Disasters: Impact of Country Level Variables on Recovery Progression

Authored by

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DISASTERS: IMPACT OF COUNTRY LEVEL VARIABLES ON RECOVERY PROGRESSION
Amy Javernick-Will¹, Paul Chinowsky² and Christopher Senesi³

ABSTRACT
The recent earthquakes in Italy, Haiti and Chile remind us of the impact that natural disasters have on communities and the important role that engineers play in redeveloping these communities. The earthquake in Haiti, a country identified as one of the poorest in the world, also created questions regarding the influence that country level variables have on the ability of the community to progress through stages of response, recovery and sustainable development. Economic circumstance, political conflict and social unrest can make progression beyond the response phase difficult, if not improbable, for developing communities. This paper seeks to introduce and discuss challenges of disaster response and redevelopment by focusing on country level variables and their impact on disaster stage progression. We start by defining a disaster and presenting a cyclical planning framework that includes preparation, the disaster event, response, recovery, sustainable development and preparation. Using the framework, we use preliminary case studies to collect and analyze publically available data to compare and contrast earthquakes in Kobe, Athens, and Iran. These locations have vastly different GDPs, education levels, life expectancies, and levels of corruption that influence not only the immediate outcomes but also the community’s advancement through the recovery phases. We end by proposing future research using Ragin’s Qualitative Comparative Analysis that will advance our understanding of community development after disasters.

KEYWORDS
Disaster, Construction, Engineering, Country-level variables, Institutions

INTRODUCTION
Recent earthquakes in Italy, Haiti and Chile remind us of the important role that engineers play in helping communities affected by natural disasters respond, recover and develop long-term, sustainable solutions for community redevelopment. Although media and professional interest is strongest immediately after a disaster event, response is only the beginning. Recovery efforts moving the community from immediate response towards sustainable development and planning are essential (Smith and Wenger 2006). Unfortunately, these phases continue to be the least understood aspect of emergency management (Drabek 1986, Berke et al. 1993, Rubin et al. 1985, Rubin 1991, Rubin 2009). However, this is precisely the area that requires expertise from the engineering and management community.

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Rebuilding a community for sustainable development requires engineers and managers to attend to factors beyond traditional engineering in the recovery and sustainable development efforts. Non-technical factors, including political, social, and economic circumstances, affect not only the technical solution, which must be adapted to the local community’s institutions, but also affect how quickly the community can progress through the recovery process. Although both developed and developing countries must address these complex interrelationships, it is developing countries where the complexity of response and recovery is magnified. In contrast to developed countries that can devote resources to quickly propel the affected community into later phases of rebuilding for sustainable development; developing countries face a challenging road to move beyond the initial phase of response to recovery, let alone planning for sustainable development. These communities face the continuous risk of being forced back to the initial phase of response if circumstances, such as conflict or an additional natural disaster, consume essential resources needed for the recovery effort.

Although there are many areas that require research from the engineering and engineering management communities, this paper will examine one: the influence of country level variables on the ability of a community to progress through disaster recovery stages. This will address prior calls (Olshansky 2005, Chang 2010) to draw insights through cross-case comparison instead of single case studies of disaster recovery. It also addresses the need to move beyond short-term relief and recovery efforts to focus on link this to long-term development (Anderson and Woodrow 1989, Drabek 1986, Kartez 1991, Smith and Wenger 2006, Rubin et al. 1985, Rubin 1991, Rubin 2009, FEMA 2005, Natural Hazards Center 2001). In addition, it includes some of the key variables, including —pre-disaster community-level contextual variables, disaster characteristics and disaster outcomes, all of which are necessary to develop a theoretical model of sustainable community disaster recovery (Smith and Wenger 2006). To address these needs and propel us toward a theoretical model, we first introduce the definition of a disaster and our framework of disaster recovery stages after a disaster event. We then present our current and future research methods, followed by a discussion of the case studies being compared, including pre-disaster community variables, characteristics of the disaster agent, outcomes from the disaster, and the community’s response and recovery progression after the disasters for each of our cases. We end my comparing the disaster outcomes and recovery efforts across the cases and proposing future research to expand the study and increase validity of the results.

Disaster Definition

Disasters have been defined in three focal research areas—the classic approach, hazards-disaster tradition, and the social phenomenon tradition (Perry 2006). The classic approach generally characterizes disasters as an unplanned disruption that impacts a community. In 1961, Fritz proposed a definition of a disaster as “an event, concentrated in time and space, in which society...undergoes severe danger and incurs...losses to its members and physical appurtenances...” (Fritz, 1961). The hazards-disaster tradition narrowed the focus on the interface between the physical or built environment and a social system. Because the social systems are the real
source of vulnerability (Quarantelli 2005), this tradition emphasizes that disasters flow from the overlap of the “physical, built and social environments” (Mileti 1999). Finally, the social phenomenon tradition focuses explicitly on the social environment. This tradition emphasizes the disruption to social systems, norms and resources.

In contrast to the disaster definitions employed by scholars, industry and governmental organizations often add a focus on outcomes. For instance, FEMA defines a disaster as “an occurrence that has resulted in property damage, deaths, and/or injuries to a community” (FEMA 1984). Another definition provides quantitative measures to classify disasters as events that cause at least 100 human deaths or injuries or at least US$1M in economic damages (Sheehan and Hewitt in Smith 1996). FEMA and other organizations also include the necessity of external resources to respond to the disaster. FEMA adds that disasters “cannot be managed through the routine procedures and resources of government. It usually develops suddenly and unexpectedly and requires immediate, coordinated, and effective response by multiple government and private sector organizations to meet human needs and speed recovery” (FEMA 1984). The UN also uses this criterion to define a disaster as “a serious disruption of the functioning of society, causing widespread human, material, or environmental losses that exceed the ability of an affected society to cope using only its own resources” (UN). Due to the importance of societal variables and the built environment in our research, we define a disaster as:

“an event in which the physical, built, and social environment undergoes danger and is severely damaged, resulting in property damage, deaths and/or injuries, and disruption to the social systems and resources in a community”  Within this research, we focus explicitly on the natural hazard of earthquakes.

**Disaster Recovery Definition and Phases**

Disaster recovery takes place after a disaster event. Broadly defined, disaster recovery is “an array of actions taken by individuals, community groups, local, state or federal agencies and other organizations to restore and rebuild the physical, psychological, social, environmental and economic well being of a community, region, state or nation” (Lindell et al. 2006). Early research viewed disaster recovery as a linear phenomenon with discrete stages (Britton 1999). For instance, Haas et al (1977) proposed a framework in which disaster recovery proceeds in four stages:

- **Emergency Response**, including search and rescue efforts, provision of food and temporary shelter, and debris removal
- **Restoration**, where public services are restored
- **Reconstruction I**, where infrastructure is replaced or reconstructed to pre-disaster levels
- **Reconstruction II**, where mitigation techniques and economic growth opportunities are included in development plans

More recent studies indicate that the four stages do not have to be sequential, but can, and often do, occur simultaneously or in different sequences (Rubin et al. 1985,
Chang 2005, Johnson 1999). As a result, the recovery process today is considered to be nonlinear and multidimensional (Lindell et al. 2006, Chang 2005, Mileti 1999). Instead of having a discrete beginning and end, the disaster management cycle is an open-ended, cyclical process (Lindell et al. 2006).

Different authors present and highlight various stages in the disaster management cycle, including warning, threat, impact, inventory, rescue, remedy, recovery (Powell and Rayner, 1952); emergency, restoration, replacement and reconstruction, and commemorative, betterment and developmental reconstruction period (Kates and Pijawka, 1977); prevention, mitigation, preparedness, response and relief, rehabilitation and reconstruction (Khan and Ali, 2001), warming, impact, emergency and recovery (Levinson and Granot, 2002); etc. The majority of these disaster management frameworks include planning and preparing for an event, the event, immediate response, and reconstruction. We draw from past literature and FEMA's disaster management cycle to develop a framework inclusive of the following stages: Disaster Event, Response, Recovery, Sustainable Development, and Preparation.

**Response**

The disaster and initial response occupy the majority of the media’s and public’s attention. In addition, this is the most studied aspect of disaster recovery (Mileti 1999). Our definition of this stage combines the Emergency phase with elements of the Restoration phase of the Haas Recovery Process (1977). This phase involves search and rescue, provision of temporary housing, removal of dangerous debris and rubble clearance. The response phase starts to come to an end when the first responders begin to return to their regular work, the majority of community members return to the area, and the community is “flogging paper, not pumping adrenaline” (Rubin 2009, pg. 2).

**Recovery**

Definitions of disaster recovery vary immensely in the literature. This variance is due primarily to a focus on returning a community to its prior condition or improving upon the community’s original condition. In other words, the focus varies according to whether the community is rebuilt to its original, pre-disaster condition, or whether planning and construction take place to improve upon the original condition, making it a “better place to live, work, and play than it was before the disaster (Lindell 2006). The Haas cycle divides these phases into Reconstruction I, which focuses on returning the community to the pre-disaster conditions, or Reconstruction II, which focuses on improving, developing and bettering the community.

We define the recovery phase as returning the provision of necessary infrastructure (e.g. ports, roads, water, sanitation) and structures (e.g. homes, commercial buildings, social infrastructure, etc.) to a level that is at or above pre-disaster conditions. We note that a return to prior conditions would not help the community prepare for future disasters, which would be considered fundamental to sustainable development. As a result, if the recovery stage is done properly, this phase will be intertwined with the subsequent stage of sustainable development to
improve the pre-disaster conditions of the community and, at the very least, enable the community to be better prepared to handle and respond to future disasters.

**Sustainable Development**

The next phase of many of the early frameworks includes an opportunity to improve pre-disaster conditions (i.e. Kates and Pijawka’s (1977) commemorative, betterment and development reconstruction period, Hass’ (1977) Reconstruction II phase, etc.). These findings are considered important components of sustainable recovery and development (Beatley 1995, 1998; Mileti, 1999, Lindell 2006) and consider long-term recovery from disasters (Rubin 2009, FEMA 2005). Recognizing that this component is crucial to and intertwined with preparation, future research must emphasize this phase to focus on rebuilding the community for a more sustainable future. We draw from the Brundtland Commission’s (1983) definition of sustainable development as that which “meets the needs of the present without compromising the ability of future generations to meet their own needs” to define sustainable development after a disaster event as: *redeveloping the community after a disaster to account for solutions inclusive of technical and social considerations that will better prepare the community for future disaster events and meet the needs of the present without compromising the ability of future generations to meet their own needs.*

**Preparation**

Finally, after sustainable development, it is necessary for the affected community to take appropriate actions to prepare itself for future disasters. This is the fourth stage of the Emergency Management Cycle and serves as the link between sustainable development and the next disaster event. Similar characteristics are shared between this stage and the previous stage, sustainable development, as a major component of sustainable development is to advance how a community will handle disaster events. Preparation can include a multitude of actions including creating emergency response plans, installing warning devices, creating back-up service systems (i.e. power, water, sewage, etc.), and developing/practicing evacuation plans (Homeland Security 2007, FEMA 2009). Preparation can be viewed as a continuous cycle in itself and really never comes to an end, as a community should always attempt to minimize the risk of disasters through preparation and betterment activities (FEMA 2009).

**Disaster Phase Timeline**

As indicated, recent developments in the disaster community recognize that the recovery stages are not linear, but overlap. For instance, Figure 1 (taken from Rubin 2009), shows overlap amongst phases.
We argue that, in addition to overlap of the phases, the recovery progression is cyclical rather than linear and that recovery progression is dependent on pre-disaster community variables. Therefore, rather than a neat linear progression, future natural hazards, political battles, economic collapse, and other environmental, social, and economic, and political factors can each affect recovery progression of the community, causing communities to “backtrack” along the cycle to previous phases or not progress to certain phases all together. For example, a community may be recovering from a natural disaster, such as an earthquake. The community may be in the recovery stage of rebuilding, only to have another natural disaster, such as a landslide, affect their community. This event would cause them to reverse directions along the progression cycle to the response phase. Therefore, we developed a cyclical diagram of recovery, shown in Figure 3, based upon the widely accepted Emergency Management Cycle by FEMA (2009), shown in Figure 2. However, we include “Sustainable Development” versus mitigation and emphasize that this phase must continue throughout the cycle from response to preparedness.
This figure accounts for the fact that the phases overlap, and are cyclical; in addition, unlike the figure presented from Rubin (2009), which designates a timeline of recovery over weeks, we believe that progression through the recovery stages is dependent on pre-disaster community variables and cannot be generalized for every community. In comparison to FEMA’s cycle, our figure emphasizes the fact that sustainable development requires a long-term focus from the early stages of response through preparation. It cannot begin when recovery ends, but must be integral with the recovery efforts and preparation efforts as described above.

To determine the effect of pre-disaster community variables on response, recovery and sustainable development phases after the disaster, we will compare disaster recovery for three earthquakes that occurred in Kobe, Izmit, and Bhuj. This directly addresses additional calls for cross-case comparative research (Olshansky 2005, Chang 2010) and focuses on the impacts of pre-disaster community variables, combined with severity, which are two of the elements suggested by Smith and Wenger (2009) elements to create a theory of sustainable community recovery following a disaster.

**RESEARCH METHOD**

We use a retrospective cross-case comparison of the earthquake recovery process to analyze pre-disaster community variables and the severity of the disaster event with factors relating to the recovery process, including disaster outcomes and progression through the stages.

For the purposes of this paper, we selected three cases of communities affected by the natural disaster of earthquakes: Kobe, Japan after the Great Hanshin Earthquake in 1995, Bhuj, India, after the Gujarat Earthquake in 2001; and Izmit, Turkey, after the Kocaeli/Marmara/Izmit/Golcuk earthquake in 1999. We selected these cases because they had a similar natural hazard, earthquakes. The scales of
the earthquakes were also similar, and ranged between 6.8 and 8.0. However, we also selected these countries for their differences: each country had pre-disaster community variable rankings for human development that varied according to “very high”, “high” and “medium”. The human development index rating and ranking system is compiled by the United Nation’s Development Programme and includes factors for life expectancy, education and GDP within the calculation. This variable allows us to compare differences in recovery phases according to community variables, which may impact the level of planning and preparation for disasters and subsequent responses and recovery efforts.

We collected explicit material that was readily available on the Internet or through journals. Material collected from the Internet included media sources and statistics related to pre-disaster community variables, characteristics of the disaster agent, outcomes of the disaster and key milestones during the post-disaster period. Journal articles included case studies of the individual earthquakes and focused primarily on activity following the earthquakes. The journal articles also provided important feedback as to how the affected areas progressed through the emergency management cycle, with particular attention to activities that went well and activities that could be improved.

The data collected allowed us to compare variables across the cases to determine how communities that had different pre-disaster conditions were initially affected by the disaster and how they recovered after a disaster event. We selected pre-disaster community variables, characteristics of the disaster agent and the elements of and timeline for recovery progression as our variables for comparison. Disaster Characteristics included the duration and magnitude of the earthquake, which were chosen to be relatively similar amongst cases. Disaster outcomes included the number of casualties, injuries, people displaced, structures destroyed or damaged, and dollars in damage. Pre-community variables include country level scores for Human Development Index and Corruptions Perception Index ratings. The Human Development Index “...provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity, PPP, income)” (HDI, 2010). We selected HDI as a unit of comparison as the level of HDI is believed to impact the ability to plan for disaster response and recovery and the existing built infrastructure within the environment. Finally, we believed that the amount of perceived corruption might also impact recovery efforts. The Corruption Perceptions Index (CPI) “measures the perceived level of public-sector corruption in 180 countries and territories around the world. The CPI is a "survey of surveys" based on 13 different expert and business surveys (Transparency International, 2010).

Collecting single case studies of the disasters and publically available information from web searches, we created variables for comparison amongst each case. We imported these into spreadsheets for cross-case comparisons of each phase and entered data regarding the community’s recovery efforts according to the number of days, weeks, months and years after the disaster occurred. We analyzed these variables for each case and across cases to determine if pre-disaster
community variables had an impact on recovery progression and stages. The results from this research effort are presented below. Plans to expand our data collection and analysis are discussed in the section entitled “Future Plans” at the end of the paper.

CASE STUDY RESULTS
Earthquakes occurred in each of the communities under investigation between 1995 and 2001. We will present each case below, attending to disaster characteristics and outcomes, pre-disaster community variables, and recovery efforts before comparing the cases in the results section.

Kobe, Japan
The Great Hanshin Earthquake occurred in Kobe Japan at 5:46 AM on January 17, 1995. It registered 6.8 on USGS’s moment magnitude scale and lasted 20 seconds.

Pre-disaster Community Variables
The Human Development Index (HDI) ranks Japan as a country with very high human development. Japan received a HDI score of 0.931 in 1995, which increased to 0.96 in 2007. In 2007, Japan was the 10th most developed country according to GDP, life expectancy and education. Transparency International ranked Japan as 20th out of 41 countries on the Corruption Perceptions Index (CPI) in 1995 with a score of 6.72. The most recent CPI rating listed Japan as 17 out of 180 countries with a score of 7.7.

Disaster Outcomes
The Kobe community had approximately 43,800 injuries (International Recovery Platform 2009) and 6,400 casualties (Chang 2000, International Recovery Platform 2009). At the peak of evacuation, 316,678 people were displaced in 1,153 evacuation areas (International Recovery Platform 2009). In addition, 105,000 houses were completely destroyed; 144,000 sustained major damage and 264,000 were partially damaged through shaking, ground failure and urban fires. In addition, the critical infrastructure systems were severally disrupted (Chang and Nojima, 2001). In all, there was over US $100 billion in damage.

Recovery Efforts
The 1995 earthquake in Japan was devastating to the city of Kobe. In addition to the primary earthquake, over 2500 aftershocks were felt for over a year. The majority of the deaths from the earthquake occurred due to roof collapse in traditional, older houses. These houses were built to withstand typhoons with heavy tiled roofs that were supported by lightweight wood. The combination of this traditional housing, ground conditions, and unreinforced masonry buildings damaged structures, which resulted in casualties.

Despite Japan’s high HDI, the country was criticized for improper warnings, slow initial response, and lack of oversight in the disaster response efforts. However, they quickly deployed the national military to assist in the response efforts, focused on getting essential services up and running, and deployed resources for search and rescue efforts. This focus enabled the majority of critical infrastructure services to be repaired or reconstructed within the first month and
allowed the majority of people to return to work 7 days after the earthquake (Risk Management Solutions 2005, Hays 2009). For example, telephone communications were available the second day after the disaster, most of the rubble from toppled highways was removed by day 6, provisional electricity was restored on day 6, and the water, sewer, and gas systems were reconnected in the 3rd week (International Recovery Platform 2009, Disaster Reduction Learning Center 2008). Full railway service took longer to complete and was restored after 4 months; however, the railway had 80% operability within one month and the government deployed bus service to supplement the rail that suffered damage (Hays 2009).

Despite the heroic efforts to restore critical infrastructure, over 70,000 people remained in shelters 2 months after the earthquake (Hays 2009). In fact, housing starts did not recover to pre-disaster levels until 3 years after the earthquake; the same time that a full recovery of city infrastructure was completed (Risk Management Solutions 2005, Disaster Reduction Learning Center 2008). It took over 5 years for all victims to move from temporary housing to permanent housing. Ten years after the quake, the Kobe population returned to pre-disaster population levels and the GRP, excluding construction, was 93% of pre-earthquake levels (Chang 2010).

The Japanese government took great efforts to ensure that reconstruction did not merely rebuild what existed before, but focused on sustainable development. These efforts took place throughout the recovery. For instance, the central government suspended rebuilding for 2 months to enable local government to focus first on planning. The Hyogo Prefecture and City of Kobe prioritized projects that would do more than simply replace what had existed before the earthquake, focusing on projects that would help to stabilize the economy and attract new businesses (Risk Management Solutions 2005). In addition, they adopted several new laws and code amendments in the first years after the earthquake and increased interim inspections for new buildings (Risk Management Solutions 2005). The government also required all pre-1981 buildings to have a seismic evaluation and be retrofitted if needed (Risk Management Solutions 2005). The amount of damage, over US$102 Billion, is one of the costliest natural disasters in any country (International Recovery Platform 2009). These costs may help to explain the insurance coverage increase within Japan. Prior to the disaster, only 3% of residents in Kobe and 7% of residents in Japan had earthquake insurance (Risk Management Solutions 2005). After the earthquake, the coverage doubled to 15% of all Japanese households (Risk Management Solutions 2005). As part of the insurance makeover, Japan initiated primary insurance deregulation and international insurers were granted licenses to accept direct risks. Finally, the Japanese government increased research efforts for seismic engineering and ground motion modeling. Ten years after the earthquake, in 2005, Japan released the National Seismic Hazard Maps from this research (Risk Management Solutions 2005). These efforts addressed a combination of technical and social needs and were focused on better preparing the community for future disaster events.
Izmit, Turkey

The earthquake in Izmit, Turkey occurred at 3:01 AM on August 17, 1999. It registered 7.6 on USGS’s moment magnitude scale and lasted 45 seconds.

Pre-disaster Community Variables

In 2007, the Human Development Index (HDI) ranked Turkey as a country with “high” human development. Turkey’s HDI score was 0.730 in 1995, which increased to 0.806 in 2007. Turkey was rated 79th out of 182 countries based on their HDI score in 2007. In 1999, Transparency International ranked Turkey as 54th out of 99 countries on the Corruption Perceptions Index (CPI) with a score of 3.6. The most recent CPI rating listed Turkey as 61 out of 180 countries with a score of 4.4.

Disaster Outcomes

The Izmit community had approximately 44,000 injuries and over 17,000 casualties (Akinci 2004, International Recovery Platform 2009). It should be noted that many sources suggest the actual death toll is closer to 40,000 (International Recovery Platform 2009). Over 16 million people in 10 cities were affected by the earthquake (Akinci 2004) and approximately 1 million people were left homeless (International Recovery Platform 2009). Many were injured or left homeless due to collapsed structures: 120,000 homes and 2,000 other buildings collapsed or were destroyed beyond repair; 50,000 houses and 4,000 buildings were heavily damaged (International Recovery Platform 2009); and 244,853 buildings sustained some form of damage (Akinci 2004). In all, over US $20 billion was reported in damage (International Recovery Platform 2009).

Recovery Efforts

The response efforts to the Marmara Earthquake in Turkey were very different than those in Japan. In comparison to the central government-led response efforts in Japan, the first 24-hours of rescue efforts in Turkey were led by untrained civilians digging through rubble with their bare hands. In addition, non-governmental organizations, such as Arama Kurtama Teskilati, helped to provide search and rescue services, which rescued approximately 200 people immediately after the earthquake (Tang 2000). Using only 3 fax machines, the government alerted provinces and requested information about damaged infrastructure and buildings (World Bank 1999).

Whereas Japan initially rejected foreign assistance (REF), Turkey accepted help. Twenty-four countries provided search and rescue teams to assist in the relief efforts. By the third day, Turkish army troops assisted with the search and rescue activities (Kurita 2000). These search and rescue efforts continued to find people alive two weeks after the earthquake (OCHA 2000).

Critical infrastructure was delivered much slower in Turkey than Japan. On the second day, water was distributed via truck and electricity began to work sporadically (Tang 2000). The country restored some communication services on the third day (World Bank 1999). By the third week, water production systems producing 90 m3/day were in place, and the Austrian Red Cross was assisting victims by providing potable water and sanitation services. (Tang 2000) By the fourth week, over 100,000 tents were deployed for temporary housing, which
helped to build over 162 tent cities (Tang 2000, Akgiray et al 2004). In addition to temporary tents, the Housing and Public Works Ministry erected approximately 40,000 prefabricated housing units three months after the event. Although the tents helped to provide temporary housing, unfortunately, after one year, 30,000 people were still living in 33 tent cities and victims remained in the cities until at least two years after the earthquake. Even more devastating, the death toll count increased over the winter due to poor housing conditions and people living on the street (Akgiray et al. 2004). The housing situation makes it difficult to understand a precise timeframe that country recovered from the earthquake; however, we do know that the Turkish economy recovered to pre-disaster levels seven months after the earthquake (Un-Habitat 2007).

From the available data, it appears that more efforts were focused on response and recovery from the Mamara Earthquake, with less effort focused on sustainable development. However, Turkey did not completely neglect sustainable development. In fact, it actually had some similarities with Japan. For instance, all construction permits were suspended until August 2000, presumably to have some preparatory planning (Akgiray 2004). Other sustainable development efforts appeared to be spurred by the international population—four months after the disaster, a national mandatory earthquake plan was initiated through a World Bank project. In addition, one year after the event the government created Emergency Management agencies at national and municipal levels (Akgiray 2004). These agencies were charged with facilitating insurance policies, modifying laws, developing municipal master plans, repairing existing housing, healthcare facilities, and infrastructure, and constructing permanent housing. Finally, the government created a professional accreditation system that required certification of engineers and architects (Akgiray et al. 2004). Although some of these actions helped to better the existing community through education, outreach and rebuilding, most of the sustainable development activities were focused on technical elements to restore and rebuild the community to better handle a future disaster event.

**Bhuj, India**

The Gujarat Earthquake in Bhuj, India, occurred at 8:46 AM on January 26, 2001. It lasted for 110 seconds and registered with a magnitude between 7.6 and 8.1 on the USGS moment magnitude scale.

**Pre-disaster Community Variables**

According to the Human Development Index (HDI) in 2007, India received a “medium” rating for human development. The country’s HDI score was 0.556 for 2000, which increased to 0.612 in 2007. In 2001, Transparency International gave India a Corruption Perceptions Index rating of 2.7, which lead to a ranking of 71 out of 99 countries. In 2009, the CPI increased to 3.4, which ranked India as 84 out of 180 countries.

**Disaster Outcomes**

Estimates vary; however, it appears that the Bhuj community in India experienced more than 20,700 severe injuries and approximately 20,000 casualties (Sharma 2001). Approximately 1.8 million people were displaced following the earthquakes.
(International Recovery Platform 2009). More than 1.2 million properties were damaged, including 15,000 schools and the homes of 1.7 million people (International Recovery Platform 2009). Approximately 75% of the Kachchh district was destroyed, with 8,000 villages damaged or destroyed and 490 towns affected by the disaster (Sanderson and Sharma 2008). The cost of the damage was estimated to be US$2.6 billion with over 6 million people affected (International Recovery Platform 2009).

**Recovery Efforts**

India’s recovery efforts were similar to Turkey’s with outside assistance welcomed and required to assist the country after the earthquake (Global Education 2009). By the fourth day, equipment was installed to restore communications and relief supplies, including food and medicine, were transported to the area (Khosia 2001). International relief supplies, including tents, temporary shelters and blankets, arrived on the fifth and sixth day (Khosia 2001, Samii et al. 2002). During the second week, the United Nations launched a four-month operation to feed 300,000 quake victims in Gujarat with a $4 Million pledge (Khosia 2001). The focus of the country during the first month was search and rescue efforts and supplying needed food, water, and temporary shelter to its citizens.

Reconstruction efforts were largely started on March 1, 2001 (Khosla 2001). After 3 years, much of the city had been rebuilt, but it wasn't until 6 years after the disaster that a Chief Executive of the municipal council indicated that nearly all of the buildings and infrastructure that were destroyed by the earthquake were rebuilt or restored (Education Services Australia 2009, Sanderson & Sharma 2008).

From the publically available information, it appeared that there was little focus on long-term sustainable development in the region following the quake. However, some efforts are aimed towards sustainable development. The State Government did establish the Gujarat Disaster Management Authority to coordinate longer-term relief and reconstruction (World Bank 2001), but there is little documentation regarding community betterment and even less documentation related to the social aspects of bettering the community during recovery.

**Cross-case Comparison for Disaster outcomes**

Table 1 summarizes statistics for the pre-disaster community variables, disaster characteristics and outcomes for each country.
Table 1: Earthquake Community comparison of disaster characteristics, pre-disaster country level variables, and outcomes

<table>
<thead>
<tr>
<th>Earthquake Community</th>
<th>Kobe, Japan</th>
<th>Izmit, Turkey</th>
<th>Bhuj, India</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Earthquake Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake Nickname</td>
<td>Great Hanshin Earthquake</td>
<td>Kocaeli Earthquake; Marmara Earthquake; İzmit earthquake; Gölcük earthquake</td>
<td>Gujarat Earthquake</td>
</tr>
<tr>
<td>Date and Time</td>
<td>January 17, 1995, 05:46am</td>
<td>August 17, 1999, 3:01am</td>
<td>January 26, 2001, 8:46am</td>
</tr>
<tr>
<td>Duration of Earthquake (sec)</td>
<td>20</td>
<td>45</td>
<td>110</td>
</tr>
<tr>
<td>Magnitude</td>
<td>$M_w=6.9$</td>
<td>$M=7.4$</td>
<td>$M=6.9$</td>
</tr>
<tr>
<td><strong>Pre-disaster Community Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDI (2007)</td>
<td>&quot;Very High&quot; (.936)</td>
<td>&quot;High&quot; (.806)</td>
<td>&quot;Medium&quot; (.612)</td>
</tr>
<tr>
<td>2009 CPI (Ranking out of 180)</td>
<td>7.7 (17)</td>
<td>4.4 (61)</td>
<td>3.4 (84)</td>
</tr>
<tr>
<td>CPI (closest ear)</td>
<td>6.72 (1995)</td>
<td>3.6 (1999)</td>
<td>2.7 (2001)</td>
</tr>
<tr>
<td><strong>Earthquake Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casualties</td>
<td>6,400</td>
<td>17,480 (40,000?)</td>
<td>20,000</td>
</tr>
<tr>
<td>Injured</td>
<td>43,792</td>
<td>43,953</td>
<td>20,717</td>
</tr>
<tr>
<td>Displaced People</td>
<td>316,678</td>
<td>1,000,000</td>
<td>1,790,000</td>
</tr>
<tr>
<td>Structures severely Damaged or destroyed</td>
<td>513,000</td>
<td>244,000</td>
<td>1,200,000</td>
</tr>
<tr>
<td>Economic Value of Damage (US$ Billions)</td>
<td>100</td>
<td>20</td>
<td>3.4</td>
</tr>
</tbody>
</table>
There are items worth noting from the comparison of pre-disaster community variables with outcomes. The countries with higher GDP, greater education and increased life expectancy are expected to be better prepared to respond to a disaster. These countries may educate their citizens to respond to a disaster event, have codes and permitting processes in place to construct buildings that include seismic design, have more resources available, and have educated people that are available to respond after a disaster. As expected, as the HDI values decreased from Japan to Turkey to India, there were increasing numbers of causalities and displaced people.

Surprisingly, the number of people injured is similar in both Japan, which has a “very high” HDI score, and Turkey, which has a “high” HDI score and decreases for India, which has a “medium” HDI score. The number of structures damaged or destroyed also varies, with no apparent link to the HDI score. For instance, Turkey, which fell between the countries for HDI score, suffered the least amount of damage to structures. This contradicts our expectations that countries with higher HDI scores—meaning that they have additional resources and education—would have increased standards for building codes and permitting processes.

Another interesting observation is that the total amount of damage decreases with decreasing HDI scores for these cases. Without additional questioning, we can speculate that the cost to rebuild in countries with higher HDI scores is substantially more than rebuilding in countries with lower HDI scores. In addition, Japan’s unique geographical constraints may contribute to higher costs of damage.

**Comparison of recovery**

The recovery efforts documented from these three cases indicate that pre-disaster community variables appear to have a significant impact not only on the immediate disaster outcomes of “deaths, dollars, and downtime”, but also on the progression through recovery stages and attention towards long-term, sustainable development. We developed Table 2 that “scores” communities for each of the recovery phases of relief, recovery and sustainable development. Each larger category is comprised of smaller subcategories that score each community with a 0, 1, or 2, where a score of 2 signifies a positive rating and 0 indicates a less than desirable rating. It should be noted that the scores received were based upon a qualitative assessment of publically available information. Some cases were not directly comparable in terms of time frame or were missing information. In these cases, we assigned a score based upon other information that was available. In addition, many of the scores for the community’s relief and response efforts were based upon a comparison with the timeline provided in Rubin (2009).
<table>
<thead>
<tr>
<th></th>
<th>JAPAN</th>
<th>TURKEY</th>
<th>INDIA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RELIEF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response from Government to assist with relief efforts</td>
<td>Immediate</td>
<td>&lt;1 day</td>
<td>Immediate</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Communication restored</td>
<td>2 days</td>
<td>3 days</td>
<td>10 days (10 districts)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Search &amp; Rescued Ends</td>
<td>5-7 days</td>
<td>2 weeks</td>
<td>6-7 days</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Accessibility of community/ Foreign aid arrives</td>
<td>N/A</td>
<td>4 days</td>
<td>5 days</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Temporary Shelter Erected</td>
<td>N/A</td>
<td>3-4 weeks: tents</td>
<td>Day 6: tents</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td>8</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>RECOVERY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstruction activities start</td>
<td>2 weeks</td>
<td>2 months</td>
<td>1.5 months</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Majority of utilities reconnected</td>
<td>3-4 weeks</td>
<td>1 month&lt;</td>
<td>3-4 weeks</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Victims no longer living in temporary shelters (does not include temporary housing)</td>
<td>5 years</td>
<td>N/A</td>
<td>5-6 years</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction industry stabilizes/recovers</td>
<td>4 years</td>
<td>3 years</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Economy recovered</td>
<td>2 years, NIC const.</td>
<td>7 months</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Urban Infrastructure Rebuilt</td>
<td>3 years, complete</td>
<td>3 years, complete</td>
<td>6 years, complete</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td><strong>SUSTAINABLE DEVELOPMENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustainable development activities undertaken by government immediately</td>
<td>2-month suspension on rebuilding</td>
<td>Construction permits suspended for one year</td>
<td>Long-term and reconstruction planning</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Engineering practices and codes are reviewed/improved</td>
<td>1 year, several laws &amp; codes enacted</td>
<td>&gt;1 year, building laws implemented</td>
<td>&lt;1 year, reviewed current laws and codes</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Country/city adopts large scale agency/act/plan to address rebuilding and sustainable development</td>
<td>3 months, Hyogo Prefecture &amp; City of Kobe adopt complementary</td>
<td>1 year, through World Bank, a national mandatory earthquake plan is initiated</td>
<td>1 month, state government creates Gujarat Disaster Management Authority (GSDMA)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>
Not surprisingly, Japan, which ranked “Very High” on the HDI scale and had the highest CPI, had the highest score for each of the phase comparisons and was able to quickly rebuild critical infrastructure after the disaster. Although improvements could have been made, relief efforts were far superior to Turkey and India. For instance, telephone communications, provisional electricity, and rubble removal all occurred within the first week, allowing many people to return to work. Reconstruction activities started quickly, with water, sewage and gas reconnected within the first month. The economic and population recovery took longer, with an economic recovery 2 years after the disaster and the population returning to pre-disaster levels a full 10 years after the event. However, a major difference between the cases was the amount of focus on sustainable redevelopment efforts. Japan focused on planning that would ensure communities were better prepared for future disasters and for communities that could recover socially and economically. They worked towards increasing insurance coverage, prioritized “betterment” projects, retrofitted buildings for seismic design, and invested in research to ensure the country was better prepared, technically and socially, for future disasters.

Turkey and India received the same total score of 11 when using un-weighted scores. This is approximately half of the score that Japan received for their efforts. Whereas India was the lowest rated country of the three on the HDI ranking scale, it scored better than Turkey in the relief and sustainable development efforts. It appears that India was primarily focused on immediate response efforts until 2 months after the earthquake. Publically available materials indicate that later efforts were focused on rebuilding the existing housing and infrastructure to pre-disaster levels. Although the government reviewed building codes and laws, there is little evidence that designs and codes were required or enforced to account for stricter seismic design. However, the government did create a Gujarat Disaster Management Authority to coordinate efforts and better prepare the community for future events. India was the lowest rated country, however, for the recovery efforts. Although many of the subcategories are not known in detail for India, it appears to have taken over double the time to rebuild the infrastructure.

Turkey, which was ranked “High” on the HDI ranking scale, meaning it was between the other cases, also had some impediments. The relief efforts took longer than in India or Japan, with tents continuing to be erected up to a month after the event. In addition, poor temporary shelters or lack of shelters appeared to cause additional deaths the winter following the earthquake. The country also did not appear to be adequately prepared to manage disaster recovery efforts: a measly 3 fax machines alerted provinces on the disaster. However, in comparison to India, Turkey did better on the recovery efforts. The economy recovered within 7 months and urban infrastructure was rebuilt within 3 years. The country scored lower on sustainable development activities. A foreign entity created an earthquake plan and it took over a year to implement new building codes.

The similarity in scores between India and Turkey is interesting to note and requires further study. It is important to take into consideration issues such as accessibility to the site, time of year and corresponding weather conditions, and the impact of centralized versus decentralized government.
OBSERVATIONS AND FUTURE PLANS
This paper discussed recovery after a disaster, presented a recovery cycle with overlapping phases, and presented results on three cases of community recovery efforts and outcomes following an earthquake. The cyclical recovery diagram is unique in the fact that it recognizes that phases overlap and that sustainable development, in particular, requires a focus from shortly after the disaster event through preparation for future events. The research was a rare effort in disaster research because it entailed a cross-case comparison. In addition, it accounted for, and compared, pre-disaster community variables with both outcomes after the disaster event and recovery efforts. Comparing earthquakes in Kobe, Japan, Izmit, Turkey, and Bhuj, India found that the pre-disaster community variables appear to correlate with the number of deaths, displaced people and the economic value of damage following a disaster. As HDI and CPI scores rise, the amount of casualties and displaced people from the disaster decreases. Conversely, the economic value of the damage rises with increasing HDI. Surprisingly, the number of structures damaged or destroyed and injured people do not follow these trends and logic. These observations lead to the need for an in-depth study that focuses on how planning efforts, existing infrastructure relate to outcome metrics following a disaster and how this varies according to country-level or community-level variables.

Recovery efforts and phases were also compared amongst the cases. Not surprisingly, Japan, which had the highest HDI and CPI scores, appeared to have more efforts focused on responding, recovering and redeveloping sustainably after a disaster faster than other countries. Turkey and India received similar overall scores for the recovery efforts. However, India appeared to fare better on response and sustainable development activities while Turkey fared better in the recovery efforts. These preliminary results set the stage for future research to understand, through in-depth analysis and original data collection, how country-level and community-level variables impact the rate and focus of disaster reconstruction. Specifically, attending to the impact of planning variables and attention towards sustainable development is warranted.

This study was novel in terms of the cross-case comparison and link between pre-disaster community variables and recovery efforts. It appears that pre-disaster community variables play a significant role in the disaster outcomes as well as the recovery process and focus on sustainable development efforts. However, the current study has many limitations and requires further efforts. Our research was limited to publically available documents and previously reported single case studies. As a result, we were forced to focus on information we could glean from each case and compare across cases. This limited our focus from the variables we believed to be important to those that we were able to analyze. In addition, it was difficult to compare cases due to missing information. Finally, although observations can be made as to correlations of data between these three studies, causal inference can not be deduced. Future work would benefit from the inclusion of additional qualitative data collection and analysis through interviews, the collection of documentation, and observations with local community members, government authorities, and international aid organizations involved in the
response and recovery efforts.

We attended to HDI rankings as we believed that the HDI rankings would lead to differences in levels of planning and preparation following a disaster. However, following comments from experts in the field of disaster planning and response and comments from reviewers of this paper, we will initially limit our future study to cases within the same country.

We plan to employ Ragin’s Qualitative Comparative Analysis (QCA) to increase the validity of the results. QCA will allow us to integrate variables and compare them across cases to help determine which contextual variables, or combinations of contextual variables, produce different outcomes (Ragin 1989, Ragin 2000). Ragin’s method is an excellent alternative when the research requires detailed, contextualized case studies, but when these case studies are limited, meaning that traditional statistical analysis techniques such as regression or structured equation modeling are unlikely to yield useful insights. Disaster recovery research requires a deep understanding of the variables within each disaster case. As a result, there are many instances of single case studies and a lack of cross-case comparisons. We believe that Ragin’s QCA will help balance the demands for depth while providing the ability to compare variables to the outcome of disaster recovery progression across cases. One of the benefits of using Ragin’s method versus statistical methods is that it allows the researcher to see how combinations of causes create different pathways leading to similar outcomes.

We aim to work with social scientists involved in natural hazards research to determine the most appropriate variables to study, and expand our data collection efforts. Completing this research would allow for a cross-case comparison of disaster recovery, examine the influence of pre-disaster community variables on recovery efforts, provide preliminary insights into pre-disaster community variables that appear to matter most for recovery efforts, and would apply Ragin’s fsQCA method to disaster research.
REFERENCES


Powell, J.W. and Rayner, J. (1952). “Progress Notes: Disaster Investigation.” Chemical Corps Medical Laboratory, Army Medical Center, Edgewood, MD.


