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OF HAZARD:
MEGA-CITIES AND DISASTERS
IN TRANSITION

Edited by James K. Mitchell
Lima, Peru: Underdevelopment and vulnerability to hazards in the city of the kings

Anthony Oliver-Smith

Editor’s introduction

The impact of external economic factors on susceptibility to urban environmental hazard is a theme that appears in several chapters of this book but nowhere is it more strongly presented than in this case study of Lima. Anthony Oliver-Smith underlines the city’s role as a conduit for resources mobilized first by self-serving decisions of colonial masters in Spain and later by exploitative international financiers based in the United Kingdom and the United States. Here Lima implicitly stands in place of other Latin American mega-cities with similar origins and histories of dependency that have also experienced severe environmental hazards. On the other hand, Lima is distinctively different. It can be argued that the signal risks of this site would have posed serious difficulties for large-scale urbanization under any socio-economic regime. Moreover Peru has fostered links with Japanese hazards scientists and other specialists that have made a distinctive contribution to the national hazard-management system. Indigenous experiences and resources combined with external skills and modest investment in local hazard management could make significant inroads on the city’s admittedly daunting hazard problems.
Introduction

Peru is Lima and Lima is the Street of the Union and the Street of the Union is the Palais Concert.

So went the ironic comment of turn of the century Peruvian writer, Abraham Valdelomar (1888-1929; as quoted in Ortega, 1986, p. 1). In a single sentence, Valdelomar captured the essence of one of Peru’s most critical problems. Since its founding over 450 years ago, the citizens of Lima have considered themselves to be Peru and have always cast their gaze toward Europe rather than toward the country at their back (fig. 8.1). The strength of that vision has strongly affected Lima’s social and economic development, its demographic growth, and its spatial expansion – all of which have in turn reinforced the city’s vulnerability to natural and technological hazards.

Lima was founded in the middle of a broad valley that includes three separate rivers. Since pre-Colombian times the central river has been called the Rimac (literally, “the who speaks” in the native Quecha language). The city that grew up on its banks has unquestionably spoken the loudest of any in Peru’s post-conquest history. As Lima continues the process of explosive growth that began early in the twentieth century, its voice threatens to drown all others. Homes and workplaces have expanded away from the Rimac into the adjacent Lurín and Chillon river valleys as well as the surrounding Andean foothills. What was once a single small municipality is now a complex fragmented urban region that contains 50 separate local governments and houses over 7.5 million people.

Lima’s environmental hazards can be understood only in a wider context. The vulnerability of Lima to natural and technological hazards has been deeply influenced by historical processes of development and underdevelopment that shaped much of the world system (Ortiz de Zevallos, 1986). In Peru these processes have not just created an unequal distribution of wealth and benefits, but also given rise to powerful symbolic images. These include polarized visions of society that define and reinforce identity and power: colonizer/colonized, white/Indian, coast/highlands, civilized/barbaric, Lima/village (Jacobsen, 1993, p. 3). For many generations of urban migrants it is the contrast between Lima’s image of utter centrality and primacy and the rest of Peru’s image as exploitable resource base or barbarous frontier that has come to define concepts of progress, hope, and modernity. These polarized visions, forged from the very moment of Lima’s founding, lie at the heart of the contemporary city’s substantial vulnerability to hazards.
Fig. 8.1 Peru
The physical environment

The natural settings in which humans find themselves, whether by accident or by design, invariably contain advantages as well as disadvantages. Often, the same phenomenon constitutes a resource as well as a hazard. For example, settlements near rivers or coastlines can be places of both sustenance and danger. Indeed, human settlements are often initially sited in close proximity to resources that later turn out also to be hazards. Such was the case in sixteenth-century Lima. The natural resources of the site included plentiful water supplies from the valley’s rivers, ample terrain for a settlement and supporting agriculture, a fine port, and a temperate climate. The Rimac is the richest and most extensive of all the valleys on the central Peruvian coast. On either side of the river’s mouth are two long bays that shelter the best natural anchorage on the entire coast (see fig. 8.2). When Francisco Pizarro chose this location for Peru’s new capital in 1535 he recognized natural advantages that were already well known to the indigenous peoples, who had practised a complex, intensive system of agriculture there for thousands of years (Pacheco Velez, 1982, p. 13). The place was also well regarded by its earliest European inhabitants. In the words of one chronicler of those times:

Its Fertility joyn’d to the Plenty of all things, never sensible of any intemperature in the air, which is so uniform, was it not interrupted by the frequent earthquakes, I do not think, says Frezier, that there is a fitter Place to give us an Idea of a terrestrial Paradise. (Lozano, 1755, p. 4)

But Lima was – and is – substantially at risk from several different kinds of natural extremes.

Natural systems and natural risks

Three vast interacting natural systems affect the environment of Lima: the Pacific Ocean, the coastal desert, and the Andean cordilleras. A fourth, the tropical Amazon forest, plays a more limited but still important hydrological role in coastal climates. These systems interact to create a unique set of geological, atmospheric, and hydrological hazards. Lima lies within a broad zone of crustal plate convergence that is characterized by land deformation, orogenic uplift (mountain-building), seismic activity, and vulcanism. Subduction of the eastward-moving oceanic Nazca plate, as it slips under the rim of the continental South American plate, has given rise to the Andes mountains as well as conditions of high seismic instability and volcanic activity (Repetto et al., 1980). Extensive weathering and erosion of the mountains around Lima
have contributed large sediment loads to adjacent valleys, and the city's substrata are mainly composed of boulders, cobbles, and gravel in a mix of silty sand. Together these materials usually form a very hard and compact mass, although clays and loose sandy soils are also present in some areas at depths of 100 m (Moran et al., 1975, pp. 5–6).

The city sits on an elevated, gently sloping plain that covers about
3,500 km² and stretches inland along the Rimac valley towards steep mountains approximately 40 km to the east. Within this plain the local rivers are separated by low rolling hills. The availability of relatively flat land has permitted Lima to spread westward toward the coast and also – to some degree – into the hills that lie north and south. Hills such as the Morro Solar, el Agustino, San Cristobal, and San Geronimo have in recent years been occupied by migrant populations from rural districts. The built-up area has also begun to extend eastward into the narrower upper part of the Rimac valley. There, towns such as Chosica and Chaclacayo are still separated by farmland from metropolitan Lima, but it is likely that this physical separation will soon end (Ferradas, 1992, pp. 36–37). Much of metropolitan Lima is roughly 100 m above sea level, but the coastline varies from 80 m bluffs near Chorrillos to sea level at the port of Callao (located on the westernmost peninsula; fig. 8.2) (Kuroiwa et al., 1984, p. 801). Predictions of sealevel rise due to global warming indicate that large, now densely populated areas of Callao may be in significant danger of future flooding.

The Rimac valley cuts across a long narrow strip of extremely arid coastal desert that stretches from the Andes to the ocean between Ecuador and northern Chile. In the vicinity of Lima, annual precipitation is low and ranges from 0 to 50 mm. The scant precipitation is insufficient to support much flora beyond a few hardy species in the coastal desert. Although the appearance of the natural environment is often harsh and barren, when the soils of these desert valleys receive water from rivers or irrigation systems, they burst into florescence; they are some of the most fertile agricultural land in Peru, on which the vast majority of export crops are grown.

In many respects the climate is unusual for a low-latitude location (approximately 12 degrees N). From May to December the region is normally completely covered with dense clouds and fog at altitudes from 500 to 800 m. These render only a heavy mist, locally called "garua," which is described as "more bothersome than dampening" (Pulgar Vidal, 1987, p. 34). Thus, for as much as eight months of the year, when air temperatures rarely drop below 11°C, the city of Lima is shrouded in a humid blanket that feels penetratingly chilly. On rare occasions, summer temperatures have reached heat wave proportions, as they did in early January of 1983 when 17 people succumbed to heat prostration and dehydration and over 2,700 people were affected (OFDA–AID, 1988, p. 154).

The unusual climate has evoked very different responses among those who experience it. In sharp contrast to Lozano’s portrayal of Lima as an earthly paradise, Herman Melville described it in quite different terms:
Nor is it, altogether, the remembrance of her cathedral toppling earthquakes; nor the stampedes of her frantic seas; nor the tearlessness of arid skies that never rain; nor the sight of her wide field of leaning spires, wreathed copestones, and crosses all adroop (like canted yards of anchored fleets); and her suburban avenues of house-walls lying over upon each other, as a tossed pack of cards; it is not these things alone which make tearless Lima, the strangest, saddest city thou canst see. For Lima has taken the white veil; and there is a higher horror in this whiteness of her woe. Old as Pizarro, this whiteness keeps her ruins for ever new; admits not the cheerful greenness of complete decay; spreads over her broken ramparts the rigid pallor of an apoplexy that fixes its own distortions. (1961, p. 194)

The bizarre climatic combination of heavy cloud cover, moderate temperatures, extremely arid terrain, high humidity, and low rainfall is closely connected with the juxtaposition of very humid cold oceanic air, which overlies the Peruvian and Humboldt offshore currents, and very dry stable air over the land. Although these conditions regularly reproduce the city's most characteristic weather, the region is also extremely sensitive to perturbations in the ocean-to-atmosphere energy transfer system (Moseley et al., 1981, p. 234). At irregular intervals, there occur natural perturbations that heat up the normally cold ocean currents and overlying air masses, reduce the biological productivity of important marine fisheries, and affect the onshore precipitation regime. These perturbations are collectively known as the El Niño Southern Oscillation (ENSO). In addition to disruptions of the marine food chain and subsequent reductions of the coastal fishing economies, El Niños bring torrential rains to the western slopes of the Andean cordilleras and devastating flash-floods in the rivers that descend from them (Caviedes, 1981, p. 288). Even without El Niños, coastal Lima is subject to variations in the climate of the neighbouring Andean region. Rainfall, or the lack thereof, in the central Andes affects water supplies and hydroelectric power for the Lima metropolitan area, as well as the threat of flooding in eastern districts of the city. The possibility of global warming via the greenhouse effect – and the consequences of its impact on El Niño – are difficult to determine, but may include accelerated desertification of coastal valleys such as the Rímac (Antúnez de Mayolo, 1986, p. 61) or increased flooding.

Lima: The city of the kings

Population projections indicate that Lima may soon host over 9 million people. For most of its existence the city grew slowly; it did not exceed 100,000 for almost three and a half centuries and required a further 80
Table 8.1 Population growth of Lima, 1614–1990

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
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</thead>
<tbody>
<tr>
<td>1614</td>
<td>26,441</td>
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<tr>
<td>1700</td>
<td>37,259</td>
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<tr>
<td>1836</td>
<td>55,627</td>
</tr>
<tr>
<td>1857</td>
<td>94,195</td>
</tr>
<tr>
<td>1862</td>
<td>89,434</td>
</tr>
<tr>
<td>1876</td>
<td>100,156</td>
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<tr>
<td>1881</td>
<td>80,000</td>
</tr>
<tr>
<td>1891</td>
<td>102,956</td>
</tr>
<tr>
<td>1898</td>
<td>113,409</td>
</tr>
<tr>
<td>1903</td>
<td>130,089</td>
</tr>
<tr>
<td>1908</td>
<td>140,844</td>
</tr>
<tr>
<td>1920</td>
<td>223,807</td>
</tr>
<tr>
<td>1931</td>
<td>373,875</td>
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<tr>
<td>1940</td>
<td>662,885</td>
</tr>
<tr>
<td>1961</td>
<td>1,632,370</td>
</tr>
<tr>
<td>1972</td>
<td>3,002,043</td>
</tr>
<tr>
<td>1980</td>
<td>4,410,000</td>
</tr>
<tr>
<td>1990</td>
<td>6,500,000</td>
</tr>
<tr>
<td>2000</td>
<td>9,140,000</td>
</tr>
</tbody>
</table>


1. Projection.

years to reach 1 million. Since the end of the Second World War population numbers have accelerated dramatically (table 8.1). This recent demographic shift has placed enormous burdens on Lima. Each migratory wave from the rural hinterland has exerted overwhelming demands on employment, services, infrastructure, and land. In other words, Lima provides a truly classic illustration of a third world city where life-support systems are drastically out of balance with population numbers.

The pre-Colombian role of natural hazards

The part of Peru in which Lima is located has a history of human settlement that stretches back more than 10,000 years, including at least 4,000 years of complex civilizations. Although tectonic uplift, earthquakes, floods, and droughts appear to have influenced large-scale culture change throughout Peru, archaeological and ethno-historical records suggest that the pre-Colombian population had developed a set of relatively effective adaptations to such threats; there is little evidence of massive mortality and destruction owing to sudden-onset disasters. All indications are that hazard preparedness and mitigation were important components in the
prevailing cultural perspective of ancient Peruvians. Evidence of sensitivity to natural hazards shows up in the sites that were selected for settlements, urban design, building technologies, and building materials. But these features of Peruvian life were altered significantly by the Spanish conquest (Oliver-Smith, 1994).

Conquest of Peru and foundation of Lima

When the Spaniards toppled the Inca empire in 1532, Pizarro at first wanted to place his new capital in the highlands near Jauja (Miro Quesada, 1982, p. 13) (fig. 8.1). He was forced to reconsider because rival conquistadors were plotting incursions into the new territory from coastal bases in Central America. If Pizarro was to retain hegemony over the new domain, he required a capital that had ready access to maritime communication. The Rimac valley was situated at the approximate midpoint of an important maritime route between Panama and Santiago in Chile. In addition to the other natural advantages of this site that have been described above, it was located at the seaward end of the primary Inca road out of the southern sierra – from which much gold and silver would eventually issue.

Thus, for reasons of both political economy as well as access to important natural features and resources, on 18 January 1535 Pizarro founded Lima – the City of the Three Kings – in the lower Rimac valley. Some historians claim that the title “City of the Three Kings” derives from the fact that Lima was established just after the Christian festival of Epiphany (6 January), which commemorates the delivery of gifts to the infant Jesus from three kings (Miro Quesada, 1982, p. 15). The name Lima is interpreted as deriving from Hispanicization of the local word for the Rimac River, pronounced “Limac” in Indian dialect (ibid.).

The city was sited just 12 km from the coast, not far from the Inca temple and pilgrimage site of Pachacamac. An expedition led by Pizarro’s brother, Hernando, had been greeted by a strong earthquake there almost exactly two years before (Giesecke and Salgado, 1981, p. 11), but this does not appear to have deterred the founders. Although it was not immediately apparent, the Rimac and other coastal valleys were also prone to mosquito infestation, which was later to lead to malaria and yellow fever epidemics in the city (Dobyns and Doughty, 1976, p. 125). The site was hazardous in another important way. Pizarro rejected Cusco, the inland Inca capital around which pivoted the internal social and economic networks of the vast conquered territory, in favour of a coastal location that looked outward towards the colonial power overseas. By placing his capital on the coast he established the basis for a form of urban and national development that is vulnerable to various external
forces that have produced – and now affect – the enormous mega-city of contemporary Lima. The act of selecting a coastal site for the colonial capital – repeated elsewhere in many other European colonial settlements – cast a mould that has compounded the vulnerability to natural hazards that is inherent in Lima’s location.

*The colonial model of development*

Lima was established with Spain’s needs in mind. Spain’s incursion into Latin America occurred simultaneously with the expansion of mercantile trading in Europe. The newly conquered possessions, particularly Peru and Mexico, both of which had an abundance of precious metals, were developed to enhance Spanish economic power. The Spanish towns and cities of Peru were either gold and silver production centres in the mountains (e.g. Arequipa, Ayacucho, Potosi [now in Bolivia]) or administration and transhipment points on the coast (e.g. Lima, Trujillo, Lambayeque, Tumbes) (Wilson, 1987, p. 200). Owing in large measure to the transportation hazards presented by bandits, pirates, and other brigands, it was decided to concentrate military protection on a single city. Because Lima had also been designated the capital, it became both the administrative centre in touch with the Spanish metropolis as well as the principal location through which surplus wealth could be extracted from the colony (Wilson, 1987, p. 200). The stage was set for the city’s rapid ascension to primacy, initially for all of the continent and later for the country of Peru.

*Early Lima*

Settlements in the early Spanish colonies of the New World were thoroughly regulated by the Laws of the Indies, which included “Royal Ordinances for the laying out of new cities, towns or villages” (Griffin and Ford, 1980; Nuttall, 1922). These ordinances recommended sites that provided fresh water, included land for farming and pasture, and were elevated so that diseases would be less prevalent. They also contained very specific requirements that cities be laid out in a grid pattern, with regular east–west and north–south streets radiating from a central plaza. The principal church, the town hall, and other official structures were to be constructed around the plaza, and nearby blocks were designated for élite residential development. (Proximity to the plaza became a marker of social status in the colonial city that continues to this day in many smaller and medium-sized cities of Latin America – Griffin and Ford, 1980, p. 399). Lima was begun before the ordinances were adopted but its layout anticipated them because such guidelines flowed from widely held
Spanish perceptions of ideal urban settlements. All the implicit guidelines were followed regarding the location of the city, water sources, pasturage, wind currents, and altitude as well as the geometric urban plan.

Lima was located with its back approximately 100 paces west of the Rimac river bank. This close proximity permitted irrigation from the river and the disposal of wastes, including those from a slaughterhouse. Indeed, the river was one of the primary formative elements of the city's development (Ortiz de Zevallos, 1986, p. 42). A second formative element was the chessboard design of streets and urban lots (ibid.). The municipal offices, the cathedral, and the palace of the governor would all eventually be located on the plaza in the eastern sector of the city close to the river. Around this plaza the primary conquistadors were allocated plots of land ranging from 4 blocks for Pizarro down to 1 block for less important Spaniards (fig. 8.3) (Pacheco Velez, 1982, p. 18).

The social structure of the colony in its earliest years consisted of a very thin layer of dominant Spaniards grafted onto an enormous indigenous population of various ethnic identities. As the colony matured, Spanish women joined the original male settlers and a Creole population of American-born Spaniards emerged. Unions between Spanish males and Amerindian women were also established almost immediately by force, purchase, gift, or, in some cases, choice, resulting in a population of people of mixed Spanish and indigenous heritage that grew steadily through the colonial period. So rapid was the growth of the mestizo population that Magnus Moerner (1967) has referred to the conquest of the New World as the conquest of women. At the same time, the number of indigenous peoples diminished catastrophically because of disease, exploitation, and outright murder. It has been calculated that in the first 100 years of the colony, the indigenous population was reduced by 98 per cent from its estimated pre-conquest level of 14 million to approximately 600,000 (Cook, 1981, p. 114). Nevertheless, Indians still constituted an overwhelming majority of the population of colonial Peru and would continue to do so into the twentieth century. Enslaved and free Black people, from Africa as well as the Iberian peninsula, had participated in the conquest as soldiers and servants. They also figured importantly among the growing number of artisans of colonial Lima (Lockhart, 1968). By the eighteenth century the social and economic base of the viceregal city became dependent on Black labour (Dobyns and Doughty, 1976, p. 124).

Though the population of Lima was composed of Spaniards, mestizos, Indians, and Blacks, the city's identity was bound up with its status as the Spanish capital and the residence of the colony's élites. Here the white population differentiated itself from the Indians; mestizos were essentially unrecognized by the élite, although Blacks were valued more highly
for valuable skills, particularly in carpentry, masonry, and construction trades. However, the colony’s economic structure was built on rights to Indian labour, enshrined in an institution known as the *encomienda*. It was this that formed the basis for the initial Spanish extraction of surplus and accumulation of wealth.

In its earliest years, Lima was merely a more or less orderly collection of large, poorly built adobe houses with woven split-cane roofs. Indian rebellions and seditious revolts by Pizarro’s rivals limited the city’s growth (Miro Quesada, 1982, p. 17). Later, the provisional buildings were replaced by more substantial structures. Large pretentious residences began to be constructed for members of the Spanish élites (Lockhart, 1968, p. 108). Monumental churches were also created. The task of building such grandiose edifices was carried out by drafted Indian labourers, in effect compounding their defeat by forcing them to contribute to the construction of the most visible symbols of their physical and ideological subordination (Fraser, 1990).

Although basically Spanish in style and inspiration, early Lima was also influenced by the cultural and environmental features of its Peruvian
location. The temperate climate permitted use of light, cheap construction materials following patterns familiar to the conquistadors from their Caribbean expeditions (Pacheco Velez, 1982, p. 19). Scarcity of locally quarried stone dictated the use of adobe and wood, and the lack of rain allowed for easily constructed flat roofs. The experience of frequent earthquakes quickly limited most buildings to two floors (ibid.). By the mid-1540s the architectural appearance of the city, which was to remain fixed for centuries, was established – long lines of bare adobe walls interrupted by elegant carved wooden doors, some as large as 7 by 9 feet (Lockhart, 1968, p. 108).

Shortly after its founding, the once auspicious settlement was awarded a coat of arms by the king of Spain (1537). It was then designated both the site of the Royal Audience and capital of the Viceroyalty of Peru (1543); its bishop was later (1545) given jurisdiction over dioceses in Ecuador, Colombia, Nicaragua, and several other countries. In 1551 the New World’s oldest university, later to become known as the University of San Marcos, was founded (Miro Quesada, 1982, p. 17). With the influx of these functions the city began to take on a more impressive appearance.

“very good houses and some very elegant with towers and roof terraces, and the plaza is large with wide streets and through most of the houses pass irrigation channels that are of no little advantage for from the waters of these are served and irrigated their many fresh and delightful gardens and vegetable plots.” (Pedro Cieza de Leon, as quoted in Miro Quesada, 1982, p. 16)

Sixteenth-century Lima evolved within the grid pattern focused on a central plaza; it also possessed many open spaces occupied by gardens and groves. Water was drawn from the efficient pre-Colombian irrigation complex constructed by the Maranga Indians. The city was also situated at the crossroads of a number of Incaic roadways, guaranteeing a steady flow of travellers (Pacheco Velez, 1982, p. 15). By the early seventeenth century, Lima had evolved into the form that it maintained almost to the beginning of the twentieth century (fig. 8.3). Instead of the city expanding into new territory, its gardens and groves became urbanized and existing lots were redeveloped at higher densities. Defensive walls were also constructed to provide protection against marauding pirates – first around Callao in 1639 and later around Lima in the years between 1684 and 1687 (Gunther Doering, 1983, p. 9). El Cercado, the largest Indian sector, was located outside the walls, but significant numbers of Indian servants and concubines lived in Spanish homes inside the walls (Butterworth and Chance, 1981, p. 15). Small settlements such as Carabayllo, Magdalena, Surco, and Cieneguilla also began to appear in the countryside at some distance from the walled city.
A flourishing colonial capital: Seventeenth and eighteenth centuries

Early in the seventeenth century there was an upsurge in the construction of major buildings, among them convents and monasteries, public buildings, and private palaces. These often adopted monumental baroque styles of architecture and layout (Pacheco Velez, 1982, p. 29). The rigid quadrangular grid of streets was cut across by diagonals, some following the line of old Indian roads, and numerous small plazas of varying shapes were added. A hierarchy of urban spaces also appeared in the form of ethnic and socio-economic neighbourhoods (barrios): Black neighbourhoods in San Lazaro, Pachacamilla, and Malambo; Indian neighbourhoods and towns in the Cercado and Magdalena; Chinatown; the English avenue; commercial streets, silversmiths’ streets, swordmakers’ streets.

By 1630, when Lima’s population reached 30,000, the city had taken on the essentials of its modern personality. Its political power and economic privilege were confirmed by the number and variety of its offices and public facilities. Furthermore, it held unquestioned status as the site of Euro-American high culture in this part of Latin America; poets, architects, painters, musicians, philosophers, and theologians pursued intensely artistic lifestyles, despite the prevalence of poverty and exploitation among a majority of the population.

Lima had also become an educational centre, owing in part to a high concentration of religious institutions and clerics (Dobyns and Doughty, 1976, p. 127). Clerics and viceregal bureaucrats displayed their finery in masses, processions, autos-da-fé, and journeys to and from the ships docked in Callao (ibid.). Lima of the elites in the years before the great earthquake of 1746 was well summed up by Lozano:

Lima had arrived to as great a Degree of Perfection as a City situate at such a distance from Europe, and discouraged by the continual dread of such Calamities was capable of. For although the Houses were of but moderate Height, being confined to one story only, yet the streets were laid out with the exactest regularity, and adorned with all that beauty which a nice Symmetry could give: So that they were equally agreeable to the Sight as commodious to the inhabitants; and display’d as much elegance as if all the ornaments of the best Architecture had been bestowed upon them . . . . It may be affirmed, that the Magnificence of these Edifices, if it did not exceed, at least might rival that of the grandest Fabricks in the whole World; for the beauty of their design, their Profiles, their Cemeteries, the largeness of their Naves, their Cloisters and Stair cases, was such as they had no Cause to envy any such for Size or Elegance. (1755, p. 5)

In contrast to the ostentation and display of the members of the elites, the general populace lived in conditions of insecurity and privation. Much
of the city was extremely unsanitary. Refuse littered the streets, most of which were uncobbled dirt with open ditches for domestic water supplies and sewage disposal. Not surprisingly, gastrointestinal diseases doomed half of the city’s newborn and many adults each year. Malaria and yellow fever were constant preoccupations. Every ship that put into Callao constituted a potential disease vector of major proportions; epidemics of smallpox, influenza, typhus, typhoid, or plague were frequent (Dobyns and Doughty, 1976, p. 127). Earthquakes also shook the city. In 1687, one of these ushered in the use of quincha walls in preference to adobe. Quincha is a form of wattle and daub that greatly reduces weight and enhances structural flexibility (Gunther Doering, 1983, p. 10). Many quincha buildings from this and later eras still exist in present-day Lima. Unfortunately, quincha is vulnerable to fires, which are easily ignited from cooking surfaces (Dobyns and Doughty, 1976, p. 127).

Real and imagined Indian rebellions posed other threats to the wellbeing of Limenos. Like peasant uprisings in the Old World—which generally occurred when abuse and exploitation reached intolerable levels—Indian uprisings in the sierra were not uncommon. The apprehension of Limenos about what was essentially a distant highland phenomenon, frequently resulted in the panicked discovery of plots to burn the city, followed by summary executions of purported Indian conspirators (Dobyns and Doughty, 1976). However, fears of rural uprisings directed against Lima were ultimately realized when the Shining Path guerrilla movement (Sendero Luminoso) emerged in the late twentieth century.

During the eighteenth century, Lima experienced crises and other changes that undermined its power and monopolies. The nation’s capacity for food self-sufficiency was seriously affected by a plague that destroyed wheat production and required the importation of food. At the same time, the seemingly inexhaustible sources of silver and mercury, on which Peru’s economy depended, began to decline. Finally, the 1746 earthquake reduced Lima to rubble and created a tsunami that virtually obliterated Callao and killed 4,000 of its inhabitants (Gunther Doering, 1983, p. 11; Lozano, 1755, p. 9). At that time, Lima contained roughly 3,000 houses in 150 blocks, occupied by approximately 40,000 people. Although the earthquake killed just over 1,100 people in Lima, it left scarcely 20 houses standing there (Lozano, 1755, p. 4).

The Earth struck against the Edifices with such violent repercussions, that every Shock beat down the greater part of them; and these tearing along with them vast Weights in their Fall (especially the Churches and high houses;) complicated the destruction of every Thing they encountered, even of what the Earthquake had spared. (Lozano, 1755, p. 3)
The natural catastrophes were compounded by a series of political and economic changes. Many élite Límeanos lost their wealth when the Spanish monarch abolished the encomienda system. The creation of competing viceroyalties in Buenos Aires and Santa Fe reduced the extent of Lima’s administrative hegemony (Gunther Doering, 1983, p. 11). Finally, the convoy and armada system, which routed all South American merchandise (and export duties) through Callao, was also discontinued. Although this was initially seen as a calamitous blow to Lima’s economy, the liberalization of trade that resulted actually proved beneficial.

Lima and Peru benefited from other changes that were sweeping the market structure of Europe. There, increasing urban populations generated demands for new agricultural products and this resulted in the emergence of a new form of colonial productive relations called latifundios. These were large landed estates, initially in the highlands and later on the coast, that utilized economies of scale to produce an exportable surplus (Wilson, 1987, p. 201). Lima and other coastal cities that were involved in the shipment of this surplus saw the emergence of a new class of wealthy merchants, brokers, financiers, and transporters. The tertiary sector of the economy developed significantly, adding to the cultural and political life of the city and decidedly altering consumption patterns toward European luxury goods (Wilson, 1987, p. 202).

Notwithstanding the calamities and other changes, Lima continued growing slowly but still at a rate that outstripped its closest competitors. According to the census of 1796, it had a population of 52,627, roughly 6 per cent of the total within the viceroyalty, and only double that of 1614 (Dobyns and Doughty, 1976, p. 124). The area encompassed by the city’s wall was a total of 506 hectares, divided into 358 ha urbanized, 130.9 ha in gardens and groves, and 16.8 ha in military fortifications (Barbagelata, 1971, p. 7). Despite the massive destruction that it caused, the earthquake of 1746 provided an opportunity for the thirty-first viceroy, Manuel Amat y Juniet, to enact significant changes as Lima was rebuilt. Public lighting was installed on the main streets and the previously unadorned plazas and parks were embellished. Churches, promenades, and a formal bullring were built. New streets and promenades were also put in place outside the city wall along the eastern bank of the Rímac (Dobyns and Doughty, 1976, p. 129). These initiatives added 58.8 ha to Lima’s total area (Barbagelata, 1971, p. 7). Thus, at the end of the eighteenth century, the primacy of Lima was unchallenged in the nascent nation of Peru. Such was the city’s pre-eminence that Spaniards charged with crimes (or official displeasure) were often exiled 5 or 50 leagues from Lima for varying lengths of time (Dobyns and Doughty, 1976, p. 126). Banishment from Lima meant banishment from the life of European luxury goods, from café society, and from the intellectual centre of the colony.
Republican Lima

Peru proclaimed its independence from Spain in 1821 but did not finally achieve control over its own affairs until 1824. The independence movement was led by colonial merchant and latifundistas who were strongly influenced by new political ideas and fresh capital inputs from Europe. Enlightenment France contributed ideas about the state, natural liberty, and the rights of man; capital came mostly from England. However, neither independence nor the shift from a hybrid form of feudalism and mercantilism to capitalism did anything to alter the social system of Peru or the commercial hegemony of Lima, although the outward flow of goods was increasingly directed to British markets (Wilson, 1987, p. 202). Chief among the new export products from the 1840s onwards was a fertilizer composed entirely of bird dung. Known as guano, this came from enormous deposits on offshore islands. The demand from European countries innovating in agricultural technology and practices created a virtual boom economy, providing a windfall with which Peru hoped to pay its revolutionary war debts.

None the less, the face of Lima did not change much for decades after independence. Population grew slowly and the city continued to experience a wide variety of communicable illnesses, including yellow fever and malaria epidemics, as well as endemic diuretic diseases fostered by the still crude water and sewage-disposal system. Even the improved water systems that were installed in Callao (1846) and in Lima (1856) failed to affect urban death rates significantly (Dobyns and Doughty, 1976, p. 170).

The demolition of Lima's city walls between 1868 and 1871 marked the beginning of significant alterations to the city. These were initiated in large measure by the North American entrepreneur and contractor Henry Meiggs, who was originally hired to construct a rail line from Arequipa to the coast but quickly adopted more ambitious plans (Barbagelata, 1971, p. 1). Although the walls' demolition did not result in any immediate expansion of the city, it paved the way for a later comprehensive redevelopment scheme. This came in the form of the 1873 plan for an area adjacent to the old city, designed along French lines, that included wide avenues, promenades, sidewalks, and multiple circular street intersections occupied by small parks and monuments, reminiscent of many European cities (Dobyns and Doughty, 1976, p. 185; Pacheco Vélez, 1982). This plan called for more bridges over the Rimac, the river's canalization, a bellevue following the line of the demolished wall, the extension of existing streets, and the creation of new broad avenues toward the coast, first in the direction of Callao and later toward Chorrillos. The greater attention to Callao was stimulated by completion of the Panama Canal, which increased the level of commerce in the port. In effect, the coast
became a third formative element in the development of the city (Ortiz de Zevallos, 1986, p. 42). The 1873 plan accurately projected and shaped the course of Lima’s urban growth for the next half-century. Indeed, some of the projects that it called for were not completed until 1960. Unfortunately, some aspects of the plan were never carried out, with substantial costs to the city. These included the recommended urbanization of peripheral areas and lands gained by rechanneling the river; instead of being systematically and carefully developed, these places were later invaded and occupied by the informal settlements of migrants (Barbagelata, 1971, p. 9).

The development of Lima in this period was flawed in a way that was to prove particularly pernicious for the country; it was financed entirely on credit obtained mostly from abroad by mortgaging future production of guano and other domestic resources. This strategy cemented the neocolonial condition of the country, solidified its dependent status, and mortgaged national economic sovereignty for over a century (Dobyns and Doughty, 1976, p. 192). Peru’s acute contemporary debt crisis is thus part of a pattern of dependent development that began by borrowing to pay off debts from the war of independence and increased by borrowing to finance national and urban growth.

The War of the Pacific (1879–1883) was fought between Chile, Peru, and Bolivia over mineral resources in ambiguously demarcated territory near their mutual frontiers. The Chilean navy began bombarding Callao in 1880, invaded Lima in 1881, and occupied the city until 1883. Living conditions plummeted and death rates rose as food became scarce. People fled the city and the population fell from 100,156 to around 80,000 (Dobyns and Doughty, 1976, p. 197). The results of this war were disastrous for Peru and Lima. The state’s bankruptcy was compounded by severe damage to infrastructure, and its major resources were controlled by foreign interests. The cost in casualties, money, and damage to infrastructure was far worse than experienced in any earthquake (Dobyns and Doughty, 1976, p. 203). Faced with economic collapse, successive governments attempted to raise monies by taxing the Indians, but this merely provoked rebellions during 1885 and 1892. None the less, reconstruction was begun using money raised by British bond holders in exchange for long-term control over resources. The rail system was rebuilt and expanded, linking settlements in both the sierra and along the coast to Lima. These and other infrastructural improvements in the sierra helped to stimulate migration to the capital. There living conditions were also improving: the incidence of waterborne diseases diminished after an improved sanitation system was introduced in 1884, and electricity was installed throughout the city in 1886, providing light for homes and power for emerging small industries (Dobyns and Doughty, 1976, p. 202).
Larger industries such as shoes, matches, bricks, and ceramics also emerged and power lines reached out to supply expanding sugar mills on the coast north of Lima (Dobyns and Doughty, 1976, p. 218).

On the eve of the new century, Lima was modernizing. Educational institutions, from primary schools to universities, were available. Up-to-date sanitation and medical facilities had finally made significant inroads into the abominable health conditions that had previously kept population in check and discouraged immigration. For the first time in its history, Lima's death rate fell below its birth rate. Electricity, clean water, theatres, schools, medical care, churches, trolley cars, automobiles, bicycles, fire companies, police protection, all became available in Lima in the period between 1885 and 1895 (Dobyns and Doughty, 1976, p. 213). The city was now ever more attractive to rural migrants at a time when population growth, agricultural stagnation, economic injustice, and other problems were making life in the rural areas less and less viable. In 1821, at independence, Peru's population stood at roughly 2 million people, with Lima hovering around 50,000 inhabitants. By 1895 the national population had more than doubled to 4.5 million. The combination of rural problems (push factors) and urban attractions (pull factors) set the stage for a demographic avalanche that would begin to encroach upon Lima in the early years of the twentieth century and later engulf it by the end of the century.

*Lima metropolitana: Evolution of a mega-city*

The turn of the century brought a change in Peru's economic relationships: the dominance of British industrial capitalism was replaced by that of US monopoly capitalism. Major US investments in mining and export agriculture strengthened enclaves of production and further solidified the financial and commercial roles of Lima (Wilson, 1987, p. 203). The large-scale rural migration to Lima that began in the late nineteenth century increased steadily during the first two decades of the twentieth. Beginning in 1908, migration-induced changes in Lima occurred in three stages: 1908–1940; 1940–1960; and 1960–present.

The first stage was marked by accelerated population growth and urban expansion well beyond the perimeter of the old medieval city. An ambitious national programme of road-building increased the mobility of highland residents and the accessibility of the capital. As a result, the urban population growth rate jumped from 2.5 per cent per year in 1920 to 6.1 per cent in 1930 (Enriquez and Ponce, 1985, pp. 13–14). The city continued expanding south toward the coast, spawning middle-class suburban communities such as Magdalena Nueva and San Miguel, upper-
class suburbs such as San Isidro and Miraflores, and beachside areas including Barranco and Chorrillos.

During the second stage of twentieth-century urban changes, the zone between Lima and Callao became fully urbanized. Urban industrialization remained sluggish, but in-migration continued at rates in excess of 9 per cent per year. However, the nature of the migrants changed: what had been primarily a movement of members of the rural élite and people from provinces near Lima became a massive and generalized phenomenon involving migrants from the whole country (Enríquez and Ponce, 1985, pp. 13–14). By 1954, the entire region between the old city centre and the southern coastline became urbanized, and informal squatter settlements began to appear in desert areas to the south and north (fig. 8.4).

During the third and latest stage, Lima has become a city of provincial migrants, and the character of the city has changed utterly (Enríquez and Ponce, 1985, pp. 13–14). To place this growth in perspective, Lima in 1984 contained the same number of people, roughly 6 million, as the entire nation had in 1940. Or, further, in 1940 Peru was a predominantly rural nation with somewhat less than 35 per cent of the population living in urban settlements. Overall rural–urban migration to all cities has turned Peru into a nation that was 70.2 per cent urban in 1990 (Economic Commission for Latin America and the Caribbean, 1991, p. 8). The city of Lima contained 29.1 per cent of the total national population in the same year (Wilkie and Contreras, 1992, p. 120). The overwhelming primacy of Lima by 1989 is evidenced by table 8.2.

Hazes and vulnerability

Over the past 450 years Lima has experienced a variety of hazards and disasters. Some of these are outgrowths of the city's location in an area of known risks. Others are the direct result of human alteration of the environment in ways that make its inhabitants more risk prone. And still others, perhaps now the vast majority, are a function of socio-economic inequities that force the most vulnerable to bear the greatest risks. Table 8.3 provides a chronology of the more noteworthy disasters.

Because this table focuses on large-scale devastating events, it significantly understates the hazardousness of Lima. A full accounting of Lima's hazards would include many past outbreaks of epidemic diseases that are now less threatening, a wide range of more or less chronic seasonal hazards, and a growing list of low-intensity risks that have serious cumulative effects. For example, malaria, yellow fever, smallpox, and plague were regular visitors to the city before the mid-nineteenth cen-
Fig. 8.4 The growth of Lima–Callao during the second half of the twentieth century (Source: Burga and Delpech, 1988)

Peru has also experienced approximately 50 major earthquakes and countless smaller ones since historical records were begun (Gieseke and Salgado, 1981, pp. 65–66). Even the smaller tremors, which do little damage, constitute a continuing source of human stress. Seasonally, Lima is subject to floods and *huaycos* (mudslides), landslides, water scarcity, food shortages, dehydration, and heat prostration. There are also the daily dangers of waterborne diseases, malnutrition, fires, toxic waste exposure, air pollution, and, since 1980, guerrilla warfare of varying intensity.

All these hazards are borne unequally, and mostly by the underprivileged. The middle and upper classes can afford anti-seismic construction
Table 8.2. The primacy of Lima in Peru, 1989

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Lima’s share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National population</td>
<td>28</td>
</tr>
<tr>
<td>Gross national product</td>
<td>69</td>
</tr>
<tr>
<td>Private investment</td>
<td>98</td>
</tr>
<tr>
<td>Banks</td>
<td>83</td>
</tr>
<tr>
<td>Commercial bank deposits</td>
<td>77</td>
</tr>
<tr>
<td>Informal businesses</td>
<td>70</td>
</tr>
<tr>
<td>Tertiary product (services)</td>
<td>80</td>
</tr>
<tr>
<td>Tax revenues</td>
<td>87</td>
</tr>
<tr>
<td>Public employees</td>
<td>51</td>
</tr>
<tr>
<td>University population</td>
<td>53</td>
</tr>
<tr>
<td>Educators</td>
<td>39</td>
</tr>
<tr>
<td>Doctors</td>
<td>73</td>
</tr>
<tr>
<td>Economically active population</td>
<td>32</td>
</tr>
<tr>
<td>Workers</td>
<td>36</td>
</tr>
<tr>
<td>Employers</td>
<td>50</td>
</tr>
<tr>
<td>University professors</td>
<td>62</td>
</tr>
<tr>
<td>Telephone hook-ups</td>
<td>76</td>
</tr>
<tr>
<td>Hospital beds</td>
<td>48</td>
</tr>
</tbody>
</table>


and can live above floodplains on solid terrain in uncongested areas with good escape routes. They can also obtain nourishing food, purified water, and good medical care. High quality and accessibility to other services are considered to be part of the bundle of rights to which the affluent are entitled and that they can normally expect to receive. The poor of Lima, more than half the citizenry, can neither avoid the hazards nor purchase the means that might mitigate them. Vulnerability to hazards in Lima, like poverty, is stratified by race, ethnicity, age, gender, and income. Moreover, the pattern of vulnerability in Lima is closely tied to the structure of the nation’s political economy and the role of the city in that structure.

Economic context

Since the Second World War, economic vulnerability has grown in Lima as a consequence of government policies and the working of international market forces. After the war, Peru’s government – like most in Latin America – adopted a strategy of industrialization that involved heavy investment of borrowed overseas capital. Foreign borrowing accelerated after the global oil price rises of the early 1970s (Portes, 1989, pp. 9–10). At the same time, multinational corporations began to reorganize production by shifting manufacturing towards lower-cost developing coun-
<table>
<thead>
<tr>
<th>Date</th>
<th>Agent</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1524</td>
<td>Smallpox epidemic</td>
<td>16 million deaths in Peru</td>
</tr>
<tr>
<td>1531</td>
<td>Smallpox epidemic</td>
<td>Generalized in Peru</td>
</tr>
<tr>
<td>1546</td>
<td>Plague or typhus epidemic</td>
<td>Moderate damage</td>
</tr>
<tr>
<td>1552</td>
<td>Earthquake</td>
<td>Significant damage</td>
</tr>
<tr>
<td>1555</td>
<td>Earthquake</td>
<td>Severe damage to homes, churches, viceroy's palace</td>
</tr>
<tr>
<td>1558–60</td>
<td>Influenza and smallpox epidemic</td>
<td>Structural damage</td>
</tr>
<tr>
<td>1578</td>
<td>Earthquake</td>
<td>Significant damage; 14–22 deaths</td>
</tr>
<tr>
<td>1584</td>
<td>Earthquake</td>
<td>Major damage in Callao</td>
</tr>
<tr>
<td>1586</td>
<td>Tsunami</td>
<td>Structural damage; Cathedral damaged</td>
</tr>
<tr>
<td>1585–91</td>
<td>Influenza epidemic</td>
<td>Structural damage; deaths undetermined</td>
</tr>
<tr>
<td>1609</td>
<td>Earthquake</td>
<td>Heavy damage</td>
</tr>
<tr>
<td>1618</td>
<td>Measles epidemic</td>
<td>Damage in Callao; undetermined number of deaths</td>
</tr>
<tr>
<td>1630</td>
<td>Earthquake</td>
<td>Severe damage</td>
</tr>
<tr>
<td>1655</td>
<td>Earthquake</td>
<td>Heavy damage in Lima; wide regional damage in adjacent coastal valleys</td>
</tr>
<tr>
<td>1678</td>
<td>Tsunami</td>
<td>Structural damage</td>
</tr>
<tr>
<td>1687</td>
<td>Earthquake</td>
<td>Almost total destruction of the city: 1,141 deaths</td>
</tr>
<tr>
<td>1690</td>
<td>Earthquake</td>
<td>Total destruction of Callao; 4,000 deaths</td>
</tr>
<tr>
<td>1746</td>
<td>Earthquake</td>
<td>Post-earthquake conditions</td>
</tr>
<tr>
<td>1806</td>
<td>Epidemics</td>
<td>Significant damage</td>
</tr>
<tr>
<td>1828</td>
<td>Earthquake</td>
<td>Significant damage; 30 deaths</td>
</tr>
<tr>
<td>1867</td>
<td>Earthquake</td>
<td>4,445 deaths</td>
</tr>
<tr>
<td>1897</td>
<td>Yellow fever epidemic</td>
<td>Significant damage in Callao</td>
</tr>
<tr>
<td>1904</td>
<td>Earthquake</td>
<td>Moderate damage</td>
</tr>
<tr>
<td>1932</td>
<td>Earthquake</td>
<td>Damage: Lima – moderate; Callao &amp; Rimac – severe</td>
</tr>
<tr>
<td>Year</td>
<td>Event</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1926</td>
<td>Earthquake</td>
<td>Moderate damage</td>
</tr>
<tr>
<td>1940</td>
<td>Earthquake</td>
<td>Heavy damage; 179 deaths; 3,500 injuries; regional impact</td>
</tr>
<tr>
<td>1966</td>
<td>Earthquake</td>
<td>Heavy damage (1 billion soles); 100 deaths; regional impact</td>
</tr>
<tr>
<td>1974</td>
<td>Earthquake</td>
<td>Heavy damage (2.7 billion soles); 78 deaths; 2,500 injuries</td>
</tr>
<tr>
<td>1991</td>
<td>Cholera epidemic</td>
<td>76,190 cases; 196 deaths</td>
</tr>
</tbody>
</table>
tries. Peru experienced some gains in average worker salaries as a result of this process, but total employment did not increase because much of the new investment was capital intensive. In addition, many of the domestically consumed goods that would previously have been produced in Peru began to be supplied from specialized assembly points elsewhere (Wilson, 1987, pp. 203–207). As a result, during the period in which migration to Lima intensified, the urban employment market actually began to shrink.

Between 1970 and 1984 the percentage of the labour force in manufacturing fell from 18.4 to 15.6 and the urban real minimum wage dropped from 107.3 in 1976 to 53.3 in 1985, using a 1980 value of 100 as a base. In the same period, urban formal unemployment rose from 8.4 per cent to 16.4 per cent, and the rate of informal market participation reached all-time highs in 1984 (Pertes, 1989, pp. 26–27). Most of the informal sector involves so-called “subsistence commerce” in urban areas, but it also includes the (mainly rural) cocaine industry, which has not generated much new employment. For certain urban dwellers, cocaine sales support the consumption of imported luxury goods and allow them to engage in urban real estate speculation as well as some construction and service businesses. The cocaine industry has also stimulated a drug problem in the cities as well as in the production areas, adding yet another hazard to Peru’s list (Morales, 1989).

Changes in the global economic system did not compensate for reductions in Peru’s labour market; instead the problem was worsened by International Monetary Fund austerity measures that had profound recessionary effects and produced negative growth rates for the first time in 50 years. They also reduced the resources that were available for maintaining urban infrastructure (Pertes, 1989, pp. 13–14). The outcome was catastrophic misery for millions of already desperately poor Lleninos during the 1980s and 1990s. It was said that Lima, where abject poverty had never been far away, was becoming “Calcutta-ized.”

**Land-use context**

The chronic and worsening imbalance between population growth and employment in Lima finds expression in two distinctive urban forms, each with its own pattern of vulnerability to hazards: (1) informal squatter settlements, which are proliferating around the fringes of the city; and (2) inner-city neighbourhoods that are becoming increasingly crowded and run-down.

Many post-war migrants dealt with the high price of urban space and urban housing by illegally occupying land on the city’s periphery. Despite their somewhat ramshackle appearance, these settlements are the result
of highly organized and purposeful behaviour. Traditionally, migrants who arrived in Lima from the highlands sought housing in the tugurios (slums) of the old inner city. Once living quarters and jobs were secured there, strategies for an "invasion" of vacant land on the urban periphery would be developed. Clandestine visits to chosen sites would be undertaken for purposes of mapping out lots for future houses, other structures, and community institutions. On an appointed day, usually in the earliest hours of the morning, rented trucks would transport the conspirators from the tugurio to the site. Before dawn brought discovery and the summoning of police, squatters would construct an entire community out of light timber and estera (woven split-cane) mats. Owners and officials were presented with the unappetizing task of forced removal or acceptance of a fait accompli. In the long run, the authorities have collaborated – at least passively – in this process by granting land titles as well as formally recognizing ownership rights and community charters (Butterworth and Chance, 1981; Mangin, 1967; Maskrey, 1989; Millones, 1978). In this way there have arisen urban communities that lack planned infrastructure or services and are vulnerable to a wide range of hazards.

During the 1950s, 56 of these settlements were located on the periphery of the city (some were then already more than 20 years old); in 1984 there were 598 such barriadas. Now called pueblos jóvenes (young towns), they contained close to 40 per cent of Lima's population (approximately 2.5 million people) (Fuenzalida, 1986, p. 185). Older barriadas gradually evolved into permanent communities and grouped together to form separate municipalities (Burga and Delpech, 1988). For example, San Juan de Lurigancho, which was incorporated in 1967, is composed of over 200 different units: 113 pueblos jóvenes, 31 urban developments, 40 building associations, and 25 building cooperatives (Poloni, n.d.). The process that gave rise to the pueblos jóvenes may be self-limiting. The tugurios are no longer staging areas for invasions of vacant peripheral land. Instead their deteriorating buildings are overcrowded with job-seekers who can no longer afford the long commutes from peripheral pueblos jóvenes to work in central Lima where most of the informal commerce is concentrated – even as such job opportunities are themselves declining (Portes, 1989, p. 32). More and more people are becoming trapped in the deteriorating buildings of old Lima.

Between 1940 and 1984 Lima's built-up area expanded from 3,966 ha to 31,255 ha. A great deal of the newly urbanized land was formerly desert, river beds, and hillsides; most of the rest is converted agricultural land that had for long provided much of the city's food (Fuenzalida, 1986, p. 184). Not all of the urban expansion is accounted for by pueblos jóvenes. Upper-middle- and upper-class Límites have also fled before the incoming wave of poor migrants, and many now live in large expensive
new developments, particularly to the south-west of the old city. However, the areal differentiation of rich and poor was reduced during the 1980s, partly because the debt crisis impoverished middle-income groups and forced them to resettle working-class areas and partly because the poor tend to occupy open land in any location (Portes, 1989, p. 22).

Infrastructure
Vulnerability to improperly managed hazardous materials and other environmental contaminants has increased in Lima, while industrial infrastructure has remained inadequate because it is underfunded and poorly developed. This has led to more respiratory, gastro-intestinal, and malnutrition-related diseases and has contributed to increased morbidity and mortality among the city's disadvantaged populations. Vulnerabilities associated with the deterioration or absence of technological infrastructure interact with natural and technological hazard agents, each compounding the effects of the others. It has also become increasingly difficult to extend existing infrastructure to service the outer metropolitan populations because they are so thinly spread. However, the combination of lower population densities in the newer pueblo jovenes and improved building materials (including both lightweight temporary wood constructions and solidly built replacements) has reduced levels of seismic vulnerability among the populations of squatter settlements (Maskrey, 1989, p. 6).

Vulnerability to natural hazards
Earthquakes
In the past, earthquakes have caused Lima's most frequent and serious disasters. Vulnerability to earthquakes is clearly related to social class and construction type, while both of these factors are in turn correlated with location. For example, middle- and upper-income groups reside in the suburbs and the poor occupy tugurios or peripheral squatter settlements. Soil stability is also important. The soils of central Lima generally bear static loads well (Moran et al., 1975, p. 6), but they tend to lose bearing strength during earthquakes, especially in a belt of alluvial soils along the river banks (Kuroiwa, 1977, p. 13). Soils that underlie middle- and upper-class areas to the south of the city and the port of Callao are also subject to seismic instability (Moran et al., 1975, p. 6; Kuroiwa, 1977, p. 13).

Inner-city slums are the most seismically vulnerable areas of the city. Houses are built from adobe (dried mud), a material that readily cracks and crumbles during earthquakes if it is poorly mixed with binding
agents, deteriorated, or weakened by previous tremors. Deterioration is common because rents are often controlled and landlords who cannot raise money by increasing rents often abandon their property. Moreover, many buildings are overcrowded, surrounded by narrow alleys, and not near open spaces that could act as refuge sites. In the economic crisis of the 1970s and 1980s, building costs became prohibitive and the budgets for self-help housing programmes were cut back. Slum-clearance projects further reduced the availability of rental housing in the inner city. More and more people have found themselves trapped permanently in the tugurios (Maskrey, 1989, p. 10). It has been estimated that a repeat of the 1940 earthquake (8.2 on the Richter scale) would destroy more than 26,000 dwellings, leave 128,000 people homeless, and kill or injure large numbers of people (Maskrey, 1989, pp. 7-11).

Bricks and concrete have been used as building materials in Lima for about 80 years (Moran et al., 1975, p. 5). Because they are more expensive than adobe, quincha, and the temporary materials employed in squatter settlements, their use has been restricted to middle- and upper-class residences and the engineered structures of commerce, government, and industry. However, brick and concrete are considered by the poor to be "noble materials" and their use for housing is much aspired to. Indeed, the houses in many older squatter settlements have evolved from estera mat huts to adobe and quincha and ultimately to brick and concrete (Burga and Delpech, 1988; Poloni, n.d.; Degregori et al., 1986).

Most brick and concrete buildings are less than three storeys high. Roofs and intermediate floors are made of reinforced concrete slabs, sometimes with hollow brick infill to decrease weight. Over the past 30-40 years, there have been some changes in construction practices that affect seismic stability. Reinforced concrete columns have been placed at corners and a ring beam of concrete has been poured where walls contact floors or ceilings; this makes brick structures quite rigid (Moran et al., 1975, p. 5). Buildings higher than three storeys are generally of reinforced concrete frame design. Anti-seismic design to resist lateral force effects became mandatory in the 1950s, but compliance with the code was uneven. In essence, earthquake resistance has become a significant part of design and construction practice only since the 1960s (Moran et al., 1975, p. 5).

Tsunamis

Together with the seismic vulnerability of adobe construction in older parts of Lima, the threat of tsunami (earthquake-generated waves) to the port of Callao is considered to be the most important natural hazard faced by the metropolis (Kuroiwa et al., 1984, p. 801). Callao occupies a transition zone between the north coast of Peru – where significant tus-
namis have not occurred in the past—and the south coast, where they are common (Kuroiwa et al., 1984, p. 804).

Most of the major earthquakes (1687, 1746, 1940) caused tsunamis that inflicted severe damage on Callao, and recent urban expansion has greatly exacerbated the problem. A repeat of the 1746 tsunami, which devastated a 6.5 km² area, would inundate 50,000 people, 67 schools, the Peruvian Naval Academy, the Maritime Academy, and the nation’s primary port and industrial area. Since 1940, 13 tsunamis have produced varying degrees of damage in the low-lying coastal areas of Lima. Recent calculations underscore the difficulties of evacuating the growing population in the event of a tsunami generated by a nearshore earthquake. As little as 20–30 minutes of warning may be all that is possible (Kuroiwa et al., 1984, p. 804).

Huaycos and floods

Over a distance of about 120 km, the Rimac River descends 5,000 m between its source and Lima. On the way it passes through several zones that are characterized by sharply different rainfall regimes. For example, between December and April the upper valley receives 865–1,025 mm, while the foothills rarely get more than 30 mm per year and the coastal desert is in effect dry (Antunez de Mayolo, 1986, p. 61). During the December–April period, a considerable number of floods and *huaycos* take place along the Rimac. According to Maskrey (1989), a *huayco* occurs when heavy rainfall saturates steep slopes and runs off into adjacent streams. Long-term deforestation, overgrazing, and inappropriate management have reduced vegetative cover so that runoff is typically charged with soil and boulders. This load is eventually deposited in broad fans at points where the valley widens out. In the lower valley, the net effect is erosion of river banks and elevation of the river bed as it becomes choked with deposited materials.

*Huaycos* often block or destroy the highway and the railway between Lima and the central Andes, causing large losses. The city is deprived of food and the country of foreign exchange earned by exporting minerals. *Huaycos* can deposit solids in the city’s main reservoir, thereby cutting water supplies by 25 percent and forcing additional expenses for cleaning the water treatment plant. Finally, the homes of the migrant poor occupy floodplains, steep slopes, and alluvial fans in the Rimac’s tributary valleys. When *huaycos* occur, these homes are destroyed and occupants are killed. Vulnerability to *huaycos* is in large measure determined by where one lives, and that is itself determined by socio-economic status (Maskrey, 1989, pp. 13–18).

People are moving in increasing numbers into the upper Rimac valley. At these slightly higher altitudes, residents are located above Lima’s
six- to seven-month cloud cover. Indeed, the year-round sunshine has attracted middle- and upper-class Limenos to weekend homes since the nineteenth century. Increasing occupancy of the upper Rimac valley has implications for future hazard losses. The river is the principal source of both water and electricity for the city. Its valley is also the route followed by roads and railways that connect Lima with the central Andes and the jungle.

Water shortages, water pollution, and public health

It is estimated that only the most affluent quarter of Lima’s population receives constant water service (Reyna and Zapata, 1991, p. 36). Occupants of the pueblos jóvenes are particularly vulnerable to various water-related hazards. Inadequate supplies of potable water are one of these. Approximately 55 per cent of Lima’s water comes from surface sources and the rest from boreholes. In both cases, the water originates primarily from the Rimac River (Puri et al., 1989, p. 290). Lima’s water supply and disposal system was constructed piecemeal and a good part of it is now 90 years old (Reyna and Zapata, 1991, p. 34). Leaks are endemic; almost 30 per cent of supplies are lost from the system owing to broken municipal pipes and leaking plumbing fixtures in homes (ibid., p. 37). Customers have little incentive to conserve piped water because only a third of the existing water meters function properly and charges are small (ibid., p. 38). Moreover, a new system would be prohibitively expensive. In 1991, the lowest estimate for a minimally adequate new system was US$470 million (ibid., p. 39). Workable and relatively inexpensive plans exist to pipe rainwater and spring water directly from the mountains, but they are not implemented because Lima’s water authority does not have enough money to undertake these projects (ibid., p. 45). In the meantime, the city continues to drill new boreholes and drain even more subterranean water (Puri et al., 1989). Without adequate recharge, subterranean reserves will eventually be drained dry (Reyna and Zapata, 1991, pp. 39–40).

Unacceptable water quality is an even greater problem than water supply (Reyna and Zapata, 1991, pp. 35, 44–46). The Rimac is considered to be one of the world’s most highly polluted rivers. More than 300 pipes dump domestic and industrial wastes in it and there are 14 large solid-waste dumps along its banks. Purification using chlorine alone costs more than US$0.5 million per year. But bacterial contamination is not the only problem. The head of Peru’s Society of Engineers has stated that neither chlorination nor boiling is sufficient to ensure potable water because the Rimac is dangerously contaminated with heavy metals from mining and industrial wastes (Reyna and Zapata, 1991, p. 35).

The homes of 20–25 per cent of Lima’s residents, primarily occupants of pueblos jóvenes, lack water and sewer services. For these people water
comes from tank trucks, but it has not been subject to quality controls (Reyna and Zapata, 1991, p. 35). There are 13 suppliers of water to the trucks, all of them connected with SEDEPAL (Servicio de Agua Potable Acantarrillado), but administered by Lima’s various municipal councils. Customers pay up to 30 times more for water than do those with pipes, and they receive inferior water. This segment of the city’s population uses only 2 per cent of Lima’s fresh water (ibid., p. 36). In 1987, samples of trucked water were found to be contaminated with faecal coliforms and other bacteria (Gilman et al., 1993, p. 1556). Another study of the *pueblos jóvenes* focused on infection by *Helicobacter pylori*, a bacterium that appears to be endemic in Lima (Klein et al., 1991, p. 1503) and that is “associated with gastric and duodenal ulcers [and] may also contribute to an increased risk of gastric carcinoma.” The bacterium was three times more common among children whose homes were dependent on trucked water than among those in homes with piped water from the central water system. However, the risks are not solely a function of income. Children from higher-income families with piped water had 12 times the infection rates of those from higher-income families that received their water from community wells, which are entirely separate from Lima’s municipal system (Klein et al., 1991, p. 1505).

A study of 70 of Lima’s 300 boreholes showed that, although water quality was generally good, water retrieved after pumping had stopped and was then restarted tended to have high counts of *E. coli* (Puri et al., 1989, p. 293). This suggests that the cessation of pumping creates negative water pressures in the system and that *E. coli* enters because contaminated water and sewage are then sucked into water pipes (Committee on Foreign Affairs, 1991, p. 35; Reyna and Zapata, 1991, p. 34). Of Lima’s 27 municipalities, 26 pour untreated sewage into the ocean (Committee on Foreign Affairs, 1991, pp. 52–53). As a result of oceanic pollution, many of Lima’s beaches are unsafe for swimming and fishing (cited in Reyna and Zapata, 1991, p. 46). Another study, in 1988, has determined that swimmers face an increasing risk of contracting contagious gastro-intestinal and skin diseases (cited in Reyna and Zapata, 1991, p. 47).

Peru’s poor suffer severely from a variety of at least 20 waterborne diseases, including cholera (Witt and Reiff, 1991, p. 461). For example, between 1981 and 1991 gastro-intestinal disease increased sevenfold, while influenza and respiratory diseases rose twofold (Committee on Foreign Affairs, 1991, p. 4). Hepatitis is endemic and unvaccinated dogs and cats pose a constant threat of rabies. However, the most visible and acute water-related crisis emerged during the cholera epidemic of the early 1990s (Witt and Reiff, 1991, p. 452; PAHO, 1994, p. 16).
Cholera

The cholera epidemic of 1991–1993 has had the widest impact, if not the highest mortality, of any Latin American disaster during the same period. One US political leader perceived a direct connection with the global economic policies pursued by external governments and agencies: “The cholera epidemic is, I suggest, the human face of the debt problem, a repudiation of the trickle-down theories that have guided development policy for more than a decade” (Rep. Robert G. Torricelli in Committee on Foreign Affairs, 1991, p. 1).

The first case of cholera in Latin America was reported in Peru on 23 January 1991. The government confirmed the presence of cholera on 5 February (PAHO in Committee on Foreign Affairs, 1991, p. 86). Peru then established a Committee of Epidemiologic Surveillance (Staff, 1991), and the Peruvian Ministries of Health and Housing both initiated programmes to purify community water supplies (Reiff, 1992, p. 19). Owing to the rapid response, the death rate was held to fewer than 1 per cent of those who contracted the disease (PAHO, 1994, p. 13). This is particularly impressive because 30–50 per cent of untreated cholera victims are usually expected to die (ibid., p. 14). Peruvians who died during the 1991–1993 epidemic appear to have received no medical treatment or to have received it late (ibid.). Cholera tends to be a disease of adults, but it responded well to oral rehydration therapy (ORT), the treatment of choice for severe childhood diarrhoea (Committee on Foreign Affairs, 1991, p. 12). Fortunately, Peru’s Public Health Service had an excellent ORT programme already in place, developed with funds from the US Agency for International Development, and it received considerable international assistance during the epidemic (ibid., pp. 13–16).

Ironically Lima had the lowest percentage of cholera deaths – despite its questionable water – because Lima has far better health facilities than most other parts of Peru (Reyna and Zapata, 1991, p. 26). Cholera victims in Lima generally received prompt treatment, owing to the ready availability of ORT and of people trained in its use (Committee on Foreign Affairs, 1991, p. 80). As a result, of the first 55,000 people with cholera in Lima, only 150 died, whereas in Cajamarca, 326 out of 6,000 cholera sufferers died (ibid.). From the start of the epidemic until May 1991, Lima had 76,190 cases of cholera, of which 26,326 were hospitalized and 196 (0.26 per cent) died. In the same period, Cajamarca had 8,602 cases, of which 4,538 were hospitalized and 376 (4.37 per cent) died. Lima’s 76,190 cases represented 34.84 per cent of Peru’s total cases (Reyna and Zapata, 1991, pp. 109–111).

Most of Lima’s cholera victims were poor people who lived in pueblos jóvenes (Reyna and Zapata, 1991, p. 26). Cholera throughout Latin America is primarily – but not exclusively – a disease of the poor.
(PAHO, 1994, p. 14). Highly contaminated water from decaying municipal water systems appears to have been a major reason for the spread (ibid., pp. 14, 16). In Peru, "cultural reasons" for the spread included the belief that freezing would kill the cholera pathogen, which led to the use of ice made from impure water (Reiff, 1992, p. 18). Cholera also appears to have been spread through dish-washing water used (and reused) by street vendors, and ingestion of raw seafood (Glass et al., 1992). On 12 February, Lima's mayor prohibited further street vending of food (Reyna and Zapata, 1991, p. 126). During the epidemic there was tremendous controversy over the eating of ceviche, Peru's national dish, which is made from marinated raw seafood. President Fujimori was shown on television eating ceviche after health recommendations against eating it had been publicized. This was followed by a rise in new cholera cases after each of Fujimori's appearances (ibid., pp. 125–132).

The cholera epidemic provoked a number of secondary stresses also. Securing sufficient fuel to boil all drinking water for 10 minutes, as recommended by Peru's Minister of Health, could be costly, particularly for those in pueblos jóvenes who used kerosene for cooking (Reyna and Zapata, 1991, p. 79). On 25 February, Peru's Minister of Health requested that the government subsidize the price of kerosene so that poor people could afford to boil their water (ibid., pp. 79, 127). On 13 March, just before the start of a new school term, a group of sanitary engineers revealed that approximately 70 per cent of Lima's public schools had insufficient sanitary facilities and should not be opened for the new school session (ibid., p. 128). Many parents kept their children out of school (Committee on Foreign Affairs, 1991, p. 63). In the end, President Fujimori ordered that all of Peru's schools remain closed until 15 April (Reyna and Zapata, 1991, p. 130).

The degradation and contamination of the rivers that supply most of the drinking water for many Latin American communities can lead to the endemic presence of cholera. In addition, the contamination of the ocean has aided in keeping the cholera pathogen viable. It was once thought that cholera was carried only by humans, and spread solely through contamination by human faecal material. However, recent studies demonstrate that the pathogen can survive in oceanic plankton and algae that thrive on industrial wastes, fertilizer runoff, and raw sewage, even in the absence of faecal material (Emmett, 1993, p. 13). It appears that this can result in continued re-contamination of drinking water in coastal cities such as Lima.

**Fires**

Fires still constitute a major hazard in the squatter settlements, much as they did in colonial times. In some cases the causes of fires are the same.
The provisional huts of *estera* mats, although never seen as permanent, are frequently lived in for extended periods while resources are accumulated for more durable housing materials of adobe or brick. The *estera* mats are flammable and kitchen mishaps with kerosene stoves frequently ignite these fragile dwellings, quickly consuming the hut and all its contents and spreading to other huts built close by. Similar fires break out in overcrowded slum dwellings (Kuroiwa, 1977).

In other cases, however, the rapid expansion of both squatter settlements and other forms of formal and informal housing and industry has created circumstances of extreme danger from industrial fire and explosion. In Callao, for example, there is considerable risk in the port and industrial zone because petroleum, gasoline, and natural gas storage tanks are surrounded by homes and their accompanying cooking facilities as well as mobile fast-food vendors and their carts. Furthermore, the historic zone of Callao, consisting of the Fort Real Felipe and many wood-frame buildings, is also close by (Preuss and Kuroiwa, 1996, p. 278). In fact, the entire greater port area suffers from severe congestion, with storage facilities for combustible and toxic substances surrounded by dense, low-quality residences of the *pueblo joven*, Puerto Nuevo. In addition, between the navy base in Callao and the commercial port is the area’s fishing fleet. The conjuncture of all these uses constitutes a high risk of fire starting either inside the industrial area from accident, inadequate maintenance, or impact or outside by the cooking carts, home accidents, terrorism, or an accident involving the many trains and trucks entering and leaving the area. In the event of such a fire, there would be little to keep the blaze from becoming a major conflagration (ibid., p. 280). The danger of fire caused by earthquakes or accidents is compounded by this mixed use pattern in this area as well as other parts of the city. Furthermore, the system of streets and roads within both *pueblos jovenes* and the old city very often presents an obstacle in itself for the access of emergency services of any kind. In the older parts of the city, dating from the colony and early republic, streets are narrow and extremely congested. The *pueblos jovenes* are honeycombed with narrow alleys and passageways, sometimes ascending the steep hillside to the east of the city and virtually impossible to traverse for emergency vehicles. Compounding the problem of fires is the fact that Lima has only a volunteer fire department that is woefully under-equipped for any fires of an industrial or chemical nature (Preuss, personal communication, 1994).

*Industrial and technological hazards*

Although, nationally, Peru’s level of industrialization is low, almost 70 per cent of all industrial establishments are located in metropolitan Lima. In 1985 the city also accounted for 57.6 per cent of the nation’s gross
Table 8.4 The share of industrial value, by sector, produced in metropolitan Lima

<table>
<thead>
<tr>
<th>Sector</th>
<th>Lima's share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foodstuffs</td>
<td>57.7</td>
</tr>
<tr>
<td>Beverages</td>
<td>63.0</td>
</tr>
<tr>
<td>Tobacco products</td>
<td>100.0</td>
</tr>
<tr>
<td>Textiles</td>
<td>83.3</td>
</tr>
<tr>
<td>Clothing</td>
<td>94.3</td>
</tr>
<tr>
<td>Leather</td>
<td>70.7</td>
</tr>
<tr>
<td>Shoes</td>
<td>95.0</td>
</tr>
<tr>
<td>Wood products</td>
<td>26.0</td>
</tr>
<tr>
<td>Paper products</td>
<td>75.7</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>83.0</td>
</tr>
<tr>
<td>Chemical processing</td>
<td>77.5</td>
</tr>
<tr>
<td>Other chemicals</td>
<td>92.4</td>
</tr>
<tr>
<td>Petroleum</td>
<td>60.1</td>
</tr>
<tr>
<td>Oil and coal derivatives</td>
<td>35.8</td>
</tr>
<tr>
<td>Rubber</td>
<td>98.8</td>
</tr>
<tr>
<td>Plastics</td>
<td>90.4</td>
</tr>
<tr>
<td>Ceramics</td>
<td>98.6</td>
</tr>
<tr>
<td>Glass</td>
<td>91.8</td>
</tr>
<tr>
<td>Non-metallic minerals</td>
<td>52.6</td>
</tr>
<tr>
<td>Basic industrial iron and steel</td>
<td>29.0</td>
</tr>
<tr>
<td>Non-ferrous basic industries</td>
<td>12.4</td>
</tr>
<tr>
<td>Metals</td>
<td>77.7</td>
</tr>
<tr>
<td>Non-electric machinery</td>
<td>76.8</td>
</tr>
<tr>
<td>Electric machinery</td>
<td>99.0</td>
</tr>
<tr>
<td>Transport</td>
<td>86.5</td>
</tr>
<tr>
<td>Optical and photographic industries</td>
<td>98.5</td>
</tr>
<tr>
<td>Other industries</td>
<td>86.9</td>
</tr>
</tbody>
</table>


National product (*Atlas del Perú*, 1989, p. 192). The city's dominance is a function of two factors. Because Lima contains almost one-third of the national population, it provides a huge market. Secondly, Lima is the only city in Peru that can satisfy the demand of industry for infrastructure and services (energy, water, transportation networks, communications networks, banking, commercial and distribution chains) at competitive prices. The city's nodality is well seen in the Peruvian road system, which radiates from it. Nodality is even more exaggerated in an economic sense (ibid.; table 8.4).

By itself the concentration of industry would pose a significantly increased threat to health and safety in Lima compared with other communities. When industrial concentration is combined with other factors, the potential for disaster is even higher. Such factors include: inadequate
infrastructure; deteriorating facilities; insufficient maintenance; lack of enforcement of industrial regulations; and mixed land-use patterns that feature intermingling of housing and industrial plants. To these can be added the propensity of developed countries to ship hazardous wastes to already burdened poor states. In these circumstances, reported negotiations between a Peruvian company and a US company that wished to dispose of toxic wastes from American industries (e.g., solvents, burnt oils, and chemical wastes) take on added importance (Hardoy and Satterthwaite, 1989, p. 188).

The combination of industrial emissions with emissions from poorly tuned vehicles using fuels with a high lead content generates severe air pollution problems in Lima. According to available data this is not yet on a par with some other developing metropolises, but this may be due to lack of research as much as to actual pollution levels. Impressionistic data indicate that the situation is worsening and represents a grave enough potential to be discussed as a threat in civil defence literature (Comité Nacional de Defensa Civil, n.d.).

The juxtaposition of industrial and residential uses is characteristic of a number of areas in Lima. It is also important to recall that the figures cited above represent only that portion of the total industrial output that is produced by the formal sector. Admittedly, almost 60 per cent of the informal economy is dedicated to tertiary activities, but there is evidence that small-scale industrial production and maintenance activities go entirely unregulated, many of them located in the tugurios and the pueblos jóvenes. Although many of the pueblos jóvenes often plan an industrial zone apart from residential areas, mechanical and electrical workshops are frequently set up in or adjacent to dwellings (Poloni, n.d.; Burga and Delpech, 1988).

Social unrest and terrorism

In the colonial era, residents of Lima frequently regarded the oppressed Indian population as a menace to the city. Indian rebellions certainly occurred in the highlands, from the early days of the colony to the nineteenth century, but Lima was never seriously threatened. Apparent conspiracies were uncovered and supposed plotters were executed to assuage the anxiety of the members of Spanish élites. But these anxieties were not realized until the recent emergence of the members a political movement known as the Peruvian Communist Party of the Shining Path (Sendero Luminoso). In many ways, Shining Path was an expression of rage and frustration felt by some sectors of Peruvian society against conditions of injustice and poverty that afflicted the majority of Peruvians (Palmer, 1992). Founded in 1970 by a philosophy professor from the University of San Cristóbal de Huamanga in the highland city of Ayacucho, the party
adopted a Maoist interpretation of Peruvian society, and emerged in 1980 to wage a guerrilla war that is unparalleled in Peruvian history for its success and cold-blooded brutality. Its leader, Abimael Guzman, interpreted Peruvian underdevelopment as deriving from the colonialist, semi-feudal system, which subjugated and exploited the Indian masses for the benefit of urban élites (Granados, 1992). He believed that urban élites were assisted by international allies in the capitalist system and therefore he prescribed a Maoist-style war on the cities. Initially this targeted provincial and departmental capitals, but the conflict gradually worked its way toward and into Lima.

During the first year of hostilities (1980) there were over 1,000 attacks on government offices, high tension towers, and police posts in highland areas (Kirk, 1991). At first the guerrillas were dismissed as gangsters and fanatical thugs, but gradually the government found itself fighting a protracted war against opponents who were often indistinguishable from the peasant population. Counter-insurgency efforts were soon marked by numerous human rights violations against the peasantry as government forces attempted to combat the growing effectiveness of Sendero Luminoso. The guerrillas replied in kind, executing peasant leaders and often whole families or neighbourhoods. Such was the brutality that large numbers of refugees began fleeing the highlands in 1983, most of them ultimately taking up residence in the shanty towns of Lima. Many of the desplazados (displaced or refugees), in effect, began to establish their own shanty towns, invading unoccupied land at the edge of other settlements. The desplazados have been estimated to have contributed approximately 200,000 people to Lima's already enormous shantytown population (Kirk, 1991).

As the desplazados began pouring into the city, Sendero Luminoso and another group – the Tupac Amaru Revolutionary Movement (MRTA) – initiated campaigns of urban terrorism. The first actions taken against residents of Lima involved dynamiting transmission towers carrying power to the city from hydroelectric plants. These blackouts (apagones) became an unmistakable indicator of the city's vulnerability to terrorism. Shortly after the first one, car bombs and assassinations also began; these targeted public functionaries, neighbourhood and barriada leaders, as well as public offices, embassies, and other facilities. After 1986, sounds of gunfire and bombings became commonplace in the city. Electricity and water were rationed and supplies were unreliable as attacks on public utilities escalated. Assassinations and bombings continued until the mid-1990s. Urban terrorism forced some better-off residents to emigrate to the United States, but most Limenos could not avail themselves of this option. Parts of the city where Sendero support was strong became known as "liberated" zones. Often these were areas of strategic signifi-
cance that controlled access to vital resources. For example, Ate-Vitarte was a major focus of Sendero activity because it is a nerve centre for both water and electrical services, as well as being the site of many large pueblos jovenes (Gonzalez, 1992; Rojas Perez, 1992, p. 127). The great mass of Lima’s population endured what became known as the “Beirutization” of their city. The capture of Abimael Guzman and many of the leadership cadres in September of 1992 has diminished Sendero’s effectiveness, if not its brutality. Conflict continues, but more sporadically; the bombings and the assassination of public officials and organizational leaders are now less frequent. A high-profile four-month-long siege of the Japanese embassy by the Tupac Amaru ended in April 1997 with the death of all the guerrillas in the building. The war thus far has cost over 25,000 lives and US$10 billion in terms of destruction and damage (Doughty, 1993).

Opportunities for intervention to reduce urban hazards

Today Peru is beset by a vast range of problems, including hazards and disasters. The country suffers profoundly from severe underdevelopment and “maldevelopment” (Amin. 1990), both of which undergird vulnerability to hazards. From the standpoint of urban hazards, Lima even appears to be regressing; this is best indicated by the resurgence of epidemic diseases that had not occurred since the early nineteenth century. Now cholera (and AIDS) have reinstated epidemics on the list of burgeoning urban environmental hazards.

The national and international dimensions of underdevelopment should be addressed, as well as the more immediate manifestations of hazard. For example, the hazards of waterborne diseases such as cholera, hepatitis, and dysentery could be substantially mitigated by addressing deficiencies in the water system, particularly with regard to issues of purity, maintenance, and delivery as well as adequate sewage and waste disposal. Fire hazards could be substantially reduced by separating industrial and residential areas, widening access roads, improving housing stock, and professionalizing fire services. Vulnerability to huaycos and floods would be substantially reduced by appropriate land-use planning and enforcement as well as by land acquisition and housing programmes for low-income people. Earthquake vulnerability in inner-city slums could be reduced by renovating buildings and reducing densities via provision of alternative housing. These steps are fundamentally contributions to development as well as hazard mitigation. Indeed, by itself, the provision of basic services to all of the city’s population would go a long way toward mitigating many of Lima’s hazards. Sadly, given the enormous
numbers of people without basic services and the resources available for such a task, this form of hazard reduction will be uneven and slow at best.

Unfortunately, the structure, circulation, and accumulation of international capital have created an economic system that consigns Peru to the role of raw materials supplier and processor. The current production system will not generate sufficient capital to alleviate Peru’s perennial international deficits, much less realistically address the multiple hazards that face the population of Lima on a daily basis. Adequate responses to these problems would require enormous transfers of capital and an escalation of the country’s indebtedness to unimagined heights. Such a goal is to be hoped for, but there seems little basis for believing that it will happen in the foreseeable future.

That fact notwithstanding, it must be recognized that numerous cities in the developed world are experiencing similar difficulties coming to grips with problems of air and water quality, fire service, land use, sanitation, toxic water disposal, and other aspects of environmental hazard. And, however overwhelming the challenges facing Lima may be, Peru is not without significant resources that can be deployed to reduce them. Important steps to address many disaster-related problems are being taken. This is partly because hazard awareness is high in Lima. It is impossible to live there and not be aware of the potential of natural, social, or technological hazards. Limenos have joked to me that they are the most adaptive people in the world because they have developed a coping system for chaos! They are extremely serious about coming to grips with hazards, despite their lack of economic resources to resolve them. They have learned from the experience of the great 1970 earthquake and have embarked on a wide range of hazard-reduction research projects.

The earthquake of 1970 killed approximately 65,000 people and devastated a vast area in the north-central coastal and Andean regions (Oliver-Smith, 1992, 1994). Although the shocks were strongly felt in Lima, they did little damage there. However, the earthquake performed a valuable service for non-affected areas by stimulating a programme of research on hazard and vulnerability that continues to the present (Casaveer and Vargas, 1984; Gieseke and Salgado, 1981; Kuroiwa, 1977, 1983; Kuroiwa and Alva, 1991; Kuroiwa and Tanahashi, 1989; Kuroiwa, Sato, and Kumagai, 1992; Kuroiwa et al., 1984; Torres Cabrero and Huaman Egoavil, 1992). Key individuals in the National Engineering University (UNI), the National Civil Defence Committee, the Catholic University of Peru, and other national and international organizations assumed responsibility for investigating the earthquake vulnerability of Lima and the rest of Peru. Secondary disasters such as tsunamis and fires were also studied. Initial work relied heavily on graduate student theses
that investigated vulnerability of structures (e.g. housing, hospitals, schools, industries) and public services (e.g. water, sewerage, energy, transportation, communications). A map of probable seismic intensities was constructed, based on past events and soil and geological analysis. This was combined with maps that showed probable damage based on the prevalence of different construction materials (Kuroiwa, 1977).

Analyses of these data revealed several critical problems in Lima. A primary finding was the debilitated condition of overcrowded adobe and quincha housing in older parts of the city, specifically Barrios Altos, Cercado, Rimac, Callao, Barranco, and Chorrillos. In the event of a serious earthquake, such dwellings remain likely to collapse, trapping victims, filling streets with rubble, and impeding rescue. Hospitals and schools in these neighbourhoods are in similar weakened condition. Moreover, the soils that underlie the older parts of Lima tend to amplify seismic movements. The same soil conditions also affect Callao, whose vulnerability to tsunamis constitutes the second most critical problem facing the Lima metropolitan area.

Newer middle- and upper-class residential neighbourhoods tend to be located on stable soils and to employ better materials and building technologies. Minimal damage is predicted for these areas. However, several factories have been found to be vulnerable to seismic damage and public services are also at risk. Water pipes are particularly vulnerable because of either age or soil instability. Electricity supplies are less vulnerable because of good maintenance. Traffic circulation in the older areas of Lima would be subject to much worse congestion in the event of a disaster and the communication system, radio, TV, telegraph, etc. were found to lack disaster preparation.

Most of the findings for the 1977 earthquake vulnerability study remain valid today, with the exception of significant improvements in the communication system (Maskrey and Romero, 1986; Maskrey, 1989). There have been continuing efforts to establish hazard-research organizations and projects, some in cooperation with international bodies and other countries. Principal among these is the Centro de Investigacion Sismica y Mitigacion de Desastres (CISMID – Centre for Earthquake Engineering Research and Disaster Mitigation). CISMID was formed under an agreement between the UNI and the Japanese government. Its facilities include a structural lab, a geotechnical lab, a computer centre, a national disasters data bank, a disaster mitigation department, a library, and educational, training, and diffusion services. The Japanese International Cooperation Agency (JICA) has sent expert advisers to Peru, and 25 CISMID staff members were trained in Japan during the late 1980s (Kuroiwa and Tanahashi, 1988). One major focus of investigation has been the transferability to Lima of disaster-mitigation techniques that are employed in Tokyo (Kuroiwa, 1977).
The process of political reorganization that is under way in Peru has broad implications for hazard reduction in Peru as a whole as well as in Lima. A basic law for political regionalization and implementing a National Plan for Regionalization were important innovations included in the new constitution of 1979. This legislation has subsequently been modified and complemented by amendments and additional laws promulgated in 1984, 1987, and 1988. It is a substantial attempt to come to grips with the overwhelming centralization of Lima and to develop an integrated policy of economic and social development among the country's 12 regions (Vargas Chirinos, 1989; Kuroiwa and Tanahashi, 1989). Important progress has been made, including the election of regional assemblies in some regions, but the process—and its intended effects on decentralization—is far from complete.

Regionalization has also provided a structure and a focus for a national programme of disaster reduction. The technical knowledge and skills of hazard-management individuals and organizations are being mobilized to develop a national disaster-reduction plan that is based on regional components. Currently, the principles and procedures of micro-zonation—a widely used tool of earthquake engineering—are being refined for use in urban and regional land-use plans throughout the country. Micro-zonation techniques are normally applicable to small areas, usually of a few square kilometres. At the regional scale, they are assigned to high-priority locations such as those with rapidly growing populations, areas with high disaster frequency and vulnerability, and areas where important engineering projects are to be located (Kuroiwa and Tanahashi, 1989). The separate regional plans will eventually be combined in a single National Programme for Disaster Prevention and Mitigation, which will also double as Peru's main contribution to the International Decade for Natural Disaster Reduction. A pilot case-study of the Grau district in the far north of Peru was carried out and produced important findings about soils, land-use planning, appropriate construction techniques and materials, expansion areas for urban development, and disaster probabilities and vulnerability (Kuroiwa, Sato, and Kumagai, 1992).

Because micro-zonation techniques were originally developed for urban planning, their application for hazard analysis for Lima is relatively straightforward and will constitute a major effort in the near future. Peru's newly established regions provide the organizational structure for a hazards database. Supporting research has been funded by a greatly expanded budget of the National Council of Science and Technology (CONCYTEC). An education, training, and diffusion initiative is also encouraged by an accord between the Ministry of Education and the UNI (Kuroiwa and Tanahashi, 1989). Eventually it is intended that all national construction in Peru will factor in disaster-mitigation measures and all
citizens, regardless of place of residence, will be informed about disaster preparedness (Kuroiwa and Alva, 1991). The level of technical understanding of environmental hazards is high and there has been a continuous process of refinement of emergency and mitigation plans for the city and the nation (Kuroiwa and Tanahashi, 1989; Kuroiwa, Sato, and Kumagai, 1992). Notwithstanding the progress that is being made in formulating national and regional policies for natural hazards and disasters, unless the Peruvian government can implement and enforce these policies, their value is limited. This has been the fate of previous efforts to modify Lima’s urban development by either planning controls or building codes.

In any case, national policies cannot reduce urban hazards by themselves; they must be complemented by hazard-mitigation and preparedness measures that incorporate high levels of local community participation. During the past decade in Peru, important non-governmental organizations (NGOs) dedicated to a community-based hazard reduction have emerged in Lima. They include organizations such as the Centro de Estudios y Prevencion de Desastres (PREDES) – a locally based NGO; and the Intermediate Technology Development Group (ITDG) – an international NGO with offices in Lima. Both of these and other groups are attempting to link disaster preparedness and mitigation to locally perceived existing needs. They seek to build awareness of hazards and risks at the community level by means of pilot projects that reinforce, rehabilitate, and rebuild slum dwellings or improve soil- and water-management techniques in huayco-prone communities. In so far as such strategies require the exercise of political pressure for expropriation of land, transfer of capital resources, or alternative financial mechanisms, they help to build the basis for future agendas aimed at general transformation of underdeveloped communities (Maskrey, 1989, pp. 45–46). The immediate goals of NGOs such as ITDG and PREDES are local, but their long-term implications are far-reaching. None the less, they realize that, at the most basic level, vulnerability to hazards is deeply embedded in broader political economic structures that are based in both national and international systems of capital circulation and accumulation. In that sense, they work not only for disaster mitigation in specific local contexts but also for forms of political empowerment to address broader issues.

Conclusions

Since the beginning of the twentieth century, and especially during the past 30 years, Lima has been transformed. Once it was a bastion of criollo elite culture where the privileged few presided over a vast multi-ethnic
population. Many Limenos used to take pride in the fact that they had travelled widely throughout Europe and North America but had never been to the highlands of their own country. They can no longer practise such evasions, for the highlands have now come to Lima. All the polarized metaphors and visions that élite Limenos once employed to define their identity are becoming irrelevant in what has become a massive city of migrants. The problems of exploitation and dependence that Lima’s dominance created for the rest of Peruvian society have now been replicated in the capital. Demographically at least, the nation has become unified. If Lima was the springboard from which Peru was conquered, it is now the chief prize of the reconquest of Peru by its native peoples. Instead of Lima “being” Peru, as Valdelomar joked, Lima finally “belongs” to Peru.

Although efforts to address environmental hazards at both national and community levels are significant, given the monumental dimensions of the problem and the complexity of the tasks required there is little reason to expect a significant reduction in Lima’s vulnerability to hazards in the near future. Both national policy implementation and community action may reduce the vulnerability of specific local populations, but an overall reduction in hazard vulnerability requires a series of actions that would alter the structure of national and international markets, debt–credit relationships, demographic movements, and political and administrative institutions. In the unlikely eventuality of such changes, efforts to come to grips with hazard vulnerability in Lima and in Peru as a whole take on real significance. The fact that such efforts are really unable to address the root causes of that vulnerability, so embedded in the historical development of the nation and its capital city during its over four and a half centuries of existence, does not mean that they will fail completely; only that they will never succeed completely. Given the similar situation of many mega-cities in the developed world, such a goal is worth the effort.

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