Seismic and Tsunami Risk on the South-West Coast of Peru

The southern coast of Peru and northern Chile are characterized by the occurrence of high-magnitude earthquakes, on the order of eight degree or more, in the subduction zone. Such earthquakes have caused severe damage through seismic vibrations and floods from tsunamis on the lower coasts, as was the case of the above-mentioned earthquake of 1868, which destroyed the coastal strip and part of the mountain chain in the departments of Tacna, Moquegua and Arequipa. Arica was devastated by tsunamis and the American warship Wateree, which had been anchored off its coast, was beached 300 metres inland.

Relief map of the region under study.

Possible effects of a high-magnitude earthquake in population centres representative of the region under study

The events of 1868 could recur, since there have been no significant earthquakes in the above-mentioned area for over 100 years, and a great quantity of energy is believed to have been accumulating, which might find release in a major calamity. In the light of these assumptions, studies were conducted on the potential impact of such a calamity on the coastal strip and part of the mountain chain in the departments of Arequipa, Moquegua and Tacna, and of tsunamis on their coasts.

The purpose of the studies was to determine the potential seismic effects on large cities such as Arequipa, Moquegua and Tacna, and on typical mountain and coastal communities.

The risk in case of major earthquakes is accentuated by the high percentage of adobe constructions in the region under consideration. In the older areas of Moquegua and Tacna this type of constructions can sustain severe damage in the event of an earthquake of the type postulated.

The results were achieved by dividing the population centres into sectors according to their soil, geology and topography and assigning each one the most probable levels of intensity; next the characteristics and state of preservation of their buildings were determined, as a prelude to calculating the number of dwellings that would sustain light, moderate or severe damage, partial destruction or collapse.

In the department of Arequipa, the adobe dwellings of typical mountain villages like Pampacolca and Chuquibamba (see Fig. on p. 14) are much more vulnerable than those of typical coastal villages like Chala and Matarani. Mountain villages are built on soft soil of medium compactness and have been damaged by previous earthquakes with their epicentres on the continent, such as the one that occurred in 1979.

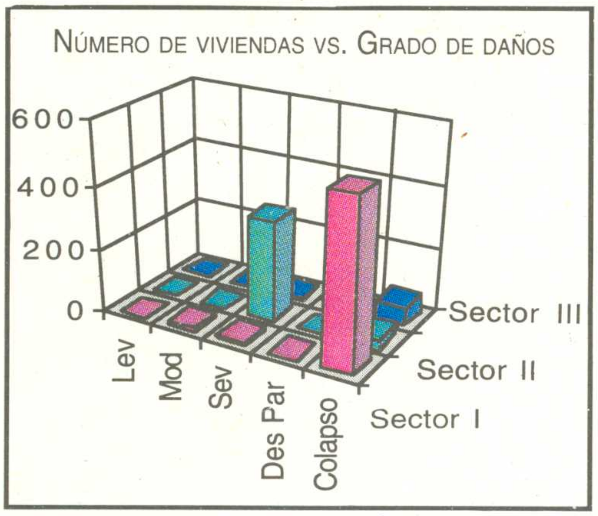
A model case is Mejía, a middle- and upper-class seashore resort in Arequipa, which combines two favourable factors: compact and dry or rocky soil, and modern buildings that are earthquake resistant for the most part. As a result, most of the houses would sustain only light or moderate damage, while only a few would be severely damaged in the three sectors into which the city was divided for the study (see fig. on p. 14).

In the case of Arequipa, the greatest damage would occur in the old town, where ashlar buildings weakened by previous earthquakes predominate, and in areas where, due to the closeness of groundwater to the surface, high seismic intensity may be expected. On the other hand, damage would be less serious in the new residential districts, where most structures are built of brick, strengthened with reinforced concrete columns and beams, and in the numerous constructions built upon rock base. In some of these places, ashlar constructions from the 1920s have been found to sustain no damage in any of the many earthquakes that have hit Arequipa since then, despite their low earthquake resistance.

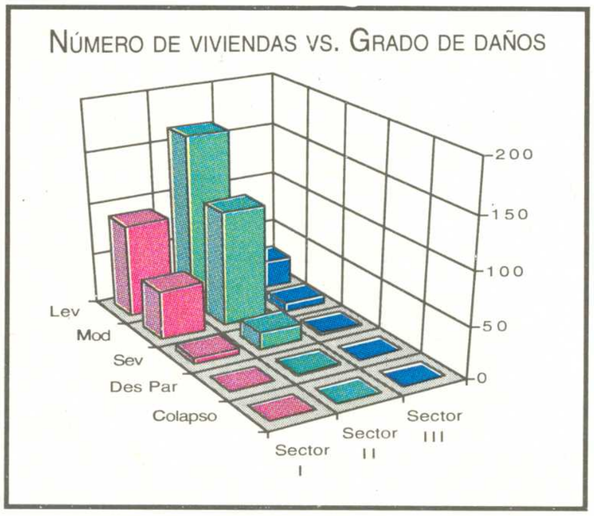
Adobe constructions weakened by past earthquakes and the soil moisture, which increases seismic intensity, making them high-hazard factors. The high adobe wall in the photograph, separated from the other walls by cracks, is a hazard for passer-bys.

Comparison of expected seismic damage in a typical village in the Arequipa mountains (Pampacolca) and a typical coastal village with favourable socio-economic conditions and soil (Mejía)

Pampacolca



Ciudad de Mejía



Seismic instrumentation

In order to study and monitor the subduction zone, a possible zone of seismic gap in south-western Peru, and to investigate intraplate events in that region, especially the extension of the San Agustín fault to the south of Arequipa, the PMDP purchased three Kinemetric semi-portable seismographs, model PS/2, AM-2, SS-1. These, together with the instruments that UNSA has already installed, made up the south-western Peru network.

The system acquired for the monitoring of the El Misti volcano consisted of one field station model SS-1, AM-2, OM-2, CM-2, powered by an M75 solar panel and a central recording station model TR-1, DD-12, MD-2, pp-1 and VHU aerial, joined telemetrically.

We know that one of the most effective ways to monitor a volcano is through seismographs. In case of any unusual increase in seismic activity, at least four stations are to be installed around the volcano in order to pinpoint the location of earthquakes caused by volcanic activity.

Possible effects of tsunamis on the south-western coast of Peru

The possible effects of tsunamis were studied over a distance of 632 km, North of the border with Chile. The localities studied were Boca del Río in Tacna, Ilo in Moquegua, and Mejía, Mollendo, Islay and Chala in Arequipa. For each place the minimum arrival time for the first tsunami wave, was determined which varied from 5 minutes for Chala to 10 minutes for Mejía.

The height of the coastal wave, or run-up, was also estimated; it ranged from 7.10 m for Boca del Río to 10.5 m in Islay.

The table below summarizes the results obtained.

The data contained in table 1 should be used with caution, since hydrological phenomena occurring during violent flooding from tsunamis cannot be estimated by linear calculation. It is practically

Table 1

Locality studied	Estimated minimum time of arrival of the first wave in minutes	Estimated height of wave (run-up) in metres
Boca del Río	6	7.1
Ilo	7	8.5
Mejía	10	8.3
Mollendo	8	8.8
Islay	7	10.5
Chala	5	9.8