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ENVIRONMENTAL IMPACTS OF URBAN LAND-USE IN DEVELOPING METROPOLISES

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1. Introduction

During the twenty year period from 1970 to 1990, urban population in developing countries has grown by more than 130 percent, in contrast to a mere 25 percent growth in the rest of the world. It has further been predicted that, in year 2000, seventeen out of twenty largest cities of the world will be in developing countries. Based on the fact that the environment of a city is affected by its human activities, the impact of this enormous growth of developing cities on environment also is tremendous. Environmental impacts of urbanization are caused by two ways; by increased amounts of pollutant emissions, and by the deterioration of natural systems. Due to the rapid growth of activities and hence emission of pollutants, difficulty for the fast deteriorating natural systems to cope up with the increased levels of pollution, and poor planning and implementation of environmental policies, developing cities are facing the threat of accelerated environment degradation. The scale of these effects vary from individual or household level to national or global level. Warnings of such massive degradation are observed at many developing metropolises already.

Although urbanization is basically characterized by increased population concentrations at urban centers, it also accompanies with increasing industrial and commercial activities, transportation demand, energy consumption etc. Type and degree of environmental damage depend on the type and magnitude of urban activity, or the dispersion of different land-uses. Hence, it is logical to relate the amount of environmental impacts of urbanization to the land-use composition and the intensity of activities on those land-uses of the city.

2. Urban Land-Use and the Environment in Developing Countries

Socio-economic characteristics of urban population in developing countries vary in a wide range, and so as the residential land-use. Twenty to fifty percent of urban population live in poorly ventilated and sanitized slums and shanties, which are highly over-crowded. Most of these low-income residential areas are illegal settlements located in areas exposed to risks of natural hazards and industrial accidents and do not receive water and sanitary services. The economic disparity of urban population yields different influences on the environment by low-income and high-income residential areas. The same phenomenon can be observed in commercial, industrial and other land-uses too. As for the environment in a city, it is important to recognize the natural and man-made environments of the city. Natural environment consists of the urban atmosphere, surface water resources, urban land and ground water resources whereas residential, industrial, commercial and transportation infrastructure, water supply and sanitation services, waste treatment plants etc. account for the man-made environment. With the growth of the urban activities, pollution levels soon exceed the restoration capacity of the natural urban system, and hence additional support has to be provided through the man-made urban system. Capacity of the natural environment to withstand the damage also depend on some region dependent factors like topography, climate (ambient temperature, humidity, wind, rainfall, solar radiation etc.), watershed characteristics etc.

In developing countries, rate of expansion of man-made urban system is not parallel to the expansion of city's activities and the increased deterioration of natural system. This has created a widening gap between the rate of emission of pollutants and the capacity of the city to withstand them.

3. Environmental Impacts of Different Land-Uses

Land-use originated environmental impacts can be divided into two types; those originated from the change of land-cover and those from activities on the land-use. The former does not depend much on the intensity of the particular land-use activity and effective from the preparation of land for the particular activity (Table 1-A). Magnitude of the latter type of impacts depends very much on the intensity of the operation of

activities (Table 1-B). For example, solid waste generation in a residential area is not only a function of the residential land area, but the population density (i.e. intensity of residential activity) of the area also.

TABLE 1 : SOME EXAMPLES FOR ENVIRONMENTAL IMPACTS OF URBAN LAND-USES

A - IMPACTS DUE TO CHANGE OF LAND-COVER

Land-Cover Change	Mechanism of Degradation	Effect on the Urban Environment
Change of land cover from green areas to paved areas	Urban heat island effect	Increased ambient temperature
	Increased surface runoff	Storm water disposal problems Drop in local ground water table Frequent flooding in low- lying areas
Land development in mangroves and other wetlands	Loss of natural habitat	Danger of losing some species of *flora & fauna*
	Loss of sponge action of wetlands	Frequent flooding of low- lying areas Increased siltation of estuaries

B - IMPACTS DUE TO ACTIVITIES ON LAND-USES

Land-Use Category	Mechanism of Pollution	Effect on the Urban Environment
Residential	Waste water disposal	Pollution of surface water resources due to discharge of waste water
	Solid waste disposal	Loss of urban land for waste filling Gas and particle emissions after incineration of solid wastes
Industrial	Dust and gas emissions	Effect on human health, animals and plant growth Contribution to global warming
	Industrial waste disposal to waterways	Effect on aqua-ecology due to toxic wastes Accelerated eutrophication in lakes

4. Estimation of Impacts Based on Land-Use Information

As major environmental impacts of urbanization are associated with change of land-cover and intensity of land-use, it is possible to estimate the environmental impacts to some extent through land-use information. Environmental impact assessment consists of the estimation of pollution level and restoring capacity of both natural and man-made systems based on land-use information, and evaluation of environmental cost. For a given zone with a combination of land-uses with different activity intensities, the pollutant generation is obtainable when the pollutant generation rate per unit activity for each land-use is known.

Activity intensity should represent the magnitude of particular land-use activity in a unit area of land-use. Multiplication of land-use activity intensity by area of land occupied for that land-use in a given zone gives the magnitude of activity in that zone; for example, population, shop space, office space etc. Pollutant generation rate per unit activity for a particular land-use (for example, waste water generation per head for residential land-use) is usually a constant. For the said example, it varies with the socio-economic characteristics of the individual and the particular region only. If the land-use categories are so selected that they represent similar members (for example, low-income residential, middle-income residential etc.), effect of individual characteristics can be minimized. These rates have to be developed through stratified random sampled pollutant generation information of zones. Once developed, these rates can be used throughout the metropolis, and irrespective of the land-use composition and growth of the city.

5. Concluding Remarks

Cities in developing countries are characterized with higher rates of expansion as well as higher rates of environmental degradation. In planning and related decision making in developing metropolises, environmental and social considerations are overshadowed by economic and political factors. Poor implementation of environmental regulations, specially regarding industrial land-use and damages to the natural system, can be clearly observed. Inclusion of environmental impact assessment in urban planning studies in developing metropolises has emerged as an urgent and important issue.

Following the concept described above, the authors are developing an analysis system of urban environment with using RURBAN, an integrated land-use and transport model.