

# **Vulnerability of Community Businesses to Environmental Disasters**

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## TABLE OF CONTENTS

ABSTRACT .....	3
VULNERABILITY OF COMMUNITY BUSINESSES TO ENVIRONMENTAL DISASTERS .....	4
PREVIOUS RESEARCH ON ECONOMIC IMPACTS OF DISASTERS .....	5
A CONCEPTUAL MODEL OF DISASTER IMPACTS ON BUSINESSES .....	7
<i>Capital vulnerability</i> .....	10
<i>Labor vulnerability</i> .....	11
<i>Supplier vulnerability</i> .....	13
<i>Customer vulnerability</i> .....	14
<i>Modeling business recovery and production losses/gains</i> .....	17
EFFECTS OF HAZARD ADJUSTMENTS ON BUSINESS VULNERABILITY.....	20
IMPLICATIONS FOR POLICY AND FUTURE RESEARCH .....	23
REFERENCES .....	30

## ABSTRACT

**Key words:** disasters, vulnerability, business, post-disaster recovery, disaster planning

Business plays important roles in community functioning. However, disaster research has been disproportionately focusing on units of analysis such as families, households, and government agencies. This paper synthesizes the major findings within the business development research field and those within the disaster research field. It constructs a research framework for evaluating business vulnerability to natural disasters. Our theoretical integration of the research conducted to date addresses five major issues. First, it defines the ways in which businesses are subject to the impacts of natural disasters. Second, it identifies the factors that determine the magnitude of business impacts after a disaster. Third, it identifies how and when businesses will return to their pre-disaster level in the disaster stricken community. Fourth, it outlines how business impacts interact with other aspects of community impacts (i.e. socio-demographic impacts) of natural disasters? Fifth, it discusses which business sectors are winners and which are losers in response to a natural disaster in terms of how to measure business losses or gains.

## **VULNERABILITY OF COMMUNITY BUSINESSES TO ENVIRONMENTAL DISASTERS**

The research literature on community economic development (e.g., Bergman 1981; Blakely and Bradshaw, 2002) and business strategic planning (e.g., Porter 1985) both recognize that extreme events can have a devastating impact on business viability. In both cases, however, their emphasis has been on events—such as economic recessions and plant closings—originating in the economic system rather than the natural environment. In the disaster literature, research on business impacts has been less developed as well, comparing to the extensive literature on community impacts of environmental disasters (see Lindell and Prater, 2003, for a review). Despite a recognition that businesses play an important socioeconomic role in community functioning by providing products/services, employment opportunities, and taxes (Cochrane 1992), disaster research has tended to focus on families, households, and government agencies (Burby 1998; Tierney, Lindell and Perry, 2001). More research on business impacts is needed so communities can better prepare for, respond to, mitigate against, and recover from environmental disasters. To achieve these aims, the following four questions need to be answered. First, in what ways are businesses affected by environmental disasters? Second, what factors determine the magnitude of a disaster's impacts on local businesses? Third, how and when will businesses return to their pre-disaster levels of production, sales, and profitability? Fourth, what measures can be taken by individual firms and community planners to reduce the impacts of environmental disasters?

## **PREVIOUS RESEARCH ON ECONOMIC IMPACTS OF DISASTERS**

Much of the research on economic impacts of environmental disasters has tended to be carried out on highly aggregated units of analysis, with national and regional business losses being the focal point of most economic research on disaster impacts. Two early studies examining aggregate economic indexes across multiple disasters concluded that, at most, environmental disasters accelerate existing trends (Friesma, Caporaso, Goldstein, Linbery, and McCleary 1979; Wright, Rossi, Wright and Weber-Burdin 1979). More recent studies have adopted inter-industry input-output analysis and social accounting approaches (Boisvert 1992; Cochrane 1974, 1997; Cole 1995 1997; Gordon and Richardson 1996; Kawashima and Kanoh 1990; Rose and Benavides 1997; Rose, Benavides, Chang, Szczesnick and Linn 1997; Wilson 1982) or regional econometric models (Chang 1983; Ellson, Milliman and Roberts 1984; Guimaraes, Hefner and Woodward 1993; West and Lenze 1994). Although these large-scale studies are useful for understanding the national and regional impacts of disasters, their level of aggregation has obscured the differential impacts of disasters on specific types of businesses within the affected communities. Indeed, Kroll, Landis, Shen, and Stryker (1990) showed that aggregation level (e.g. city, county, state) strongly affected conclusions about the economic impacts of the 1989 Loma Prieta earthquake. Thus, microanalytic studies are needed to provide guidance for community planners and business owners in developing better methods for reducing disaster impacts.

Consistent with this principle, other studies of the economic impacts of environmental disasters have examined the ways in which individual business prepare for, are disrupted by, and recover from these events. Dahlhamer and D'Souza (1997),

Dahlhamer and Reshaur (1996), Drabek (1991, 1995), Lindell and Perry (1998), Mileti, Darlington, Fitzpatrick and O'Brien (1993), Tierney (1997a), Tierney and Dahlhamer (1998), and Whitney, Dickerson, and Lindell (2001) have found that disasters disrupt businesses through a variety of mechanisms in addition to direct physical damage to buildings, equipment, vehicles, and inventories. Specifically, disruption of infrastructure such as water/sewer, electric power, fuel (i.e., natural gas), transportation, and telecommunications frequently forces businesses to shut down in the aftermath of a disaster (Alesch, Taylor, Ghanty and Nagy 1993; Kroll, Landis, Shen and Stryker 1990; Tierney 1997b; Tierney and Nigg 1995; Webb, Tierney and Dahlhamer 2000). For example, Tierney (1997b) reported extensive lifeline service interruption after the 1993 Midwest floods caused many business closures in Des Moines, Iowa even though physical damage was confined to a small area. Moreover, disasters can cause population dislocation, losses in discretionary income among those victims who remain in the impact area (which can weaken market demand for many products and services) and competitive pressure from large outside businesses. All of these indirect effects cause small businesses to experience a high rate of failure in the aftermath of a disaster (Alesch and Holly 1996; Alesch, Holly, Mittler and Nagy 2001). Indeed, these factors can produce business failures long after the precipitating event, especially if the community was already in economic decline (Bates and Peacock 1993; Durkin 1984; Webb, Tierney and Dahlhamer 2002), especially those businesses that were marginally profitable before the disaster. Small businesses experience more obstacles than large firms and chains in re-establishing pre-disaster levels of operations. This is because small firms are more likely to be located in non-engineered buildings, depend primarily on neighborhood customers,

lack the capacity to design and implement hazard management programs, lack the financial resources needed for recovery, and lack access to governmental recovery programs (Alesch and Holly 1996; Alesch, et al. 2001; Dahlhamer and Tierney 1996, 1998; Durkin 1984; Kroll et al. 1990).

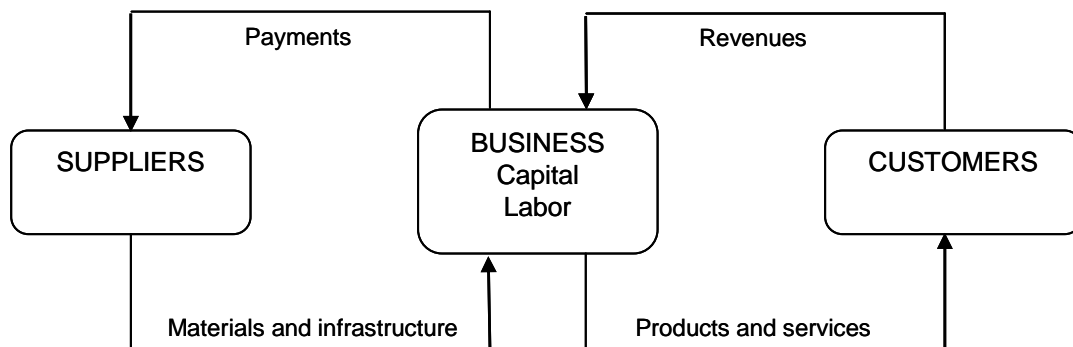
There also is variation among business sectors during recovery. Whereas wholesale and retail businesses generally report experiencing significant sales losses, manufacturing and construction companies often show gains following a disaster (Durkin 1984; Kroll et al. 1990; Webb et al. 2000). Moreover, businesses that serve a large (e.g. regional or international) market tend to recover more rapidly than those that only serve local markets (Webb et al. 2002).

This research provides useful empirical evidence for understanding business impacts of environmental disasters and suggests what measures local businesses can take to reduce their hazard vulnerability. It also provides a basis for local government policies that will protect the community's economic base in the event of environmental disasters. However, none of this research has articulated a systematic model of the business impacts of disasters. Therefore, a systematic model of the business impacts of environmental disasters is presented below.

## **A CONCEPTUAL MODEL OF DISASTER IMPACTS ON BUSINESSES**

Businesses are entities engaging in commercial activities that involve the manipulation and assembly of productive resources to create products and services. Figure 1 depicts the process by which businesses use capital and labor to convert materials and infrastructure received from suppliers into products and services that are

delivered to customers. Capital comprises fixed assets, inventories, and cash, securities, and accounts receivable, whereas labor is the contribution of people working with their knowledge and skills (Brigham and Houston 2002; Schugart, Benjamin, Francia and Strawser 2002). These resources are organized into a value chain that includes purchasing, operations, sales/marketing, service, finance/accounting, research and development (product and process), supervision, general administration (Thompson and Strickland 1996). By selling its products and services to consumers, a business generates revenues that are then returned to suppliers to make payments that maintain business continuity in a dynamic equilibrium of input and output flows. Conversely, interruption of any part of the flow has the potential to jeopardize business viability.



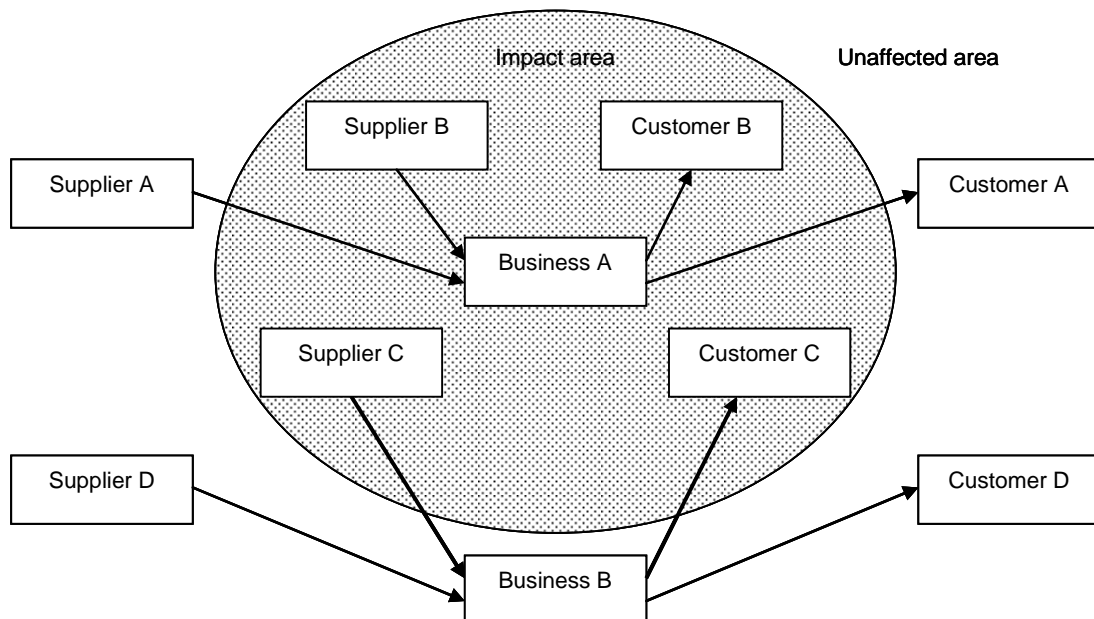
**Figure 1:** Conceptual model of business operations

Government, households, and other businesses all play important roles as suppliers and customers for business operations. Government is a supplier of the road network and some lifeline facilities (e.g. water/sewer, electric power, and fuel) and is also a consumer for some of businesses' products and services. Furthermore, government can influence business development through policies such as taxes, loans, land use, building construction, and capital development (Blakely and Bradshaw 2002). Households contribute to business operations as the primary suppliers of employees and, at the same



time, as the major consumers for most products and services. Finally, inter-business linkages are also important; other firms continually supply those portions of infrastructure not supplied by government and also distribute or consume products and services.

Of course, businesses vary in the geographic areas they serve; some have dispersed markets covering large areas whereas others are supplied by and serve only very local markets. A business inside the impact area (Figure 2) might have suppliers either inside or outside the disaster impact area. Similarly, its customers might be located totally inside, partially inside, or totally outside the impact area. Conversely, a business located outside the impact area can be affected through supplier and customer disruptions. Indeed, it is possible for a business outside the impact area to be more severely affected than one inside the impact area.



**Figure 2:** Businesses' relationship to the disaster impact area

The model presented in this section makes it possible to enumerate the ways in which environmental disasters affect businesses—capital vulnerability, labor vulnerability, supplier vulnerability, and customer vulnerability.

### ***Capital vulnerability***

As noted earlier, business capital can be classified into three categories according to the level of liquidity: fixed assets (e.g. buildings, equipment, furnishings, and vehicles), inventories (e.g. raw materials, intermediate products, and finished products), and cash and securities (e.g. cash, marketable securities, and accounts receivable). Fixed assets are highly vulnerable because they have low mobility and are subject to direct physical damage by disasters. For this reason, businesses with large amounts of fixed assets are more vulnerable than those with small amounts of fixed assets (Alesch et al. 1993; Tierney 1997a; Tierney 1997b). Similarly, businesses with large inventories are highly vulnerable because these materials have low mobility and are subject to direct physical damage. Cash, securities, and accounts receivable are less vulnerable to environmental disasters because they are intangible assets that are processed electronically, so information about them can be stored in multiple locations.

Business vulnerability to environmental disasters also can be affected significantly by managers' decisions about whether to own or lease capital. Leased capital (e.g. leased building and equipment, debt) requires businesses to generate revenue more rapidly than the interest it pays to creditors. In the aftermath of disaster, businesses with lower proportions of leased capital have greater cushions against creditors' interest payments and, thus, face less financial pressure. This is a significant issue because Alesch et al. (2001), Tierney (1997b), and Webb et al. (2000) reported many businesses avoided

recovery loans from the Small Business Administration (SBA) and commercial banks because additional indebtedness would compound their financial burdens. Instead, most small businesses rely on personal savings and grants or loans from relatives.

Business size, measured by the number of employees, is a correlate of a business's ability to cope with environmental disasters (Alesch et al. 2001; Drabek 1991, 1995; Durkin 1984; Kroll et al. 1990; Tierney 1997b). Small businesses have encountered many more obstacles to recover from disaster effects than large ones, but many factors can account for this finding. Large firms are more likely to spread their risk by operating in multiple locations. In addition, large businesses are more likely to be located in newer disaster-resilient facilities and are more likely to have sufficient staff to employ specialists in developing disaster response and recovery (Lindell and Perry 1998; Whitney, et al. 2001). Moreover, large businesses are more likely to be able to afford hazard insurance, business interruption insurance, or contingency funds for disaster recovery. Large businesses also have a significant amount of financial and political influence in their communities, which gives them a high priority in governmental recovery policies and also substantial influence in getting private contractors to rebuild their facilities first. Large firms and multi-branch firms are better positioned in inter-business and intra-business collaborations on supplying, purchasing, and labor shifting to cope with emergencies. Finally, large businesses are likely to have much stronger input and output ties that facilitate recovery from disasters.

### ***Labor vulnerability***

Environmental disasters can disrupt businesses' labor inputs by causing significant short-term population changes in a disaster-stricken community. Employee casualties

(deaths, injuries, and illnesses) will obviously hinder normal business operations because employees are either permanently or temporarily unavailable for work. The degree of disruption to a business depends upon the ease of employee replacement. All other factors being equal, a large labor pool and reliance on less skilled workers makes it easier to replace employees that have been displaced by a disaster. Similarly, casualties within employees' families could either reduce their work hours or require extended leaves of absence. Moreover, damage to employees' dwellings might cause victims to relocate permanently or to move into temporary housing for a lengthy period of time (Bolin and Stanford 1998; Girard and Peacock 1997; Quarantelli 1982). In some cases, permanent employee dislocation causes employee turnover because the new housing is so far from the workplace that it is infeasible to continue with an employer. However, even temporary population dislocation can disrupt business operations many ways. For example, victim employees can become so preoccupied restoring their household routines that their working hours must be reduced or entirely curtailed for some period of time. Such tasks include filing insurance claims, applying for building permits, applying for loans or grants, cleaning debris, and repairing structural damage. Moreover, even employees that can remain in their homes can be kept from working by disrupted access to workplaces. For instance, closure of the Oakland/San Francisco Bay Bridge following the 1989 Loma Prieta earthquake required a quarter-million commuters to rearrange their travel patterns. Many of these were forced to take longer, more costly routes to work. Damage also caused closure of the major highway linking Santa Cruz to job centers in Santa Clara County, so many people changed from private vehicles to rail or bus services (Federal Emergency Management Agency 1999). Kroll, et al. (1990) concluded that

damage to transportation networks after the Loma Prieta earthquake caused significant economic impacts in San Francisco Bay Area and Santa Cruz area.

A business's internal labor organization—defined in terms of the coordination of employees' working times and locations—also affects the magnitude of disaster impacts. Businesses with flexible forms of labor organization can return to operation shortly after the event, but this response varies by type of business. After the 1989 Loma Prieta earthquake, flexible work hours were widely used in FIRE sector (40.6% of affected companies) and manufacturing (45.5%), but significantly less in construction firms (22.2%) in the Oakland and Santa Cruz areas. However, employees' work locations are less flexible than work hours, so only 10 percent of the companies in the FIRE sector and almost none in the manufacturing and construction sectors allowed employees to work at home (Kroll et al. 1990).

### ***Supplier vulnerability***

Tierney and Nigg (1995) and Tierney (1997b) reported water/sewer, electric power, fuel (e.g., natural gas pipelines), telecommunications, and transportation experienced varying degrees of interruption after the 1993 Midwest flood and 1994 Northridge earthquake and loss of lifeline services was among the main reasons for business closure after these disasters. Their research found lifelines vary significantly in the immediacy of their disruptive effects, with Nigg's (1995) study in Memphis and Shelby County reporting business owners' estimates of the amount of time their businesses could continue operation after different types of infrastructure loss: 0 hours for electricity, 4 hours for telephones, 48 hours for water/sewer, and 120 hour for natural gas.

Disasters can close suppliers, which can force a business to adjust to materials shortage for at least a short time even if it does not experience any physical damages. Suppose a neighborhood grocery store depends on a regional distribution center for its supplies. If this distribution center suffers severe damage and is forced to shut down, the grocery store must either find a new business partner or also suspend operations. This “domino” effect on production operations produces an economic multiplier in which indirect losses ripple out from the direct losses. Thus, businesses experience *direct* losses when their capital assets are physically damaged and *indirect* losses when they are functionally connected to other businesses that have themselves experienced either direct or indirect losses (Committee on Assessing the Costs of Natural Disasters 1999).

### ***Customer vulnerability***

For the same reasons as they lose employees, businesses can also lose customers during the disaster aftermath either because of population casualties or, more likely, short-term population dislocation. In addition, demographic changes in disaster stricken communities can destroy the established customer base of local businesses (Girard and Peacock 1997; Smith 1996; Smith and McCarty 1996). A long period of regaining new customers could be fatal for some firms, especially small ones (Alesch et al. 2001). Furthermore, disasters can cause consumer preferences to change and thus influence the market demand for some products and services. Following a major disaster that causes extensive building damage, victims will tend to decrease their consumption of luxury goods and services. For those businesses that provide only these products and services, a disaster can cause an immediate drop in sales.

This problem is especially difficult for impacted businesses serving only a market in the impact area (Alesch and Holly 1996; Alesch et al. 2000; Webb et al. 2000, 2002). Businesses of this kind, usually small wholesale and retail firms, face the loss of all their sales because of short-term customer losses (e.g. temporary or permanent relocation because of housing damage). By contrast, businesses serving regional or international markets experience less impact on their sales, a phenomenon that explains why manufacturing in the San Francisco Bay Area experienced smaller losses than general wholesale and retail businesses after the Loma Prieta earthquake (Kroll et al. 1990). As is the case with consumers, inter-business purchasing partnerships are also subject to disaster-induced disruption. If a major buyer suffers serious disaster impact and decreases its purchases, then the provider business will soon experience decreased sales unless it can find alternate customers.

It is important to recognize that some demand shifts rather than disappears. Specifically, households put more of their expenditures into reconstructing their homes and replacing damaged furnishings. Consequently, disaster relevant industries such as construction, building materials, and home/office furnishings can experience increasing demand from disaster stricken communities to meet short-term needs for reconstruction of residential, commercial, and industrial structures, and infrastructure (Committee on Assessing the Costs of Natural Disasters 1999). In addition, a large influx of construction crews into a community also stimulates demand for hotels and restaurants (Alesch et al. 2001; Webb et al. 2002). One nonobvious consequence of this shift in demand is a compensating shift in supply, as when building supply outlets find themselves facing competition from large outside wholesalers whose sales volume allows them to sell at

lower prices. Furthermore, local demand for construction materials experiences a precipitous drop after reconstruction is finished and remains at a depressed level for several years before returning to a stable replacement rate for these products. This “second wave” disaster continues the pressure on local firms’ sales.

**Table 1: Dimensions of business vulnerability**

<i>Vulnerability Dimensions</i>	<i>Key Factors</i>	<i>Operationalization</i>	<i>Expected Direction of Effect</i>
Capital	1. Capital mobility	1. Proportion of fixed assets, inventories, cash/securities	-
	2. Capital ownership	2. Proportion of owned capital	-
	3. Business size	3. Number of employee	-
Labor	1. Ease of employee replacement	1. Availability of the labor pool	-
	2. Flexibility of labor organization	2. Flexible work hours and/or flexible work locations	-
Supplier	1. Lifeline infrastructure dependence	1. Operation duration without different lifeline infrastructure	+
	2. Inter-business dependence	2. Operation duration without inter-business supplies	+
Customer	1. Market stability	1. Regional/national/local market coverage	-
	2. Reconstruction relevance	2. Reconstruction related or not	-

Based upon the above discussions, Table 1 lists these four dimensions of business vulnerability, the underlying key factors for each dimension, operationalization of each factor, and the expected direction of causal effect of each factor on business vulnerability. Regarding the capital dimension of business vulnerability, mobility, ownership, and business size are three major determinants. These three factors are expected to have negative effects on the level of business vulnerability, which means that business with higher capital mobility, higher proportion of owned capital, and bigger size are less



vulnerable to disasters. For the labor dimension of business vulnerability, ease of employee replacement and flexibility of labor organization are two major determinants. Businesses that have larger labor pool to retain their employee level and those who have flexible labor organization to accommodate the disruption caused by disaster impacts have lower level of vulnerability. The supplier dimension of business vulnerability is determined by dependence on lifeline infrastructure and dependence on other businesses. The higher level of dependence in both cases will lead to higher level vulnerability. For the customer dimension of business vulnerability, market stability and level of reconstruction relevance are two major determinants. These two factors both negatively affect the level of business vulnerability, which means that businesses with larger and more stable market coverage and those with services/products readily for post-disaster reconstruction activities are less vulnerable. Although previous research in disaster literature provides some empirical evidence supporting each dimension of the business vulnerability listed above, few studies have captured all aspects of business vulnerability. More research is needed to fully test the causal relations depicted in the table.

### ***Modeling business recovery and production losses/gains***

One direct implication of these findings is a classification of businesses into groups experiencing similar levels of sales losses following a disaster. Specifically, small wholesale and small retail businesses are generally quite vulnerable to disasters, but wholesale and retail chains, as well as companies in the construction, manufacturing, and FIRE sectors have only moderate vulnerability. Professional services companies such as law firms generally have low vulnerability. However, this generalization must be qualified by noting a need to adjust for businesses' variations in exposure to

environmental hazards within a community as well as the structural vulnerability of their capital assets. In the latter case, decreased structural vulnerability—generally created by more stringent building codes and enforcement—can substantially decrease the absolute level of vulnerability of a given business sector even though the rank order of the different sectors remains the same. For example, local building construction practices are significantly more stringent in the state of California than in other seismic zones (e.g., the New Madrid Seismic Zone; see Prater and Lindell 2000, for an example). Thus, business vulnerability analysis should be conducted at the community level because each community varies in its exposure to environmental hazards, the vulnerability of businesses' capital assets, and the vulnerability of these businesses to direct and indirect losses. For these reasons, it is not currently possible to uniquely define the vulnerability of each economic sector in the North American Industry Classification System.

This discussion of vulnerability also enables us to conceptualize changes in production, sales, and profits—and thus the dynamics of business recovery. In particular, four cases illustrate firms' variation in their post-disaster sales levels. According to Figure 3, gains and losses in sales (the ordinate) over time (the abscissa) are defined by the area enclosed within the (vertical) disaster line, (horizontal) pre-disaster sales level, and (diagonal) recovery curve. Gains are represented by the size of the area above the pre-disaster sales level and losses are represented by the size of the area below the pre-disaster sales level (the shaded area in each panel). The first case is defined by businesses in the impact area having minimal hazard vulnerability. Such businesses (e.g., professional services) experience only small decreases in sales after impact and return quickly to pre-disaster levels (Figure 3a). The second case consists of businesses that also

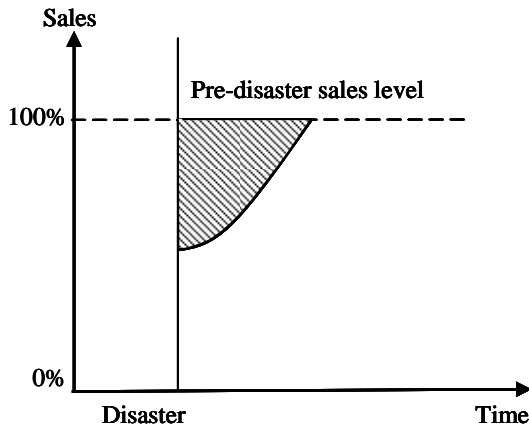


Figure 3a

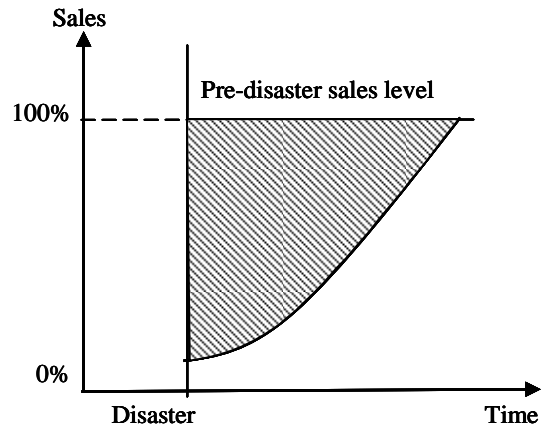


Figure 3b

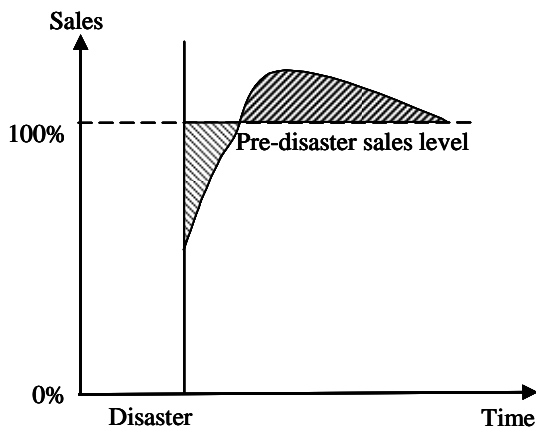


Figure 3c

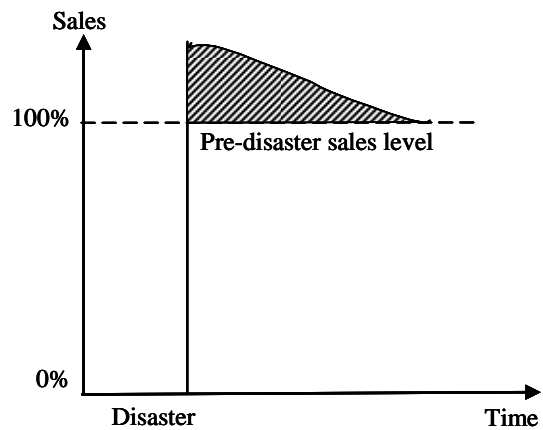


Figure 3d

**Figure 3:** Patterns of business sales changes after environmental disasters

are in the impact area, but have moderate vulnerability. Such businesses (e.g., large manufacturers) experience larger initial drops in their sales levels so recovery takes longer (Figure 3b). By contrast, the third case consists of businesses that experience initial sales losses because they are inside (thus experiencing direct losses) or near (thus experiencing indirect losses) the impact area. However, they later experience an increase in demand for their products/services during disaster aftermath (Figure 3c). Recovery related businesses in the building construction, construction materials, and hospitality (e.g., hotels and restaurants) industries exemplify a pattern in which an initial loss (e.g.,

due to minor damage or infrastructure disruption) is rapidly restored and followed by increased sales. The final case describes recovery related businesses just outside the impact area. Not only do they avoid initial losses, but they also can take advantage of expanded demand in the stricken community to reap gains in the disaster aftermath (Figure 3d).

### **EFFECTS OF HAZARD ADJUSTMENTS ON BUSINESS VULNERABILITY**

Hazard adjustment refers to practices taken to respond to environmental threats in ways that reduce threats to personal safety, property, and community functioning. It is well documented that achievement of community emergency preparedness takes place by pre-impact planning, training, and exercising of four groups of activities: emergency assessment, expedient hazard mitigation, population protection, and incident management (Lindell and Perry 1992, 1996; Perry and Lindell 2003; Tierney, et al. 2001). These emergency preparedness principles should be similar for a business, but the contents are somewhat different from those for a community. Emergency assessment consist of actions that evaluate the potential impacts of an imminent disaster (e.g. monitoring an approaching hurricane), expedient hazard mitigation consists of last-minute actions to protect physical assets (e.g. covering inventory with plastic sheets), population protection aims at protecting employees from impact (e.g. stocking first aid supplies), incident management actions coordinate an emergency response (e.g. establishing backup communications). Actions in the recovery phase include inventorying and salvaging damaged goods, protecting undamaged property, and re-establishing contact with suppliers and customers (Federal Emergency Management Agency, no date).

Some studies examining business hazard adjustment provide only anecdotal data about their implementation and effectiveness. Eguchi and Munroe (1992) reported that before the 1989 Loma Prieta earthquake, the Pacific Gas and Electric Company (PG&E) had a mutual aid plan with Southern California Gas (SCG) addressing emergency inventories, resources, and labor sharing. PG&E also engaged in regular drills involving recovery and restoration of services. After the Loma Prieta earthquake, with support from SCG, PG&E restored disrupted gas service to 50,000 homes within two weeks—four weeks less than the estimated duration. Alesch and Holly (1996) reported cases of mutual emergency coordination on purchasing and distribution among businesses that facilitated a quick recovery following the 1994 Northridge earthquake. Suppliers extended credit periods for victims, whereas customers expedited payment on invoices and, in some cases, even temporarily increased their purchases. In the aftermath of Hurricane Andrew, many corporations in Miami-Dade County mobilized resources to protect their work force (Sanchez, Korbin and Viscarra 1995). Businesses used emergency relief services such as transportation, financial assistance, housing, cleanup, and reconstruction materials support to facilitate employees' rapid return to normal conditions. Businesses in the San Francisco Bay Area affected by the Loma Prieta earthquake introduced several emergency mechanisms (e.g. expanded business hours, new shipping schedules, flexible employee working time, temporary relocation) to minimize operational losses (Kroll et al. 1990). Chemical plants on Texas Gulf Coast were actively involved in county hurricane emergency management so they executed shutdown procedures well before the landfall of Hurricane Bret and resumed normal operations shortly after the hurricane

made landfall (Richards 1999). In summary, business hazard adjustments might take many different forms that depend upon the distinctive nature of their core operations.

Research on household hazard adjustments (for review, see Drabek 1986; Lindell and Perry 2000) suggests that businesses engaging in preparedness and mitigation activities would be less vulnerable to environmental disasters, but the findings of recent studies on business hazard adjustment adoption are inconsistent with this expectation (Dahlhamer and D'Souza 1997; Dahlhamer and Reshaur 1996; Webb et al. 2000). Instead, these researchers found no significant relation between a business's hazard adjustment and the magnitude of the impacts it experienced. To explain the discrepancy, they suggested that most business hazard adjustments involve employees' life safety rather than continuity of business operations. Indeed, these studies used a checklist similar to those employed in studies of household disaster preparedness to evaluate business's preparedness adoption level. Alternatively, the failure to find a significant relationship between hazard adjustment and business impact might arise from selective adoption of hazard adjustments by those at greatest risk. Specifically, it might be that businesses with the greatest levels of hazard adjustment were those that had the greatest initial level of hazard vulnerability. If this were the case, their greater level of hazard adjustment actions might have cancelled out their greater level of hazard vulnerability—thus resulting in comparable levels of damage regardless of the level of hazard adjustment.

## **IMPLICATIONS FOR POLICY AND FUTURE RESEARCH**

Emergency response plans have long drawn wide support from scientists and practitioners as an effective way to guide the immediate response to a disaster (Dynes, Quarantelli and Kreps 1972; Lindell and Perry 1992; Tierney et al. 2001). A more recent emphasis has been the development of pre-disaster recovery plans (Comerio 1998; Geis 1996; Mileti 1999; Schwab, Topping, Eadie, Deyle and Smith 1998; Wilson 1991). Such plans have been found to be effective in accelerating community recovery and integrating mitigation measures into the reconstruction process (Spangle Associates and Robert Olson Associates 1997; Wu and Lindell 2004). However, most policy initiatives in these discussions have been directed toward household recovery (e.g. sheltering and housing), so business recovery has been neglected. Nonetheless, economic development and employment are major issues in the local political agenda, so local government needs to take steps before and after a disaster to protect its economic base by enhancing local businesses' capability to cope with disaster impacts.

Because businesses vary significantly in their vulnerability to disaster impacts, local planners need to work with the businesses in their own communities (Federal Emergency Management Agency 1997, no date). This vulnerability assessment should identify businesses that are located in hazard-prone areas, assess their structural vulnerability, and evaluate their needs for emergency response and disaster recovery after different types (hurricanes, earthquakes, floods) and intensities of environmental disasters. Local jurisdictions should use the information in the vulnerability assessment to revise their emergency response (Federal Emergency Management Agency 1996) and disaster recovery (Schwab et al. 1998) plans to meet the needs of local businesses. Changes in

these emergency response and disaster recovery plans could have important effects on business recovery because local agencies can establish temporary locations for displaced businesses in the immediate aftermath (Durkin 1984), restore disrupted road network and lifeline service in a timely manner (Kroll et al. 1990; Alesch and Holly 1996), expedite building inspection and permit issuing (Kroll et al. 1990), and protect local businesses, especially small firms from the sudden influx of legitimate and “fly-by-night” competitors into the community (Alesch et al. 2001).

This vulnerability assessment can be accomplished through collaboration between community economic development planners and emergency managers. Such cooperation is important because it fulfills statutory obligations of both parties. Economic planners benefit from the hazard analyses conducted by emergency managers which, in turn, will enrich the emerging practice of community economic development contingency planning (Blakely and Bradshaw 2002; Bergman 1981). Conversely, emergency managers can save time and effort by obtaining detailed information directly from economic development planners about the community’s economic base—including an inventory of businesses, their employment levels, and linkages among industries.

In addition, procedures for providing congregate care for displaced households can be readily adapted to accommodate displaced small businesses. For example, Durkin (1984) reported many displaced retail outlets were directed into a local college gymnasium. These businesses were able to operate from temporary booths for about one month until alternative accommodations were available. Procedures that have been incorporated into a community’s pre-impact recovery plan, such as monitoring contractors and retail prices (Wu and Lindell 2004) can also be extended to facilitate



local business recovery. For example, local construction companies can be given a head start by allowing them to register for post-disaster reconstruction before a disaster strikes. Moreover, government contracts for infrastructure restoration can give bonus points to those contractors that utilize local firms. To alleviate the discounted price of construction materials that undercuts the sales of local firms (Alesch et al. 2001), local jurisdictions can promote the establishment of pre-impact group marketing that facilitates pre-disaster ties between local businesses and prospective customers (Blakely and Bradshaw 2002). Local government involvement in such marketing efforts is especially important for small businesses because they generally lack adequate resources for advertising. Businesses can avoid this vulnerability by adopting “just in time” manufacturing but adoption of this strategy can shift vulnerability to telecommunication (for placing orders for new materials and receiving orders for completed products) and transportation (for delivering raw materials and finished products) networks.

Local government can also organize assistance from other businesses to ameliorate the impacts of a disaster by shortening the time that victimized firms take to return to normal operations. Support from the business community can include emergency labor support (Eguchi and Munroe 1992), extended credit from suppliers, accelerated payments for products and services, and above normal levels of purchases made by regular customers (Alesch and Holly 1996). Such arrangements by local planners are sorely needed because federal programs such as SBA loans and Federal Emergency Management Agency (FEMA) recovery programs are often ineffective in facilitating business recovery following environmental disasters (Alesch and Holly 1996; Alesch et al. 2001; Durkin 1984; Kroll et al. 1990; Tierney 1997b). The most frequently cited

reasons include a slow application process and demanding loan requirements. Local governments in disaster impact areas can take actions to establish and maintain closer ties with these federal agencies so arrangements on the locations of program offices, streamlined loan application processes, and local staffing/resource support can be implemented to improve the accessibility of these programs immediately after disaster impact. Indeed, this vertical integration with higher-level government agencies will facilitate the recovery of both households and businesses (Berke 1995; Berke, Kartz and Wenger 1993).

In particular, the emergency response and disaster recovery needs of small businesses deserve special attention from local officials, because they are more vulnerable to disaster impacts than their larger counterparts. This is particularly unfortunate because small business is a crucial contributor to community employment and local government revenue generation. Indeed, small business development has been a long-standing revitalization strategy utilized by local economic development planners and community development corporations, especially in socio-economically distressed neighborhoods (Blakely and Bradshaw 2002; Porter 1997). Disaster research has repeatedly shown that these neighborhoods are disproportionately vulnerable to environmental disasters and experience more difficulties in returning to normalcy after an event (Bates and Peacock 1993; Blaikie, Cannon, Davis and Wisner 1994; Bolin and Stanford 1998; Comerio 1998; Peacock and Girard 1997). For these reasons, it is very likely that policy initiatives facilitating small businesses emergency response and disaster recovery will gain support from different local government agencies, non-government

organizations and residents—an important condition for successful formulation and implementation of hazard mitigation policies (Prater and Lindell 2000).

In addition to developing policies that help businesses after disasters, local government agencies need to encourage businesses to engage in more effective hazard management before disasters strike. However, disaster research has revealed relatively low levels of hazard adjustment adoption, so community hazard awareness programs need to be carefully examined before targeting local businesses. Current research and local practices of risk communication are disproportionately oriented toward households (Lindell and Perry 2004), but business owners and managers also need to be informed of threatening environmental hazards and alternative hazard adjustments. Many corporations have begun to integrate environmental issues into their strategic plans (Douglas and Judge 1995; Makower 1993; Newman and Breeden 1992; Stead and Stead 1992; Taylor 1992), but their primary focus has been the reduction of environmental pollution and resource depletion—not the reduction of vulnerability to environmental disasters. There are clear indications that businesses fail to protect their capital assets before disasters occur because they do not know what can be done (Alesch and Holly 1996).

The discussion presented in this paper only begins to illustrate the uniqueness of businesses' adjustments to environmental hazards. Future research is needed to identify which hazard adjustments are suitable for businesses in general, and which are suitable only for businesses of a particular size or in a particular economic sector. In addition, future research is needed to examine the ways in which local planners and emergency managers can more successfully construct hazard messages, select appropriate

communications channels, and select message source—all of which are all critical components for an effective hazard awareness program (Lindell and Perry 2004). Furthermore, research is needed to identify other policy tools, such as incentives and sanctions, that can effectively induce businesses to adopt hazard adjustments.

One challenge for business disaster preparedness is that investments in hazard mitigation and emergency decrease short-term profitability. For example, employee losses can be avoided by cross training, but this requires an initial investment and might also require refresher training if the alternative tasks are complex. Overstaffing is another strategy to ensure continued labor availability, but this also produces continuing costs. Contracts for outsourcing can limit the routine costs, but the effectiveness of this strategy after a disaster might depend upon the survival of the telecommunications and transportation networks. Thus, further research is needed to identify additional hazard adjustments and increase the effectiveness and reduce the costs of existing adjustments. Several other research questions raised by the business impacts and vulnerability analysis include the more detailed qualitative description and quantitative measure of households' consumption changes before and after a natural disaster and the impact of population dislocation on the viability of businesses in disaster impact areas.

Because this is a preliminary model, further research is needed to provide a closer examination of the emergency response and disaster recovery demands of different business sectors in communities with different natural hazard threats, various impact intensities, and different socioeconomic and socio-demographic settings. Also needed is a more detailed understanding of the ways in which local jurisdictions can facilitate businesses' emergency response and disaster recovery. The business impacts model,

which shows how businesses impacts can result from input disruption (e.g. building/equipment damage, inventory damage, infrastructure failure, and workforce losses) and output disruption (e.g. customer loss, demand shifts) can serve as a starting point for research along this line.

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