Urban Environmental Degradation and Vulnerability to Disasters

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1. Introduction

The Increasing pace of urbanization and the growing scale of urban-industrial activity is exacerbating environmental degradation in developing country cities, and increasing the vulnerability of urban dwellers to both natural and technological disasters (Kreimer and Munasinghe 1992). In addition to intensifying the problems of the urban poor, such disasters result in a loss of productivity resulting from collapsed infrastructure, and damage to industry. This has a secondary effect on the national economy, as investment often declines due to concerns about such losses. The resultant decline in growth and increase in poverty leads to a further strain on resources, thereby raising the vulnerability to future environmental disasters.

Across Asia, cities are expected to double in population in just over 20 years, and in Africa in just under 20 years. The pace of urban expansion has led to increased pressure on the environment, in terms of more air pollution linked to transportation, an increase in solid waste, the depletion and degradation of the fresh water supplies, damage to coastal zones, and soil degradation.

The demand for more urban space has pushed the poor onto marginal, environmentally vulnerable terrain. At the same time greater demands are placed on forest resources for fuelwood, timber, raw materials, roads, and recreation. Deforestation increases the vulnerability of urban areas to droughts, fires, floods, runoff, landslides, sedimentation of dams and reservoirs, pollutants, and diseases.

Disasters are relatively more costly in developing countries than in wealthier countries because losses are higher (as a percentage of natural wealth). Incentives for development and investment are undermined, thereby increasing poverty. Thus, poverty and environmental vulnerability leading to disasters are mutually reinforcing. Moreover, disasters are particularly damaging to the informal sector, which plays a significant role among the poor in large cities of the developing world.

2. Urban vulnerability and Sustainable development

Sustainable development of urban areas requires a balanced approach based on economic, social, and environmental criteria (Munasinghe 1993). Therefore, the framework for analysis of environmental vulnerability leading to disasters can be structured around these three different, but interrelated, concepts of sustainable development.

Economic aspects

The economic approach to sustainability is based on the Hicksian definition of income, which is the maximum amount that a person or community can consume over some time period, and still be as well off at the end of the period as at the beginning. This means that the stock of capital (or assets) which yield these benefits must be maintained intact. Such assets include natural, and the capacity

of the environment to absorb shocks, both technologically-induced and natural. Natural and manmade capital may be more complements than substitutes, and natural capital, or the loss of ecological resilience, often plays a crucial role as the limiting factor in development. Of course, the degree of loss of productivity that occurs as a result of natural disasters is determined also by the capacity of human societies to adapt and continue functioning in the face of stress and shocks.

There is a growing awareness that urban poverty and environmental deterioration are closely inter-related. Thus, the economic approach requires cost-effective methods of preventing and mitigating environmental catastrophes, by improving regulatory measures, market-based control mechanisms (such as pricing and taxation) and municipal management. In addition to providing more comprehensive environmental protection and basic services, this would alleviate constraints on productivity and economic growth.

In order to determine the level and types of such policies, some awareness of the cost of impacts, and an internationalization of environmental externalities into cost benefit analysis (CBA) is essential. Incorporating environmental concerns into economic decisions involves two basic steps. The first is to compare the "with" and "without" project scenarios to quantify the physical impacts of a given economic activity. Putting an economic value on these impacts is the second step of the analysis. A variety of valuation techniques may be used to estimate values – effects on output or productivity, dose-response functions, contingent valuation, hedonic pricing, travel cost, replacement cost, etc. The basic concept of economic valuation underlying these techniques is the willingness to pay for an environment improvement or reduced possibility of environmental disaster.

Given the multifaceted aspects of environmental disasters and their management (including social and ecological concerns), multi-criteria analysis (MCA) offers a complementary approach to conventional CBA, especially in cases where it is very difficult to value all associated costs and benefits. MCA has several advantages over traditional CBA in facilitating the best choice among the investment options or policies available, since it does not focus solely on efficiency, but permits the consideration of social equity and other criteria. It allows for the inclusion of qualitative as well as quantitative data. Finally, it does not require the mandatory use of prices, but relies instead on weighting involving relative priorities of different groups.

Risk and uncertainty are an inherent part of any economic decision, and are even more relevant in the area of environmental disaster prevention and mitigation. The traditional and simple way of incorporating risk and uncertainty consideration in CBA is through sensitivity analysis. Using optimistic and pessimistic values for different variables can indicate which variables will have the most pronounced effects on benefits and costs. Option values are based on the existence of uncertainty, and are essentially the premium that consumers are willing to pay to avoid the risk of not having an amenity or good in the future. In this sense, the question of irreversibility comes in. A cultural site that is destroyed by an earthquake is gone forever. While that site may not have a survival value per se, it is an aspect of existence that gives value to survival. Furthermore, irreversible catastrophes (especially life-threatening nuclear or industrial disasters), tend to complicate the analysis of uncertainty, with regard to the long term consequences of technologically-induced accidents, and their relationship to environmental condition.

Social aspects

The impacts of environmental catastrophes fall disproportionately heavily on the poor – they do not have the financial resources to absorb the damages, their housing is often of inferior quality which cannot withstand the disaster, and they often live on marginal lands which are the most vulnerable and exposed to natural shocks. Often, the poor live close to environmentally hazardous industry, both because these polluted areas are the least desirable residentially, and because they work in these industries. Moreover, poor areas, because of their limited political and financial influence, receive the lowest priority, both in the initial installation and in the restoration of basic services such as water, sewage, solid waste management, and electricity.

It has become increasingly evident that community participation in addressing the avoidance and mitigation of environmental disaster is vital. In order to devise and implement effective strategies and reduce vulnerability, the communities most affected must have a voice in the procedure to identify site-specific solutions, and to assess the efficiency of proposed measures.

The implementation of disaster planning is best performed jointly by local communities, the government, and industry. More community awareness is essential. There is a need to identify and understand people's perception of risk, to develop better channels of greater communication and popular consultation, and to rely n local resources. The profound changes brought by urbanization have undermined the traditional support system in many cases. The government should play a role in encouraging the rebirth of community interaction, in an adapted format compatible with urban life. Decentralization of decisionmaking is important in the strengthening of organization for disaster preparedness prevention and mitigation, particularly given the need for rapid response in the face of swiftly occurring catastrophe.

Finally, the question of intergenerational equity is relevant, particularly in the case of irreversible environmental catastrophe. This essentially supports the view that future generations should be bequeathed an undiminished or even enhanced stock of natural resources. It also implies that the environmental carrying capacity of the earth (e.g., ozone layer, atmosphere) should not be exceeded in the future.

Environmental aspects

The ecological or environmental view of sustainable development places emphasis on preserving the resilience and dynamic ability of biological and physical systems to adapt to change. The preservation of biodiversity allows the system to retain resilience by protecting it from external disasters. These shocks, when they occur, often result in the loss of biodiversity. The interconnection between natural resource degradation and increased vulnerability to natural catastrophe, emphasizes the need for preventive measures to limit pollution and natural resource loss.

While stressing the importance of the preservation of biological diversity, it should also be recognized that biodiversity conservation does not require the preservation of all the species, nor the static maintenance of current environmental conditions. An evolutionary system requires that a level of biodiversity be maintained that will guarantee the resilience of the ecosystems on which human consumption and production, and therefore human welfare, depend. Therefore, what is essential is

the preservation of basic environmental assets, especially air, water, and soil quality.

The failure to limit environmental degradation resulting from human intervention increases the vulnerability to risks posed by natural hazards. For example, in Manila, the 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 roads, rivers, and channels and the lack of understanding among decisionmakers concerning the merits of planning and preparedness has exarcebated the city's vulnerability to floods. Similarly, in Rio the vulnerability to earthslips and damage to life and property caused by recurrent floods have been exacerbated by denundation and erosion of the hillsides on which slum dwellers live. In Jakarta, 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. Uncontrolled development in the south, combined with deforestation and dumping of liquid and solid wastes into rivers and canals that drain the city, has led to increased runoff and heavy flooding in the north.

3. Implementation Issues

Project and policy coordination and the role of market and regulatory tools

A suitable balance must be struck between investment projects, market incentives and regulatory measures to improve environmental management and reduce vulnerability. A dynamic cross-sectoral approach might be pursued, and regulations, technology, and policy options could be tailored better to the particular needs of a city. For example, the attempt to decrease the air pollution in Mexico City by decreasing alternate day driving was not as effective as expected. The specific problem of air pollution in Mexico City could be better addressed by combining an environmental tax instrument with regulatory approaches. By this combined approach, targeted emission reductions may be achieved more cheaply than with "regulatory-only" approaches.

Investment in technological options such as earthquake-resistant building techniques; water purification and waste recycling systems; the establishment of rescue squads; early warning systems; and water control and flood abatement systems should be combined with zoning regulations and enforcement to govern land use patterns. However, by themselves, these changes are insufficient – they need to be complemented by improvements in policies and institutions in order to be effective. Complementary actions on pricing of essential services, cost recovery, expenditures, and incentives for private investment are also essential.

Comprehensive land use plans are required, that address the issues of lack of secure tenure, poor titling and land registration systems, and inadequate tax policies and systems. Once land management objectives and strategies are identified, the next challenge is to select locally appropriate land management instruments that can achieve a proper balance between land use efficiency and equity as well as the protection of urban populations. When the poor are given title to land, they will invest whatever resources are at their disposal to improve and manage their environment, and to organize their collective essential services on an informal basis (when such services are not provided by the government).

A study performed to assess the environmental concerns specific to the city of Rio de Janeiro

identified the following threats: slope-stability problems and floods caused by deforestation; beach erosion caused by road construction; the filling of mangroves, marshes, and lagoons caused by drainage; and water, sewage and industrial pollution caused by non-existent or inadequate pollution treatment processes. The results suggest that taxation of transportation and the improvement of the quality of mass transportation would reduce the externalities that are having negative impacts on Rio's environment. Other methods suggested to limit environmental vulnerability include rationalization programs in the industrial sector; energy conservation and pollution reduction through energy substitution schemes; innovative systems for waste treatment; and other environmentally friendly technological approaches. Implementation of coastal zone management should be handled in a manner that allows full participation of all parties involved, from administrative regions and residents' associations. There is a need to decentralize urban infrastructure in order to reach a balance of physical space within the city that would remove pressure created by overcentralization of resources in populated areas. Finally, the need to improve public awareness, and institutional capacity building, is stressed as a means of improving environmental protection in the long run.

Information and monitoring

In order to deal with accidents and sudden events, citywide assessments of risks and their probabilities and costs are needed, (for example, for earthquakes, industrial accidents, and flooding). To deal with unknown events, more work must be done to assess possible breakdowns in urban systems to develop a method for determining priorities.

In order to adequately identify efficient resource allocation alternatives, priorities must be established according to vulnerability – the marginal cost of disasters, the effectiveness of vulnerability reduction, and the amount of disaster cost that can be avoided for each unit of dollar invested. It is essential that adequate information be available for any prioritization to be realistic and effective.

Constraints and problems of implementation

In implementing the abovementioned policies, several constraints must be overcome that are perhaps more common to developing country cities. There is a lack of institutional capacity, both to handle the disasters, and to enforce regulations, and impose taxes.

The lack of facilities for monitoring and information collection are an obstacle to effective disaster prevention strategies, and to rehabilitation after the occurrence of disasters. The large informal sector renders a lot of information inaccurate and incomplete. Furthermore, exchange of information among developing country cities would help to disseminate the successful lessons of experience more effectively.

Political pressures to maintain lifeline subsidies on essential services put an additional burden on resources Lack of rural employment also encourages migration to urban areas, where facilities are not properly funded to handle the influx of people.

4. Summary and Conclusions

The growing scale of urban-industrial activity is exacerbating environmental degradation in

developing country cities, and increasing the vulnerability of urban dwellers to both natural and technological disasters. Sustainable development of urban areas requires a balance approach based on economic, social and environmental criteria. An integrated analytical framework is needed to analyze the principal links between unsustainable urban development and vulnerability, especially in large cities. Physical and social impacts of disasters and their economic value need to be determined. The balance between investment projects, market incentives and regulatory measures to improve environmental management and reduce vulnerability require assessment of the relative costs and benefits of these actions. Information availability and education of urban dwellers, as well as risk perceptions and political motivations play a key role. Constraints at all levels of city governments, especially those that hinder local community participation and action, are major problems. A major effort is required to encourage urban administrators to strengthen disaster preparedness, prevention and mitigation; redirect municipal spending; and learn from the experience of other urban communities.

5. References

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Risk Management and Preventive Planning in Megacities: Scientific Approach for Action

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1. Background

Urban concentration: a planetary tendency

It is expected that by the year 2000 about 50% of the World's population, or 6.5 billion people, will live in an urban environment, and thus will be concentrated on less than 3% of the land surface. Most of these urban sites have been in use for centuries and in some cases for millennia, and their selection usually took to account of the potential dangers presented by geodynamical phenomena, nor of the ecological fragility of the environment. In fact, until the beginning of the 20th Century, most towns saw but little growth and it was not until the middle of this century that growth became intense. In 1900, less than ten cities had more than a million inhabitants, but by the end of this same century it is expected that this number will have risen to 430 or 450. In 1960, three cities had more than 10 million inhabitants and all were located in industrialized countries. In 1980, there were 10 cities of this size, and it is expected that by the end of the century there will be 25, 18 being in developing countries.

The growth of megacities increase the vulnerability of human society

The accelerated and uncontrolled present growth of such "megacities" in exposed areas has led to their sudden bursting out of their historical confines. This has made them increasingly vulnerable to hazards that have all but disappeared from the collective memory of the citizens, who have lost the ability to perceive dangerous natural phenomena. To this must be added the hazards caused by the impact of Man's activities and structures on an already fragile physical environment, whose degradation further increases the type, number and intensity of "natural" hazards that threaten Man. Rural depopulation which comes together with the migration toward cities also induces new phenomena of physical instabilities. These latter are linked to the decay of drainage and other civil works which where previously Maintained by the country people. The hyper-concentration of people, goods, services, infrastructure and production means in the megacities today renders Mankind particularly vulnerable, the more so as construction quality and the technology used often leave many things to be desired. The multiplication of natural hazards and the increased vulnerability are graphically shown by the worrying statistics since 1960: the number of persons affected by catastrophes increases regularly each year by 6%, which is three times the World's population growth; of these, more than 90% are the victims of natural disasters.

Poverty increases vulnerability to disasters and vice versa

Poverty increases vulnerability to disasters. The loss of GNP from natural disasters is about 20 times greater in developing than in developed countries, and the number of victims is 150 times greater. The urban explosion in the Third World is no longer related to industrialization, as is still the case in developed countries, but to poor development policies on the national scale.

The megacities in developing countries double in size every 12 to 15 years, but the poorer parts of such cities double in size every 7 years! The poor quality of construction and of the technology used, the absence of basic infrastructure elements and of understanding the effective capacity of the natural environment to support urban growth, all render such spontaneous urbanisation in the more informal parts of megacities particularly vulnerable.

In any cases, the economic and environmental disturbance, and the social and institutional disorganization that usually result from disasters in megacities, form a true brake on the development of developing countries (the direct damages of the Managua's earthquake, 1972, represented 209% of the GNP of Nicaragua).

The means for prevention exist, but are particularly neglected in developing countries. Megacities can no longer tolerate this situation.

Though most natural hazards may be inevitable, their effects can be prevented or mitigated. The physical instability of megacities can be avoided. Reliable mechanisms for prediction and warning, carefully planned emergency response, judicious land-use policies, disaster-resistant designs, as well as enforceable and enforced codes specific actions have led to notable successes in the developed countries. However, until now, mitigation measures have not been widely implemented because of economic, social and political barriers. Mitigation is commonly perceived as restrictive in nature, costly, and incompatible with the goals of economic development. Furthermore, where economic resources are already inadequate to meet basic human needs, risk reduction may appear to be very low on the list of national priorities, the more as it is always long-term and difficult to measure, which gives the politicians very little to show for the measures they advocate.

In fact, disasters undermine development efforts and waste development resources. When disaster-proneness or environmental fragility are well known, failure to include them into planning represents a serious mismanagement of resources. In addition, even if it were "cheaper" to let disasters happen than to prevent them, it is generally agreed that widespread human suffering should be avoided when possible. Megacities form geographic units where the respecting of such rules is fundamental. Faced with a growing international awareness, the authorities of megacities are increasingly forced to manage this new reality.

The preventive management of risks and the environment: a common commitment to ensure an environmentally sound, safe and sustainable development.

Certain megacities that experience an explosive growth can no longer control their expansion, in particular in their suburbs. For most large cities, their development strategy is based on a project-by-project approach (sectoral investment projects). If environmental constraints are not taken into account for such projects, new natural hazards may be caused, or existing ones may increase in frequency or severity, the cumulative effect of multiple independent decisions can thus lead to serious environmental crises. The project-by-project approach is an ineffective means of promoting social well-being. Integrated development strategies are very much preferable, but they also require an effective control over growth. A development policy must be based on a double socio-economic and environmental approach. The Brundtland Report of 1987 declared that, even though Man for some time has been aware of the effects of economic growth on the environment, the time has now come to question in how far environmental aggressions may affect our economic perspectives; in fact, causes and effects are inextricably interwoven. In a more general sense, the reduction or the prevention of risks must go hand in hand with the protection or improvement of the environment, in

the same perspective of environmentally sound, safe and sustainable development.

From this it is obvious that the control of the increasing problems of the physical instability in megacities must form one of the priorities of the International Decade for Natural Disaster Reduction (IDNDR) decreed by the United Nations Organisation (UNO) for the 1990s.

2. Aim and Objective of a Scientific Approach for Action in Preventive Urban Planning

The megacities should be integrated in an "organic" fashion into their natural site.

Today, many megacities seem to be creations that are divorced from nature, which they exploit at their convenience, imposing on it their own equilibria and dynamics, and degrading its physico-chemical and biological characteristics. They behave like autonomous entities, devouring natural space, difficult to control, and whose entropy in a physical, social and cultural sense can end up by compromising the medium- and long-term development projects.

The accelerating growth of megacities throughout the world has produced situations which, even in well-established cities, are self-destructive. In addition, the demand for ground space in fast-growing cities has led to the use land which, earlier avoided, is fraught with hazards when developed.

Hazards associated with man's occupation of the terrain include:

i) subsidence (due to groundwater extraction), settlements and collapse (due to underground cavity collapse);
ii) the rise of piezometric levels and the resulting flooding of space below the ground surface (i.e., basements, underground space, parking, garages, etc.);
iii) the contamination of the soil and water from solid and liquid wastes, accidental spills, leakage and poorly designed landfills sites:
iv) the loss in bearing capacity of soil foundations 9due to saturation, concentrated loads, internal erosion, etc.);
v) the loss of natural resources (construction materials, water, etc.).

Natural hazards, with or without the influence of man, include:

a) floods, mudflows, erosion and sedimentation (particularly that resulting from deforestation);
b) landslides, natural as well as man-induced (i.e., the cutting or overloading of slopes, groundwater-flow changes);
c) earthquakes, volcanic eruptions;
d) coastal erosion and sedimentation;
e) swelling or contraction (desiccation) of soils.

In urban and regional planning, man acts on his environment by drawing up a plan of spatial organization. However, he cannot create such a space without taking into account of the properties, limits and threats of the natural environment. The time has come to wake up the megacities to the reality that they, like all other cities in the past, must integrate themselves into their natural site into an organic fashion. From this viewpoint, engineering geology has a pivotal role to play. The physical environment (structure and dynamics) that surround and support human life, represents the conceptual framework for environmental-planning action.