AN ABSTRACT OF THE THESIS OF

Monika Z. Moore for the degree of Master of Science in Geography presented on January 8, 2007.

Title: Hazards of Inequality: Comparing Two Neighborhoods in San Francisco in the 1989 Loma Prieta Earthquake

Abstract approved:

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Ronald E. Doel

This study examined two neighborhoods in San Francisco with similar earthquake-induced ground failure history -- the Marina District and the South of Market Area (SoMa) -- in the aftermath of the 1989 Loma Prieta earthquake. The earthquake struck shortly after 5 pm on October 17th, 1989 and registered 6.9 in magnitude, killing 64 people and causing $6 billion in damage. The recovery of the two neighborhoods proceeded at different rates and along dissimilar paths, with the Marina reappearing much the same following a relatively rapid reconstruction, while SoMa's pre-earthquake social and economic problems worsened in the aftermath of the earthquake. This study identified possible factors affecting these different rates including uneven coverage in newspaper media, different pre-earthquake socio-economic make up and different pre-earthquake property types and values. Analysis of the 1989 earthquake, the 1906 San Francisco

earthquake and other disasters such as 2004’s Hurricane Katrina is supplemented by theoretical arguments on ethnicities during disaster, the role of the media in disaster and social processes of recovery during and after disaster to help explain how the physical and social geography of these neighborhoods shaped their earthquake experience.

Hazards of Inequality: Comparing Two Neighborhoods in San Francisco in the 1989 Loma Prieta Earthquake

by
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Major Professor, representing Geography

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Monika Z. Moore, Author

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Chapter 1 Reconstructing Urban Environmental Inequalities, Then and Now

The equanimity with which Californians today coexist with the imminence of natural catastrophe can be explained, in part, by the pathos of such moments, in which the loss of property is offset by the temporary gain of a felt sense of community.
- David Wyatt, *Five Fires*

The sight of collapsed, burning buildings in the Marina is etched into the memory of many San Francisco Bay Area residents that were in the city in 1989 (Fig 1). Images of the Marina burning permeated the air waves and made front page headlines in the days and weeks that followed the magnitude 6.9 earthquake (Bardet et al 1992). But the earthquake itself originated 70 miles south in the Santa Cruz Mountains, causing a wide swath of destruction up and down the Bay (Fig 2). In total, 63 people were killed and $6 billion worth of damage was inflicted on the region in the span of roughly thirty

Figure 1: Photos of Loma Prieta damage in the Marina. Images like these were regularly displayed in newspaper and television media in the aftermath of the quake, likely because of the dramatic scenes (Source: top right USGS 1999, J.K. Nakata 1989, bottom and top left)

seconds (California Geological Survey 2006). The Marina damage was spectacular, but hardly the only site of major destruction.

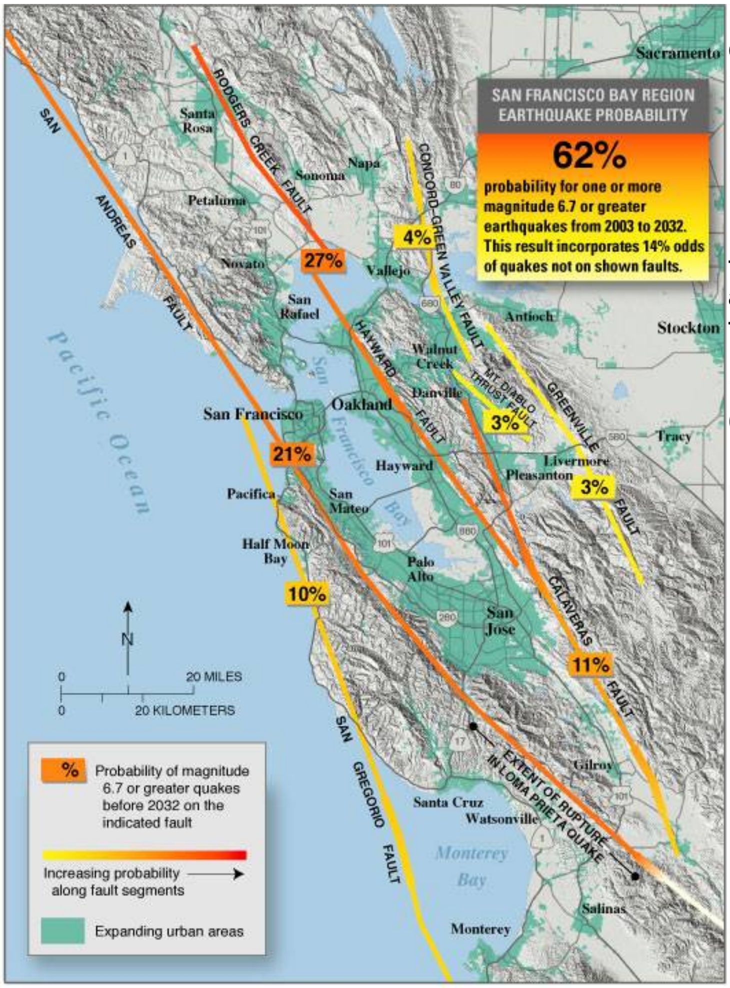

Figure 2: US Geological Survey map of earthquake probabilities published in 2003. Because earthquake predictions cannot yet be accurately forecast, probabilities are often announced to aid the public in hazard awareness and preparedness (Source: USGS 2003)

Throughout the Bay Area most damage occurred in areas of artificial fill (Figure 3). In the South of Market District of San Francisco (SoMa), the ground also failed, structures were shaken out of plumb and the highest number of casualties in the city occurred when the wall of an unreinforced masonry collapsed onto the street below (Figure 4). Shaking in both neighborhoods was amplified by the loose, poorly compacted fills through a process called liquefaction, leading to extensive ground failure despite the distant epicenter and relatively moderate magnitude of the earthquake.

These two neighborhoods experienced particularly extensive damage during Loma Prieta because of ground failure and liquefaction. In the Marina District news of the damage was widely reported; scenes of fallen and burning buildings were captured by local television network

Figure 3: Map displaying land areas filled in during San Francisco's development. Some regions were filled in directly upon bay waters, while other areas such as marshland and beaches were filled. (Source: USGS 2006)

cameras, in town for the 1989 Major League Baseball World Series, almost immediately after the earthquake struck. The same cannot be said of the SoMa, where only limited photographic and video documentation of the damage exists.

Why such a contrast? This study shows that a primary reason is the two neighborhoods had significantly different economic and ethnic compositions in 1989. The Marina District was (and remains) an upscale, picturesque neighborhood of elegant architecture and exclusive streets. SoMa was (and still is) heavily industrial and commercial, with residential niches of mixed income households. The neighborhood is home

Figure 4: Photo taken shortly after the 1989 earthquake at 6th Street and Bluxome in the South of Market District. (Source: C.E. Meyer, US Geological Survey 1999)

to a wide range of architectural and structural styles set down in a grid style similar to that of the adjacent downtown center. The Marina is populated by mostly middle and upper income white professionals while SoMa houses a diversity of ethnic backgrounds from various layers of economic strata.

The fact that representations of SoMa and the Marina in the media differed dramatically in the days following the earthquake has thus far received comparatively little attention. Other scholars have suggested that differences in media coverage have been related to differences in recovery time and community response (Rodrigue 1993; Rodrigue and Rovai 1998; Rovai 1994). Their research also identifies economic and cultural differences (relating to both interest in and recovery of these neighborhoods) and underscores the inequalities with which poor areas must deal.

The underlying causes for the different recovery patterns of these two neighborhoods, and the geographic and policy implications that flow from improved understanding of this dynamic, are the central subject of my thesis. I chose the SoMa and the Marina neighborhoods because of several overlapping circumstances: their underlying soils shared similar liquefaction potential, both neighborhoods experienced significant structural damage in 1989, and both were sites with the highest number of casualties in the city.

I argue that the two neighborhoods under comparison -- though faced with the same earthquake risk as determined by earthquake probability and liquefaction potential -- had very different levels of vulnerability: not only because of economic circumstances, but also because of what outlets of popular culture, particularly the media, reported. Values in popular culture are informed by ideas about ethnicity, social class and geography, and these issues are further amplified when commercial media face bottom-line expectations of profiting from offering programming to a wide audience (Kellner 1995).

This research aims to elucidate the role of the media as a facilitator of popular culture, one that contributed to different rates of recovery in the post-earthquake environment. My goal is not to socially critique the media, but instead to illuminate its role in disaster recovery within these two neighborhoods following the 1989 earthquake by answering the following question: Was there a difference in media representation between the Marina and SoMa following the 1989 Loma Prieta earthquake? As models for the current study I draw on geographer Christine M. Rodrigue's research on media coverage following the 1994 Northridge earthquake (1993; 1997; Rodrigue and Rovai 1998; Rodrigue et al 2004) as well as geographer Eugenie Rovai's research on community response to the 1992 North Coast earthquakes (Rodrigue and Rovai 1998; 1994) and modify the scope of their methodology and approaches to fit the confines of this thesis.

Before venturing into specifics, I first need to define *risk* and *vulnerability*. The two terms are often used interchangeably but have inherently different meanings: therefore, my use of these terms in this study needs to be defined. *Vulnerability* results when an individual or community is subjected to a hazardous situation, and one's ability to respond is limited by gender, class and ethnicity, and other socio-cultural factors. *Risk,* on the other hand, is the probability of danger within a given context. As Rodrigue at al (2004) define it:

> Risk is a statistical concept quantifying the probability of specified dangers; vulnerability is the inability to evade, withstand, recover from, or externalize the costs of a disaster or of preparing for it.

An underlying assumption of this study is that landscapes can be used as historical evidence. By analyzing significant historical phases of San Francisco's physical and cultural landscape, interesting changes occurring in the landscape over time can be revealed. These ideas stem from Emily Russell's *People and the Land Through Time* (1997), a description of techniques and methodology for studying the landscape as historical evidence. Though historical documents may be limited in quantity and narrow in geographic scope, these low resolution data sources still provide important, long-term data through which the *extent* and the *intensity* of historical change can be examined. Historical sources include photographs, newspapers, written testimonials, court records and oral histories, all of which were consulted for this study.

Justification

Why undertake such a study? Two key reasons immediately emerge. Earthquake hazards must be recognized in areas subject to significant future hazards, for this can in order to reduce vulnerability and increase preparedness. But more than this, the less obvious (or perhaps less popular) effects of earthquakes on socially or economically vulnerable populations deserves no less attention. The impact of Hurricane Katrina on New Orleans and the Gulf Coast region may provide a stark reminder that these social inequalities likely persist and can lead to increased levels of vulnerability.

2006 proved an incredibly useful year during which to study this topic. With the one hundred year anniversary of the 1906 Great San Francisco Earthquake and Fire approaching, the Seismological Society of America (SSA) and the Earthquake Engineering Research Institute (EERI) arranged a joint annual conference focusing on the history of and current danger of major earthquakes in California and the US. At this 1906 Centennial Earthquake conference I raised the idea that the SoMa neighborhood had been underrepresented in research and the media after the Loma Prieta earthquake. Why was this? Was it symptomatic of an American culture fixated on wealth and aesthetics, making the Marina a more agreeable focus? Or was it more complex than that, related to wealth but more entangled with socio-economic conditions existing before the disaster? Was SoMa so much less desirable that perhaps the destruction wrought by Loma Prieta was a blessing in disguise, where the neighborhood could be made better in the aftermath? In discussing these issues with other researchers interested in the complexities of urban earthquakes and their recovery, we noted that these topics arose as an interesting side-note, but rarely served as the main focus of study. This realization served as the inspiration for my study of SoMa and the Marina.

The study continues with a detailed description of my methodology. The data gathered to support this study included Geographic Information Systems (GIS), photographic analysis, a review of newspaper articles, and a thorough literature review of disaster research including social theories about recovery including the impact of socio-economics and media attention. Also included is a brief history of both the 1906 and the 1989 earthquakes in the San Francisco Bay Area, framing these earthquakes in their relevant socio-economic and historical contexts. These data are analyzed in a historical context, and the results of this analysis provide further insight on the socio-economic and geophysical conditions surrounding these two neighborhoods in 1989 that led to differential recovery rates. This study closes with a detailed discussion that relates 1906 and 1989, revealing how trends in socio-economic segregation and media attention continue to affect recovery, regardless of wider social and urban developments and changes.

Chapter 2 Historical and physical data: sources and methods

This thesis aims to address a lack of research on differential recovery rates following earthquakes in the San Francisco Bay Area. The San Francisco Bay Area is culturally and economically diverse and so represents a wide cross-section of urban populations like those found throughout the United States. Understanding the neighborhood and community dynamics existing in a population prior to a disastrous event is necessary in explaining why things unravel the way that they do after disaster strikes.

Improving seismic safety of structures and addressing weaknesses in emergency management are well-represented avenues for research regarding most disasters, but the underlying issue of vulnerability at the neighborhood, community and/or individual level often receives less attention. Vulnerability can be directly linked to recovery rates, so revealing the multitude of manners in which recovery is achieved by residents of varying socio-economic stature can help explain some of the barriers to rapid recovery that hinder some populations.

Drawing connections between social and environmental conditions is inherently problematic methodologically simply because the environment and society are quantified and described in exceedingly different ways, making comparisons of data difficult. Adding the component of time adds another dimension that is again quantified and described in very different terms, and requires a methodology that can incorporate numerous data of different types and from different sources. In this research GIS has served as an invaluable tool for comparing diverse data, and the resulting maps (discussed in further detail below) influenced my decision to study this phenomena at the neighborhood level, as well as helped me to determine which neighborhoods to study.

By examining vulnerability at the neighborhood level, in this case SoMa and the Marina, I have been able to identify some socio-economic factors that affect levels of vulnerability. Previous research on Loma Prieta hints at these socio-economic factors, such as homelessness or being a renter rather than an owner, but I was unable to find any study that examined the region at a consistent and fine scale to specifically identify and quantify these differences. In this research US Census Bureau data was collected to provide data on these socio-economic factors.

There are limitations in comparing two neighborhoods with a different balance of commercial and residential buildings for the sake of studying post-earthquake recovery. The Marina is substantially more residential than SoMa, and this difference may have an effect on the speed of recovery because commercial buildings have a different route to reconstruction than residences do, among other differences. The quantitative data collected from the US Census Bureau for this research focuses on household populations, so the interpretations made based on this data are limited to this particular population. Likewise newspaper media data collected covered both residential and commercial recovery in both neighborhoods, so the interpretations made based on this data do not distinguish whether the article mentioned a residence or a commercial building.

There are limitations to the extrapolation of these results to other cities, but the contribution of this study to the wider body of research is valuable because it provides a comparative case study and an illustrative example of what has been previously documented in disaster recovery.

Methods

The following steps were completed in order to conduct this study:

1) Literature Review: A broad review of the social and physical-environmental dimensions of disaster was conducted to provide a suitable background with which to conduct this study, as well as to provide a context within which to analyze the results. A literature review on Bay Area earthquakes was also conducted.

a. This step included compiling witness accounts and documented observations of earthquake damage following the 1906 earthquake. These accounts were geo-referenced upon a contemporary map of San Francisco, allowing me to create a GIS layer containing locations of structures rendered uninhabitable during the 1906 earthquake.

b. This step also included locating visual information on both earthquakes in the form of photographs and maps. This data was used to supplement historical accounts and documents on both earthquakes.

2) <u>GIS:</u> The GIS layer of buildings rendered uninhabitable in the 1906 earthquake was utilized in conjunction with other GIS layers to analyze patterns of damage in San Francisco. I created a map using the 1906 layer and layers including soil type, acquired from the US Geological Survey, a layer of buildings rendered uninhabitable that I created by converting the red-tag list data from the 1989 earthquake, acquired from the Association of Bay Area Governments. This compilation of GIS layers allowed me to identify locations where damaged buildings and poor soil type intersected, as well as to identify clusters of damage. I chose two sites sharing

these characteristics, SoMa and the Marina, to serve as locations for this research based on this map.

3) <u>Newspaper Review:</u> A review of newspaper articles was conducted. The *San Francisco Chronicle* and the *San Francisco Examiner*, the city's two largest newspapers, were reviewed for mentions of either neighborhood, Marina or SoMa, during the three months following the earthquake. Media "mentions" were tabulated and utilized in comparing media representations of both neighborhoods which will be described below.
4) <u>Socio-economic Setting:</u> Socio-economic data was obtained from the 1990 census in order to supplement socio-economic information gathered through the literature review conducted in Step 1. Estimates of damage gathered during the literature review were included in the results of this section for convenience.
5) <u>Synthesis:</u> The data described above were synthesized in order to reconstruct the earthquake events in a geophysical as well as a social context. The information derived from the synthesis forms the basis of the discussion section.

The results of the literature review form the basis of the next chapter, Chapter 3. Results of the GIS analysis, newspaper review and socio-economic setting will be reported in Chapter 4. Synthesis of the results will be discussed in Chapter 5.

Conducting the research

The following procedures were used to conduct the research steps described above:

Step 1: Review of existing data and research

To frame the Loma Prieta earthquake and its aftermath in the proper context, a history of the region and the 1906 earthquake and fire were achieved using historical environmental research methodology. Emily Russell's work (1997) serves as the primary model wherein low-resolution data such as photographs, maps and historical documents are used to provide information about past conditions despite their inconsistent and sometimes limited availability. Comparative works such as Klett's *After the Ruins, 1906 and 2006*, which took 1906 earthquake damage photos and displayed them next to photographs from the same exact site taken one hundred years later, provide one manner in which to analyze historical photos. Comparisons between old San Francisco maps from the1800s, maps from the earthquake period and current maps also provide useful information on how land has been used and transformed over time, all within the context of damaging earthquake events.

UC Berkeley's Bancroft Library has an extensive collection of scanned historical documents, books, reports and records available online. The Virtual Museum of the City of San Francisco also contains an extensive collection of photos, memoirs and other documents. Hard copies of many historical documents, magazines and texts were also accessed at UC Berkeley's Bancroft Library and the Summit/ORBIS library system through Oregon State University.

These texts were used to supplement historical visual images, namely photographs and maps, from both earthquakes which could then be compared across time and space – 1906 damage could be compared with 1989 damage, and 1906 population dynamics could be compared with 1989 population dynamics. By making these cross comparisons, both similarities and differences were identified. For instance, San Francisco was much more ethnically segregated geographically in 1906 than in 1989, which made the earthquake experience of the ethnic groups in 1906 somewhat easier to identify than the experience of various ethnic groups in the 1989 earthquake.

<u>Step 1a: Creating the 1906 GIS layer</u>

The resources described above were combed for any and every mention of structural damage following the 1906 earthquake. Each time a building was described as collapsed or partially collapsed *before* the subsequent fire, the approximate location of the building was calculated using contemporary paper and internet maps. From this list a spreadsheet was created which was then converted into a format suitable for use in a GIS.

This research on damage sites in 1906 coincided with the production of an insurance company document on the 1906 earthquake by the international reinsurance company (insurance for insurers) Swiss Reinsurance (Swiss Re). After initial contacts with a Swiss Re representative I was hired as a consultant to their 1906 earthquake document. The GIS layer of damage in 1906 was utilized in maps created for their 1906 earthquake document. The Association of Bay Area Governments (ABAG) also provided entire datasets on Loma Prieta damage in 1989 that were used in conjunction with this 1906 damage file. Swiss Re provided funds in support of the creation of these map documents.

Step 1b: Photographs and other media

The photographic records available for the 1906 and 1989 earthquakes give evidence, both through their existence and non-existence, of actual physical damage, as well as the popular perception of damage in these two neighborhoods. It is possible that those images still existing today do so because they were, and still are, the most popular. This evidence left by photographers gives the sense of the post-earthquake environment in physical terms, but also in terms of what locations could be and/or were accessed. Unknown quantities in using photographs in this research include images known to have existed but since disappeared, such as the collection of 1906 earthquake documents amassed by H. Morse Stephens (Starr 2005.) Personal photographs are also missing from this body of evidence, as are photographs that may have at the time been deemed irrelevant, but have since taken on meaning simply because of they represent the past. All of these potential omissions from the historical record were taken into account in utilizing photographic evidence for this study.

Given that the Marina District did not exist in 1906, photographs of this neighborhood were helpful only for 1989. The lack of photographs that captured the devastation in SoMa is a remarkable fact in itself, as this neighborhood was both under-represented and perhaps so thoroughly devastated as to warrant little value for preservation in photographs. It is also quite feasible that few photos exist simply because the residents of this neighborhood had limited access to photographic technology. Even if they did take photos, there also exists the possibility that these photos would not have been preserved. While Condon and Hansen (1989) provide a close account of hearings conducted after the 1906 earthquake to evaluate insurance claims stemming from SoMa damage, the damage described was not captured on film and provides little more than eyewitness accounts of roughly where damage occurred and whether or not people were killed there. The area was so completely decimated by the fire that local officials may not have considered documenting this damage simply because it appeared so absolute.

In 1989, limited photographic evidence of SoMa exists, but at this point it is media coverage that becomes telling evidence of differential treatment. Extensive documentation and publication of media images in the Marina District have been located in newspaper records. The same cannot be said of SoMa.

Step 2: GIS

I created a GIS compilation map displaying soil type, topography and buildings rendered uninhabitable by earthquake damage in order to analyze the environmental and social characteristics of the city and earthquake damage. The layers of earthquake building damage included the 1906 layer created as described above, as well as a layer displaying damage in 1989. The 1989 damage layer was created by converting a spreadsheet of red-tagged buildings purchased from ABAG into a GIS layer. The conversion of the 1906 and 1989 spreadsheets from .exl format to .dbf format enable them to be imported into a GIS.

The damage layers overlay the soil type layer obtained from the USGS. The soil type layer is important because it displays different types of soil (rock, mud, fill, etc.) which have an impact on earthquake damage. Typically the poorest quality soil, fill, will perform the poorest in earthquakes, leading to liquefaction, ground failure and sometimes collapse.

By superimposing the damage layers atop the soil type layer, patterns of damage that coincided with poor quality soils became apparent. Clusters of damaged buildings that occurred above poor quality soil were noted, as these sites were deemed most suitable for further study given the high degree of damage in past earthquakes, and the potential for damage in future earthquakes. This map led to the selection of the Marina and SoMa for further analysis.

The city of San Francisco maintains several GIS datasets online. *SF Prospector* was the primary source for contemporary data on the

Marina District and SoMa and was used to create the layer that depicts the outline the two neighborhoods. The maps based on this data are displayed and will be discussed further in the following chapter.

Step 3: Socio-economic Setting

The socio-economic setting in which the 1989 Loma Prieta earthquake took place was determined by reviewing US Census Bureau records from the 1990 census. Because the 1989 Loma Prieta earthquake occurred only months before the end of this decade, the data provided by the census reflects the pre-earthquake population characteristics. Data on ethnicity and socio-economic status was gathered for each of the neighborhoods as well as for San Francisco as a whole. The US Census Bureau website was the source of this data. The Marina District includes the following census tracts (1990 census): 126, 127 and 129 (128 was excluded for convenience because less than 1/8 of it lies in the Marina; roughly ½ of 129 is included in the Marina, so these figures were calculated accordingly). SoMa includes the following census tracts (1990 census): 176.98, 176.02, 178, 179.01 and180.

Also included in this section of the results is data on the number of damaged structures in both of these neighborhoods as well as estimates of the cost of damage. This data was collected during the literature review but is reported in this section because it is relevant in the comparisons drawn here.

Step 4: Newspaper Review

This portion of the research was modeled after Rodrigue's (1993; 1998; 2004) extensive work examining the role of the media in the wake of disaster. Media mentions of Marina District damage and SoMa damage were tabulated for the three months following the 1989 Loma Prieta earthquake. The *San Francisco Chronicle* and the *San Francisco Examiner* were the primary sources for newspaper media data, given that they were the primary morning and evening edition newspapers. Sections included in this tabulation included news, business, community and science sections, but eliminated sports, entertainment and editorials. Because part of this study was conducted using an online repository of newspaper articles, some of which contain only an abstract, only full text articles were included. Likewise only articles with a title indicating the subject matter included the earthquake were used.

As described above, results of Steps 2, 3 and 4 will be described in Chapter 4. Synthesis of the results will be discussed in Chapter 5. The results of Step 1, 1a and 1b are the subject of the next section, Chapter 3.

Chapter 3 Economic and regulatory aftershocks: two 20th century earthquakes compared

To appreciate the significance and value of comparing two neighborhoods, their development must be traced over time. Both neighborhoods were established even before the 1906 earthquake – a fact which allows further and additionally helpful comparisons – and they are intricately connected to the growth of San Francisco and the geography of the city. In this section I describe the physical geography of the Bay Area, the historical evolution of the city (including the two major earthquakes that devastated it during the 20th century), and also offer a brief history of earthquake mitigation efforts in California, the first US state to vigorously promote building codes to address this form of natural disaster. I then provide the necessary theoretical background for this paper, including a history of disaster research, social theories of disaster recovery, and an analysis of the significance of ethnicities and disaster, particularly within the context of media coverage.

Unstable ground: the physical geography of San Francisco Bay Area

Much of the soil in San Francisco is prone to liquefaction. Liquefaction is the result of loosely consolidated soils being compacted by earthquake shaking. The pore space between individual particles is reduced through the introduction of water, where the soil begins to behave like a liquid. The ground surface above no longer has the support required to uphold the structures upon it, and the result is ground failure.

During the magnitude 7.8 Great Earthquake and Fire of 1906, extensive areas of filled land near downtown liquefied (Figure 5). In the SoMa district of San Francisco, clusters of buildings on artificial fill were rendered uninhabitable. In 1906 the Marina District was mostly a bay cove, but the few homes on the edges of recently placed fill also suffered extensive damage. Even the magnitude 7.0 1868 earthquake in the San Francisco Bay Area revealed that filled areas experienced proportionately higher damage (Fradkin 2005 p 11 – 12). Following the 1868 quake the *San Francisco Real Estate Circular* suggested that appropriate precautions be taken upon fill but their warnings went unheeded as San Francisco continued to grow at a rapid pace (Hansen & Condon 1989 p 9 - 11).

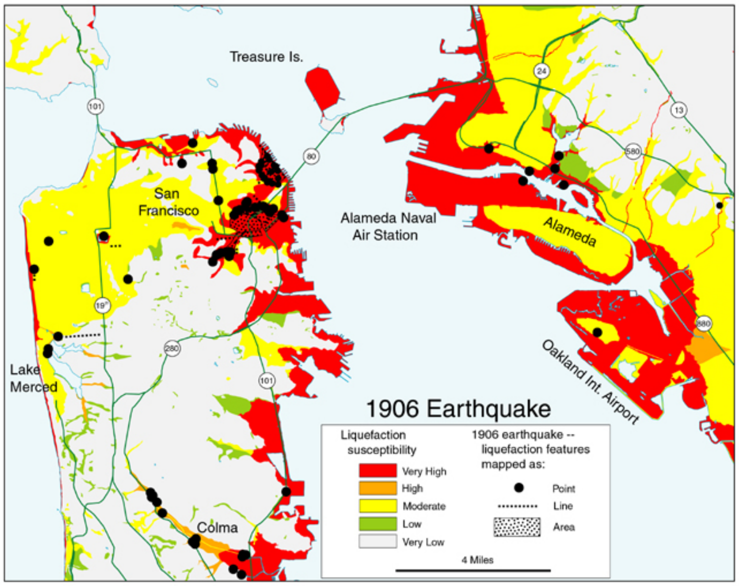

Figure 5: Map of liquefaction in 1906 earthquake. These new maps of old earthquakes created by the USGS show where damage occurred in the past, which is helpful in evaluating damage potential for future earthquakes (Source: USGS/California Geological Survey 2006)

Scientists and seismologists predict that a major earthquake in San Francisco is imminent (USGS 2003). A magnitude 6.7 or higher has a 67% probability of occurring in the Bay Area before the year 2032 (Figure 2). San Francisco lies within a network of at least seven faults, two of which are considered highly dangerous, the San Andreas and the Hayward. Risk in areas of artificial fill is extremely high in the case of a future earthquake, especially one with a local epicenter and/or more prolonged shaking. Given the continued instability of the land in these regions, they are likely to experience a repeat of damage in a future major earthquake.

Precautions against damage in areas of artificial fill have consistently been left up to property owners, with uneven success. After the Loma Prieta quake in 1989, local government restrictions on rebuilding pending geologic analyses were eventually eliminated in response to public disapproval (Eadie and Johnson 1997; Tyler and Mader 1993). For residents of the Marina District, reconstruction was undertaken rapidly and with whatever improvements the property owner was interested in and able to afford (Bauman 1997). By contrast, for many residents of SoMa – living in low-income residential hotels -- the decision to repair was not left up to the individual, but instead reflected the needs and limitations of the property owner.

Evolution of the city's built environment

The city of San Francisco was born and quickly developed during a seismically active period. Moderate to large earthquakes occurred throughout the mid 19th and early 20th centuries and alerted the growing populace that the earth beneath their feet was unstable (Table 1). Structural development in San Francisco occurred rapidly as a result of the Gold Rush in 1849, when as many as 100 buildings went up per month (Vance 1964 p 9 - 12; Winchester 2005 p 206 - 9). The city was initially considered an unfavorable site for military occupation or commercial connections because vessels were repeatedly grounded in deep mud that lined the bay. In response to industries settling in nearby Sacramento, Vallejo and Benicia, San Francisco eagerly filled in shores and extended wharves in order to provide more efficient and accessible transportation routes (Figure 6) (Meinig 1998 p 38 - 9).

Table 1: Major Bay Area Earthquakes, nineteenth and twentieth centuries (Sources: California Geological Survey 2006)

Year	**Fault or region**	**Mag-nitude**	**Cost (2005 USD, est)**	**Casualties**
1836	East of Monterey	n/a	n/a	n/a
1838	Greater Bay Area	7.4	n/a	n/a
1865	Santa Cruz Mountains	6.6	$0.5 million	n/a
1868	Hayward Fault	7	$350,000	30
1906	Great San Francisco Earthquake and Fire	7.8	$8.2 billion	3000
1984	Morgan Hill	6.2	$8 million	0
1989	Loma Prieta	6.9	$6 billion	63

The 1865 and 1868 earthquakes caused significant destruction to the newborn city. Land that had recently been filled became unstable during these earthquakes, providing early evidence of San Francisco's potential for ground failure that did not go unnoticed (Lawson 1908 p 235, 436). Real estate developer George Gordon was among the few early advocates for earthquake hazard mitigation, attempting to stimulate mitigation efforts such as bolting homes to foundations and strengthening shear walls, but his pleas were virtually ignored (Geschwind 2001 p 16).

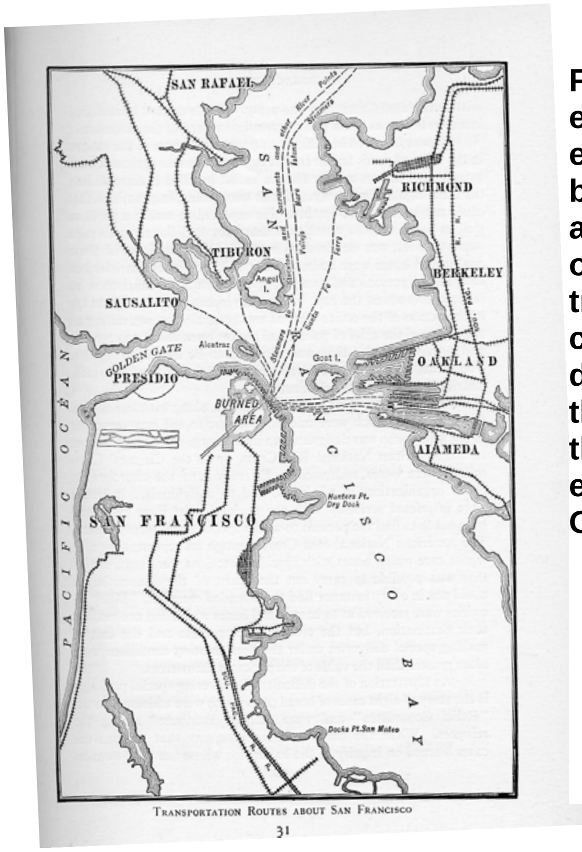

Figure 6: Transportation routes existing prior to the 1906 earthquake. Extensive filling of bay mud and sand dunes had already been completed in order to strengthen transportation routes, as commerce was heavily dependent on waterways at that time. The area burned in the fire that followed the earthquake is shown. (Source: O'Connor et al 1913)

Though engineering capabilities at the time of the 1868 quake could have made strides towards strengthening buildings for future events, earthquakes were seen as inevitable and impossible to mitigate for, so most of these improvements would not be seen for nearly half a century (Geschwind 2001 p 16 - 7).

San Francisco's population quickly grew with the influx of migrants from all over the country and the world, giving it a culturally diverse but somewhat chaotic character. In 1870 the city's population of 150,000 was supplemented with rapidly growing suburbs dependent on the commerce, finance, agriculture and freight industries (Meinig 1998 p 42). San Francisco was considered the most metropolitan city of the American west, complete with diversity in people, geography and efficiency.

The Gold Rush brought a massive influx of people, displacing Native Americans and exerting tremendous pressure on the land (Brechin 1999). Large-scale hydraulic mining denuded the Sierra Nevada foothills and polluted waterways (Gilbert et al 1907). This brutal treatment of the environment persisted when miners left the foothills for the brothels of urban San Francisco where trees were felled in tremendous quantity to build up the city and natural features of the landscape were manipulated in order to make it more suitable for occupation (Figure 3) (Brechin 1999; Vance 1964). The manner in which the muddy bay was filled to solidify the city gave evidence of this: dunes and marshy shorelines were haphazardly filled in with debris such as urban refuse, animal carcasses and the hulls of grounded ships (Clough and Chameau 1979). This all occurred so rapidly that development in San Francisco was largely unchecked, poorly planned and precariously balanced (Brechin 1999; Meinig 1998).

Prior to the earthquake of 1906, the social character of early San Francisco was one of wanton lawlessness and “glittering pleasure palaces” driven by the influx of gold-rush-related capital (Winchester 2005; Wyatt

1997). The intense and short-lived mining boom led to a mostly male populace anxious to both make and spend money, and the city served as a landing for all types of characters, from immigrants to hoodlums to wealthy financiers. This included its fair share of crooked politicians and large groups of persecuted minorities including Native Americans, blacks and immigrants from Mexico and China, to name just a few (Wyatt 1997). Massive brothels and bribery funded the city, and the rich became richer through fraudulent record-keeping and illegal subsidies (Geschwind 2001; Fradkin 2005; Winchester 2005). By the 1870's the city's lawlessness was reigned in by a growing tourist industry, an influx of women and a growing cultural base (Winchester 2005; Wyatt 1997).

Earthquakes in San Francisco merely added to its unique and colorful identity, considered an inevitability that really wasn't all that bad compared to "runaway horses, apothecaries' mistakes, accidents with firearms and a hundred other little contingencies" (Geschwind 2001 p 17). It was this type of dismissive attitude that left most Californian's uninterested in earthquake mitigation and more likely to rebuild structures in the exact same place once destruction had occurred. Brechin (1999 p 152) mentions briefly that "San Francisco's cheap frame structures [were] pragmatically built to resist quakes." However, most building ordinances were aimed towards reducing the flammability of the wood-frame, kerosene-lit neighborhoods (Winchester 2005). Considering the high degree of corruption at every level within the city, it is unsurprising that poor workmanship would be blamed for the majority of the earthquake damage to buildings.

1906: The Great San Francisco Earthquake and Fire

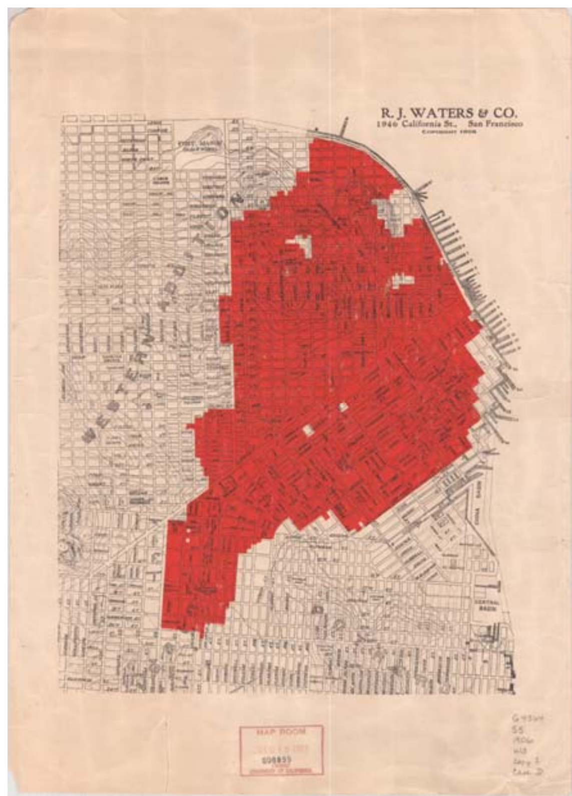

Figure 7: Map of downtown San Francisco after the 1906 earthquake and fire. Red indicates the portion of the city that burned during the disaster. (Source: UC Berkeley 2007)

The violent, nearly minute-long earthquake that struck San Francisco on April 18, 1906 is estimated to have caused $8.2 billion worth of damage (in 2005 dollars) (California Geological Survey 2006). 3000 people were estimated to have been killed out of a population of 410,000 (Hansen and Condon 1989 p 11). Fires spawned by the earthquake raged out of control for two and a half days. This led to a second round of casualties as victims awaiting rescue in collapsed buildings were killed by the fire. The fire caused a significant portion of the structural damage in downtown San Francisco, covering over four square miles.

Damage in San Francisco was concentrated in the burned downtown district, filled areas around the shoreline, and the area south of Market, or South of the Slot (later referred to as SoMa) (Figure 7). Lawson noted that "great violence was manifested" in areas of filled land (1908 p 223), where approximately 1/6th of San Francisco's population resided (Hansen & Condon 1989 p 11).

The response of city officials and emergency respondents to the earthquake and its victims was anything but well organized. Historians such as Kevin Starr have been highly critical of the response to the 1906 earthquake, referring to the San Francisco political body of 1906 as "an establishment eager to rebuild the city and that wanted to disconnect it from its reputation as a dangerous place" (2005). Starr (2005) followed with a close analysis of other aspects of the inadequate response including the role of the ill-prepared Brigadier General Frederick Funston in the fire response. In the early aftermath of the earthquake, Fire Chief Dennis Sullivan was mortally injured and General Funston began taking control of the emergency response activities (Starr 2005). Smith (2005 p 63) argued that had Fire Chief Sullivan survived, his experience might have dramatically changed the manner in which the fire was fought. Instead, Funston and his men began dynamiting buildings in order to create fire breaks, which may have simply added to the inferno (Starr 2005).

San Francisco Mayor Eugene Schmitz, a highly respected, young dynamic politician, also contributed to the increasingly disorganized and counterproductive aftermath by declaring that all looters would be shot on sight. Police officers and volunteers alike had banded together in an attempt to keep the peace, but were also reportedly responsible for the murders of at least 15 suspected looters that were indeed shot on sight (Fradkin 2005). The city remained under control of soldiers and National Guardsmen for about three days, and they were feared just as much as they were revered.

The political situation in San Francisco at the time of the 1906 earthquake contributed in large part to this haphazard response. San Francisco was already under scrutiny for political graft: indeed President Roosevelt had sent a Secret Service agent to investigate this problem shortly before the quake (Fradkin 2005; Starr 2005). City boosters eager to keep tourists and investors coming waged an all-out campaign to have the event referred to as a conflagration rather than an earthquake (Geschwind 2001 p 21 - 2). Contemporaneous publications such as the *Fireproof Journal* and the South Pacific Company's (California's most powerful business at the time) *Journal of Progress* documenting recovery both provide evidence of the highly convoluted public relations efforts underway in San Francisco to repair the city's image and place blame (Fitzpatrick 1906 p 67 – 83; Hansen & Condon 1989 p 108). Casualties were downplayed as well. In 1906 the official death toll stood at 300 (Lawson 1908). Archivist Gladys Hansen later calculated this figure to be over 3000 (1989 p 153).

The scientific investigation of the 1906 earthquake resulted in one of the most rigorous scientific reports of an earthquake up to that time. University of California at Berkeley geologist Andrew Lawson and a team of scientists and engineers investigated San Francisco and the surrounding areas, observed fire and structural quake damage, and identified the fault trace and areas of "filled land" (Lawson et al 1908). Although clearly delineated, these areas of filled land -- and their poor performance in earthquakes -- would come back to haunt San Francisco in the 1989 Loma Prieta quake.

Other areas that experienced liquefaction damage, including the waterfront and South of Market, were also rebuilt in the same location. Though Lawson et al (1908 p 235 - 6) mentioned the need to place pilings very deep into fill in order to prevent structural damage in the event of ground failure, the usage of this technique was inconsistent and generally limited to larger commercial buildings that had the financial resources to utilize it. Engineer A.L.A Himmelwright, sent by the Roebling Construction Company to investigate, boldly recommended in his final report “The Lessons of the Earthquake” that builders should ‘Avoid Locations in Close Proximity to Geological Fault Lines’, a suggestion that garnered little, if any, attention whatsoever (Wyatt 1997 p 110 - 1).

UC Berkeley engineer Charles Derleth was another vocal supporter of earthquake-resistant construction. Derleth had spent time outside of the city inspecting damages sites unaltered by the intense fires where he developed a deeper appreciation for quake damage (Geschwind 2001 p 29 - 30). Derleth and the few other scientists and engineers who saw potential for improving San Francisco’s earthquake resistance were not supported by major architecture and engineering firms in the area; their warnings went largely unheeded (Geschwind 2001 p 31 - 2). Instead poor workmanship was repeatedly blamed for the destruction.

Cultural aspects of the disaster provide further insight into the chaotic aftermath of the quake. The Chinese were openly displaced in the aftermath of the 1906 earthquake at a time when politicians tried to enact into law their continuing desire to relocate Chinatown, which they looked down upon as opium dens full of unassimilated immigrants (Fradkin 2005 p 28, 34 - 37). Though the loss of paper records aided many Chinese in the quest for citizenship, the loss of these documents also may have hid a high death toll in the devastated Chinatown neighborhood (Wyatt 1997 p 112 - 3). Similarly, South of the Slot (modern day SoMa) had been nearly obliterated by the earthquake and fire. Along with it went records of numerous working class immigrants and untraceable shipyard workers who perished in the buildings that collapsed on the failed ground of SoMa. Hundreds may have perished in this neighborhood, their remains destroyed by the fire and their identities unknown to this day (Wilson 2002).

Much of the residential rebuilding in San Francisco occurred in an unorganized fashion as individuals regained the means to house themselves. However, commercial recovery occurred in a relatively orderly fashion as businesses swept in to take advantage of newly cleared space. Eager to return to financial viability, retail firms returned first, followed by the hotel and theater businesses (Haas et al 1977 p 73 - 7). Rebuilding was funded primarily by $12 million in financial aid gathered by the Red Cross and insurance monies totaling $7.3 billion (2005 dollars) (Platt 1999). Efforts to improve the livability of the city, including Burnham's City Beautiful plan, went by the wayside as residents and city officials alike eagerly moved to repair the city, both visually and metaphorically (Platt 1999). Poor, displaced residents were eager to find permanence in their temporary lodging quarters, which city officials had difficulty regulating (Arnold 1993). Residents able to rebuild did so according to their own standards, with little regard for future earthquake mitigation. Fires were considered to be the main cause of damage, and fire resistance dominated improvements in building quality.

Within a decade, San Francisco showed off a fully recovered built landscape at the 1915 Panama Pacific International Exposition (Figure 8). The site of the Expo was the Marina District, which was filled in between 1851 and 1912 (O'Rourke 1992). The quality of the fill consisted of debris and sand and its quality was not significantly improved from that used along the downtown waterfront. The Expo was considered successful, and provided emotional closure for the city. However, by using the extra land

Figure 8: The 1915 Panama Pacific International Exposition was held in San Francisco on what would later become the Marina District. This photo was taken during a speech by Mayor Rolph. The land was created after the 1906 earthquake to house the Expo and was a symbol of San Francisco's recovery. (Source: SanFrancisco Memories.com 2007)

created to house the Expo, city officials unknowingly encouraged the development of a residential neighborhood upon land of highly questionable integrity. If a connection had been made between filled land and increased building damage, it was not enough of a threat to prevent the recently in-filled Marina from being densely developed during the ensuing decades.

1989: Loma Prieta Earthquake

On October 17, 1989 the San Francisco Bay Area was rocked by an M6.9 earthquake originating 70 miles away in the Santa Cruz Mountains. Despite the distant epicenter and comparatively moderate magnitude, over 60 lives were lost and the cost of the damage was estimated at $10 billion (Steinbrugge and Roth 1994). As in 1906, areas with significant structural damage were usually on filled land, including the Marina District where 40 buildings collapsed (Bardet et al. 1992; Bolin 1990). Once again the SoMa neighborhood was devastated by structural damage in areas underlain by unstable, liquefaction-prone soil (NRC 1994). The greatest number of casualties occurred in the East Bay where a segment of the double-decker Cypress Freeway in West Oakland collapsed, killing 45 motorists. The soil underneath the collapsed segment was also unstable and thus susceptible to liquefaction.

Media attention focused particularly on damage in the Marina District, the collapsed Cypress structure and the damaged Bay Bridge, a point which will be discussed in Chapter 3. This was partly because these events were so visually spectacular (Figure 1) and partly because this is where damage was centered. However, other regions of the Bay that were significantly damaged -- such as the SoMa, Watsonville and downtown Oakland -- received far less attention in television and newspaper reports. In sum, 22,000 residences (9000 of which were low income), 1567 commercial buildings, and 137 public buildings were damaged in the region. Almost 4000 of these structures were rendered uninhabitable (Greene 1991; Platt 1999).

The severe damage to transportation systems -- including the Cypress and the Embarcadero in San Francisco -- gave policy-makers the ability to draw attention, and therefore funds, to seismically retrofitting infrastructure. Likewise, severe damage at the Oakland City Hall and other federal and state buildings encouraged policies aimed at upgrading federal and state buildings. However, one of the underlying problems made apparent by Loma Prieta -- that of unstable soils throughout the Bay Area -- presented a problem that could not be easily addressed by the government.

While city officials and developers acknowledged that the quality of fill in the Marina was worse than the quality of fill in SoMa, the performance of seismically upgraded structures in Loma Prieta had done more to encourage building on fill rather than discourage it (Massey and Chung 1989). Buildings that had been seismically upgraded, or new buildings meeting the latest earthquake engineering standards, performed exceedingly well in Loma Prieta. But plans to develop the Mission Bay section of SoMa suddenly came under increased scrutiny by groups such as San Francisco Tomorrow, a slow-growth organization, because of the presence of fill. Although planning officials joined city officials and developers in agreeing that projects needed re-examination in light of the recent earthquake, they discouraged any actions that would create a longer review and approval process than was already in place (Massey and Chung 1989). In fact local officials expedited the recovery process by shortening the time it took to have a building permit approved (Eadie and Johnson 1997). This enabled homeowners requesting to rebuild exactly what had previously existed to more quickly navigate the permitting process, which otherwise could easily take two years or longer (Greene 1991).

Rebuilding in the Marina and other damaged regions went ahead rapidly, as home-owners sought to bring their homes back up to code to avoid foreclosure on their mortgages (Bauman 1997; Greene 1991; San Francisco Chronicle 1989). The majority of Marina residents had the financial resources to repair their homes. However, those who did not own their homes were left to the mercy of their landlords. In total, more than a billion dollars in insurance was paid to settle 56,667 claims, amounting to little over half of all reported claims (Steinbrugge and Roth 1994).

Throughout the city, roughly 12,000 were left homeless by the disasters. A large portion of these people were already economically disadvantaged (Platt 1999). Almost 70% of low-income, single room occupancy rooms (SROs) in residential hotels were lost in SoMa alone (Bolin 1990). Forty-four shelters were in place within a week of the quake, but these only housed less than 10% of the total displaced, leaving the remaining newly homeless to find shelter on their own. Adding to the problem were stipulations for financial aid that residents provide evidence of stable housing prior to the quake, something that many low income residents simply did not have. They stayed in residential hotels on a short term basis, sometimes sharing rooms, which left them without proof of a 30 day or longer residence (Comerio 1998; Green 1991). Many of these “semi-homeless”-to-homeless residents were thus made “doubly homeless” by the earthquake.

Residential hotels that had previously provided shelter for many of these economically disadvantaged individuals did not always provide their owners with sufficient financial incentives to repair them and therefore some of these housing units were permanently lost (Comerio 1998). Greene (1991) explains that low-income housing is the most difficult to replace, as agencies that work with low-income populations and build low income residences were already working in a near crisis mode during normal conditions. Their workload is pushed beyond what is capable during disaster.

Local community agencies stepped in to help find housing for low income residents, often without distinguishing between those made homeless by the earthquake and those that had already been homeless before it struck. Under intense pressure, the Red Cross also redirected excess donations towards projects aimed to assist low income and homeless residents (Green 1991).

In 1990 the South of Market Earthquake Recovery Redevelopment Project (SMERRP) created the Redevelopment Plan to repair and improve upon SROs. Though the SMERRP was successful at making renovations in some SROs, their efforts were criticized for their piecemeal style that brought about inconsistent improvements (Camper 2003). According to the SMERRP (now shortened to South of Market Redevelopment Project), 1000 affordable housing units were either rehabilitated or constructed in the aftermath of the earthquake (SFRA).

The damage in SoMa also led to its rebirth in the mid 1990s. According to the South of Market Health Center (2005), the open space created by earthquake damage and demolitions was quickly snapped up in the ensuing years by high tech companies and their employees from the South Bay. This caused property values to rise and dramatically changed the economic and cultural landscape of SoMa.

Mitigation-related policy measures followed the Loma Prieta quake, yet these were limited primarily to infrastructure and to government buildings. The government does not necessarily have the ability to control how property owners repair their damaged property, so mitigation measures were limited to the sector that the government *can* control.

The Loma Prieta earthquake was not a worst case scenario earthquake so it was not a true test of California's earthquake mitigation standards. Effective, high-quality earthquake mitigation practices in California have grown since the turn of the century, often spawned by scientific discoveries made during earthquakes in other parts of the world. However, a review of California's earthquake mitigation, which is described in the next section, revealed significant limitations to what can be controlled through legislation.

Earthquake mitigation in California

Governmental interest in and support for earthquake mitigation and awareness measures often followed damaging earthquakes in California and other parts of the world (Comerio 2004). This trend of post-disaster policy-making and relief -- rather than pre-disaster policy-making and mitigation -- has been noted in previous research (Birkland 1997; Eadie 2005; Godschalk et al 1999; Mileti 1999; Nigg 1996). It is the result of pressures on politicians and policy-makers to deal with immediate rather than prospective events. Once disaster strikes, the hazardousness of the event is an immediate concern, or focusing event, which fades with time (Birkland 1997; Comerio 2004; Godschalk et al 1999). Wu and Lindell (2004) describe a 30-day window of opportunity following a disaster, after which public interest and political popularity of mitigation-oriented policies diminishes significantly.

The 1906 Great San Francisco Earthquake and Fire was perhaps the most significant focusing event in California history. The groundwork for modern seismological work in California was laid in the aftermath of the M7.8 1906 event when Andrew C. Lawson conducted his momentous report on the quake and its effects. His scientific technique set new standards for earthquake study, and the Seismological Society of America was established to facilitate and encourage research on earthquakes and seismology (Geschwind 2001).

In the aftermath of the 1906 quake, various techniques were considered to reduce the hazardousness of the city. Mostly, however, these techniques addressed the fire hazard. City leaders recognized the political and financial losses that would come from widespread perceptions of San Francisco as prone to earthquake hazards, so efforts create policies to address the region's seismic potential were also unpopular and rendered virtually null by a public eager to recover and move on (Geschwind 2001).

In the first half of the twentieth century, after the 1906 event, California experienced several major earthquakes (Table 2). Following the Long Beach earthquake of 1933 -- in which many unreinforced masonry school buildings were damaged -- the Field Act was established to standardize and improve school building standards. The Uniform Building Code (UBC) also evolved during the 20th century. The UBC was published in 1927 by the International Conference of Building Officials as a means to standardize building construction and improve building quality. After the 1933 Long Beach earthquake, the UBC was updated in 1935 and included specifics on requirements to resist earthquake forces (Fatemi and James 1997).

Table 2: Major earthquakes and subsequent mitigation measures
(Sources: California Geological Survey 2006; Fatemi and James 1997; Godschalk et al 1999; Greene 1991; Scott and Olson 1993; Steinbrugge and Roth 1994)

Event	Mag-nitude	Casualties (approx)	Cost (2005 USD, est)	Results
Great San Francisco Earthquake and Fire, California, 1906	7.8	3000	$8.2 billion	General improvements in fire resistance
Long Beach Earthquake, California, 1933	6.4	115	$500 million	Field Act (upgrade schools); Update to Uniform Building Code (UBC)
Good Friday Earthquake, Alaska, 1964	9.2	131	$1.8 billion	Funds made available to research tsunami and earthquake hazards
San Fernando Earthquake, California, 1971	6.6	58	$2.4 billion	Hospital Seismic Safety Act; Alquist Priolo Special Studies Zone Act (to identify hazardous zones prior to building); Strong Motion Instrumentation Act (identifying dam-related hazards)
Coalinga Earthquake, California, 1983	6.4	0	$59 million	California Earthquake Hazards Reduction Act; inventory of unreinforced masonry buildings
Mexico City Earthquake, Mexico 1985	8.0	9500	$7 billion	
Loma Prieta Earthquake, California, 1989	6.9	63	$10 billion	Seismic Hazards Mapping Act; Executive Order 12699 (established seismic guidelines for federal buildings)
Northridge Earthquake, California, 1994	6.7	57	$51 billion	California Earthquake Loss Reduction Plan of 1997
Kobe Earthquake, Japan, 1995	6.9	5400+	$250 billion	

This pattern continues through the second half of the twentieth century. In 1964 a M9.2 earthquake caused tremendous damage in Alaska, again triggering research on earthquake and tsunami hazards throughout the world. The 1964 Good Friday earthquake was not only the largest magnitude earthquake recorded in North America, but it was also remarkable for its low casualties. In many areas in Anchorage and its surroundings the ground failed as a result of liquefaction or landslides, causing extensive damage, but the state is so sparsely populated that there were relatively few quake-related deaths. The massive coast-side quake also produced a tsunami 70 meters high at its maximum near the epicenter. This tsunami spread out into the open ocean and caused more damage and deaths in Oregon and Northern California (Public Seismic Network - Alaska 2006).

In response to the widespread damage resulting from the 1964 Good Friday earthquake, federal, state and local government and concerned scientists began coordinating efforts to study earthquake hazards in California and other earthquake-prone regions (Scott and Olson 1993 p xiii - xxiv). This included research in earthquake prediction, geophysical analysis of hazardous regions, policy-making and public awareness programs. Seismic monitoring capabilities were strengthened by installing new stations through Alaska and the rest of the United States (USGS 2004).

Starting in 1970, the Working Group on Earthquake Hazards Reduction made recommendations for short, intermediate and long term research goals and mitigation (Scott and Olson 1993 p xxiii). UC Berkeley professor emeritus Karl V. Steinbrugge was instrumental, in conjunction with California Senator Alfred E. Alquist, in raising awareness of earthquake hazards in California (Scott and Olson 1993 p xxiii). In this same year, federal funding for repairs to public and private health care facilities following disaster became available through the Disaster Relief Act of 1970 and subsequent amendments in 1972 (Birkland 1997).

Cities in California have been required to address earthquake hazards in their development plans since 1971 (Bolt 1993). This legislation came about following the M6.6 earthquake that occurred in the San Fernando Valley that same year. Major structural problems were revealed in hospital collapses and freeway damage, leading to intensive interest in and research by engineers. The Governor’s Earthquake Council was established by then Governor Ronald Reagan; this was superseded three years later by the California Seismic Safety Commission (Scott and Olson 1993 p xxiv). In addition, the Hospital Seismic Safety Act was passed in California in 1972 as a response to the 1971 quake in order to improve structural stability of hospitals (BSC 2003).

Also in 1972, the California legislature focused attention on mapping and identifying hazardous regions in a response to the significant damage through the Alquist-Priolo Special Studies Zone Act. This legislation identified areas as seismic-hazards zones that required geologic study as a requirement to building in this area (USGS 1995). Though this legislation addressed earthquake faults, it did not address ground shaking and soil conditions.

The identification of fault zones was productive because it brought awareness to communities, developers and potential homebuyers of the earthquake hazard in their area. However, damage occurring as a result of ground shaking is a separate matter. Ground-shaking can be amplified by certain soils such as mud, sand or other loosely consolidated material. The consequences of building upon poor soils were exemplified by liquefaction and structural damage in the 1906 event, and recommendations for a comprehensive San Francisco Bay plan addressing the condition and quality of fills were presented in 1967 by the San Francisco Bay Development Commission (Lawson 1908; Steinbrugge 1968). These vulnerabilities would not be addressed in actual policy until 1990, twenty-three years later (USGS 1995).

A more successful recognition of earthquake hazards came during the 1960’s when California officials addressed the structural integrity of dams. The State’s Water Code examined all state dams (excluding federal dams) to evaluate their safety in the event of a major earthquake, resulting in regulations and physical strengthening programs where appropriate (Steinbrugge 1968).

During the 1971 San Fernando Valley earthquake, liquefaction occurred under the Lower San Fernando Dam, the terminus for the Los Angeles aqueduct system. This liquefaction led to landslides which sent the water level in the dam to just below the edge of the reservoir and shook loose the concrete facing on inner supporting walls of the dam. Eighty-thousand nearby residents were evacuated for eleven square miles while the water level in the dam was reduced over three days (Page et al 1995). Though disaster was averted in this case, the near failure of these dams in the 1971 earthquake was yet another wake-up call.

In 1977 the National Earthquake Hazards Reduction Program was established to fund research, mostly through the National Science Foundation (Scott and Olson 1993 p xxiv - xxv). Its creation was a direct result of Senator Alan Cranston’s strong support for the National Earthquake Hazards Reduction Act throughout the 1970s (Birkland 1997). This enabled agencies such as the Applied Technology Council (ATC) to conduct research on seismic engineering and building standards. The Building Seismic Safety Council (BSSC) was created ten years later to encourage implementation of the standards devised by the ATC and other research outcomes (Scott and Olson 1993 p xxv).

In 1979 the Federal Emergency Management Agency was created at the federal level to unite disparate disaster-related programs and policies (Tierney et al 2001). It left the main responsibility of hazard mitigation up to local entities. This was important in enabling communities to address their local hazards effectively, but was also problematic as local entities did not necessarily have the revenue or power to create and enforce mitigation. The state emergency management body, the Governor's Office of Emergency Services (OES) had been established in 1956 and would serve as a facilitator between various organizations and FEMA (Yeats 2001).

Other projects conducted during the latter half of the 20th century included seismological research conducted by the USGS. Much of their research on seismology and earthquake engineering began during the Cold War era in order to research structural response to nuclear impact (Scott and Olson 1993 p xxv). Seismology was also an invaluable tool in evaluating compliance in proposed nuclear test ban treaties during the Cold War era (Barth 2003).

By the 1970’s the USGS had produced probabilistic ground-shaking maps of the San Francisco Bay Area (see Figures 9a and 9b). Policy-makers could then base their earthquake hazard policies upon these probabilistic maps. Probabilistic risk maps are also used in developing building construction standards and regulations (Bolt 1993). When maps are verified by earthquake events, such as the Loma Prieta quake, building standards can be upgraded accordingly (USGS 1995).

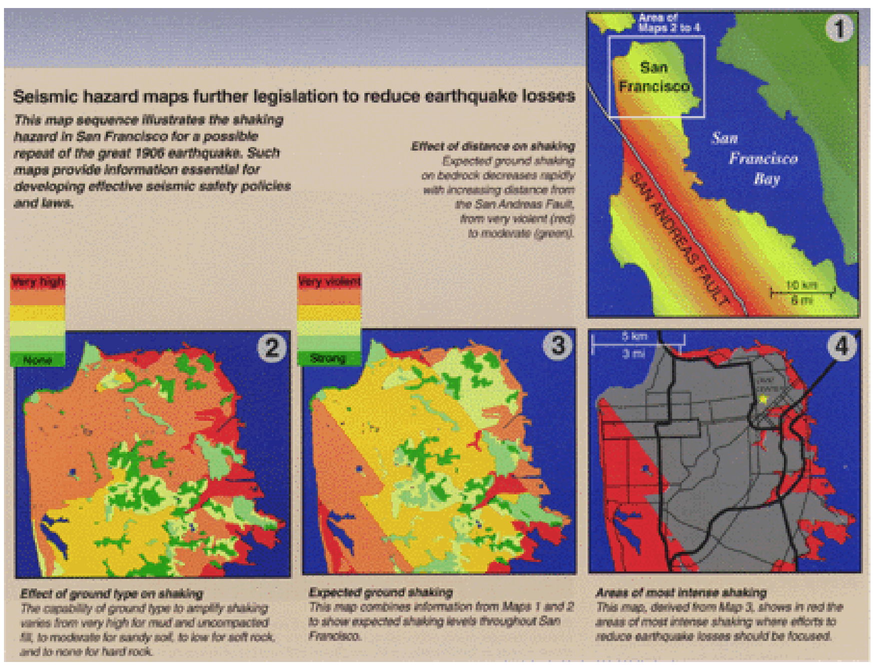

Figure 9a: Probabilistic shaking map created by the USGS in the 1970’s to address potential damage during a repeat of the 1906 earthquake (USGS 1995).

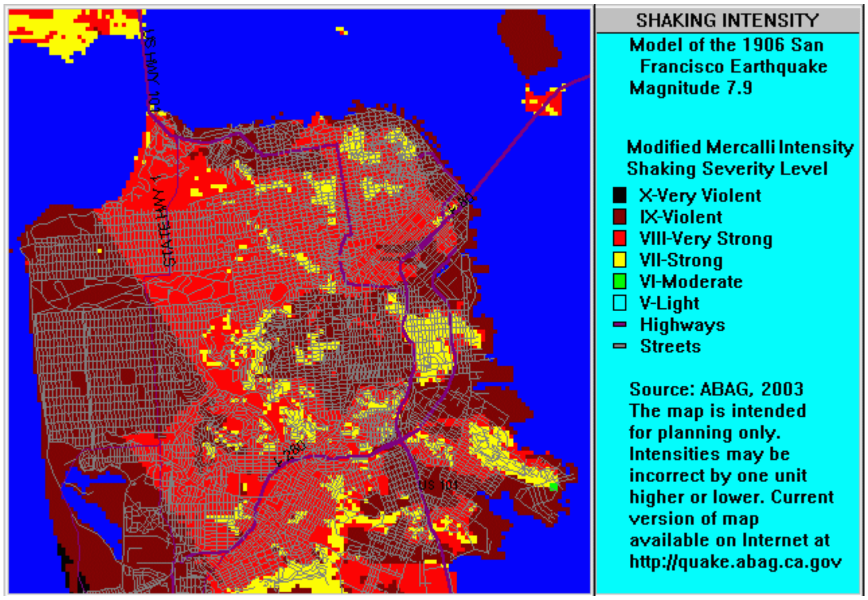

Figure 9b: Modern probabilistic shake map based on a repeat of the 1906 earthquake. (Source: ABAG 2007)

In 1986 the California Earthquake Hazards Reduction Act required the California Seismic Safety Commission to draft reports every five years with the goal of reducing hazards. Action plans and proposed legislation were a part of the "advisory document" that would be produced to describe progress. The plans excelled in describing relevant agencies, their relationships and methods of implementing policy. However they lacked in describing the role of local organizations (Godschalk et al 1999).

The M6.9 Loma Prieta earthquake of 1989 led to another flurry of action. The damage occurring in response to the moderate Loma Prieta earthquake was particularly significant in San Francisco because the epicenter was over 60 miles away in the Santa Cruz Mountains. The advisory document “California at Risk 1987 – 1992”, created by the California Earthquake Hazards Reduction Act of 1986, was adopted, and FEMA granted the California Seismic Safety Commission a $20 million grant through the Hazard Mitigation Grant Program (Godschalk et al 1999).

Projects initiated by this grant funded improvements needed during recovery from Loma Prieta. Though funds were utilized during the relief and recovery phase of the Loma Prieta disaster, decisions were based on the advisory document created prior to the disaster, giving evidence of the value of such preemptive analysis and documentation of hazards policy recommendations.

Yet another response to the 1989 event was the Seismic Hazards Mapping Act, introduced in 1990. In some ways this act was an extension of the 1970’s legislation and ground-shaking maps in that it required a state geologist to investigate earthquake hazards and identify zones as hazardous based on shaking, with the addition of ground failure potential (USGS 1995). The investigation and mitigation of these hazards became a precursor to receiving building permits in these areas, and required disclosure of the hazard upon sale of property (Yeats 2001).

Mandated disclosure was initiated to inform consumers of earthquake hazards within and around property. Palm (1990) investigated the results of mandated disclosure upon the housing market and found that generally disclosure of risk did not negatively affect the housing market. This could result from many factors, including the amenities of the area outweighing the risk, inadequate communication of risk, and personal attitudes towards the risk (Palm 1990). In 1998 the Natural Hazards Disclosure Act was instated to ensure that potential buyers would be given a statement that the property fell into a zone mapped as hazardous (California Geological Survey 2006). The densely populated San Francisco Bay Area, plagued by extremely costly real estate in and around hazardous zones, suggests that mandated disclosure has not detrimentally affected the market in this region.

The M6.7 Northridge earthquake which struck southern California in 1994 was also highly damaging considering its moderate magnitude. Soft-first floor buildings (which are often apartments on top of garages or carports where extra support provided by interior walls is lacking) performed exceptionally poorly. Moreover, the quake occurred on a previously unmapped fault. Exactly one year later, an M6.9 earthquake struck Kobe, Japan, killing over 5000 and causing $200 billion (US) in damage (Somerville 1995). Liquefaction was responsible for a great deal of the damage in Kobe.

Lessons learned from these two quakes, in addition to Loma Prieta, were incorporated into the California Earthquake Loss Reduction Plan of

1997. The plan included a strategic plan to continue to improve seismic safety including upgrading structures and increasing preparedness (CSSC 2004). Additionally the CSSC document “California at Risk” was updated in order to include lessons learned from Northridge (Godschalk et al 1999).

The Disaster Mitigation Act of 2000 was signed into federal law in order to provide FEMA funds for local mitigation and awareness programs, address multi-hazards and encourage pre-disaster mitigation through a Local Hazard Mitigation Plan. This resulted in fund availability for small communities and local regions, improving the ability of a community to prepare for and address local hazards. FEMA was reassigned to the newly created Department of Homeland Security in 2003, which weakened its role and cut these funds. As of this writing, FEMA’s absorption into the Department of Homeland Security remains a highly controversial and criticized decision.

As part of the Disaster Mitigation Act of 2000, the Bay Area Multi-Hazard Local Hazard Mitigation Plan was created by the Association of Bay Area Governments (ABAG). This plan continues ABAG’s efforts in hazard research and public awareness of hazards. The plan includes existing policy information for each of the nine counties in ABAG but leaves the task of upgrading and updating codes up to individual communities (ABAG 2005).

Earthquake hazards are difficult to address through legislation because of their relatively infrequent nature and high cost. Although there is significant savings from mitigation in the long term, short term factors such as cost and economic development incentives often obscure the benefits (Berke 1998; Comerio 2004). Even when events are statistically likely, people do not necessarily respond accordingly by demanding local mitigation policies. In fact the public at once both expects the government to protect them from disasters and disapproves of the government restricting their use of private property in order to protect them against disasters (Comerio 2004; Eadie and Johnson 1997; Godschalk et al 1999; Tyler and Mader 1993).

Another form of earthquake hazard mitigation is achieved through seismic building codes. Building codes are created to preserve lives but not necessarily to preserve structures, which may give the public and property-owners an unrealistic sense of security. They also do not apply retroactively to older buildings, some of which may be particularly susceptible to damage, as is the case with unreinforced masonry (Comerio 2004). Another limitation of building codes is enforcement. Some buildings that are not up to code may simply slip through regulatory cracks and their flaws remain hidden.

However, some buildings *cannot* slip through the cracks because they house federal offices and therefore fall under federal support and legislation. In 1990, Executive Order 12699 established new minimum seismic guidelines for federal buildings, which was an excellent step towards improving overall seismic safety, but left unchanged all areas outside of their jurisdiction including private and commercial property (Godschalk et al 1999).

Mitigation is typically a long-term procedure, but often long-term projects may not be financially feasible when the time comes for their completion (Comerio 2004). In San Francisco in particular, rent control, which was initiated to help keep rent affordable in the city, may have actually limited owners from undertaking mitigation measures because they could not increase rent to offset the cost of such measures. To address this issue, the city of San Francisco restricted any buildings constructed after 1990 from being under rent control, but the problem still exists for the 71% of rent controlled buildings remaining (Hohmann 2006). Earthquake insurance, another form of mitigation, is not consistently utilized because of the high cost of premiums and deductibles (Godschalk et al 1999; Kunreuther and Pauly 2004; Palm and Hodgson 1992). Additionally earthquake hazard regions are more difficult to delineate clearly in order to limit development than flood or coastal hazard regions (Comerio 2004; Eadie and Johnson 1997).

When compared to other states with earthquake hazard potential such as Missouri and New York, California has made strides towards addressing hazards in the aftermath of major earthquakes (Berke 1998; Yeats 2001). Palm (1990; Palm and Hodgson 1992) reinforces previous research suggesting that familiarity with earthquakes raises earthquake awareness, but still within the context of a limited period of time following an earthquake. After this limited period of time more frequent and visible issues take the forefront on political and public agendas.

A brief history of disaster research

In order to develop an appropriate context within which to interpret this study, it is helpful to know something about the disaster-related research that preceded it. Gilbert White is widely considered to be the father of modern natural hazards research in the United States. His 1945 study *Human Adjustments to Floods* was a landmark piece in that it successfully and succinctly linked processes in the natural environment with social behavior and adjustments. By the 1970s he established the Natural Hazard Research and Information Application Center at University of Colorado, Boulder which continues to be one of the preeminent institutions for hazards research. In addition to his extensive work on hazards, namely flood hazards, he also studied water conservation and quality issues outside of the US in regions facing water crises (Natural Hazards Center 2006).

White's work, along with that of Ian Burton, J. Eugene Haas and Robert Kates, among others, centered around four thematic issues in hazards through the latter half of the 20^{th} century (White and Haas 1975; Burton 1993; Rodrigue 1993):

1) The spatial **distribution** of hazardous events
2) The **vulnerability** of individuals and society within that spatial matrix
3) Their **perceptions** of that vulnerability and
4) Their **adjustment** to that perceived vulnerability

Choice in adjustments to hazards is addressed within the context of the theory of bounded rationality, wherein an individual will make a decision based on an assessment of their situation with the understanding that they cannot meet the absolute highest standard of hazard mitigation given their situation (Burton 1993; Perry and Mushkatel 1984).

Research geared towards identifying preferred methods of hazard mitigation and understanding why losses continued despite mitigation paved the way for future generations of researchers whose work concentrated on loss reduction (Mileti 1999). Hazards research contemporary to White’s own work in the United States developed along two different lines of inquiry in two disciplines: human ecology and loss reduction in geography, and human behavior in and response to hazards in sociology.

In the post-war era, hazards research was looked upon as a means of strengthening civil defense, and interest in the field of human ecology as a whole waned through the 1960s. The two fields of hazards research began to merge together in the 1970’s as a part of Eugene Haas and Gilbert White’s 1975 assessment of the state of hazards research (Mileti 1999). The focus of hazards research at the time was mostly within the geophysical realm, with little attention paid to hazards with a slower progression, such as drought and climate change (White and Haas 1975; Burton 1993).

Long range hazards such as global warming and desertification began to find root in hazards research, particularly as the anthropogenic causes of these hazardous conditions were identified (Burton 1993). Technological and biological hazards would soon join the hazards research paradigm, and by the 1980s risk assessment had become a part of the field as well. Risk assessment research centers upon evaluating specific outcomes of disastrous situations in which an individual makes decisions based on his or her unique situation (Perry and Mushkatel 1984).

The next major leap of hazards research was the transition from the individual to the community. As hazards research evolved, the idea of the individual actor underlay most analyses of hazard perception and response (White and Haas 1975; White 1945 Rodrigue 1993; UNESCO 1978). With more attention paid to Third World countries in the ensuing decades, the constraints imposed by an individual's social system became interlaced with ideas about hazard perception and response. The individual was placed within the framework of his or her unique social, economic and cultural situation, permitting evaluation of differential vulnerabilities (Burton 1993; Rodrigue 1993).

More recently, disaster research has been linked with the environmental justice movement. Environmental justice proponents argue that the environment is experienced differently depending on socio-economic conditions, often to the disadvantage of economically limited or socially segregated populations (Fothergill et al 1999). The movement grew following President Clinton's recognition of the disproportionate amount of environmental pollutants faced by minority-dominated communities, and soon expanded to natural disasters (Environmental Justice Project 2006).

Supporters of this movement identify the geography of socio-economically limited populations with reference to environmental vulnerability in an effort to bring attention to these disparities. Federal and state regulations addressing this issue are uneven and often nonexistent. In 2004 California published the "Environmental Justice Action Plan" to research preemptive guidelines, regulate evaluation of hazardous situations and incorporate public awareness and input into the process. This project is currently being implemented but remains in the early, evaluative stage (California EPA 2006). The following section describes previous research on hazards and the differing experiences of ethnicities that lend support to this movement.

Social theories of disaster recovery

There are multiple stages of a disaster, ranging from before to during to after the event. The human ecology perspective considers these stages part of a cycle including: *preparedness, response, recovery* and *mitigation* (Mileti 1999). Though this thesis focuses particularly on recovery, some aspects are interconnected such as mitigation measures undertaken during the recovery phase, so mitigation occurring within the context of recovery will also be discussed.

1. ***Preparedness*** includes the time before disaster when warnings are disseminated, emergency plans and kits are organized and information about disasters is taken in by the general public.

2. The ***response*** phase includes the moments directly after disaster when populations take shelter, ride out events and perform emergency response such as search and rescue for survivors.
3. The ***recovery*** phase is a period that overlaps with response and includes reconstruction and reparation of social norms.
4. ***Mitigation*** is a phase that overlaps preparedness and recovery and includes addressing the physical structure of a region or building in order to minimize losses.

Natural disasters are social events that have an effect that is not uniform. Though a region may experience an earthquake of generally uniform magnitude, the effects of that earthquake on the population will vary depending on the social conditions of that population. Economic stability, cultural assimilation and quality of living conditions are all factors that contribute to the different experience of disasters (Bolin 1994; Haas et al 1977; Mileti 1999; Palm and Hodgson 1992; Perry and Mushkatel 1984; White and Haas 1975). Aesthetic values and the ability of more wealthy individuals or a community to absorb the high cost of a hazardous event often offsets the downside of living in harm's way (Palm and Hodgson 1992; Rodrigue 1993).

Social problems tend to be exacerbated in urban regions where resources are scarce, infrastructure is dense and oftentimes older and the wide gap between rich and poor is clearly evident (Greene 1991). In urban regions the most favorable land, usually outside of the central business district, is often occupied by the wealthy, leaving the poor and the homeless to occupy less favorable housing in the inner city. The quality of structures in the inner city varies but is commonly older building stock with varying degrees of upkeep (Greene 1991; Lindell and Prater 2003; Mitchell et al 1999). Adding to the difficulty of obtaining adequate housing following disaster is the problem of temporary housing becoming permanent in areas already experiencing a housing shortage (Bolin 1994; Comerio 1998; Lindell and Prater 2003). For instance, two years after Loma Prieta, 100 displaced residents in Oakland still resided in temporary living quarters (Greene 1991).

Post-disaster housing options for individuals and families also progress through stages (Quarantelli 1982):

1) Emergency shelter – during and immediately after the event
2) Temporary shelter – in the days and weeks that follow the event
3) Temporary housing – in the days and weeks that follow the event

4) Permanent housing – varies depending on length of earlier stages

The shelter stages signify a need to get people into safe quarters such as inside a school gymnasium. Temporary shelters may require many people to share facilities with a large number of people using cots, sleeping bags or simply sheets and blankets, with cafeteria style food and little privacy. Temporary shelter can also include residing with friends or relatives. Temporary housing is a transition from these mass quarters to a temporary structure, sometimes still shared, that may have bedrooms and kitchens and provide more privacy. The transition to permanent housing varies tremendously from individual to individual, and may not be attained by low income or semi homeless for years (Wu and Lindell 2004).

Haas et al's *Reconstruction following disaster* (1977) describes patterns of urban recovery in San Francisco and thus provides a very helpful framework for examining how urban disaster recovery typically occurs in a market economy. This pattern was observed in the aftermath of the 1906 earthquake (and can be applied directly to the aftermath of the 1989 earthquake to discover if similar patterns emerged). Full recovery, or a return to normalcy, from a disaster typically takes between ten and fifteen years to achieve, with housing recovery occurring within three to eight years (Greene 1991; Eadie and Johnson 1997).

As Haas et al's analysis shows, the first signs of recovery following the devastating 1906 earthquake coincided with the return of businesses to the downtown commercial district. The first businesses to return to the commercial district were retail establishments, many of which were able to rebuild because of insurance payments received. Once these businesses began to re-establish themselves, tourist and luxury oriented businesses including hotels and theaters began to return to the business district (Haas et al 1977 p 73-7). The next step in recovery included the adjacent mixed use areas, both commercial and residential (usually housing poor workers), which re-established themselves on the periphery of the downtown district. SoMa was reconstructed in just this way, with commercial and industrial businesses dominant and a sprinkling of mostly low-income and middle-income residences throughout.

Patterns of recovery in residential neighborhoods analyzed by Haas et al (1977) revealed the significance of socio-economic and ethnic factors. In the residential sector, recovery was typically marked by factors such as a physical return to a previous residence (persistence) and stabilization of commuting distance to work (stability). The speed with which these recovery indicators were reached varied among different socio-economic and ethnic groupings. While no group showed significant recovery in the year following the 1906 quake, by the second year after the quake 92% of the “high white-collar” group had recovered. This was in part linked to the rapid recovery of the business district that allowed many of these white-collar employees to continue working (stability), and in part because much of the upper class housing west of the fire’s farthest extent was repaired fairly rapidly (persistence) (Haas et al 1977 p 79-80).

By contrast, “unskilled workers” (henceforth referred to as “low-income”) in Haas et al’s (1977 p 79 - 84) study exhibited very different patterns of recovery. In cities unaffected by disasters, low-income workers tend to show levels of persistence and stability that are below an average baseline. In San Francisco following the 1906 event, these low-income workers were attaining persistence and stability at levels even lower than their counterparts in unaffected cities. The problem of attaining persistence and stability was further exacerbated by the cost of longer commutes as well as the slow re-establishment of the mixed commercial, industrial and residential sectors outside of the business district where this low-income population was typically employed (Haas et al 1977 p 79 - 84).

The re-establishment of the mixed commercial, industrial and residential sector in San Francisco took place in such as way as to eliminate some of the low-income housing that had previously been available to low-income workers (Haas et al 1977 p 80 - 84). Many of these low-income workers had the longest time period to recovery and many would even relocate out of the area to re-establish themselves (Haas et al 1977 p 87 - 90). Of the 300,000 that left San Francisco after the quake, a large portion of this group was of the lower socio-economic classes.

Ethnicity as a control on recovery was also documented by Haas et al (1977). Based on surnames, Haas et al (1977 p 84-91) found that Jewish, German, French and English ethnicities were the earliest to recover, with Polish, Scandinavian, Italian, Portuguese and Mexican ethnicities experiencing much slower rates of recovery. This second grouping of ethnicities was often composed of more recent immigrants, which in part explains their slower recovery rates (Haas et al 1977 p 90). The first grouping of ethnicities shared some employment characteristics that also enabled their relatively rapid recovery.

Haas et al (1977 p 91-3) also found geographic segregation (henceforth referred to as “specialization” when referring to businesses) taking place during recovery that contributed to a strengthening of San Francisco’s economy. As districts rebuilt, businesses were able to specialize along common lines, creating geographical divisions according to specialized roles and the inclusion of necessary infrastructure. For instance, the manner in which San Francisco’s downtown was rebuilt to incorporate a variety of transportation methods enabled it to remain viable throughout the 20th century while other downtown business districts went into decline (Haas et al 1977 p 93).

Eadie and Johnson (1997) noted a similar trend towards specialization in other post-disaster environments. In order for businesses to regain a foothold post Loma Prieta, they made adjustments that “modernized” their businesses to reflect current needs and customer bases. In Santa Cruz, for instance, the downtown district was rebuilt with the large university population in mind to incorporate more entertainment venues and specialty goods. In nearby Watsonville, the downtown district was rebuilt to better accommodate the large Latino population (Eadie and Johnson 1997). A side effect of building reconstruction was again a specialization of districts, deemed a necessity in order to rebuild the financial capital that was needed to rebuild the district.

Haas et al (1977) also found trends towards segregation in the residential sector. Demand for housing was so high following the 1906 earthquake that people were essentially shut out of areas according to their socio-economic status, leading to socio-economic segregation. New housing built to the west of the city was exclusively available to the wealthy, leading to further geographical division between rich and poor. Middle-class housing was also in high demand, which inflated rents beyond the means of lower-income and marginal middle-class residents

(Haas et al 1977). Low-income residents were forced to look elsewhere for housing and virtually eliminated them from upper and middle-class neighborhoods.

A side effect of this residential “re-sorting” was segregation along ethnic lines, as many of San Francisco’s ethnic groups were closely associated with a certain socio-economic status (Haas et al 1977). Germans and French, for example, were so heavily assimilated prior to the 1906 quake that their “segregation” following recovery was based primarily on socio-economic status. Some ethnic groups either unable or unwilling to assimilate -- particularly the Chinese, Italian and Jewish -- were segregated along lines that were sometimes socio-economic and sometimes ethnic (Haas at al 1977). The Chinese, for example, were initially and with great hostility displaced following the quake but eventually re-established themselves in an even more dynamic and culturally-rich Chinatown.

Earthquake damage can also facilitate *de*-segregation. In the Loma Prieta earthquake of 1989, portions of two major roadways were damaged beyond repair: the Cypress Structure in Oakland and the Embarcadero Freeway in San Francisco. West Oakland residents were adamant that the Cypress not be rebuilt, as it had severed this community ever since it was constructed. Additionally there was resistance to rebuilding the

Embarcadero Freeway in San Francisco, long considered a blight on the waterfront. In both cases, the structure was not rebuilt in the same manner, allowing for a renewal of community in West Oakland and a revitalization of the waterfront in San Francisco (Eadie and Johnson 1997). This type of major reconstruction is unusual, however, because it requires a large consensus and suitable alternatives.

At this point it is worth mentioning the paradox that commonly occurs during rebuilding. The need to rebuild after disaster arises from the vulnerability of a structure and the damage wrought by an event. To rebuild an identical structure in an identical place may bring about a sense of closure and a return to normalcy to a homeowner, but it also may leave them just as vulnerable to a future event as they were to the event that required them to rebuild (Petterson 1999). In the Marina District, soil conditions are highly unsuitable for housing. However, modern seismic engineering standards enable structures to be built on poor ground because they are designed to withstand increased shaking. But in doing so, the owner or builder is relying heavily on the accuracy of engineers and the “promise” of increased safety. Though complete relocation is not a viable option, property owners need to address mitigation during reconstruction to preserve their real estate, their property and possibly their lives. This is at present left up to the individual, and individuals have not responded well to construction delays caused by the need for geologic investigation of soil suitability.

This paradox of placing oneself directly back in the path of danger is demonstrated by other disasters, most recently Hurricane Katrina along the Gulf states. During the 1940s Congress allowed Louisiana to make “productive” use of wetlands by converting them with the installation of new levees and by raising older levees (Burby 2006). This was geared towards protecting current residents from hurricane storm surge, but also created room for significant new residential development. This, coupled with the National Flood Insurance Program (NFIP) -- which provided insurance to those in flood hazard regions starting in 1968 -- enabled 76,000 housing units to be built in these flood prone areas over ensuing decades (Burby 2006).

Over the next few decades these and other similar neighborhoods were faced with ongoing problems of sinking land and muddy soils while population density continued to increase. When a large hurricane finally swept over this region in 2006, these low-lying flood-prone areas were devastated. Some neighborhoods were completely flooded as levees were breached. Others were destroyed by storm surge, the impact of which would have been lessened by acres of wetland that had previously existed. The NFIP has paid out so much in claims over the years that when Hurricane Katrina struck it was already indebted to the National Treasury, making the need to pay Hurricane Katrina claims daunting (Burby 2006).

The paradox of “improving” land can have unintended consequences. By converting wetlands to residential land, Gulf coast residents both lost a protective buffer against hurricane damage and were also allowed to build their lives and livelihoods in extremely dangerous areas. In comparison, by improving design standards to enable residents to live on very poor soils, residents in the San Francisco Bay Area have also built their lives and livelihoods on extremely dangerous land. We continue to put our faith in engineering against disaster, but, as pointed out by Tenner (1997) in *Why Things Bite Back*, there may be unintended consequences.

Ethnicity and disasters

In terms of preparedness, Aguirre (2004), Blanchard-Boehm (1997), Goltz (1992) and Palm (1990) found differences in the way hazards are perceived by different races and by gender, with white males generally feeling safer in comparison to members of other ethnic groups. White males have also been found to have taken more preparation measures, including assembling emergency kits, purchasing hazard insurance and employing structural retrofit (Blanchard-Boehm 1997). White males with past disaster experience were also found more likely to believe disaster-related warnings or information (Palm 1990; Perry and Mushkatel 1984; Perry and Lindell 1991). Perry and Mushkatel (1984) comment that perhaps ethnic minorities are less likely to believe and/or respond to disaster warnings because those that are impoverished are already facing the constant struggle of survival and therefore have a less intense reaction to disaster warnings.

Hazard preparation measures have historically been printed in English only (Tierney 1993) and focused on neighborhoods that were less likely to be ethnically or economically diverse (Faupel et al 1992). During the response phase, Mexican Americans have been found to utilize social and family networks more heavily than whites and blacks to spread information about impending disasters (Blanchard-Boehm 1997). Perry and Mushkatel (1984) also found that blacks did indeed utilize family networks more heavily than whites by way of welcoming disaster victim relatives into their homes. This is part of a larger field of disaster and ethnicity research that suggests minority families generally have closer ties within the home and within the ethnic community than white families; disasters, according to this view, simply reveal these close ties.

A disturbing trend of higher disaster-related fatalities in minority groups has been documented by Fothergill et al (1999). This is in part related to poorer housing conditions in minority-dominated regions (Arnold 1993; Bauman 1997; Bolin and Bolton 1986; Bolton et al 1993; Comerio 1998; Perry and Mushkatel 1984). Housing also becomes a troublesome factor in the wake of any disaster when households are displaced and temporary housing must be acquired. In the 1989 Loma Prieta earthquake, the city of Oakland alone lost 800 units of low income housing (Bolin 1990). The economic limitations affecting such a population before disaster, such as a housing shortage, will only be exacerbated after the disaster as losses accumulate and stable living situations are disrupted (Bolin 1990; Greene 1991; Comerio 1998). Emergency mass shelters tend to be more heavily utilized by minority populations because of their lack of additional financial resources (Bolin and Stanford 1990).

Researchers (Fothergill et al 1999; Lindell and Prater 2003; Perry and Mushkatel 1984) have found significant evidence that in general the psychological stress and trauma experienced during and after disaster is higher, more long lived and/or more severe for minority groups.

In addition, during the response phase to a disaster the needs of minority groups may not be addressed in the same manner as the needs of whites. This has been related to language barriers and cultural customs (Bolton et al 1993; Greene 1991). Beady and Bolin (1986) found evidence that in Alabama, the needs of whites were met before the needs of blacks in the aftermath of Hurricane Frederick in 1979. Dhesi (1991) found that emergency shelters in more financially viable neighborhoods received better treatment.

Following the 1983 Coalinga, California earthquake, the scarcity of low-income emergency housing affected those with economic limitations most severely. According to Bolin (1994) a disproportionate percentage of those affected were Latino. Not only did they have the most difficulty during the immediate aftermath of the earthquake, their financial limitations led to difficulty obtaining long term housing and lack of funds available through insurance claim payouts. In the 1987 Whittier Narrows earthquake, as well as the 1989 Loma Prieta quake, Latino immigrants were reluctant to return to their homes after the ground stopped moving, not only because of recent experience with the 1985 Mexico City earthquake, but also because of the close ties formed in their new community and a reluctance to venture somewhere new (Bolin 1994). Their difficulties during the response phase continue into the recovery phase.

Because poor quality housing suffers during an earthquake and is often used as rentals in urban centers in California, low-income residents that occupy these residences are put in further distress during the recovery phase (Bolin 1994; Comerio 1998). These poor quality buildings often must be upgraded before they can be occupied, and so the residents most limited financially are also the most likely to be displaced as a result.

Near its epicenter, the Loma Prieta earthquake provides another example of how social problems are amplified by disaster. Racial divisions between the Latino community and the Anglo community existing prior to the quake in Watsonville were exacerbated by the housing crisis that followed (Bolin and Stanford 1990). Mostly Latinos were displaced and were in need of aid; while the Red Cross did provide such aid, its workers were criticized for being culturally insensitive. This arose because of the fact that the Red Cross did not acknowledge the predominantly Latino tent city that developed in Watsonville, outside of the five designated shelters, and refused to provide services (Bolin 1994; Comerio 2004). As a result the Red Cross remained in the area significantly longer than expected, and FEMA ultimately had to provide trailers for temporary shelter.

In the city of Santa Cruz, those displaced by the earthquake were low-income renters, lower income Latino service workers and those already homeless. Those already homeless were not eligible for FEMA's long term temporary housing programs, though they were allowed to remain in the emergency shelters in which many had already been residing (Bolin and Stanford 1990). In Santa Cruz County as well as the Bay Area, a significant proportion of low-income elderly residents were also displaced from residential hotels after Loma Prieta and presented another group affected by the post-disaster housing crisis (Bolin and Stanford 1990; Bolin 1994).

Natural disasters and the media

Rodrigue et al (2004) describe the manner in which the media can blow disasters out of proportion, a trend that may be exacerbated by the ease of communication on the internet. At the time of the Loma Prieta earthquake, media outlets of all kinds were concentrated in San Francisco to cover the 1989 Major League Baseball World Series. The heavy media presence enabled an almost instantaneous shift to damage coverage following the earthquake. The fire that broke out in the Marina District made it the first region to gain media attention, and the images captured of that event greatly influenced impressions of damage as a result (San Francisco Chronicle 1989; Bolin 1990).

Rogers et al (1990) visited the San Francisco Bay Area the day after the earthquake and took stock of the major exaggeration of casualties and damage reported by radio, television and newspaper outlets. Some of these reports specifically mentioned impassable intersections, which Rogers and his team found very much passable (1990). The three main sources of information for media outlets in the aftermath of Loma Prieta were the national newswire, network television broadcasts and witness accounts, which all suffered from misinformation, inadequate estimations and pre-conceived views in the immediate chaos that followed the event (Rogers 1990).

Following the 1994 Northridge earthquake, media coverage of damaged areas was directly linked towards race and income: white, wealthier populations were disproportionately represented in media accounts. Yet they were the fastest to recover: six months later, underrepresented populations exhibited a slower recovery rate than the overrepresented populations (Rodrigue and Rovai 1998). Likewise a random survey of residents following the 1994 Northridge earthquake revealed that awareness of damaged areas by residents closely coincided with those mentioned most heavily in the media. Rodrigue (1997) argues that the fact that the earthquake was coined “Northridge,” despite the fact that the epicenter was closer to Reseda, was also related to Northridge’s relatively higher social status.

Mike Davis (1998) faced heavy criticism from his peers and foes alike for his analysis of media bias in southern California disasters. Davis documented the manner in which fire hazards in Malibu and East Los Angeles were downplayed, California tornados were virtually ignored and flood hazards were disguised by Los Angeles’ complex network of concrete channels. The role of the media as a determinant of what was publicized, how it was publicized and how residents and victims were portrayed painted a stark picture of a community in denial and the media as a significant contributor to this distorted reality (Davis 1998).

What is most troubling about media bias in reporting natural disasters is the way in which underrepresented regions receive less attention and therefore fewer resources geared towards recovery. After the Loma Prieta event, where media coverage focused on the Marina District, much less coverage was given to the more ethnically diverse East Bay and Santa Cruz, even though these areas were equally devastated (San Francisco Chronicle 1989; Rogers 1990; Rodrigue 1997). Dymon and Boscoe (1996) report a tendency for newspapers to utilize a “hook” during disaster reporting, wherein a compelling visual image -- such as a memorable landscape or a site of dramatic fatalities -- is used to draw in viewers and readers regardless of severity of damage in comparison with other regions.

Rovai’s (1994) research on the 1992 North Coast earthquake in California exemplified this media bias towards certain regions. Two towns, Ferndale and Rio Dell, both sustained damage. The earthquake was named after Ferndale, a community full of picturesque Victorian homes, a thriving art community and a regular tourist base. Rio Dell, on the other hand, had lower per capita income and higher unemployment rates and was generally poorer than Ferndale. Rovai argued that the media's attention was focused on Ferndale rather than Rio Dell as evidenced by significantly higher visibility in newspaper articles and photographs (1994). Rovai also noted more structures were actually damaged and more residents were displaced in Rio Dell than in Ferndale.

Rovai concluded that socio-economic factors existing prior to the earthquake contributed to differential rates of recovery, and that financial resources were clearly more available and accessible to Ferndale residents than to Rio Dell residents. This is in part a result of increased media attention on Ferndale which led to residents' perception of Ferndale as more seriously damaged than Rio Dell. Rovai's informal interviews of residents of both cities revealed that Rio Dell residents were also less likely to know that financial aid was available and how to go about securing it, a consequence that Rovai attributes to "less successful" channels of communication in Rio Dell than in Ferndale.

What Rovai's, Davis's and Rodrigue's work suggests is not an overt attempt to ignore impoverished or ethnically diverse neighborhoods on the part of disaster relief agencies. Rather, these works identify possible barriers to securing relief funds such as media visibility, or lack thereof. These studies lend support to the environmental justice movement because they incorporate the role of socio-economic and/or minority status in evaluating disaster vulnerability and response.

Dymon and Boscow (1996) reiterate that maps are necessary to convey less biased spatial information, but most are not appropriately used to do so in newspapers, where they merely identify regions rather than displaying thematic or statistical information. A close review of two major San Francisco newspapers during the weeks after Loma Prieta confirms that these newspaper maps generally conveyed limited information with a minimum of cartographic detail. Additionally the “mental maps” of emergency managers may be influenced by media bias and result in inappropriate allocation of resources (Kiernan 1995).

For an idea of what a mental map may or may not contain, imagine that you are asked to provide directions from a friend’s home to your workplace, and you make a sketch that includes all of the landmarks that you regularly use. Will your map have all of the street names crossed on the way to your workplace? Will your map have more detail of your friend’s home, which you may only be slightly familiar with, or your workplace, with which you are intimately familiar? Your sketch may be perfect for getting your friend to your workplace, but would probably be useless for much else. While emergency managers would likely be working from accurate, commercially produced maps, their awareness and perceptions of the regions will still color their understanding and mental images of that region.

Rodrigue et al (1997) describe “filters” through which information provided by the media must pass. Advertising supplies significant funds for media outlets, so placating advertisers and their interests is a necessary evil of funding a newspaper. Likewise, funding from parent corporations limit the topics which can be addressed and criticized, depending on what interests and subsidiaries may be supported by the same parent corporation.

The media is a highly commercialized industry which depends in large part on sensationalism to draw in and keep customers to maintain a steady base of support. This includes focusing on likeable individuals and “feel good” stories to help the reader identify with the subjects discussed (Dymon and Boscoe 1996) but these stories do not necessarily represent the general public. At least one article in the *San Francisco Chronicle* during the weeks after the Loma Prieta quake quoted residents expressing frustration with the media attention that the Marina was receiving because of its glossy image.

There is always the problem of simple miscommunication. The high number of fatalities reported by newspapers and television following the earthquake may have resulted from numerous unconfirmed reports that could not be verified by local sources due to the inherent chaos that follows a disaster. It is not uncommon for news reports to overestimate casualties following disaster, which is particularly likely when they are based on the independent estimates of several different organizations (Rogers et al 1990).

The various theories about disaster preparedness and response help to frame this study in the appropriate context. This study is intended to further validate what has already been established about the very different experiences of people during disaster and the role of the media during disaster, using a population subset that has not yet been fully explored. This study's contribution to the wider field of hazards research is illustrated in the following section.

Chapter 4 Study results: The shadow of ethnicity and class on disaster experiences

Results of the methodological steps 2, 3 and 4 (detailed below) will be provided in this chapter. These results will be synthesized (Step 5) in Chapter 5.

Step 2: GIS Results

The 1906 and 1989 data were compared in the GIS in order to identify regions experiencing repeat damage in both events (refer to Figure 10). Upon inspecting the map, it becomes apparent that SoMa, the Marina, Downtown, the Mission District and the Embarcadero were sites that clearly experienced repeat damage in 1906 and 1989. This group of

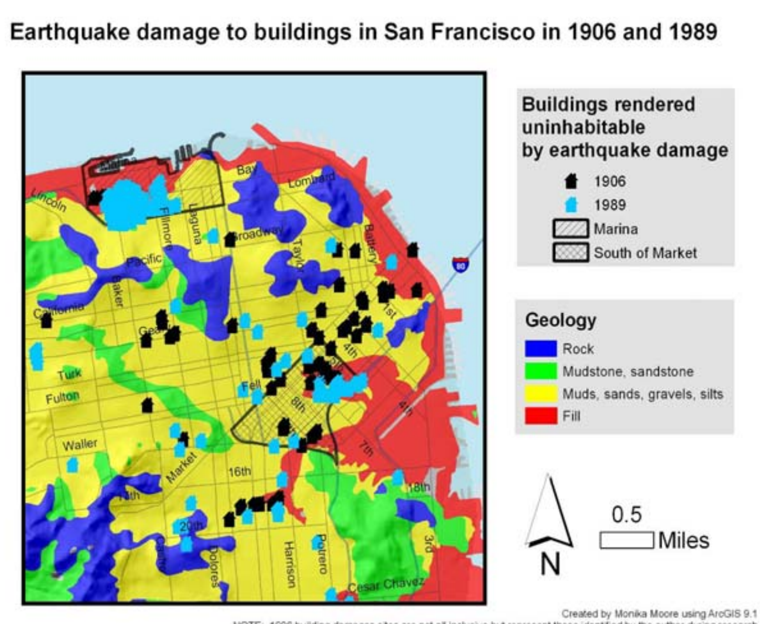

Figure 10: Buildings rendered uninhabitable by earthquake damage in 1906 and 1989. The 1906 dataset was compiled by the author to compare to the 1989 dataset acquired through ABAG. This map aided in selection of SoMa and Marina as study sites, as both had damage in 1906 and 1989 and both reside on filled land. (Source: author)

sites also closely coincided with poor soil quality, as is evidenced by the soil type layer in the GIS map.

The results of this analysis were used to select sites to study, SoMa and the Marina, because of their similar geophysical and differing socio-economic characteristics. These were also areas experiencing a high degree of damage in both earthquakes. A second map was created (Figure 11) using a liquefaction layer obtained from USGS's online GIS

Study Sites: Marina District & South of Market (SoMa)

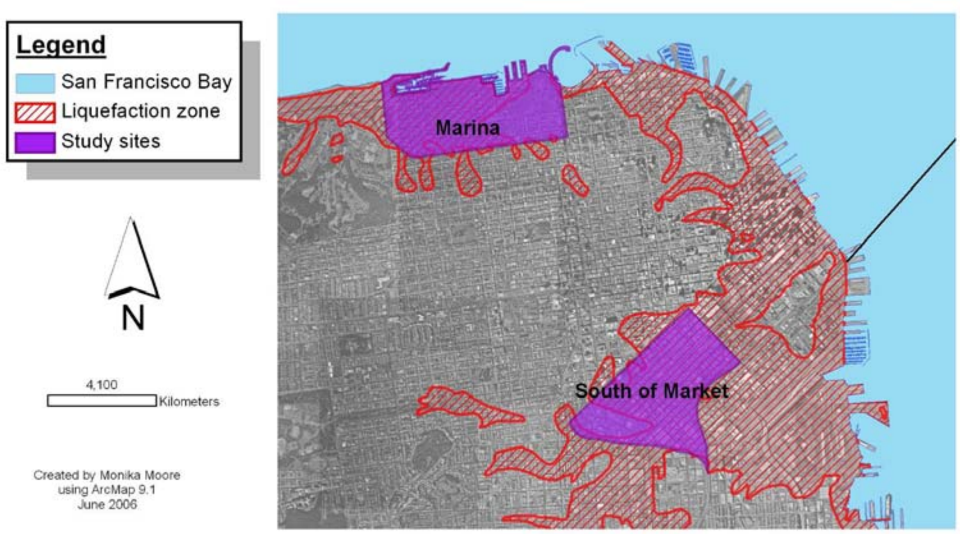

Figure 11: These two neighborhoods, the Marina and SoMa, are the focus of this study. This map shows their location within San Francisco as well as their local liquefaction potential (Source: author)

GEODE where the outline of the neighborhoods was overlain. This map reveals that both neighborhoods reside over ground that is subject to liquefaction, lending further evidence of their vulnerability to earthquake damage.

Step 3: Socio-economic Setting Results

Data gathered from the 1990 US Census Tables is displayed in Table 4 and 5 below. Also included are figures on the number of damaged structures and estimates of the cost of damage (Table 6).

Table 3: Comparative population & land area (Source: 1990 US Census)

	Marina	**SoMa**	**San Francisco City and County (total)**
1990 population	9775 (1.4%)	11770 (1.6%)	723,959
Land area (sq mi)	.595	1.54	47

Table 4: Economic data ~ 1989 (Source: 1990 US Census)

	Marina	**SoMa**	**San Francisco City and County (total)**
Population below poverty level (average)	4.93%	18.72%	12.4%
Median home value	$500,000 +	$192,700	n/a
Number of **owner** occupied buildings	1374 (1.3%)	173 (0.2%)	105497
Number of **renter** occupied buildings	4787 (2.3%)	5183 (2.6%)	200087
Number of **vacant** buildings (for rent, sale or boarded up)	1185 (5.1%)	1086 (4.8%)	22887

Table 5: Ethnic data ~ 1989 (Source: 1990 US Census)

	Marina	**SoMa**	**San Francisco City and County (total)**
White householder *Householder refers to head of household	5706 (2.9%)	2989 (1.5%)	198214
Owners	21.5%	3.6%	33.4%
Renters	78.5%	96.3%	66.6%
Black householder	37 (0.1%)	522 (1.7%)	30477
Owners	10.8%	0.95%	28.7%
Renters	89.2%	99.04%	71.3%
Asian householder	371 (0.6%)	1609 (2.5%)	63607
Owners	37.2%	3.3%	43.3%
Renters	62.8%	96.7%	56.7%
Hispanic householders	228 (0.7%)	474 (1.5%)	30955
Owners	8.8%	0.4%	28.2%
Renters	91.2%	99.6%	71.8%
Other minority householders	47 (0.4%)	236 (1.8%)	13286
Owners	10.6%	2.5%	22.4%
Renters	89.4%	97.5%	77.6%

Table 6: Damage estimates (Sources: Harris 1992; Taylor et al 1994)

	Marina	**SoMa**
Buildings destroyed	74	25
Damage (estimates, USD in 1989)	$55,233,241	$36,893,325

The tables above reveal that the socio-economic structures of these neighborhoods are very different. The Marina has a mostly white population with median home values well above $500,000, while the median home value in SoMa was below $200,000. SoMa has more ethnic diversity than Marina as evidenced by the higher percentages of minority populations. SoMa also has a much higher percentage of people living below the poverty line (18% in SoMa, roughly 5% in Marina). The damage figures show that the Marina experienced roughly twice the damaged structures than SoMa, while the cost of damage in SoMa was more than half that in the Marina.

Marina has more owner occupied buildings than SoMa, although both neighborhoods have more renters than owners. The Marina also has more of the city's vacant buildings than SoMa (5.1% in Marina, 4.8% in SoMa). Vacant buildings include buildings that were boarded up, are for rent or sale and/or are seasonal residences. To compare the percentages of renters to owners, the city average was provided as a baseline. In both SoMa and the Marina, there are more renters than owners in comparison to the city average. In the Marina, white, Asian and black ethnicities are closest (within 20%) to the city average of number of owners versus renters, while in SoMa there are very few owners in every race category.

Details on the tax structure in San Francisco at the time of the 1989 earthquake might shed further light on this subject in future research, but within the constraints of this study its impact on recovery in Marina and SoMa was not identified. The data described above and their impact on this study will be further described in Chapter 5.

<u>Step 4: Newspaper Review Results</u>

Results of the tabulation of newspaper media "mentions" are displayed below in Table 7.

Table 7: References to SoMa &/or Marina made during the three months after the Loma Prieta earthquake in San Francisco Chronicle and/or San Francisco Examiner, 10/18/89 – 1/18/90

	Chronicle		Examiner	
	SoMa	Marina	SoMa	Marina
October	35	206	30	184
November	18	95	20	55
December	8	15	10	19
January	0	7	7	5
Average word count of articles	*900*	*762*	*NA*	*NA*
Total	**61**	**323**	**67**	**263**

This study clearly indicates that the Marina District was mentioned far more frequently than SoMa in San Francisco newspaper reports of the earthquake's aftermath. While SoMa is roughly three times larger than the Marina, approximately twice as many buildings in the Marina were rendered uninhabitable than in SoMa. Moreover, estimates of damage in SoMa were approximately 1/3 less than in the Marina. Yet, by comparison, the Marina was mentioned more than four times more often than SoMa in the newspaper. The average word count of articles mentioning SoMa was higher (900) than the average word count of article mentioning the Marina (762) but this may be in large part related to the sheer number of Marina mentions in articles of various word counts, while

SoMa was typically only mentioned in more substantial articles. While the Marina had more than twice as many damaged structures and about 1/3 higher cost of damage than in SoMa, the Marina was mentioned nearly *five* times more often than SoMa in the newspaper.

The implications of this study and the constraints inherent in this methodology will be discussed in the following chapter.

Chapter 5 Discussion & Concluding Remarks

In response to the question posed at the outset of this research, “Was there a difference in media representation between the Marina and SoMa following the 1989 Loma Prieta earthquake?” I can definitively say yes, there was a difference. The Marina was mentioned far more frequently than SoMa, as evidenced by the data provided above. There are many possible reasons for this uneven representation and many possible effects on recovery as a result. Fundamental differences between Marina and SoMa’s socio-geography further complicate the effect of uneven media representation on recovery. This research has elucidated some of those differences that helped to shape building recovery in both neighborhoods.

By focusing on the Marina District following the earthquake, the media may have inadvertently caused the general public to also focus upon the Marina District. As described by Rodrigue (1997) and Rovai (1992), repetitious images of damage in certain locations shown by the media coincided with public perceptions that damage was most severe in these locations. This perception may then lead the public to direct their attention and donated resources towards these locations.

Can less visible but equally damaged locations receive less attention and therefore fewer resources to aid recovery? In the late 20th century California earthquakes studied by Rodrigue (1997) and Rovai (1992), there was a clear connection between increased media attention and relatively more rapid rates of recovery. In this research I have found that the Marina both received more media attention and recovered more rapidly (Bauman 1997; Greene 1991; San Francisco Chronicle 1989), but because of distinct socio-economic circumstances existing in each neighborhood *before* the quake, recovery very well may have occurred more rapidly in the Marina than in SoMa *regardless* of media coverage. Haas et al's 1977 study of reconstruction following disaster helps to explain why.

Haas et al (1977) found that recovery took place differently depending on three factors: geography, socio-economic status and ethnicity. In the following paragraphs I applying the patterns observed in 1906 described by Haas et al (1977) to the scenario in 1989 which reveals that these three factors again helped to shape recovery.

As noted earlier, the geography of the Marina District is different than the geography of SoMa in that the Marina is mostly residential with a high-end commercial district. SoMa is mixed industrial and commercial with some small residential enclaves. Following the Loma Prieta earthquake, owners in the Marina displayed an overwhelming urge to repair their neighborhood to its former state, as evidenced by its rapid and nearly identical (to its pre-earthquake state) recovery (Arnold 1993; Bauman 1997). Therefore in this region, reconstruction was geared towards replacing damaged structures with new structures that served the same purpose of providing housing.

In SoMa, many displaced residents had resided in single room occupancy hotels (SROs). Evidence provided above shows that SoMa has a higher percentage of renters rather than owner-occupiers compared to the Marina. In the aftermath of the earthquake, many SRO owners found it cost prohibitive to replace their damaged hotel with a new hotel serving the same purpose and population (Comerio 1998). Additionally not all of the damaged commercial and industrial buildings were replaced with new structures to serve the same purpose.

The two regions exhibited very different post-quake trends: the Marina was rebuilt in a similar manner while SoMa was not. In fact many damaged buildings in SoMa were simply not replaced, leaving substantial open space in this neighborhood. Although both neighborhoods had a higher percentage of renters than owners, Marina owners may have had a higher cost-benefit ratio to justify their rebuilding than did SRO owners in SoMa. This left the two neighborhoods in very different states following

Loma Prieta. Relatively quickly, the Marina District returned to its previous state as a middle-to-high income residential enclave (Bauman 1997). SoMa, however, did not return to its previous state and was left with a significant amount of empty space.

These patterns exhibit trends that are somewhat similar to those observed by Haas et al (1977). Like in 1906, businesses were the first to make use of newly available space. Like in 1906, low income residents experienced the most displacement as low income housing damaged in the earthquake was replaced by other types of structures. Low income residents again were forced to compete for housing with middle and high income residents because of the overall reduction of available housing. Adding to the problem was the requirement that those requesting housing assistance from FEMA often did not meet requirements of having stable housing prior to the quake, leaving them unable to rely on this resource in the manner that regular home-owners and renters could (Comerio 1998).

To rebuild what had previously existed, as we have seen, was the aim of many displaced Marina residents eager to regain a sense of normalcy (Arnold 1993; Bauman 1997). For displaced SoMa residents, rebuilding what had previously been was not an option. Not only were displaced SoMa residents, typically renters or shelter residents, unable to make rebuilding decisions on their own, they were often coming from a position of instability (Comerio 1998). To return to this instability may have technically been a return to normalcy, but in no way would it be a permanent, favorable situation. The chronic problem of financial hardship would exist even if one's SRO was rebuilt.

As an issue of public policy, reconstruction of damaged structures requires negotiating a very fine balance. It is natural to desire what had previously existed, but the fact that a structure was damaged by the earthquake to begin with implies that perhaps the structure, or the ground surface below, is an inappropriate style (or site) for rebuilding. Large-scale relocation is incredibly rare and looked upon unfavorably by those closely connected to their community. There is an immediate need for shelter which adds to the need for rapid reconstruction. However rapid reconstruction may leave residents in a position that is still vulnerable to future earthquakes.

In considering the issue of rebuilding in light of low income and homeless residents, to rebuild what had been before is to return to a subsistence living that is not always favorable. Hurricane Katrina serves as a more recent model for this type of paradox. There is an overwhelming desire to return "home," but the reality may be that "home" no longer exists. Many Katrina victims lived on marginal property that was in constant danger of being flooded. To rebuild in this same area could return people to an equally vulnerable position, but with greater losses if reconstructed homes and newly purchased goods are again lost in another event.

Returning to the research outcomes of this study, while the Marina had over twice as many damaged structures and a slightly higher cost of damage than SoMa, it was mentioned more than four times more often in the newspaper. This statement affirms that media representation in the Marina was *not* directly proportional to that of its damage, and that it did receive disproportionately more coverage in these newspapers than SoMa. This in itself is not especially remarkable, and is likely a result of the higher commercial appeal of the Marina in the media compared to SoMa.

Though it is now certain that the newspaper media disproportionately represented the Marina in the aftermath of the 1989 earthquake, the reasons for this are still not clear. Research in this field suggests that, as mentioned above, certain stories have higher commercial appeal than others, and it is quite possible that the Marina represented a more popular story for the media than SoMa in the quake's aftermath. But the specific reasons that one region might make a better story than other cannot be directly linked to socio-economic status or ethnicity. Even if there appeared to be a tendency to over-represent one socio-economic class or ethnic group over another, this trend would be very difficult to quantify simply because it involves subjective opinions about neighborhoods, people and their socio-economic circumstances and what makes for an interesting newspaper story.

This study has revealed connections between media coverage, socio-economic status and damage rates, though it is not exactly a causal connection as may have been anticipated at the outset of this research. At the outset of this research, a causal link between media coverage and damage rates was expected, where areas with a lower socio-economic standing would receive less media coverage, and this lower degree of media coverage might possibly be linked to fewer resources for recovery and therefore slower recovery rates. This research has not identified this causal relationship, in part because there are too many competing factors to accurately assign cause, but also because these three aspects of the study interact in somewhat unexpected ways.

This research suggests that the slower rates of recovery were linked to socio-economic status, as poorer boarding house residents had a more difficult time in regaining adequate housing than did Marina residents. This is evidenced not so much by the change in tenancy but by the changes in the environmental and cultural *landscape.* For instance, the recovery process in SoMa was much longer and involved many more changes in the physical and cultural landscape than did the Marina. Socio-economic status before the earthquake appears to be the main factor that differentiated recovery rates in these two neighborhoods. Even if resources towards recovery were allotted based on newspaper media representation, these financial resources still probably wouldn't have been enough to offset pre-earthquake financial circumstances. Grants, loans and donations are used in emergency situations to bring one's situation back up to where it was prior, not above and beyond.

The data tables above indicate that SoMa has both lower property values and more ethnic diversity than the Marina, so the conditions experienced in SoMa after the 1906 and 1989 earthquakes can be directly related to geographic segregation on socio-economic lines. The low-income, ethnically diverse immigrants that dominated SoMa in 1906 were geographically segregated according to their socio-economic status and ethnicity to an area that was considered unfavorable. The land was unfavorable primarily because of the heavy industry located there, and the piecemeal way in which the Bay was being filled in this region to increase real estate. Once the 1906 earthquake occurred this land continued to be unfavorable, perhaps increasingly so after the dramatic ground failures. Therefore it is not surprising that over the next eighty years or so, SoMa remained a relatively low-income neighborhood, as it was never really considered favorable and therefore would continue to attract low-income residents. Or, conversely, the residents of SoMa that were able to later move into a higher socio-economic status, both literally and figuratively, were replaced with more low-income residents.

So, while the media focused on one neighborhood more than the other, this may not have changed the rates at which recovery occurred. These steps served as a useful guide to navigating historical documents and choosing which sources to utilize for this research, but tabulating newspaper media references to these two neighborhoods is only one method by which to assess the effect of media on recovery rates. For time's sake this study utilized newspaper articles from only three months following the earthquake, whereas similar studies such as Rodrigue's (1993; 1998; 2004) cover up to a year after the event. It is also very important to note that simply because they reported on the Marina more often than SoMa does not mean that newspaper reporters and editors were intentionally covering the Marina more heavily because they thought it was more severely damaged. This study instead approached this situation from the opposite perspective, observing first that the Marina was more heavily covered by newspaper accounts and then attempting to locate an explanation as to why.

Supplementary to newspaper articles as evidence was a reconstruction of the historical landscapes of the 1906 and 1989 earthquakes. As mentioned above, historical photographs, written testimonials, court records and oral histories were limited in quantity and cover only certain regions in the San Francisco Bay Area, but these low resolution data sources provided evidence about the changing landscape through time. These snapshots of past landscapes can be interpreted to elucidate the changing perceptions and patterns of its inhabitants.

For instance, reconstruction of the 1906 and 1989 landscape in San Francisco revealed that building patterns in SoMa have consistently remained the same. In 1906 and 1989 SoMa was mixed commercial/industrial with some residences. As stated above, residents in 1906 were overwhelmingly low income and often recent immigrants, and residents in 1989 were often low income, with a significant homeless or near homeless population. Almost a century passed between the two earthquakes, during which massive reconstruction, urbanization and globalization of San Francisco occurred. Yet the demographics of the neighborhood between 1906 and 1989 were very similar. Though industries changed as technology developed, the same types of blue collar industry and blue collar residents remained in this neighborhood. This demonstrates how socio-economic segregation of this neighborhood persisted even after the 1906 earthquake when this neighborhood was virtually destroyed, and that the neighborhood was rebuilt along much the same lines after the earthquake.

Though the Marina did not exist in 1906, reconstructing this landscape gives some insight into the psychology of San Franciscans in the post-earthquake environment. After the 1906 earthquake, land was created in what would become the Marina by more infilling of bay mud. This clearly indicates that although a connection had been made between poor soil quality and ground failure, as evidenced by scientific and engineering reports from after the earthquake described above, this did not lead to better quality fill being used to create the Marina only a few years later. Focus was upon beautifying the site for the upcoming Panama Pacific International Exposition, which would be San Francisco's first major opportunity to showcase its recovery. This historical reconstruction suggests that the scientific and engineering knowledge gleaned after the 1906 quake did not have an immediate or direct impact on the quality of man-made fill, or the decision to locate buildings upon fill. The sociological need for a repaired landscape and a renewed sense of *normalcy* seems to have driven the development of the Marina, in direct contrast to what had been recently learned about the dangers of filled land.

Similar patterns are revealed by a historical reconstruction of the 1989 quake. The destruction of the Marina District was not a surprise to the scientific community, and was the first opportunity for residents to experience this neighborhood in an earthquake. Even after the experience, most residents rebuilt in a nearly identical fashion, though not necessarily without utilizing improved mitigation measures. Again this suggests that lessons learned during the earthquake about soil quality and ground failure did not have an immediate or direct effect on the decision to locate buildings upon fill. In fact it proves that the destruction wrought by an earthquake, and even the increased risk of living on poor quality soils, was not a major deterrent to living in this neighborhood.

In SoMa, historical reconstruction requires looking beyond the immediate aftermath of the 1989 quake. In the immediate aftermath, damaged buildings were often demolished or neglected and residents were displaced, keeping property values low. When this relatively inexpensive land was "discovered" in the ensuing years, it was snapped up by young professionals and entrepreneurial establishments. Though it is still very much mixed with residential and commercial businesses, the local character was undoubtedly changed by these new industries and middle-income residents. Their arrival generated an increase in property values, which likely put further stress on low income residents (SMHC 2005). A recent visit to this neighborhood revealed there is still significant blight and poverty, but the earthquake actually freed up space for new-comers. The end result of this analysis is that, once again, poor quality soils, evidence of ground failure, and a landscape scarred by earthquake damage is not enough to significantly change the decision to build upon fill.

Now, returning to the idea that the newspaper media may have had an influence on recovery, imagine for a moment that the increased media coverage did in fact allow the Marina to be rebuilt faster and with more resources. Following that assumption, SoMa was rebuilt more slowly and with fewer resources because of this biased media coverage. However if SoMa had identical media coverage to the Marina, recovery may have still been delayed because of a lack of property owner financial resources, or decisions to relocate, or by community organizations that wanted to help shape recovery. In fact, large scale recovery in SoMa was delayed until its extensive, relatively inexpensive and available real estate was recognized, and, as might be expected based on Haas et al (1977), business came in, signaling progress in recovery.

Another important aspect of recovery is the role of government, local, regional and federal, as a regulatory body. In 1906, it appears that the primary role of local government was to help repair San Francisco's public image, and the primary role of federal government was to watch and learn from the disaster that had occurred, in addition to helping fund recovery. In 1989, the primary role of local government became intertwined with federal government goals of facilitating emergency response and funding recovery. Regulations to improve earthquake safety for the future were not a significant part of the immediate aftermath of the earthquake in 1906. In 1989, attempts to regulate recovery were quickly shelved in order to speed up recovery.

In both events, the short term need for shelter outweighed long term goals for safety. The lessons that were learned in both events would take decades to be integrated into functional regulatory measures such as building code improvements, as evidenced by the historical review in Chapter 2. Some of these lessons, such as the hazards of building on poor quality fill, cannot be addressed by governmental regulation because of the problems associated with restricting how private property is used and replaced.

The media is just one cog in a much larger and more complex socio-economic machine. It is an important cog, however, because previous research has connected media coverage and socio-economic status. This study has found that media coverage is connected to so many factors in addition to socio-economic status that it is difficult to isolate any one in trying to explain earthquake recovery rates.

While it is possible that SoMa was a less popular subject for the newspaper media because its stories covering displaced homeless at the

Moscone Center temporary shelter were less commercially appealing than stories covering displaced families at the temporary shelter at Marina Middle School, these deductions cannot be made within the scope of this research. To the contrary, this research has revealed the complex interplay of competing and coexisting socio-economic, environmental and political factors that impacted disaster recovery in San Francisco that may be fruitful for future research in this area, particularly in the field of environment justice.

Concluding Remarks

The complexity of the socio-economic and environmental interface during disasters is what makes the concept of environmental justice so critical in evaluating vulnerability to disasters. The current state of SoMa is one in transition from socio-economically and ethnically segregated neighborhood to one with less homogeneity. It may take the next disaster for us to see how this less segregated neighborhood responds to disaster and if there is any increase in its visibility. With increasing awareness of environmental justice, perhaps there will be more recognition of the higher relative vulnerability of neighborhoods like SoMa during disaster that will avail them to increased attention, newspaper media or otherwise, that may perhaps result in speedier and more efficient recovery.

The purpose of this study was to identify the role of the media in recovery from the Loma Prieta earthquake. Although clearly expressing bias in its coverage, the role of the media may have had less of an effect on recovery than pre-earthquake socio-economic factors. Though this does not necessarily refute conclusions about media and recovery drawn by Rodrique and others, it suggests that, at least in San Francisco, the multitude of influential factors is so complex that to focus on only one in isolation is likely not the most effective route for analysis.

In the aftermath of disaster, there has to be a compromise between rapid recovery and sustainability if a community hopes to withstand the next disaster. However the decisions that guide recovery are often not made by the impoverished individuals who experience the most severe effects. That these impoverished individuals are often residents of ethnically diverse neighborhoods that typically reside in less favorable environmental conditions is no coincidence. The environmental justice movement is a highly appropriate vehicle for further research on geographic segregation and increased vulnerability to disaster as it stresses public awareness and involvement, which could be a launching point for neighborhoods such as SoMa that are trying to reduce vulnerability and increase sustainability.

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