tries, inadequate resource extraction and inefficient processing technologies account for the large quantities of raw sewage and industrial waste that are dumped annually into rivers and water sources. Given the strong linkages between disaster vulnerability and urban-environmental stress it is obvious that the conditions and development patterns of most Eastern European cities could trigger irreparable disasters or amplify the adverse impact of potential hazardous events. Economic and political reforms will need to address the future pattern of environmental degradation and urbanization in these countries.

The ecological transformation of urban areas

In most developing countries, the rapid rate of urbanization has not been accompanied by a corresponding increase in the level of economic growth. Increasing demands have intensified conflicts over land use among sectors and threatened to exhaust or degrade soil, forests, water, air, and climate. Stringent fiscal and financial conditions compound the problem as governments are forced to cut back on expenditures in basic infrastructure and services. Moreover, as Bahl and Linn (1987) explain, increased local government expenses also result from the locational options of poor migrants which often squat on or purchase at cheap prices unsuitable land that is difficult to service owing to topography (unstable hill slopes, flood plains, swamps and coastal areas).

Cities have been unable to absorb the increasing pressures posed by poor people and squatter settlements in highly vulnerable areas. Eloquent examples of the devastating consequences of environmental management are Jakarta, Lagos, Manila, and Mexico City. Between 1940 and 1990, the Mexico City's area grew almost tenfold—from 130 to 1,250 sq km (Harris and Puente 1990). This process of dispersal has implied considerable service deficits and illegal occupation, placing the urban population at danger from the potential impact of natural disasters. Poorer families have settled on dried lake beds which, because of insufficient drainage have become flood-prone areas during the rainy season, a problem that has been exacerbated by clogged channels and poorly maintained piping subject to devastating dust storms in the dry season. This unwise use of land seems to have affected increased risk factors in earthquake-related hazards. Likewise, in Lagos and Manila, filling some swamp and coastal lands for construction resulted in blocking the waters of an extensive river system. As a consequence, large urbanized areas in both cities are now periodically flooded. Metropolitan Manila lies in a flood-prone area located in the coastal margin of the Manila Bay between two large bodies of water, Manila Bay and Laguna de Bay Lakes. Rapid and uncontrolled urban development and a population of about 7.35 million—which is expected to exceed 10 million by the year 2020—has encouraged squatter encroachment on waterways. In conjunction with this pattern of urbanization, built-up areas have sprawled over farmlands, forests, and grasslands with the consequent increase of water-impermeable areas (Lee 1985). In addition to floods, environmental degradation resulting from human intervention has increased the vulnerability to risks posed by natural hazards. For example, shortage of appropriate drainage systems and poor or nonexistent maintenance of facilities compounded with squatter encroachment on the waterways, indiscriminate disposal of solid waste on the roads, rivers and channels, and lack of understanding among decision makers concerning the merits of planning and preparedness measures have exacerbated the city's vulnerability to floods (UN 1990a). Furthermore, groundwater demand has grown so rapidly that for the last thirty years natural recharge was far exceeded leading to problems of land subsidence—which has been estimated to be some 36 mm in the south harbor of the city—and salinization (Munasinghe 1990).

Jakarta also illustrates the phenomenon of rapid environmental degradation. In that city, rapid population expansion is seriously threatening the availability and quality of groundwater resources. The unconstrained use of wells to provide drinking water has caused salinization of the aquifer in the northern part of the city, and land subsidence has occurred in the coastal area (UN 1990). Moreover,

uncontrolled development in the south, combined with deforestation and dumping of solid and liquid wastes into rivers and canals that drain the city, have led to increased runoff and heavy flooding in the north, where most of the city's poor live (Lee 1985). Illegal squatters have spread in the low-lying, flood-prone areas and along channels and coastal zones, resulting in the contamination of rivers and water sources. Large amounts of uncollected garbage exacerbates the problems of flooding. Inadequate and poorly maintained drainage systems results in drains clogged with debris, and water weeds that proliferate in rivers and floodways polluted by domestic wastes and chemicals. In addition, deforestation in the upstream hilly areas has contributed to siltation problems in rivers and canals that provide natural drainage to the metropolitan region.

The dramatic deterioration of economic and social conditions of developing countries, has heightened the impact of natural hazards in populated areas of Latin America, Africa and Asia. Lack of clean water in the poorest areas is threatening the health of low-income families. Water receives little or no purification; thus it contains dangerous levels of toxic wastes, viruses, and bacteria. Contamination of water sources used for drinking and cooking has become widespread. In 1991, a cholera epidemic affected more than 50,000 people in Peru. The first major outbreak appeared in the coastal city of Chimbote, north of Lima, quickly expanding in other port cities and in Lima, where more than 2 million people live in shantytowns that have no running water or sewage treatment facilities (Robinson 1991). In Sao Paulo, Brazil, water pollution has reached alarming proportions. Recent studies have demonstrated the danger of stormwater runoff from cities and towns. Residues, such as street refuse, garbage, asbestos, oil, and fuels, can be washed into surface and groundwater sources, becoming a major cause of freshwater pollution. Inadequate maintenance of drainage networks, severely blocked by silt and uncollected solid wastes, can further compound the problem. The situation becomes particularly dangerous when natural phenomena and topography combine to create high volumes of stormwater in steep terrains. An increasing demand for urban shelter and services is placing further stress on aging buildings and infrastructure, exacerbating their vulnerability to breakdowns and potential catastrophic events. Brown and Jacobson (1987) report on the vulnerability of Jakarta and Manila residents to epidemic outbursts and endemic diseases. In Jakarta, for example, less than 25 percent of the population's needs can be met by the current water supply system. Furthermore, many wells have been deteriorated by sewage contamination and saltwater intrusion. The conditions for Manila residents are similar. In a city of about 9 million, only 11 percent of the population is served by sewers. Road gutters, open ditches, and canals are conduits for raw sewage.

The urban growth pattern of the twentieth century has failed to control the ways in which the environment is altered by human settlements. The continuous increase of energy demand to meet urban needs has largely contributed to the degradation of natural ecosystems, hazards and accidents, particularly in countries lacking environmental management and energy strategies aimed at efficient resource use. Since the oil price hikes of the early 1970s, developing countries have turned to renewable energy sources such as hydropower, wood and geothermal energy. The environmental impact of large-scale water works has become one of the most controversial issues in several countries as hydro power is increasingly seen as an effective way to accelerate the transition to renewable energy (Goodland, Juras, and Pachauri 1991). Despite some major side benefits of hydropower projects—such as providing cities with a clean energy supply—their potential adverse impact in terms of increasing disaster risks cannot be ignored. In some cases, irreversible loss of native forests have resulted from the construction of hydro reservoirs. Deforestation along the perimeter of reservoirs have been known to cause serious sedimentation problems in dams built around steep banks. Slope instability can have disastrous consequences in landslide-prone areas where overtopping and failure of reservoirs might trigger downstream

flash floods and massive avalanches affecting densely populated areas. Moreover, the potential for dam-induced seismicity increases with natural stresses. Risk assessment concerning the location of hydropower projects in relation to hazardous geographic areas and the vulnerability of urban centers exposed to such hazards are essential development tools.

In addition to the potential adverse effects of growing energy demand cities have been subjected to many types of hazardous risks derived from poisonous waste as an end product. As one of the main generators of solid waste, industries in developing countries dump their refuse in nearby rivers, open grounds, or even in the streets. Uncollected wastes accumulate, clogging drainage and contaminating water sources. In some cases, as a result of the combination of flawed impact-and-control measures for industrial location, design, and operation, high-risk facilities—such as the petrochemical complex in Cubatao, Brazil, the liquefied natural gas facility in Mexico City, and the pesticides factory in Bhopal, India—locate in highly populated areas. The accidents in Mexico City and Bhopal indicate that there are gaps in regulatory structures and sitting decisions for preventing industrial accidents. Concomitantly, lack of appropriate and environmentally safe production processes has increased the risk of industrial hazards. The dissemination of technological adaptation and innovation at the levels of overall sectors and firms encounter in many cases financial difficulties. In most developing countries, access by both public and private enterprises to environmentally adequate information and technological alternatives is still limited. Efforts to promote the dissemination of clean technologies are lagging behind.

Urban pollutants are not confined to city limits. As Faiz (1991) points out, airborne pollutants, such as sulphur and nitrogen oxides, contribute to acid rain, which can destroy forests and eat slowly through buildings and infrastructure. Some of these pollutants have become important if not the main contributors to greenhouse gases that are changing the earth's chemistry. One of the most significant environmental impact of urban/industrial civilization is the large-scale transfer of carbon dioxide (CO_2), methane (CH_4) and chlorofluorocarbons (CFCs) into the atmosphere. According to Norberg-Bohm (1991), human activities in residential and commercial buildings are among the largest contributors of greenhouse gas emissions, mostly CO_2 from fuel combustion, for heating, cooling and lighting. Currently, energy use in buildings accounts for about 30 percent of all anthropogenic CO_2 emissions which depend on both the energy source and the efficiency of energy use (coal and fossil fuels are among the critical elements that determine current CO_2 emissions). While industrialized nations are currently the main contributors to all CO_2 discharges, the share of developing countries has been growing, and it is expected to continue, particularly in urban areas (Sathaye, Ghirardi, and Schipper 1987). The view that increases in energy retention by the earth due to greenhouse gases, and consequent global warming, would result in major environmental and social disruptions—including a great increase in the number and severity of natural disasters—is becoming more accepted by the scientific community. Among the most devastating effects that may occur are flooding of densely populated areas, increases in the severity and frequency of tropical storms, sea surges, a rise in sea level, and coastal line regression.

Urban populations are also threatened by obsolete technologies (e.g., Eastern Europe), as well as by the unexpected consequences of hazardous waste. Energy conservation and fuel switching can help preventing the potential perilous consequences of increased greenhouse gasses. Global and regional efforts need to be mobilized to support appropriate technology transfer, training and coordinated policy options. For example, reducing CO_2 emissions from the building stock is a multifaceted problem that requires overcoming a variety of barriers to investment in energy conservation and technology transfer (Norberg-Bohm 1991). This policy shift implies the use of a combination of mechanisms, ranging from end-use taxes, as well as building codes and consumer information and marketing. The integration of

technical knowledge in decision making is a key issue. According to Williams (1991), "the technical character of many contemporary public questions leads to the thought that nonexpert decision makers might with advantage aim to acquire and enhanced technical mindedness, a feel for technical questions similar to what they would claim for nontechnical ones."

Urbanization, technology, the labor market, and regional disparities

In the last decade, new technologies and communications systems have promoted the internationalization of production and distribution. New transportation modes and communications technologies now make possible the spatial spread of productive activities that needed to be located in spatial clusters in the past. Some countries—the newly industrializing countries (NICs)—have shown an increased capacity to absorb technological innovation, utilize new communications systems, integrate new concepts in products and processes and adapt to new performance and quality standards. Other countries, developing countries, have remained at the periphery of those developments. According to Dahlman (1989), the new technological development in the industrial sector tends to work against developing countries whose most abundant resource is cheap unskilled labor which will account for 95 percent of labor force growth in the next two decades, as compared with less than 15 percent of capital investments. Hence, harnessing labor markets to provide employment, not for a very small fraction of workers at very high wages, but for a much larger number of workers in labor-intensive industries is—in Summer's words—a major challenge for the next years. Since human capital is the principal asset of the poor, raising its return has to be a central investment priority (Summers 1991, p. 6). Consequently, prevalent industrialized trends that privilege technology development and production quality raise important issues concerning the abundant supply of unskilled labor in many developing countries. Currently the competitive advantage in many sectors depends more on reliable communications, speedy and reliable delivery, high-quality production, and on the ability to expand the range of products and services to fit customers' changing needs than on lower production costs. Many countries, particularly in Africa and Latin America, have not been able to integrate these industrial changes into their development strategies. Thus, in Dahlman's words there is an " . . . increasing polarization between LDC's that can successfully adjust those technical changes and those that cannot" (1989).

Regional and technological disparities have increased with new approaches in industrial development in recent years. A substantial structural change has occurred, particularly in the industrial manufacturing sector with (a) a tradeoff between industry and services; and (b) an accelerated rate of innovation in microelectronics, biotechnology and new materials (Dahlman 1989). The structural change is mostly based on a broader applicability of new technologies, such as electronics and communications, and a reduction in the life cycle of technological processes and of products. The new technologies include new electronics-based technologies for computer-aided design (CAD), numerically controlled machine tools, industrial robots, computer-aided manufacturing, and automated order and distribution systems. Dahlman points out that these innovations permit a short period of time between new product design and production, rapid response, and flexibility in relation to the specifications of different customers. He describes the resulting trend as a movement toward product diversification, more competition in design, distribution, and service, in addition to actual production activities. Regional disparities have increased with technological innovation. Industries based on high technologies tend to locate in those metropolitan areas in which infrastructure and services available to support them are accessible. The existence of a pool of skilled labor is another factor in promoting the location of high technology industries.

Eastern Europe illustrates regional disparities in technological development which

reflects on environmental degradation. Most of Eastern European plants are not only severe polluters but are obsolete and unable to compete in world markets (Alonso 1991). Although lack of industrial competitiveness is due to political, economic and organizational factors, the impact of an inadequate physical plant is not trivial. In environmental terms, inefficient building stocks have a long life with subsequently long-lasting environmental impacts. As Jones explains in his paper in this volume, "the built environment is the accumulation of social overhead capital over time . . . it is durable and can last for extraordinary periods of time." Environmental impacts brought about by an inappropriate building stock may be due among other factors, to energy inefficiency and to failures in design and construction. Concerning energy, in the United States, the "building sector" accounts for 36 percent of primary energy use and 34 percent of CO_2 emissions (Norberg-Bohm 1991). Data on energy-efficient construction indicate that new commercial buildings can achieve energy savings of about one-half the average energy used by existing buildings without increases in initial costs.

Pertaining to design and construction, costly but avoidable losses from natural hazards due to an inappropriate building stock are commonplace. In the specific case of earthquakes, the damages sustained in Mexico (1975) and Armenia (1989) indicate that building technology was a significant contributor to vulnerability. In Mexico, for instance, significant damage was suffered by high-rise buildings due to (a) design and construction based on codes formulated on dynamic characteristics of ground motions that were substantially exceeded during the earthquake; (b) poor behavior of reinforced concrete structures with a dramatic pancaking of floor slabs; and (c) change in building occupancy that lead to the vertical overloading of structures and an increase in the reactive mass to lateral accelerations. Centralization of facilities was also a main factor in social services losses in Mexico. The earthquake caused disproportionately heavy damage to the health care facilities concentrated in the capital city center. Poor location, and weak design and building techniques were also among the critical issues in the Armenia earthquake. In Spitak and Leninakan, located at about 50 km from the epicenter, tall buildings of about nine stories built with prefabricated concrete had a high rate of collapse (Kreimer 1991). "Of more than 50 frame buildings with precast components attached to column and beam construction, less than a dozen remained standing and even these were heavily damaged." (Kerr 1991). Contrary to what it could be expected, modern buildings performed worse than older ones. As Krimgold (1991) notes, "the level of damage was almost inversely related to age"; the new, high-rise, engineered structures tended to collapse while low-rise, unreinforced buildings were virtually unaffected.

Consideration of the environmental impact of an inappropriate building stock, infrastructure and services are key issues in future investments by the Bank to manage risk and to address the need to reduce environmental degradation (see Box 1.4). Risk management is among other factors, a function of good location decisions and engineering practice, which include risk assessment, regulation, and communication.

The impact of policies on urban-environmental degradation

The role of national economic policies in determining the pattern of resource utilization and urbanization cannot be ignored. It is the development policies of governments and their regulation of economic activities which have a decisive influence on the effectiveness with which human and natural resources are allocated and on the patterns of urban growth and management. Most urban-environmental problems in developing countries have been the result of inappropriate trade policies, credit allocations, public investment and subsidies which tend to intensify conflicts between spatial and human settlement planning and sound environmental management. In many cases, protectionist policies tend to drive out the output of agriculture and nontradeables and to stimulate the output of manufacturing

Box 1.4. Results of OECD Workshop on Emergency Preparedness and Response and on Research in Accident Prevention, Preparedness, and Response

Organisation for Economic Co-operation and Development

In 1988, the Environment Committee of the Organisation for Economic Co-operation and Development (OECD) began a project to improve the prevention of, and response to, accidents involving hazardous substances. Monograph no. 31 comprises the conclusions from the discussions at the workshop held in Boston in May 1990.

The planning process for developing an emergency preparedness plan provides the basis for a successful emergency response by examining (a) a range of accident scenarios, (b) the possible implications of such accidents; (c) the response needs; and (d) existing capabilities. In addition to responsible government officials, the groups who will be called on in an emergency must take part in the planning process. Among the many such groups are people from civil defense agencies, fire departments, schools, and hospitals.

Following are some important components of an emergency preparedness plan:

- training of all emergency response personnel to ensure a continuous state of readiness for a variety of emergencies.
- testing of the plan to reveal its limitations and problems beforehand when they can still be corrected.
- public knowledge of the plan so that they know what to do during an emergency, where to find further information, and how to evacuate; most fatalities and injuries occur because residents take inappropriate actions to protect themselves and others.
- identification of enterprises which use, transport, or store potentially hazardous chemicals.
- special training to enable responders to assess and act on each situation quickly since there is no time to undertake a major analysis.
- appropriate human health protection if a toxic substance is released, i.e., decision whether to shelter in place or evacuate.
- involvement of media to provide crucial information to the public and to help avoid confusion in the community.
- decontamination and clean-up, regulatory investigation and long-term effects assessment and monitoring.
- documentation of actions and decisions taken during emergency response in order to evaluate responses and improve them for the future.

Research on accident prevention, preparedness, and response is invaluable if it has practical objectives and considers the "users." Widely applicable results must be disseminated in easily understood language. Better methods are needed for informing workers and subcontractors of effective accident prevention and response measures.

industry. Moreover, tariffs and industrial incentives have a differentiating effect on the location of economic activities accentuating the concentration of people in major urban regions. In addition, government regulation of economic activities such as the pricing of energy resources, often biased in the manufacturing sector have reinforced the system of incentives for urban concentration. Unbalanced productivity developments favoring modern sectors and distorted fiscal and monetary policies fostered accumulation in the

urban modern sectors at the expense of agriculture and encouraged rural migration to cities.

In many resource-poor regions, government policies have had the perverse impact of encouraging a rapid and extensive resource degradation by either artificially increasing the profitability of or failing to tax adequately environmentally harmful activities. These phenomena have resulted in increased pressures on both natural resources and the urban environment, which in turn have disturbed the balance within ecosystems, exacerbating their vulnerability, and increasing the risks associated with natural hazards.

Economic policies that favor modern urban activities have been a powerful influence in the distribution of population. Technological change in agriculture and the accompanying increase in productivity fostered out-migration of workers from traditional employment in rural areas to modern urban activities. Domestic price distortions compounded with skewed credits and biases within the agricultural sector have been a key determinant of rapid immigration and city growth. As national populations have increased and severe distortions in product and labor markets have persisted, rural people have tended to migrate to cities in search of employment and economic advancement.

The massive growth of cities in low-income countries has not been accompanied by a more efficient and effective pattern of urban and economic growth. Until the end of the 1970s, gross domestic product (GDP) growth in developing countries remained strong—averaging 6.5 percent a year between 1965 and 1973. After 1980, however, due in part to unforeseen changes in the world economy (weak external demand, declining terms of trade, a diminishing supply of external finance, and increasing instability of interest rates), and to macroeconomic unreliability (distorted and inflexible markets, large fiscal deficits, and high inflation) growth rates plunged from an average of 5.4 percent a year during 1973-80 to 3.9 percent for 1980-87 (World Bank 1988, p. 23). These changes not only had a direct adverse effect on the economy by reducing investment, promoting capital flight, and leaving workers worse off, but also affected the countries' ability to respond to social needs. The pattern of social expenditure became even more regressive in many developing countries, with fewer social services and safety nets available for the urban poor. As a result, the demand for services within the cities quickly outweighed the capacity of governments to provide them. Most recent estimates indicate that 23 percent of urban residents in developing countries have no potable water within 200 meters; the figure rises to 35 percent in Sub-Saharan Africa (World Bank 1990). Traffic congestion is spreading, and escalating transport costs have reduced productivity. Housing shortages are common in many cities. Spending does not always reach the poor, who are forced to buy services usually water from private vendors at rates from 4 to 100 times higher than those paid by the better-off groups, who have access to piped water (World Bank 1988, p. 145). At the same time, basic services are neglected, and only a small portion of the urban population usually benefits from the cities' financial resources.

It can be argued whether macroeconomic conditions are solely to blame for environmental degradation and increasing physical, social and economic risks in the cities of the developing world. Current trends indicate that developing nations need to promote sustainable development through greater reliance on market forces as well as through redirecting government incentives. In cases where disasters are prone to occur, failure to implement policies directed at reducing the potential environmental impacts of macroeconomic disequilibria may increase the impact of natural disasters both in human and economic terms. An integrated approach to enhance environmental safety must address the cost-effectiveness of the provision of social services. Policies concerned with reducing hazard vulnerability may themselves provide a means for sustainable development. They must show how disaster prevention and mitigation is cost beneficial to urban as well as to national economies.

Cost-benefit calculations must incorporate prevention and mitigation concerns in construction techniques, location decisions, the potential of certain projects to serve special emergency functions in times of disaster or disaster threat, the need to maintain disaster resource reserves, and other disaster vulnerability factors not normally considered in such estimations.

Managing the urban environment

The role and functions of the public sector

This section is concerned with the efficient functioning of private and public sectors in developing countries. The main emphasis is on identifying the responsibilities of governments in creating the conditions that are more closely related to people's interests and that would help cities to function in more productive and environmentally safe circumstances.

Disaster severity impact and government effectiveness in environmental and risk management are closely linked. Vulnerability is not only related to geophysical phenomena, but also to socioeconomic variables such as population density, industrialization, technological change, and institutional development. The poorest countries are confronted with scarce resources, which often force governments to make difficult choices in their response to environmental crises. Effective mitigation measures are needed on a wide variety of problems which arise in conjunction with the progress of urbanization and environmental degradation. In the short run, low-income countries face difficult tradeoffs between stimulating urban economic growth and reducing environmental degradation. They are severely constrained in their ability to act because of limited financial and human resources. As a result, failure to enforce existing regulations and policies is a common phenomenon.

The reduction of hazard-related losses may partly depend on government efficiency in promoting and implementing effective legislation and enforcement. However, regulatory mechanisms are not always cost-effective, and many developing countries are unable to afford high environmental standards. Means are required to create a setting for private sector innovation and initiative in the pursuit of environmental quality and in the prevention and mitigation of negative consequences from natural hazards. Sound economic management must be considered the one vital element of an integrated approach to long-term commitment for natural disaster reduction in urban areas.

Recent studies have demonstrated that the dimension and characteristics of environmental degradation and the vulnerability of cities to natural disasters are the foremost result of allocative inefficiency and uneven distribution of resources and growth (Mills 1991; Harris and Puente 1990; OAS 1990; Kreimer 1989). Thus, there is a need for the adoption of targeted policies that increase market efficiency and private sector participation focusing on economic instruments for urban environmental management and hazard prevention and mitigation. Economic incentives, which operate through market mechanisms along with cost-effective regulatory instruments, provide ways for achieving major improvements in the patterns of resource use and environmental protection. (For a detailed analysis of these mechanisms, see Tietenberg (1990) and Stavins (1990)). By channeling market mechanisms into environmental programs, economic incentive mechanisms can create a setting for private sector innovation and initiative while strengthening the financial capacity of local institutions. For instance, changing the citywide regulatory framework governing markets for land use and housing in urban areas could meet two central objectives, namely to improve the efficiency of resource use and to increase government revenues to help finance hazard mitigation and emergency preparedness planning. Emphasis should be placed on establishing conditions under which consumers and producers take full responsibility for the environmental effects of their activities. In other words, governments must ensure that the different actors in the economy bear the true costs of their decisions (Stavins 1990).