Risk, Vulnerability, and Disaster Prevention in Large Cities

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Abstract

This work is a brief descriptive history. It provides an overview of disasters that have occurred in large urban centers over the last 30 years, as well as the damages and deaths these have caused. I believe that phenomena with destructive potential will occur with greater force in urban conglomerations, since the degree of vulnerability in these areas is quite high.
I discuss the factors behind the disasters in large cities, with special emphasis on the processes of urbanization and growing metropolization worldwide; random urban growth, destruction of the environment; urban poverty; and the low levels of economic and institutional development available to prevent and mitigate natural and/or man-made disasters.

Finally, I make recommendations for developing institutional plans that will help reduce the vulnerability of urban and densely populated areas in the face of disasters.

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Table of Contents

Introduction

Over the past 30 years, an increasing number of disasters occurring in the world, as well as the deaths and damage they cause, have taken place in urban centers, specifically in some of the largest cities on the planet. This trend appears to be on the rise. Despite the undeniable fact that the media tends to focus more attention on what is happening in large human settlements, all signs indicate that the higher incidence of disasters in large cities is a definite reality.

A series of questions immediately springs to mind: What are the features of this phenomenon of disasters in large cities? What factors lie behind the phenomenon? What are the specific characteristics of urban vulnerability? What can we expect in the next few years in this area? How can we reduce vulnerability and mitigate the effects of disasters in large cities?

In this paper we will attempt to provide an initial answer to these questions. Our premise is that natural phenomena with destructive potential will occur with greater force in the major cities on earth, since these settlements present the heightened levels of vulnerability requiring specialized concepts and approaches to reduce them as well as the development of institutional strategies to implement mitigation efforts.

1. Occurance of Disasters in Large Urban Centers

In order to provide exhaustive support for our claim that disasters take place with greater frequency and intensity in large urban centers, we would have to construct a historical series of at least 100 years so that we could compare the various stages of the world urbanization process with the occurrence of disasters. This would show us the relationship between the two phenomena.1 However, since such work exceeds the scope of this article, we will present as evidence of such a trend a table of information on the occurrence of disasters in major urban centers over the last 28 years.

As we can see in Table 1, destructive events have taken place in various regions of the globe. We have recorded 36 of them but this is not an exhaustive list. Rather, we list occurrences that caused the greatest damage.

Table 1. **OCCURRENCE OF DISASTERS IN CITIES WORLDWIDE, 1970-1999**

YEAR	COUNTRY	CITY	NO. OF INHABITANTS	TRIGGER EVENT	HUMAN AND MATERIAL DAMAGES (U.S. Dollars)
1972	Nicaragua	Managua	493 thousand (1975)	Earthquake	▪ 6 thousand dead ▪ 17 thousand missing ▪ 3.018 billion
1974	Australia	Darwin	-------	Cyclone	▪ near-total destruction ▪ 50 dead
1976	Guatemala	Guatemala City	1.3 million	Earthquake	▪ 1,200 dead ▪ 90,000 victims ▪ 1.1 billion
1976	China	Tangshan	1.8 million	Earthquake	▪ 148 thousand dead ▪ 81 thousand wounded ▪ 95% of homes & 80% of industrial facilities destroyed or severely damaged ▪ 5.6 billion

1978	Iran	Tabas	-------	Earthquake	▪ 8,000 dead or missing ▪ 11 million
1980	Italy	Naples, Potenza, Salerno Avellino	1.2 million 100 thousand 200 thousand 60 thousand	Earthquake	▪ 3 thousand dead ▪ 75% of buildings at epicenter destroyed ▪ Pugliese Aqueduct, blocked ▪ 10 billion
1984	India	Bhopal	819 thousand (1985)	Gas poisoning	▪ 3,000 dead ▪ 100,000 wounded ▪ 200,000 evacuated
1984	Mexico	Metropolitan area of Mexico City	14 million	Explosion of gas deposits	▪ 500-600 dead ▪ 10,000 evacuated
1985	Mexico	Metropolitan area of Mexico City	14 million	Earthquake	▪ 10 thousand dead ▪ one thousand buildings destroyed & 65 thousand damaged ▪ 4 billion
1985	Colombia	Armero	25 thousand	Volcanic eruption	▪ Near-total destruction
1986	El Salvador	San Salvador	750 thousand	Earthquake	▪ 1,200 dead ▪ 10,000 wounded ▪ 200 thousand victims ▪ 1.15 billion
1988	Brazil	Rio de Janeiro	9.9 million	Floods	▪ 20% of population affected, squatter settlements ▪ Acre, Petropolis, neighboring cities affected ▪ 1 billion
1988	Pakistan	Islamabad	200 thousand	Explosion	▪ 100 dead ▪ 3,000 wounded
1988	Armenia	Spitak Gumri Vanadzor	50 thousand 220 thousand 180 thousand	Spitak earthquake	▪ 25 thousand dead ▪ 120 thousand inhabitants evacuated ▪ New buildings are first to fall
1988	Benin	Cotonou	650 thousand	Floods	▪ Economic activity paralyzed for one week ▪ Site of frequent flooding, 56% of homes flooded
1989	USA	San Francisco Bay	3.6 million (1990)	Loma Prieta earthquake	▪ 67 dead ▪ 12 billion
1990	Iran	Manjil Zanjan Rudbar	25 thousand 254 thousand 95 thousand	Manjil earthquake	▪ Three towns destroyed ▪ 50 thousand dead ▪ 500 thousand victims ▪ 1600 rural settlements affected
1991	India	Uttarkashi	240 thousand	Earthquake	▪ 2 thousand dead ▪ 90% of homes destroyed ▪ 100 million
1991	Bangladesh	Chittagong Cox's Bazaar	2.4 million 40 thousand	Cyclone	▪ 140 thousand dead
1991	Philippines	Ormoc	45 thousand	Tropical Storm Thelma	▪ 5 thousand dead ▪ 46 thousand victims ▪ 28 million
1992	Egypt	Cairo	9.7 million	Earthquake	▪ 561 dead ▪ 5 thousand buildings collapsed ▪ 12 thousand wounded ▪ 300 million

1992	Mexico	Guadalajara	3.5 million (1990)	Explosion of gasoline accumulated in sewer pipes	▪ 250 dead
1992	USA	Miami	1.9 million (1990)	Hurricane Andrew	▪ 29.5 billion
1992	Turkey	Erzincan	300 thousand	Earthquake	▪ 230 thousand affected ▪ 547 dead ▪ 18 thousand buildings damaged or destroyed
1993	Japan	Hokkaido	-----	Earthquake	▪ 163 dead ▪ 429 wounded
1994	USA	Los Angeles	12.4 million	Northridge earthquake	▪ 57 dead ▪ 30 billion
1994	Mozambique	Nacala	1.4 million	Cyclone Nadia	▪ 75% of homes destroyed ▪ Electricity and transport services cut
1994	Papua New Guinea	Rabaul	30 thousand	Eruption, Rabaul Volcano	▪ 40% of buildings and services damaged
1995	Japan	Kobe	1.5 million	Hanshin-Awaji Earthquake	▪ 6,300 dead ▪ 34,000 wounded ▪ 230,000 victims ▪ 436,000 buildings destroyed ▪ 100 billion
1997	Mexico	Acapulco	1.1 million	Hurricane Paulina	▪ 228 dead ▪ 165 missing ▪ 288 thousand victims ▪ Destruction of homes
1998	Honduras	Tegucigalpa	1 million	Hurricane Mitch	▪ 300 dead
1999	Colombia	▪ Armenia ▪ Pereira	270 thousand 380 thousand	Earthquake	▪ 1,230 dead ▪ 5,300 wounded ▪ 200,000 affected
1999	Turkey	Izmir	2. 4 million	Earthquake	▪ More than 17 thousand dead and 50 thousand affected
1999	Taiwan	Taipei	2. 64 million	Earthquake	▪ 9.2 billion dollars ▪ More than 2,500 dead
1999	Greece	Athens	3 million	Earthquake	Data not available
1999	Venezuela	Vargas, suburbs of Caracas		Floods	• 100,000 victims and damage to infrastructure totaling 20 billion

Sources: UN, Cities and Risk, IDNDR 1990-2000; CENAPRED, Prevention, SNPC, issue 6, August 1993, Mexico, issue 11, June 1995; Brunner, Borgna, The TIME Almanac-1999. Information Please, Boston; SNPC (1995), La prevención de Desastres. Secretaría de Gobernación, México (Disaster Prevention. Office of Secretary of the Govt., Mexico). Revista Proceso, issue 1094, Oct. 19, 1997, Mexico; DIRDN (1999), DIRDN-Informa, issue 14. DIRDN Hemisphere Meeting (1999), Evaluación de logros obtenidos durante el decenio, (Assessment of the Decade's Achievements), Costa Rica; SICA (1999), Estrategia para la Transformación con Prevención y Mitigación de la región Centroamericana (Strategy for Transformation with Prevention and Mitigation in the Central American Region).

The previous table clearly shows that the greatest number of events with the highest level of destruction have occurred in cities in less developed countries. Despite this predominant trend, the earthquake in Kobe, Japan showed that the cities of the developed world are not exempt from the probability of experiencing major disasters. But we must emphasize that although property damage is quite extensive in developed countries, the loss of human lives is significantly lower than in less developed countries. As noted in a World Bank document, more than 95% of all deaths caused by disasters occur in underdeveloped countries.[2]

It is also noteworthy that in the past decade, disasters associated with industrial and chemical accidents—Bhopal, Islamabad, San Juan Ixhuatepec, Chernobyl, and Guadalajara—have

increased in intensity and frequency. We should also point out that in addition to the "major disasters," most cities in the underdeveloped world experience series of destructive events, of both natural and human origin, that cause fatalities or destroy the homes of hundreds or thousands of inhabitants as well. For example, cities such as Caracas and Rio de Janeiro witness washouts and landslides every year that affect primarily low-income populations.

II. Casual Factors

The constant occurrence of disasters in large urban centers cannot be attributed to one particular cause, but to a host of factors that will be analyzed below.

1. Urbanization process worldwide

One of the causes of the growing incidence of disasters in large urban centers is undoubtedly related to the concentration of people and economic activity in these areas. As we see in Table 2, world population overall has become urbanized, a trend that will continue well into the 21st century.

There are obviously major differences by region, for example, between Europe and Africa, but even in the less urbanized regions the urbanizing trend will continue at a very clipped pace over the next few decades.

Table 2. DISTRIBUTION OF WORLD'S POPULATION OVER URBAN AND RURAL AREAS, 1994

AREA	POPULATION		PERCENTAGE URBAN
	URBAN	RURAL	
World total	2,520,510,00	3,109,122,000	44.8
More developed regions	867,803,000	294,643,000	74.7
Less developed regions	1,652,706,000	2,814,479,000	37.0
Less developed countries	122,340,000	436,978,000	21.9
Africa	239,604,000	468,680,000	33.8
Asia	1,159,325,000	2,244,111,000	34.1
Europe	532,306,000	194,042,000	73.3
Latin America and the Caribbean	348,923,000	124,618,000	73.7
North America	220,574,000	69,324,000	76.1

Source: World Urbanization Prospects, The 1994 Revision. UN.

One of the consequences of this process is that an increasingly large percentage of the population is occupying a denser area of land, especially in large urban centers. This process

increases the risk of an event affecting a larger number of people, buildings, infrastructure, and economic activity.

The phenomenon of urbanization can be explained by two basic factors: a) the natural population growth, b) migrations that occur from the country to the city. Not only is this accelerated transformation of society into a predominantly urban one important, the phenomenon exhibits specific characteristic features that are experienced throughout the world.[3]

2. Metropolization process worldwide

An even more decisive factor than the above-mentioned phenomenon of urbanization is the process of population concentration in large urban centers having over one million inhabitants.

Just 50 years ago the world had only one urban agglomeration with over 10 million inhabitants (New York), seven cities with five to 10 million people, and 75 major cities with between one and five million inhabitants. Together, they accounted for 26.4% of the total urban population on earth. By 1990 there were 12 cities with over 10 million, 21 cities with five to 10 million, and 249 with one to five million. In relative terms they accounted for 34.7% of the world's urban population. By 2015 the figures will reach 27, 44, and 472 cities, respectively, and will account for 40.4% of the world's total population. This means that within fifteen years, nearly half the urban population will be living in cities with over one million inhabitants, and one out of every ten will be living in a megacity of over 10 million people.

As Tables 3 and 4 show, the phenomenon is already occurring mainly in the least developed regions of the world, and this trend will become steeper in the coming decades.

Table 3. NUMBER OF CITIES, URBAN POPULATION, AND PERCENTAGE OF URBAN POPULATION BY SIZE OF CITY, WORLD POPULATION, MOST-DEVELOPED, AND LEAST-DEVELOPED AREAS

	World Population				Most-Developed Areas				Least-Developed areas			
Size of city	1950	1970	1990	2015	1950	1970	1990	2015	1950	1970	1990	2015
A. 10 million or more												
Number of cities	1	3	12	27	1	2	4	4	0	1	8	23
Population	12	44	161	450	12	33	63	71	0	11	98	378
Urban percentage	1.7	3.2	7.1	10.9	2.8	4.8	7.5	7.2	0.0	1.7	6.9	12.0
B. 5 to 10 million												
Number of cities	7	18	21	44	5	8	6	8	2	10	15	36
Population	42	130	154	282	32	61	44	56	10	69	110	226
Urban percentage	5.7	9.6	6.8	6.8	7.2	9.0	5.2	5.7	3.5	10.2	7.7	7.2
C. 1 to 5 million												
Number of cities	75	144	249	472	43	73	98	120	32	71	151	352
Population	140	265	474	941	84	136	191	240	56	129	283	701
Urban percentage	19.0	19.6	20.8	22.7	19.1	20.1	22.7	24.2	19.0	19.0	20.4	22.2
D. 500,000 to 999,999												
Number of cities	105	175	295	422	59	85	104	12	46	90	191	299
Population	73	122	203	293	42	61	72	84	31	61	132	209
Urban percentage	9.9	9.0	8.9	7.1	9.5	9.0	8.5	8.5	10.5	9.0	9.2	6.6
E. Fewer than 500,000												

Population	470	792	1284	2178	272	386	472	540	198	406	812	1638		
Urban percentage	63.7	58.5	56.4	52.6	61.5	57.1	56.1	54.5	67.0	60.0	56.6	52.0		

Source: World Urbanization Prospects, The 1994 Revision. UN

Table 4. LARGEST CITIES IN THE WORLD, 1999

City, economic position in the world	Population size in 1999 (Millions)	Expected growth, % 1995-2015	Predicted position occupied in 2015	Predicted population in 2015 (Millions)
1. TOKYO, JAPAN	26.3	2.6	1. TOKYO, JAPAN	26.4
2. MEXICO CITY	17.9	15.8	2. BOMBAY, INDIA	26.1
3. BOMBAY, INDIA	17.5	72.7	3. LAGOS, NIGERIA	23.2
4. SAO PAULO, BRAZIL	17.5	23.4	4. DHAKA, BANGLADESH	21.2
5. NEW YORK, USA	16.5	6.7	5. SAO PAULO, BRAZIL	20.4
6. LOS ANGELES, USA	13.0	6.7	6. MEXICO CITY	19.2
7. SHANGHAI, CHINA	12.9	11.2	7. KARACHI, PAKISTAN	19.2
8. LAGOS, NIGERIA	12.8	125.3	8. NEW YORK, USA	17.4
9. CALCUTTA, INDIA	12.7	44.7	9. JAKARTA, INDONESIA	17.3
10. BUENOS AIRES, ARGENTINA	12.4	18.6	10. CALCUTTA, INDIA	17.3
11. DHAKA, BANGLADESH	11.7	124.3	11. DELHI, INDIA	16.8
12. KARACHI, PAKISTAN	11.4	97.4	12. METRO MANILA, PHILIPPINES	14.8
13. DELHI, INDIA	11.3	69.0	13. SHANGHAI, CHINA	14.6
14. OSAKA, JAPAN	11.0	-0.3	14. LOS ANGELES, USA	14.1
15. BEIJING, CHINA	10.8	10.8	15. BUENOS AIRES, ARGENTINA	14.1
16. JAKARTA, INDONESIA	10.6	88.4	16. CAIRO, EGYPT	13.8
17. METRO MANILA, PHILIPPINES	10.6	59.4	17. ISTANBUL, TURKEY	12.5
18. RIO DE JANEIRO, BRAZIL	10.5	16.9	18. BEIJING, CHINA	12.3
19. CAIRO, EGYPT	10.3	44.3	19. RIO DE JANEIRO, BRAZIL	11.9
20. SEOUL, SOUTH KOREA	9.9	-3.2	20. OSAKA, JAPAN	11.0

Source: U.N. Dept of Economic and Social Affairs Population Division World Urbanization Prospects (The 1999 Revision). The size of the city was estimated based on the urban settlement and not on political administrative limits. Taken from Healthy futures for APEC Megacities, Vol. I, Summary Report of a Foresight Project Bangkok, Thailand, September 2000.

3. Unplanned urban growth

Most cities in the least-developed countries have grown rapidly, and without any adequate planning or regulation. Land-use rules, building codes, and ordinances are flouted. Occupation of zones on mountainsides, in riverbeds, drained lakes, flood plains, or near hazardous manufacturing facilities is a constant throughout the underdeveloped world. Most large cities began as small villages or historic cities with relatively small populations; informal residential areas sprang up around these planned downtown areas, upsetting the capacity of the cities' planning processes and infrastructure. As a result, the urban features that exert strong pressures on land use and distribution of inhabitants are aggravated by unreliable and inadequate supply of water, electricity, and transportation, as well as a limited supply or total lack of public health services.

It is not hard to understand that the magnitude of a disaster is largely the logical result of an anarchic and irregular urbanization process where the inability to follow urban development plans and programs has been the norm, along with the permissiveness and tolerance of illegal squatting on the part of authorities.

4. Environmental destruction

Many cities of the underdeveloped world and also the developed world have seen an increase in the destruction of natural resources due to deforestation, drainage of swamps, land reclaimed from the sea or riverbeds. The establishment of cities and their excessive growth effect a radical transformation of the local ecosystems' natural conditions. The sustainability of these ecosystems deteriorates rapidly and the urban environment loses its naturalness and becomes an artificially constructed environment.

The natural environment begins to deteriorate at an accelerated pace and increasingly cannot keep pace with a society's ability to adapt to the changes imposed on the environment. The process of urbanization has played a decisive role in this relationship between society and environmental change since cities exhibit a natural tendency toward the deterioration of resources caused by increased human densities and the existing artificial material elements.[4]

5. Urban poverty

No exact figures exist for the proportion of the world's population living in absolute poverty in urban zones.[5] Figures vary from one estimate made in 1989 of 130 million people living in extreme poverty in southern countries to another estimate by the World Bank of 330 million. However, as indicated in the Global Report on Human Settlements,[6] these figures are hard to reconcile with the numerous national reports and studies of specific cities showing that one third to one half of the urban population does not have sufficient income to meet its basic human needs.

Today, the majority of the poor in a country can be found in the cities. All signs indicate that we have been witnessing the urbanization of poverty over the past few years, a phenomenon that has been confirmed in Latin America. As we see in Table 5, this phenomenon of urbanization of poverty can also be seen in the increase in the number of families below the poverty line in cities. In countries like Egypt, Gambia, Morocco, and Tunisia, in Africa; Indonesia and South Korea in Asia, poverty in relative terms is equal to or greater than rural poverty. However, we should stress that in most countries today, urban poverty exceeds rural

poverty in absolute terms.

Table 5. **LATIN AMERICA: PERCENTAGE OF FAMILIES BELOW POVERTY LINE IN URBAN AREAS, 1970-1992**

YEAR	Argentina	Brazil	Chile	Colombia	Costa Rica	Mexico	Peru	Uruguay	Venezuela
1970	5	35	12	38	15	20	28	10	20
1980	7	30(a)		36	16(b)		35(a)	9(b)	18(b)
1986	12	34(d)	37(d)	36	21(e)	28(c)	45	14	25
1990		39	34	35	22	34(f)		12	33
1992			27	38	25	30		8	32

(a) 1979; (b) 1981: (c)1984; (d)1987: (e) 1988; (f) 1989.
Source: Cities, democracy and governance in Latin America. International Social Science Journal, issue 147, March 1996.

For the most part, poverty translates into hazardous living conditions where inadequate housing, lack of services, etc. prevail. The real effect of a natural risk in impoverished areas can be devastating. Populations located in flood zones or high-risk areas for earthquakes are directly affected. A large percentage of the people in these areas suffer from varying degrees of malnutrition and susceptibility to disease, and lack of health services and supply networks. Urban indigent people depend on the functioning of the city as a commercial center over the long term, and if commercial activity is interrupted for a period, these are the people most likely to suffer and lose their lives in the aftermath of a disaster and subsequent recovery efforts.

6. Low levels of economic and institutional development

It can be said that all megacities have varying degrees of equilibrium, which can be upset by a number of circumstances, including natural phenomena. Nevertheless, the degree to which an event upsets the equilibrium of a large city depends on the stability of the city's infrastructure and the nature of the event. Inadequately planned and constructed buildings will have a direct vulnerability to impact from natural phenomena. Damage to the infrastructure will also cause secondary effects such as interruptions in transportation and energy supply, food shortages, and contaminated water. Where there is a substandard institutional framework and a fragile economy, these problems become aggravated. In a developed country, the existence of a solid infrastructure that can predict disasters, established evacuation procedures, and a strong institutional organization prevent problems from intensifying, even when natural phenomena upset transportation, electricity, water, or public health services. This is why, despite the fact that there are major economic losses and certain health problems, the loss of human life is generally not large.

In developing countries, the perception of what constitutes acceptable living conditions tends to be very different. Many people (particularly the informal sector), experience low quality in services for transportation, electricity, water, and health care on a daily basis. In places where buildings and infrastructure are seriously deficient or nonexistent, vulnerability to natural phenomena can be very high.

III. FEATURES OF VULNERABILITY IN LARGE CITIES

1. General definition of vulnerability

In recent decades, some authors have developed the concept of vulnerability by incorporating the social factor into the elements of a disaster.[7] In this sense, social agents are present and involved in the processes related to vulnerability, prevention, and mitigation.

The risk of a disaster (or the disaster itself) is the result of the specific and unique combination of threats (physical aspect) and a society's vulnerability (social aspect). To a great extent, the social conditions that people live in determine the level of destruction, dislocation, or interruption in society's functions; therefore, physical hazards are a necessary factor in the disaster, but they are not a sufficient or predetermining condition. Vulnerability is a social construct that encompasses multiple aspects, conditions, and structures of the society itself and it is the essential component in creating the conditions that favor disasters,[8] which are viewed as "unresolved problems of development" (Wijkman and Timberlake).

Vulnerability is the critical component in the disaster equation. It can be defined as the condition or conditions of society that make it susceptible to the impact of a specific physical event, whether it be small, medium, or large. In this sense, vulnerability is seen as an objective condition of a society and it is constantly changing, since it is the result of the society's (or subsets of this society's) historic process of change. Therefore, the root of the problem of disasters can be found in the methods by which a society develops. The social concept of disasters views them not only as products but as processes where vulnerability is historically constructed. Research on the topic should include not just the formulas that determine the existence of disasters, but a reconstruction of the historic social processes that comprise these conditions. A disaster is a concrete moment in normalcy, it is not an abnormal phenomenon that erupts in a stable and balanced society. It speaks to us of a crisis in the heart of the society that accompanies other crises. Vulnerability is built up gradually. Therefore, a "natural" disaster is inevitable only insofar as the social conditions allow it. Disaster is the culmination of a process and continuum of a disconnect between human beings and their interrelations with the environment.[9]

The size and impact of a disaster are generally considered to depend on three sets of factors:

a) **Threats:** The conditions and processes that tend to initiate episodes of exceptional damage (earthquakes, droughts, industrial explosions, or oil spills);
b) **Vulnerabilities:** The conditions and status of a community, which will increase or decrease the probability and severity of the damage in a given stress situation;
c) **Mitigation of Disasters and Response Measures:** Those plans and actions intended to directly change risks or respond to disasters.[10]

With this in mind, we can define the risk of disaster as the probability that a specific threat will occur to a given vulnerability system, discounting the prevention-mitigation activities that are implemented:

RISK=Threat x Vulnerability - (Prevention + Mitigation)

There are various conceptions of risk. One of the most widespread is the idea that societies are at risk inasmuch as their social and material structures are located in areas where there is a high incidence of threats occurring. The physical-natural element plays a dominant role in this conception and it is the active element. As for the society, it is a passive element in the face of natural elements. The most advanced versions of this view have introduced "social" elements into the risk equation. Vulnerability to threats is acknowledged, but it is generally understood as a physical or structural (material) vulnerability that can be reflected in various levels of a society's resistance to the impact of threats.

Allan Lavell[11] was the first to establish a comprehensive view of the conception of risk by breaking down the concept of threat into four different categories (natural, socio-natural, anthropic, and technological), thus demonstrating that in the process of constructing the risk, the social element is not exclusive to vulnerability. It also has a decisive role in creating and accentuating certain types of threats.

Mansilla states that "based on this new conception, the previous equation should not be seen solely as the mere multiplication and subtraction of isolated parts, independent of each other. What it shows us is that risk and its composition should be understood as part of a dynamic or continuous process and not as a static element. Its main components (threats and vulnerability) respond to the logic of social processes, and therefore, they interact permanently in a dialectical relationship. Threat indicates that it has ceased being the simple "external" factor, alien to the society it impacts. It destroys and arises as a trigger of disasters. As for vulnerability, it is consubstantial to the development of the society. Its evolution and accumulation are, therefore, indicative of the existing styles of growth and forms of social organization."[12]

2. Features of vulnerability in large cities

Are there specific traits of vulnerability in large cities that make it different from vulnerability in other areas or lands? Despite the fact that in the future, large cities will be increasingly similar in terms of architecture, esthetics, and lay-out, current urban areas still display important variations in form and structure. Urban analysts recognize numerous cultural variants among cities, each with its own characteristic land use patterns and population distribution. Cities are organized functionally in different ways and with different geographic expressions. When a disaster strikes or erupts, it can destroy not only the lives of citizens and the physical structure, but the functional organization of cities as well.

Mitchell asserts that defining and describing the varied contexts of disasters is not a task that will be easily accomplished in the short term. "The best way to do it would be by a joint effort of comparison and collaboration between a large group of researchers drawn from various fields."[13]

Both cities and disasters have undergone fundamental changes. The global tendency toward increasingly large cities is undeniable, as is the tendency towards similar urban forms. It is equally clear that there are still many differences between the megacities in developed countries and those in developing countries. The main issue in the latter cities is the contrast between rich and poor. The dichotomy has major implications for the management and reduction of natural urban disasters.

The megacities of rich countries possess a fundamental importance in the global economy, which means that the problem of disasters has repercussions beyond material damage and loss of human life. Disasters emphasize vulnerability in megacities that form the global network of finance and trade.

Disasters in large cities have different characteristics from disasters in smaller communities. These create distinct problems, such as:

- Disasters striking megacities that control the market for mass media are broadcast extensively, continuously, and obsessively, while the impact on other communities

  with less access to these media is played down, thus affecting post-disaster aid.
- The complex social mixes of megacities impose new problems on the operation of rescue services, emergency response, and aid distribution. There are marked ethnic and linguistic differences.
- The huge size and complexity of infrastructure networks in megacities make them particularly susceptible to poor coordination.
- Recovery has been shown to occur more slowly in smaller areas.

There is a great deal of uncertainty about the future of megacities. Although they appear to be similar across distinct cultures and continents, they contain different internal structures and features. The division between rich and poor megacities may end up being sharper and thus influences their susceptibility to disaster, at the same time as the differences between megacities and their rural areas widen as well.

In addition to being vulnerable to phenomena occurring within their borders, megacities are exposed to events beyond city limits. Flooded rivers are caused by excessive rains in other areas. The supply of water and energy frequently reaches the city from sites located far from it. Both the source and the means of supply of these resources can be vulnerable to events, placing the city at risk. Chain reactions can often exacerbate incidents.

The economic impact of a serious natural disaster depends on the economic importance of the area affected. Factors such as international investment and reinsurance establish a close link between the major commercial centers of developed countries. An event affecting the economy of one of these centers will undoubtedly have a significant impact on the others, as well as on the respective economies of a nation.

The effect of a disaster on the national or regional economy of megacities in developing countries is devastating and elemental. These cities represent the nexus of life and trade in a country and they control a high percentage of their country's wealth. The effects are therefore direct (for example, interruption of manufacturing capacities and communication networks), and will reverberate throughout the country. Large cities invariably dominate national and regional trade. Therefore, the vulnerability of its ports, airports, and internal transportation systems is particularly important. Likewise, they quickly exceed their capacity for supplying water and electricity, and must seek these services from other, far-away sources. The most important major supply routes for providing water and electricity to the megacities are seriously vulnerable. The unique role played by large urban centers means that the vulnerability of their supply systems worsens distribution not just in the city, but in many other urban developments.

IV. ACTIONS TO PREVENT AND REDUCE THE IMPACT OF DISASTERS IN LARGE CITIES

Reducing the effects of disasters in large urban centers is not something that can be done easily, or from one day to the next. In the previous section we saw how vulnerability and policies for prevention, mitigation, and emergency measures are deeply embedded in the social, economic, political, and cultural structures of society. Obviously, the necessary changes for reducing, preventing, and limiting the impact of various threats must go through the various spheres of society. However, acknowledging this conditional context does not mean accepting that a widespread change must occur throughout the system in order for substantial change to start taking place in the area of disasters. Changes can occur along distinct points of the social continuum and can help to reduce vulnerability and boost preventive measures.

An instructive example can be seen with what has taken place in the handling of environmental affairs. Until a few years ago, the idea was very widespread that protecting the environment and reversing damage to ecosystems was impossible without a comprehensive change in the ruling political-economic systems. But thanks to a series of solid and gradual measures in many countries, considerable progress has been made that adds up to a profound economic, political, and cultural change in environmental affairs without needing to undergo a radical transformation in systemic structures.

I believe this same possibility exists in the area of disasters and that if we want to make progress in that direction, the first thing to do is recognize the possibility of change.

Some plans of action that can be developed to reduce the vulnerability of large cities are as follows:*

1. Develop a knowledge base, approaches, and methodologies that will allow for an in-depth understanding of vulnerability and risk in large cities.

- Compile historic studies that show the impact of disaster on cities.
- Draft methodologies that allow us to know the urban impact of disasters, based on knowing the consequences of a disaster on the operation of a city, the quality of its services, its interurban and international links, and its prospects for future growth.
- Develop analytical models that will reveal the vulnerabilities; draw up disaster scenarios, make predictions, estimate probabilities of certain consequences occurring, and propose strategies for mitigation and reduction of vulnerability.

2. Support development policies that help reduce disaster vulnerability.

- Land development. Introduce or update rules for development along faults, mountainsides, swampland, and other disaster-prone areas. Ban dense settlements and construction in hazardous zones, creating instead recreation areas or gardens.
- Risk assessment. Perform assessments of risk and vulnerability in the urban centers in question. Use the results to adopt special measures for reducing disaster vulnerability, and development projects.

* The basic recommendations in this section are based on IDNDR (1996), *Cities at Risk*; issue 28, Stop Disasters publication.

- Assess the effects of disasters. Include in feasibility studies assessments of the effects of disasters on the environment.
- Design, construction, maintenance. Train citizens and offer them financial incentives to encourage them to build safe, profitable, and adequate housing. Apply design and construction standards. Protect household belongings and office equipment with proper maintenance.
- Integration. Integrate projects and policies for managing the environment, reducing disaster, and urban planning. Encourage collaboration among various professionals to make their efforts more efficient immediately or in the short term.

3. Train authorities to handle emergency situations.

- Create plans to manage emergency situations. Clarify functions and responsibilities with municipal, provincial, and national plans. Consider all members of the community who can play a role.
- Strengthen institutions. Train professionals so they can take on new responsibilities by means of refresher courses. Allocate the necessary funds for applying regulations, hiring extra personnel (where necessary), and purchasing new equipment. Maintain and upgrade equipment and databases adequately. Strengthen the legal mandate of institutions that have a key role in disaster management. Decentralize responsibilities and resources, giving more power to municipalities.
- Review communication channels and alerts. Establish the necessary channels so that authorities can announce warnings, evacuations, and/or assistance measures. Attempt to have alarms reach local authorities and inhabitants quickly and comprehensibly.

4. Design new agencies and prevention plans in keeping with the new territorial realities (metropolitan areas, industrial corridors, etc.)

- Create agencies to meet the needs of socio-spatial units that are not confined to the existing political-administrative boundaries.
- Metropolitan areas have multiplied worldwide, and agencies, plans, and coordinated actions are needed that can meet the needs of these new socio-spatial realities.
- Draw up joint prevention plans among different political-administrative units.

5. Prepare citizens to cope with emergency situations.

- Public awareness and education. Inform the public that they have the first responsibility for their safety. Promote public education campaigns. There should be increased awareness of disaster risks, and of preventive and preparedness measures that may affect the population. Local media, educational institutions, professional training programs, and NGOs should take part in this process.
- Community-based programs and solutions. Consult citizens regularly (especially those most exposed to disasters) in order to identify feasible solutions. Create maps that plot risks and community resources as the basis for programs adapted to local needs.

6. Special programs for high-risk situations.

Some of the priorities are:

- Squatter settlements. Problems such as land occupation, equity, job creation, supply of vital services.
- Basic services. Restructure existing buildings. Apply disaster-resistance measures in new construction. Build first-aid systems. Train enough staff to provide vital services to the community in emergency situations.
- Groups considered to be high-risk. Children, the elderly, the handicapped, indigents. Sample programs: education campaigns, income-generating projects, specialized health care, specific construction measures (for example, ramps), etc.
- Cultural treasures. Reinforce and protect artistic monuments and buildings that comprise the cultural heritage of a country.
- Buildings with hazardous zones. Restore buildings and insure objects in densely populated residential zones.

V. FINAL CONSIDERATIONS

As we approach the second half of the 21st century, the total population on Earth will reach 12 billion. Current trends indicate that populations and human activities will tend to concentrate predominantly in urban areas. Exposure to natural risks and to the negative synergy between natural and technical-industrial disasters will also tend to rise. The probability of disasters due to natural risks occurring on a scale never before seen is a reality that countries should heed at all costs. According to figures from the Munich Re Group, in the past 10 years, disasters have caused economic losses of $400 trillion and insured losses of $100 trillion. At least three million people have died in disasters over the past 30 years, and hundreds of millions have been affected. The same company reported that natural disasters were responsible for the deaths of over 50,000 people in 1998, and that material losses accounted for over $90 billion—three times more than the year before.[14]

During the inauguration forum concluding the International Decade for Natural Disaster Reduction,[15] United Nations Secretary General Kofi Annan stated recently that as long as the cities in underdeveloped countries continue to grow and the urban media, energy, and transportation systems become denser and more complex, the risk of greater losses increases accordingly.

These signs all indicate that concerted efforts will be needed over the coming decades to reduce vulnerability in large cities. If we do not take a series of effective measures to prevent and mitigate disasters, the first years of the 21st century could witness a growing number of more destructive disasters in the earth's major urban centers, particularly its least-developed cities.

END NOTES

[1] Consider that, from the start of the 20th century until 1975, the average annual number of victims just from earthquakes was calculated at 24,000. However, from 1975 to the present, the earthquake toll has been especially high: earthquakes have affected densely populated areas such as Guatemala, Indonesia, Italy, Turkey, China, Greece, Mexico City, Japan, to name a few representative cases.

[2] The World Bank (1999), Disaster Management Facility. World Bank, Washington, USA.

[3] Mansilla, Elizabeth (1999), *Riesgo y Ciudad (Risk and the City)*, Doctoral thesis, UNAM-Division of Postgraduate Studies, School of Architecture, Mexico.

[4] *Ibid*.

[5] United Nations Centre for Human Settlements (1996), *An Urbanizing World, Global Report on Human Settlements 1996*. Oxford University Press, EUA, p. 109.

[6] *Ibid*.

[7] The "physicalist" focus prior to the eighties presents disasters as extreme events in the natural or physical world whose repercussions buttress each other, leaving society as a secondary, or dependent, factor.

[8] Hewitt, Kenneth, "Daños Ocultos y Riesgos encubiertos: Haciendo Visible el espacio Social de los Desastres", (Hidden Damages and Invisible Risks: Making the Social Space of Disasters Visible), in Mansilla, Elizabeth (edit.) (1996), Desastres, Modelo Para Armar (Disasters, An Assembly Kit). La Red, Perú.

[9] Information based on Lavell, Allan (1996), "La gestión de los desastres: Hipótesis, concepto y teoría" ("Disaster Management: Hypothesis, Concept, and Theory), in Lavel, Allan and Eduardo Franco (ed.), *Estado, Sociedad y gestión de los desastres en América Latina (State, Society, and Disaster Management in Latin America)*. La Red-FLACSO-ITDG, Perú.

[10] Hewitt, Kenneth (1996), *Op. Cit*.

[11] Lavel, Allan (1996), *Op. Cit.*

[12] Mansilla, Elizabeth (1999), Riesgo y Ciudad *(Risk and the City)*, Doctoral thesis, UNAM-Division of Postgraduate Studies, School of Architecture, Mexico.

[13] Mitchell, James K. (1996), "Negociando los contextos de la prevención" (Negotiating the Contexts of Prevention), in Mansilla, Elizabeth (edit.), *Desastres, Modelo para Armar (*Disasters, An Assembly Kit *),* pp 72-76.

[14] IDNDR (1999), Disasters and Climate Change: The Insurance Industry Looks Ahead, in "Partnerships for a Safer World in the 21st Century", IDNDR Programme Forum 1999.

[15] Speech by the UN Secretary General at the inauguration of the IDNDR Programme Forum, 1999. United Nations Press Release, July 5, 1999.

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