Seismic disasters in Turkey and Colombia in 1999

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«On an urban scale for example, vulnerability as an internal risk factor should be related not only to the exposure of material aspects or their physical susceptibility to being affected, but also to social fragility and the lack of resilience of the affected community. A lack of institutional and community organisation, weaknesses in the preparations for dealing with emergencies, political instability and a lack of economic health in a geographical area contribute to increasing risk.»

In 1998 and 1999 the end of the century saw two years during which a number of very notable disasters occurred in the world. In 1998, when the effects of El Niño had still not ended in various places, two powerful hurricanes appeared which seriously affected the Caribbean and Central America: **Georges** and **Mitch,** these caused unprecedented consequences in these regions. In 1999 there were a surprising number of disasters caused by earthquakes. The first event with consequences of great magnitude occurred in Colombia on January 25 in the coffee growing region. After this there were events in India, in Chamoli, on March 29 and in Mexico, Tehuacán, on June 15. In the second half of the year, on August 17, there was one of the worst seismic disasters in modern times, the Kocaeli earthquake in Turkey. After this, on September 7, there was an earthquake which seriously affected Athens, in Greece, and a very serious earthquake occurred on the 21st of the same month in Taiwan. A few days later the city of Oaxaca, in Mexico, was affected by an earthquake on September 30, and on November 12 another earthquake affected the area of Düzce, again in Turkey. The year 1999 ended with a disaster of another type which contributed towards a notable increase in the number of disaster victims: enormous mud slides and rubble movements brought about by heavy rainfall and which destroyed a large number of towns and villages in the state of Vargas in Venezuela between December 17 and 18.

It seems ironic that these types of situations so notably worsened at the end of the 90s, when the same period also marked the close of the International Decade for the Reduction of Natural Disasters, promoted by the United Nations in order to stimulate the mitigation/prevention of disasters in various countries around the world. The fact is that although the decade contributed towards raising public and institutional awareness of the matter, in practice no more was achieved than to attain a better understanding of why disasters occur around the world. The word "disaster" is not synonymous with "natural phenomenon"; economic and social development conditions are factors which without any doubt play a role in the level of vulnerability and resilience of human settlements. Science is necessary, but is not sufficient in order to guarantee hazard reduction when confronted by natural phenomena, and hazard management forms a fundamental component of urban planning and an inescapable strategy in

order to achieve sustainable development.

In order to manage risk it is necessary to quantify it in terms of its possible economic, social and environmental consequences in a particular place, bearing in mind, from a multidisciplinary point of view, not only the physical damage which is expected - the victims or equivalent economic losses - but also social, organisational and institutional factors. All of these factors are related to the development of communities. On an urban scale for example, vulnerability as an internal risk factor should be related not only to the exposure of material aspects or their physical susceptibility to being affected, but also to social fragility and the lack of resilience of the affected community. A lack of institutional and community organisation, weaknesses in the preparations for dealing with emergencies, political instability and a lack of economic health in a geographical area contribute to increasing risk. Potential consequences are therefore not only related to the impact of the event but also to the ability to deal with it and its implications in the geographical area under consideration.

«These disasters easily lead to the conclusion that it is also necessary to have controls and supervision which guarantee that regulations are correctly applied. There should be a continuous process of professional training and updating, not only to guarantee that the personnel correctly apply the regulations but also in order to educate them as to the desirability of applying the regulations with due rigour.»

Collapse of old building constructed without anti-earthquake requirements in Armenia, Colombia.

The Kocaeli disaster in Turkey and the Quindío event in Colombia have been the source of some important lessons for seismic engineering and disaster prevention:

a) The danger for a region of **having a number of buildings not complying with minimum earthquake resistance requirements** was confirmed. The majority of buildings which were affected by these earthquakes were reinforced concrete structures with structural elements of insufficient dimensions, low quality concrete and insufficient reinforcement steel. The main damage to structures was caused by sharing strains, due to deficient reinforcement steel specifications and the lack of transverse steel and concrete confinement in structural elements. The faults were of a brittle nature, evidencing deficient capacity for dissipation and absorption of inelastic energy in the affected structures, many of which went on to collapse. It was also confirmed that non-reinforced fragile brick masonry buildings are a grave danger to their inhabitants due to the fact that they do not give enough time to react when affected by an earthquake.

b) It was convincingly demonstrated **that adverse interaction of non-structural elements** with the buildings themselves is the cause of serious damage which may even lead to the collapse of the buildings. The "short or captive pillar" effect was evident, as was torsion due to eccentric rigidity caused by the asymmetric arrangement of dividing walls and the poor behaviour of buildings of irregular shape. There is no doubt that an earthquake resistance design and construction code which is up-to-date and in accordance with present-day knowledge is a necessary condition for hazard prevention and reduction, al-

Building overturned due to ground liquefaction and intense acceleration in Adapazari, Turquía.

though it should be said that a code by itself is not sufficient. These disasters easily lead to the conclusion that it is also necessary to have controls and supervision which guarantee that regulations are correctly applied. There should be a continuous process of professional training and updating, not only to guarantee that the personnel correctly apply the regulations but also in order to educate them as to the desirability of applying the regulations with due rigour.

c) The necessity of **reinforcing buildings which are indispensable or essential to the community in case of disaster was confirmed.** Hospitals, fire stations and in general the buildings which serve to attend the community should be assessed and renovated from an earthquake resistance point of view.

d) It was also confirmed that it is vital to consider **collateral seismic phenomena,** such as the liquefaction of the ground and the rupture areas of geographical faults. These location-specific effects should receive primary attention in urban development plans and in the regulations concerning the use of land in order to avoid these areas being urbanised.

e) In the city context, the importance of having **inter-institutional hazard reduction programmes** was confirmed. These should consider technical and scientific aspects as well as planning and development, education, public information and training in order to deal with emergencies and disasters. The importance of rediscovering and maintaining local seismic culture was noted, in the case of Colombia this is expressed through traditional bamboo buildings which since the last century have been a construction technology which has evolved and has been perfected through the community's interest in coping with earthquakes.

f) It was demonstrated that it is necessary to possess **local capacity in order to respond in case of emergency.** Local government should be backed by a local disaster prevention and attention committee which is supported and properly led by the political authority of each area. Although the inter-institutional response in case of emergency should start from the bottom and progress to the top, starting with the local reaction and later on the regional level, in the case of dealing with a very severe disaster which exceeds local and regional capacity, it is vitally necessary to be able count on adequate coordination and capacity in the national response, in this case this

was put to the test and demonstrated its present day technical and operating weakness.

Many regions and countries are in similar situations. Buildings with the same characteristics –making them more vulnerable– have been constructed and are continuing to be constructed in many of the world's cities. On these occasions the disasters occurred in Turkey and Colombia amongst others in 1999, but this situation will probably be repeated in other places over the next few years. Unfortunately, for a seismic disaster to occur it is not simply necessary that there should be a high seismic threat or danger, a high level of building vulnerability also increases risk - this is frequently associated with the fact that the seismic threat is considered to be slight. **Bearing in mind factors such as the magnitude of these disasters, the communication difficulties, the lack of a rapid quantification of damage, the restrictions on resources in order to deal with the crisis and a lack of training of the personnel who should deal with the emergency, it is possible to say that a similar situation might present itself in any country or region in which an event of these characteristics could occur.** This does not excuse the delay and lack of institutional coordination of the official bodies, but it does confirm that even if there is a high response and reaction capacity when confronted by an event such as this, this capacity will never be enough, although it is clear that it is necessary to be able always to count on emergency and rescue teams which are a of a high technical level and are well trained. Without any doubt similar events may occur in many other parts of the world, and the consequences could be similar.

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The need to correctly apply earthquake resistance construction codes, the reinforcement of buildings which are a vulnerable to earthquake and the application, in general, of hazard prevention and reduction measures, has again been revealed to be the one and only true path towards avoiding disasters such as those which occurred at the end of the 20th century. ■