A SOCIO-ECONOMIC STUDY OF THE CHI-CHI EARTHQUAKE IN TAIWAN

Submitted to the faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelors of Science

by

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Date: March 19, 2000

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Special Thanks

The success of this project would not have been possible without the help of several generous people. We would like to give special thanks to Dr. Jeng Fu Shu for his guidance, generosity and help. We would like to extend our gratitude to the Dean of Academic Affairs at Tatung University Jan-Chen Hong, Ph.D. for giving us a home in Taiwan. Private Christopher Loiu of the Taiwan National Army deserves recognition for the "trouble-shooting" he performed for us. We would also like to give special thanks to the following graduate students in NTU's Department of Civil Engineering; Tony "Handsome" Chen, Ann "Venus" Chen, Tomas "Good" Chen, Andrew "Tuton" Wang, Johnson "Speedy" Chang, Wong "Robinhood" Ueng, Lieshim "Spin" Tsie and Steve "Grandpa" Huang.

Abstract

The socio–economic effects of Taiwan's Chi–Chi earthquake are presented based on a series of field investigations, interviews, and an extensive literature review.

The Chi–Chi earthquake was one of the largest natural disasters to hit Taiwan in this centaury killing over 2,400 people and injuring more than 10,700. Thousands of buildings were damaged or destroyed. Huge landslides, moving millions of cubic meters of soil, were triggered. Large sections of the infrastructure was ruined, sending the northern half of the island into three weeks of power rationing and isolating several mountain villages.

The effects on Taiwan's society can be identified in three categories, short term, long term, and old. These effects describe the economic, political, and personal changes that came about as a result of the earthquake. The major topics discussed include, the industry specific economic impact, Taiwan–China relations, the year 2000 Presidential campaign, the psychological effects and volunteer work.

A comparison to the 1994 Northridge California earthquake is also made to highlight the efficiency of the Taiwan governmental response. The comparison focuses on the command structure for the relief and reconstruction efforts and their effectiveness.

Suggestions concerning governmental responsibility and the creation of an emergency management organization are recommended based on the discussion described above.

Executive Summary

The Chi-Chi earthquake was one of the most powerful natural disasters to hit Taiwan within the last hundred years. Thousands of people were killed and the damage was extensive. In this project, carried out at National Taiwan University, the economic, political, and personal impacts of the earthquake are discussed as well as the efficiency of the government response in comparison to the 1994 Northridge, California earthquake. Finally suggestions for preparation for future disasters are made. The information researched came from English sources as well as Chinese sources that had to be translated with the help of some graduate students at NTU.

The geography, climate, ethnic and religious backgrounds of Taiwan are unique when compared to Western society. The island that has become Taiwan was created at the intersection of the Eurasian and Philippine Sea plates. These two tectonic plates uplift to form this island in a subtropical location off the coast of mainland China. Taiwan has become one of the most densely populated areas of the world in recent years. It is comprised of a blend of 22 million people from ethnic backgrounds including Aborigines, Hakkas, Fukienese, and the Mainland Chinese. The Aborigines being the original inhabitants, the rest have emigrated from China over the years. With such a diverse ethnic mixing, it is only natural to find and equally unique blend of religions. The most dominant of these are Animism, practiced by the Aborigines, the mainland introduced Taoism, Confucianism and Buddhism. Dutch explorers introduced Protestant Christianity, the Spanish brought Catholicism and Shinto came with the Japanese occupation from 1895 to 1945.

Part of this study included research on the scientific explanation of the Chi-Chi Earthquake. The hypocenter of the earthquake, which is the location of the geographical center of the earthquake, was in the City of Chi-Chi near the center of the island. The magnitude of this quake was 7.3 on the Richter Scale, making it the largest to hit Taiwan this century, and one of relatively few with a magnitude greater than 7 in the world in since the creation of the Richter Scale. The intensity of an earthquake is how powerfully it is felt on the surface, which is directly related to how deep below the surface the center of the earthquake is. This earthquake's center was only five kilometers below the surface, which resulted in a very high intensity. Earthquakes occur when stress from moving plates becomes too high, and result in a release of energy. In this case, the energy was released on the Chelungpu fault, which had been inactive for a long time relative to the overall activity of the area. This powerful earthquake has been credited for the deaths of 2,405 people, and inflicting injuries on 10,718 people. In addition, the damages caused to homes, buildings and roads are drastically significant. In order to provide this report with a representation of the power of this quake an extensive supply of on-site taken photographs are included. Other data gathering methods included onsite interviews, translation of important documentation, and consultation with experts from National Taiwan University.

The effects of the Chi–Chi earthquake all fall into three distinct categories, short term, old, and long term. Economic problems struck hard in the short term but will not have a long lasting effect. In the political realm many of the problems that arose are more reincarnations of old difficulties, freshly aggravated, than new problems. The personal effects that are apparently well under control in the short term will have psychological

effects for many years to come. These differences show how the earthquake will affect the society as a whole.

Materially much, if not all, that was broken or destroyed will be repaired or rebuilt quickly. This is not to say that the economy will not show the effects of this disaster. Simply put the economy will recover quickly. The reason for this quick recovery is the economic structure of Taiwan. The large number of small to medium size companies gives Taiwan's economy an enormous flexibility and resiliency. The market is able to respond quickly to the demands forced upon it, either by normal market pressures or by the sudden change caused by the earthquake. In a way the fact that Taiwan has been so paranoid of a Chinese invasion had helped them to prepare for this earthquake. Limiting the size of the companies by limiting the amount of available capital keeps Taiwan from putting all of its eggs in one basket. This means that even though large sections of Taiwan were devastated by the 9–21 earthquake, most notably Taichong and Nantou counties, the national economy as a whole will be able to continue without much more than a slight pause.

Many of the political issues raised by the earthquake were not new problems but rather old problems that had been aggravated by the pressure that the earthquake has caused. The tension, that the Chi–Chi earthquake released from the Philippine Sea and Eurasian plates, was absorbed by Taiwanese society. This tension caused problems that had once seem acceptable or at least under control to seem unbearable.

Those problems that were new, such as the allocation of relief funds, or favoritism during the reconstruction were compounded by old problems, or arose because of unresolved issues. Corruption and favoritism surrounding public works projects was

accepted, though not condoned, in the past but with the tensions high and the heat of public attention focused on the issue it has grown to a major problem. Because of these seemingly new troubles the people in need have balked and complained, some forming their own political groups, others calling to those already in power. Their reactions were, just as the causes were, simply an amplification of current political paths. Protests and grassroots politics are not new ideas in Taiwan, but now that there is cause, these ideas have grown more common.

The personal effects from the earthquake are not just old problems, reborn because of the stress. The problems are very new and will likely leave a lasting mark on many of the people involved. In the short term people handled the effects of the quake well but the long-term damages are enormous.

The Taiwanese responded quickly and calmly in the terrible aftermath of the 9–21 earthquake. Volunteers from all over the island arrived at the hardest hit areas within a day of the initial shock, some within a few hours. Money from companies and from the public flowed to the various institutions set up to help the victims. No instances of looting collapsed buildings were reported. For all the confusion and tears from collapsed buildings and lost loved ones, hysteria did not break out and there has been very little civil unrest.

While it is still too early to see how long the psychological effects will last, it is clear that they will not be as short lived as the economic problems. The actual testing for PTSD cannot start until February 2000, but the memories of the earthquake are still fresh in people's minds.

Taiwan will feel the effects of the 9–21 earthquake for years to come. Not all of the problems that loom large today will last, but many will start strings of events that may change parts of the society. The different effects will last for different lengths of time, but people are the ones who will change the society in the end.

There are many similarities between the Chi-Chi earthquake in Taiwan and the Northridge earthquake that occurred a couple years earlier in California. They both occurred in densely populated areas, and were vastly expensive. The ways that they were dealt with were very different though. The United States had a very experienced organization to deal with such disasters called FEMA or the Federal Emergency Management Agency. FEMA is in charge of communication, organization, and flow of aid in any disaster in the United States and offers aid to disasters in foreign countries as well. They are connected to every important agency and organization that would play a part in the daily lives of any Americans. As a result of the experience and efficient organization of FEMA, the response to the Northridge earthquake was the most successful in US History and is therefore a prime example of how to deal with such a natural disaster. Taiwan could benefit from adopting some of the proven techniques used by FEMA and the US government.

Taiwan lacked the proper communication, organization, and proper flow of aid during the Chi-Chi earthquake response and recovery phases. This failure was largely due to the fact that Taiwan had no pre-existing organization to deal with such devastating disasters, therefore lacking the experience that FEMA has acquired. The government reacted rather slowly for the first couple days as they developed a plan to deal with the disaster, though unfortunately the lack of initial action caused much confusion in the

latter parts of the response and recovery. Taiwan did finally organize themselves and fared rather well in the end considering the fact that things could have been much worse, though the government caught much negative press in the process. The citizens of Taiwan, through their bravery and teamwork, contributed greatly to the response effort and were the real hero's during this tribulation.

In addition to developing a better response procedure for future disasters, Taiwan also needs to improve the quality of construction by developing more efficient ways to enforce their building codes and crack down on corruption, and by further researching better building techniques.

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Chapter 1

Introduction

1.1 Project Goals

The following project is a study of the social, economic, and political impacts of the 9–21–99 Chi–Chi earthquake in Taiwan. Through a case study of the 9-21 earthquake, the project will gather data on how the society reacted to the earthquake and its aftermaths. An analysis of the case study of the 9-21 earthquake, compared to the Northridge Earthquake in California will be used to generate our conclusions on the effectiveness of Taiwan's dealings with the situation. Incorporated in this analysis will be our conclusions and suggestions, which will be aimed at the improvement of Taiwan's ability to efficiently react to future earthquakes as to minimize damage and loss of life.

1.2 Motivation

One of the great opportunities open to all WPI students is the chance to study abroad. Before any group was formed or project was found, all we had in common was the desire to study in a foreign country. In order to study abroad most students need to go through applications and interviews to be accepted to one of WPI's established project centers. Taiwan, however, has no existing project center; so for students to take the initiative and set up a project there made extra work for them. So the question arises, why, out of all the places in the world, did we choose to come to Taiwan?

The first part in answering this question is in Matthew Lewis's past. When he was a child his family lived in Taiwan's capital of Taipei for two years, so when given the opportunity to return he took the initiative in setting up an IQP in Taiwan. This is by

no means a complete answer. After already spending two years there why would he want to return? Additionally, why would anyone else want to join in the adventure?

Taiwan offers a near perfect atmosphere for studying the effects that an earthquake has on society. Taiwan is in one of the most seismically active regions of the world. Coincidentally, after we had already set up our project, Taiwan was hit by its most powerful earthquake of the century. Unfortunate as that may be, it created fresh data on the subject. Adding to our good fortune, much of the research done on the recent earthquake was done by professors at National Taiwan University, the school where the project would be sited. This made the information we would need readily available. It seemed that everything we could look for in a project location was waiting for us in Taiwan.

On a more personal level, living in Taiwan offered the three of us a unique experience. All of us spent the majority of our lives in the United States of America. It is a large country, with many different cultures mixed together which prevents any one culture from having a dominant influence on our lives. Regardless of the traveling done with family, to be three independent students in a foreign country was bound to challenge and stretch our abilities. It is the chance of a lifetime to experience a completely foreign culture firsthand, one that none of us hesitated to take advantage of.

1.3 Personal Experiences

Taiwan has a population of 22 million asians; and we are three caucasian Americans studying in the capital city. The culture is half a world away from where we all grew up, and the distance is obvious in everything we see. Being immersed in a new culture we have had to learn to survive by trial and error. Using public transportation was one of the first major things we had to learn how to handle on our

own. Eating is always an adventure, nothing is familiar and everything looks scary to our unaccustomed eyes. Ordering food in restaurants is always a challenge because the menus are written in Chinese, which makes a lifetime of experience with a 26-letter alphabet completely useless.

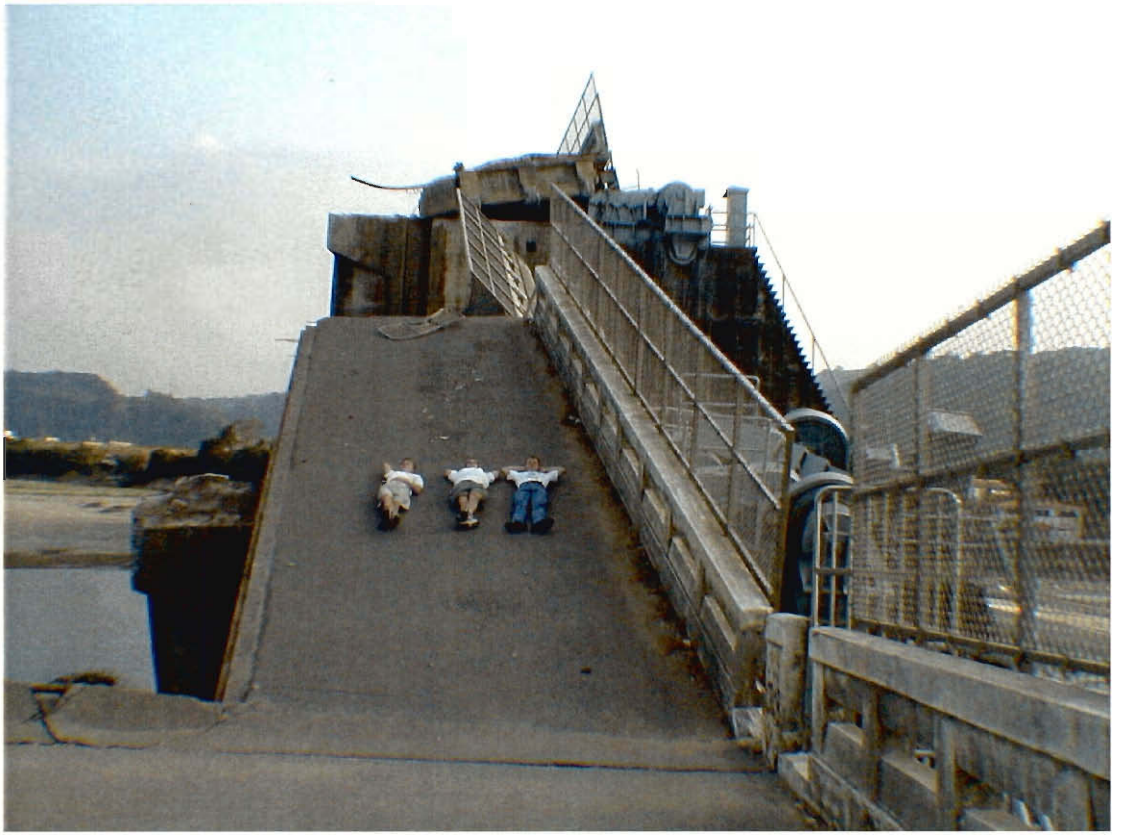


Figure 1.1

A picture of the authors on the Shi Kung Damn on the first site visit

Our room is at Tatung University, we do our work at National Taiwan University, as a result we have to take public transportation to and from work everyday. Anyone who is familiar with public transportation in America is aware how confusing it can be, but in Taiwan this difficulty is topped with the change in language. For the first week we got lost every time we tried. We laughed and joked about with each other and the students at NTU, which was probably the only thing that kept us sane. One night it took us over three hours to make a 30 minute trip home. First we got on the wrong bus. In our ignorance we stayed on the bus until the end of its route where the

bus driver showed us the door. Lost in Taipei, walking the streets with a map and confused looks, we would have been out all night had it not been for a friendly native who pulled over in his scooter and pointed us to the train station.

The food is always unknown when we eat with our friends. Ordering take–out Chinese food does not prepare someone for the shock of "real" Chinese food. Food is placed before us, and all we can do is wonder what we are eating. We used to ask what we were eating but after a while the only response we could get was "*its edible*", or "*its chicken, eat it*". In time, our questions changed from asking what we were eating to asking, "*is it edible chicken?*" With this philosophy we have eaten a few interesting things. Out of the sea and into our bellies we have put sea slug, whole dried fish mixed with peanuts, eel, blowfish, octopus and other forms of "*edible chicken*". From the land we have enjoyed the taste of cow stomach, pigskin and any number of other things that we remain ignorant of, but it was all edible.

In our time here we have had our personal victories. One time we walked into a restaurant alone, and the restaurant had no English menus. Rather than moving on to something we knew, we took the point and smile approach. When the waitress came up to us and started speaking we simply pointed to something on the menu and smiled. In return we got a delicious meal of beef and noodles for half what we would have paid in the US. Ordering food from a street vender is even simpler. All you have to do is a smile, and hold up a few fingers. In our time here we have picked up some of the language. Using the language as you learn it is far more rewarding than learning a language in school.

As part of our project we traveled to many of the areas that were hit hard by the Chi–Chi earthquake. We took a very emotional four-day trip, if not because of what we felt, then because of what we saw. People walked by destroyed homes and

buildings with their faces turned away from the memories and thoughts that seeing the destruction brings to mind. In other cases people travel to see damages, viewing the quake as a national event that should be understood by all. One man even found an income by selling photograph books of the destruction.

Life in Taiwan is extremely different from the academic atmosphere that we had grown used to. In Taipei we are members of an extreme minority, and it is noticeable every time we step outside our room. As we walk down the street people smile, wave and say hi. It's constantly obvious that we stick out like sore thumbs, in our time here we've grown so used to it that it seems odd when we see any other Americans. We smile, wave, say hi and generally view them as a novel difference from everyday life, the same way we are looked upon by the people we pass everyday

1.4 Report Content

There are three main sections to this report. The first is a case study of the 9–21 earthquake. The second is a discussion of the economic, political and personal effects of the earthquake and the third is a comparison of the response of Taiwan's government to the earthquake with the response of the United States to the 1994 Northridge earthquake. The case study is a detailed summary of technical and statistical data from previously published articles, reports, books and WebPages. The discussion section uses the data gathered in the case study together with newspaper articles, personal experience, and other publications to analyze the social response to the earthquake. The response is broken into three main sections, economic response, the political response and the personal response. Each type of response is looked at individually while conclusions are drawn from the three together. The comparison section uses the response of the Federal Emergency Management Agency to the Northridge earthquake as a benchmark to measure the response of Taiwan's

government. This gives a context in which to examine the merits and faults of the government's efforts in the weeks and months following the disaster. Together these three sections give a broad base of general knowledge about the 9–21 earthquake with a focus on the social effects and efforts by the Taiwanese people.

Chapter 2

Methodology

There are three main parts to this project. The first part consists of a case study of the 9–21–1999 earthquake centered in Chi–Chi, Taiwan. The second is a discussion of Taiwan's social response to the Chi–Chi earthquake and the third is a comparison of Taiwan's governmental response to California's response to the 1994 Northridge earthquake.

Several troubles were encountered during the data collection process. The language barrier proved to be a significant obstacle, as did the fact that the Chi–Chi earthquake was so recent. Much of the information that was required was not available in English and none of the project team was able to read Chinese. There was also a problem with data collection because a large amount of the statistical data was not yet compiled.

In order to gain an understanding of the material that was only available in Chinese we had to work closely with an employee of National Taiwan University, Private Christopher Loiu of the Taiwan Army, who struggled with us to translate a series of reports and the Taiwan building code. This process was further hindered because of the language barrier between Private Loiu and ourselves. The information was eventually found and translated with considerable effort and a strong understanding of the context of the material.

It proved impossible to receive an official listing of the damage caused by the Chi–Chi earthquake because no such list had been compiled. As a result figures from several different sources had to be used. The body of the statistical data that was used in this report was collected from the various ministries and organizations of the Taiwan Government. This information was usually outdated the moment it was

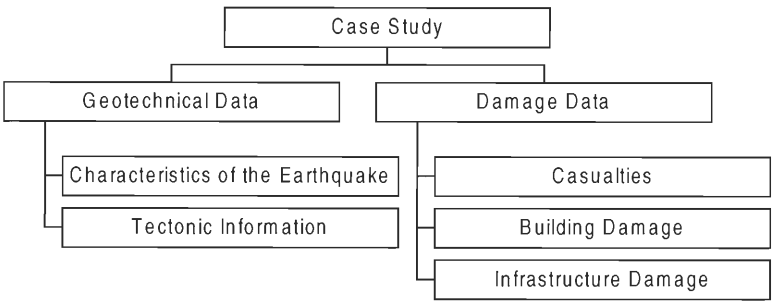
published because of the near constant flow of damage reports. This collection is as near to complete as possible considering the scattered nature of the data colleted

2.1 Case Study of the 9–21–1999 Chi–Chi Earthquake

The case study gives us the seismological and statistical data related to the Chi–Chi earthquake. The scale of the disaster is described with this collected data. This section also contains the specific factual information that will be used later during the discussion section of the report.

Figure 4.1

Organization chart of the Chi–Chi earthquake case study



As seen in figure 4.1 above, the first section of the report is the case study of the Chi–Chi earthquake and can be broken up into two parts that can then be further broken into two sub–sections. The first part is a study of the earthquake itself and can be sectioned into a study of the geological data and the resulting damage data. These sections can then be further separated into the characteristics of the earthquake and the tectonic reason for the earthquake, and into the casualties, building damage, and infrastructure damage, respectively.

2.1.1 Geo–technical Data

This is the seismological data and facts concerning the specific nature of the 9–21 Chi–Chi earthquake, this information is useful in explaining why some areas were more severely hit than others as well as explaining the immense impact that the

earthquake had. This information includes facts relating to the specific characteristics of the Chi–chi earthquake

Characteristics of the Earthquake

This information is gathered from technical reports generated by previous studies of the earthquake, which include reports by the United States Geological Survey (USGS), Berkley College, Seneca College, National Taiwan University (NTU), and Taiwan Normal University. These reports give a technical description of the 9–21 earthquake.

The Tectonic Reason for the Earthquake

This section is mostly completed by web research on the tectonic history of the area as well as current plate movements. This information aids in the general understanding of the earthquake and its power in affecting the lives of millions of people.

2.1.2 Damage Data

The statistical data concerning the damage caused by the earthquake is directly related to how the earthquake affects the society in Taiwan. This information contains statistical data related to several different types of damage including, casualties, buildings and infrastructure. The statistical data reflects the official data generated by the National Fire Protection, Ministry of the Interior of Taiwan. A set of pictures is also included in this section to give a more personal understanding of the damage.

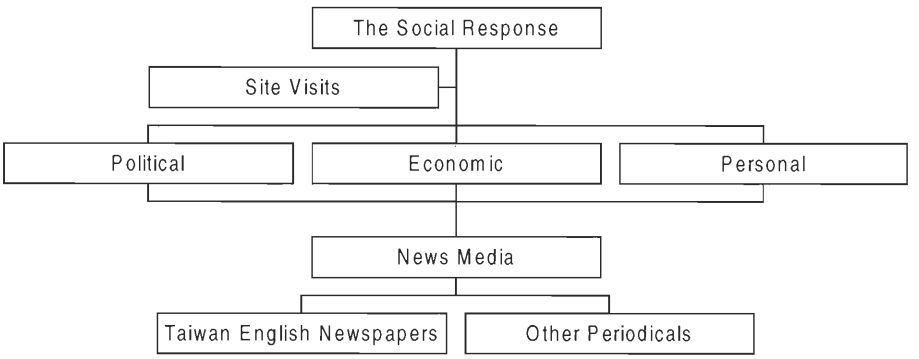
2.2 The Social Response

This section of the case study relies more heavily on personal impressions than the technical data section. As a result we needed a personal understanding of the magnitude and effects of the Chi–Chi earthquake to properly interpret the information

gathered through the news media and interview process. To acquire the understanding we will undertake several site visits of the disaster zone.

Figure 2.2

Organization of the study of the social response to the Chi–Chi earthquake



2.2.1 Site Visits

We conducted several site visits to the damaged areas in Taiwan, particularly in the Nantou county and Taichong county where the damage was most severe. The purpose of these visits was to gather photographic evidence of the damage as well as to gain an understanding of the scale of the damages and the personal responses to the Chi–Chi earthquake.

2.2.2 Political, Economic, Personal

The social response to the earthquake is separated into three categories. The categories are the political response, the economic response and the personal response. There is some overlap in these categories, but this separation assured that important details were not overlooked. These responses were considered separately while general conclusions and observations were drawn from all three and discussed and compared in the discussion section of the report.

2.2.3 News Media

News media is a strong source for the personal responses to the earthquake as they have had months to conduct surveys and interview victims. We reviewed the

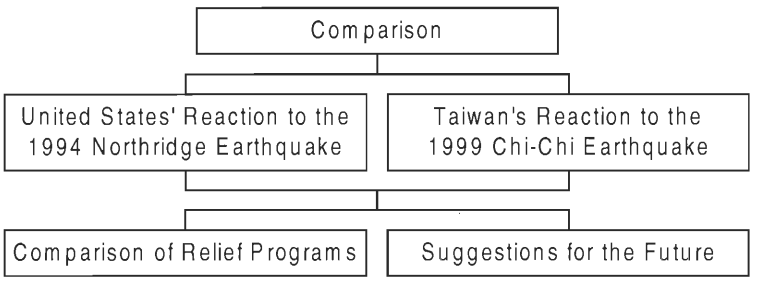
responses from several newspapers and periodicals including the Taipei Times, the China Post, the Taiwan News and the Economist. We used mostly local newspapers as they are more focused on the earthquake and its effects than other publications, but we also included foreign publications to get a more objective view on important issues.

2.3 Comparison

In the comparison section of the report we looked at the command structure and reactions of the Taiwan government to the Chi–Chi earthquake in reference to the United States' reactions and command structure during the aftermath of the 1994 Northridge earthquake.

Figure 2.3

Organization of comparison of Taiwan's and the United States' disaster relief efforts



2.3.1 United States' Reaction to the 1994 Northridge Earthquake

We gathered the information necessary to give a clear understanding of the events after the Northridge earthquake with specific focus on the command structure and actions of FEMA. This information was gathered from governmental memos and press releases as well as from a variety of other sources.

2.3.2 Taiwan's Reaction to the 1999 Chi–Chi Earthquake

This section gives a detailed description of the command structure used by Taiwan during the relief and reconstruction efforts. This information was gathered from governmental press releases and reports. Much of this information does not exist in

English so a substantial amount of translation was necessary to acquire the needed data.

2.3.3 Comparison of relief programs

This section includes a comparison of the structure of Taiwan's and the Unites States' relief efforts and organization using the information outlined above. The comparison focused on the efficiency and effectiveness of the relief efforts.

2.3.4 Suggestions for the Future

Based on the information gathered and discussed we suggest improvements or corrections which may aid in future relief efforts. We hope that these suggestions will help improve Taiwan's future disaster mitigation efforts.

Chapter 3

Taiwan in the World

In order to fully understand how the earthquake has affected the society of Taiwan, it is important to have an understanding of its history, culture and the economy. Taiwan's unique past, climate and current globalization and economic trends have given this country a strong presence in today's world. Truly Taiwan's struggles with adversity have tempered it into a formidable and innovative country.

3.1 Globalization

Globalization is the process by which the nations of the world become more economically open to trading and exchanging information. Today it is evolving very quickly, and this fast paced development is part of its own international cycle. Successful countries of the world have had to learn how to constantly improve and adapt. The manner in which they do this is very similar to the way companies compete with one another. To see these similarities Thomas L. Friedman, in his book The Lexus and the Olive Tree, has broken down the worldwide globalization system into simple concepts that he has developed.

One of the most important qualities of a country in today's society is how well connected every computer is to one another and to the Internet. The strength of this connectivity will become increasingly important to the economic health of countries as time moves on because companies will want to set up in these stronger countries. Connectivity is not enough though. Countries must also use their knowledge and technical prowess to their fullest extent. As with independent companies, countries must be able to take what they know and use it in every possible manner, as opposed to being used in only the original single facet for which it was developed. In the global economy, countries need to have very powerful electronic connections so that

they know how to use these to their fullest potential, just as independent companies need to. (Friedman)

Successful countries have also found the benefits of being interdependent rather than independent. It is very important for a country to keep itself open to the outside world. If a country were to close itself off from the input of outside sources its knowledge would become outdated very quickly since interaction is mutually beneficial in these situations. To this end Singapore has developed a program called "Contact Singapore", through which it recruits young talent in the scientific fields in order to help them expand their own knowledge and abilities. Tariffs are a big part of this concept also. In the 1980's both Brazil and Taiwan decided to try to make their presence in the electronics business a significant one. They were both particularly interested in the fax machine market, one in which they would both need the technology of the Japanese company Fujitsu. In order to protect its small national companies from competition Brazil passed a significant number of tariffs on electronic products. Taiwan, on the other hand, announced zero tariffs. Consequently there were no incentives for companies to share their superior technologies with Brazil instead of Taiwan[1]. (Ibid.)

As the world becomes more advanced, it will also become more complicated. It is not possible for any one world–leader to understand and be in control of every situation. What is becoming increasingly important is having advisors that understand their field of expertise so they can help their leader to make the right decisions. (Ibid.)

Many countries have very old proud histories, and the successful ones are realizing how economically unimportant that is. In the past a country's geological location was

[1] In 1995 Brazil changed their policy and lifted the tariffs it had on Fax machines to compete on an open market with the rest of the world.

very important, but with today's globalization system, that is no longer a deciding factor in the well being of a nation. The only ingredient that a country must supply is an understanding of the system, and the initiative to take advantage of it. (Ibid.)

3.2 The Land and the People

Taiwan is a country half way around the world from where any of the authors of this report grew up. Before we left we knew that it would be important to do some background research on the people and the culture of Taiwan. The geography, climate, ethnic and religious background of the people of Taiwan is very unique when compared to what the authors grew up in. This research allowed us to understand that no matter how much we read, we would experience some culture shock when we reached our destination.

3.2.1 Geography and Climate

The island of Taiwan is separated from China by the Taiwan Strait, which spans slightly less than 100 miles. The island is located between latitude 25'30" North and 22' 00" North. The island itself is roughly 230 miles long, and 85 miles across, covering 13, 814 square miles. There are several other islands surrounding Taiwan that are also considered geologically linked to it.

The climate is subtropical, with long summers extending from April at the earliest to October at the latest, and short winters during the other months. Due to its close proximity to the ocean, and the presence of the Japan Current, the temperature fluctuates very little on a short-term basis. There is an annual precipitation of 102 inches, of which, more will usually fall on the east coast than the west. This plentiful rainfall makes agriculture in Taiwan a fairly healthy and reliable source of work. This also makes hydroelectric power a reliable energy source.

Due to the fact that much of Taiwan is either volcanic or partly volcanic, the lowland plains have very rich soils despite years of farming. The lands in the higher elevations, however, are more acidic than its lowland counterpart, and therefore are not as good for farming. The diversity of the soils quality, elevation, and climate have given rise to over 190 indigenous plant families, and 4,000 species that are considered to be either tropical or subtropical. Similarly, there are also in excess of 60 different mammals, and 330 different types of birds.

3.2.2 Ethnic Groups

Taiwan has a population of nearly 22 million people, and if it were to be considered an independent nation-state, it would be the second most densely populated nation in the world. Its birthrate, however, has been decreasing and is now down to 0.85. If this continues the population can be expected to peak at 26 million in the next thirty years, and then proceed to decrease steadily. The population is composed of four major ethnic groups; the Aborigines, Hakkas, Fukienese, and Mainland Chinese. (Cooper)

The Aborigines are the islands original inhabitants. It is believed that they migrated to the island several millennia ago from Southeast Asia, or Southern China. The Hakkas were the next group to arrive in Taiwan, arriving around 1,500 years ago. They moved to Taiwan because they were a persecuted minority in Mainland China where they were considered a "gypsy" like group. The Fukienese were the next group to arrive. They left from the Fukien province in China between the fourteenth and seventeenth centuries. Most of this migration occurred because of the fall of the Ming dynasty in 1644. In 1949 a wave of Mainland Chinese immigrants arrived in Taiwan when the Communists defeated the Nationalist Chinese armies. (Ibid.)

The Aborigines of Taiwan make up 1.9 percent of the population. They are lower in the socioeconomic and educational areas of society that the other ethnic groups on the island. They have a higher unemployment rate, more alcoholism, adolescent prostitution, and a higher birth rate. Much of their oral history is being lost due to the modernization of their society. (Ibid.)

The Hakkas have always been more of a "clannish" people because of their minority status when they were on the mainland. In recent years this feeling has weakened with social blending. As a people, the Hakkas generally work in the more physically strenuous fields such as road building, construction, and agricultural work. They perceive themselves as being Taiwanese, as do the Fukienese, but the two groups generally do not get along well. (Ibid.)

The Fukien Taiwanese were originally mostly tradesmen like the citizens of the Fukien province in China. However a lack of contact with the mainland, and the influence of other cultures have helped lead them in becoming more active in business and politics. (Ibid.)

The Mainland Chinese arrived in the mid 1900's, and see themselves as the preservers of ancient Chinese culture. When Communism took over China they came to Taiwan, bringing with them many Chinese cultural traditions. Many of them were either soldiers, or government officials in the old nationalist China, and represent all parts of China. They speak Mandarin Chinese, which is the dialect that is considered the language of the educated (this has become the national dialect, and is now spoken by everyone). With this high view of themselves, some of them tend to see themselves as being superior to the other ethnic groups that arrived in Taiwan before them. With all of these differences in the four major ethnic groups it is important to

note that in recent years the prejudices and ethnic barriers have been rapidly diminishing. (Ibid.)

3.2.3 Religion

Taiwan is a country that has engulfed a blend of many religions. The Aborigines practice animism, which is based on the worship of nature and various animal sacrifices. The other three groups have brought Taoism, Confucianism, and Buddhism with them over the years. The Dutch brought Protestant Christianity and the Spanish brought Catholicism to Taiwan in the short periods when those two countries were exploring and colonizing in the area. The Japanese taught Shinto during their reign that existed before the Mainland Chinese arrived. Thus there is a wide range of religious beliefs that are followed by the many different citizens of Taiwan. (Ibid.)

While all these social and religious changes have been occurring, the economy of Taiwan has been growing rapidly. From 1950 to 1970 the farming industry grew two to three times faster than the population. The addition of a significant industrial business has also dramatically encouraged the countries economic growth. In 1950 the average personal income was $50 a year, and it is now close to $20,000. The rapid growth of the economy has caused a minimal amount of unemployment. Workers can easily find new work, and even training in new fields. The unemployment rate in Taiwan has consistently remained below 3%. With such a low unemployment rate, the salaries of the unskilled and inexperienced workers have become higher than in other developed countries. The income gap between the rich and the poor, which is observed through comparisons of the top and bottom 20% of the population, is one of the lowest among modern countries. (Ibid.)

As a direct result of this economic equality, Taiwan has become a society of mass consumption. As of 1986, 97.2% of families owned color TV's, 98.8% owned refrigerators, 79.8% in the city subscribed to newspapers, 78.5% had washing machines, 83.2% had telephones, and the trend continues with all nonessential utilities. The economy of Taiwan is in strong shape, and only shows signs of improving. (Ibid.)

In the earlier part of the century, an emphasis began to be placed on mass education. By the time the Mainland Chinese arrived in Taiwan, 70% of the children were enrolled in elementary school, consequently education was no longer a tool used only by the elite. When the Mainland Chinese came to the island, they brought with them a nationalist government, and a constitution that stated that all citizens had a right to education. It provided a significant amount of its budget towards education, and these regulations of their constitution have been strictly followed. The success is apparent in the percentages; in 1950, 88% of school aged children attended school, by 1979, 99% attended. The educational system is also free of any sexist restrictions, and it is apparent that women and men are treated equally in school. (Ibid.)

There is also a strong educational structure in the colleges and universities in Taiwan. Over half of the educated population has received degrees in some form of secondary education. Statistical data gathered by the U.N. has indicated that the educational strength of Taiwan exceeds that of all other underdeveloped, or developing countries. While many students have gone abroad to seek a higher education in better-established countries, in recent times the local universities have improved to the point where fewer students are finding a desire to look across national borders for education. In addition to this, Taiwan is attracting more students from other countries to study at their universities. (Ibid.)

With all this wonderful modernization, and social development, it is important to take notice of the negative aspects that have also increased in recent years. One problem of note is an increasing shortage of housing in some cities. Crime has also been increasing since the late 1960's. Even more alarming is that juvenile crime is making up a larger portion of the overall crime rate in the country. It is also found that in direct relation to the increase in crime, the rate of drug use is also increasing. In addition to these issues, there has been a rise in the divorce rate now that marriages are no longer arranged for the progress of the family. The increasing divorce rate is seemingly related to the rise in child abuse in recent times. With all of these hard to deal with "modern" situations suicide is becoming a more significant issue than it had been in the past. Air pollution, and environmental damage are beginning to make a noticeable impact on the people. Still, with this sudden increase in the negative aspects of society, Taiwan still does not exceed the rates of crime and social problems in the modern countries of the western societies. (Ibid.)

Figure 3.1

An Arial photography of the Chiang Kaishek Memorial hall in Taipei City; Taipei has a population of over 2 million but was originally designed to house no more than 1 million consequently much of the city lacks modern urban planning.

3.3 Taiwan Economic Development

The economy of Taiwan is unique in the world today. Just fifty years ago its economy was based on agriculture, and today it has become a power in international commerce. Its overall growth in recent years has been exceptionally high, among the highest in the world. The economy of Taiwan is driven in part by the socialist

philosophy of government brought from the main land, the mistrust between the KMT and the Taiwanese population, and a constant fear of Main Land China.

3.3.1 Development Model

Taiwan has been able to reach "*double-digits of overall growth*"(Sutter and Johnson 28) a feat that only Korea and China have been able to match in recent years. As a result of this rapid growth and extreme economic success Taiwan has become a development model for other Asian countries that are struggling to gain economic stability and growth.

3.3.2 Rapid Growth

Taiwan went from a small agricultural economy to a major player in international commerce in under fifty years. This amazing transformation was a result of numerous factors. According to Heginbotham, director of Gateway to Japan and formally of the Foreign Service, there are seven main contributing factors to Taiwan's growth; market economy, export-led growth, foreign investors, agile entrepreneurship, familial connections, intra-Asian trade integration, and trade triangulation (Sutter and Johnson 23). These seven features of Taiwan's economy have allowed it to reach growth rates equaling or surpassing the highest growth rates in Asia.

Taiwan has a "semi-open economy, generally market driven" (Sutter and Johnson 24). The market does not have complete control in Taiwan, as there is extensive government intervention with international trade and domestic affaires. Strict and extensive import barriers on an island where raw materials necessary for industry are scarce forces the Taiwanese to focus on export to finance their high import spending. This was especially true in the 50's and 60's when domestic savings were low. Of course even an export-focused businesses requires start up capital. In Taiwan, startup capital comes from a combination of foreign investment and private funds raised from

within family units. Because of the tight restrictions that the government put on direct foreign investment much of the growth was made possible by extremely talented local entrepreneurship.

The entrepreneurial talent of the Taiwanese was also assisted by family ties, which are very strong in Chinese culture, often stretching across Asia giving the Taiwanese a large network of contacts and opportunities. Intra-Asia trade integration has also played a part in Taiwan's economic boom. Taiwan has not passively sat by while the integration took place. Taiwan has played a major role in this increase in trade, giving itself a support network as a further bulwark against China. Intra Asia trade has not been the only international trade Taiwan has taken part in. The United States and Japan have both played major roles in trade triangulation between the three countries.

3.3.3 A Paranoid Economy

It is not paranoia if they are really out to get you, it is just good sense. Taiwan lives under the menace of a nuclear superpower. Naturally much of their economic development since 1949 has had to adapt to the stringent regulation and restriction that the shadow of China causes.

China will not have diplomatic relations with any nation that has diplomatic relations with Taiwan, causing Taiwan to become an outcast from the international community. Taiwan cannot join the UN or any other large international organization. If there were ever an economic crash in Taiwan there would be no IMF to aid in the reconstruction. This means that in order to survive Taiwan has to be prepared. "*Not by chance, [Taiwan] has the world's third-largest foreign reserves and one of the world's lowest foreign debts.*" (Ibid.) Taiwan is prepared to pull it self up by its own bootstraps.

China's threat has lead to another uniqueness in the Taiwanese economy; there are almost no large companies in Taiwan. The KMT did not want to deal with rivals in the economic sector so they restricted the flow of capital investment in the economy. Large companies require large amounts of investment in order to grow. However, in Taiwan it is nearly impossible to get a loan from the government-run banking system. Foreign investment is also restricted which leaves companies with three choices. They can either grow purely from reinvestment of profits, they can turn to family and friends or they can try to find capital on the "Kerb" market[2]. The restrictions on capital have led to a proliferation of small companies that cannot grow to a size where they control large portion of the market share. "*There is a Joke in Taiwan that if you throw a stone in the air in Taipei you will most likely hit a chairman of the board.*" (Ibid.) As absurd as the commentary may seem it is almost the case since there is roughly 1 company to every 18 people in Taiwan.

3.3.4 Made in Taiwan

Taiwan's High-tech firms have found for themselves a wonderful little niche in the Original Equipment Manufacture (OEM) market. In all sorts of industries the company whose label is on the box may never have seen what is inside. Companies in Taiwan labor in the back while their clients get all of the credit and most of the profit. "*Three quarters of Taiwan's electronic production today is eventually sold under someone else's brand name.*" (Ibid.) By focusing on the OEM market Taiwan companies are freed from any of the marketing effort, which allows them to focus on the manufacturing process.

[2] The Kerb market can mean any thing from loan sharks to community lending associations where the interest rates inevitably are higher than the official interest rate.

Chapter 4

Supplemental Data

Before an analysis of an earthquake and its effects on structures and human safety can be done it is necessary to gain an understanding of the building codes that refer to this area of study. The Universal Building Codes were the first set of codes that we found and summarized. It is a general outline that can be applied to most areas. In extreme cases, however, it is necessary to supplement it with more specific codes. Taiwan, for instance, is much more seismically active than most places in the world. In response to this Taiwan has adapted the UBC and supplemented it with its own set of codes which have stricter regulations regarding earthquakes and other geological hazards.

In addition to the direct damages caused by earthquakes, there are also indirect effects on the landscape. The landslides that result from earthquakes often do more damage than the earthquake itself. The Tsao Ling landslide occurred due to the Chi–Chi earthquake, moving 350 million cubic meters of soil a maximum distance of four kilometers. With such a significant impact on the landscape, an understanding of landslides becomes very important to the case study of the Chi-Chi earthquake.

4.1 Universal Building Codes

The Universal Building Code (UBC) is a set of standard codes that have been internationally accepted by many countries and most states in the US. Having similar geological areas to other countries and states that have adopted the code, Taiwan has also decided to use the UBC. The most recent printing of the codebook was released in 1997, and is available in most libraries. The UBC is a three-volume set that goes into great detail on how to design, construct, and maintain an appropriate level of safety in all structures. Consideration is given to how connections will be made, the

strength of each part of the structure, and what type of loads need to be designed for. The relevant codes that this project includes cover such things as life safety, earthquake design and regulation, foundation design, structural tests and inspections.

The first thing that a building code must realize is that no two buildings are the same. Consequently, the UBC groups buildings into different types based on certain distinct characteristics. The different types of buildings have their own specific regulations in addition to the broad requirements of the UBC. In addition to the rules written in the UBC, a building official will be either present or available when work is being done on a building. This individual will be a highly qualified engineer, with experience and significant knowledge of the situation at hand. The building official will be a licensed practitioner in the state or country of the work site, and he will be responsible for ensuring that the building in construction is safe for use. This is assuming that both the original plans were without fault, and that the building inspector competently completed his job. He will have the power to make on-sight decisions where the UBC does not specifically address a situation. He is also given responsibility in specific situations where the codes say that the building official will have the authority to make sure that a specific part of the construction is within an appropriate measure of safety. He also has the authority to stray from the UBC if he can justify the need, or feels that they are not physically possible and can back up his decision in case it is ever called into doubt.

Figure 4.1

A collapsed high rise in Taiwan; Many on the building that were destroyed by the 9–21 earthquake roughly 12 stories high, or just below 50 meters, which meant that there did not require a special review board to approve the plans.

All soils are placed into classifications by the UBC. These divisions are SA, hard rock; SB, rock; SC, very dense soil and soft rock; SD, stiff soil; SE, soft clay; SF, soil requiring site-specific evaluation. The properties of these soils will need to be taken into account in the design and construction of any building being built on it. The soil that any building is to be built on will be classified when the building official feels that it is necessary. These tests will be used to evaluate the soil strength, effect of moisture, variation on soil-bearing capacity, compressibility, liquefaction, and expansiveness. These classifications and qualities are required to be shown on the plans. The UBC makes special considerations for all of these qualities in the soil, and gives instructions as to what needs to be done for the different results of each test.

When making the footings for a building out of masonry or concrete they will need to be solid, and of an approved size to support the anticipated loads. When the building is to be built on a surface with a slope of 10% or more the footings must be made to compensate and make both the top and bottom of the foundation level. In general, when a building is being built below a slope it is up to the building official to decide how far back it needs to be made in order to be safe from slope drainage, erosion, and shallow slides. In addition, the UBC has geometrical standards for figuring out how far back from a given slope a foundation will need to be. It is also stated that if a footing is going to be placed on a slope, it will need to be in firm material with an embedment and setback from the slope far enough to provide vertical and lateral support for the footing without producing an excess amount of soil settlement. The building official, if he feels that it is unnecessary or impractical, can overturn all of these requirements. In general the UBC has requirements for every possible form of stress that can be placed on a foundation. The testing procedures are all at the discretion of the building official.

In areas of earthquake activity there are many types of considerations that need to be taken into account in the design of structures. The UBC has classified every area of the globe into its seismic zoning system. It ranks every location on a scale of one to four, where four is the most active, and one is the least active. Based on a locations seismic zone, and distance to active seismic sources, soil profile characteristics, and the importance of the structure the sites seismic hazard characteristics will be established.

The major concern is the lateral forces created by an earthquake. The UBC goes into great detail defining which kinds of human occupancy buildings are required to conform to the regulation for seismically active regions. In an earthquake there are many different types of forces acting on a structure and the land being built on. Depending on the size and/or design of the structure, not all of the forces will have a significant effect on the structure in question.

The UBC contains a large collection of charts that give the necessary information for many types of situations. Many conclusions can be drawn from these charts using the accompanying formulas. The UBC also explains how to interpret these results, and what action to take for the range of values that the calculations produce. A scientific explanation of the process is also included with the equations and charts.

All buildings in seismic zones 3 and 4 over six stories must have at least three accelerographs. The instruments must be placed with one in the basement, one near the middle stories, and one in the upper stories. They must also be accessible at all times and marked with a sign stating "MAINTAIN CLEAR ACCESS TO THIS INSTRUMENT". This is required because these are such large buildings and it is necessary for them to have an early warning of an imminent earthquake so that evacuation and safety procedures can be taken.

For particular types of construction and operations there must be a special inspector present. The inspector must be a qualified individual who has demonstrated competence in his field and will be chosen by the building official. The inspector will be responsible for making sure that the construction being done is of a satisfactory quality, so that it will successfully bear the forces and stresses that can be expected. In seismic zones of 3 and 4 it is required that the special inspector use nondestructive testing in welded, or otherwise fully restrained connections. This testing may be done by a licensed tester by ultrasonic or radiography testing.

The actual codes go into great detail to explain how to compensate for the possible dangers of building on unsafe land. The formulas, informational charts, and testing procedures are all presented and explained in a reasonably clear manner. What we find surprising, however, is that the UBC does not under any circumstance designate any area unsafe for construction. Precautions are made and can be adjusted by the building official to fit any situation. However, there are no sections that restrict where it is safe to build. Areas prone to landslides can be built on simply by considering the UBC's regulations in the design. However, if land is likely to slide down a slope every ten years, then a structure can simply be rebuilt there every ten years. There are no human-safety precautions that must be taken for this situation either. If the land goes, the structure goes with it, and no alarms or properly illuminated exits would prevent it. There is a certain amount of risk being taken when a building is built on landslide prone slopes. It is possible to design a building to withstand almost any amount any of stress, the technology is known, but it can be very expensive. It is actually more cost effective to build the structure with minimal design requirements, and then pay the higher insurance than it is to build with the best technology that we have. It being cheaper to do so, people would rather pay the high insurance and risk

their house and family because they obviously don't understand the significance of the danger the structure is in. Perhaps it would be wise if the codes would make the decision to declare certain areas unsafe for human occupancy.

4.2 Taiwan Building Codes

Taiwan has adopted the Universal Building Codes (UBC), whose relevant sections on earthquakes and ground stability have been summarized in the previous section. The UBC is a strong basis that many countries and states use as a starting point for their codes. However, since there are so many variances in the land of different countries, it is necessary that each country adopt its own specific codes. These are some of the more specific considerations that the Taiwan building codes take into account that the UBC doesn't go into detail with. This code was made with considerations based on the pre-existing codes of Japan and California, which have similar seismic activity zones.

The seismic codes of Taiwan are much more specific than the UBC, but they are still only the minimal requirement for design and construction. As of 1974 every section of every building must be designed to resist an earthquake of magnitude six with no damage. Each section of the building will be interacting while in equilibrium, and during an earthquake. The interaction of these sections must be taken into consideration during the design and construction process. It is essential that every part of the building follow the codes because one weak section will make the strength of the rest irrelevant.

There are also other factors that need to be taken into consideration with respect to a structure in Taiwan. Zoning is a very important section of the code. Taiwan has been sectioned off into four areas of seismic activity based on the past activity of the area. The zone that a building is constructed in decides what the minimal

requirements will be. It is also against the regulations of the code to build within 100 meters of a known fault. The intensity that an earthquake is felt depends on how close to the epicenter one is; this is why zoning is so important.

Regardless of the precautions taken, it is inevitable that there will be damages and loses as a result of an earthquake. Consequently post quake preparations are necessary. This includes an organized plan to inspect the safety of a damaged building, and whether or not it should be removed. When a building is designated unsafe or beyond repair, the codes have a generalized method for the cleanup process explained within it's more detailed sections. For those that experience significant loses, it is also necessary to provide compensation in order to aid in them getting back on their feet.

4.3 National Transportation Research Board Special Report on Landslides

Landslides can be a very complicated subject matter to study and understand. The scientific viewpoint of landslides, however, is not within the scope of this paper. The purpose of this section is to give the reader a basic understanding of the effect that landslides can have on society. It will also be important to discuss what can be learned from them, and how this knowledge can be used to improve safety. Above all else, one of the most important things that can be learned from landslides is how to prevent them from occurring.

Landslides don't happen by accident; they must be triggered by some event. Possible trigger mechanisms include intense rainfall, rapid snowmelt, water-level change, volcanic eruptions or earthquakes. These events cause a pre-existing weak layer in the soil to slip, which results in all the soil above the weak layer sliding down the slope.

Landslides have caused a very significant amount of both public and private losses. These include economic loses, casualties, and property damage. All of these subjects are very significant and are generally underestimated. Additionally, future landslide activity is anticipated to increase in spite of improvements in recognition of danger, prediction accuracy, mitigation measures, and warning system improvements.

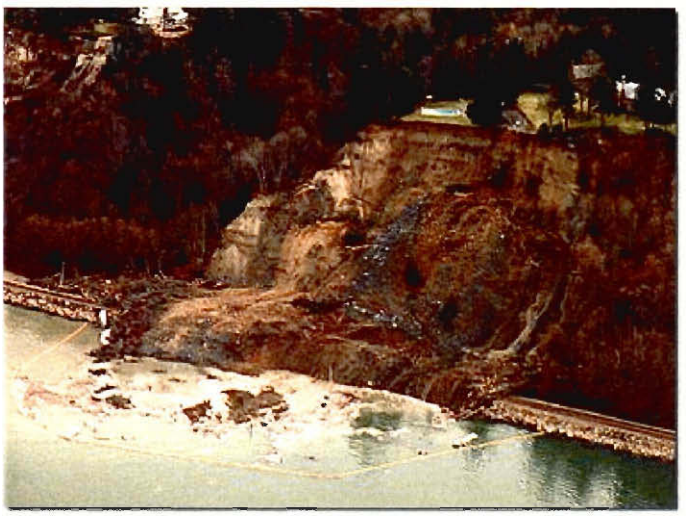


Figure 4.2

A picture of a landslide that knocked a freight train off of its tracks in Seattle, Washington

One of the reasons for this is a worldwide increase in urban development. This is a result in the worldwide trend of population growth. With this increase in population, human development, including housing developments, structure construction and other forms of development, people have been forced into more landslide prone areas.

Another reason that landslide occurrences are increasing in frequency is the continued deforestation of sloped lands. The root systems of plant life are known to help hold land and soil together, and with the removal of these plants and their root systems, flooding, erosion, and landslide activity have and will continue to increase in years to come.

Weather and climate changes are also a concern in the changes in landslide activity. Increased precipitation has caused landslide occurrences to increase. It is hard to predict how weather patterns will change in the future due to the many factors that must be taken into account. El Ninõs for one must be taken into account, but its worldwide effects are unpredictable. The results of the greenhouse effect are also

uncertain. There are many theories on the matter, but they all have different results, and none of them can be proven to be true by anything other than time.

Regardless of how often landslides occur, there are many costs associated with them. There are two different types of costs that can be examined, direct and indirect costs. These costs may then be classified as either public or private costs. Direct costs include things like repair, replacement, and maintenance that result from damage to property. Indirect costs are more long term than direct costs. Things that are included in this area are loss of productivity due to the damage done to land or facilities or interruption of systems. Landslides can also reduce real estate values, which will lower the tax revenues for property. Private costs are those that must be paid for by citizens and private companies. These include things like purchasing insurance, and repairing industrial facilities. Public costs are those that the government must pay for. These include the repair of government buildings, bridges, roads, railroads, sidewalks, and other public structures.

Landslides can cause a great deal of damage, and death when they occur in populated areas. Because of this steps must be taken to limit the losses that result from landslides. One possibility is a restriction of development in landslide prone areas. For this to work, several things must be available. There needs to be a comprehensive database with technical information containing a list of landslide prone areas. It is also important that the information can be properly understood, and used for the benefit of the safety of the community.

There are also other ways to help decrease the losses caused by landslides. One is by making stricter codes for excavation, grading landscapes, and construction activities on sloped land. Another step would be the development of an effective warning system. It is also important to provide protection for existing structures and

population through such means as improved drainage systems, slope-geometry modification and by installing protective barriers along landslide prone slopes. Additionally, it is important to provide adequate relief and rehabilitation assistance after a landslide.

In order to better prepare for landslides in the future the study of past landslides is crucial. When a proper investigation is done, the information gathered can be used to help predict and prevent future landslides. However, there is rarely enough time or money available to collect every relevant fact. Therefore, the investigator must also rely on his judgment and experience to draw conclusions. Once the conclusions and data collection are finished it is necessary to interpret the information. Only with properly interpreted data can appropriate safety and preventative measures be taken.

Every case is different; therefore each individual investigation must be approached with a very site-specific methodology. For each case to be studied according to its own individual traits several things must be appropriately planned for. The investigator must determine what type of measurements are needed, what instruments will be necessary to gather this information and how the information gathered should be managed and presented. Based on this information, proper-zoning codes should be implemented. By limiting what can be built on a slope, the stability of the slope can be safely controlled.

When a slope with known qualities is being used for some purpose, several steps must be taken to ensure safety. First, a general idea of what the final product will be and its functional requirements should be created. Next, all possible problems should be investigated, and the most efficient solutions must be discovered based on its cost, functionality, and appearance.

By continuing to study and learn from them we can begin to find ways to be better prepared for them, and even to prevent them in certain situations. Hopefully, with our ever-growing knowledge of their causes and potential, better measures can be learned to decrease the impact they can have on our lives.

Chapter 5

Chi–Chi Earthquake and Aftermath

Before the effects that the Chi–Chi earthquake had on Taiwan's society can be examined in detail it is necessary to gain an understanding of the magnitude of the quake. This section will give the reader basic background information on the geological situations that resulted from the earthquake. It will also include a summary of the damages that resulted from the earthquake. This knowledge will help the reader to better understand the scientific cause and magnitude of the earthquake, which will in turn help in understanding how this event managed to have the significant effect on society that it did.

5.1 Hypocenter

The hypocenter of an earthquake is comprised of two different factors. The first is the epicenter, which gives the latitude and longitude of the center of the earthquake. The second is the depth of the epicenter of an earthquake, these characteristics define the hypocenter of the earthquake

5.1.1 Location

The united States Geological Survey (USGS) Earthquake bulletin originally reported the 9–21–99 earthquake had an epicenter located near the center of the island of Taiwan in Nantou County at 23.78N 121.09E.[1] This conflicts with the report by the Central Weather Bureau of Taiwan (CWB), which states that the epicenter was located at 23.85N 120.81E. Nonetheless the epicenter was just outside of a small village named Chi–Chi. For this reason the earthquake is often referred to as the Chi–Chi earthquake. Chi–Chi is roughly 12.5 kilometer south–west of Sun–Moon Lake, a

[1] USGS, National Earthquake Information Center, Earthquake bulletin, http://earthquake.usgs.gov/neis/bulletin/99_EVENTS/990920174719/990920174719.HTML

popular tourist attraction in Taiwan, or about 160 kilometers (100 miles) South–South–West of the capital city of Taipei.

Nantou County is the only county in Taiwan that does not have any coastal borders. Nantou County makes up 410 square kilometers of Taiwan's total area of 32,260 square kilometers. Most of the land in this County is mountainous, and has an abundant amount of forestry, and natural beauty. There are many parks and other naturally beautiful sites to be seen, which account for much of the tourism in the area. Nantou encompasses Sun Moon Lake, the countries largest natural lake, and a very significant tourist attraction. Nantou County's overall income is based mainly on the business that tourism brings in. It has many hotels along all of the main streets, and many shops directed at tourists. If not for tourism of the area, the local income would

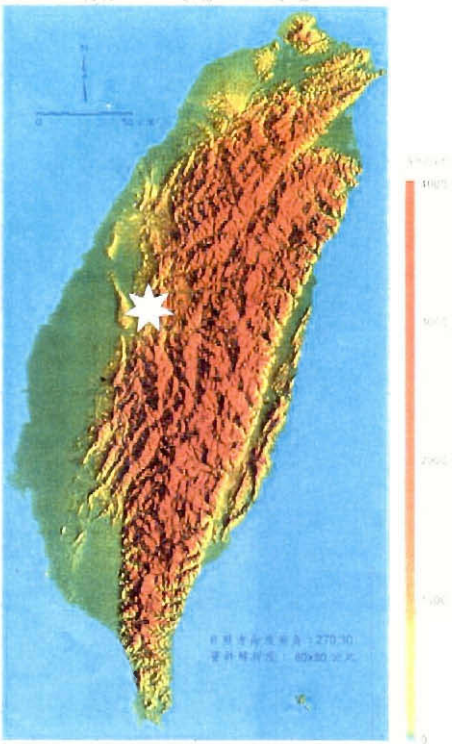


Figure 5.1

A map of the island of Taiwan with the epicenter of the 9–21 Chi–Chi earthquake marked with a large white star.

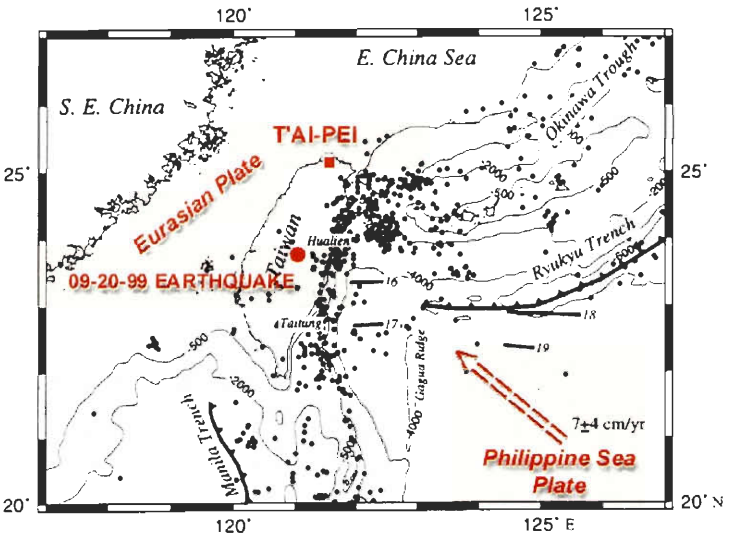


Figure 5.2

Earthquakes with magnitude greater than or equal to 5.0, occurring between 1964 and 1995 Most large earthquakes are located east of Taiwan and have caused minimal damage. This situation is unlike the September 20 1999 earthquake and aftershocks, which are located in the central part of the island.

be very small. Thankfully, however, the tourist industry lasts nearly year round in Nantou County due to the temperate climate. Unfortunately the Chi–Chi earthquake hit the tourism industry very hard.

Most of Taiwan's earthquakes are located off its eastern coast and cause very little damage but often create a risk of tsunamis, depending on the magnitude and distance from the island. The Chi–Chi earthquake was located near the geographical center of the island and therefore created a minimal risk of a tsunami, but caused high risk in the population centers of Taiwan due to destruction of infrastructure.

5.1.2 Depth

There are also conflicting reports on the location of the hypocenter[2]. USGS reports the hypocenter as 33 kilometers below the surface while the CWB reports the depth as only 6.99 kilometers. The shallower the earth quake the greater its intensity[3]. The local measurement for the depth better fits the intensity of the Chi–Chi earthquake.

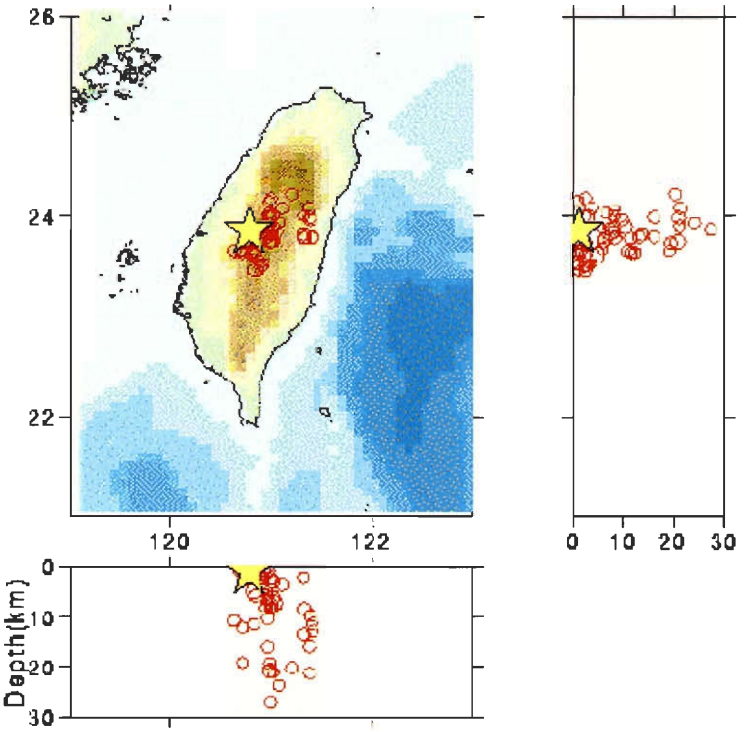


Figure 5.3

The hypocenters and epicenters of the Chi–Chi Earthquake and aftershocks

[2] The hypocenter of an earthquake is the actual three-dimensional center point. The epicenter of an earthquake is the point on the surface of the earth directly above the hypocenter.
[3] Intensity is a measurement of the effects of an earthquake on humans and structures at a particular location. It is measured in numerical units on the modified Mercalli scale.

5.2 Magnitude

The official CWB report states that the Chi–Chi earthquake had a magnitude of 7.3 on the Richter scale[4]. The Earthquake bulletin given by USGS rates the Chi–Chi earthquake as a 7.6 on the Richter scale. Taiwan has received several major earthquakes over the last century but because of their locations most of them caused little or no damage.

Table 5.1

The following table shows magnitude 7.0 and greater earthquakes that are located in the *zone 22.0-25.0 deg N by 120.0-122.5 deg E. This zone closely bounds Taiwan.*

Year	Month	Day	Origin Time	Latitude	Longitude	Focal Depth	Magnitude
1906	3	16	22:42	23.6	120.5	Unknown	7.1
1920	6	5	4:21	23.5	122.0	10	8.3
1922	9	1	19:16	24.5	122.0	60	7.6
1935	4	20	22:01	24.2	120.8	Unknown	7.1
1936	8	22	6:51	22.3	120.8	Unknown	7.3
1941	12	16	19:19	23.4	120.4	Unknown	7.1
1951	10	22	3:29	23.7	121.2	Unknown	7.1
1951	11	24	18:50	23.0	122.5	Unknown	7.3
1957	2	23	20:26	23.0	122.0	69	7.1
1963	2	13	8:50	24.5	122.1	47	7.3
1967	10	25	0:59	24.5	122.2	63	7.0
1972	1	4	3:16	22.5	122.1	6	7.6
1972	1	25	3:41	23.1	122.1	34	7.7
1972	4	24	9:57	23.6	121.6	33	7.2
1978	7	23	14:42	22.28	121.51	17	7.4
1978	12	23	11:23	23.25	122.07	33	7.2
1986	11	14	21:20	23.9	121.57	33	7.8
1999	9	20	17:47	23.78	121.09	5	7.6

5.3 Type

The Chi–Chi earthquake was a subduction-thrust earthquake. The two intersecting plates that caused this earthquake were the Philippine Sea and Eurasian plates. These two plates intersect running north–south through Taiwan. A subduction-thrust

earthquake occurs when two plates collide and one plate is of a greater weight. The heaver plate is forced down, while the lighter plate moves parallel to the earth's surface, onto the side of the heavier plate.

In this case the Philippine Sea Plate is the heavier of the two, so it is the one being forced down. These two plates are in constant motion with respect to each other. This constant movement causes stresses to build up in the plates. When this stress becomes too great for the soil to resist either a previously existing fault will slip, or a new fault will develop within the plate. In either case, the result is an earthquake. In the Chi–Chi earthquake the fault affected was the Chelungpu fault in the Eurasian Plate. The slipping of the plate caused an upward movement of the Eurasian plate.

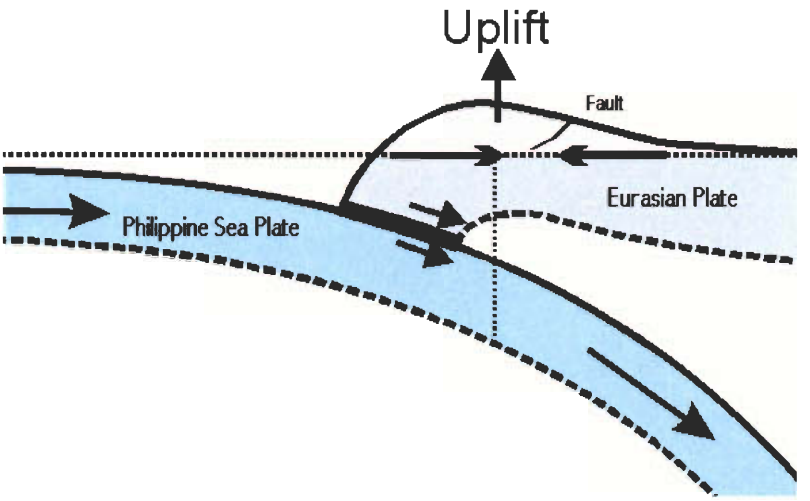


Figure 5.4

At the Philippine Sea plate and the Eurasian Plate intersection the Philippine Sea plate is forced beneath the Eurasian plate.

5.4 Intensity

The Chi-Chi earthquake was reported within two minutes of its occurrence. This was due to the Taiwan Rapid Earthquake Information System operated by CWBSN (Wu et al.), which included the location, magnitude, and intensity distribution within the report. Because the information on the report came out so fast, the government was able to take emergency response action very soon after the earthquake.

[4] The Richter scale is used to measure the energy released by an earthquake. For every increase of one on the scale, the energy released increases by 32 times.

The Peak Ground Acceleration (PGA) is used to measure the acceleration over time of the amplitude of the shock waves given off at the epicenter of the earthquake. The peak ground acceleration is the point with the greatest magnitude on the acceleration vs. time graph in the vertical, North-South, and East-West directions. The PGA of the Chi-Chi earthquake was over 1g. The PGA to the East of the Chelungpu fault was 0.5g, and PGA values over 0. 25g were reported by hundreds of measuring stations all over the island. This is a very significant distribution of PGA recordings, and resulted in damages all over the island.

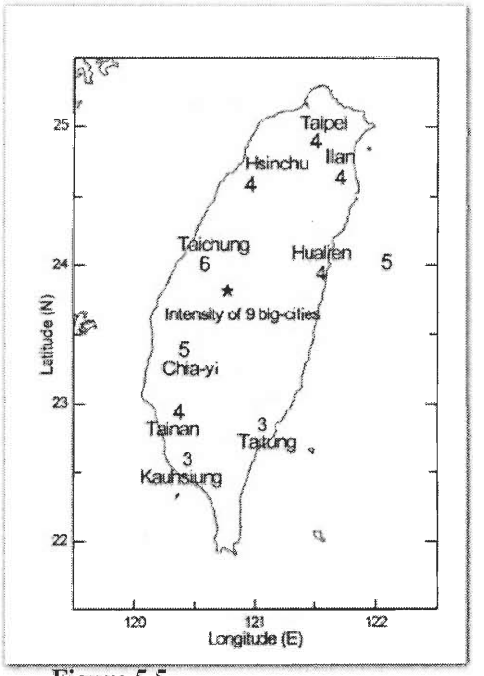


Figure 5.5
Intensity of the Chi–Chi earthquake for large cities in Taiwan

It is also relevant to note that the areas with the greatest surface faulting had lower PGA's than the areas with less surface faulting. The land in the northern end of the fault, for instance, had a surface fault displacement of as much as 8 meters, but had a much lower PGA than the land in the South, which had a significantly smaller surface fault displacement. A possible reason for this is that the vertical movements in the North were fairly slow and smooth, which reduced the shaking. The information gathered by the Taiwan Strong Motion Network supports this theory.

5.5 Fault Line Information

The Chelungpu fault is part of a fault system that has been developing over the last two million years. The Chelungpu fault itself did not develop until approximately 500,000 years ago. Most geologists consider the entire region an active faulting relation.

There was surface faulting for nearly 60 km along the north-south length of the fault beginning around Churhan in Nantou County, and going as far North as Fengyuen in Taichung County. The faulting appeared to be generally 1-8 meters of displacement of thrust. Based on this earthquake and previous seismic work done, it is estimated that the dip of the fault is approximately 25-30 degrees.

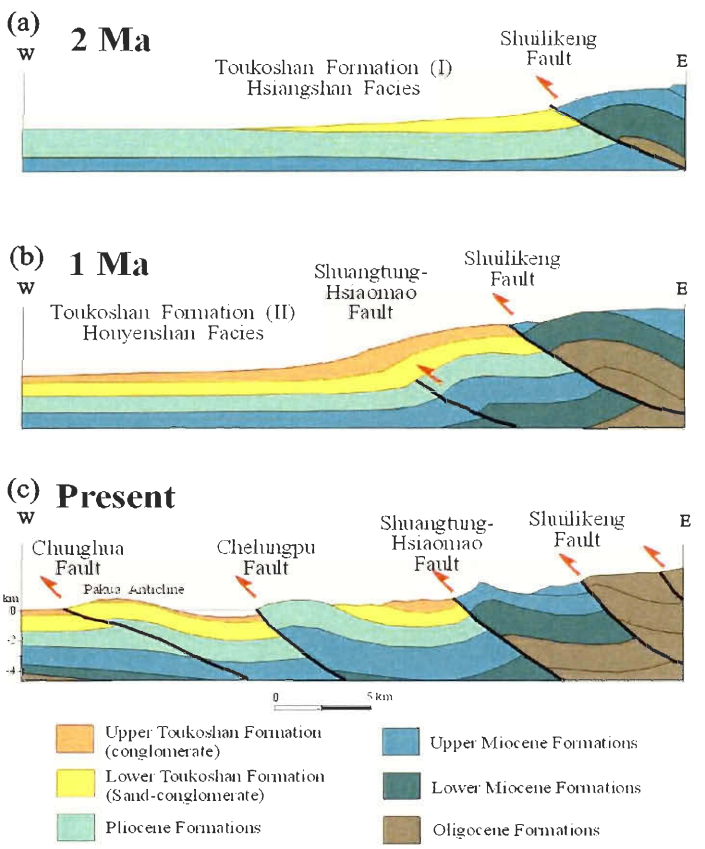


Figure 5.6

The evolution of the thrust fronts in the foothills and the relationship between erosion, sedimentation and tectonics.

In the Northern end of the surface rupture the faulting of Chelongpu disturbed other smaller faults nearby for about 15 km. In this area there was a vertical displacement of 4-8 meters, and lateral offset of 1-9 metes. The displacements of these magnitudes occurred on several short faults parallel to one another. This vertical displacement is in the class of the largest surface fault movements for earthquakes all over the world.

5.5.1 Location (Map)

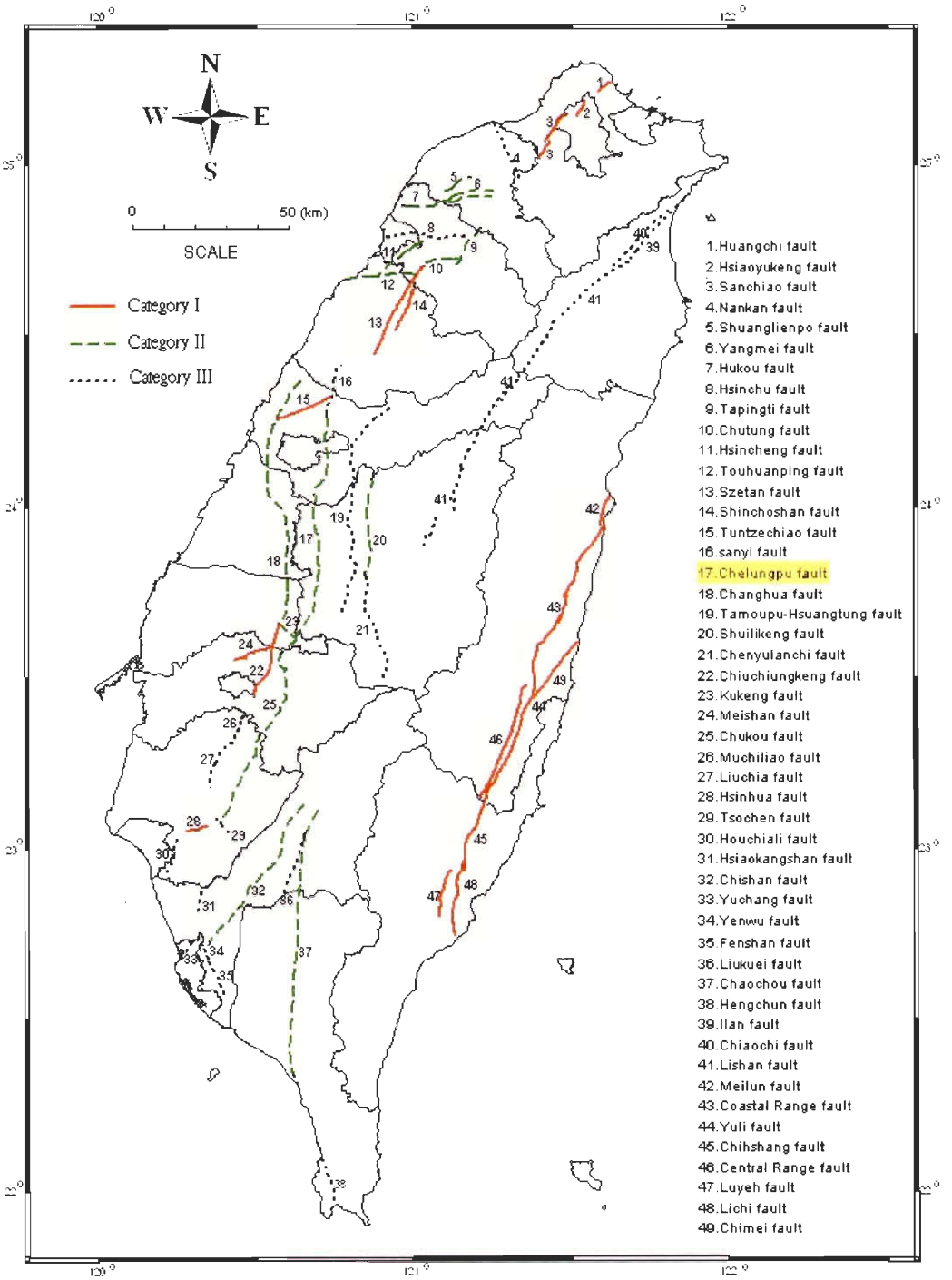


Figure 5.7

The location of the Chelungpu fault as well as other active faults in Taiwan

5.5.2 Surface Movements

The active faulting caused a three dimensional shift in the surface of the earth. This shift has serious repercussions because the central surveying benchmark moved over three meters, which means that the entire island must be resurveyed. This will cause a large number of land disputes until the resurveying is complete or a systematic solution is found.

One such solution, utilized by the Japanese, simply relocates all land proportionally to the shift in the surveying benchmark. This does not mean that the resurveying is no longer necessary but it does eliminate the legal problems.

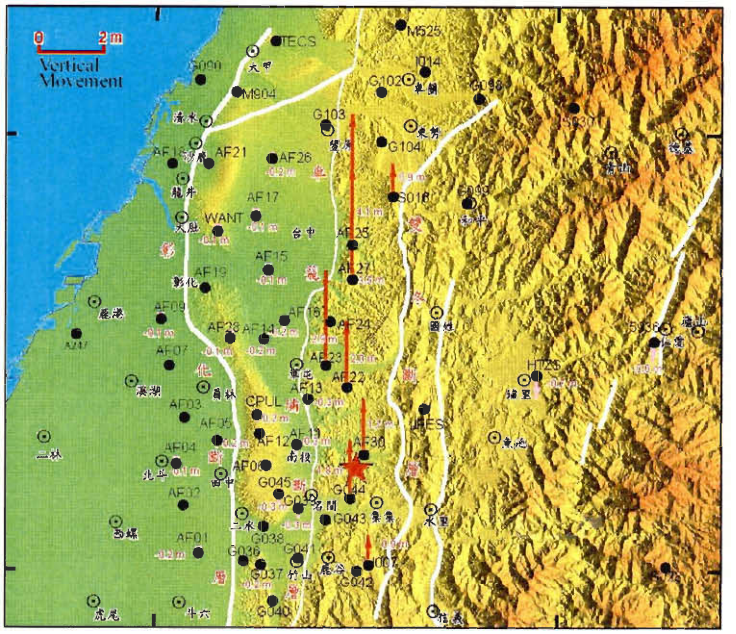


Figure5.8

The vertical displacement around the Chelungpu fault

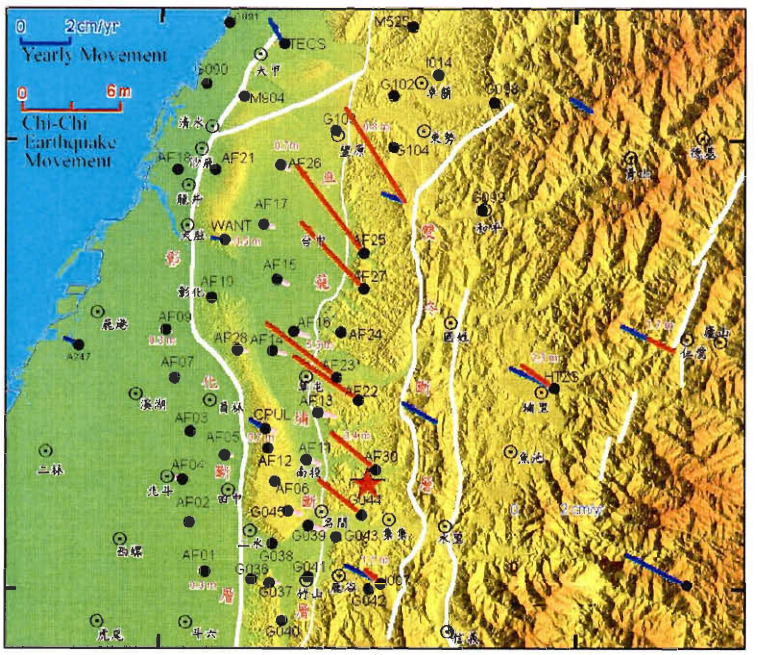


Figure 5.9

The horizontal displacement around the Chelungpu fault

5.6 After shocks Information

The Chi–Chi earthquake was followed by thousands of aftershocks. As of 9–30–99 there were 12 aftershocks of magnitude greater than 5.5. The largest of these had a magnitude of 6.8 and caused considerable damage in its own right. It is very difficult to get a definite count of the number of aftershocks, as there is still considerable dispute about which tremors were aftershocks and which were earthquakes in their own right.

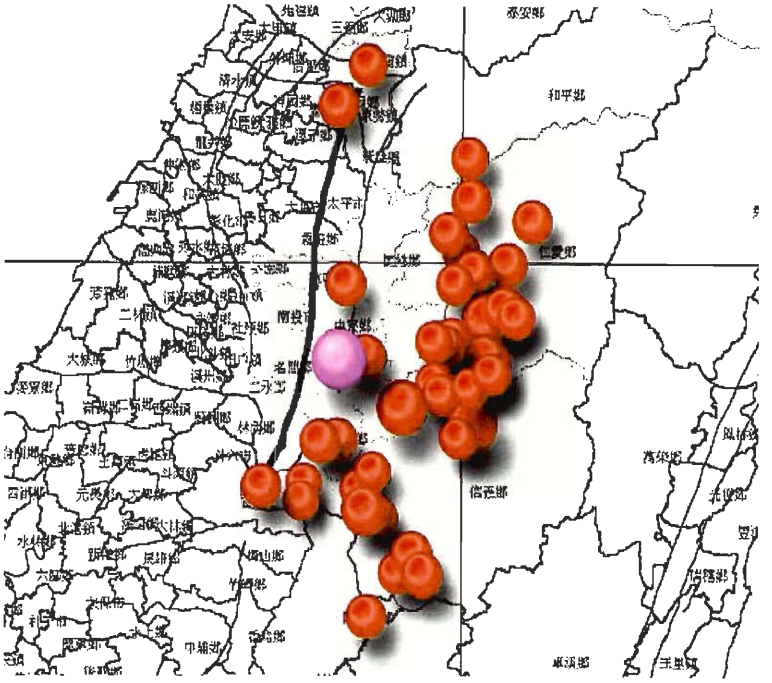


Figure 5.10

Aftershocks from the Chi–Chi earthquake with the main quake marked in purple. The relative size of the spheres represents the relative magnitudes of the quakes

5.7 Liquefaction

Liquefaction is a powerful side effect of earthquakes. It occurs when soil takes on liquid properties due to the presence and effects of water. It happens during earthquakes because the shaking of the ground can disturb the state of equilibrium that it previously held. As a result of liquefaction the soil acting with liquid properties moves, leaving the ground above it without support, causing the ground to collapse.

Professor T. H. Ueng of National Taiwan University recently wrote a report on the effects of liquefaction because of the Chi-Chi earthquake. It compiles the results of surveys done in the areas that were affected by liquefaction. The goal of this report was to learn as much as possible from the evidence that the disaster left behind. It studied the liquefied soil that rose to the surface, and the relationships of all the soil

present, and the damage that it caused to buildings, bridges, roads, retaining walls and riverbanks. The goal is to learn how to better predict and prepare for liquefaction. The biggest problem for scientists in this study is time because the weather is destroying what evidence was left behind.

It is known that the shaking of the ground and an accumulation of excess pore pressure[5] are the causes of liquefaction in an earthquake. The damages that can result include the destruction of buildings, the overturning of structures and roads and the

Figure 5.11

The affects of liquefaction were made visible in the Chi–Chi Earthquake at Taichung Harbor.

formation of cracks in structures and roads, and the lateral and horizontal movements of the land. The results of the surveys done made several observations. First, the results were the most noticeable in areas with a high density of buildings present. The second major factor noticed was that the areas nearest to large bodies of water were severely affected by liquefaction.

The immediate goal of the research is to learn what types of areas and soils are most affected by liquefaction. In the long term it is hoped that scientists will be able to tell which areas are most likely to suffer from the effects of liquefaction. It is hoped that with the aid of zoning, and improved awareness during the designing period of a structure the damages caused by liquefaction will be minimized. This research will also help to re-evaluate the effectiveness of building codes in Taiwan and help create changes to better reflect the awareness of the scientific community.

[5] Excess pore pressure is when underground water pressure exceeds the force generated by the mass of the soil above. This results in upward movement of the soil

5.8 Damages

The Chi-Chi earthquake was the second most devastating earthquake to hit Taiwan this century. The last major earthquake to hit Taiwan occurred in 1935 and had a magnitude of 7.4 killing 3,276 people. A total of 2,405 deaths and 10,718 injuries are attributed to the Chi–Chi earthquake. About ten percent of these injuries required hospitalization.

Table 5.2

Taiwan Earthquake of September 21, 1999 (Ministry of the Interior Report of 10/2/99 10:00am) the casualties and housing damage cause by the 9–21 earthquake by city and county.

City/County Area	People Rescued	People Buried Under Rubble	People Evacuated Via Temporary Road	Injured	Missing	Deaths	Multi-Family Buildings Destroyed	Houses Destroyed	Multi-Family Buildings Damaged	Houses Damaged
Taipai City	149			316	22	71	3		20	
Hsinchu City				4		2	5			
Taichung City	155			1112		113	496		516	
Chiayi City	14			11			1			
Taipei County	192			145	7	39	1		2	
Taoyuan County				84		3	9		2	
Hsinchu County				4			2		1	
Miaoli County	34			196		6	136		221	
Nantou County	2144	24	912	2421	10	889	19320		19281	
Taichung County	1402	4	1992	5602	8	1170	6528		4062	
Changhua County	286			387		29	29		106	
Yunlin County	628		454	423		80	256		250	
Chiayi County			1327	5	4	2	40		33	
Tainan County				1		1			1	
Ilan County				7			5			
Total	5004	28	4685	10718	51	2405	26831	31534	24495	25506

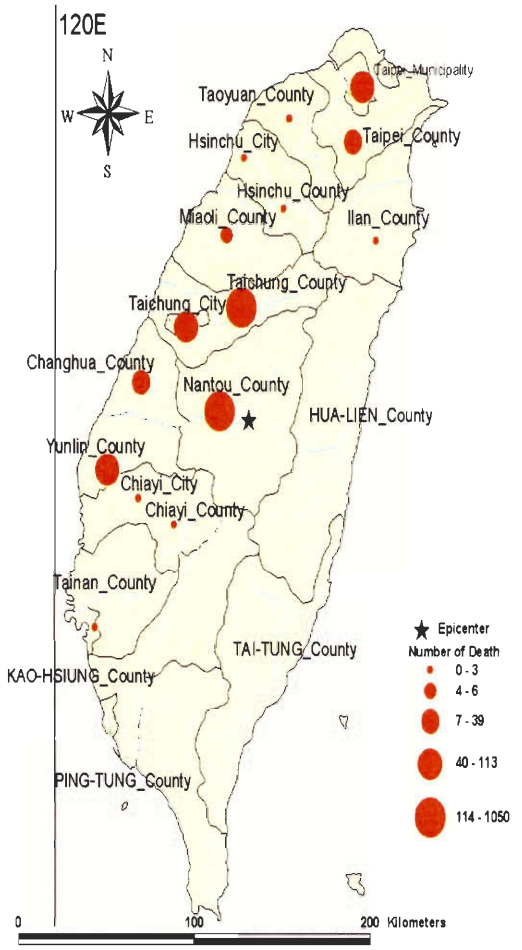


Figure 5.12

This image gives a visual representation to the distribution of deaths in the Counties and major cities of Taiwan.

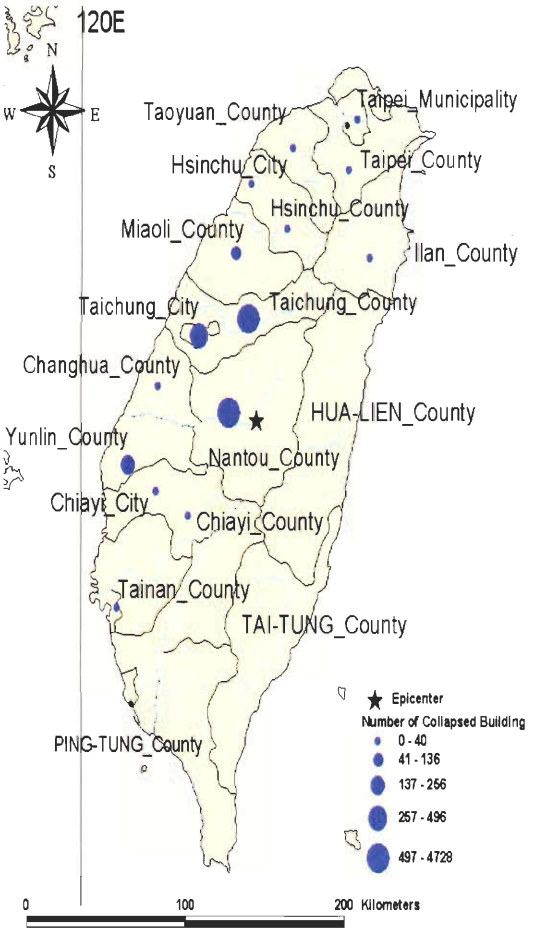


Figure 5.13

This image gives a visual representation to the distribution of collapsed buildings in the Counties and major cities of Taiwan.

Most of the fatalities occurred in two jurisdictions: Taichung County and Nantou County. These areas account for 85% of all injuries and 90% of the fatalities. The distribution of damaged buildings follows a similar pattern as would be expected as the damage and fatalities are greatest near the epicenter. Table 5.1 on the previous page shows the distribution of fatalities and damaged buildings.

It is easy to get detached from the magnitude of this earthquake just by looking at technical data. In order to compensate for this the following pictures were added to give the reader an impression of the powerful nature of the earthquake.

Figure 5.14

A major shipping dock in Taichung harbor was severely damaged due to liquefaction during the earthquake. The soil lost its strength and as a liquid, caused the actual dock to rise, while huge sinkholes formed throughout the entire area. The shipping dock was a major source of income for the local population. The port was a significant location in the trading of molasses, the tanks for which can be seen on the right of the picture. The cost of returning the harbor to an operational state will cost a significant amount of money. Businesses will also be losing money everyday that the harbor is out of commission due to lost revenues

Figure 5.15

A power station in Chong Liao was damaged, subsequently causing major power outages throughout Northern Taiwan. This is what caused much of the economic damage since most major factories suffered little damage but could not continue production without power. The fault line runs directly through this power station.

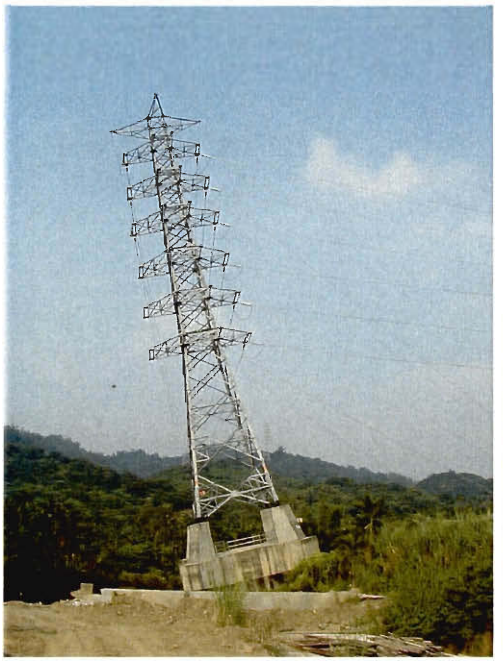


Figure 5.16

The force of the earthquake is evident here along the fault line. This high–tension wire tower extends 27 meters into the ground, almost as low as it is high. Luckily enough, this tower was able to remain in operation

Figure 5.17

This piece of railway was destroyed in the earthquake. This damage is two fold as the line that uses this set of railway was a tourist attraction that connected several hotels on a scenic tour of the area.

Figure 5.18

The Yi–Gain Bridge was built before the building codes were revised to make structures better able to withstand earthquakes. While a new permanent bridge is constructed, a temporary bridge has been erected.

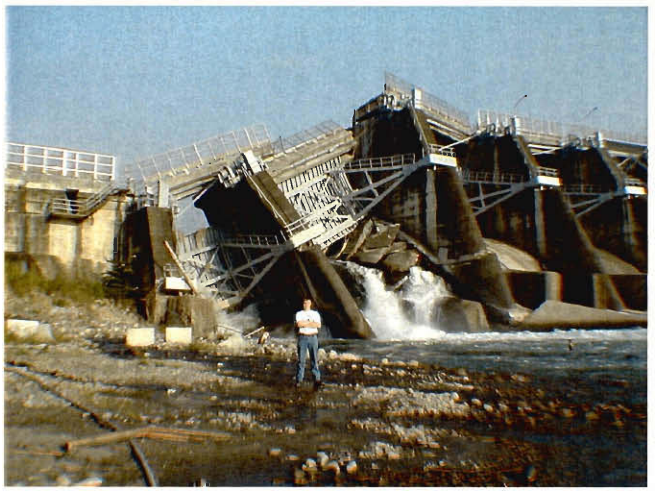


Figure 5.19

The Shi Kung Dam lies directly in the path of the fault line. This is where some of the greatest upward thrusts were found. The change in elevation here is about eight meters.

Figure 5.20

Kung Fu Jr. High School, a school along the fault line. The upward thrust is easily seen in the field and along the track. Some of the buildings on this school campus were damaged beyond use. The school does still have classes though; it has just been forced to adjust and make do with what was left behind by the earthquake.

Figure 5.21

Both buildings at the Kung Fu Jr. High School once looked much alike. The building on the right once was three stories, now it is roughly three feet high. If this had happened during the day, many children would have lost their lives here.

Figure 5.22

The removal of fallen buildings continued over two months after the earthquake. It is hard to imagine that the rubble on the right used to be somebody's home. It was in many such fallen buildings that many lives were lost in the areas nearest to the epicenter.

Figure 5.23

This ruin was once a bank. Now former employees quickly recover bank records that were once buried under tons of rubble.

Figure 5.24

There were over 20,000 people who were left homeless with nowhere to go. The problems with settling back soon are numerous. Many people, who have lost their homes, do not want to leave their home neighborhoods to available housing in other cities so they continue to live in tents for the meantime.

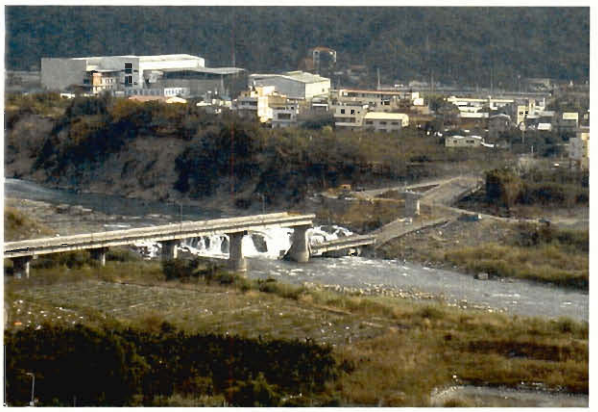


Figure 5.25

The Bei Fon Bridge is also along the fault line downstream of the Shi Kung Dam. The upward thrust of the fault caused a beautiful waterfall to form, collapsing a large portion of the bridge in the meantime.

Figure 5.26

The size of the Tsao Ling Landslide is almost incomprehensible. 350 million cubic meters of dirt and rock moved up to four kilometers, blocking a river and moving a house nearly the whole four kilometers in the process. The tan colored mountains in the far center of the photograph is where the landslide started and it continued at least a kilometer behind where the picture was taken.

Figure 5.27

Two views of the Tsao Ling landslide; the hole in the right is where workers searched for the bodies of victims. Dogs were used to search the entire landslide for missing persons, this is just one of such sites.

Figure 5.28

The condition of this vehicle gives one an idea of how powerful the landslide really was. There were visible pieces of houses throughout the area though not even remotely resembling what the structures once were.

Figure 5.29

The Town of Chi–Chi was the location of the epicenter of the 9–21 earthquake. It suffered severe damages, which left many people homeless and jobless. Many people were forced to live in temporary tent housing grounds. The Chi–Chi railroad station (partially seen here) was put out of commission by the quake. This station is a culturally historic site that was built by the Japanese when they occupied Taiwan.

5.9 General Information

On Tuesday morning of September 21st an earthquake measuring 7.6 on the Richter scale hit central Taiwan, near the town of Chi–Chi in Nantou County at 1:47am (1:47pm EDT). Buildings in at least 19 cities and counties suffered damages, many collapsing due to poor construction. At least 2,101 people lost their lives to the quake and 8713 were injured. This has been the worst earthquake to hit Taiwan since 1935 when a 7.4 Richter scale earthquake hit, killing 3,276 people. Although only five to ten earthquakes greater than 7.0 are recorded per year they rarely hit heavily populated areas such as Taiwan.

Damages to the infrastructure include heavy damage to the Jung Liau electric power substation causing power outages across the island. The Shrgang Dam, which provides water to Taiwan's third largest city, Taichung, was destroyed due to ground failure. The river port facilities in Taichung suffered much damage also. At least 600 road interruptions have been reported. 400,000 or 36%, of homes in the central parts of Taiwan lost their safe or reliable water supplies. Over 31,000 homes have been destroyed, while many others have suffered major damage.

An 80-kilometer surface rupture along the Chelung Pu fault ripped through the island with vertical uplifts of up to 8 meters. This fault is caused by the collision of the Eurasian and the Philippine plates. This type of fault is formed when the pressure from below pushes one plate up while the other plate drops below. This type of fault causes the energy to be focused upward, causing widespread damage.

Officials have warned of another potential problem; mudslides. Cooler temperatures and heavy rains could cause mudslides and landslides adding to the difficulty of rebuilding the infrastructure of the island and posing a threat to anyone in its path. Landslides have also blocked waterways, creating new reservoirs that could

become dangerous if the natural damn were eroded. One landslide has also completely buried a village, under up to 100meters of dirt and mud in certain areas.

Chapter 6

Impact on society

It is beyond argument that the Chi-Chi Earthquake raised emotions and reactions in Taiwan's society. The only thing in question is how the effects of the quake were visible. To answer this the quakes impact on society has been divided into three subsections to be discussed independently. It is the shared feelings of the authors that Taiwan's economy, politics, and personal lives are the three areas of society that were most significantly affected by the 9-21 quake.

6.1 Economic Suffering

The economic effects of the 9–21 earthquake will be felt for a long time but hopefully the worst part is over. The earthquake caused a short-term drop in spending. Spending is what keeps an economy moving, when spending drops, so does the economy. An example is the great depression during the 1930's in the United States. The crash of the stock market is not what really caused the economy to fall; it was the lack of spending that occurred afterwards. No money was ever lost, just distributed differently. People lost faith in the economy to provide them with the money they needed when they needed it. When people stop trusting the economic system they save their money rather than investing it. This causes a chain reaction, which can cause a recession or even a depression. Money is the blood of the

Figure 6.1

This twelve-story apartment building fell to its side as a result of the earthquake. The owner of this building has not only lost property; he has also lost the revenue that he would have made from tenants living in his building.

economy, when money stops circulating, the economy starts to die.

Taiwan's GDP is about US$297 billion. Private consumption, which accounts for 62% of Taiwan's gross domestic product (GDP), dropped by US$1 billion a month after the earthquake. This means that the earthquake only caused a 0.54% drop in private consumption and subsequently a 0.34% drop in the GDP due to this decrease. This is a significant fact because private consumption is a good indicator of people's feelings on the stability of the economy.

An infrastructure is needed to supply an economy with the means to operate. This may include roads, bridges, railways, airports, shipping ports, electric power, internet connectivity and just about any physical thing that is used to support the exchange of money and goods. The physical damage to the infrastructure due to the 9–21 earthquake amounted to US$11 billion and indirectly caused losses of US$9.42 billion because of its effects on personal incomes.

One major part of the infrastructure that was severely crippled was the power industry, which was not prepared for such a disaster. What should have been just a damaged substation and a temporary blackout caused a chain reaction, which forced the power industry to ration power for the northern part of the island for three weeks following the quake.

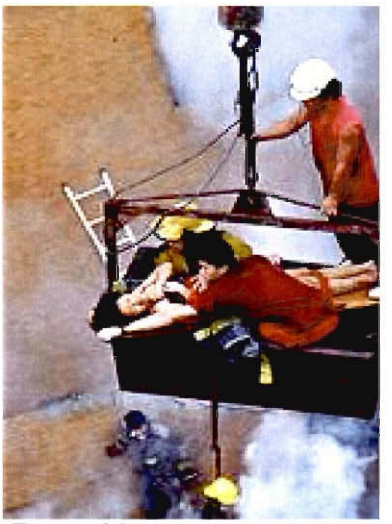


Figure 6.2

Amid the ruins of a Taipei building, rescuers battled successfully to save a trapped woman. Others were less lucky.

The area north of Taichung County lost power when a 345 kV substation in Chungliao collapsed. The First and Second nuclear power plants at Chinshan and Kuosheng went off-line when the power failed. The Third Nuclear Power Plant near Kenting

did not fail, but the power it produced could not be transmitted to the northern part of the island. The Peisan, Takuan and Mingtan hydroelectric power plants near the epicenter were rendered inoperable by the quake. Taipower implemented power rationing in the northern part of the island and diverted the unused power to the Hsinchu science park so that wafer fabrication could be continued. The government estimates financial losses at the Hsinchu science park at US$1.7 billion. The semiconductor industry estimates losses at US$3.3 billion. There were no reports of damage by the independent power plants at Hsinchu Science-based Industrial Park and Mailiao power plant.

Taiwan is dependent on electronic devices for just about every aspect of daily life. Without electric power the economy will almost come to a halt. This is what nearly happened during the first few days after the earthquake. The stock exchanges were closed for several days afterwards and there was power rationing throughout the northern half of the island, meaning different areas in the northern section of the island would receive power for only a limited amount of time per day. Different areas received more power than other based upon priority. Examples of areas receiving priority are government offices, hospitals, and major manufacturing areas.

Manufacturing, which is a major contributor to Taiwan's economy, could only operate during the hours that it received power. For this reason many of Taiwan's manufacturing companies received power within days of the earthquake because the sooner they were back online and at full production, the easier it would be to get the overall economy back on it's feet. Taiwan's infrastructure was operating at close to normal levels within two months of the quake but there are areas that felt the effects of the quake for a much longer time.

The earthquake caused many people to lose their jobs. The Council for Economic Planning and Development (CEPD) estimated that there was a 60% unemployment rate in Nantou and a 30% unemployment rate in Taichung County immediately following the earthquake, these were the two most heavily affected areas in Taiwan. The CEPD predicted that the unemployment rate would not drop below 3% again before the end of the year. The earthquake had only small long-term effects on this rate, since the area affected by the earthquake was not a major center for manufacturing or service industries. Some of the smaller industries were damaged in one way or another. The food industry had total losses amounting to US$4.44 million. The textile industry endured US$21.38 million in loses, the plastics industry had US$11.94 million in losses and the chemical industry endured US$10.94 million in losses.

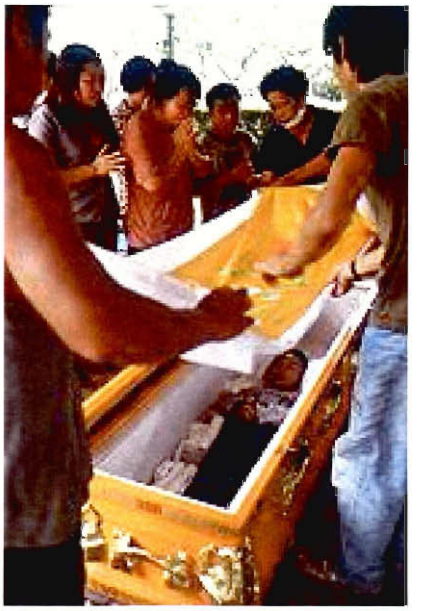


Figure 6.3

A mother and her family mourn the death of her young son.

Another industry to suffer immediate and long lasting damage was the tourism industry. The quake cost the industry roughly US$ 32.3 million. About two thirds of Taiwan's popular tourist attractions are in areas severely affected by the earthquake. A few examples are Sun Moon Lake, Ali Mountain, Formosa Aboriginal Cultural Village and many hiking trails throughout the mountains. Roughly 90 % of inbound tours and 20 % of outbound tours were cancelled since the earthquake. The Tourism Bureau estimates that foreign visitors spend about US$3.37 billion in Taiwan each year. Since the earthquake, sales at Taiwan's major theme parks and other recreational areas have dropped by more than 50% compared with earlier periods.

One travel agency owner thinks that it might take three to five years for the industry to return to normal. It is possible that as many as one third of the almost 3,000 travel industries in Taiwan could be put out of business. Disaster tours may help the overall industry but probably won't help the local economy since many of the travel agencies in the highly damaged areas are just branches of larger ones located in Taipei. Many see it as unethical to go to damaged areas to sightsee, they see it as similar to going to a zoo, as if the people in those damaged areas were animals.

Taiwan's manufacturing industry has also taken a hard hit. "*Industries such as electronic products, computers, CD-Rs, printing circuit boards, liquid crystal displays, telecommunication equipment and synthetic fibers, were hardest hit.*" (Deadly Quake Causes Damage of NT$4.1 Billion to Taiwan's Factories) The integrated circuit (IC) fabrication industry has quickly recovered from the earthquake. By the weekend after the earthquake, Taipower decided to give Hsinchu Science Based Industrial Park priority for power so that they could continue production as soon as possible. The Hsinchu Science Based Industrial Park (HSIP) is the center for production of one of Taiwan's most important industries, the fabrication of electronic microchips and circuit boards, and includes 22 separate firms. Sixteen of these firms reported losses due to the earthquake. One of these companies, Taiwan Semiconductor Manufacturing Co. (TSMC) was fully operational after only ten days. They lost about US$32.3 million but their insurance will cover most of it. United Microelectronics Corp. (UMC) had restarted 90% of their equipment six days after the earthquake but still suffered some damage. "*TSMC and UMC are the world's largest and second-largest silicon-wafer foundry providers, respectively.*" (Demand for IC Foundry Service Remains Strong) Both firms reported that demand for their products remained strong. TSMC announced that it would still register record sales for the

year. UMC said that revenue would recover to pre-quake levels by December. For the industry as a whole, it was projected that about 33 million PCs and notebooks would be produced in the fourth quarter, later that estimate dropped to about 30.6 million. One reason Taiwan's IC industry got back on its feet so quickly is that the industry had been growing at an incredible rate. For example, TSMC has posted a 75% rise in revenues and a 190% rise in profits over last year's third quarter, despite the damage from the earthquake. TSMC's revenues have also risen 14% from this year's second quarter.

As power was returned to HSIP, many of Taiwan's IC companies contributed to the relief effort. Taiwan Semiconductor Manufacturing Co. (TSMC) decided to donate US$7 million, US$2 million of which was donated by the employees, this is 20% of their September salary. The money was donated to the Red Cross Society of the Republic of China. United Microelectronics Corp. (UMC) gave a pledge of US$6.5 million and an additional US$3 million from company employees. UMC gave the company donation to the local governments of Nantou and Taichung whereas the employee's donation was distributed throughout the island. VIA Technologies Inc gave a US$1.8 million donation to local churches.

Figure 6.4

A toppled hotel in the Sungshan area of Taipei; rescue efforts were underway within hours of its collapse.

The insurance industry was also affected by the earthquake but in quite a different way. The earthquake cost life insurers US$80.6 million to fill the 2,280 earthquake related claims according to the

life Insurance Association of the Republic of China as of the third week in October, this figure is likely to grow. Non-life insurance claims are expected to rise as far as US$677 million and while 90% of this will be transferred to foreign reinsurance companies, US$67.7 million is still a heavy blow to the local non-life insurers. Alianze President General Insurance estimated that property damages could reach as high as US$3.23 billion and insured losses would account for 25% of this total. Only about 1% of the households in Taiwan had supplementary earthquake coverage. The standard premium in Taiwan for quake insurance is US$35.5 to US$187 for every US$32,300 of coverage. The rate varies depending on the location and number of floors in the home. In addition, quake policies are combined with fire coverage. Fire insurance costs were around US$18 per US$32,300 of coverage. Since the quake, many people looked to buy earthquake insurance policies but were turned down. The insurance agencies usually purchase reinsurance policies from larger firms that allow a limited amount of policies to be provided, and that number was reached by many of the older well-known firms. If these insurance agencies wish to provide more insurance, they would have to pay higher prices. The newer firms on the other hand were able to give out more policies so the situation is in their favor. The insurance companies would re-negotiate their contracts with the reinsurance companies near the end of 1999. Therefore by the year 2000 there should be no shortage of policies from most if not all of the major insurance companies.

The Steel and Cement industries did very well as a result of the earthquake. These industries are some of the few that did better after the quake than before the quake. Before the earthquake, there was a surplus of housing so there had been little demand for steel or cement. The increase in demand for new buildings helped to revitalize the steel and cement industries. The building and construction industry did not fair well,

much of the surplus housing was destroyed causing losses amounting to US$12.53 million. This problem would prove to be a problem for banks too. The money used to build many of those buildings was borrowed and that meant an increase in bad loans.

The banking industry took a hard hit because of the earthquake. Earthquake related bad loans reached US$2 billion; this is enough to add another 0.6 percent to the bad loan ratio, confirming the worst predictions of industry analysts. This was another string of bad news since the banking industry went on a constant slide since the outbreak of the Asian financial crises. A good portion of the bad loans was from unpaid mortgages from houses that were destroyed by the quake. How this would be dealt with was still under some debate months after the earthquake. Some said that the government should take the burden. One way to do this would be to eliminate the business tax, it had already been lowered down to 2% from 5% but the banks wanted more. Another way would be for the government to subsidize the banks to compensate them for all of the lost loans but neither idea got support. The banks said that if they were left to endure all the bad loans it might result in another financial crisis in Taiwan. Others said that the banking industry would be able to survive fine and should stop complaining. The reduction of the business tax increased bank profits by roughly US$4.2 billion, which is enough to cover the US$2 billion in lost loans due to the earthquake. One problem was that these statistics take the whole banking industry of Taiwan into account and

Figure 6.5

A man is lowered from a collapsed building on a backboard.

not every bank suffered the same. The banks that covered much of the damaged areas could be in much more trouble than those that covered areas with little damage. A suggestion put foreword by the banks is that they would take over bad housing loans and debts that meet four conditions.

These four conditions were: they have to be loans for destroyed buildings, not land; only non-commercial buildings or apartments are eligible; homeowners must plan on building on their original sites; and only loans and debts longer than seven years will be included in the program. The Ministry of Finance considers the banks' proposal to be acceptable. This would allow quake victims who owned houses to discuss mortgage matters directly with the banks and will greatly decrease the amount and subsequently the cost of lawsuits against those who cannot pay their mortgage right away. This would also prevent the judicial system from having to deal with the possibly overwhelming number of lawsuits, which it was not meant to deal with at once. This plan could cause a possible future clash between the Council of Economic Planning and Development (CEPD) and the banks over the issue of urban renewal. "*Once the problem of housing loans and debts is solved between the banks and qualified quake victims, the victims would naturally want to rebuild their homes immediately, instead of waiting for the CEPD to finish it's urban renewal design.*" (Sun)

Figure 6.6

Taiwanese army personnel remove rubble trapping people inside a collapsed home in Puli.

Another broader problem was how the government would finance the rest of the debts it created by offering relief to the victims of the quake. The government offered US$32,300 for each death to his or her respective families and US$1,610 for each injured person. Many think that this should be the other way around, giving the greater amount to the injured persons since they would most likely still have a long life to live, but that would not have been possible, the bill would have been US$360 million as compared to US$97.6 million to do this. The government started a "Jobs For Relief" program to provide those who have been left unemployed by the quake with a source for income (US$17.50 per day) while contributing to the reconstruction effort. The bill for this will amount to between four and ten million USD. The Directorate General of Budget, Accounting, and Statistics (DGBAS) estimated:

> "[The] total government reconstruction expenditure would amount to [US$4.3 billion]. … This figure includes [US$1.9billion] for social welfare and subsidies, [US$1.2 billion] for school demolition and reconstruction, [US$532 million] for traffic and water-supply infrastructure restoration, [US$258 million] for disease control and sanitation, [US$226 million] for transportation, and [US$48.4 million] for natural environment protection." (Sun)

The Council for Economic Planning and Development hoped that the reconstruction bill would not exceed their estimate of roughly US$5.1 billion. So where does this money come from? Eventually it had to come from taxes. The real question was how.

Figure 6.7

This woman is in mourning for the death from the earthquake

There were four major ways that the money can be raised: increasing taxes directly, issuing government bonds, printing more bank notes and letting loose the inflation rate or postponing current projects to address the critical situation. The direct raise in taxes would not occur since it was an election year and it would be a political death sentence to do so. The government has scraped together US$2.6 billion from bond issues, US$970 million at most from reprioritizing budget spending, and US$32.3 million from the public lottery, that came to US$3.6 billion. The most viable solutions left to cover remaining costs, which would most likely raise the cost of construction rises as it often does, is to look for private funding and creating a special tax. *"...the government clearly cannot afford to meet the expectations it's raised among the public in the past month. The budget deficit is nearly 10 times the previous fiscal year's at more than [US$13 billion]. But it's still more than 4 percent of the GDP; by comparison, members of the European Monetary Union run at around 3 percent...the government's debt has grown in the past two years (from 24 percent to 38 percent of GDP...The cap, mandated by law, is 48 percent.*" (Sun) Many politicians avoided this problem since however they might fix it, someone would not be happy.

There is a light at the end of the tunnel however. All the money that the government spent was being funneled directly into Taiwan's economy. This could cause a short-term deficit in the government's budget but this will not be a long-term problem. The money will eventually make its way back to the government and the overall effect is a stronger economy able to continue to play a major role in the world market. The island's economic growth rate could rise 6.69 percent, a level not recorded since the Asian economic crisis in mid-1997, though this may be offset due to two factors. Some key firms are moving their production lines abroad for fear of

future damages from earthquakes and some experts are predicting a decline in private spending which could deliver a heavy blow to the economy. Overall, the economy has weathered the earthquake rather well.

6.2 Political Aftershocks

It is strange to think that politics play such a large role in place so recently ravaged by natural disaster. Nevertheless, politics got involved with the earthquake within hours of the first shock. In a way it is necessary, wherever people are involved politics are inexorably entangled. It is not the politics that are difficult to understand, it is the politicking, using the suffering of others for political gain. Disaster politics may not be new in Taiwan or even in the political world in general but they are new to the authors, and the more we have learned the less we have approved.

On our third site visit while most of the group we were traveling with were listening to a lecture given in Chinese we went to get a closer look at the collapsed bridge that we had come to see. A temporary bridge had been build next too the ruins, there was little traffic mostly motor scooters and trucks, coming at random intervals to break the quiet of the nearly dry river bed. As we looked at some graffiti that had be etched into the now vertical wall of assault on the collapsed bridge a kind of scratchy amplified voice shouted from somewhere up the road.

The voice got louder as it approached until a garish colored truck appeared around the bend. The four loud speakers on the roof of the truck blared political slogans as the driver drove across the temporary bridge. He did not glance at the ruins to his left or at the workmen that were maintaining temporary construction or even the strange foreigners that had come to study the wreckage. He was on his way to the next village spreading word about one politician or another. Politics took little notice of

how the world had been damaged by the earthquake. They simply changed roads while heading to the same place.

6.2.1 Cross–Straights Relations

As is often the case in modern Taiwan, Mainland China and cross–straight politics have been in the spotlight after the 9–21 earthquake. Because Taiwan is officially a rogue province in the eyes of most of the international community Mainland China, Peoples Republic of China (P.R.C.), had to give its assent before the United Nations could send humanitarian aid. Naturally the United States and most of Europe also waited for the P.R.C.'s permission before sending help. This was a slap in the face for most Taiwanese who either felt that humanitarian aid should not enter into the political realm or felt that P.R.C. was using the publicity gained from the catastrophe to throw "*cheap pro-reunification remark[s]"(*Ta Ya and Shen Hsing Ju). This Politicking during the "*worst disaster since the end of WWII*" (Ibid.) left a bad taste in the mouths of many.

Most of the international community politely offered aid to Taiwan through the mainland. The United States officially sent its aid to "Taiwan, a province of China" even though it called the Taiwanese government to inform them that satellite imagery had shown some thing serious had occurred just a few hours after the quake. In fact one of the reasons that the Taiwan military was able to mobilize so quickly, with the first of the troops arriving on scene within three hours, was because of that phone call. This highlights the interesting, and extremely hypocritical, roll that the United States has played in China–Taiwan relations.

The United States has not recognized the government of Taiwan since the late 70's, but there has been a continuance of trade and even unofficial relations through two supposedly private organizations, Taiwan Economic and Cultural Office (TECO) and American Institute in Taiwan (AIT). An interesting fact about both TECO and AIT is that they are both funded by their respective governments, The United States for AIT and the Republic of China (ROC) for TECO. Not only that, people who worked for the Foreign Service run the offices. They must officially resign from the Foreign Service in order to work for AIT, but they are promptly hired back, with no loss of pay or position as soon as their two-year stint, the same amount of time for a tour in the Foreign Service, ends. In fact they are more than strictly hired back, they are hired at a position as if they had been working for the Foreign Service the entire time they were "away". TECO is not so deceitful as it is simply another branch of the Foreign Service.

The United States Hypocrisy goes even deeper. The United States has repeatedly defended Taiwan from China's aggression by shielding it with the 7th (Pacific) Fleet.

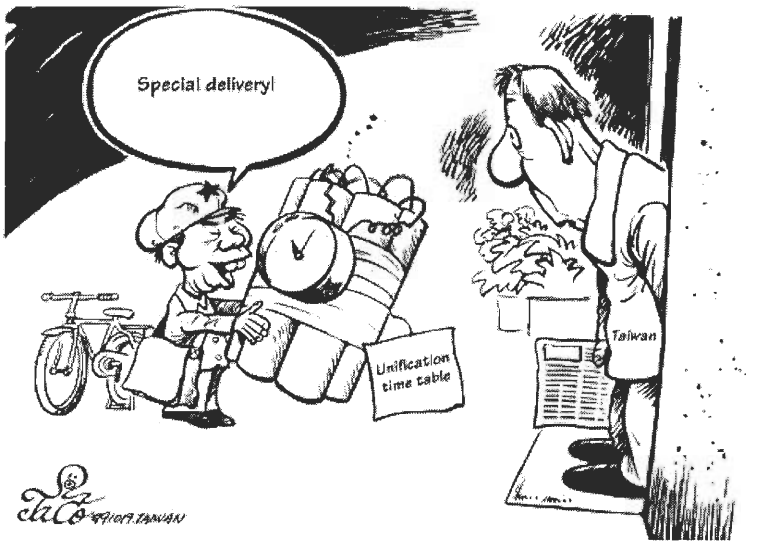


Figure 6.8

China's only offer to Taiwan

According to several treaties the aid will stop if Taiwan ever declares independence. Of course China refuses even to consider a two China, or a China and Taiwan policy, and Taiwan refuses to accept any form of

reunification without a complete democratization of Mainland China. Therefore, both nations are embroiled in an arms race that Taiwan is certain to lose.

Cross-Straight issues are always a struggle for Taiwan as most international debate is dominated by P.R.C. China refuses to accept any comprises short of a One-China policy and is more or less supported by the international community. Unfortunately reunification is not widely accepted in Taiwan. In fact the current president, President Lee Teng-hui, ran successfully on a platform that advocated a state–to–state type of relationship between Taiwan and China. This prompted some very serious sword rattling on the part of China, and as a result much of the pro–separatism seemed to have toned down, with an emphasis on "seems". The Chi–Chi earthquake stirred the pot of public opinion and as usual sentiments lay strongly against P.R.C.

The Taipei Times ran several editorials and letters that vehemently express their distaste for China's behavior in the aftermath of the 9–21 earthquake. Most people believe that neither side of the straight has acted with particular credibility and that most of the political posturing "*serves to prove that human values are given a second place to that of political expediency*". P.R.C. used the earthquake to put on a show for pro–unification offering, a pittance of aid, while soliloquizing about how "*blood is thicker than water*" and that "*Taiwan and China are 'as closely linked as flesh and blood.'*" (Ibid.) The show did little to help Taiwan. The propaganda produced by China's Public Relations Office showed hundreds of Chinese volunteers waiting to board airplanes that are in fact headed nowhere because Taiwan refused any non monetary aid from the Mainland.

Taiwan did not lose too much support by rejecting aid from China even though many were upset that any humanitarian aid was rejected. The total amount of aid offered by the P.R.C., only $100,000, amounted to less than what had been gathered

by private overseas Chinese who mounted their own efforts to support their homeland. In fact the main contribution by China's government was hindering incoming aid offered by other countries. In one well-publicized event China delayed the arrival of Russian aid by 12 hours by not allowing it to fly through China's airspace. (Unknown Author, Taipei Times, 9–26–99) More than the political posturing it is the hindrance of humanitarian aid that has most infuriated the Taiwanese. The scathing remarks have not improved cross–straight relations, but they are not the only remarks that have caused tension between Taiwan and its largest and most threatening neighbor.

Annette Lu, president of the Foundation of National Development and Research, Taiwan, purchased two half-page ads, one in the Washington Post and one the New

Figure 6.9

This cartoon depicts a common view of main land Chinese in Southeast Asia because China lays claim in one way or another to nearly all of its neighbors.

York Times. "*The half-page advertisement, which ran on the day of China's National Day, October 1, was an open letter from the people of Taiwan to the PRC communicating 'the heartfelt feelings of Taiwan's people.*'" (Lu) Naturally she was promptly inundated with letters and e–mail, most of which expressed their "support" for the advertisements. Two of the letters that she received were not so supportive however. (Ibid.)

Both of the Antagonistic letters were sent from China. The first was a continuous threat of war and an accusation of cowardice. The second criticized Taiwan for not accepting humanitarian aid, a point of view that some Taiwanese agree with, but ended with a tacit threat of violence. Luckily these were not the only letters received from China, one woman wrote to thank Taiwan for the $40 million in aid that they had sent to China after a devastating flood in 1995. The decidedly warlike stance taken by the majority of Chinese responses does give cause for concern however. (Ibid.)

6.2.2 The Presidential Campaign

Taiwan is on the verge of its second presidential election, which is scheduled to occur in May 2000. Currently the race has three major candidates, one from each of the main political parties in Taiwan, the Kuomingtang (KMT) and the Democratic Progressive Party (DPP),

Figure 6.10

Taiwan in well versed in "disaster politics". The political maneuver that uses the suffering of others as a political show piece in an effort to gain popularity or consolidate power.

and one maverick KMT candidate, running as an independent. The 9–21 earthquake took political center stage and it looked like it would continue to hold that position well past the elections in the following spring.

The KMT candidate is Vice-President Lien Chan. He has the full backing of the current president, President Lee Teng-hui, as well as the support of the political machine that is the KMT party.

The DPP Candidate is Chen Shui-bian, the past mayor of Taipei. The DPP has been growing with incredible celerity since the parties founding in 1986, gaining 41% of the popular vote in the 1993 city and county magistrate elections, doing even better in 1997 winning 43% of the popular vote compared to the KMT's 42%.

James Soong, the maverick KMT candidate, currently leads the race, and is the former Governor of the Taiwan Province, until that office was removed from existence. Soong was one of the main supporters of President Lee Teng–hui, until President Lee discarded the office of Governor to consolidate the power of the central government.

Figure 6.11

From left to right are KMT Presidential Candidate Lien Chan, DPP Presidential Candidate Chen Shui-bian, and Independent Presidential Candidate James Soong.

Vice–President Lien Chan benefited the most from the earthquake as his high profile role in the reconstruction efforts breathed new life into his campaign. Lien's ratings were disparagingly low in the opinion poles but they rose steadily after the earthquake. According to a report in a TVBS survey "*Lien's approval rating risen*

from 16 percent before the quake to 20 percent on October 17th." (Prelypchan) The Gallup poll is not so optimistic about his standings, which placed him with a 10.4% approval in October. This rating has gone up however to 12.4% in the most recent polls. This boost has not been enough to push him out in front in fact he has fallen even farther behind the other candidates. With the earthquake playing such a major role in the up coming elections it leaves the KMT and Lien open to nearly endless public criticism. If the reconstruction "*work is done well, people will count this to the KMT's credit. And vice versa.*" (Prelypchan) The same can be said for Lien, if reconstruction goes well, his popularity will continue to grow but there are problems it could be a fatal blow to the Lien campaign.

In the months since the Earthquake Chen Shui-bian's popularity rose 6% to 22.5% according to the latest Gallup poll. This increase puts him all the closer to the lead candidate James Soong who has a popularity rating of just 29.1%. The reason for the increase in popularity seemed to be that the DPP was closing ranks, as the elections grew closer not because of any fundamental change in opinion caused by the earthquake. According to Spencer Yang, a political scientist at Chinese Culture University, "*Soong used to have a popularity of 10 to 15 percent among DPP members or supporters in previous polls. But the figure this time around is only 6.7 percent,*"(Hsu). Regardless it does not appear that Chen's increased popularity is a result of the earthquake.

James Soong has ridden out the earthquake without particular loss or gain, aside from a temporary down turn just after the quake caused by Lien's increase in popularity. As politics have returned to normal however Soong's supporters returned. Since October Soong's popularity has grown by 3.1%, according to the Gallup poll released in early November, which was just above the increase in Lien popularity of

2% released in the same poll. Soong has been the leader throughout and is presently leading by a 6.6% margin. While Soong can take no part in the current disaster relief, he is trusting in his record of accomplishment from previous disasters, while he was governor of Taiwan Province to carry him though. This is not to say that he had nothing to say about the issue. Every one of the candidates has been prolific in their statements about the earthquake.

While the earthquake has not seemed to disrupt the standings by a large amount, issues raised by it dominated public debate, and therefore public sentiment up though the 2000 Elections and beyond. "*Normally presidential elections include many public policy issues. However, after the earthquake, people will focus more on the reconstruction process than on other issues.*" (Ibid.) By all appearances the presidential race will not be won solely on the earthquake and reconstruction issues but they will have a considerable impact on the candidates running platforms.

6.2.3 Perception of the government

Taiwan's reconstruction efforts after the Chi–Chi earthquake are often compared with Japan's efforts after the Kobe earthquake in 1995. Taiwan usually does very well in the comparison, having learned from the Japanese, but people were still very dissatisfied with the government's efforts. The reconstruction seemed endlessly mired in red tape and

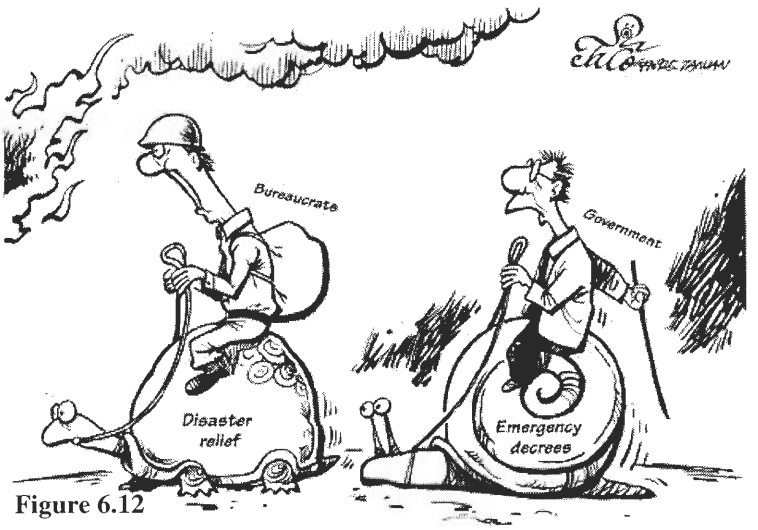


Figure 6.12

The public's view of the reconstruction efforts

bureaucracy; the question that remained was how widespread is the discontent and if it was well founded?

The reconstruction after the Kobe earthquake in Japan was often held to be a model for reconstruction efforts. Kobe became a flourishing sector in Japan, with significant increases in local pride and community involvement after the earthquake. In a comparison with the Kobe incident Taiwan responses were considerably better in the early stages.

In Japan the Self Defense Forces did not even mobilize for the rescue mission for five hours after the earthquake while Taiwan's military headed for the disaster zone within one hour. The Japanese Prime Minister did not tour Kobe for three days and his cabinet did not hold a meeting for equally as long with the first disaster relief meeting held 15 days later. President Lee Teng-hui, Vice President Lien Chan and Prime Minister Vincent Siew all visited Taichung and Nantou counties on the day of the earthquake, and the first central disaster relief meeting was called that same night. (Wang)

Why then are so many residents upset with the governmental response to the 9–21 earthquake? To find the answer one must look a little deeper, and see behind the glamorous tours of the disaster zones and the rapid response times. One by one the major players in national politics flew down by helicopter and each received an individual

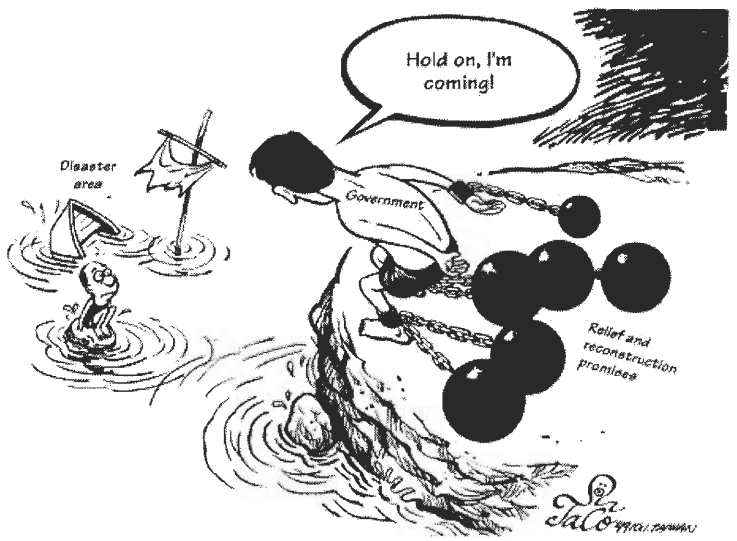


Figure 6.13

Often the political promises and showmanship get in the way of disaster relief

tour of the area. For every tour, the important local officials had to stop their work on actual rescue and aid efforts, give the same progress report and attend official receptions and farewells. Not only that but also many of the roles that the government assumed after the Kobe earthquake had to be filled by volunteer organizations. The day the Kobe quake left thousands homeless the Japanese government immediately made housing available for all of the victims. In Taiwan all of the necessities for the victims of the 9–21 earthquake were supplied by non–governmental organizations.

In some cases the problems of implementation were so rampant that the politicians themselves stated to criticize them. Vice Premier Liu Chao-shiuan has spoken out against the "*bureaucratic attitude of some officials, and cited disability certification for victims as an example*"(Chen). It sometimes took three weeks for the paper work to be passed back and forth between agencies before any help was given.

People's views of politics are not changing only at the national level. Taiwan officials are very well versed with disaster politics but so are the Taiwanese people so while some applauded the rapid response most remained skeptical until the promises were kept, and their towns were rebuilt. At a local level people have been forced to look to their political leaders and they are not always happy with what they see. Many local elections are still won by black gold politics, vote buying, intimidation and other unsavory political methods. This normally has little effect on legislative and governing issues because the officials hold mostly ceremonial responsibilities. The Chi–Chi earthquake changed things however.

6.2.4 Grass Roots Politics

The 9–21 earthquake put considerable pressure on the local governments, and often they were not up to the task. This forced many locals to start their own grassroots organizations to cope with the reconstruction issues themselves. This shake up on the

local level was often overshadowed by the effects that the earthquake had on the presidential campaign, but the changes that are occurring in the neighborhoods are fundamental changes in people's thought process and are therefore far more important to the future of Taiwan.

Taiwan has moved towards democratization with a top down approach. Even though the first elections were held at the local level, many of these positions have little real authority or were purely ceremonial. These positions do have important political roles, as they are the main way in which the local factions feed into the national political system.

As a result of the earthquake residents were forced to depend on their local officials and in many cases they were not satisfied with their civil servants. One way that this dissatisfaction showed itself was through the formation of "community self-help organizations (SHOs)." (Tedards) Often the groups were geographically organized, or formed to handle a specific problem. In one case, the large trucks that carried water to the residents were too large to fit into the back alleyways so "*residents organized teams to keep track of their schedule and bucket brigades to bring the water into the alleys*"(Ibid.).

One activist organization, Humanistic Education Foundation (HEF), recruited volunteers specifically to help in the formation of these groups. "*These activists felt that if real political power could be given to ordinary citizens, the stranglehold of the local factions could be weakened*"(Ibid.). In order to have an influence with the residents HEF had to first build a trust. Therefore they started working like any other volunteer group, throwing themselves into the rescue operation by helping to pull victims from the rubble and set up shelters. They then changed the name of their operation and called it a "service operation" rather than a "rescue operation". This

change in terminology placed the volunteers under the residents, at least rhetorically, which further helped to build a trust. According to Shi Ying , HEF's founder, "*Many volunteers don't understand, they say 'all we're doing is talking to them, and their house has fallen down.' But we're giving them a thought process, not just solving problems for them*"(Ibid.).

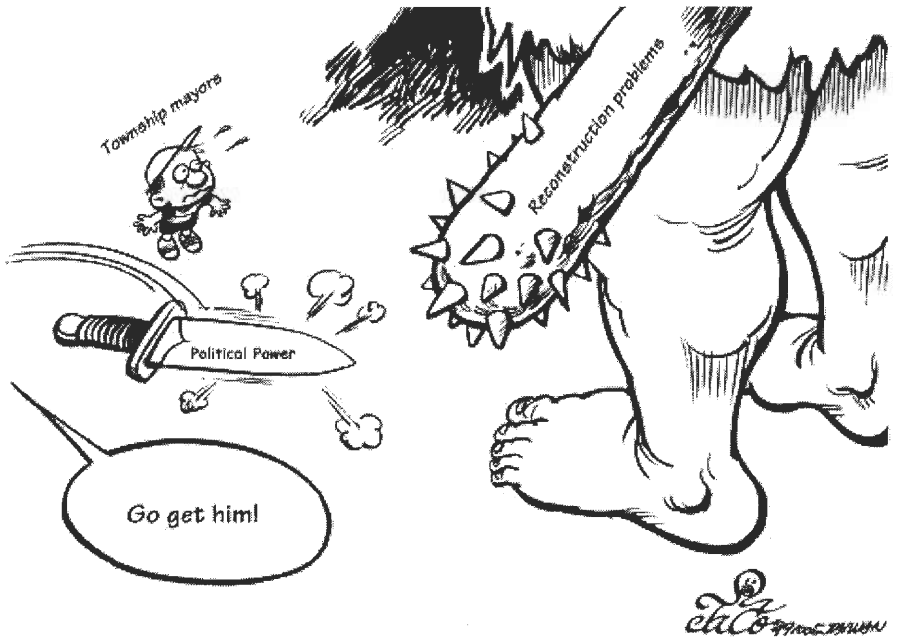


Figure 6.14

Quite often the local officials proved unable to handle the responsibilities forced upon them by the Chi–Chi earthquake

Even with out this understanding HEF volunteers were influential in the formation of a sort of umbrella organization at one of the largest shelters in Taichung County. They were also asked by local officials to help with some of the inspections of collapsed and damaged buildings, they refused however as that would have distracted them from their mission. It was however an admission for the local officials that they were not up to the task set for them and local organizations stepped forward to help.

There is no guarantee that this grassroots political movement will have a lasting impact on the people of Taichung after the emotional damage caused by the earthquake no longer serves as a bond between people, the bond that brought everyone together and sparked this movement. Nevertheless, even a slight change in

personal views might be a big loss for the political factions and black gold politics. That change would be worth the enormous effort of HEF and the residents of the area.

6.2.5 Social Unrest

The local governments were not the only part of the political structure that was under pressure because of the demands of the reconstruction efforts. On October 9th, the day before National Day, the boulevard in front of the Presidential Office was crowded with protesters and riot police. A group calling themselves the '921 Earthquake Disaster Victim Coalition' had gathered there in the afternoon to hold a demonstration and overnight vigil. They were hoping that their presence would force the government to take more immediate action to help the people that were in need of aid get back on their feet.

The rioting was a direct result of the decision of the Taipei City police to revoke the group's license to hold the vigil in front of the Presidential Office. A later statement released by the police said that the decision to revoke the groups' license was a result of President Lee's visit to Taichung and the recently issued Emergency Administrative Order. It was claimed that the presidential trip provided victims with direct links to the administration, eliminating the protesters' need to march.

Figure 6.15

Demonstrators in front of the Presidential Office demand regress.

Police warned that anybody who came to the protest could be arrested for spreading false information and disturbing the peace. Regardless of this threat 600 people, including women and children who were made homeless by the Chi–Chi earthquake came to the demonstration.

They demanded that the government restore their houses, and supply them with compensation faster. They also wanted building contractors and the government to take responsibility for rebuilding their homes and that the contractors who were responsible for the sub-standard building be punished quickly. Protesters also demanded to talk to Lee Yuan-tseh, president of the Academia Sinica and Huang Kun-huei, secretary-general of the presidential office. They were refused a meeting with Huang, and were told that Lee's telephone number was unavailable.

By late that night repeated negotiations by the protesters had failed to produce any redress on the part of the government. The only response received was the promise of a low-level presidential office official to relay the messages. The end came shortly after 11pm when riot police agreed to give the people more room so that they could calmly return to their buses and leave.

The emotional level at the demonstration was very high. "*I was there today, when President Lee was chairing the meeting [in Tali]. I believe Lee was sincere and concerned, but the residents need more than just someone to complain to,*" said one man from Taichung County. "*I had to fill out so many forms to collect compensation for my collapsed home,*" said another, "*but I have gotten nothing*". "*It has been a long time since I last saw the government suppress a demonstration with such severity*," said a labor activist who had helped put on the demonstration. (Low)

Due to the excessive damage done to buildings as a result of poor construction and/or design, an investigation implicating 101 people has been started. Of these 56 were barred from leaving the country, and 12 were held on charges of involuntary manslaughter and endangering public safety. Taiwan's Vice Justice Minister Tseng Yung-fu said, "*We hope to conclude the inspection on the collapsed constructions by the end of this month before formal prosecution begins*". If they are found guilty, the

accused may face as much as five years in prison and a hefty fine. It is worth noting that this statement was released just three days after the rioting in front of the Presidential Office.

6.3 Personal Reactions

The Chi-Chi earthquake was the largest in Taiwan this century. There was widespread destruction, injury, and death. People lost friends, family and homes. The jobs that people held were changed or lost in many instances. There were many reactions in society because of the earthquake. Undoubtedly, the personal effect that the earthquake had on Taiwan's society was very significant.

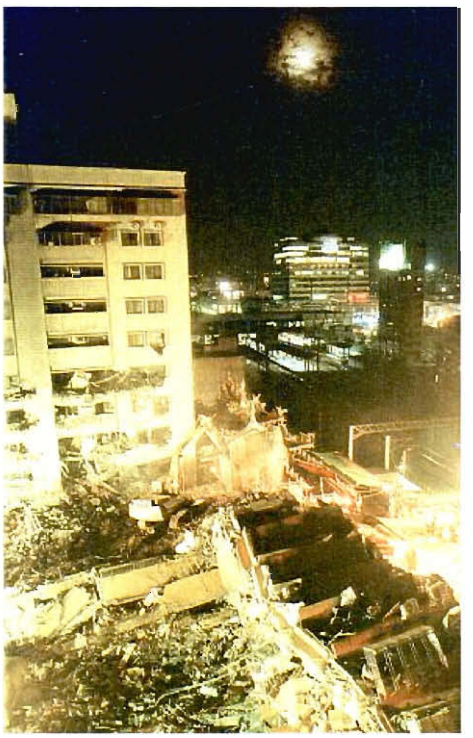


Figure 6.16

The Chi–Chi earthquake had devastating effects on the community

It is hard to imagine the shock and fear that a person woken in the middle of the night by an earthquake of such magnitude must have felt without any first hand experience in such a situation. There is no limit to the possibilities of what people were doing when the earthquake hit. Anything from watching TV to talking on the phone, from studying for school to sleeping sound as can be in their bed. Then, in a matter of seconds, the whole world was turned upside down. People were left standing in the streets, homeless, with the well being of loved ones in question.

With this endless supply of possibilities there are undoubtedly a number of very interesting stories to be told. The sights of destruction and damage seen inflicted on huge structures surely must have been noticed by many in the night. Occurrences of

lucky men who survived with relatively no losses are always a happy story to be heard. Stories of people buried alive who nonetheless managed to survive never fail to lift up the spirits and hopes of the public and rescue workers. The heroic efforts of rescue workers always seem to make the human spirit seem indomitable.

Figure 6.17

A father and son light candles on the bank of the Tamshui River before a Back to Life event. The vigil was held to raise funds for a project providing counseling for the victims of last month's quake.

Despite all the endless possibilities and unknowns, the one thing that is certain is that the public needs help getting back on its feet. Some people will be satisfied with the available aid, and some will not. This will be a direct result of how well they faired in the earthquake. Nonetheless, the aid will be given. The government has supplied monetary compensation, rescue workers and organized a cleanup process. Volunteers will also play a key role in the publics need for assistance. The public's satisfaction with the aid they receive will hold a great power over their general feelings about the quake.

In the aftermath of the quake there are bound to be psychological side effects as a result. Post-traumatic stress disorder will more than likely be a topic that will become an issue for many people, regardless of whether they lost friends or family, their home or if they were simply scared by the disaster. The stress of seeing all the pain and suffering will also play a role in the stress level of volunteers and rescue workers. These psychological reactions are inevitable when a society is faced with an earthquake of such magnitude.

In the time following the quake there will be public reactions that will need to be addressed. With so many of the countries cultural buildings damaged, restoration verses rebuilding will be a serious topic of discussion in the months following the quake. Whether or not the cost of restoration is worth the historical significance of a building will have to be analyzed on a case-by-case basis.

The quake played a very large role in many people's lives. The high-density population of Taiwan will compound the reactions of the people because when emotions are strong, and people are close together, their emotions tend to be shared and amplified by one another.

6.3.1 Initial reactions

Tuesday the 21st of September was not unlike any other day at 1:45 am, at 1:46 am, however, that all changed. The power suddenly went out in more than 1.5 million homes in Taipei. People thought that it was just another power failure, like one that had occurred several months earlier, but they were wrong. By 1:47 am the shock waves from the earthquake hit the city. The entire population of 2.7 million people felt the horrible shaking throughout the city of high-rise buildings and homes. "*The whole apartment just kept rolling,*" said 31-year-old Anthony Lawrence, living on the 11th floor of a high-rise apartment. "*It was frightening. Our television smashed, plates smashed, cabinets fell. I grabbed my wife and child and fled into the stairwell.*"

Figure 5.18

A father pulls his child from the wreckage of a residential building

Many people fled into the streets for fear of being trapped in a collapsed building. These citizens were greeted by a dark sky that was soon to be lit up with blues and greens when underground gas pipes exploded. As soon as rescue measures began to be taken people began standing by to watch rescue workers, hoping to find relatives safely pulled from the rubble.

From the start there was much skepticism over the construction of the buildings that had fallen down in the quake. A Fengjia University student named Na De-hui speculated, "*It's strange that the older buildings are fine, but the newer ones fell ... Construction workers probably used shoddy materials in the building process*". A nearby red cross volunteer Wang Ming-shen agreed with Na De-hui saying "*Look at how thin the rebar is in certain areas*" as he pointed at the destroyed supports along a nearby building. Spirit dropped as time passed on, one-bystander noted "*It's been too long for some of those inside to survive*". But even with that feeling growing among everyone, workers continued to work, and relentlessly search for survivors.

6.3.2 Specific Cases

Figure 6.19

The Tunghsing Building in Taipei used to stand 12 stories high

Hsu Wen-sheng is an employee at a building adjacent to the Tunghsing building, and was there when it fell. "*As soon as the shaking started, I went up to the roof to discover that the [Tungsing] building had collapsed, sending dust everywhere,*" Hsu said. "*Then I heard people shouting 'help!' I used my flashlight to try to signal to them ... only to see people [trapped in the building] wave a white cloth for assistance. But all I could do was signal them with my flashlight ... to let them know that at least people were aware of their situation. I*

also saw some people trying to climb out of the tilted building, but gas was already leaking out."

The gas was indeed leaking out, and it ignited into a large blaze that workers were not able to control until 7am that morning. By the end of the day 113 survivors had been rescued from the building, three of whom died in the hospital later. This still left the status of 60 more people unknown, a fact that left friends and family with heavy hearts.

From the rubble of the Tunghsing Building, a 65-year-old Lin Chin-lien told reporters how fortunate he was. "*All of my five family members were saved,*" he said. "*I was trapped under a wardrobe in the corner [of the room], unable to move. And my wife couldn't move either. And the water from the fire hose [being used to douse fires in the wreckage] hit me like a waterfall, pulling me down. But I finally managed to push away the wardrobe and climbed up two floors to escape. It's a relief to know that all of my family finally escaped.*"

As time passed and spirits fell, there were a few stories of hope that helped to keep up spirits of the rescuers in the face of such overwhelming destruction. One lucky man was Lin Yu-lung, a 33-year-old resident of Fengyuan was rescued from a collapsed building where he had been trapped for over a day and half. After his rescue he told the story of how he survived. He said that once he was trapped he found space to crawl around in, where he discovered bottles of champagne, coffee mate, and a cell phone. He used the phone to call his relatives to make his situation and location known to rescue workers, and fed himself with the coffee-mate and champagne.

In the face of adversity, heroes let their true colors shine. A 48-year-old man by the name Chang Chi-si is one such man. "*I have only one life. To trade that life for*

many others is worth it," said Chang Chi-si. When the earthquake hit Chang was in a hospital bed awaiting his fourth surgery for liver cancer. "*When the lights went out I knew something was terribly wrong,*" he said. "*My first thought was to reassure other patients who had been scared out of their wits.*" He warned them that they would be safest if they stayed in bed. Ignoring his own advice, he immediately ran outside.

Chang is a member of Taichung County's Shengang Township fire and rescue squad. Therefore, it was only natural that his first move would be to contact the captain of the Shengang district fire department, and then proceed to make arrangements to begin rescue operations. He contacted other volunteers, and made his home the center for the volunteer work that was to be done. Chang was easily able to find volunteers, in addition to his position in the fire squad; he is also the head of a union in Taichung County for heavy machinery operations. Chang and his wife were able to supply rescue workers with much of the heavy equipment needed.

Figure 6.20

A woman whose mother was killed in Tuesday's earthquake holds a sign saying 'SOS - Protesting against the delay of rescue operations' in Tali yesterday.

After doing all that he could for the moment, he returned to the hospital to check out. "*My doctor said to me, `what are you doing, you need to have an operation',*" Chang said. "*I told him that I couldn't stay. And besides, there were others who would need the staff's help, so I told them to give my bed to someone else.*"

He began work in Fengyuan, where he was amazed at what he saw. "*People had arrived there in droves, everyone enthusiastically offering their services for free,*" Chang said. "*But in the end, the saddest thing was that we were unable to be as*

effective as we would have liked. The operation was in a mess, disorganized and inefficient. Everybody had their own opinions and were making their own demands, which gave us little room in which to work properly. I felt really sorry that I couldn't help rescue people trapped inside and bring them out to their family members."

After six days of endless work the military arrived, and Chang said that with their presence there was a noticeable improvement in the aid that the people were receiving. Chang was finally able to take a much needed rest. His wife has a very understanding outlook on her husband's active life style despite his illness. "*He's tired now and weak, but I never really worry, because his will is strong,*" his wife, Yang Su-lan said. "*In the beginning I was upset and angry. I worried a lot because of his cancer, but now I don't have any complaints or fears,*" Yang said. "*Some people have lost everything but at least we still have hope.*"

Figure 6.21

A volunteer disaster relief worker rests during rescue efforts at Taipei's Tunghsing building.

6.3.3 Aid and Volunteer Work

People throughout Taiwan have put forth a commendable effort in working together in response to the disaster. Despite continuous aftershocks, and power outages there was little panic. Drivers drove cautiously because of the lack of streetlights, thus avoiding what could have easily become a very dangerous atmosphere on the roads. Small businesses worked to quickly re-open markets and food stalls so that people could still find food amongst the rubble.

It was heartening to learn that many private and charitable institutions quickly joined the government in dispatching relief materials including food, medicine and other daily necessities.

Referring to the US$6.7 million that the KMT party decided to put forth for relief efforts spokesman Huang Hui-chen said, "*The funds will be used on the dead and injured as well as the provision of medical equipment.*"

Figure 6.22

Rescuers and medical personnel in Puli attend to a survivor who had been pulled out from a collapsed building, 30 hours after the initial quake. The man, who had once survived a stroke, had suffered no apparent injuries.

Additional aid was made available by the military that sent in 5,000 soldiers to aid in the relief and cleanup efforts of the hardest hit areas of Taiwan. Foreign countries including Japan, Singapore, Turkey and Russia also sent in rescue teams. France's President Jacques Chirac, U.S. President Bill Clinton, Germany's Chancellor Gerhard Schroeder, Philippines' Vice President Gloria Arroyo, and the Vatican's Pope John Paul also expressed condolences. When asked what advice he would give to local volunteers, the general secretary of Japan's Medecins Sans Frontieres office Dominique Leguiller replied, "*Let's try to be faithful. Instead of 50 people working for a few weeks, let's have just two or three people working for a few years, or at least for a few months*". Leguiller and two other Japanese volunteers arrived in Taiwan on October 18th to share the knowledge that Japan gained from dealing with their 1995 quake in Kobe. He said that when he went to aid in the relief of Kobe the volunteers told the local government "*We shall do whatever you want, but we shall remain faithful until the end, we shall not leave Kobe until you ask us to leave Kobe*". They did not leave until five months after the disaster, and then sent social workers and other professionals to stay and help in the community, and they did not leave until the summer of 1999. This is the type of effort that Leguiller says volunteers in Taiwan need to put forth.

All the Rescue authorities worked well together according to the information available to the public. Police, fire, rescue services, and volunteer workers all came together to help contain the damage, and save lives as efficiently as possible.

Figure 6.23

A woman is comforted by a volunteer medical aid.

There was, however, a shortage of food, shelter, and space in hospitals and morgues. The deputy director of the nursing department at Taichung's Jen-ai hospital described the situations that they were facing with victims "*Most of them suffered serious fractures and head injuries, while some of them had critical burns covering over 60 percent of their bodies. We are running out of beds and spaces in our hospitals*".

TVBS, a popular television station in Taiwan, conducted a survey in Nantou and Taichung Counties, which polled 733 people. While the government has come up with several resettlement options, the survey showed that only 33% understand their options, 52% were not quite sure, and 14% were unaware that there were any resettlement plans in progress. When made aware of all there options, 56% replied that they would prefer a rent subsidy that would provide them with cash. Another 23% said they would choose to take up residence in provisional or prefabricated

Figure 6.24

With hospitals already filled, victims in Taichung County are treated in a parking lot.

housing, and 10% responded that they would choose to live in public apartments or in military barracks.

6.3.4 Psychological Effects

Early in the morning of November 2nd another earthquake hit off the East coast near Hualien and Taitung cities. It caused only brief power failures and little damage, it did, however, have some psychological effect on the citizens of the area. In Taitung and Hualien people slept the rest of the night outside in tents for fear of being crushed in aftershocks that might destroy their homes. Many residents of Puli and Nantou County that were strongly affected by the Chi-Chi earthquake immediately ran out of their homes as soon as they felt the earthquake. Many people chose to spend subsequent nights out in tents because they felt safer than they would inside their homes. It was not until the weather bureau forecasted a cold spell that people became willing to once again brave the indoors.

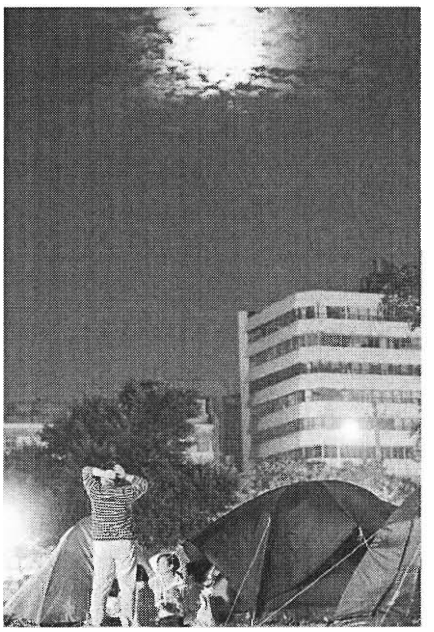


Figure 6.25

Residents in Taipei camp out in a city park. Fearing further aftershocks, some felt the light of the moon overhead was safer than their own roofs.

National Taipei Teachers' College art professor Yang Meng-cheh spoke of an interview he had that expresses the psychological damage that can be inflicted by serious losses. He said, "*One 70-year-old Aboriginal woman said she had lost her children, grandchildren and husband. She said that the government had given her a lot of compensation money, but whether you use an abacus or a calculator, it doesn't add up. Then I understood what psychological healing was about. It was more important to spend time with her than give her money.*"

As of November 3rd 574 victims' responses to a self-evaluation form (this form did not include the Hualien-Taitung earthquake) that was intended to measure stress and depression had been analyzed. The evaluated victims were those from Nantou and Taichung Counties, which would be expected to be the most effected by the events of the Chi-Chi earthquake. These people were those found in refugee camps, Tsaotun hospital, an earthquake clinic, and from visits to the local households that lost family. According to the results of this survey 43% of the victims surveyed need professional help. Of this percentage 54% were women and 39% were men. It was also noted that according to the survey, adults are more than twice as likely as children are to need help. The Department of health explained these results by saying that it is easier for women to have emotional responses to earthquakes, and children's responses take longer to show up.

According to Chen Chung-ying, director of the Tsaotun Psychiatric Center's Child and Adolescence Psychiatric Department some of the respondents may be showing signs of post-traumatic stress disorder (PTSD). Some of these symptoms may include flashbacks of the event, an aversion to people and objects associated with the quake and extreme alertness leading to fear and paranoia. This does not, however, mean that PTSD is present. In order for PTSD to be diagnosed these symptoms must continue until well after the threat of future quakes has passed. Thus, with the recent seismic activity, PTSD cannot be diagnosed until early December.

Figure 6.26

A couple, who gave their names only as Mr. and Mrs. Chang, walk around their former home in Kuohsing Township, Nantou County, yesterday, searching desperately for their missing son.

Chen mentioned another self-evaluation survey, which was filled out by all the students in every elementary and middle school in Tsaotun. The results say that 2.18 percent of the 7,000 students surveyed might need some sort of psychological treatment. Chen was pleased with how low the numbers were, but added, "*Our past experience shows that these kinds of evaluations are not very appropriate with children*". In addition to this Chen says that the 166 students identified by the survey will be given individual treatment, and teachers will carefully observe the 461 students that were identified as "borderline cases".

Figure 6.27

Taoist nuns perform morning prayers at a temple in Taipei. Many Taiwanese have turned to traditional healers and religion rather than psychiatrists to deal with the after affects of the Chi–Chi earthquake.

The work of aiding victims has also put a lot of stress on the shoulders of workers in disaster areas. According to data provided by the military, approximately 3.3% of the troops involved in relief work were put under excessive psychological stress from the work. This can be a very difficult situation to identify in a soldier. One doctor who preferred to remain nameless explained why. "*The highest-ranking psychological counseling officer in an army division is only a captain,*" the doctor said, "*It is very hard for a major or higher-ranking officer to confess to a captain that he is mentally ill and needs help.*" (Hsu)

6.3.5 Post Quake Reactions

In addition to the concerns that the government has for compensating the people that suffered great losses at the hands of the Chi-Chi earthquake, restorations of old cultural structures damaged by the quake was also a serious issue. There was a conference held on October 14th 1999 to discuss what steps should be taken towards the restoration of cultural buildings in Taiwan. Experts attended the conference from

local universities and specialists in cultural preservation from Japan who share concerns for the preservation of cultural buildings in Taiwan.

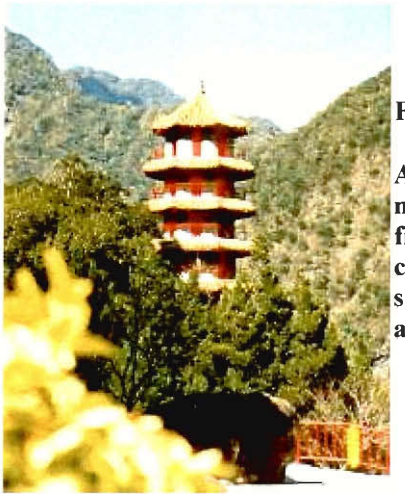


Figure 6.28

A temple in the hills near Hualien is one fine example of the cultural heritage shown by Taiwan's architecture.

"*I'm personally and professionally for restoration,*" said Murakami Yasumichi, conservation architect from Japan's Hyogo prefecture board of education. "*Restoration is not only cheaper but also faster. What's more important is that restoring has a more sentimental meaning. Taking care of cultural assets is like looking after an elderly person. It needs day-to-day tender loving care.*" According to Adachi Yuji, a professor at Kobe University, restoration faces three major problems, time, money, and workers. There are plenty of volunteers to help restore damaged sites of Taiwan culture, time and money, however, are not as abundant.

Information on restoration is readily available for all the sites that Taiwan decides to restore. "*There is no problem for us to provide you with information on restoration techniques,*" Yuji said. Japan has all this information because of all the work it went through in recovering from the Kobe earthquake of 1995. According to Yuji, "*The question is whether you want to rebuild or restore. It is a question which requires a lot of careful thinking, because once cultural property is gone, it's gone forever.*"

6.3.6 Societal Growth

Clearly there were many personal effects in society because of the Chi-Chi earthquake. It has had a large impact on the people of Taiwan. It has been an experience for many people in Taiwan that is unknown by most people around the

6.3.6 Societal Growth

Clearly there were many personal effects in society because of the Chi-Chi earthquake. It has had a large impact on the people of Taiwan. It has been an experience for many people in Taiwan that is unknown by most people around the world. Most of the world does not lie on the intersection of tectonic plates, and most of the world's population does not live in areas of such extreme seismic activity. With such a large population it is only natural that such a wide variety of painful reactions were expressed. Much was lost at the hands of the earthquake. People lost family and friends, homes and jobs, pieces of their past and peace of mind.

As hard as it may be to find, something must be gained from this event or society will never grow as a whole. The importance of quality construction was brought to the surface by the extent of damage done as a result of sub-standard building. With the loss of human life and cultural structures, the importance of these things will also become more apparent to society. The people lost so much, and in order to get through this, they must take solace in what they may still have. If nothing else, the people can take a greater understanding and awareness of the environment they live in from this experience.

Figure 6.29

The losses experienced took a heavy toll on the people.

Earthquakes will continue to be a significant occurrence in the years to come for Taiwan, and the people will have to understand and live with this fact. Fault movement formed Taiwan, and it will continually be changed and shaped by further movements. The past of Taiwan is full of seismic activity, and will continue to see the movement of the Earth's plates in the future.

hard in the short term but will not have a long lasting effect. In the political realm many of the problems that arose are more reincarnations of old difficulties, freshly aggravated, than new problems. The personal effects that are apparently well under control in the short term will have psychological effects for many years to come. These differences show how the earthquake will affect the society as a whole.

Materially much, if not all, that was broken or destroyed will be repaired or rebuilt quickly. Factories that were stopped by power outages were restarted within a few days or weeks, and while profits may reflect the lost time, the economy as a whole will quickly recover as if things had always been working. This is not to say that the economy will not show the effects of this disaster. Simply put the economy will recover quickly.

The reason for this quick recovery is the economic structure of Taiwan. The large number of small to medium size companies gives Taiwan economy an enormous flexibility and resiliency. The market is able to quickly respond to the demands forced upon it, either by normal market pressures or by the sudden change caused by the earthquake. In a way the fact that Taiwan has been so paranoid of a Chinese invasion had helped them to prepare for this earthquake. Limiting the size of the companies by limiting the amount of available capital keeps Taiwan from putting all of its eggs in one basket. This means that even though large sections of Taiwan were devastated by the 9–21 earthquake, most notably Taichong and Nantou counties, the national economy as a whole will be able to continue without much more than a slight pause.

The damage done to the infrastructure was quickly repaired with priority given to the commercial sights. This means that within a year even the industries most dependant on the roads and bridges can be fully up and running.

With much of the short term destruction on its way to being reconstructed many of the attention is turned to the future. Naturally this forward looking attitude drags with it old problems and old politicians.

Many of the political issues raised by the earthquake were not new problems but rather old problems that had been aggravated by the pressure that the earthquake has caused. It is not that the earthquake corrupted the local politicians, China did not start threatening Taiwan because the ground shook, nor did the tension over the presidential race spring out of a crack in the ground. Nevertheless, these problems did all seem to raise their heads at the same time. The tension, that the Chi–Chi earthquake released from the Philippine Sea and Eurasian plates, was absorbed by Taiwanese society. This tension caused problems that had once seem acceptable or at least under control to seem unbearable.

Those problems that were new, such as the allocation of relief funds, or favoritism during the reconstruction were compounded by old problems, or arose because of unresolved issues. The conflict about who should be in charge of the federal aid is really just a power struggle between the KMT, who controls the majority of the township offices, and the DPP, who controls most of the offices at the county level. The struggle helped no one and slowed down the aid. Corruption and favoritism surrounding public works projects was accepted, though not condoned, in the past but with the tensions high and the heat of public attention focused on the issue it has grown to a major problem. Because of these seemingly new troubles the people in need have balked and complained, some forming their own political groups, others calling to those already in power. Their reactions were, just as the causes were, simply an amplification of current political paths. Protests and grassroots politics are

not new ideas in Taiwan, but now that there is cause, these ideas have grown more common.

The personal effects from the earthquake are not just old problems, reborn because of the stress. The problems are very new and will likely leave a lasting mark on many of the people involved. In the short term people handled the effects of the quake well but the long-term damages are enormous.

The Taiwanese responded quickly and calmly in the terrible aftermath of the 9–21 earthquake. Volunteers from all over the island arrived at the hardest hit areas within a day of the initial shock, some within a few hours. Money from companies and from the public flowed to the various institutions set up to help the victims. No instances of looting collapsed buildings were reported. For all the confusion and tears from collapsed buildings and lost loved ones, hysteria did not break out. Neighbors, who were not hit as hard, for whatever reason, offered help to those around them. For all the complaints about the speed of the response, there has been very little civil unrest.

The aftershocks of the Chi–Chi earthquake will be far more than geological. People will be carrying the scars of the event for the rest of their lives. While it is still too early to see how long the psychological effects will last, it is clear that they will not be as short lived as the economic problems. The actual testing for PTSD cannot start until February 2000, but it is clear that the memories of the earthquake are still fresh in people's minds.

On November 2nd, over a month after the Chi–Chi earthquake, there was a relatively small earthquake (6.9 magnitude) centered 45.5 kilometers off the eastern coast of the island (Taipei Times, 11–2–1999). It caused little material damaged and was not even strong enough to wake the authors of this report. Never the less, it did wake the other citizens of Taipei and sent many running for support beams. Some,

mostly people who lived along the eastern coast, fled to the streets in their bedclothes. The Chi–Chi earthquake has put people on edge, a small tremor that used to be ignored is now cause for worry.

Taiwan will feel the effects of the 9–21 earthquake for year to come. Not all of the problems that loom large today will last, but many will start strings of events that may change parts of the society. The different effects will last for different lengths of time, but people are the ones who will change the society in the end.

Chapter 7

Comparison of Taiwan and the USA

Both Taiwan and the USA have large active faults within their borders, and both countries have been faced with large earthquakes. One important step in improving the methods used to deal with these events is to look at how well a country handled the situation. Another way is to look across international borders, in an attempt to make a comparison between oneself, and a country that has faced similar difficulty. The purpose of this section is to compare the methods for dealing with and recovering from a major earthquake of Taiwan and the USA. Hopefully this will aid in pointing out the flaws and qualities of each country's disaster recovery system.

7.1 Case Study of the Northridge Earthquake

In January 1994 Northridge, California suffered a similar earthquake to the Chi–Chi earthquake. The magnitude was only 6.7 on the Richter scale and though only 72 deaths are associated with the earthquake, the fact that it hit in a densely populated city with damage covering almost 2,200 square miles causing US$25 billion dollars in damage, plus losses makes it one of the more devastating earthquakes in the history of the United Sates. About 114,000 residential and commercial buildings were damaged and 11,846 people received hospital treatment for quake related injuries due to the main shock and the 14,000 aftershocks, eleven of which were 5.0 or greater. What merits our attention though is the efficiency in which it was dealt with. The amount of lives lost could have been much higher if the system put in place to mitigate the damage had not been as efficient. First, strict building codes resulted in buildings being built to withstand the shear forces involved in an earthquake and California has been very strict in enforcing them, especially with public buildings. Second, California has to deal with threats from many disasters ranging from wildfires to powerful earthquakes and the experience they have had has contributed to their knowledge of how to

deal with such disasters. There are a number of programs in place to provide immediate aid to victims who are trapped in buildings and/or left homeless. These programs are mostly run through the government, which directs the relief and reconstruction effort.

The most important part about coordinating an effective response is communication. This is probably the single most important reason that the response to the Northridge Earthquake was so successful. Immediately after the earthquake struck at 4:31am local time on January 17th, the Whitehouse was notified and began to organize a response. A half hour later President Clinton was officially notified of the earthquake and called his brother who lived in the area affected to make sure he was ok. At this time the Federal Emergency Management Agency (FEMA) was officially notified and quickly began organizing their response. By 9am, the president was officially debriefed on further information including preliminary disaster surveys, which estimated the required response and how FEMA was carrying out that response. The damage survey was not very promising, buildings had collapsed, freeways were destroyed, power was cut off, gas mains had exploded, water systems were destroyed, people were injured and some were killed. FEMA was working on activating their planned response, including the national urban search and rescue and the distribution of monetary aid to get the economy back on its feet as soon as possible. After the briefing, the President called Mayor Riodan of Los Angeles to give him encouragement and to tell him that they would have the full cooperation of the federal government. The president then called Governor Wilson of California and stated that he would sign the disaster declaration once he received it. The disaster declaration would enable the federal government to provide all possible aid, including the relief coordinated by FEMA to those affected by the earthquake. More specifically it would launch a number of programs that would provide low interest loans for the damaged areas to help cover the replacement of homes, businesses and personal property. Emergency unemployment assistance, funds to rebuild highways, schools, and

other infrastructure were also supplied. FEMA, Small Business Administration (SBA), and the Economic Development Association provided these loans. There were additional cash grants provided by FEMA and the Department of Housing and Urban Development (HUD) for disaster housing for up to 18 months after the quake for those who lost their homes. James Lee Witt, the director of FEMA departed for California at about 12:30pm and landed in California at about 5:30pm to direct the response in person. Other federal officials were sent by the President to make sure the Federal Government could and would provide any assistance needed. This group of officials included Secretary of Transportation Pena, Secretary of Housing and Urban Development Cisneros, Rodney Slater (Federal Highway Administrator), and John Emerson of the President's staff. Roughly 1500 federal personnel across the nation were involved in the response effort. By the second day afterwards, the state of California had been advanced US$100 million dollars from the Presidential Disaster Fund for Public Assistance. This was used for repairs to local, city, and state infrastructure and facilities. US$249 million in loans had also been approved by this time along with US$2.5 billion dollars that were already in place to handle immediate responses by FEMA, HUD and other agencies.

The Emergency Operations Center was in full operation 45min after the earthquake and ran 24 hours a day until the people of LA, and surrounding communities were safe and life returned to some semblance of normality. The Emergency Operations Board was chaired by Chief Willie Williams of the Los Angeles Police Department and coordinated the efforts of all city, county, state, and federal departments. A curfew from 11pm to dawn was established to reduce crime and the National Guard was brought in to patrol. People were encouraged to use other forms of transportation and detour routes were established to reduce traffic jams caused by the damage. The private sector was encouraged to use a four-day workweek and to encourage staggered work hours in order to reduce traffic jams. Five rail cars were added to

the metro system, which suffered very little damage, on January 18th and eleven more were added by the end of the week. Over a hundred busses were also added to the daily Mass Transit Service. Tents were set up in parks for the homeless victims who numbered in excess of 20,000 people. A 24–hour disaster information service was set up at the Federal State Disaster Field Office in Pasadena California via a mobile satellite uplink. TV's were set up in Disaster Application Centers to relay the information.

Eleven Disaster Application Centers were opened two days later at 1pm and fourteen were open by the following Saturday. Operating hours were from 9am to 10pm. At these centers, people could apply for individual assistance, family aid and grant programs. They could get crisis counseling, help from the Red Cross, and vouchers for free housing. Insurance companies and the Small Business Administration were also at the centers to answer people's questions. By the end of the week, over 63,927 applications were registered for disaster assistance and checks started to go out a week after the earthquake. Over 2,500 people were given free housing vouchers. Home loans were available within a week of applying and no more than twenty days for businesses. Loans for real estate property were allowed to be as high as US$100,000 and US$20,000 for personal property. Loans for businesses are allowed to be as high as US$1.5 million. Both types of loans carried a low interest rate, as low as 3.6% for homeowners, 5 percent for businesses and have a maturity of up to 30 years. The SBA worked with each borrower individually so that the loan could be customized. Everything was geared towards helping the individual, because they are the ultimate economic bases. The sooner they are happy and feel secure, the sooner they will be willing to spend money as they normally would, speeding up the recovery of the economy.

The whole effort was highly organized. There were different teams assigned for the distribution of water, food, housing, and general human services. Over a million gallons of

water were supplied by FEMA in addition to the drinking water in the parks by many local organizations.

The local water system was hit hard. Three of the four aqueducts serving the LA area were severed. Two of those were in operation two days later. Many people were without water for up to four days because there were roughly 4,000 breaks in the system. There were also problems at the chlorination and filtration facilities due to damage caused by the quake. Power was restored to 90% the next day, and all fires were either out or under control by noon or eight and a half hours after the quake occurred.

People were afraid to return to their homes. They feared what might happen to themselves and their loved ones. The city of LA had a high crime rate so citizens often refused to leave the vicinity of their homes and/or belongings for fear that they would be looted and have their lives even further thrown into turmoil. The federal and local government immediately dispatched many inspectors to survey all of the homes in the city to determine whether homes and apartment buildings were safe or not. The local government also worked with counselors to talk to people, help them sort out their problems and to encourage people to return to their homes. Many volunteer from local religious organizations and community centers were also sent out to give the victim someone to talk to and help them deal with emotional trauma resulting from the earthquake.

Once the dust started to clear, what had become the most expensive natural disaster in US history had also turned out to be one of the most successful relief efforts in US history. Of the nine major overpasses that were destroyed, 7 were completely cleared by the end of the week and detour routes were established. Twenty five thousand dwellings were deemed uninhabitable leaving 22,000 people homeless. Seven thousand buildings were labeled as severely damaged and unsafe to occupy while 22,000 buildings were moderately damaged and authorized for limited use or restricted use. Nine hospitals were closed which meant that

2,500 beds were lost; 9 parking garages collapsed and 11 major roads into Los Angeles had to be closed. Ninety-seven schools suffered major damage, forcing many children to move to other schools. The President approved US$9.52 billion for federal assistance. US$4.71 billion of this went to FEMA, US$1.109 went to the Small Business Administration's disaster loan program and most of the rest went to emergency assistance for individuals.

There were three lines of defense that were put into practice. The first line of defense was the police, fire, rescue, and medical personnel. The second line of defense was the governmental rescue and relief efforts and was coordinated by FEMA and HUD through local emergency operations boards. FEMA accepted over 300,000 applications for disaster assistance, HUD provided emergency housing, and ESPA processed about a quarter of a million applications from homeowners and business for disaster loans. The short–term cooperation of the federal and local governments, being the second line of defense, greatly sped up the recovery. The third line of defense was the long–term federal and local reconstruction efforts. This is included in the US$9.52 billion provided by the government.

7.2 Command System and Organization for the USA

The division of the US government specifically designated to deal with Natural disasters is the Federal Emergency Management Agency. FEMA is an independent government agency that reports directly to the President. "*...the Federal Emergency Management Agency, FEMA, works to reduce risks, strengthen support systems and help people and their communities prepare for and cope with disasters regardless of the cause.*" "*FEMA's organizational structure mirrors the functions that take place in the life cycle of emergency management: mitigation, preparedness, and response and recovery. FEMA also contains the U.S. Fire Administration, which supports the nation's fire service, and the Federal Insurance Administration, which provides flood insurance to property owners nationwide.*" (www.fema.gov)

Figure 7.1

This is the organization chart of the command system of FEMA.

FEMA's responsibilities are very broad and deal with all aspects of any disaster in the country. This includes "*advising on building codes and flood plain management...teaching people how to get through a disaster...helping equip local and state emergency preparedness...coordinating the federal response to a disaster...making disaster assistance available to states, communities, businesses and individuals...training emergency managers...supporting the nation's fire service...administering the national flood and crime insurance programs...the range of FEMA's activities is broad indeed.*" (www.fema.gov)

In response to a disaster there are 28 federal agencies that FEMA will work with to provide assistance. These agencies provide state and local governments with personnel, technical expertise, equipment and other resources.

Figure 7.2

This is the cycle under which FEMA operates.

To coordinate the federal efforts, FEMA makes recommendations and the President will appoint a Federal Coordinating Officer (FCO) for each state that is affected

by a disaster. The FCO and the state response teams set up a Disaster Field Office (DFO) near the disaster scene. From here the federal and state personnel work together in order to carry out response and recovery functions. These functions are grouped into 12 Emergency Support Functions (ESFs).

ESF 1: Transportation. Providing civilian and military transportation.
Lead agency: Department of Transportation

ESF 2: Communications. Providing telecommunications support.
Lead agency: National Communications System

ESF 3: Public Works and Engineering. Restoring essential public services and facilities.
Lead agency: U.S. Army Corps of Engineers, Department of Defense

ESF 4: Fire Fighting. Detecting and suppressing wild land, rural and urban fires.
Lead agency: U.S. Forest Service, Department of Agriculture

ESF 5: Information and Planning. Collecting, analyzing and disseminating critical information to facilitate the overall federal response and recovery operations.
Lead agency: Federal Emergency Management Agency

ESF 6: Mass Care. Managing and coordinating food, shelter and first aid for victims; providing bulk distribution of relief supplies; operating a system to assist family reunification.
Lead agency: American Red Cross

ESF 7: Resource Support. Providing equipment, materials, supplies and personnel to federal entities during response operations.
Lead agency: General Services Administration

ESF 8: Health and Medical Services. Providing assistance for public health and medical care needs.
Lead agency: U.S. Public Health Service, Department of Health and Human Services

ESF 9: Urban Search and Rescue. Locating, extricating and providing initial medical treatment to victims trapped in collapsed structures.
Lead agency: Federal Emergency Management Agency

ESF 10: Hazardous Materials. Supporting federal response to actual or potential releases of oil and hazardous materials.
Lead agency: Environmental Protection Agency

ESF 11: Food. Identifying food needs; ensuring that food gets to areas affected by disaster.
Lead agency: Food and Nutrition Service, Department of Agriculture

ESF 12: Energy. Restoring power systems and fuel supplies.
Lead agency: Department of Energy

All of the federal agencies that may provide assistance, include:

Department of Agriculture
Department of Commerce
Department of Defense
Department of Education
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Department of Justice
Department of Labor
Department of State
Department of Transportation
Department of the Treasury
Department of Veterans Affairs
Agency for International Development
American Red Cross
Environmental Protection Agency
Federal Communications Commission
Federal Emergency Management Agency
General Services Administration
National Aeronautical and Space Administration
National Communications System
Nuclear Regulatory Commission
Office of Personnel Management
Office of Science and Technology Policy
Small Business Administration
Tennessee Valley Authority
U.S. Postal Service
(www.fema.gov)

7.3 Command System and Organization for Taiwan

In a state of emergency any government must adjust it's priorities, and sometimes parts of its structure, in order to deal most efficiently with the situation at hand. The results of the Chi-Chi earthquake were no exception. In order to recover from the aftermath of the earthquake the government had to make certain adjustments to its structure so that it could most efficiently aid the public in its recovery. Without a pre–existing structure for disaster

relief Taiwan had to setup and organize one in response to the Chi–Chi earthquake. This step alone took three days to setup.

The government organized itself in response to the Chi-Chi earthquake as shown in figure 7.3. The Control Center came into existence for the purpose of helping the country recover from the quake as fast and as efficiently as possible. It has ultimate control over the distribution of goods and services that were distributed through the counties of Taiwan. It is also responsible for taking into account every aspect of life in the affected counties, and insuring that they are able to return to normal working conditions. The priorities for response and recovery set by the Control Center are as follows:

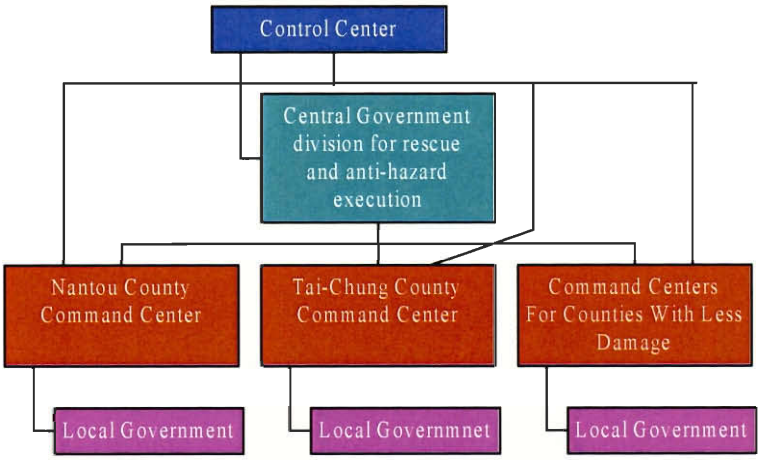


Figure 7.3

Governmental Organization in Chi-Chi Earthquake

1. Provide monetary compensation for deaths, injuries and for those whose homes were destroyed in the earthquake.
2. Provide temporary houses for those displaced.
3. Set up an emergency fund for assistance centers and for local government disaster relief in the disaster area.
4. Provide special mortgage loans for those displaced.
5. Reduce taxes and interest rates on existing loans for those displaced.
6. Provide emergency medical service and control the spread of diseases.
7. Provide safety inspection of buildings.
8. Provide daily necessities including food, water and electricity.

9. Stabilize retail prices
10. Set up an organization to accept donations.
11. Reopen schools and provide psychological counseling for students.
12. Set up special telephone numbers for disaster-related services.
13. Set up a special disaster relief account.
14. Dispatch the army to assist in disaster recovery.
15. Maintain environmental hygiene.
16. Assist unemployed workers in the disaster area to find new jobs.
17. Establish a list of the injured and dead.
18. Provide assistance to children and the elderly who lost family members in the disaster.
19. Provide traffic information and a special postal service.

(Goltz)

The Central Government Division for Rescue and Anti-hazard Execution is the contact between the Central Government, the Control Center and the counties. This division creates a communication line between the Central Government and the disaster area. All the requests of the county level governments, and control center for aid go through this division. This division section of the relief system has no official power. Its purpose is to relay the requests of the control center and the counties to the divisions of the central government that are responsible for providing the different forms of aid that is being requested.

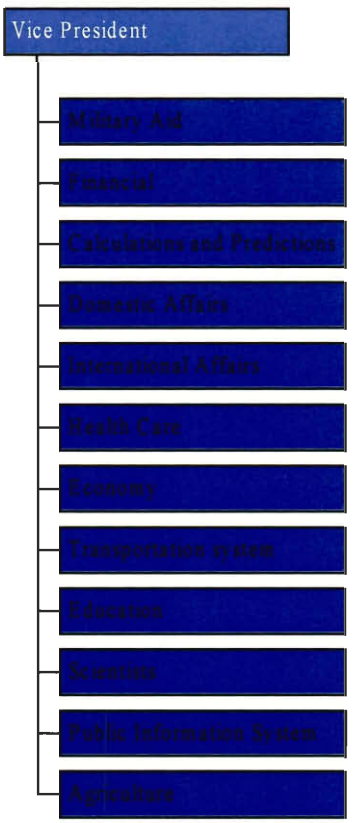


Figure 7.4

Control Center level of the Taiwan's disaster recovery system.

The county level must pass information on to both the control center and the central government division for rescue and anti-hazard execution. It is responsible for collecting the damage

reports from the local governments, and sharing them with the Control Center. The requests for aid that it must make will have to go through the central government division. The Control Center will know what resources the county gets, and it will also know the extent of its damages. Based on this information, the county will be told how to distribute and use its disaster recovery aid.

The local governments are the direct link between the people and the resources provided for their needs. They must survey all the damages and losses that it received from the quake, and then pass the report up to the county level, who in turn passes the report on the Control Center. The local government must likewise make requests for aid that it will pass on to the county government, which will in turn be passed onto the Central Government Division for Rescue and Anti-Hazard Execution.

By following this system all the information and requests for aid are passed up from the local level to the highest governmental level. Similarly, the highest levels of government collect the relief resources needed, and then pass it down to the local governments. The Control Center makes sure that all this information and aid are distributed, and used to its fullest potential.

The Vice President is in charge of the Control Center. This division is concerned with the distribution, and use of the resources provided in the sections mentioned in Figure 7.4. It is this section of Taiwan's emergency response system that controls how the government's aid is distributed to and used by the counties. A few of the subsections of this division lost their specific meaning in the translation. The "Financial" section is concerned with the international effects on the value of the monetary units (NT$) of Taiwan. The "Calculations and Predictions" section calculates the present GDP, and predict what the GDP will be in the future as a result of the quake. The "Economic" section is concerned with the use of resources during the recovery period of the country. The "Scientists" section consists of

professionals that inspect the land in their area of expertise, and give their professional opinions on the matter.

The organization of the county level during the recovery period is shown in Figure 7.5. The Vice-Governor is second in command of the executive branch at the county level. The scientific aid section is responsible for analyzing the results of the local surveys in order to look for any significant data that will help to understand the earthquake and the damage it inflicted. The military branch is responsible for organizing the distribution of all the aid and resources available for distribution throughout the damaged areas in the county. This level is responsible for the distribution of these resources to the local governments, and from there to the people.

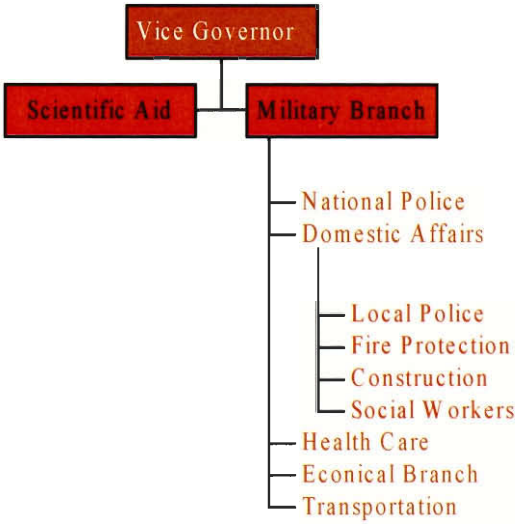


Figure 7.5

Members of County Level of Taiwan's disaster control system.

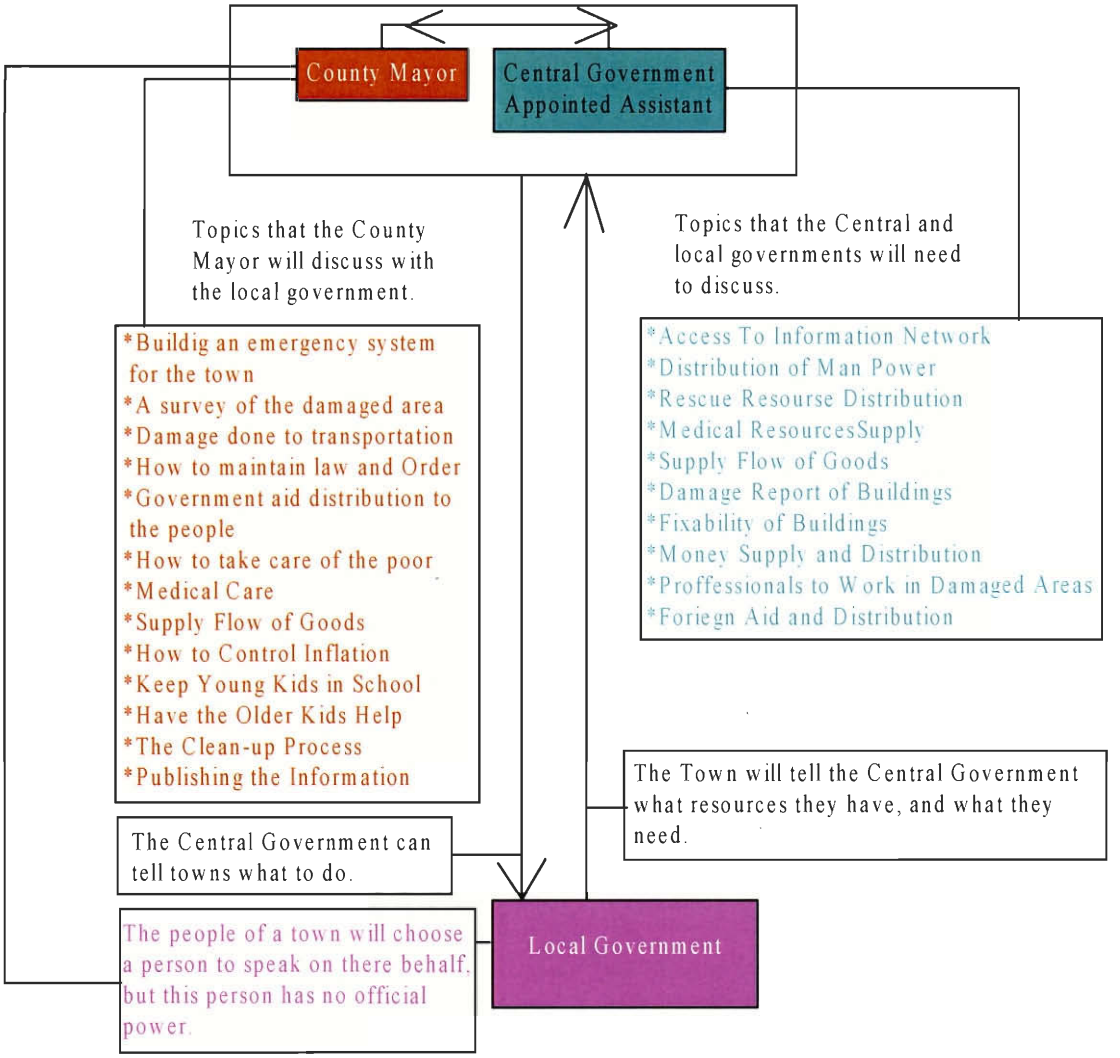


Figure 7.6

County - Town Interaction

Figure 7.6 shows the interaction between the county and the local levels. The county level is led by a governor, and the Central Government appoints an assistant to him. This assistant is the link between the county and the Central Government, and he is on an equal level of authority with the County Governor. The starred topics on the left-hand side of the chart are subjects that will need to be discussed in detail by the county governor and the local government. The starred topics on the right-hand side of the chart are topics that the government appointed assistant would need to discuss with the local government. The county government has the authority to tell the town government how to use the resources it receives.

The local government is responsible for telling the county government the damages it suffered, and what aid it feels it needs. Additionally, the people of the town may choose a representative to talk to the county major and tell him the opinions of the people, but he has no official power.

7.4 Comparison

In order to make an accurate judgment of how well Taiwan's government dealt with the recovery from the Chi–Chi earthquake it is necessary to compare this disaster with similar ones that have occurred elsewhere in the world. This is the reason why the Northridge earthquake in 1994 has been examined. Both the Chi–Chi and Northridge earthquakes were very large, and cause the affected areas to be placed in a state of disaster. While the Chi–Chi earthquake was the stronger of the two, the Northridge quake occurred in a more densely populated area. Consequently the damages done by each quake are comparable.

7.4.1 Command Systems and Organization

Taiwan's Control Center, and the USA's FEMA are the two comparable organizations that deal with the recovery from a disaster. These two organizations are faced with the same task in the event of a national disaster, to run the recovery effort of the nation. While the two do have the same ultimate purpose to their existence, they are run and organized differently.

The first noticeable difference between FEMA and Taiwan's Control Center is age and response time. When the Northridge earthquake shook California it was only a matter of the President to order FEMA into action. FEMA has had experience dealing with such disasters in the past such as the 1989 Loma Prieta Earthquake near San Francisco, devastating floods in the Midwest and numerous hurricanes in the South East. FEMA has learned their lessons though; it has not been until relatively recently that they have been able to be so effective. Under the Carter Administration, the United State's preparedness for disasters was pitiful, but

FEMA slowly gained power as future presidents found that a quick and efficient response to any disaster did wonders for their popularity in the polls.

In the instance of the Chi–Chi earthquake there was no pre–organized program to deal with such a natural disaster although there were plans for such a program, they were in the earlier stages of development and unable to be implemented. After the earthquake occurred, it was not until three days later that the Control Center was activated, compared with 11 hours in the case of the Northridge Earthquake. During those three days the relief efforts were based on the arrival of military aid and the effort of local volunteers. This lack of a pre–existing version of the Control Center is a concern in Taiwan. While the initial aid and rescue efforts seemed significant during the period of recovery, the possibility that governmental efforts could have been put forth more smoothly will continue to be a subject of analysis and criticism.

Another difference between the two systems is the existence of the Central Government division for rescue and anti–hazard execution in Taiwan's system. There is not a similar organization separate from FEMA because the powers of this division are within FEMA's authority. This results in more efficient communication between the central government and local governments since the people providing the aid and talking to the local citizens are part of the same organization that talks to the government.

One more major difference between Taiwan's Control Center and FEMA is the clarity of procedures and power to carry them out. FEMA has been given the funds and power to develop a highly organized and thorough set of guidelines for dealing with any probable disaster from a major terrorist attack to a crippling natural disaster that would normally throw any nation into utter chaos. This earthquake was a test of Taiwan's ability to handle this kind of chaotic situation. Taiwan's citizens performed well on the disaster scene, courageously digging victims out after the earthquake. The government found that leaving vague

procedures, even in the intention giving officials more power to deal with a situation creatively, does little to help the situation and often throws it into more confusion. There are too many variables that are left to be able to enter the situation such as political grudges and lack of power to carry the needed actions out.

7.4.2 Analysis

Many people are very dissatisfied with how the government reacted to the earthquake. Some people seem to be using the government as a scapegoat, venting their anger over the deaths of so many citizens and encouraged by the media's grabbing logic. The media often seems to imply that if the government had acted faster and more efficiently, most of the over 2,100 lives would not have been lost but this is not true. It is estimated that between 80 and 90 percent of all those killed in the earthquake, lost their lives within the first 30 seconds. In fact, the immediate response was very strong. The instant after the earthquake, the citizens started digging victims out of the rubble. *"...Taiwan's frontline relief workers preformed admirably..."* (Chen Chin-Kuei)

One basis for their anger is the government taking three days to declare a state of emergency to facilitated the efficient distribution of relief efforts including water, food, tents and excavation equipment, and allowing for quick reconstruction of the infrastructure. Although three days will not matter much at all in the overall reconstruction process, it could have expedited the other relief efforts. Declaring a state of emergency essentially cuts much of the bureaucratic red tape that prevented a quick and efficient initial reaction in the first place. In order to accomplish this though, many policies and laws have to be bypassed and this can be a very sensitive political issue. The government eventually implemented the state of emergency because it had no other option to deal with the disaster.

The fact is, Taiwan's government lacked the experience of dealing with a disaster of this magnitude and though it did not preformed perfectly, it could have been worse. Japan for

example, it took four weeks to react to the Kobe earthquake. Taiwan's response could have been better though. There was an apparent lack of communication between the central government and the rest of the government of Taiwan. "*The problem is that the government hasn't set forth a clear set of guidelines.*" (Tsai Huang-Liang) Since the state of emergency was adopted, the rules have changed for dealing with this disaster, but few, really know what they mean and/or what it means for them. The government has distributed $156 million for emergency relief and gave out US$32,300 to the families that lost lives of its members and US$1,610 to people who have been injured. Since there are laws being bypassed, people have to follow different paths in order to get tasks accomplished, and those paths have not always been clarified. For example there is a problem with distribution of funds to victims whose houses were damaged.

> "...the government has ruled that people whose dwellings have completely collapsed should be compensated [US$6,700], whereas residents or owners of half-collapsed dwellings get [US$3,300]. I'd like to ask, 'How do you define a completely collapsed house? And how do you define a half-collapsed house?'...county governments don't know who to give the compensation to" (Feng Ting-Kuo)

These officials did not distribute some of the monetary aid for fear that the government would find them guilty of distributing the aid wrongly. Over two months after the earthquake had passed, and there were still no clear directives on how to deal with all of the aid coming from the government. "*...There's a lot of ambiguity in [the government's] policies that is preventing public servants from carrying them out.*" (Tsai Huang-Liang) There is also tension between government officials in different parties from the top all the way down to the local governments and this does nothing to help the situation.

The government as part of its plan for recovery has outlined what is being done:

- Temporary shelters for those left homeless will be built by the end of October. A second batch of shelters will be built after that time if necessary
- The reconstruction of collapsed buildings will begin immediately. All reconstruction details will be made public within six months.
- All investigations into building collapses and prosecution of those found responsible for shoddy construction contributing to the disaster will be carried out by October 15th. Construction companies and architects should complete safety check within two weeks on all buildings they have constructed.
- Safety surveys on public infrastructure including dams, roads. Bridges, railways, power systems, schools, and cultural centers will be completed within one month.
- Restoration of farmland in central Taiwan will start immediately to allow farmers to resume agricultural production. Countless acres of farmland were seriously damaged by the earthquake and the thousands of aftershocks that have been recorded since September 21st.

One of the first outrages to emerge after the earthquake was in reaction to the unnecessary damages caused by the low quality construction and disregard for building codes. Ironically the building codes in Taiwan are some of the best in the world, they just need to be enforced better. The demand for housing had been a major problem for construction companies in Taiwan for the past few years. In order to meet these demands and to compete with other construction companies in the same position, they felt they had to disregard many building codes in order to stay in business.

If all construction companies just followed the relevant codes, no one company would have any major advantage over another by reducing costs in the construction by ignoring building codes. Instead companies choose to cut corners to decrease cost, and increase their own profits.

The construction of "soft stories" caused a lot of the damage in the multi-story buildings. A soft story is a story that is weaker than the stories above and/or below. Soft stories can be commonly found on the ground level of many buildings where the supports built were not strong enough to support the load of the upper stories during an earthquake. The ground level is also the level that is under the most stress during an earthquake. Another reason that so many 12 story buildings collapsed is because buildings fewer than 50 meters tall do not have to go to a special engineering committee to be approved; twelve stories barely fit into the 50-meter limit. Additional stories are also sometimes illegally built on top of the existing 12 stories, which puts additional loads on the building that it wasn't designed to withstand.

The practice of renting out licenses is another loophole in the system that allows contractors to more easily disregard codes. An engineer may rent out his license to a building contractor so that the contractor can then claim that a qualified engineer approved the blueprints, while the real engineer never even saw the blueprints. This opens a huge door for corruption and disregard for codes. Another problem is the fact that low quality workers being paid low wages are doing much of the building. Work is done as quickly as possible and codes are disregarded in order to save time and money. In order to make concrete flow easier into narrow columns, water is often added. When 20% more water is added to cement, the cement and aggregate tend to separate causing a 25% decrease in the strength of the column. This type of behavior might be curtailed by stricter law enforcement, increased power for building inspectors, and harsher punishments for those that ignore building faults for monetary gain.

Many of the destroyed buildings were built on soft soil. Much of this land used to be marshes or ponds that no one really lived on before. This type of soil is often very susceptible to liquefaction. Development in these areas should not have been allowed unless precautions were taken to ensure the stability of the building.

Politics have interfered with getting rid of this practice since the construction companies will support politicians who do not actively fight to deter this practice and those who do not support it, risk not being elected. One solution to this would be to take it to the highest levels of government and deal with it there. After the earthquake the people of Taiwan will be much more open to changing this practice.

7.4.3 Adequacy

The citizens of Taiwan did a commendable job in providing voluntary assistance as needed in helping the victims of the earthquake. The lack of leadership required in guiding them in the process made the use of the workers inefficient. Taiwan lacks a clear communication system in two ways. There is no way of relaying clear information from the damaged areas throughout the whole government. A sound and highly organized set of guidelines describing how the whole government operates in a state of emergency is needed. The enforcement of building codes is a crucial problem that the country needs to deal with. The authors have seen firsthand many of the buildings that suffered damages due to such violations in building codes. Many such buildings occupy the City of Taipei. If the buildings are all up to code, the number of lives lost could be greatly reduced in the future, as there will be less overall damage.

The government was not as prepared as it could have been for such an earthquake. They lacked a strong central command system with good communication; this would include translators for the foreign rescuers and between people coordinating the rescue efforts. They also lacked such high-tech gear as search cameras, microphones and proper heavy lifting gear to help save the lives of those trapped beneath the rubble. One goal should be to develop a stricter regulation of the construction industry that will keep up with the speed of the growing demand for housing. Another would be to develop a better system of command and communication to deal with such disasters.

Many people of Taiwan who have lost their homes to the quake have asked the government to allocate new land for them to build on that will be safer. One suggestion put foreword by the people is to build homes on the farmland and farm on the land their homes were built on. This is because the farmland in many areas was farther away from the fault line than many homes. Any building can be almost earthquake proof; the only difference is the cost of materials and the way they are put together. However the cost of such a building is prohibitive. Taiwan is known for having many innovative engineers, maybe once the building code is more regulated, there will be some more breakthroughs in the construction of cheaper and stronger buildings.

Taiwan is currently investigating and prosecuting those who have violated building codes, especially those who built buildings that should not have fallen and caused unnecessary deaths. The government is trying to bring the people behind the corruption that cost so many lives to justice as fast as possible. They have arrested or confiscated the passports of over 60 contractors, architects and surveyors accused of being involved in the disregard of building codes that caused the destruction of many buildings. Hopefully this will help eliminate the disregard of codes and corruption in the construction industry so fewer lives are lost and less damage has to be suffered during the next major earthquake.

Chapter 8

Conclusions

8.1 Suggestions

In order to show a complete understanding of the subject matter it is necessary to make suggestions as to how certain things could have been done better, or how the over all system might be improved. An analysis of the situation is nothing more than a culmination of what happened until the data is interpreted and suggestions are made. The suggestions that the authors have made are the result of our analysis and discussion on the information and experiences we have had during our stay in Taiwan.

How Much Should the Government Pay For?

As Taiwan reforms its disaster mitigation policies, the problems encountered by the United States should be taken into consideration. The United States has taken a very proactive stance on disaster mitigation; this has had its drawbacks though. The spending of money can, on occasion, be done in a manner that offers short-term solutions, but accomplishes little in the long-term. For example, The National Flood Insurance Program offers compensation to those who lose property as a result of flooding. "*One of the most serious weaknesses of the National Flood Insurance Program is the problem of repetitive losses. The Program has been notoriously willing to continue insuring structures despite repetitive claims, often with little*

increase in premium." (Disasters and Democracy) This creates what is called a moral hazard, when people willingly build on hazardous land because they know the government will compensate them for any losses and subsequently risk their lives in the process, not to mention wasting federal taxpayers' dollars. The program does much good for the those who innocently become victims of natural disasters but there are major loopholes in the system that make it possible for people to knowingly rebuild in dangerous areas. The owners of property on hazardous land feel that not being allowed to live there or posing restrictions on their land is a violation of their constitutional rights. Repeatedly rebuilding on the same dangerous property, however, is a waste of taxpayer's money and a threat to those who live there.

As Taiwan reforms their disaster relief and mitigation programs, they should try to prevent their programs from making living in dangerous areas too appealing. As the United State's original intent for federal aid was to be a supplement to private donations, so should Taiwan's. Granted there will be times when private funding for aid will not always be enough, in which case the government should provide a portion of the aid. The important part is to not offer oversized amounts of relief for smaller disasters, especially disasters that could have been prevented. In the past Taiwan's government has relied heavily on private aid and local communities to deal with such disasters as typhoons and landslides. Now that they have shown they have the

money, political figures will want to use more monetary aid in future disasters to further their popularity. Since the government has already done it once, it will become easier and easier to justify handing out money to aid the people. This has happened in the United States and there is no reason to believe that it will not happen in Taiwan.

Future Considerations for Improvement

The building codes in Taiwan are some of the strictest in the world; the damages caused by the Chi-Chi earthquake were not the result of any problems with the codes. What should be analyzed and changed is the enforcement process of the codes. If this had been set up better in previous years then the resulting buildings would not have suffered as much damage from of the earthquake. This process would mean taking steps to eliminate corruption, which could include stricter enforcement of the law, and greater punishments for those in violation. If done efficiently this would eliminate the unnecessary damage inflicted on structures in future earthquakes.

It would also be helpful if Taiwan had a pre-established system whose specific purpose is to deal with national disasters. Such a system could be set up using similar organizations in other countries as a model from which to start. In time the system could be changed to reflect what experience would help to teach those involved in the systems organization. It would start with a set of standards used to

react to different situation, and as new situations arise, the standards can be changed to best reflect a universal method of dealing with any form of natural disaster.

The general consensus of the authors is that the citizens of Taiwan performed admirably during the recovery period following the quake. The government's actions were not all of the high moral quality that might have been hoped for. For the benefit of the people it would have been helpful if the politicians could have put aside their differences for the time being. Cross-Strait relations with China, for example, put on a circus performance using strong words to attract the attention of the people. For the benefit of the people in the future it might be an idea worthy of consideration for politicians to learn to put aside old grudges for the good of the people.

As things stand now, the people have survived one of the most devastating earthquakes of the century. While Taiwan's society has managed to pull through these hard times, it must still hope to learn from this earthquake. Hopefully by learning from the past the country can learn to better react to similar situations, which are inevitable in consideration of the geological formations of Taiwan, in the future. In response, every aspect of mitigation and recovery done in response to this earthquake should be analyzed by the government to find every aspect that should be repeated in the future, and what should to be changed.

8.2 Closing remarks

The Chi-Chi Earthquake has affected Taiwan in many ways. Different parts of the society will feel the effects for different amounts of time but in the end it is not how the politicians changed their slogans or how the NT dollars stands against the US dollar that will dictate how Taiwan changes because of the earthquake. People are the building blocks of a society. Therefore any change is a society as a whole must start and end with them.

The Chi-Chi earthquake was the largest disaster to hit Taiwan this century, but for all the economic loss, for all the squabbling over political power, the things that will be remembered are: who lost a father, who lost a daughter, who lost a friend. Those are the true lasting effects of the Chi-Chi earthquake, buildings can be rebuilt, new jobs can be found, political power can be gathered, and even terror of the memory can be faced, but nothing will change the fact that over 2400 people died. Each one of them had a family, each one of them had friends, and it is that loss that will truly change Taiwan.

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Appendix–2 Table List

Appendix–3 Site Visits

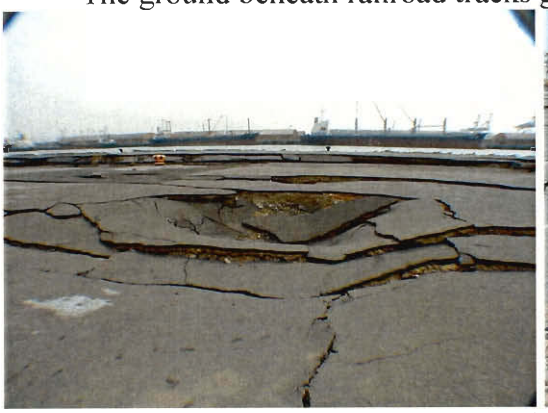
Trip 1

Casey (Left), and Tomas (Right) were our guides on the first trip to visit the seriously effected areas of Taiwan.

Day 1 – 11/3/99


The Chi-Chi earthquake hit Taichung Harbor very hard.

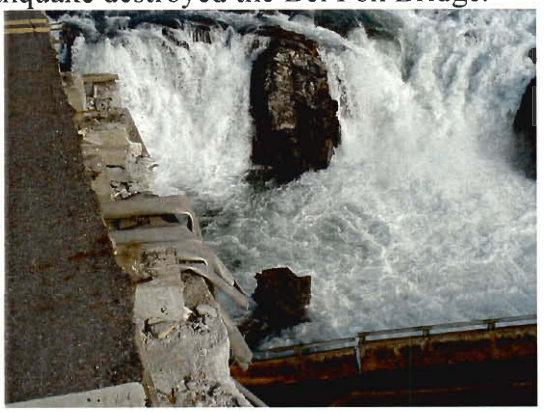

(Left) The surface deformation made the soil layers very easy to distinguish. (Right) The ground beneath railroad tracks going through the harbor collapsed.



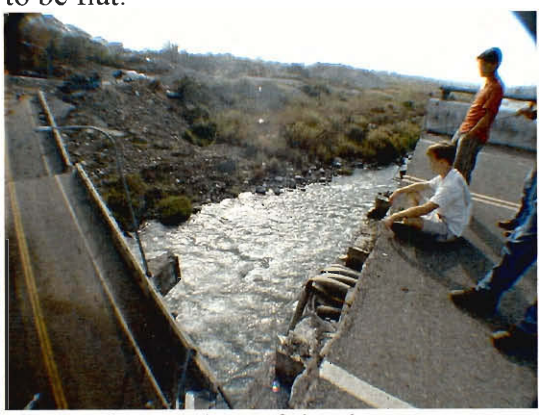

This used to be flat.

Bei Fon Bridge


Surface faulting from the Chi-Chi earthquake destroyed the Bei Fon Bridge.

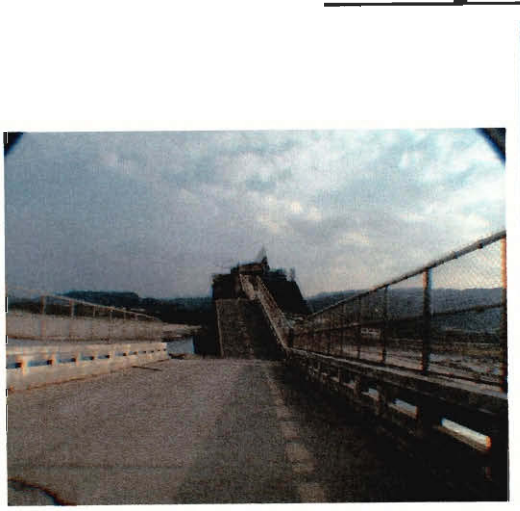
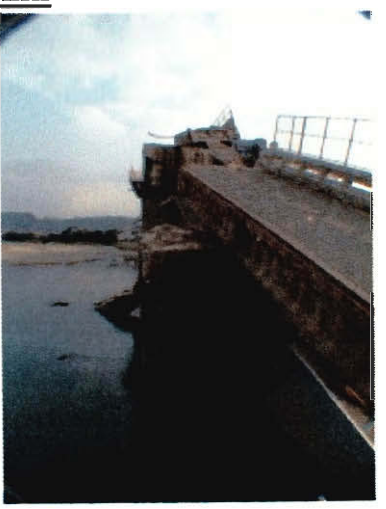



This used to be flat.

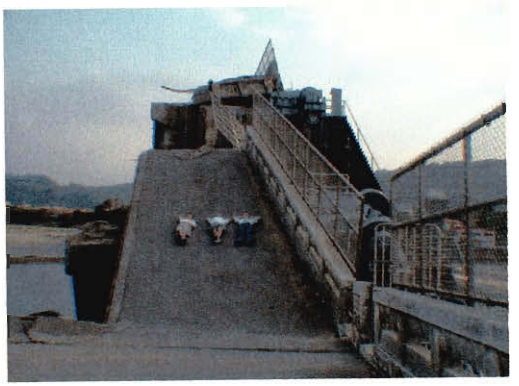
People crossed the tapped off area to get a better view of the damage.

Shi Kung Damn

The Shi Hung Dam was another victim of the Chi-Chi earthquake.


Local residents came to see the destruction. (Right) One man in the background found an income by selling pictures of disaster areas.

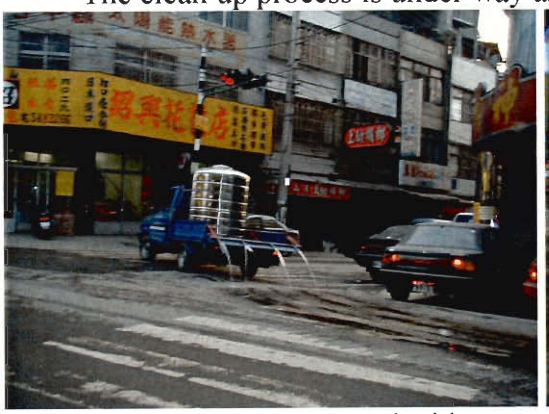
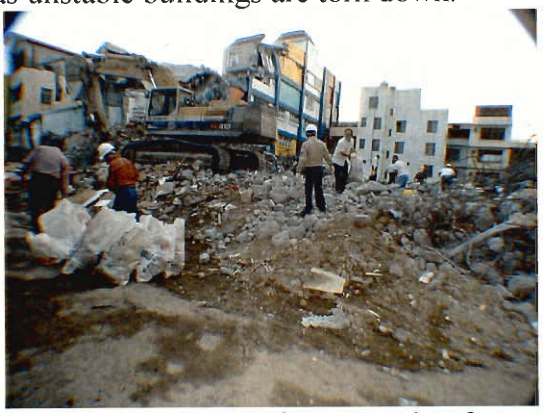


The scientists take a much-needed rest.

Tung Shi


Buildings in Tung Shi experienced immense structural damage.

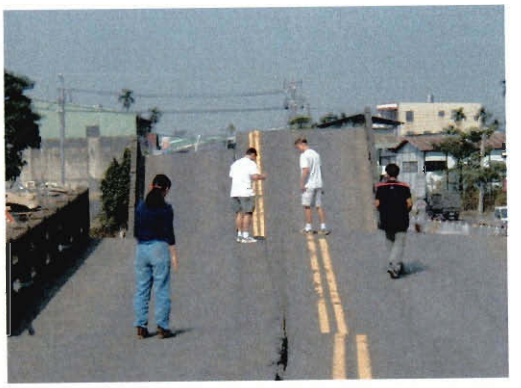
The clean up process is under way as unstable buildings are torn down.

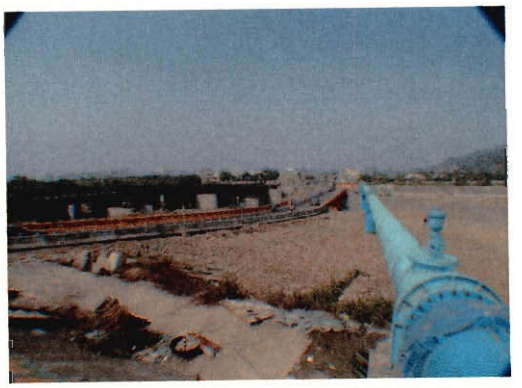
(Left) The streets are sprayed with water to prevent the dust of construction from becoming overwhelming. (Right) Volunteer workers help to clean up the mess of a local building that was destroyed.

Day 2 – 11/4/99

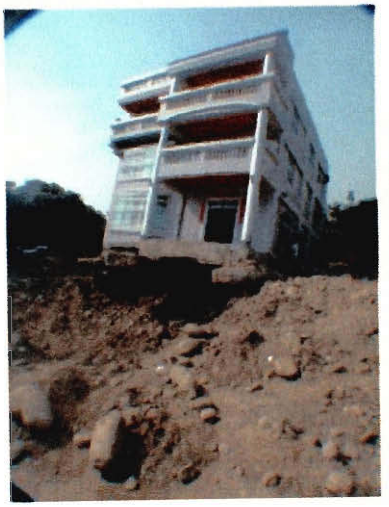
Yi–gian Bridge

After careful inspection, we decided that the Yi–gian Bridge was no longer safe for traffic.

Within a few weeks of the bridges collapse, a temporary one was put in place.

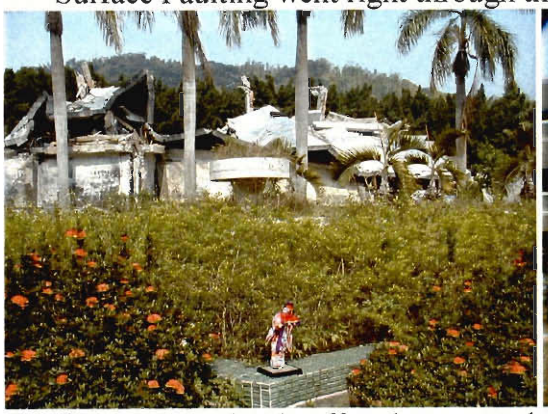



A nearby house lost its balance.

A friendly volunteer told us about his job of directing traffic around the impassible Yi–gian Bridge.

Kuang Fu Jr. High School

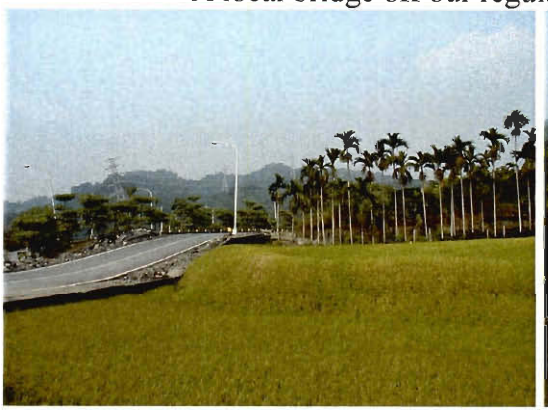
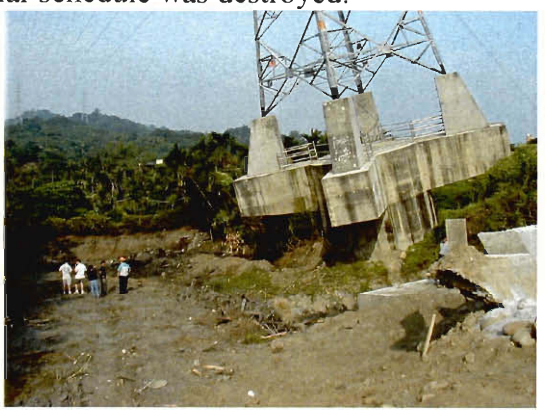

Surface Faulting went right through the track of Kuang Fu Jr. High School.



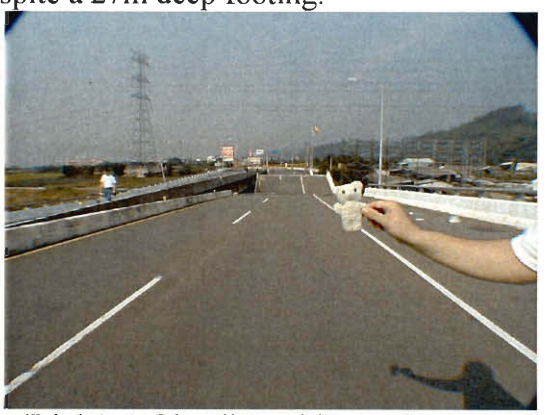

Buildings at the school suffered extreme damages, making them unusable for classes.

Once again, sleep takes hold of the scientists.


A local bridge off our regular schedule was destroyed.

Significant surface faulting can be seen; it runs all the way through to this power line tower that was moved despite a 27m deep footing.

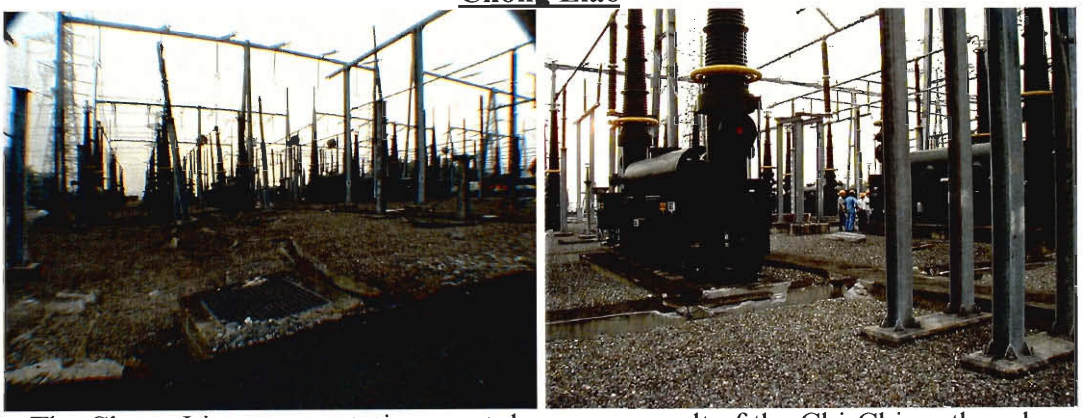
(Left) the local railroad was destroyed. (Right) A friendly resident points out interesting damages.

Chi-Chi


The epicenter of the earthquake was in Chi-Chi.

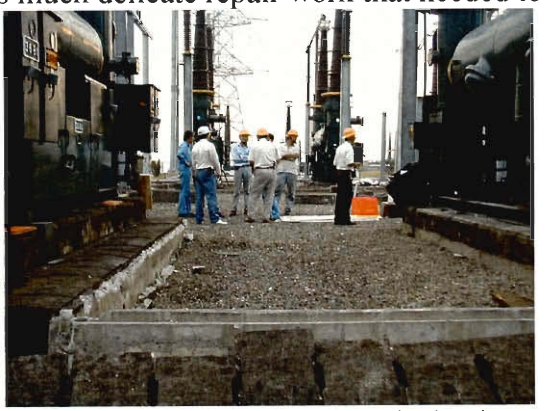

(Left) People choose to live in tents out of fear of their houses collapsing on them.
(Right) The Chi-Chi railway station, built by the Japanese when they occupied Taiwan was destroyed.

Chong Liao



The Chong Liao power station went down as a result of the Chi-Chi earthquake

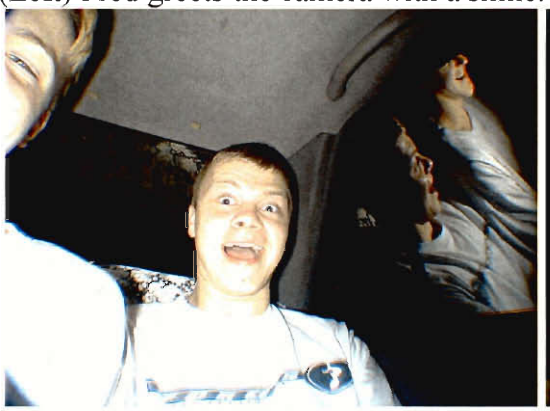
There was much delicate repair work that needed to be done.



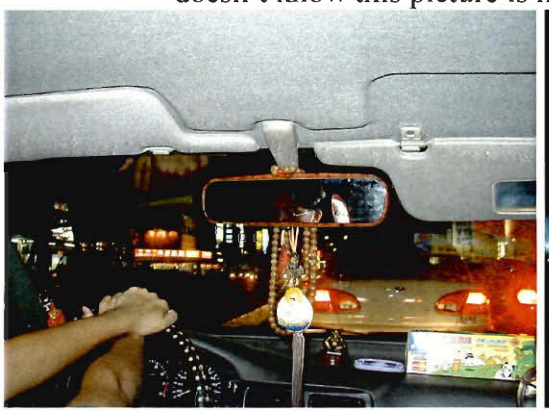
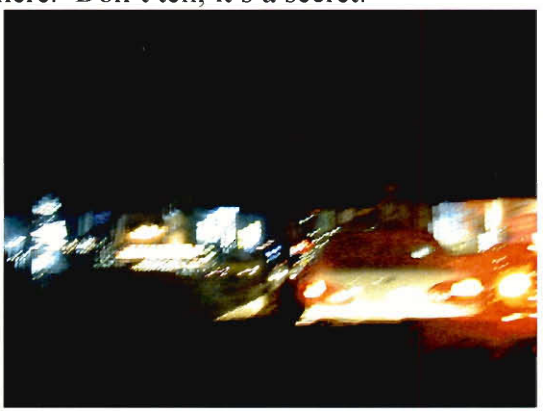
Workers consider the best ways to repair the damage done.

Things got a little crazy on the way home that night…


(Left) Fred greets the camera with a smile. (Right) Never camera shy, Lewy says hi.




(Left) Dahmer is a little skittish, and the flash gives him a fright. (Right) Casey doesn't know this picture is here. Don't tell, it's a secret.

Tomas is a lunatic behind the wheel.

Day 3, 11-5-99
Chi Nan University and Puli


The camera was held straight; it's this building in Puli that is actually no longer upright.


Chi Nan University is only a of couple years old, and suffered purely esthetic damages.

A minor landslide occurred next to campus. This retaining wall broke, but caused no other damage.

Trip 2 – 11-6-99

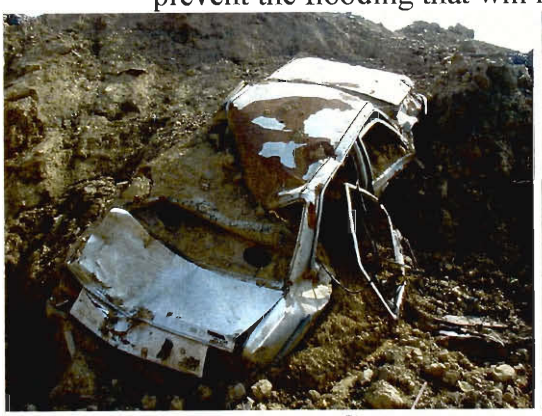
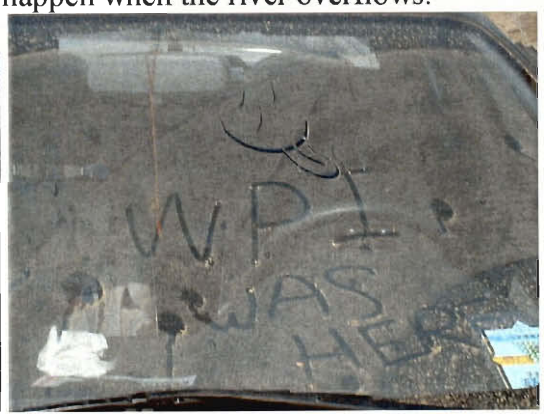
This is Tony; he was our guide on the second trip. He's crazy.

Tsao Ling

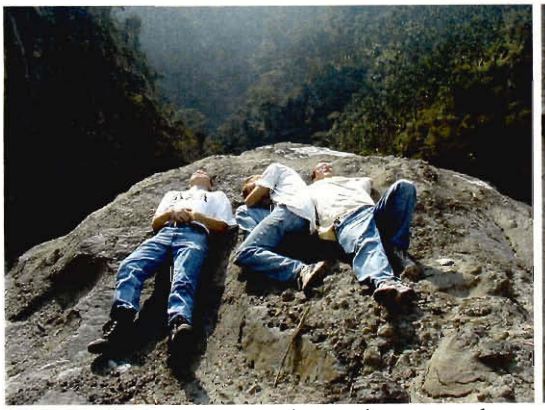

In the Tsao Ling landslide 350,000,000 cubic meters of soil moved.


Graduate students from Central Taiwan University learn what they can from the site.


The landslide created a damn that cut off a river. One concern for engineers is how to prevent the flooding that will happen when the river overflows.

Cars can get very dirty in this area.



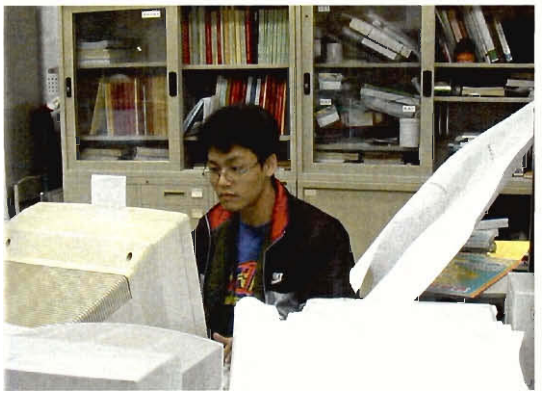

The tired scientists take a much-needed nap. Some are lazier than others.

Appendix–4 Friends

Starting from the left are Tony, Enid, Ann, Thomas, and Fred. We were on our way to Tamshui, a part of Taipei known for their seafood. (Left) Starting from the left are Speedy, Robinhood, and Thomas during a typical day at the office at NTU. (Right)

On one Sunday we visited some old friends of Matt Lewis's. We went on a relaxing walk in the park and enjoyed a traditional Chinese dinner later that afternoon.

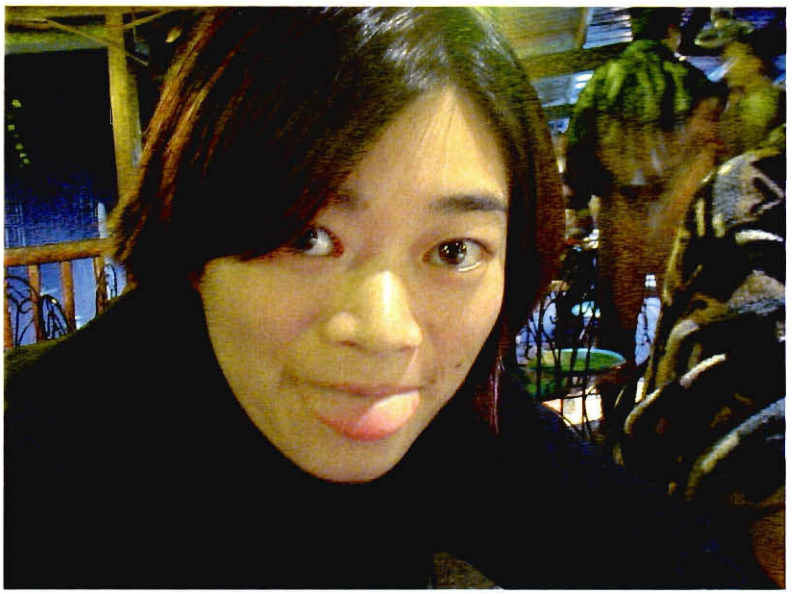
Professor Jeng explained some interesting geological formations along the fault line. (Left) Jack was working on his Ph. D., although he was often very busy, we still had enough time to become friends. (Right)



Andrew was helpful in the creation of our report and in solving other problems that arose occasionally. (Left) Ann and Steven during another typical day in the office. (Right)

This photograph of Tony's car speeding was taken by a hidden police camera while he was driving us somewhere. The sacrifices our friends took for us were admirable. (Left) Starting from the left are Matt Dahmer, Ann, Thomas, Fred, Matt Lewis, Enid, and Tony. We were at a nice seafood restaurant by the water in Tamshui. (Right)

We were invited to the birthday party of one of Horng's friends at a Karaoke TV. The Birthday girl is in the middle in the left-hand picture and Horng in on the far right in the right-hand picture



Ann was one of our closest friends in Taiwan. This is her second year studying for her masters in geotechnical engineering and she hopes to start studying in America within the next couple of years to obtain her Ph. D.

Thomas and Tony were also two good friends of ours during our time in Taiwan. They drove us too the disaster areas during our site visits and allowed us to stay with their families while we were away from Taipei. They are also both graduate students studying to get their masters in civil engineering.