Chapter 1 Case Studies and Study Guide: Introduction to Natural Disasters and Human Impact - DRAFT

Case Study 1: Two Moderate Earthquakes – Very Different Outcome

Population density; time of day; Bam vs. Northridge

- population density
- time of day controls number of fatalities

bad times in areas with poorly build residential housing: night times when most people are at home (e.g. 2003 Bam, Iran)
bad times in areas with extensive transit systems: rush hour times

Figure 1.1a The ancient part of the city of Bam, Iran before the 26 December 2003 earthquake. (source: Wikipedia)

Figure 1.1b the Bam Citadel before and after the earthquake. (source: Wikipedia)

Bam, Iran, 12/26/2003 5:26am local time

- magnitude 6.6
- at least 26,000 fatalities
- displaced 90% of residents
- destroyed 70% of modern city
- severely damaged famous citadel (tourist attraction)

The Bam Citadel (Arg-é Bam) was the largest adobe building in the world and a UNESCO world heritage site. The enormous citadel on the Silk Road was built before 500 BC and in use until 1850 AD.

Figure 1.2 Collapsed section of the Santa Monica freeway (I-10) at La Cienega Blvd. exit after the 17 January 1994 Northridge earthquake. (source: Wikimedia)

Figure 5.1 The Northridge Meadows Apartment Building where 16 people were killed in the 17 January Northridge earthquake. The apartment is located in an area of Northridge of about five square miles where intense damage occurred to this type of apartment. The building building had garages on the ends of the first floor and apartments in the middle. Some of these first floor apartments collapsed. (source: NOAA; photo: J. Dewey, USGS)

Northridge, CA, 01/17/1994 4:13am local time (PST)

- occurred on previously unmapped fault (blind fault, covered by sediments)
- situated in sedimentary basin that enhanced shaking
- magnitude 6.7
- 65 fatalities
- $12.5 billion damage
- damaged thousands of homes in Northridge
- severely damaged Santa Monica Freeway (I-10) which was rebuilt in record time
- in response to EQ, new building codes set up and all freeways in Southern California were retrofitted

Case Study 2: The 18 April 1906 San Francisco Earthquake(3)

Figure 5.1a Photographer Arnold Genthe took the most famous photo of the destruction of San Francisco by earthquake and fire on 18 April 1906. The photo shows Sacramento St. near Powell St. on the first day of the fire. (source:Wikipedia)

Figure 5.1b Damage of the 1906 San Francisco earthquake in the vicinity of Post and Grant Avenues, looking northeast. (source:Wikipedia)

Figure 5.1c The 1906 earthquake also affected Stanford University in Palo Alto. The iconic photo shows the fallen statue of geologist Louis Agassiz outside the Zoology building, 50 km (30 mi) from downtown San Francisco. (source:Wikipedia)

The magnitude M_W=7.8 1906 San Francisco earthquake struck at 5:12 am on 18 April and was felt from Oregon to Los Angeles, and inland into central Nevada. The epicenter was likely off-shore as a small tsunami was registered at the San Francisco Presidio. The quake ruptured the northern third of the San Andreas Fault for a length of 475 km (295 mi). At some places, the ground moved by 6m (20 ft). A strong foreshock preceded the main shock by 20 to 25 s and the shaking from the main shock lasted between 45 and 60 s. The shaking in San Francisco reached intensity VIII on the Modified Mercalli Intensity scale, and up to IX in areas to the north such as Santa Rosa. It was noticed that the shake intensity reflected underlying geological conditions. Areas in sediment-filled valleys experienced stronger shaking than nearby sites on solid bedrock. The strongest shaking was observed on ground reclaimed from the San Francisco Bay. In Monterey County, the earthquake permanently shifted the course of the Salinas River near its mouth. Previously, it flowed into Monterey Bay near Moss Landing. The quake diverted it 8 km (5 mi) to the south into a new outlet halfway between Moss Landing and Marina.

The quake destroyed 80% of San Francisco. Most of the destruction resulted from subsequent fires that raged out of control (see also Chapter 6). Initial estimates of the death toll were some 375 but even then it was felt that this number was rather low. Suspicion arose that the number was downplayed by government officials and business people who feared that reporting a higher death toll would hurt the real estate market and investment efforts to rebuild the city. At the very least, hundreds of fatalities in Chinatown were ignored or unreported. More recent estimates stemming from renewed analyses in the 1980s place the death toll at 3000 or even more. This would make the 1906 earthquake the second deadliest natural disaster in U.S. history after the 1900 Galveston hurricane and the deadliest natural disaster in California history. The quake would leave a significant impact on the development of the city and of California as a whole. With 410,000 residents, San Francisco was the ninth-largest city in the U.S. and was the largest on the west coast. Over a period of 60 years, the city had become the financial, trade and cultural center of the West. It also operated the busiest port on the

West Coast. Between 227,000 and 300,000 people were left homeless. About half the population evacuated across the bay to Oakland and Berkeley but many residents took refuge in tent cities. 20,000 people lived in redwood and fir "relief houses" in temporary housing camps. By 1907, most people had moved out of these houses but tent cities in Golden Gate Park, the Presidion and some other areas were still in full operation in 1908. After the quake, building standards were at first made very stringent. But after a year, building codes were relaxed to expedite the rebuilding, allegedly because contractors complained. Though San Francisco rebuilt quickly, the disaster diverted trade, industry and population growth south to Los Angeles which is now the largest and arguably the most influential urban area in the West. Overall damages were estimated at around $400 million ($9.5 billion in 2009 dollars).