.</p>	
<p>Focus area: communities and social services</p> <p>This focus area contains metrics capturing the restoration and availability of health and social services post disaster.</p>	
Metric	Description
Availability of social services	Restoration of the provision of governmental and non-governmental social services.
Re-establishment of social networks and community facilities (such as community meeting facilities, houses of worship, and schools)	Restoration of key social gathering spaces and networks, including community social groups, places of worship, and schools.
Re-establishment of day-care, after-school, and teen programmes	Restoration of key community child care facilities and programmes.
Community health care facilities operational	Restoration of key community health care facilities, including community health clinics, hospitals, and trauma centres.
Workforce assistance programmes available	Restoration of community workforce assistance programmes, including employment and hiring centres and unemployment/disability agencies.
Number of physicians available to the public	Physicians available to assist disaster-affected individuals, both immediately after the disaster and to offer continuing care.
Organisations available to offer disaster-related medical or mental health support for depression, post-traumatic stress disorder, etc.	Creation or restoration of facilities to assist affected individuals with disaster-related medical or mental health support, including anxiety, depression, and post-traumatic stress disorder. Organisations may be governmental or non-governmental.
Number of domestic violence incidents	Reported incidents of domestic violence in community.
Self-reported trust rating of local government	Community's faith in their local government to govern effectively, efficiently, and equitably, particularly pertaining to the distribution of resources during disaster recovery.

Focus area: households	
<p>This focus area examines recovery at the household level through metrics assessing housing values, patterns of home-ownership, and income levels.</p>	
Metric	Description
New resident housing tenure	Percentage of households that have moved in since 2010 (or latest figure available to approximate number of new residents).
Owner- versus renter-occupied housing units	Percentage of housing units in the community that are occupied by owners or renters (subtract census-generated data from 100 to obtain renter-occupied units).
Percentage of population residing in temporary housing units	The number of affected individuals currently residing in temporary structures.
Average level of homeowner's insurance	A measure of the average level of insurance taken out by affected households, obtained by dividing the total value of homeowner's insurance policies by the value of all housing units.
Median home value	Median value of homes in designated geography.

Developing indicators to measure post-disaster community recovery in the United States

Median and mean household income	Median and mean household income in designated geography.
Residential unit vacancy rate	The percentage of housing units classified as vacant in designated geography.
Number of abandoned housing units	The number of abandoned residential units in designated geography.

Focus area: population characteristics

This focus area contains metrics capturing community demographics, including potentially vulnerable populations.

Metric	Description
Total population	Absolute population in designated geography.
Disaster-displaced individuals	Number of individuals no longer residing in their permanent residence owing to disaster impacts.
Unemployment rate	Percentage of unemployed individuals in designated geography.
Households in poverty	Household population falling within federal poverty guidelines.
Households without access to a car	Households in designated geography that lack access to an automobile.
Population over the age of 65	Absolute number and percentage of individuals over the age of 65 residing in designated geography (vulnerable population).
Population under the age of 16	Absolute number and percentage of individuals under the age of 16 residing in designated geography (vulnerable population).
Disabled population	Absolute number and percentage of disabled individuals residing in designated geography (vulnerable population).
Population without a high-school diploma	Absolute number and percentage of individuals without a high-school diploma residing in designated geography (vulnerable population).
Non-white population	Non-white population determined by subtracting the 'non-Hispanic white alone' population from the total population; absolute number and percentage of non-white individuals residing in designated geography (vulnerable population).
Non-English-speaking population	Absolute number and percentage of individuals who speak English less than 'very well' residing in designated geography (vulnerable population).
Households headed by single parents	Absolute number and percentage of households headed by single mothers in designated geography (vulnerable population).

Focus area: cultural sites and resources

This focus area examines the state and availability of the community's cultural resources, including art galleries, landmarks, museums, and other local attractions.

Metric	Description
Reconstruction/repair of damaged cultural or heritage sites (such as cultural artefacts and landmarks)	State of repair of key cultural sites and resources.
Reconstruction/repair of damaged cultural arts and religious facilities	State of repair of key arts and religious structures.
Re-establishment of arts and sports organisations	Resumption of local arts and sporting events.
Religious service attendance	Changes in attendance at places of worship owing to disaster impacts.

PUBLIC SECTOR THEME	
This theme contains focus areas examining recovery in the public realm by evaluating the functionality of government and the restoration and repair of public buildings, infrastructure, and natural resources.	
Focus area: public sector recovery	
This focus area contains metrics examining whether or not the government and public services are fully operational.	
Metric	Description
Governing body fully functioning	All government buildings open and operational; government operating under 'normal' conditions rather than 'emergency' conditions; continuity of government plan/procedures no longer necessary.
Number of civic organisations	Number of operational civic organisations, including, Chamber of Commerce, Lions Club, National Association for the Advancement of Colored People, Parent Teacher Association, and Rotary International.
Tax revenue	Tax revenues collected in the current fiscal year.
Public services available	Availability of public services, including fire departments, law enforcement, libraries, and waste collection.
Pupils enrolled in community schools	Enrolment totals for all local schools.
Number of voter registrations	Absolute number of registered voters in the community.

Focus area: public buildings and infrastructure	
This focus area contains metrics examining the state of transportation systems and other critical infrastructure such as roads and utilities.	
Metric	Description
Re-establishment of transportation and transit system(s), local and regional	Infrastructure, including crosswalks, roads, traffic signals, and way-finding signs, repaired/restored. All debris removed from roadways. Re-establishment of buses, light rail, subways, taxis, and para-transit systems to functional levels.
Public transit ridership	Number of citizens reporting use of public transit, including buses and subway systems.
Disaster-damaged roads and bridges repaired	Total miles of road system and total number of bridges needing repairs owing to disaster impacts.
Damage to critical infrastructure (such as gas pipelines, utilities, and water treatment plants)	Repairs made to all disaster-affected infrastructure systems and components.
Railway and maritime shipping infrastructure repaired	Repairs made to all disaster-affected rail and maritime shipping routes, stations, and ports.
Damage to public facilities (such as municipal buildings) repaired	Repairs made to all disaster-affected public facilities.
Status of debris management	Disaster-related debris collected and disposed of properly or recycled; debris management/storage sites decommissioned.

Focus area: natural resources	
This focus area examines the recovery of natural resources such as coastal and environmental assets and soil.	
Metric	Description
Re-establishment of environmental governance/pollution monitoring	The continuance of environmental assessment(s) in impacted geography.

Restoration of protected natural areas	Re-establishment of soil, flora, and fauna in areas designated as protected through park services or other designations.
Coastlines and wetlands assessed to determine if additional hazard mitigation measures should be implemented	Assessment of the possibility of the need for additional hazard mitigation policies that would protect the coastline and preserve/improve wetland quality.
Damage to coral reefs, shrimp hatcheries, or other coastal resources inventoried	Comprehensive inventory of damage to production and distribution, and overall health, of coastal resources for farming, tourism, or coastal protection.
Soil testing at debris management sites	Quantitative measure of chemical/biological pollution, pH level, salinity, and soil distribution of areas designated as potentially at risk of degraded soil quality.
Rates of erosion	Quantitative measure of disaster-related changes in riverbanks, shorelines, and soil systems; stabilisation of accelerated erosion owing to disaster.
Incidence of landslides	Total number of landslides recorded in the months/years following the disaster.

Source: authors.

Discussion

The process of validating the recovery indicators and the development of a Community Recovery Checklist revealed that utilisation of this tool can potentially serve as an effective means of tracking the recovery of a community or jurisdiction following a major disaster. The results of this pilot project also suggest some improvements to ensure that end users can employ the tracking instrument to its fullest extent.

A strong, pre-existing, jurisdictional fact-base is essential to ensure the accuracy of recovery goal tracking. Baseline conditions must be inventoried (and updated at least annually) prior to the occurrence of a disaster. While existing jurisdictional plans might be used for this purpose, typically they are updated on a quinquennial basis. To assist users with this task, suggested data sources for all metrics have been provided as part of the Checklist. In an online version, one is able to import automatically some baseline data from available online data sources. For instance, baseline data in the household recovery and population characteristics focus areas can be uploaded from the United States Census Bureau.

Similarly, permanent and freely accessible sources of current status data must be identified and secured before a disaster, continuing through the ongoing recovery period. In informal discussions about the Checklist with federal, state, and local practitioners, they identified this need for data as a potential opportunity to improve collaboration and data sharing among agencies responsible for different aspects of recovery, and as a way to determine what new partnerships might be necessary to ensure access to reliable current status data.

The proposed metrics necessarily include a mixture of quantitative (n=63) and qualitative (n=16) measures. Some recovery goals or activities were difficult to measure or assess using traditional, quantitative means of evaluation. These goals often

are the more intangible, yet equally important, aspects of community recovery following a disaster, including improved community resilience or outreach methods used to engage the public (both in the disaster and recovery management focus area) or those lacking a validated metric or system of measurement, such as restoration of protected natural areas (natural resources focus area). Validated metrics or qualitative assessment tools should be identified or developed for all community recovery indicators in the future to ensure data quality and comparability over time and across events.

Limitations

Several important limitations were highlighted as part of the validation process. One of the most significant is that most jurisdictions do not have a standalone recovery plan in place, and therefore have no document from which to draw and/or house indicator data that can be linked to a set of internally consistent objectives and policies from which to operationalise recovery actions. The recovery plans reviewed included indicators of recovery that also were derived from the literature review, providing confidence about the applicability of the indicators to planning practice. However, only a minority of communities had recovery plans, and only a small percentage of those plans contained any measurable indicators of recovery. In the future, additional recovery planning mandates or incentives could be used to increase the number of jurisdictions with recovery plans.

During both the plan review and the case studies, geographic discrepancies were pinpointed between the data reported for the baseline condition and the available reports detailing any achievement of the recovery goal or activity. For example, the media frequently report data aggregated at the state level when describing disaster damage. This information is not useful if the practitioner is attempting to assess disaster damage at the county or municipal level. Furthermore, for this project, much of the baseline data was procured from existing hazard mitigation plans or emergency operations plans, which tended to be crafted at the county level, complicating the desired city- and municipal-level evaluations of recovery status.

Discrepancies also may occur between available data owing to the length of time that has passed between the reporting of the baseline status and the achievement of a recovery goal or activity. For instance, the *City of Hoboken Master Plan* was used in this case study to determine the baseline status of certain recovery indicators on the Checklist. Since it was written and adopted in 2004, US Census data from 2000 is reported within the Plan's fact-base. Consequently, it is likely that this data does not reflect a true baseline condition if a disaster were to strike Hoboken tomorrow. Recovery indicators most sensitive to this limitation include demographic statistics such as population data, community racial composition, and economic indicators like median household income and median home values; efforts should be taken to ensure that the Checklist is populated with the most up-to-date data available, from, inter alia, the United States Census Bureau's American Community Survey.

One of the main issues to surface during the evaluation of the current status of the indicators, for both New Hanover County, NC, and Hoboken, NJ, was a lack of publicly available online media resources. Major media outlets in the two communities (most notably *The New York Times* and *Wilmington Star-News*) had full access to articles restricted by subscriber-only services. While university researchers generally have access to these media resources through institutional use agreements, field practitioners may not enjoy the same level of access. The media restrictions were less limiting in Hoboken, where a number of competing media entities operated; in New Hanover County, however, restricted access to the region's main newspaper greatly hinders the practitioner's ability to gather data from post-disaster media reports. An additional limitation to the use of electronic media is that it may include reports that are biased or erroneous. This can be addressed by focusing on information related to observable phenomena (such as utility outages) rather than reports on behaviour or perceptions (Chang, McDaniels, and Beaubien, 2009).

Overall, the use of the RSFs and Core Capabilities as an organising principle ensured the inclusion of the priorities of the whole community (for instance, federal agencies, non-governmental partners, and other stakeholders) in the indicators, focus areas, and metrics. The study team does not believe that the use of the RSFs and Core Capabilities as an organising structure limited the types of indicators and metrics ultimately included in the Checklist, as all indicators and metrics were recorded as part of the literature review before they were sorted by RSF and Core Capability. The use of this framework, though, may limit the applicability of the Checklist to recovery occurring outside of the US. Additional available documents, such as the *Guide to Developing Disaster Recovery Frameworks* (World Bank, 2015), may provide a more appropriate organising structure for recovery indicators and metrics that are most applicable to the international setting.

Finally, several additional limitations are associated with the data used for the validation process. To save time and money by maximising synergies across federally-funded research projects, a group of previously content-analysed recovery plans was employed as a part of the validation process. These plans were selected only from coastal counties on the Atlantic and Gulf Coasts of the US, and hence may have reflected some risks (such as coastal storms) and not others (such as earthquakes). In addition, since the case study communities had also experienced coastal storms (Hurricanes Irene and Sandy, for example), data collected here also may be biased towards the impacts of storm surge, inland flooding, and wind damage. It is felt, though, that the indicators and metrics, initially gathered from studies of many types of disasters across the US and internationally, include measures that account adequately for all hazards.

Future research

Given the above limitations, additional research is planned to validate further, and perhaps consolidate, the indicators to improve on the usability of the Checklist. This

will include key informant interviews with planning and emergency management practitioners at the local, state, and federal level, as well as with academic researchers with expertise in disaster recovery (based on their published scholarship). Focus groups with practitioners also are planned, as are pilot field tests with planners, emergency managers, and members of long-term recovery committees.

Conclusion

The findings of the literature review were widely supported by the evaluation of recovery plans from coastal counties and by the two case studies. Both indicated that a large number of the recovery indicators and metrics documented in the literature were well represented, within the fact-base of community planning documents (baseline conditions) and within electronic media reports following a disaster (current status data). However, this project also revealed that the information and data being provided in existing planning documents (including comprehensive plans and hazard mitigation plans) often are not the same as that being communicated post disaster. This discrepancy is most apparent in the fact that both baseline data and current status data for individual recovery indicators rarely were discovered.

The preparation of a high-quality community pre-disaster recovery plan might help to narrow this information gap. The development and dissemination of the Community Recovery Checklist hopefully will assist in this endeavour, as well as in the documentation and the regular updating of baseline data prior to a natural disaster and in the documentation of how well a community is recovering from such an event.

Acknowledgements

This material is based on work that was supported by the Coastal Hazards Center of Excellence—a US Department of Homeland Security Science and Technology Directorate Center of Excellence—under Award Number 2008-ST-061-ND 0001. The views and conclusions contained in this document are those of the authors and they should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Science and Technology Directorate, Department of Homeland Security.

Correspondence

Jennifer Horney, Associate Professor, Epidemiology and Biostatistics, School of Public Health, 1266 TAMU, College Station, TX 77843, United States.

E-mail: horney@sph.tamhsc.edu

Endnotes

- ¹ Jennifer Horney is an Associate Professor, Epidemiology and Biostatistics, at Texas A&M University, United States; Caroline Dwyer is a Research Assistant, City and Regional Planning, at the University of North Carolina at Chapel Hill, United States; Meghan Aminto is a Research Assistant, City and Regional Planning, at the University of North Carolina at Chapel Hill, United States; Philip Berke is a Professor, Landscape Architecture and Urban Planning, at Texas A&M University, United States; Gavin Smith is a Research Professor, City and Regional Planning, at the University of North Carolina at Chapel Hill, United States.
- ² Personal communication with Walker Banning, Community Program Manager, Florida Department of Community Affairs, Tallahassee, Florida, 30 April 2009.
- ³ See: Kates et al., 2006; Tanaka, Shigekawa, and Takashima, 2007; Topping, Siembieda, and Boswell, 2007; Toshikazu, 2007; Brown et al., 2008; Ganapati and Ganapati, 2008; Glavovic, 2008; Kondo, 2008; Olshansky et al., 2008; Robinson and Jarvie, 2008; Powell, 2009; Zhang and Peacock, 2009; Afedzie and McEntire, 2010; Comfort et al., 2010; Finch, Emrich, and Cutter, 2010; Garnett and Moore, 2010; Godschalk, Brody, and Burby, 2010; Rose, Wei, and Wein, 2010; Sherrieb, Norris, and Galea, 2010; Burton, Mitchell, and Cutter, 2011; Chamlee-Wright and Storr, 2011; Corey and Deitch, 2011; DeMel, McKenzie, and Woodruff, 2011; Haynes, Danes, and Stafford, 2011; Hill, Weiner, and Warner, 2011; Johnston et al., 2011; Jordan, Javernick, and Amadei, 2011; Xiao, 2011; Alesch and Siembieda, 2012; Athukorala, 2012; Berke and Glovavic, 2012; Blakely, 2012; Chang and Rose, 2012; Chang et al., 2012; Freeman et al., 2012; Ganapati, 2012; Ganapati, Cheng, and Ganapati, 2012; Guarnacci, 2012; Hayashi, M., 2012; Hayashi, T., 2012; Johnson and Hayashi, 2012; Johnston, Becker, and Paton, 2012; Jordan and Javernick-Will, 2012; Jordan, Javernick-Will, and Amadei, 2012; Kusumasari and Alam, 2012; Liu et al., 2012; Mannakkara, Wilkinson, and Potangaroa, 2012; Miller, 2012; Mulligan and Nadarajah, 2012; Smith and Birkland, 2012; Storr and Haefle-Balech, 2012; Teirney and Oliver-Smith, 2012; Unen, 2012; Xu and Lu, 2012; Doberstein and Stager, 2013; Kim and Choi, 2013; Parvin and Shaw, 2013.

References

- Acosta, J., A. Chandra, and K.C. Feeney (2010) *Navigating the Road to Recovery: Assessment of the Coordination, Communication and Financing of the Disaster Case Management Pilot in Louisiana*. RAND Corporation, Santa Monica, CA. http://www.rand.org/pubs/technical_reports/TR849.html (last accessed on 27 January 2016).
- Afedzie, R. and D.A. McEntire (2010) 'Rethinking disasters by design'. *Disaster Prevention and Management*. 19(1). pp. 48–58.
- Alesch, D.J. and W. Siembieda (2012) 'The role of the built environment in the recovery of cities and communities from extreme events'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 197–211.
- Astleithner, F., A. Hamedinger, N. Holman, and Y. Rydin (2004) 'Institutions and indicators – the discourse about indicators in the context of sustainability'. *Journal of Housing and the Built Environment*. 19(1). pp. 7–24.
- Athukorala, P. (2012) 'Indian Ocean tsunami: disaster, generosity and recovery'. *Asian Economic Journal*. 26(3). pp. 211–231.
- Bayram, J.D., S. Zuabi, and I. Subbarao (2011) 'Disaster metrics: quantitative benchmarking of hospital surge capacity in trauma related multiple casualty events'. *Disaster Medicine and Public Health Preparedness*. 5(2). pp. 117–124.
- Bean, J. (2002) 'The implementation of the Incident Control System in NSW: span of control and management by objectives'. *Australian Journal of Emergency Management*. 17(3). pp. 8–16.

- Beatley, T. (1994) *Promoting Sustainable Land Use: Mitigating Natural Hazards through Land Use Planning*. Hazard Reduction and Recovery Center, Texas A&M University, College Station, TX.
- Berke, P. and B. Glavovic (2012) 'Ecosystems and disaster resiliency: contributions to a holistic theory of recovery'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 182–196.
- Berke, P. and T. Beatley (1997) *After the Hurricane: Linking Recovery to Sustainable Development in the Caribbean*. Johns Hopkins University Press, Baltimore, MD.
- Berke, P., J. Cooper, M. Aminto, S. Grabich, and J.A. Horney (2014) 'Adaptive planning for disaster recovery and resiliency: an evaluation of 87 local recovery plans in eight states'. *Journal of the American Planning Association*. 80(4). pp. 310–323.
- Berke, P., J. Kartez, and D. Wenger (1993) 'Recovery after disaster: achieving sustainable development, mitigation and equity'. *Disasters*. 17(2). pp. 93–109.
- Blakely, E.J. (2012) 'Recovery of the soul: rebuilding planning in post-Katrina New Orleans'. *Housing Policy Debate*. 22(11). pp. 117–131.
- Brown, D. et al. (2008) *Indicators for Measuring, Monitoring and Evaluating Post-Disaster Recovery*. Proceedings of the Sixth International Workshop on Remote Sensing for Disaster Applications, Pavia, Italy, 11–12 September 2008.
- Burton, C., J.T. Mitchell, and S. Cutter (2011) 'Evaluating post-Katrina recovery in Mississippi using repeat photography'. *Disasters*. 35(3). pp. 488–509.
- Chamlee-Wright, E. and V.H. Storr (2011) 'Social capital as collective narratives and post-disaster community recovery'. *The Sociological Review*. 59(2). pp. 266–282.
- Chandra, A. and J. Acosta (2009) *The Role of Nongovernmental Organizations in Long-term Human Recovery after Disasters*. RAND Corporation, Santa Monica, CA.
- Chang, S.E. and A.Z. Rose (2012) 'Toward a theory of economic recovery from disasters'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 171–181.
- Chang, S.E. and S.B. Miles (2004) 'The dynamics of recovery: a framework'. In Y. Okuyama and S.E. Chang (eds.) *Modeling the Spatial Economic Impact of Disasters*. Springer, Berlin. pp. 181–204.
- Chang, S.E., T. McDaniels, and C. Beaubien (2009) *Societal Impacts of Infrastructure Failure Interdependencies: Building an Empirical Knowledge Base*. Proceedings of the Technical Council on Lifeline Earthquake Engineering Conference, Oakland, CA, US, 28 June–1 July 2009.
- Chang, Y., S. Wilkinson, R. Potangoroa, and E. Seville (2012) 'Managing resources in disaster recovery projects'. *Engineering, Construction and Architectural Management*. 19(5). pp. 557–580.
- Clay, P.M., A. Kitts, and P. Pinto da Silva (2014) 'Measuring the social and economic performance of catch share programs: definition of metrics and application to the U.S. northeast region groundfish fishery'. *Marine Policy*. 44. pp. 27–36.
- Comfort, L. et al. (2011) 'Factors affecting business recovery immediately after Hurricane Katrina'. *Journal of Contingencies and Crisis Management*. 19(3). pp. 169–181.
- Comfort, L., T. Birkland, B.A. Cigler, and E. Nance (2010) 'Retrospectives and prospectives on Hurricane Katrina: five years and counting'. *Public Administration Review*. 70(5). pp. 669–678.
- Dash, N., W. Peacock, and B. Morrow (1997) 'And the poor get poorer: a neglected black community'. In W.G. Peacock, B.H. Morrow, and H. Gladwin (eds.) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters*. Routledge, London.
- DeMel, S., D. McKenzie, and D. Woodruff (2011) 'Enterprise recovery following natural disasters'. *The Economic Journal*. 122(559). pp. 64–91.
- Department of Homeland Security (2011a) *National Preparedness Goal*. First edition. September. <http://www.fema.gov/pdf/prepared/npg.pdf> (last accessed on 27 January 2016).
- Department of Homeland Security (2011b) 'Housing recovery support function'. http://www.fema.gov/pdf/recoveryframework/housing_rsf.pdf (last accessed on 27 January 2016).
- Department of Homeland Security (2011c) *National Disaster Recovery Framework: Strengthening Disaster Recovery for the Nation*. September. <http://www.fema.gov/pdf/recoveryframework/ndrf.pdf> (last accessed on 27 January 2016).

- Department of Homeland Security (2012) 'National Disaster Recovery Framework'. <http://www.fema.gov/national-disaster-recovery-framework> (last accessed on 27 January 2016).
- Department of Homeland Security (2013) 'Recovery toolkit'. <http://www.fema.gov/disaster/4086/updates/recovery-toolkit> (last accessed on 27 January 2016).
- Doberstein, B. and H. Stager (2013) 'Towards guidelines for post-disaster vulnerability reduction in informal settlements'. *Disasters*. 37(1). pp. 28–47.
- Dwyer, C. and J.A. Horney (2014) 'Validating indicators of disaster recovery with qualitative research'. *PLoS Currents: Disasters*. 16 December. <http://currents.plos.org/disasters/article/validating-indicators-of-disaster-recovery-with-qualitative-research/> (last accessed on 27 January 2016).
- Federal Emergency Management Agency (2011) 'North Carolina Hurricane Irene (DR-4019)'. <http://www.fema.gov/disaster/4019> (last accessed on 4 February 2016).
- Federal Emergency Management Agency (2014) 'New Jersey Hurricane Sandy (DR-4086)'. <http://www.fema.gov/disaster/4086> (last accessed on 4 February 2016).
- Finch, C., C. Emrich, and S. Cutter (2010) 'Disaster disparities and differential recovery in New Orleans'. *Population and Environment*. 31(4). pp. 179–202.
- Frazier T.G., M.H. Walker, A. Kumari, and C.M. Thompson (2013) 'Opportunities and constraints to hazard mitigation planning'. *Applied Geography*. 40. pp. 52–60.
- Freeman, C., M. Gollop, N. Taylor, and K. Nairn (2012) *Children and Young People's Voices in the Aftermath of the Christchurch Earthquake*. Presentation at the Sixth Australasian Natural Hazards Management Conference, Christchurch, New Zealand, 21–22 August 2012.
- French, S.P., E. Feser, and W.G. Peacock (2008) *Quantitative Models of the Social and Economic Consequences of Earthquakes and Other Natural Hazards*. Mid-America Earthquake Center, University of Illinois at Urbana-Champaign, Urbana, IL.
- Ganapati, N. (2012) 'Enhancing disaster recovery: lessons from exemplary international disaster management practices'. *Public Administration Review*. 72(3). pp. 419–427.
- Ganapati, N. and S. Ganapati (2008) 'Enabling participatory planning after disasters: a case study of the World Bank's housing reconstruction in Turkey'. *Journal of the American Planning Association*. 75(1). pp. 41–59.
- Ganapati, N., S. Cheng, and S. Ganapati (2012) *Resilient Rural Communities? Housing Recovery Patterns Following Hurricane Katrina*. Presentation at the United States Department of Agriculture Disaster Resiliency Conference, University of Central Florida, Orlando, FL, United States, 29 March 2012.
- Garnett, J.D. and M. Moore (2010) 'Enhancing disaster recovery: lessons from exemplary international disaster management practices'. *Journal of Homeland Security and Emergency Management*. 7(1). pp. 1–20.
- Glavovic, B. (2008) 'Sustainable coastal communities in the age of coastal storms: reconceptualising coastal planning as "new" naval architecture'. *Journal of Coastal Conservation*. 12(3). pp. 125–134.
- Godschalk, D., S. Brody, and R. Burby (2010) 'Public participation in natural hazard mitigation policy formation: challenges for comprehensive planning'. *Journal of Environmental Planning and Management*. 46(5). pp. 733–754.
- Government Accountability Office (2008) 'Disaster recovery: past experiences offer recovery lessons for Hurricanes Ike and Gustav and future disasters'. Testimony of Stanley K. Czerwinski, Director of Strategic Issues, before the Subcommittee on Emergency Communications, Preparedness and Response, Community on Homeland Security, House of Representatives. GAO-08-1120.
- Guarnacci, U. (2012) 'Governance for sustainable reconstruction after disasters: lessons from Nias, Indonesia'. *Environmental Development*. 2(1). pp. 73–85.
- Hayashi, M. (2012) 'A quick method for assessing economic damage caused by natural disasters: an epidemiological approach'. *International Advances in Economic Research*. 18(4). pp. 417–427.
- Hayashi, T. (2012) 'Japan's post-disaster economic reconstruction: from Kobe to Tohoku'. *Asian Economic Journal*. 26(3). pp. 189–210.
- Haynes, G., S. Danes, and K. Stafford (2011) 'Influence of federal disaster assistance on family business survival and success'. *Journal of Contingencies and Crisis Management*. 19(2). pp. 86–98.

- Hill, H., J. Wiener, and K. Warner (2011) 'From fatalism to resilience: reducing disaster impacts through systematic investments'. *Disasters*. 36(2). pp. 175–194.
- Horney, J.A., M. Nguyen, D. Salvesen, and P. Berke (2009) 'The effects of pre-disaster recovery plans on post-disaster recovery among socially vulnerable populations'. National Science Foundation Grant, Division of Civil, Mechanical, and Manufacturing Innovation (CMMI) 1066310. http://nsf.gov/awardsearch/showAward?AWD_ID=1066310 (last accessed on 27 January 2016).
- Institute of Medicine Board on Health Sciences Policy (2012) *Post-Incident Recovery Considerations of the Health Care Service Delivery Infrastructure*. National Academies Press, Washington, DC.
- Institute of Medicine Committee on the State of the USA Health Indicators (2009) *State of the USA Health Indicators: Letter Report*. National Academies Press, Washington, DC.
- Johnson, L.A. (2009) *Developing a Management Framework for Local Disaster Recovery: A Study of the U.S. Disaster Recovery Management System and the Management Processes and Outcomes of Disaster Recovery in Three U.S. Cities*. PhD thesis. Kyoto University, Kyoto.
- Johnson, L.A. and H. Hayashi (2012) 'Synthesis efforts in disaster recovery research'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 212–238.
- Johnston, D. et al. (2011) *Exploring Elements of an Effective Recovery Process*. Proceedings of the Ninth Pacific Conference on Earthquake Engineering, Auckland, New Zealand, 14–16 April 2011.
- Johnston, D., J. Becker, and D. Paton (2012) 'Multi-agency community engagement during disaster recovery – lessons from two New Zealand earthquake events'. *Disaster Prevention and Management*. 21(2). pp. 252–268.
- Joint Commission on Accreditation of Healthcare Organizations (1990) *Primer on Indicator Development and Application: Measuring Quality in Health Care*. Oakbrook Terrace, IL.
- Jordan, E. and A. Javernick-Will (2012) *Measuring Community Resilience and Recovery: A Content Analysis of Indicators*. Proceedings of the Construction Research Congress: Construction Challenges in a Flat World, West Lafayette, IN, 21–23 May.
- Jordan, E., A. Javernick-Will, and B. Amadei (2011) *Pathways to Communicate Recovery and Resiliency*. Proceedings of the Engineering Project Organizations Conference, Estes Park, Denver, CO, US, 9–11 August 2011.
- Jordan, E., A. Javernick-Will, and B. Amadei (2012) *A Qualitative Comparative Analysis of Neighborhood Recovery following Hurricane Katrina*. Proceedings of the Engineering Project Organizations Conference, Rheden, Netherlands, 10–12 July 2012.
- Kapucu, N. (2014) 'Collaborative governance and disaster recovery: the National Disaster Recovery Framework (NDRF)'. In R. Shaw (ed.) *Disaster Recovery*. Springer, Tokyo. pp. 41–59.
- Kates, R. W., C.E. Colten, S. Laska, and S.P. Leatherman (2006) 'Reconstruction of New Orleans after Hurricane Katrina: a research perspective'. *Proceedings of the National Academy of Sciences*. 103(40). pp. 14653–14660.
- Kim, K. and J. Choi (2013) 'Breaking the vicious cycle of flood disasters: goals of project management in post-disaster rebuild projects'. *International Journal of Project Management*. 31(1). pp. 147–160.
- Kondo T. (2008) *Planning for Post-Disaster Recovery in New Orleans after Hurricane Katrina*. Proceedings of the International Symposium on City Planning, Jeonju, Republic of Korea, 21–23 August 2008.
- Kusumasari B. and Q. Alam (2012) 'Local wisdom-based disaster recovery model in Indonesia'. *Disaster Prevention and Management*. 21(3). pp. 351–369.
- Liu, C., W.C. Black, F.C. Lawrence, and M.E.B. Garrison (2012) 'Post-disaster coping and recovery: the role of perceived changes in retail facilities'. *Journal of Business Research*. 65(5). pp. 641–647.
- Mannakkara, S., S. Wilkinson, and R. Potangaroa (2012) *Build Back Better – Implementation in Victorian Bushfire Reconstruction*. Proceedings of the Sixth Australasian Natural Hazards Management Conference, Christchurch, New Zealand, 21–22 August 2012.
- Mileti, D.S. (1999) *Disasters by Design: A Reassessment of Natural Hazards in the U.S.* Joseph Henry Press, Washington, DC.

- Miller, L.M. (2012) 'Controlling disasters: recognizing latent goals after Hurricane Katrina'. *Disasters*. 36(1). pp. 122–139.
- Miner, M.C. et al. (2010) 'Integrated preparedness for continuity of tuberculosis care after Hurricanes Gustav and Ike: Louisiana and Texas, 2008'. *Public Health Reports*. 125(4). pp. 518–519.
- Mulligan M. and Y. Nadarajah (2012) 'Rebuilding community in the wake of disaster: lessons from the recovery from the 2004 tsunami in Sri Lanka and India'. *Community Development Journal*. 47(3). pp. 353–368.
- National Oceanic and Atmospheric Administration (2012) *Service Assessment: Hurricane/Post-Tropical Cyclone Sandy, October 22–29, 2012*. <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf> (last accessed on 27 January 2016).
- National Research Council (2006) *Hazards and Disaster Research, Social Science, and Public Policy*. National Academies Press, Washington, DC.
- National Research Council (2012) *Disaster Resilience: A National Imperative*. National Academies Press, Washington, DC.
- North Carolina Division of Coastal Management (2000) *Post-Hurricane Recovery Policies from Current CAMA Land Use Plans*. North Carolina Division of Coastal Management, Raleigh, NC.
- Olshansky, R.B. and L.A. Johnson (2010) *Clear as Mud: Planning for the Rebuilding of New Orleans*. Island Press, Washington, DC.
- Olshansky, R.B., L.A. Johnson, J. Horne, and B. Nee (2008) 'Longer view: planning for the rebuilding of New Orleans'. *Journal of the American Planning Association*. 74(3). pp. 273–287.
- Parvin, G.A. and R. Shaw (2013) 'Microfinance institutions and a coastal community's disaster risk reduction, response, and recovery process: a case study of Hatiya, Bangladesh'. *Disasters*. 37(1). pp. 165–184.
- Paton, D. and D. Johnston (2001) 'Disasters and communities: vulnerability, resilience and preparedness'. *Disaster Prevention and Management*. 10(4). pp. 270–277.
- Peacock, W.G. et al. (2008) 'Toward a Resiliency and Vulnerability Observatory Network: RAVON'. <http://www.nehrp.gov/pdf/ravon.pdf> (last accessed on 27 January 2016).
- Powell, F. (2009) *Business Recovery and the Rebuilding of Commercial Property*. Proceedings of the 'Shaken Up' Workshop on Recovery following the Gisborne Earthquake, Wellington, New Zealand, 7 December 2009.
- Reiss, C.L. (ed.) (2012) 'Special issue on disaster recovery'. *International Journal of Emergency and Disasters*. 30(2). pp. 120–247.
- restoreyoureconomy.org (2009) 'Louisiana speaks: long term community recovery planning'. <http://restoreyoureconomy.org/louisiana-speaks-long-term-community-recovery-planning/> (last accessed on 27 January 2016).
- Robinson, L. and J.K. Jarvie (2008) 'Post-disaster community tourism recovery: the tsunami and Arugam Bay, Sri Lanka'. *Disasters*. 32(4). pp. 631–645.
- Rose, A.Z., D. Wei, and A. Wein (2010) *Economic Impacts of the Shakeout Scenario*. Non-published Research Reports. Paper 87. http://research.create.usc.edu/cgi/viewcontent.cgi?article=1117&context=nonpublished_reports (last accessed on 27 January 2016).
- Rubin, C.B. (1985) 'Contributions to effective recovery'. In C.B. Rubin, M.D. Saperstein, and D.G. Barbee (eds.) *Community Recovery from a Major Natural Disaster*. Institute of Behavioral Science, University of Colorado, Boulder, CO. pp. 44–57.
- Rubin, C.B. and R. Popkin (1991) *Disaster Recovery from Hurricane Hugo in South Carolina*. Working Paper No. 69. Natural Hazard Research, Center for International Science, Technology and Public Policy, George Washington University, Washington, DC.
- Schwab, J., K. Topping, C. Eadie, R. Deyle, and R. Smith (1998) *Planning for Post-Disaster Recovery and Reconstruction*. Planning Advisory Service Report No. 483/484. American Planning Association, Chicago, IL.

- Sherrieb, K., F.H Norris, and S. Galea (2010) 'Measuring capacities for community resilience'. *Social Indicators Research*. 99(2). pp. 227–247.
- Smith, G. and T. Birkland (2012) 'Building a theory of recovery: institutional dimensions'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 147–170.
- Smith, G.P. (2012) *Planning for Post-Disaster Recovery: A Review of the U.S. Disaster Assistance Framework*. Island Press, Washington, DC.
- Smith, G.P. and D. Wenger (2007) 'Sustainable disaster recovery: operationalizing an existing agenda'. In H. Rodriguez, E.L. Quarantelli, and R. Dynes (eds.) *Handbook of Disaster Research*. Springer, New York, NY. pp. 234–274.
- Storr V.H. and S. Haefle-Balch (2012) 'Post-disaster community recovery in heterogeneous, loosely connected communities'. *Review of Social Economy*. 70(3). pp. 295–314.
- Tanaka, S., K. Shigekawa, and M. Takashima (2007) *Analysis of the Building Damage Evaluation Processes in Japan: A Case Study from the Recent Earthquake Disasters*. Proceedings of the Second International Conference on Urban Disaster Reduction, Taipei, Taiwan, 27–29 November 2007.
- Tierney, K. and A. Oliver-Smith (2012) 'Social dimensions of disaster recovery'. *International Journal of Mass Emergencies and Disasters*. 30(2). pp. 123–146.
- Topping, K., W. Siembieda, and M. Boswell (2007) *Transfer of Stakeholder-Based Disaster Risk Reduction Lessons: Assessment of California Local Hazard Mitigation Planning*. Proceedings of the Second International Conference on Urban Disaster Reduction, Taipei, Taiwan, 27–29 November 2007.
- Toshikazu, O. (2007) *The Kobe City Restoration Plan: Factors that Facilitated its Rapid Formulation*. Proceedings of the Second International Conference on Urban Disaster Reduction, Taipei, Taiwan, 27–29 November 2007.
- Unen, H.C. (2012) Developing a Framework for a Social Vulnerability and Consequence-Based Post-Disaster Behavior Analysis Methodology. Proceedings of the Ninth International Conference on Information Systems for Crisis Response and Management, Vancouver, Canada, 22–25 April 2012.
- United State Census Bureau (2014a) 'State and county quick facts: Hoboken (city), New Jersey'. <http://quickfacts.census.gov/qfd/states/34/3432250.html> (last accessed on 27 January 2016).
- United State Census Bureau (2014b) 'State and county quick facts: New Hanover County, North Carolina'. <http://quickfacts.census.gov/qfd/states/37/37129.html> (last accessed on 27 January 2016).
- World Bank (2015) Guide to Developing Disaster Recovery Frameworks. Sendai Conference Version. March. <https://www.gfdrr.org/sites/gfdrr/files/publication/DRF-Guide.pdf> (last accessed on 27 January 2016).
- Xiao, Y. (2011) 'Local economic impacts of natural disasters'. *Journal of Regional Science*. 51(4). pp. 804–820.
- Xu, J. and Y. Lu (2012) 'Meta-synthesis pattern of post-disaster recovery and reconstruction: based on actual investigation on 2008 Wenchuan earthquake'. *Natural Hazards*. 60(2). pp. 199–222.
- Zhang, Y., W.G. Peacock (2009) 'Planning for housing recovery? Lessons learned from Hurricane Andrew'. *Journal of the American Planning Association*. 76(1). pp. 5–24.