

Skills focus

Find photographs on the internet of two urban areas in very different parts of the world that have suffered from devastating earthquakes (not the cities covered in this chapter). Use your observational skills to describe the damage shown in each photograph, in particular focusing on the differences that may be seen. If you identify any major differences, try to explain how they have come about.



Managing the seismic hazard

● **Prediction:** The prediction of earthquakes is very difficult. Regions at risk can be identified through plate tectonics, but attempts to predict a few hours before the event are questionable. Such attempts are based upon monitoring groundwater levels, release of radon gas and unusual animal behaviour. Fault lines such as the San Andreas can be monitored and the local magnetic fields measured. Areas can also be mapped on the basis of geological information and studies made into ground stability in order to predict the impact of an earthquake and to produce a hazard zone map that can be acted upon by local and even national planners.

Close studies of fault lines can sometimes indicate the point along the fault where the next earthquake could be due. A study of the pattern of the events along the San Andreas fault between 1969 and 1988 indicated the existence of a 'seismic gap' in the area of Loma Prieta (that is, the area had not had any real seismic activity for the past twenty years). This area suffered an earthquake in October 1989 that measured 6.9 MMS and was the worst to hit the San Francisco region since 1906. In total, 63 people died as a result of the event with over 3,700 seriously injured. Because of the seismic survey, this event was not entirely unexpected, but like all earthquakes, it was not possible to predict it precisely. Such a system, however, would not work for events such as the one at Northridge, as this took place on an unknown fault line.

● **Prevention:** Trying to prevent an earthquake is thought by almost all to be impossible. This, however, has not stopped studies into the feasibility of schemes to keep plates sliding past each other, rather than 'sticking' and then releasing, which is the main cause of earthquakes. Suggestions so far as to lubricating this movement have focused on water

and oil. Some people have even gone as far as to suggest nuclear explosions at depth!

- **Protection:** Since earthquakes strike suddenly, violently and without warning, it is essential that everyone from civil authorities to individuals are prepared. In the USA, the Federal Emergency Management Agency's (FEMA) programme has the following objectives:
 - to promote understanding of earthquakes and their effects
 - to work to better identify earthquake risk
 - to improve earthquake-resistant design and construction techniques
 - to encourage the use of earthquake-safe policies and planning practices.

Protection therefore means preparing for the event by modifying the human and built environments in order to decrease vulnerability. It also includes attempts to modify the loss by insurance and aid. Some of the ways are described below:

- **Hazard-resistant structures:** Buildings can be designed to be aseismic, in that they can be earthquake resistant. There are three main ways in which this can be achieved:
 - By putting a large concrete weight on top of the building which will move, with the aid of a computer programme, in the opposite direction to the force of the earthquake in order to counteract stress.
 - Putting large rubber shock absorbers in the foundations which will allow some movement of the building.
 - By adding cross-bracing to the structure to hold it together better when it shakes.

Older buildings and structures, such as elevated motorways, can be **retrofitted** with such devices to make them more earthquake proof. A comparison between the 1989 Loma Prieta earthquake (6.9 MMS) and the 1988 event in Armenia (6.8 MMS) shows the effects of different types of buildings. The greater earthquake-proof buildings of California resulted in 63 deaths, whereas in Armenia, over 25,000 people died, many inside buildings that collapsed as a result of soft foundations and no earthquake-proofing features. In the town of Leninakan, for example, over 90 per cent of more modern 9–12 storey pre-cast concrete frame buildings were destroyed.

- **Education:** For many areas, this is the main way that loss of life can be minimised. Instructions are issued by the authorities in how to prepare for such events by securing homes, appliances and heavy furniture, and assembling 'earthquake kits'. Children have earthquake drills at school as do people in offices and factories. Government offices and many companies in Japan observe Disaster Prevention Day (1 September) which marks the anniversary of the Tokyo (Kwanto Plain) earthquake in 1923. Following the Loma Prieta event (1989), the American Red Cross issued a list of supplies that people should keep at hand in case of an earthquake. These include water (at least a three-day supply for all persons in the house, and pets!); a whole range of foodstuffs (particularly canned and high energy foods); clothing and bedding; first aid kit; and tools and supplies (to include radio, torch batteries, can opener, matches, toilet paper, small fire extinguisher, pliers and aluminium foil).
- **Fire prevention:** 'Smart meters' have been developed that can cut off the gas if an earthquake of sufficient magnitude occurs. In Tokyo, the gas company has a network that transmits seismic information to a computer which then informs employees where to switch off major pipelines, so reducing the number of fires.
- **Emergency services:** These need careful organisation and planning. Heavy lifting gear needs to be available and many people should be given first aid training, as it could be some time after the event that trained medical personnel arrive. Much of the preparation in California involves the establishment of computer programs that will identify which areas the emergency services should be sent to first.
- **Land-use planning:** The most hazardous areas in the event of an earthquake can be identified and then regulated in terms of land use. Certain types of buildings should be put in areas of low risk, such as schools and hospitals. It is also important to have sufficient open space, as this forms a safe area away from fires and aftershock damage to buildings.
- **Insurance:** In richer areas, people are urged to take out insurance to cover their losses, the only problem being that for individuals, this is very expensive. In the Kobe earthquake in Japan in 1995, for example, only seven per cent of the people were covered by earthquake insurance.
- **Aid:** Most aid to poorer countries has generally been to help in the few days after the event, providing medical services, tents, water purification equipment, search and rescue equipment, etc. Aid over the longer term is much more problematical; it is something which is needed for the reconstruction of the built environment and redevelopment of the economy.
- **Tsunami protection:** Tsunamis cannot be entirely predicted, even if the magnitude and location of an earthquake is known. Certain automated systems can be installed to give warnings, the best of which uses bottom pressure sensors, attached to buoys, which constantly measure the pressure of the overlying water column. Regions with a high tsunami risk use warning systems (such as a klaxon) to warn the population before the wave reaches land. The Pacific Warning System is based on Hawaii. It monitors earthquake activity and issues warnings to countries around the Pacific edge if tsunamis are likely. Some countries have built prevention walls up to 12 m in height. These have not proved very effective, as large tsunamis are likely to overwhelm them.

Seismic events

Haiti (West Indies), January 2010

In January 2010 an earthquake of magnitude 7.0 MMS and depth of 13 km, struck the Caribbean country of Haiti, the poorest country in the western hemisphere. The epicentre was located 25 km west of the capital, Port-au-Prince (Figure 5.25). Following the initial event, the area recorded at least 50 aftershocks measuring 4.5 or greater.

- **Risk and vulnerability:** The risk from physical hazards is high in Haiti. It lies at the junction of the North American and Caribbean plates and between two fault zones: the Septentrional Zone to the north and the Enriquillo-Plantain system that runs directly beneath Port-au-Prince. The 2010 earthquake was the seventh major event recorded since observations began in the 1550s. Earthquakes also occur in the neighbouring country of the Dominican Republic; a tsunami generated by an earthquake there in 1946 killed 1,800 people in Haiti and injured many others. People are also at risk from tropical cyclones, with frequent flooding and widespread damage. Several storms in 2008 killed over 800 people.