

# **Quantifying Business Interruption, Downtime, and Recovery following the 2014 South Napa Earthquake and Identifying the Causes**

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## **Abstract**

The Earthquake Engineering Research Institute (EERI) was awarded a grant by the National Science Foundation (NSF), titled “Seismic Observatory for Community Resilience”, to identify a framework that could observe and measure resilience after future earthquakes. EERI’s Resilience Panel was tasked with fundamentally altering its Learning from Earthquakes (LFE) program to satisfy this objective. Following the 2014 South Napa Earthquake in California, a sub-committee of the EERI Resilience Panel convened a small team of additional researchers who developed a survey tool which can be used by reconnaissance teams, business groups, policy makers, and researchers to track business impacts and recovery after future earthquakes.

The survey is comprised of two separate parts. The first part (Physical Building Damage survey) is meant to be administered directly following an earthquake to record a detailed account of physical structural and non-structural damage caused by the earthquake (utilizing damage state

descriptors for all building component types following the FEMA P-58 approach), contents/inventory damage, utility disruption, and the status of building evaluation placards. The second part (Business Impact survey) was developed to determine the business impacts relative to pre-earthquake business information and health (as a benchmark) and can be administered multiple times over the course of recovery to track how a business recovers from an earthquake (including specifics such as duration of and causes of downtime including construction repair time and impeding factors, revenues/profits, supply chain and customer issues, and financial issues).

The intent of the survey tool is to provide comprehensive data to enable researchers to identify the primary contributors for business interruption, downtime, and recovery. The detailed damage survey, coupled with building-specific downtime information will help to inform new downtime modeling procedures (such as the REDi downtime assessment method). This paper will describe a pilot program which has been

launched in Napa, almost two years after the South Napa Earthquake, to help further develop and refine the survey tool based on user responses and feedback for the purpose of improving future deployment. As part of this pilot program, a small sample of responses to the Business Impact survey were gathered and some case studies will be shared to provide preliminary findings.

## Introduction

As part of the Earthquake Engineering Research Institute (EERI) National Science Foundation (NSF)-funded Community Resilience Observatory Program, EERI invited a team of researchers to discuss ways of understanding the business impacts of an earthquake. The team included 2 engineers and 3 social scientists, with experience in consulting, academics, and regional and federal public agencies. The team first convened in December 2014, and focused discussion around the best ways to understand the effects of the August 24, 2014 South Napa earthquake. Aggregated measures of economic activity could eventually provide an overall estimate of the net costs of the earthquake, in terms of the value of building damage, direct costs of rebuilding, and any short term or long term changes to economic output, employment, or industry competitiveness. The team agreed such data would only scratch the surface of understanding the complexity of how such an event may impact individual businesses or the economy in general, and of the factors or actions that would improve economic resilience to future events.

The multidisciplinary team soon focused on developing a data collection framework for tracking the consequences of an event at the individual building and business level. The team determined that a variety of measures would be needed to understand the type and duration of impacts and the underlying causes and remedies. These included background (pre-event) descriptions of the condition of buildings and of businesses (size, profitability, preparedness efforts), detailed descriptions of building damage (life safety issues, other structural damage), and measures of individual business activity prior to the event and at several intervals following the event. Over the next 18 months, the team convened at approximately monthly intervals to discuss development of a data collection mechanism. This involved development of a set of survey questions that could be used for the immediate purpose of tracking how the impacts of the Napa event affected local businesses, but for broader application to future earthquakes. Surveys of businesses conducted after the Christchurch earthquake were comprehensive and provided a useful precedent. However, the individual responses to these surveys were aggregated and thus only general correlations were identified – it was not possible therefore to identify the causes for how a particular business was impacted. The team

attempted to address this issue to provide more meaningful information that could then be used to influence building design and contingency planning. The Business Impact survey described herein is located at [surveymonkey.com/r/napa-case-study](http://surveymonkey.com/r/napa-case-study).

This paper describes the development of the survey, the results of a pilot effort to launch the survey, and the implications for a longer term effort to consistently track impacts of earthquakes over time to measure resilience. The following section puts this survey development effort in the context of earlier research on business impacts of disasters. The next section briefly describes the survey development process, including some of the major challenges of developing a multipurpose, cross disciplinary set of questions. The following two sections concentrate specifically on the Napa event, the first describing the macro-level impacts to Napa's economy and business community, the second describing the survey launching and some preliminary results, focusing on three illustrative case studies. The concluding section evaluates the results of the survey pilot, giving implications for the design of a generic data collection effort across events and across time for a single event, as well as some of the highlights of the Napa pilot survey findings. Since the survey was only completed almost two years after the Napa earthquake the team did not deploy the first part of the survey (which recorded detailed building damage). In addition, due to the delay and because the impacts in Napa were relatively minor as compared to the Christchurch earthquake, the number of responses was limited. Current efforts are being undertaken in conjunction with the Mayor's office to increase business participation.

## Understanding the Effects of Disaster on Local Business from Past Research

A business is vulnerable to natural disasters because of the vulnerabilities of its capital, labor, suppliers, and market (Zhang et al., 2009). Businesses often report direct physical damage, (i.e. damage to a building, equipment, furnishings, and inventory), as a result of a disaster (Dahlhamer and Tierney, 1998; Tierney, 1997), and such damage was found to significantly increase the probabilities of business losses (Chang and Falit-Baiamonte, 2002), as well as forced business relocation and closure (Tierney, 1997a; Wasileski et al., 2011). Business characteristics, such as size, sector, and property ownership (i.e. rent versus own), are important factors to explain business losses (Chang and Falit-Baiamonte, 2002). Small businesses, retail, and renters are more likely to suffer losses (Chang and Falit-Baiamonte, 2002) and encounter closure (Wasileski et al., 2011). Because businesses are linked in societal networks with households, other firms, government, and perhaps international institutions, their vulnerability can be caused by the

vulnerability of the units in their networks; likewise, their vulnerability can be passed on to the other units through the networks (Albala-Bertrand 2009a; 2009b). For instance, business operation depends on its suppliers, such as providers of material, equipment/machinery, and utility lifeline services (i.e. water, electricity, gas, sewage, mail, phone, and internet). Even if a business does not experience physical damage, it may still encounter operational problems and therefore experience losses because of disaster-related interruption to its suppliers (Mayer et al., 2008; Tierney, 1997a; Tierney et al., 1996; Zhang et al., 2009). Disasters may cause changes in a community, which force businesses to adjust to altered consumer demand (Graham, 2007). Evidence shows that businesses can suffer severe losses and even failure due to loss of customers (Alesch et al., 2001; Mayer et al., 2008; Tierney, 1997). Business recovery and household recovery are found to be spatially linked (Xiao and Van Zandt, 2011). To date, the study of business recovery is quite sparse and haphazard. To fully understand the dynamics, we need a comparable and generalizable framework to document business recovery processes over time.

### **The Survey Development Process**

The multidisciplinary team had a broader set of goals for the survey than might have been developed for any single research approach. The business impacts would be influenced by the physical conditions (as defined by building characteristics and physical damage), business characteristics and approaches (as defined by the experience and actions of individual businesses), and the social and institutional setting (as defined by the range of institutions and organizations influencing the ability of building owners to repair and rebuild, of business owners to reestablish operations, and of suppliers and customers to return). The survey also needed to be flexible enough to apply to a range of building or business ownership structures, industry types, and time periods following the event.

Several of the team members who were selected for the project had also been deployed to Napa in the initial period of earthquake response by their various programs. In the course of this earlier work, they had obtained knowledge on the location and types of major physical impacts, as well as some of the types of businesses most seriously affected, and the ways that different firms coped with the impacts.

Survey development was an iterative process. Team members took responsibility for developing segments of the survey reflecting their areas of expertise. Major components included:

- 1) Baseline building information, such as location, size, age, material, structure, square footage occupied by businesses.
- 2) Baseline business information, including employment size, years at location, tenure status, additional locations within and beyond the affected area, revenues, profitability, growth history, business structure, industry sector(s), customer base, and owner demographics.
- 3) Extent and severity of physical damage to the building structure (utilizing FEMA P-58 damage states), operations and contents; inspection status.
- 4) Building downtime, including site restrictions, repair and relocation history, and duration of repairs and impeding factors such as the time required to obtain financing, find and mobilize a contractor, obtain permits, etc.
- 5) Business impact and recovery, including temporary (or permanent) closure history, temporary or permanent relocation, and any changes to the baseline characteristics (size, revenues, structure, customers, etc.). Also in this section is a series of questions on factors related to the business outcome, ranging from effects on the customer base and supplier networks, to availability of space, to regulatory issues regarding repairs and operations. This section also asked about pre-disaster planning and preparation
- 6) Funding and financing including insurance status before the disaster, insurance payments following the event, and other sources of recovery financing.

The team sent out an initial draft of survey questions for review in summer of 2015. The review went to people knowledgeable about the Napa area and the aftermath of the earthquake, as well as to researchers who had experience conducting surveys in other disaster settings (New Zealand, the east coast experience following Hurricane Sandy, gulf coast following hurricane Ike). Reviewers were asked to comment on clarity of the questions, usefulness for policy or analysis, and were also asked for suggestions on sampling sources and protocol. The review period lengthened the effort, but provided useful insights on several issues.

One of the important items that the team had to grapple with is the balance between the length of the survey and the comprehensiveness of the survey. A respondent who answers all questions thoroughly could need up to an hour to respond. Reviewers commented on the difficulty of getting business owners or managers to take the time to respond to such a lengthy set of questions. The team therefore separated the survey into two main parts – the first to assess the initial

baseline building conditions and physical damage (which should be completed by an engineer or other qualified professional) and the second to assess the baseline business conditions and business impacts.

### **Summary and General Observations from 2014 South Napa Earthquake**

The M6.0 South Napa earthquake struck in the early morning of August 24, 2014. It was a Sunday morning. The shaking was fairly intense in downtown Napa. Several measurement stations recorded pulslike ground motions which reached 1 to 1.5g spectral accelerations for periods of 1 to 1.5 sec (these correspond to a roughly 2,500 year return period) (EERI, 2014). The ground shaking at shorter periods was lower (corresponding roughly to a 225 year return period).

Structural damage to older residential buildings and unreinforced masonry buildings was extensive. Non-structural damage was prevalent, even in newer engineered buildings. Utility disruption was relatively limited. It took less than 36 hours to restore all power (Quackenbush, 2015).

### **General Impacts to Napa Businesses**

When the M6.0 Napa earthquake struck, approximately 12,000 businesses were operating in the city of Napa (InfoUSA, 2014), and the greatest number of businesses were in the physician/surgeons, attorney and restaurant sectors (6-digit NAICS). Outside of the city the greatest number of businesses were wineries (manufacturing) and vineyards. Over the last two years, business impact information has been reported in an ATC building/tag survey (EERI Clearinghouse); early surveys of downtown businesses, wineries, and hotels (written communication, Jennifer LaLiberte, 2015); a list of closed businesses and repair permit data (written communication, Robin Klingbeil, 2016); media articles, conversations with businesses by some of the survey team members, and EDD employment data.

Initial reports of the earthquake noted extensive shaking damage to building contents, and inventories, loosened ceiling tiles; broken windows; collapsed facades, complete damage to historic buildings and adjacency risks to nearby buildings in the downtown. Wineries suffered fallen barrels which spilled wine. Damage to building water infrastructure also made buildings (or parts of them) uninhabitable primarily due to electrical hazards. Thirty six businesses suffered major quake damage and 210 suffered minor damage (Quackenbush, 2015). It is difficult to obtain an accurate count of tagging information for businesses. There were 3680 tagged buildings (all occupancy types) in Napa, 1752 of which were yellow and 199 of which were red (EERI Clearinghouse). Many were tagged due to adjacent buildings

which suffered severe damage and were not damaged themselves. Of the 69 commercial and government building inspections in the ATC data, 14 were red tagged, and 15 were yellow tagged. Today, some red tag buildings have been demolished; others are still cordoned off to prevent access.

Six months after the earthquake, the exact amount of damage to downtown businesses was unknown. Local government had estimated total losses from the quake at \$362 million (including residential damages), with an additional \$80 million to \$100 million in losses to the wine industry, bringing the countywide total to more than \$442 million (Huffman, 2015a). In March 2016, City of Napa permit data indicated \$12 million value of repairs to commercial (including religious) buildings (mostly remodels) and \$13 million for residences (mostly fireplaces, foundations and remodels).

Businesses disruption ranged from less than a day or two for clean-up, or weeks or months for repairs or relocation, and more than a year if relocation was problematic. A handful of businesses in the City of Napa closed permanently as a result of the earthquake damage. Some of these businesses relocated out of the city; some closed in Napa, but had other business locations, while others were planning to move on to another line of business (Huffman, 2015b).

Further disruption was felt through a reduction in the customer base. In the city's survey of lodging establishments two weeks after the earthquake, most lodging establishments reported room cancellations. In conversations with businesses, restaurants reported business was slower for approximately six months. A slowdown in the hospitality sector can be detected in the EDD data that shows slightly depressed employment in Napa county during this time period compared to previous years and other counties. Similarly, the seasonal decline of employment in the manufacturing sector (of which wine making is the top industry), appears to have been exacerbated and elongated compared to previous years. On the other hand, employment in the construction industry did not show the usual downturn during the winter months. This result is consistent with comments by businesses about using local contractors and some repair delays while waiting for labor or materials (glass, in particular). Overall, there is not an obvious effect on employment in the county.

When talking with business owners, it was apparent that the social bonds strengthened the resilience of the community. This was evident through numerous acts of kindness to fellow business owners. They spoke of assistance from community funding sources, storage space, and volunteers. Businesses that opened soon after the earthquake reflected on "retail therapy" in the sense that their stores provided a place for

people to gather and talk. Some businesses which were not disrupted offered temporary space to other businesses which were impacted.

### **Impacts to Individual Napa Businesses from Survey Responses**

As mentioned above, the number of responses to the survey were limited for various reasons. At the time of this report, there are approximately 20 responses from business owners, several of which did not suffer significant business impacts. The case studies presented below were selected because they either reflected a number of similar cases, had building damage and permit data available from other sources, or because they had more significant business impacts relative to the other survey respondents. While general trends or causations cannot be extrapolated from such a limited dataset, it is instructive to share the types of data that was collected and what conclusions could be made for individual businesses. Business identities are kept anonymous and where detailed information would help identify the business, a range is given.

#### **Case Study #1: Coffee Shop in Downtown Napa**

This case study illustrates a scenario which several Napa businesses experienced – the impact of adjacency issues causing site access restriction.

This business is a coffee shop which was opened in the last 5 years and employs less than 10 people. It has a single owner. Approximately 50% of its customers are local and the remaining 50% from national and international locations (likely tourists). Its annual revenues are less than \$500,000. Prior to the earthquake, the business was breaking even but it was growing rapidly.

The business rents the building housing the coffee shop. During the earthquake, it experienced some non-structural damage including ceiling cracks and overhead duct failure according to the ATC survey results. No structural damage was reported. It was a brand new building, with steel moment frames in one direction and reinforced masonry in the other. However, the building was located adjacent to other buildings which experienced significant damage. For that reason, the building was posted as a “yellow” placard.

It took approximately 1 to 3 months for business operations to resume. It took approximately 3 to 6 months for the placard to be changed to “green” because danger from adjacent building damage was removed. It is not clear if business was being conducted while the “yellow” tag was still in place. The street was closed for 16 months and access is still limited (including no parking availability). The

respondent indicated it would be another 2 years until all repairs to surrounding areas will be completed. They also indicated that the inability of customers to access the business was a major impact. Since the earthquake, the customer base has shifted such that 70% are now local (which indicates that less tourists are visiting the area). The business is currently operating at 50% reduced capacity (e.g. fewer hours and closed on some days).

Aside from the major impact of site access restrictions, utility disruption at this site seemed particularly impactful. While electricity and water were restored within 24 hours, natural gas took 6 to 12 months to restore.

The business also suffered cash flow issues and decreased revenues. Prior to the earthquake, the owner had property insurance (including for contents), business interruption insurance, and business liability insurance. A few days after the earthquake, the owner made insurance claims which were rejected. The owner also submitted requests for other funding from the Small Business Administration, corporate assistance, and local, state, or federal assistance, and was rejected on all counts. The owner indicated that the reason they were not eligible for FEMA or other grant money is because they had re-opened. To fund recovery, 70% came from personal savings, 20% from business revenues, and the remainder from debt.

#### **Case Study #2: Downtown Napa Winery Business**

This winery has been in business for approximately 15 years and employs less than 10 people. Approximately 50% of its revenues were from local customers and the remainder from international customers. It was highly profitable and growing prior to the earthquake.

The winery rents administrative office space in a downtown Napa building. The earthquake caused the office to cease operations completely for less than 72 hours and when it resumed, it was operating at 100% capacity. It is currently still operating at normal capacity and the business is fully recovered.

Information about the building and building damage was available from survey data provided by the Applied Technology Council (ATC) and the SEAOC Post-Disaster Performance Observation Committee (PDPOC). The building is an unreinforced masonry (URM) building (with lightweight additions) constructed in the early 1900’s but was seismically retrofitted with steel braces prior to the earthquake. It is three stories tall. The initial posting placard was “yellow” due to minor to moderate structural damage including buckling of some braces. Non-structural damage was insignificant including some cracking of the exterior.

Permit data obtained by Napa shows that the structural repair costs were roughly \$200,000 - \$300,000.

It took more than 1 year to complete the structural repairs. The “yellow” tag was removed between 6 months to 1 year after the earthquake. Since business resumed within 72 hours after the earthquake, this seems to indicate that the business was not impacted by the “yellow tag”.

### **Case Study #3: Winery and Office in Napa**

This business has an office located in Napa, and warehouse outside of Napa. Their wine is produced at a custom crush facility which also caters to other clients. They’ve been in business for more than 10 years with less than 5 employees. 72% of their customer base is national, 25% regional, 2% international, and 1% local. They generate an annual revenue of \$500,000 to \$2,000,000 from their business location in the earthquake impacted region. Before the earthquake, they were growing rapidly.

Immediately after the temblor, this business temporarily ceased operations for 24-72 hours. They suffered some damage in their office including broken furniture and electronics, however, they were majorly impacted at the winery where they suffered from significant inventory loss. The business lost a total of 13,000 gallons of wine when one tank containing 10,500 gal of liquid exploded after falling, and 60 gal barrels containing a total of 2500 gallons toppled over. They lost about 14-15% of their entire bulk wine volume which was a significant financial loss.

The business took 16 hours to clean up the winery. Their employees still came to work to help restore operations despite some of them having lost their homes. Once they resumed the business, they were operating at 25% capacity. Other significant impacts include non-structural damage, site access issues due to neighboring buildings, lack of power and internet, cash flow problems and increased cost of business.

After the disaster, the business was reimbursed 44% of the inventory loss incurred by the custom crush facility which eased their recovery process. They also received discounts on bills by managing partners. One of their brokers offered a no-interest loan to rebuild but the business declined this offer.

The business was not insured prior to the quake, but they acquired insurance afterward that includes earthquake insurance, business property insurance on contents, flood insurance through National Flood Insurance Program, and business liability insurance. Since the earthquake, they have also braced their remaining tanks. The business had a very profitable year following the earthquake, and the loss incurred helped on their tax burden.

### **Lessons on Launching a Post-Disaster Business Survey**

The pilot survey was informative to both the process of launching the survey and the impacts to business from building damage and other aspects of the event.

Several barriers make this type of survey particularly challenging.

- 1) The definition of a “business” is fluid. Any business list may be too comprehensive (for example, including small, part-time or home-based operations) or not comprehensive enough (excluding many small businesses, or excluding branches of firms from outside the area). At the time of the event, with so many other priorities, and with physical disruptions to normal operations, it will be difficult to assemble a representative sample of businesses to survey.
- 2) The definition of the geo-spatial extent of the survey in relation to the earthquake ground motion intensity may lead to over-sampling of impacted businesses (if the extent is too small) or under-sampling (if the extent is too large).
- 3) Businesses that close permanently after the event or that move away from the impacted area may be particularly difficult to identify and include in the survey sample.
- 4) Business owners, especially of sole proprietorships, tend to be very pressed for time and reluctant to spend more than a few minutes on survey responses. Breaking down a set of questions into small segments to be administered at any one time may increase the response rate, but this then presents the challenge of keeping track of the business to be able to administer the survey at several points in time.
- 5) A “personal touch” could improve the willingness of a business proprietor to take the time to respond to a survey. This was the experience of the research team and was also mentioned by one of the reviewers. This approach provides the interviewer with the opportunity to elicit a much richer picture of the firm’s experience, but once the effort shifts from surveying to interviewing, the time commitment of the research team expands, at the same time reducing the ability to broadly cover a large number of businesses.

- 6) A survey approach may fail to capture the complex and idiosyncratic nature of the response efforts. A survey can be most useful when combined with data analysis at the more aggregate level, interviews with key local officials and key participants in response efforts, and participant observation at various stages of response and recovery.
- 7) The business experience is likely to change over time. To capture each of the phases of impact (immediate drop in business, boom for some businesses in the early stages of recovery, construction boom in later months, tapering off of response efforts), the survey will need to be launched at several points in time. At the same time, interpreting the results

Even with these barriers, some meaningful results emerged from the pilot survey responses.

## Summary and Conclusions

A survey tool was developed to help collect information and facilitate research into post-earthquake resilience and recovery. To be effective, a detailed building damage survey should be completed in the immediate aftermath of the earthquake and business impact surveys should be deployed shortly thereafter. This requires pre-earthquake preparation on the part of non-profit organizations that are involved in post-earthquake reconnaissance to ensure that the tools are available and a general data collection plan is in place. Thus, the next steps would be to establish a protocol for rolling this out after an event, including how to identify the sample at the outset, build the sample over time, and distribute the survey at different stages following the event (to track recovery over time). This may include developing a template to allow particular regions at risk to gather baseline information prior to a disaster, facilitating later analysis.

## References

- Albala-Bertrand, J. M. (2009a) *Economic Localization, Societal Networking & Functionality*. Available from: <<http://www.gfdrr.org/gfdrr/node/284>>. [25 September 2011].
- Albala-Bertrand, J. M. (2009b) *Endogenous Reaction and Public Response in a Systemic Context*. Available from: <<http://www.gfdrr.org/gfdrr/node/284>>. [25 September 2011].
- Alesch, D.J., J.N. Holly, E. Mittler, and R. Nagy (2001) *Organizations at Risk: What Happens When Small Businesses and Not-for-Profits Encounter Natural Disasters*. Fairfax, VA: Public Entity Risk Institute.
- Chang, S. E., and A. Falit-Baiamonte (2002) *Disaster vulnerability of businesses in the 2001 Nisqually earthquake*. Global Environmental Change Part B: Environmental Hazards. 4(2-3). pp. 59-71.
- Dahlhamer, J.M., and K.J. Tierney (1998) *Rebounding from Disruptive Events: Business Recovery following the Northridge Earthquake*. Sociological Spectrum. 18(2). pp. 121-141.
- EERI (2014) *Special Earthquake Report: M6.0 South Napa Earthquake of August 24, 2014*. Earthquake Engineering Research Institute. October, 2014
- EERI Clearinghouse, South Napa Earthquake. Available from <<http://eqclearinghouse.org/map/2014-08-24-south-napa/>>
- Graham, Leigh T (2007) *Permanently Failing Organizations? Small Business Recovery After September 11, 2001*. Economic Development Quarterly. 21(4). pp. 299-314.
- Huffman, J. (2015a) *6 Months Later, Napa Businesses Bounce Back*. Napa Valley Register. Available from <[http://napavalleyregister.com/news/local/six-months-later-downtown-napa-businesses-bounce-back/article\\_9c3bae53-13c5-528e-af98-698160763af4.html](http://napavalleyregister.com/news/local/six-months-later-downtown-napa-businesses-bounce-back/article_9c3bae53-13c5-528e-af98-698160763af4.html)> [23 February, 2015]
- Huffman, J. (2015b) *Dozens of Business Changes Alter Face of Downtown in 2014*. Available from <[http://napavalleyregister.com/news/local/dozens-of-business-changes-alter-face-of-downtown-in/article\\_510b473c-cb38-57b9-b73c-8bad850d1234.html](http://napavalleyregister.com/news/local/dozens-of-business-changes-alter-face-of-downtown-in/article_510b473c-cb38-57b9-b73c-8bad850d1234.html)> [1 March, 2015]
- Mayer, Bradley W., Jimmy Moss, and Kathleen Dale (2008) *Disaster and Preparedness: Lessons from Hurricane Rita*. Journal of Contingencies & Crisis Management. 16(1). pp. 14-23.
- Quackenbush, G. (2015) *Lessons from Napa Quake Recovery*. The North Bay Business Journal. Available from <<http://www.northbaybusinessjournal.com/industrynews/construction/3074179-181/lessons-from-napa-quake-recovery>>. [25 March, 2015]
- Tierney, K. J. (1997a) *Business impacts of the Northridge earthquake*. Journal of Contingencies & Crisis Management. 5(2). pp. 87-97.
- Tierney, K. J., Joanne M. Nigg, and James M. Dahlhamer (1996) *The Impact of the 1993 Midwest Floods: Business Vulnerability and Disruption in Des Moines*. In Richard T. Sylves and William L. JR. Waugh (eds) *Disaster Management in the U.S. and Canada: The politics, policymaking, administration and analysis of emergency management*. Springfield, IL: Charles C Thomas Publisher, LTD. pp. 214-233
- Wasileski, Gabriela, Havidan Rodriguez, and Walter Diaz (2011) *Business Closure and Relocation: a Comparative Analysis of the Loma Prieta*

*Earthquake and Hurricane Andrew*. *Disasters*.  
35(1). pp. 102-129.

Zhang, Yang, Michael K. Lindell, and Carla S. Prater (2009)  
*Vulnerability of community businesses to  
environmental disasters*. *Disasters*. 33(1). pp. 38-57.

Xiao, Yu and Shannon Van Zandt (2011) *Building  
Community Resiliency: Spatial Links between  
Household and Business Post-Disaster Return*.  
*Urban Studies*. 49(11) 2523-2542.