POPULATION GROWTH AND URBAN ENVIRONMENT: A STUDY OF THE METROPOLITAN CITIES IN INDIA

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CERTIFICATE

This is to certify that the dissertation entitled **POPULATION GROWTH AND URBAN ENVIRONMENT: A STUDY OF THE METROPOLITAN CITIES IN INDIA,** submitted by **Ms. POOJA RAMAN** in partial fulfillment of the requirements for the award of the Degree of **Master of Philosophy,** of this University is her original work and has not been submitted for any degree of this or any other University.

We recommend that this dissertation be placed before the examiners for evaluation.

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Pooja Raman

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER-I
INTRODUCTION

I.1 STATEMENT OF THE PROBLEM

As the 21st century begins, growing numbers of people, rising level of consumption per capita are depleting the natural resources & are degrading the environment. The growth of human population has been unprecedented in the recent times, so much so that the burgeoning population has become an environmental issue as well.

The world's population approximately reached 5.7 billion in 1995 with an annual growth rate of about 1.6%.[1] Of this population nearly 2/3rd lived in the developing countries like Bangladesh, India, countries in Africa, Asia, and Central & South America, which had an average population growth rate of 1.9% in 1990. "*It is projected that world population would reach nearly 8.5 billion in the year 2025.*"[2] In 1960's the global population was growing at about 2.1% annually which had declined to nearly 1.2% per year in 2000. Yet, it is important to note that the population has doubled since 1960.

The world reached the 6 billion mark on Oct. 12th, 1999. India crossed the 1 billion mark on 11th May 2000 and is projected to reach 1.26 billion by the year 2016. The Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat states that the world's population reached 6.1 billion in mid-2000 currently growing at the rate of 1.2%, or 77 million people per year. India accounts for 21% of this annual growth. According to the projections made by it, by 2050, world population is expected to be between 7.9 billion (low variant) and 10.9 billion (high variant), with the medium variant producing 9.3 billion.[3]

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[1] UNITED NATIONS POPULATION DIVISION. "World Population Prospects: the 1994 Revision." In: Demographic Yearbook: 1995, Department for Economic and Social Information and Policy Analysis, Statistics Department Division, Publishing Division, United Nations, New York.

[2] United Nations, "The Global Partnership for Environment and Development," UNCED, Geneva, April 1992, pp33.

[3] United Nations, "World Population Prospects: the 2000 Revision." In: Population and Development Review 27(2), June 2001, pp389-391

Urbanization was more remarkable in developed countries in the 19th century, while for the Third world countries it is in the 20th century whereby cities are growing at an annual growth rate of 5 to 8% and the urban population doubling every 10 to 15 years.[4] Though in the present situation the rate of population growth has slowed in the wealthy, industrialized & developed nations, but population continues to increase rapidly in the poorer and the less developed nations.

Earth's resources, natural system, and human population are inherently connected. Population growth is inevitable, but it is their consumption pattern that impacts the environment. The fundamental relationships are easy to grasp. People rely on food, energy, & raw materials for human activities, and those activities in turn, have an impact on the earth's resources & systems.

"In the process of interacting with the environment, people change & modify it."

Population and environment are not separate entities that can be seen as independently or even in opposition to each other. The human population is an integral part of nature (even in the man made environment and infrastructure called development) and at every stage dependent on the functioning life support systems.

The aspects of population-environment relationship, which are strongly population-related, as opposed to effects more attributable to income-growth and technology, are: *urban environment & water.* All over the world the population explosion is a serious threat to the provision of congenial environment.[5] Human populations are increasingly influencing the environment. While their own health, longevity, and well-being are also dependent crucially on the environmental factors.

At the turn of the century, natural resources are under increasing pressure, threatening public health and development. Population is a critical variable influencing the availability of the natural resources. Rapidly increasing population leads to increasing demand for natural resources, employment, education and social services. This will make it difficult for the mankind to protect the natural resources and improve their living conditions. Most developed economies currently consume resources much faster than

[4] Jones, R. (ed,) 1975. "Essays on World Urbanization," George Philip & sons limited, London.

they can regenerate. While most of the developing countries with rapid population growth face the urgent need to improve living standards and their consumption patterns are affected by "demonstrative effect" leading to more extensive utilization of the available limited natural resources. As humans exploit the nature to meet their present needs, they are destroying the resources needed for the future.

As the human population grows, it will need more food and more space. This will ultimately lead to the destruction of the natural ecosystems and their replacement by the human modified ecosystems. As the population increases and the resources become scarcer, this pressure will become greater throughout the world. Through processes such as cultivation, irrigation and urbanization, man has modified or created new physical systems, either accidentally or deliberately.

"The power of population is infinitely greater than the power in the Earth to produce subsistence for man." – Thomas Malthus, (1766-1834)

Urbanization, the dynamic process of accretion of human settlements into larger entities with the concomitant changes in the social, psychological & occupational character of the urbanizing population has been accompanied by complex problems worldwide. The concomitant phenomenon involving the complex process of change involving population concentration, structural transformation, and socio-psychological changes affecting both the people and the places is referred to as urbanization. Population growth leads to urbanization. Foremost among them are a surfeit of infrastructural problems stemming from the grossly excessive size of most of the urban areas beyond their holding capacities like overcrowding, lack of adequate housing, mushrooming of slums and squatter settlements, lack of civic amenities with consequent disease & squalor so typical of our cities. Environmentally, urbanization has taken a heavy toll with our green belts devoured by concrete jungles & potentially fatal level of air, water & noise pollution.

Man's impact on the environment has accelerated rapidly since the Industrial Revolution. Technology, by creating demands for minerals, has led to human settlement in the most hostile of the environments and there has been an intensified use of the

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[5] Gopal Bhargava, 1992, "Environmental Challenges and Ecological Disaster (Global Perspective)" Mittal Publications, New Delhi, India. Pp 58.

resources to increase the productive capacity. In the process of maximizing space and resource-utilization man exploits his environment to the full though not wisely. There has been an over-exploitation of the environment and interference in the natural processes over a long time-period, which require cautious monitoring for the adverse effects.[6] In the beginning of the twenty-second century urbanization has become a force throughout most of the world and has determined many of the economic, social and environmental changes that have an impact on our daily life. Industrialization and urbanization are worldwide phenomena. "There's a direct relationship between national development and the growth of large cities."[7] Big cities are essentially phenomena of the Twentieth century, which grew rapidly under the impact of Industrial Revolution, and also under the impact of the rapid population growth.[8]

Greater the uncontrolled activities, more is the damage to the environment.

The rapid growth of cities in the developing world puts them in the forefront of the struggle for improved living standards and protection of the environment. Since 1950 the urban population has more than tripled, from just over 750 million to about 3 billion.[9] By 2030 some 5 billion people will live in cities.[10] In the developing world the urban population is projected to double from 1.9 billion in 2000 to be just under 4 billion by 2030. Worldwide, about three-fourths of all current population growth is urban.[11] Cities are gaining an estimated 55 million people per year-over 1 million new residents every week from in-migration and natural population increase within cities. In developing countries many cities are growing two or three times faster than populating growth for the country as a whole.[12] As cities grow ever larger, their impact on the environment grows exponentially.

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[6] S. Ghosh, 1998. Introduction to Settlement Geography, Orient Longman Limited, pp136.
[7] Sivarama Krishnan, K. C. 9178, Indian Urban Scene, Indian Institute of Advanced Study, Shimla.
[8] P. Hall, "The phenomena of Urban Growth," pp55.
[9] O'MEARA, M. Reinventing cities for people and the planet. Washington D. C., Worldwatch Institute, Jun 1999. (Worldwatch paper no. 147) 94p.
[10] UNITED NATIONS POPULATION FUND (UNFPA). The state of world population 1999. Six billion: A time for choices. Marshall, A., ed. New York, UNFPA, 1999. 76 p.
[11] UNITED NATIONS POPULATION DIVISION. World Urbanization Prospects: The 1999 revision. New York, UN, 128 p.
[12] Gelbard, A., Haub, C., and Kent, M. World Population beyond Six Billion. Population Bulletin. Vol. 54(1): 3-40. Mar. 1999.

The population growth in the large agglomeration is due to the natural increase, migration and the reclassification of the population due to the areal spread of the urban concentrations beyond its limits. In context of transformation form ruralism to urbanism, urbanization is concerned with a three-fold change: (a) behavioural, (b) economic, (c) demographic. All these affect the spatial organization of a human settlement, and thereby the design of the city landscapes itself.[13] Of all the three aspects of urbanization, only demographic aspects can be studied better and analyzed. Millions of people move from the countryside to the city to seek a better life, but they often find that their lives become more difficult. In many cities 25% to 30% of the urban population live in poor shantytowns or squatter settlements, or they live on the streets.[14] Nevertheless, cities in the developing countries continue to attract more and more people... Cities occupy only 2% of the world's land surface, but city populations have a disproportionate impact on the environment.

The concentration of people in urban areas is integral to the process of economic development, resulting from both push and pull factors. "Large urban agglomerations are engine of economic growth and development and their share of GNP is increasing."[15] This is the main reason behind the operation of the "pull" and "push" factors for the migrants. Push factors like poor working incentives and generally harsh living conditions initiate rural to urban migration. Better jobs & income prospects in urban areas-which reflect the greater productivity of labour supported by economies of scale and agglomeration-attract migrants. This dynamics underlie the positive correlation observed between the extent of urbanization across countries and per capita incomes.

Expanding population and slow income growth in combination with generally inadequate technology is causing over-exploitation of the land resources for food and fuel in many developing countries. The result is a deteriorating human and natural environment in a worldwide perspective. The economic forces of urbanization are powerful, and population growth intensifies them.

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[13] S. Ghosh, 1998. Introduction to Settlement Geography, Orient Longman Limited, pp121.

[14] UNITED NATIONS DEPARTMENT FOR POLICY COORDINATION AND SUSTAINABLE DEVELOPMENT. Critical Trends: Global Change and Sustainable development. New York, UN, 1997.

[15] Sivarama Krishnan, K. C. 1978, Indian Urban Scene, Indian Institute of Advanced Study, Shimla. pp2.

Large urban agglomerations are consumers and producers of higher degree of resources and have become the economic engines of development. In the process of higher production and consumption they contribute to pollution of the natural environment in a large scale not only in the urban areas but also in its hinterland and consequently on a global scale. "Cities require the concentration of food, water and fuel on a scale not found in nature. Just as nature cannot concentrate the resources needed to support life, neither can it disperse the waste produced in the cities. The waste output of even a small city can quickly overtax the absorptive capacity of the local terrestrial and aquatic ecosystems."[16]

Urbanization and industrialization have stressed the environment much and have caused much personal inconveniences to the masses: a sewage- polluted beach, the smog that leaves one's eyes watering, the black granules of soot that drifts in through an open window, traffic congestion, noise, ugliness, the smoking vehicles and industries. Urban environmental degradation has been an inbuilt syndrome of urban growth. The quality of air in large urban agglomerations has been below the standard set by the World Health Organization. Exposure to higher levels and duration of noise has been observed, which is mainly due to vehicular and air traffic. The noise pollution created by the air traffic is however area specific.

"*About 90% of the population increase today takes place in developing countries, having risen from 1.7 billion in 1950 to 4.2 billion in 1991. At present over 40% of the urban population in the developing countries lives in squalor, without access to essential services such as health care, civic amenities and public transportation. Coping with these projected population in future poses major challenge to sustainable development and better environmental quality.*"[17]

Population explosion, large backlogs in terms of shelter and essential urban services, growth of slums and squatter settlements and above all the increasing deprivation of environment quality for a majority of the city dwellers are the common characteristics of most of our large cities particularly the metropolitans. Poverty and sub-standard living conditions have a direct impact on the environment. The habitat of the

[16] Quoted in George Benneh, "Environment Consequences of Different Pattern of Urbanization." Pp159.

urban poor has a deteriorating and unhygienic style of living has eventually caused congested and inhuman environment.[18] The haphazard large-scale industrialization, massive rural to urban migration and inadequacy of shelter and related infrastructure of waste and sewerage, as well as the efficiency of transport and other public services have caused serious social and environmental problems in urban settlements of the developing world.

The per capita income in developing countries will be reduced by population growth, which will obviously lead to the hazardous living conditions in slum and squatter conditioning particularly in the Third World.[19] "The urban poor, consisting of 30 to 40 percent of residents in the cities of the developing countries, live in squatter settlements, illegal subdivisions, substandard inner-city housing, custom-built slums and boarding houses. Most housing in those categories lacks essential services and contributes to the spread of epidemic disease and physical disorder."[20] Collection and disposal of solid waste is inadequate in large urban agglomerations. Water supply connections are frequently worn out or inappropriately installed causing enormous wastage and potential cross-pollution. Environmental problems (like these) can certainly get worse, but with faster population growth, they may get worse more rapidly.

The scale and speed of urbanization are thus likely to present demanding challenges for urban management and development. Cities are finding it increasingly difficult to provide and maintain infrastructure due to enormous increase in the growth rate of population which does not allow bridging the gap between the demand & supply of infrastructure, over-dependence upon fiscal resources, starved public sector for infrastructure provision, political decision making & lack of coordination on the part of various departments involved in providing these services.[21] Unless development is geared for taking care of the population, more especially the weak and downtrodden, the mere

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[17] United Nations, "The Global Partnership for Environment and Development," UNCED, Geneva, April 1992, ppl.

[18] Gopal Bhargava, 1992, "Environmental Challenges and Ecological Disaster (Global Perspective)" Mittal Publications, New Delhi, India. Pp.60

[19] Gopal Bhargava, 1992, "Environmental Challenges and Ecological Disaster (Global Perspective)" Mittal Publications, New Delhi, India. Pp 58.

[20] Hamza Ahmed, "Urban Settlement and the Environment in the Developing World: Trends and Challenges."

[21] Gupta, J. K., "Urban Infrastructure Development: Some Innovative Approaches." In: Spatio-Economic Development Record, Vol. 8, No. 6, Nov.- Dec. 2001.

talk of environmentalists to diminish pollution will have no meaning to the masses. However, the creation of a healthy society, it is necessary that the resource base of the poor should improve. Unemployment among them should decline.

The significance of the present concern goes much deeper than nuisance abatement. It is a belated recognition that as we "succeed" in terms of production, size, speed, growth, and the quality of life may deteriorate catastrophically. It is a belated recognition of our oneness with nature, a concern for man himself and his natural environment. It is a belated awareness that our fate as individuals is inseparable from our fate as a species and the future of life on this planet, Earth. Never before has any one species had such a great impact on the environment in such a short time and continued to increase at as rapid a rate. "With increasing awareness of the environmental fact that have direct and indirect, adverse and beneficial as well as short-run and long-run impact on development process. The question is no longer generally hinged on the necessity of incorporating environmental impact assessment in the planning management and implementation process successfully."[22]

"Success may be costly by degrading & homogenizing the earth's environments."

I.2 THE CONCEPTUAL BACKGROUND

Pope Alexander in his article " Man-made Observation" has said that 'man is the real study of the humanity', which became a popular viewpoint, but, today any study concerning the human beings cannot remain limited to the human race only. It is seen that in his daily activities, man impacts upon the environment. Hence, it has become important to study the total environment concerning him.

The Rio Declaration on Environment and Development adopted at the 1992 UN Conference on Environment and Development – The Earth Summit, in Rio de Janeiro, Brazil – expressed concern about the deteriorating status of the environment and established goals for improvement besides witnessing a controversial debate between the developed and the under-developed countries. The developed countries accused the under-developed countries for the environmental degradation, the root cause for which

[22] Asit K. Biswas and Qu Geping (eds.), "Environmental Impact Assessment for Developing Countries, Published for United Nations, University by Tycooly International, London. 1987.

was large population size according to them. While on the other hand the under-developed countries accused the developed countries and their "Consumption level" as the root cause for the same.

After the heat and dust raised by this plethora of allegations and counter-allegations settled down, one point was clearly visible that the higher consumption level and large population size coupled with technology level lay at the root cause of environmental degradation[23]. Most developed economies currently consume resources much faster than they can regenerate. While most of the developing countries with rapid population growth face the urgent need to improve living standards and their consumption patterns are affected by "demonstrative effect" leading to more extensive utilization of the available limited natural resources.

There is a need for environmental awareness, a need to know about the extent of environmental degradation and its impact on the lives of the people. It has become necessary to stop the further deterioration and destruction of the environment not just for the quality of life, but also for the very existence of life. Harmony between such major goals as environmental protection and social equity must be achieved, otherwise the environmental movement will not be able to go beyond criticism of the existing development process or a few attempts to reform it here and there.... Unless people take it upon themselves to improve the environment, the administration can hope to achieve a little success by itself. People's movements are not born on a single day. There are certain basic factors that create an environment in which people's movement can begin. And it is to sensitize the masses towards the environmental issues that this work was taken up.

The study of environment has come close to the basic human problems and quality of life. The impact of human activity on the environment was negligible 3000 years ago when less than 100 million people inhabited the planet. But the collective impact of 6 billion & more people living on this earth is tremendous. It is because I wish to know the importance of each factor (population size, level of consumption and technology level) in deteriorating urban environment of metropolitan cities of India that I have undertaken for this study.

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[23] United Nations (1994), "Agenda 21", Report on Rio Summit, New York, 1994

The environment is too important to be left to the environmentalists.
-- HELMUT SIHLER (German chemical company president), 1990, in Nigel Rees, *Cassell Companion to Quotations*, p. 173, 1997

I.3 REVIEW OF LITERATURE

Every environmental issue has a potential for generating debate. All these issues are involved with the entire gamut of human existence. Basically, environment is natural environment and has interactive relationship with humankind, to which it provides both context and resources for development. While there is no inherent conflict between environment and development, the priorities in the identification, study, and solution of environmental problems must be realistic and related to the environmental perception of the majority of the population/ Environmental problems are also intimately related to the class structure of the communities, political economy, and government.

The main interest of this dissertation is to analyze the deteriorating physical urban environment. The quality of urban environment has suffered losses due to exploitation of the resources and disposal of energy & energy products. The deterioration of the physical environment in urban centres is grave. This is because the qualitative components of life sustaining forces like air, water, food & space seem to be gradually reduced and are polluted.

- After the first ***UN Conference on Human Environment at Stockholm, Sweden (June 1972)***, there has been a proliferation of literature related to population growth, economic development, & their impact on environment. In this section an attempt has been made to review the available studies from various sources. Although a clear-cut classification is not possible, an effort has been made to classify the literature reviewed according to the focus of study.

- Population, Resources and Environment,
- Population, Environment and Economic Development,
- Slums, Environmental Pollution and Environmental Management and Planning,
- Various Issues of Environment.
- Case studies on the state of environment of various Indian metropolitan cities.

a) Population, Resources and Environment

Rodenburg (1998) says that human interaction with environment –resource use, consumption, pollution, and water involves the same processes today as it did at the dawn of the human history, but the scale & complexity of these human activities are vastly greater. And the pace and magnitude of population over the last few 100s of years, and the projected growth in this century are unprecedented in the human history.

Ness (1993) provides a brief summary of the long historical trends that link population growth to environmental on a global scale. It then presents the underlying population dynamics that mark our modern period, the demographic transition, which helps to explain differential growth rates in the major regions of the world. Finally it examines broad patterns of population and economic growth over the past four decades, with projections to 2025.

"Population, Resource and Environment: Issues in Human Ecology" by ***Ehrlich and Ehrlich*** in 1970 was among the earlier available literature on the subject. To Paul Ehrlich (biologist & an educator): the total environmental effect is a product of impact per individual times the total number of individuals. An increase in either the individual impact each of us has on the environment or the total number of people results in an increase in the total human effect on the environment. The combination of rapid increases in both population and technology has geometrically increased our effect on the environment. The authors have given a pessimistic view regarding the crisis posed by the explosive growth of Human population. According to them, the people of the underdeveloped countries will be unable to escape from poverty & misery unless their population is controlled. Since this population growth rate is high it is expected that conditions going to get steadily and rapidly worse. Today they have a larger population than they can support given their natural resources. On the other hand developed as their struggle to maintain affluence level and grow more food degrade the environment through mass consumption. ***Stolnitz (1991)*** has expressed similar views.

Harrington (1996) also holds the view that in most developed countries, population is growing slowly or is not growing at all, but, the level of per capita consumption are so high that the environment is under pressure. The less developed

countries face even a greater pressure as the population is growing rapidly, while the consumption is increasing as living standards are improve. Every person has an equal right to achieve a high standard of living.

Arizpe, Stone, and Major (1994) in their monograph exposed the micro & macro linkages at the local, regional, or global level in their social, political, & economic settings. They have discussed the failure of the Ehrlich/ Simon dichotomies. They suggest that the global views did not adequately explain the links between population & environment. Models should be local and capture the causal links between production, consumption, and population. They have focussed on the importance of consumption by a new birth. Consumption of one person in the developed world was viewed as not equivalent to consumption of a person in the developing world. They have exposed the social and welfare issues and the effects of population size factors on deforestation. The links between the environment and population growth emphasized the importance of recognizing the multiple and complex social factors involved. Socio-economic transitions and processes like migration, urbanization, industrialization, and trade may be more important in influencing environmental degradation than population size and growth. All economic and social problems do not belong to environmental degradation. Focus should be on environmental changes occurring in different social settings among different social actors. It has been suggested that the South has carried the burden of being held responsible for earth's environmental degradation due to population growth and poverty, while the consumption patterns of the North and other causes of environmental damage were ignored. The capacity of the society to provide sustainable livelihoods for all is a measure of development.

Agbo, Sokpon, Hough & West (1993) explore a middle range theory... of differences in population –environment relations under conditions of 'constrained ecosystems'. Using rather extreme case from a village in northern Benin (Tannougou), this theory is elaborated and illustrated. The basic theoretical proposition they posit is that the greater number of types of ecosystem constraints involved and the greater degree of constraint these components, the more tightly linked population- environment relations will be; i.e., the more intensely population pressures will negatively effect the

environment and the more intensely the environmental degradation will redound upon the human population.

Dirzo & Garcial (1992) are of the view that the environment is also made by the various socio- cultural activities of man. How the environment relates to population is more than a technical issue; it is also an allocative, social, & a political issue. One of the major means of inter- relationship between man & environment is through the land and its use. Deforestation rates and landuse changes are related to environmental factors, in addition to the local population & economic attributes.

Gupta & Gupta (1997) reviewed the environmental consequences of current population trends in India, including the decline in available natural resources because of increasing demand, and attempt to establish the among various existing ecosystems. They have discussed forest and wasteland development, forest policies, poverty and environmental degradation, urbanization, energy demand and management, water supply, food supply, environmental pollution, and environmental legislation.

Gregory (1979) views that as the human population grows, it will need more food and more space. This will ultimately lead to the destruction of the natural ecosystems and their replacement by the human modified ecosystems. As the population increases and the resources become scarcer, this pressure will become greater throughout the world. Through processes such as cultivation, irrigation and urbanization, man has modified or created new physical systems, either accidentally or deliberately. Nearly a third of the world's land area has been modified and cleared of its vegetation. Cultivation has changed the soil as well as the original forest or grass cover. In a more extreme case of man's influence, urbanization has led not only to the removal of vegetation & soil cover, but new surfaces of bricks, mortar, cement and tarmacadam have been created & the consequence has been a new physical landscape with its own physical geography.

Orians and Skumanich (1995) opine that knowledge of demographic trends is a key factor in achieving the new environmental goals, which adopt a multiple (air, water, and land) perspective focused on pollution prevention rather than simply on control. This report seeks to provide the necessary demographic information in a format that will allow exploration of the two-way linkage between population and the environment. It specifically attempts to create an awareness of:

1. The importance of demographic changes in shaping the future challenges to be faced by the US,
2. The existing theoretical perspectives and models that can be applied to an analysis of the relationship between population and environment.
3. The knowledge base that supports this theory.
4. The role that environmental policy –makers can play in developing a more responsive set of policies.

The report also seeks to inspire population analysts to engage in a more comprehensive examination of the relationship between population and environment. Besides it also puts forth the current theoretical perspectives (neoclassical economics, natural science, political economy/dependency theory, and combination theory) and models (*the POET-'Population, organization, environment, technology' model and the IPAT – 'environmental impact equals population size times level of affluence times type of technology' model*). It systematically reviews the basic set of demographic variables (population size, population distribution, age structure, racial –ethnic identity, socioeconomic status, immigration, and household composition) to determine their potential environmental linkages. This relationship is verified by examining four environmental problem areas (drinking water, solid waste, coastal and esturaine protection, and radon exposure) and their linkages to demographic trends and conditions. It indicates how an analysis of population-environment linkages can support effective policy development and makes specific recommendations towards creating a body of research on population-environment linkages and a supportive infrastructure.

Jolly (1994) analyzed four theories of the relationship between population change ands environment, particularly land use in developing countries. He highlights the social, cultural, institutional, and political context in which population and environment relationships occur. Population growth has a different role to play in each of these theories.

1. For the Neoclassical economist, high population growth is a natural factor; it has no intrinsic effect on environment. How population growth effects environment depends on –whether free market policies are operative or not in an efficient market, population growth can serve to induce innovation and the

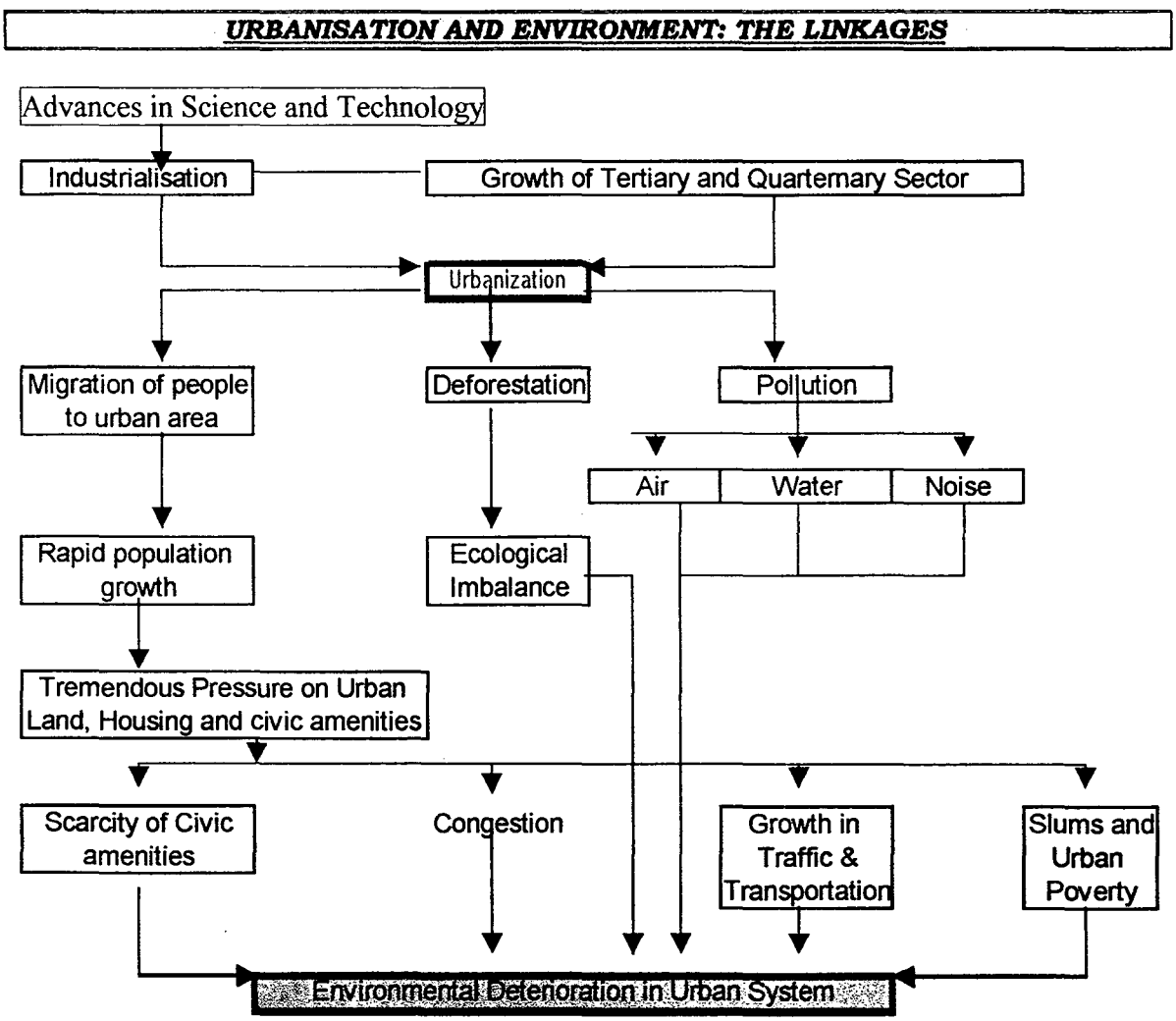
development of advanced technologies. In an economy full of distortion, high population growth can exacerbate the effects of these distortions.

2. For the Classical Economists, high population growth is an independent factor causing environmental degradation. Increasing population puts pressure fixed resources available to maintain or increase the population's standard of living.
3. For the Dependency theorists, high population growth is a symptom of a deeper problem-Poverty. Environmental degradation and high population growth are linked, not because one causes the other their root cause is same, i.e., unequal distribution of resources.
4. For the Analysts, who see population as a proximate determinant, high population growth is an exacerbating factor. It strengthens the effects of the final cause on environmental degradation. The degree to which these causes such distortions, any policies and polluting technologies damage the environment is intensified by the number of people.

Pathak (1983) holds that there is a symbiotic relationship between man and environment i.e., "ecological balance" & whenever such environmental factors cannot support human needs & aspirations because of exterior deterioration and over-exploitation of such environment it is called "ecological imbalance." Environmental issues emerging with the growth of urban settlements vary widely from one size & functional class of urban places to the other, which is primarily concerned with the living conditions of the people. Large cities are internally differentiated in terms of population density pattern, functional land- use, transport network and other infrastructure. Thus, there may be good living conditions in some parts, while other parts sport slums or workingmen's colonies indicating low living standards. And hence, the problem of environmental pollution is more complex in large metropolitan cities.

Kalipeni (1992) tries to use Malawi, from the sub –Saharan Africa, as a specific case study to develop a conceptual framework to examine the linkages and interrelationships between population growth and environmental degradation. The paper discusses Malawi as an interesting case study for empirical verification of the theory of *Multiphasic- Demographic Response* to acute environmental stress and/or land degradation. Certain parts of the country that are experiencing extreme environmental

stress are going through a rapid phase of demographic and social change and transformation. The central question attempted to elucidate is how people have responded in demographic and non-demographic avenues to rapid population growth and attendant environmental pressure. The basic argument is that environmental degradation currently underway in Malawi, etc., can be linked directly linked to population growth and pressure on land as a result of deforestation, overgrazing, overuse of land for subsistence, and government development strategies that favour large –scale agricultural development. It concludes that population growth is just one of the many factors affecting agricultural change, others include differences in environment, market access, social institutions, land tenure, technology, and politics etc.



Source: V. Ganeshwar, "Dimensions of environmental pollution", ITPI, Journal, Vol. 1 (139), September 1989.

"In his anxiety to improve the living conditions of his race he has unwittingly spoiled the quality of the environment and has the existence of other life of earth ...However, the exploitation of energy sources to accentuate the manufacture of goods for man's comfort has left ugly scars on the land -pools of sludge and air that is dangerous to breathe."[24]

McLaren, Digby J. (1996) holds the view that because of continuing acceleration in number of births, in resource use and in many aspects of environmental rundown, including growing destruction of the eco-system, and encouraged by an exploitive economic system and misuse of technology, the planet's carrying capacity has long exceeded and any immediate prospect of sustainability has faded. Nearly half the population of the world is below breeding age and although growth rates are falling in some regions, they are constant in others. Family Planning has only been effective in limited areas of the world. Any prospect of demographic transition to lower fertility is uncertain and (has) yet to be realized. The momentum of population growth will continue at present rates for at least another 20 years.

The quality of life and its indicators in the urban area have been widely discussed by ***Bose (1992) & Swamy (1992). Mathur (1994)*** explores the link between urbanization and resources in the Indian context and also attempted to understand the use of resources in the Indian cities as well, concentrating on two resources, ground water, & fuelwood. He also described the under –use and inefficient use of land in urban India. He then takes a brief look at the future scenario for India in the light of rapidly growing urban population, its large requirements of energy and other resources as well as the waste it generates. Surprisingly, however the author found no conclusive evidence of the relationship between population growth and resource depletion.

b) Population, Environment and Economic development

Gupta (2001) opines that the rapid growth of urban population has obvious implications in terms of infrastructures & services needs of the cities. The likely increase in the urban productivity & population due to the new economic policies of the

[24] Pradeep, S. Pal, "Environmental Crisis," The Hindustan Times, 3rd April 1985.

government will place heavy demand on all kinds of infrastructure & services in urban areas. The infrastructure bottlenecks in urban areas are likely to pose serious impediments in enhancing productivity. The failure to expand water supplies, sanitation system, housing supply, and transportation to match the growth of population has emerged as the prime cause of misery in urban areas.

- ***Khalatbari (1996)*** describes the continuing rapid growth of world population, particularly in developing countries. "The backward social and economic environment is not able to keep pace with the growing population. The result is an increasing population pressure which finds its expression in unemployment, hunger, the depletion of... nature, deforestation as well as migration, uncontrolled expansion of the cities and slum – building. These problems (already have) global dimensions and their aggravation is expected in the next 30 years. Our civilization is exposed to these global risks. And we have no practicable conception for solving them."

- ***Ghosh (1984)*** had documented and analyzed the then prevailing trends in the development of effective policies related to population, resources and environment of the Third World Countries and also evaluates the progress made by them in the decade before, in attaining long term objectives of a sustained economic growth and improvement in the quality of the living future populations.

Chaing (1990) made an attempt in his paper to know the environmental impact and cost of increasing income through economic development in Malaysia. Benneh (1992) has considered environmental problems of the urban centres at different geographical scale: (1) within the house & its immediate surrounding; (2) within the wider neighbourhood; (3) the city government; (4) the region surrounding the city; (5) at the global level.

Pachauri & Qureshi (1997) have put forth a collection of papers presented at the *Conference on Population, Environment, and Development*, held in March 1996 in Washington, D. C. thee book includes "discussion and debate on environmental subjects such as water scarcity, deforestation, biodiversity, and global warming, and social issues examining consumption patterns, energy policy, and migration... The papers presented focus on the many structural features of economic activities and population changes, which determine the extent and nature of environmental damage and pollution.

Simon (1986) studied the effect of additional people (population growth) in long run on the standard of living by applying the mathematical theory of economic growth. The key element of the analysis was that technical change responds in various ways to population size, density, and growth.

Singh (1988) put forth both the positive and negative consequences of industrial development near the urban areas. He also examined the deteriorating quality of urban environment as well as Human Health due to air, water, and noise pollution on one hand and heavy immigration to the cities (rural to urban migration) on the other hand.

Nyati (1994) holds that while the global transition from an agrarian society to an industrial one sparked economic growth, major increases in the extraction and use of natural resources, population growth, and improvements in living standards also accompanied it. Technology can help reduce both current and future population pressure upon the earth's natural resource base. Problems are considered with regard to population growth, resource depletion, and environmental pollution resulting from discharges. Solutions to such problems may be found through population control measures, resource conservation, and ensuring the environmental compatibility of discharges. Solutions of each of these domains will be technology oriented. In developing countries, technological solutions may be aimed at establishing pollution control measures and/or switching to environmentally–friendly technologies. The importance of technology transfers is discussed, with the argument that technology partnerships should involve not just transfer of hardware, but be a cooperative process in which information and know–how are exchanged.

Myers (1993) attempts a comprehensive review of the relationships among population, environment, and development in a paper intended as background to the *International Conference on Population and Development held in Cairo, Egypt,* in September 1994. "The paper reviews the principal factors and analyses relating to the three problems, with emphasis upon their interactive relationships. It concludes with an extended list of strategies to reduce both population growth and environmental degradation –twin challenges to be tackled within a framework of sustainable development, to which both will make significant contributions."

Danfulani (1991) identified a strong inseparable association between development and environment, so much so that a non-concomitant concentration of effects on one negates the importance of others and results in distortion & disequilibrium. As a result, environmental problem per se are those, which could be overcome by the development process. However, development without goal-oriented objectives will create in the long –run environmental problem resource deterioration- physical & human; chemical & biological pollution.

– Panayotou (1996) focuses on the impact of population growth on local ecosystems. Global impacts are not discussed, not because they are any less significant but because they are beyond the scope of the present study. It begins with an analytical abstraction of how households, communities, and societies respond to population growth under alternative conditions, focussing on natural resource depletion and scsarcity. Issues of environmental pollution and degradation are taken up later where economy –wide responses and empirical evidence are introduced." The geographical focus is on developing countries.

Muzammil & Srivastava (1991) in their monograph set out to analyze the inter relationship among population, resource, environment and development in the Indian context. They are of the view that the major problems in India encountered in the field of environment arise due to poverty and underdevelopment and also the negative effects of development programmes, which have been badly planned or implemented. Since the whole of the planning process is aimed at immediate economic development and instantaneous removal of poverty, those concerned with developmental activities miss out on the ecological and environmental imperatives.

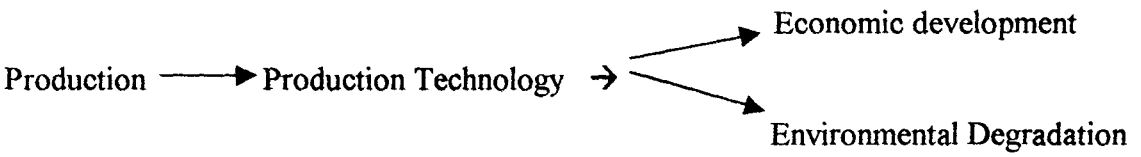
Pachauri (1994) compiled the views presented at the *Conference on Global Partnership for Sustainable Development* organized by Tata Energy Research Institute [TERI], New Delhi, India, which was held in the District of Columbia (US). At the conference, Senator Tom Wirth pointed out that it was necessary to study both population growth in developing countries and consumerism in North. To solve these problems, different disciplines and perceptions need to intersect; thus, the necessary research program requires partnerships between organizations and institutions. Organizations from both the developed & the developing worlds must work together:

1. To define the relationship between population and the state of natural resources;
2. To understand the patterns and causes of resource degradation;
3. To find the means of reversing the present trends; and
4. To find the approaches necessary to ensure sustainability of the natural resource base.

Commoner (1992) argues that there are important relations linking population, economic development and the environment. Though there is a difference in the opinion regarding the nature of those linkages and what guidance they can provide for policy options? A common view of these relations is that the needs of population are met by economic development, which in turn causes environmental degradation.

Population → Economic Development → Environmental Degradation

However, this approach omits the basic human action that is a necessary precursor to economic development the creation of the means of producing the goods that generate wealth. It is this intermediary function the technology of production, which leads in parallel to both economic development and environmental degradation.



Bhattacharya (1993) analyses and criticizes the widely held theories concerning the relationship between population growth and economic development. "The central purpose of the paper is to critically analyze the zero population growth movement. The hypotheses of Neo-Malthusian theory or Zero Population Growth and the concept of the Population Bomb are briefly stated. It also discusses the demographic transition theory & critically examines the validity of Neo-Malthusian theory of population growth. The main contention of the author is that over-consumption in developing countries is a major cause of deterioration of the environment rather than over-population in the developing countries.

Selden and Song (1994) & Holtz-Eakn and Selden (1992) in their studies tried to correlate Gross National Product (GNP) with pollution level. In their opinion, environmental degradation and income have an inverted U- shaped relationship, with pollution increasing with income at low levels of income and decreasing with income at high level of income. *World Bank (1992)* further supported this view except for pollutants like Carbon-di-oxide.

Grossman & Krueger (1995) studied the relationship between GNPs & Pollution Levels. In their view, environmental degradation and income have an inverted U – shaped relationship, with pollution increasing with income at low levels of income and decreasing with income at high level of income.

Helmut Haberl, Fridolin Krausmann (2001) in their paper have related the changes in aggregate population, affluence (measured as GDP), and indicators for environmental pressures, the latter being based upon the socioeconomic metabolism concept, for Austria from 1830 to 1995. During this period of time Austria underwent a transition from a predominantly agricultural mode of subsistence to an industrial economy. The Austrian population increased by a factor of 2.3, total GDP by a factor of 28.2 and per capita GDP by a factor of 12.2. Environmental indicators change by factors of between 0.85 and over 1000. In general we find that although efficiencies (environmental pressure per unit of GDP) increased dramatically, total environmental pressures increased considerably for most indicators, except for those that are related to an agricultural mode of subsistence. Our results indicate that environmental policies that aim to reduce the environmental pressure per unit of GDP (i.e., increase "ecological efficiency") are not likely to be sufficient for sustainable development because efficiency gains are more than compensated for by increases in affluence. Instead, sustainability policy should focus on reducing total environmental pressures.

Smith and Lee (1993) put forward the idea of "risk transition." According to them, the cities of currently economically developed countries have become "dirty" first. However, after a certain level of prosperity has been achieved environmental improvement started. According to them, a country passes through different stages of development and as their per capita income increases, traditional risks like malnutrition, cooking –fire air pollution, food spoilage etc. decreases but modern risks like automobile,

industrial air pollution, pesticide poisoning, ground –water pollution radioactivity etc. increases.

Similarly ***United Nations in 1993*** put forth that richer, more industrialized countries will not only find the integration of population, environment, and development policies desirable but also easy and even essential for maintaining the quality of life for their people. On the other hand, the poorest countries will find that such integration is neither a high priority, nor is easy, nor even perhaps possible in view of their primary concern for food, employment, and income.

Bongaarts (1992) accepts that global warming due to emission of various green house gases (GHGs) will have enormous economic and ecological consequences. That is why emissions of various gases should be reduced or stabilized, particularly in the developed countries. But not only the developed countries but also the developing countries should make efforts to curb the emissions of GHGs, for in near future they would become major emitters of these gases.

c) Slums, Environmental Pollution and Environmental Management and Planning

Hamilton & Turton (1999) are of the view that the impact of population growth on the state of environment has become a subject of vigorous public debate and has led to a number of official reports. The paper is the first systematic analysis of the implications of population growth in Australia on one of the most important environmental problems, the emissions of greenhouse gases that are associated with climate change. This is especially important since Australia has signed up to international emission reduction obligations under the 1997 Kyoto Protocol.

UN. Secretariat (New York), 1988 in the Population Bulletin states that the interrelationships among demographic and environmental factors in developing countries are examined, with an emphasis on the need for comprehensive programs at both national and international levels. It is noted that "efforts to promote development in a way which preserves the resource base for the future generations will have to take into account demographic factors, since excessive population pressure in specific geographical areas can pose serious ecological hazards, including soil erosion, desertification, dwindling supplies of firewood, deforestation and the degradation of sources of fresh water...

Population policies should also be formulated with due regard for environmental factors. Priorities should be given to population activities in those geographical areas likely to experience acute environmental stress. Programmes for influencing the distribution of population should also consider the environmental impact.

– ***Bhargava (1992)*** holds the view that the environmental pollution is an inevitable phenomenon in a global perspective. In developed countries, environmental pollutants have threatened the human survival. However, in context of the third world and India, population explosion in metropolitans and large cities has given rise to the slum and squatter settlements causing uncongenial environment. Further he says that the threats in the developing countries have assumed the excessive and haphazard trend of urbanization leading to unmanageable control of environmental pollution.

S. B. Mukherjee (1988) in his monograph tried to study population situation and trends in south & south- east Asia and examine how the demographic variables are related to some relevant economic variables. He tries to find answers the questions regarding the nutrition, education, & employment of the burgeoning population, the strategy that would be successful in stabilizing the population growth or possible reasons for its failure. Aspects of population structure, urbanization, and city growth have been specially treated. These parts of the world have been passing through a stage of rapid population growth and urbanization has spread without commensurate industrialization resulting in semi- rural urbanization, unbalanced urbanization, and parasitic urbanization.

Burgess (1939) from his intensive study of USA's cities maintained that the slum develops within the zone surrounding the Central Business District with the expansion of commercial & industrial ventures the neighborhood becomes infiltrated with industrial storage and wholesale operations. Due to less income of workers, they are bound to live in surroundings because of cheap rental value in congested localities.

Charles Abraham (1946) stated that the residents of slums couldn't afford good housing because the private enterprises will not provide it at price, which they can afford. He analyzed very critically their income structure and other related problems. The worst slum condition occurs when the physical slum is accompanied by over-crowding. This now seems to be the general tendency in most of the cities. After 2nd world war due to shortage of dwellings and increasing over-crowding caused the spread of slums.

Nambier (1970) described that the poor living condition of slum dwellers was because of less income. ***Trivedi*** in the same year observed that slums are not confined due to the industrial growth only, they exist in the midst of the non-industrial area also. But the problem of industrial slums is acute owing to the concentration of all unhappy features of the unhygienic & insanitary life, which exerts its own tale.

Malkani (1957) raised various problems of people living in slum localities and also suggested measures to improve their living conditions with the help of Corporation authorities. Later on ***Mazumdar (1960)*** stated in his article 'Social Contours of an Industrial city- Social Survey of Kanpur', that due to industrial growth of the 1st world war, problem of housing had risen up in the city, which resulted in the growth of slums near to new industrial establishment. ***Singh (1972)*** in his work on Kanpur, examined various factors of slum growth & he also analyzed various categories of slums and associated problems. Muslim majority areas have enormously swelled up in consequences overcrowding, congesting & insanitary conditions prevailed in many parts of Kanpur City. ***Badami (1976)*** in his monograph evaluated very critically the problems of slum dwellers & also suggested appropriate measures for improvement of living condition in slums & blighted areas of Kanpur City.

Dubey (1976) in the study of 'KAVAL' towns pointed that a greater part of the low class residence represents the horrible slums of poor and insanitary state of affairs. They are a menace to the health of the urban life and hence require immediate demolition and their inhabitants need to be provided with better accommodation. Pathak (1983) critically evaluated the physical environment of Kolkata's slums and provided suitable measures to improve them.

Berry (1974) analyzed the importance of urban environmental management, which was the key factor in abating environmental pollution. *Weich and Johnson (1976)* studied the social urban environment where they have tried to correlate crowding with urban crime rate.

"One person's trash basket is another's living space."
NATIONAL ACADEMY OF SCIENCES, on pollution, "Waste Management and Control," 1965

Faludi (1987) comprehensively evaluated the role of environmental management & planning in controlling pollution in urban areas. ***Acharya (1988)*** has dealt with slums and their living conditions. He has done a case study of slums of Mumbai. ***Spain (1988)*** has dealt with the issue of social urban environment. For his study he took a physical indicator viz. neighbourhood satisfaction. He concluded in his analysis that most of the American neighbours have very less interaction.

Biswas (1995) evaluates urban environmental management, which is the key-factor in abating urban pollution. Savage in the same year picked up the same discussion. He studied the urban environmental problems of Singapore and suggested remedial measures to control it. ***Prasad (1995)*** explored that the metropolitan centres and large towns dominate the economic activity and people in large number migrate from village with the hope of sharing the 'cake'. Population explosion in al parts of the country resulted in both 'push' & 'pull' factors of rural to urban migration on an unprecedented scale. The millions who migrate from the rural poverty ended up to urban poverty. Moving from poverty to poverty, a vast majority of migrants hope neither for a better economic change not for a social change in their life. They end up living in slums & slum –like condition without access to have education, sanitation, and development.

Edesio Fernandes, 1998 his book addresses these concerns by providing a sort of 'Laboratory' to examine different experiences and approaches to urban EPM in the context of the South. The book also contains a selection of papers, which were presented at the International Conferences titled ***"Environmental Strategies for Sustainable Development in Urban Areas: Lessons from Africa and Latin America"***; and that was jointly promoted in September 1996 by the *Institute of Commonwealth Studies* (***ICS***) and the *Institute of Latin American Studies* (***ILAS***) of the University of London. It takes a new angle, rather than simply compiling 'good practices': it provides a basis to compare, reflect and learn from several experiences in Africa and Latin America fostering a forum for North-South dialogue. Before the recent growth in concern for the contribution of cities to sustainable development, urban environmental planning and management (**EPM**) was largely focused on addressing the traditional problems, like clean water supply, sewerage, solid waste management and reduction in air pollution. The emphasis was much on the sectoral interventions and investments in the engineering works designed to

reduce pollution and its incidence. Water-treatment and distribution systems, and systems to collect and dispose of solid waste were usually seen as the only answer to the environmental problems. This focus on '*Hardware*' solutions was not inherently wrong, as reflected from a major aspect of the way in which these problems have been successfully minimized in the cities of the North of the regions under study in the book. However, there has been a relatively high incidence of failure of such investments in the cities of the South of the same regions. This can be ascribed in almost all cases to the lack of attention given to the '*Software*' aspects of environmental management. The several experiences reviewed, reveal the inventiveness, creativity, and originality of emerging approaches to urban EPM: these are cross -sectoral and hardware and software components.

Hamza (1992) discussed the growth and quality of urban settlement and also recommended actions for urban environmental management. According to him, as the urban settlement of the developing ward grows in size, problem arise at two environmental levels: (1) internal living environment and its immediate surroundings; (2) outer environment that cities provide for their inhabitants.

Phantumvanit and Liengcharensit (1989) described Bangkok's environmental problems and the government's initiative to address them. Aspects like water pollution, land subsidence and flooding, domestic and industrial solid waste, air pollution and noise pollution have been dealt with their study.

Shekhar (1996) in her paper assessed the comparative effectiveness of public services delivered to the urban poor residing in the slums in the five large and medium – sized cities in India. These cities were- Ahemdabad, Bangalore, Pune, Calcutta, and Madras. The urban poor in all cities under the study have identified sanitation as the most unsatisfactory public service.

Habitat II (1996) explored a variety of issues faced by urban economy ranging from poverty, housing and urbanization to environmental pollution, and environmental management and planning. The Indian report presents the problems of India, according to which there had been significant improvement in the coverage of population to the basic human settlement related to amenities and the quality of habitats with longer durability and increased use of market sourced materials in both urban and rural areas. At the same

time, housing cost are rising, floor area per capita is falling and growing number of people and pushed out to the formal housing market. The impact situation is reflected in proliferation of slums.

- ***Basavanappa (1976)*** explored the problem of slums and suggested way to overcome these problems. ***Sivaramakrishnan (1978)*** examined the metro cities of India problem like water supply, sewage disposal and sanitation, scarcity of housing and their living conditions have been dealt with extensively. ***Nagpaul (1987)*** also illustrates the problems of India's giant cities and provide avenues to solve them. Poverty, slums and pavement dwellers, public health and sanitation, lack of infrastructure, air, water & noise pollution are among the main problems. The provision like strategy for environmental improvement; Public and subsidized housing, reducing over urbanization through rural reconstruction, population control through family planning are some of the measures to cope up with the problem.

- ***Kumra (1985)*** is of the view that the continued growth and expansion of existing industries, development of the latest technologies and products and increasing use of vehicles coupled with population growth especially in the large urban areas are emitting pollutants in large quantities in the atmosphere, causing environmental pollution. He also says that the urban centres are expanding by migration and natural increase of population. Growth of Indian cities & towns both in terms of population and areal coverage is phenomenal. Industrial growth is adjunct to these features in making the problem more complex. He has studied noise pollution, solid waste disposal, and environmental management in the major cities of the country.

Agarwal, Agarwal & Puri (2001) are of the view that technology has been a dominant factor in shaping the cities. It has given the modern city its organization, structure and much of its economic and population base. Technologies have also primarily affected the cities of advanced nations. The metropolitans of the developing nations are divided into two parts. One, relatively small portion which looks like big cities of the developed nations like New York, London, Paris or Tokyo. Remaining portion contains a larger portion of people living in poor to slum conditions, comprising of as much as 80 to 90% of the urban population. The way in which the urban areas evolve will differ among cities, nations and regions. All the cities will have to deal with

one problem i.e., automobiles. While the older cities are automobile uncongenial, newer cities are auto –congenial but have sacrificed pedestrian and neighbourhood amenities. It is reiterated that technological changes are bound to happen whether one plans for it or not; the impact will be felt by all.

d) Various Issues of Environment.

Srivastava and Kumar (2002), extensive energy utilization has made urban Air Pollution a growing problem. Deteriorating air quality in the cities is a result of rapid economic expansion, rise in population, increased industrial output and unprecedented growth in use of passenger vehicles. Emissions from automobiles, factories, domestic sources and refuse burning threaten the well being of the city dwellers, imposing not only long term productivity of population. With development and industrial growth and its bountiful resources have become scarce. The paper attempts to estimate the Air Pollution loads and their impacts on health in the Mumbai city caused maily by automobiles and domestic sources in the year 1997.

Ahmed (1996) described the scarcity of municipal services in Indian cities. Sanitation and drainage facilities are the most important municipal services in which inadequacy is found. In the absence of any basic amenities the growing concentration of people in Indian cities like Bombay, Delhi, and Hyderabad etc. great pressure exist on the municipal services.

Jacobi (1992) evaluates both the physical & environmental issues and also health and sanitiary conditions of metropolitan cities. He studied the problems of Sao Paulo, Brazil. The delay in solving problems of drainage in Greater Sao Paulo is contributing to the continuing high level of infant mortality. About 90% of Sao Paulo is served with treated water & 70% are connected to the sewerage system. ***Schelkle et. Al. (1992)*** in their study tried to access how German Development Corporation may contribute to alleviating the housing problem of the urban poor in Indian metropolises. The study focussed on the analysis of integrated housing project in Delhi & Mumbai.

Chakrabarti (2001) says that at 300 million, the urban population of India is still less than one third of its total population. It is projected that by 2045 nearly 800 million Indians will be living in its cities - more than the total population of the whole of present-

day Europe. Already, the infrastructures of all the six mega- and 40 million-plus cities of India are under very severe stress. The ground water is depleting rapidly, pollution is reaching crisis levels, the transportation system is in disarray, and sewerage and sanitation are in shambles, all of which is affecting public health and hygiene. This explosive state of affairs has not been adequately appreciated at the national and international level.

e) Case studies on the state of environment of various Indian metropolitan cities

Kolkata: Kolkata exhibits an extreme congestion of population with uneven distribution. The over-crowdedness leads to a chain of undesirable side effects, of which pollution is one. In 1982, the National Environmental Engineering Research Institute (NEERI), of Nagpur observed the air pollution load of suspended particulate matter (SPM) to be high in the city at 43.5%, Carbon Monoxide (CO) at 33.4%, Sulphur dioxide at 9.1%, Hydrocarbons (HC) as 8.7% and Nitrogen Oxides (NO_x) at 5.3%. The uneven growth of the city together with overcrowding is primarily responsible for the poor environmental conditions.[25] Abundant water is readily available in Kolkata's natural environment but few people can consume water with any confidence in its purity. Supply sources have been contaminated; the formal system fails to reach millions of the city's population. Despite the favourable hydrological setting, millions of the low –income Calcuttans receive no water from the municipal network and have to provide for their own needs.

Kanpur: Once hailed as the Manchester of the East, Kanpur chased a dream of being a major industrial hub. A number of industrial establishments are located within the urban agglomeration. It is an important trade and commerce centre and also has tourist attractions around the city. The existing air quality in the core areas is 5 to 6 times higher than the standards. Bereft of greenery and left with sick industrial units, the city has merely raised its place among the most polluted cities of India. About 60% of the city has problem of Air Pollution. The city encounters severe dust and smoke problems and the

[25] Ghosh, A. R. "Air Pollution and Health in Calautta: A Geographical Analysis." In: Geographical Review of India, Vol. 62, No. 4.

prescribed limit of 500 ug/m^3 in terms of SPM is often exceeded in many locations.[26] Large –scale use of diesel and kerosene operated gensets are also a major source of pollution. The city has inadequate transport network and traffic and transportation system leading to considerable air pollution problems. Due to impact of vehicular pollution, air quality at major road crossings exceeds the norms of SPM and lead. About 0.2 million petrol /diesel driven vehicles are plying on the roads contributing to 142 MT of pollutants per day. Badly maintained roads, mixed traffic pattern, road encroachments, apart from meter gauge railway track traversing the city length aggravate the impact of the vehicular pollution. The diesel driven tempos, which constitutes the major public transport system in Kanpur, causes nuisance to the commuters as well as population living along the roadside.[27] Of the over three lakhs automobiles in the city, 70% are two wheelers. Vehicles passing through the city add to the problem. Noise levels are alarmingly high in the commercial areas, far exceeding the prescribed limits. Residential and silence zones are also marginally exceeding the safety norms.[28]

Lucknow: Lucknow the Capital and the second largest city of Uttar Pradesh suffers from consequences of rapid urbanization, industrialization and strain in natural and man made resources. A number of polluting industries are operating in the city, which is not treating their wastewaters up to the desired levels, and similar case applies with air polluting units also.

Vadodra: Problem of air pollution due to industries located in residential areas of the city is the major environmental problem, which the residents of some part of the city also felt significantly in the recent past.[29]

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[26] Central Pollution Control Board, "Parivesh Newsletter: Environmental management plan Kanpur Urban Area." Central Pollution Control Board, Ministry of Environment and Forests, May, 2001.
[27] Central Pollution Control Board, "Parivesh Newsletter: Environmental management plan Kanpur Urban Area." Central Pollution Control Board, Ministry of Environment and Forests, May, 2001.
[28] Central Pollution Control Board, "Environmental Management Plan Kanpur Urban Area." Central Pollution Control Board, Ministry of Environment and Forests, May 2001.
[29] Central Pollution Control Board, "Annual Report: 2000-2001." Central Pollution Control Board, Ministry of Environment and Forests.

Agra: Even the Apex Court's initiative to protect the area around the Taj Mahal from pollution has not managed to keep Agra off the list of polluted cities. Arid climate, close proximity to the sandy belt of Rajasthan and the dry riverbed of the Yamuna keep SPM levels high. Frequent power cuts have led to widespread use of locally manufactured diesel generator sets, which are highly polluting. Use of coke and coal as domestic fuel is also a major source of pollution.

Ahmedabad: Even after hundreds of textile mills closed down, Ahmedabad continues to record very high Air Pollution. It figures among the top four polluted cities in the country. Though nearly 10 lakhs vehicles, mostly two-wheelers, run in the city, pollution consultants do not agree that vehicles are solely responsible for pollution. They equally blame lack of greenery and near absence of rains, which could down the level of SPM for rising the level of pollution in the city. Thousands of auto-rickshaws running on kerosene to save the expenses on petrol are also to be responsible for rising pollution levels.

Pune: Vehicles have catapulted Pune from a 'pensioner's paradise' nestled in the Sahyadris to the most polluted city in Maharashtra. Over 400 vehicles are registered everyday. Vehicular pollution accounts for 70% of the city's Air Pollution. With eight lakhs two-wheelers out of the 10-lakh vehicles in the city, Pune is justly called the two-wheeler capital of the country.

Faridabad: Faridabad's huge number of industrial units along with unprecedented growth in the number of vehicles has contributed to the city's air becoming polluted beyond acceptable beyond acceptable standards. The over 10 lakhs vehicles registered in the city include 15,000 three wheelers fitted with diesel engines and vehicles phased out of Delhi. Old auto rickshaws phased out of Delhi are moving out to Faridabad and the diesel run vehicles are the main source of Air Pollution in the city.

Patna: Even without any industrial growth in Patna the pollution level continues to climb. This is attributed to the myopic planning of the city and vehicular emission. Vehicles on the alley like roads are a major cause for pollution. Patna has over 3.15 lakhs

vehicles, a majority of which are three wheelers. Every year, 18,000 vehicles are added. However, the city's road map has stayed almost unchanged, despite the growing number of vehicles. Mixed traffic of rickshaws, tongas, pedestrians, cars and heavy vehicles cause traffic snarls. There is no control on the registration of old cars. Hence, the vehicles coming into the city are second hand, mostly coming from Delhi or Mumbai.

Surat: The city of Surat in Gujarat, previously world-renowned for its diamond cutting and art silk, recently held the dubious distinction of being the "plague city" of India. Pneumonic plague claimed hundreds of lives in this city in September 1994, owing to abysmal civic conditions. All these diseases are water-borne and claim a large number of lives every year in spite of better health facilities and increased expenditure on health.

From the literature reviewed there is an indication that the differential rates of population growth degrade the environment at different levels. A faster growth of population puts more pressure on the resources and consequently on the environment, than a slower growth of population.

Economic development has also been identified as one of the major causes of environmental degradation. Not every development process deteriorates the environment. Developmental process without an insight into environmental consideration puts pressure on the environment. The authors are of the view that it is not development, which is actually exerting pressure on the environment rather it is the technology of production which on one hand leads to economic development and environmental degradation on the other. It has also been put that environmental improvement depends on the income level of the economy. Environmental degradation and income have inverted U –shaped relationship, with pollution increasing with income at low levels of income and decreasing with income at high levels of income.

Different aspects of urban environment like housing; sanitation, public health, infrastructure, slum and their environment; environmental management and planning have also been dealt with. As population concentration takes place in a region, the residents face problems relating to housing, sanitation, public health etc. Urban

environmental management is the key to control pollution and sustainable development of the cities.

From the various case studies done by Central Pollution Control Board & SPCBs on the state of environment in the Indian cities, it is obvious that the urban environment is not in a very good state, as the population of the metropolitan cities increases, so does the number of vehicles and thus, the pollutant load in the air increases, which is the major source of pollution in the metropolitan cities.

Urbanization leads to concentration of population. The urban areas having a relatively higher level of income also have a higher level of consumption. Thus, both large population and higher level of consumption exert pressure on the environment. Hence the urban environment is deteriorated due to three basic factors namely – population size, affluence and the level of technology. The main aim of this dissertation is to understand and evaluate the relative importance of each of these factors (population size, level of consumption and technology level) in deteriorating urban environmental of metropolitans of India.

Nature, human beings and culture constitute an amazing and abiding triangle... through a persistent manipulation and sculpting of natures, human beings create their social milieu...." Nature is nothing more than a raw material for production." And this raw material man exploits for his own development. Environment does have to do a lot with the people, as; it has been inextricably bound with development. Living in the 'Biosphere' man has been struggling very hard for his economic, social and moral development. The human population, its conditions, and the state of the environment are closely related to each other.

I.4 STUDY AREA

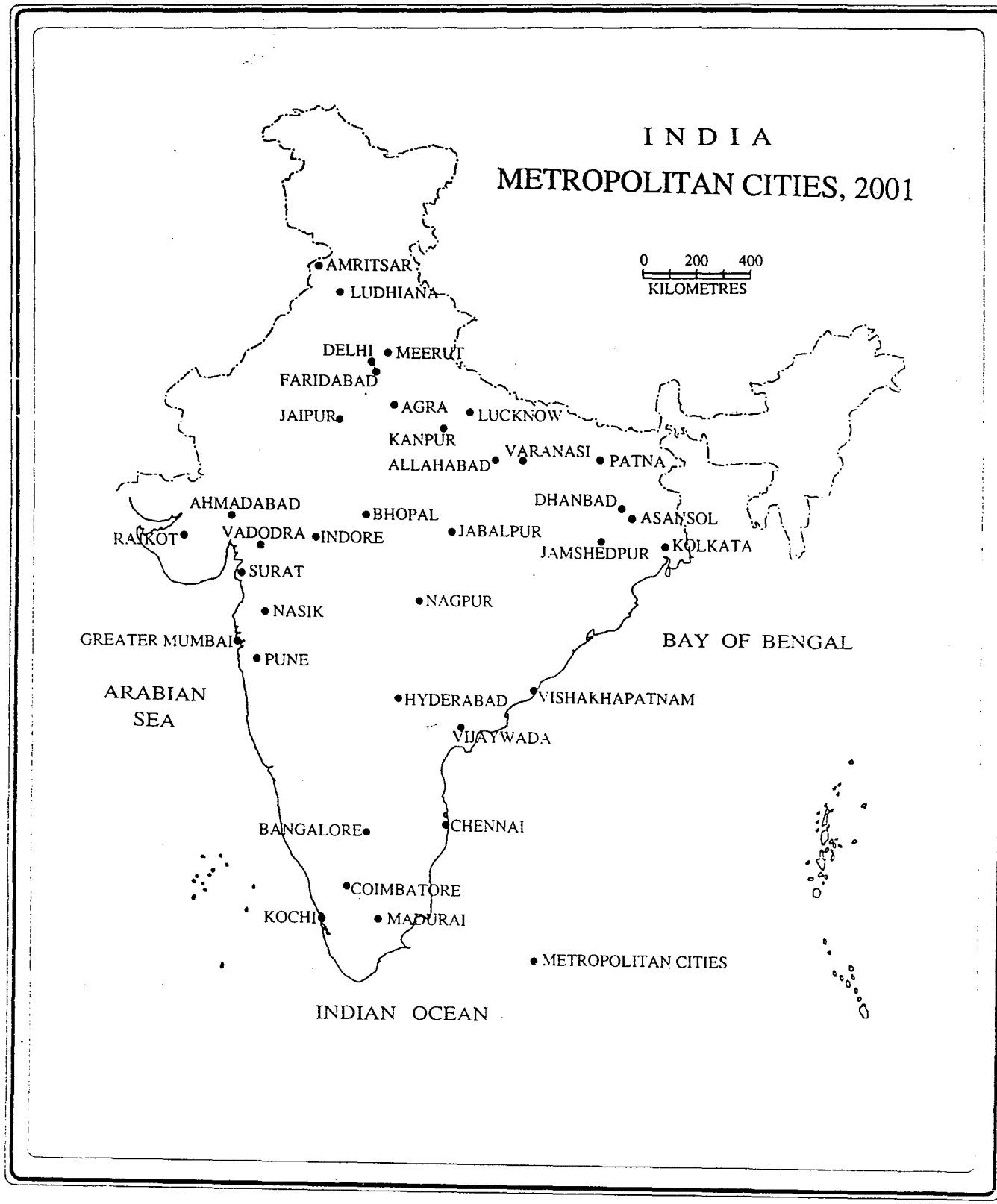
The main objective of the study is to analyze the impact of population growth & urbanization on the urban environment, the 35 metropolitan cities in India according to the Census of India, 2001 with population above 1 million have been considered.

Rank in 2001	Urban Agglomeration/City (1,000,000 + population)	Civic Status	State / UT	Population in 2001	Year of becoming metropolitan city
1	Greater Mumbai	UA	Maharashtra	16,368,084	1911
2	Kolkata	UA	West Bengal	13,216,546	1901
3	Delhi	UA	Delhi	12,791,458	1951
4	Chennai	UA	Tamil Nadu	6,424,624	1951
5	Bangalore	UA	Karnataka	5,686,844	1961
6	Hyderabad	UA	Andhra Pradesh	5,533,640	1951
7	Ahmedabad	UA	Gujarat	4,519,278	1961
8	Pune	UA	Maharashtra	3,755,525	1971
9	Surat	UA	Gujarat	2,811,466	1991
10	Kanpur	UA	Uttar Pradesh	2,690,486	1971
11	Jaipur	M.Corp.	Rajasthan	2,324,319	1981
12	Lucknow	UA	Uttar Pradesh	2,266,933	1981
13	Nagpur	UA	Maharashtra	2,122,965	1981
14	Patna	UA	Bihar	1,707,429	1991
15	Indore	UA	Madhya Pradesh	1,639,044	1991
16	Vadodra	UA	Gujarat	1,492,398	1991
17	Bhopal	UA	Madhya Pradesh	1,454,830	1991
18	Coimbatore	UA	Tamil Nadu	1,446,034	1991
19	Ludhiana	M.Corp.	Punjab	1,395,053	1991
20	Kochi	UA	Kerela	1,355,406	1991
21	Vishakhapatnam	UA	Andhra Pradesh	1,329,472	1991
22	Agra	UA	Uttar Pradesh	1,321,410	2001
23	Varanasi	UA	Uttar Pradesh	1,211,749	1991
24	Madurai	UA	Tamil Nadu	1,194,665	1991
25	Meerut	UA	Uttar Pradesh	1,167,399	2001
26	Nasik	UA	Maharashtra	1,152,048	2001
27	Jabalpur	UA	Madhya Pradesh	1,117,200	2001
28	Jamshedpur	UA	Jharkhand	1,101,804	2001
29	Asansol	UA	West Bengal	1,090,171	2001
30	Dhanbad	UA	Jharkhand	1,064,357	2001
31	Faridabad	M.Corp.	Haryana	1,054,981	2001
32	Allahabad	UA	Uttar Pradesh	1,049,579	2001
33	Amritsar	UA	Punjab	1,011,327	2001
34	Vijayawada	UA	Andhra Pradesh	1,011,152	2001
35	Rajkot	UA	Gujarat	1,002,160	2001

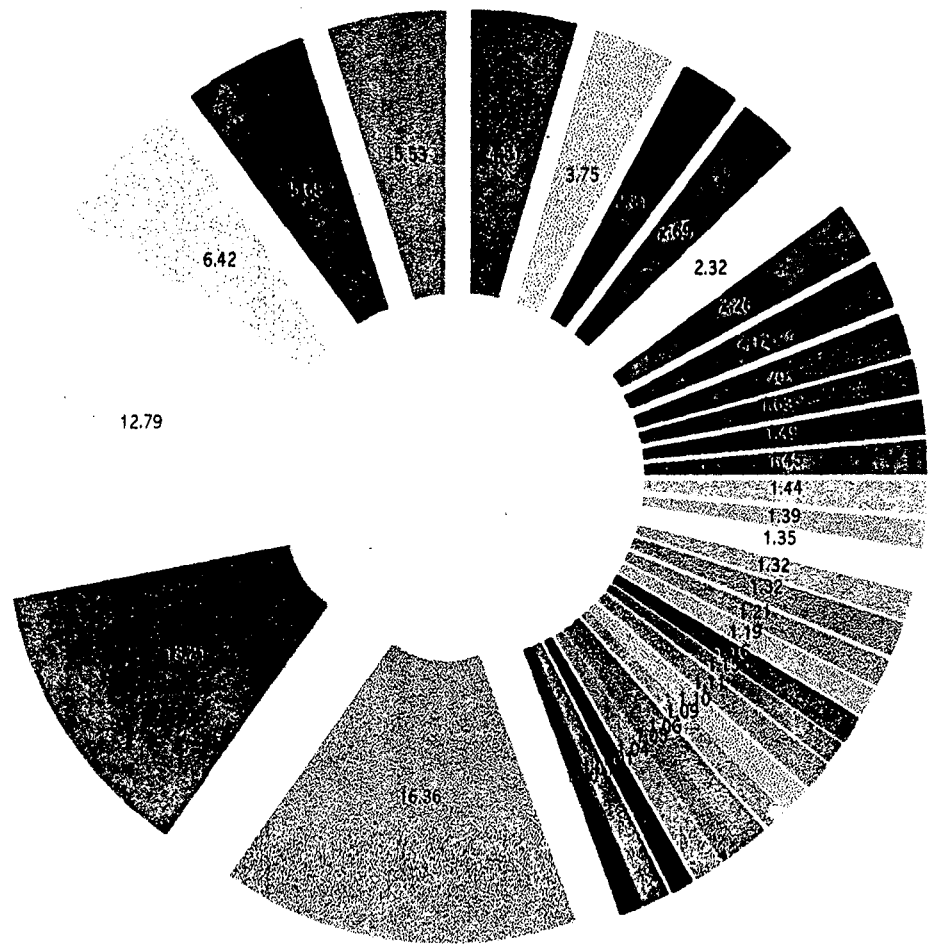
Source: Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

The metropolitan cities have been placed on the map of India in figure 1.1 and their share of population in 2001 is shown in figure 1.2.

FIGURE 1.1


INDIA
METROPOLITAN CITIES, 2001
0 200 400
KILOMETRES
AMRITSAR
LUDHIANA
DELHI
MEERUT
FARIDABAD
JAIPUR
AGRA
LUCKNOW
KANPUR
VARANASI
ALLAHABAD
PATNA
AHMADABAD
BHOPAL
DHANBAD
ASANSOL
RAJKOT
VADODRA
INDORE
JABALPUR
JAMSHEDPUR
KOLKATA
SURAT
NAGPUR
NASIK
GREATER MUMBAI
PUNE
BAY OF BENGAL
ARABIAN SEA
HYDERABAD
VISHAKHAPATNAM
VIJAYWADA
BANGALORE
CHENNAI
COIMBATORE
KOCHI
MADURAI
METROPOLITAN CITIES
INDIAN OCEAN

Share of population of Metropolitan cities in 2001



- Greater Mumbai
- Kolkata
- Delhi
- Chennai
- Bangalore
- Hyderabad
- Ahmadabad
- Pune
- Surat
- Kanpur
- Jaipur
- Lucknow
- Nagpur
- Patna
- Indore
- Vadodara
- Bhopal
- Coimbatore
- Ludhiana
- Kochi
- Visakhapatnam
- Agra
- Varanasi
- Madurai
- Meerut
- Nashik
- Jabalpur
- Jamshedpur
- Asansol
- Dhanbad
- Faridabad
- Allahabad
- Amritsar
- Vijayawada
- Rajkot

Out of the 35 Million Plus UAs /Cities, 6 are located in Uttar Pradesh, 4 each in Gujarat and Maharashtra, 3 each in Andhra Pradesh, Madhya Pradesh and Tamil Nadu, 2 each in Punjab and West Bengal, Jharkhand and 1 each in Delhi, Haryana, Bihar, Kerala, Karnataka and Rajasthan. Because of the varying degree of growth, the population ranks of these metropolitan cities have been changing from one census to another.[30]

I.5 OBJECTIVE OF STUDY

Against this backdrop the main objectives of the following study are:

1. To analyze the process and pattern of population growth and urbanization in the metropolitan cities in India,
2. To study the state of physical environment of the metropolitan cities in India and to analyze the changes in the level of pollution in these cities in India,
3. To show the relative importance of population, consumption level and technology in a deteriorating urban environment, and
4. To suggest possible solutions for the urban crisis.

I.6 DATABASE

For the purpose of this study, the data is collected from the following secondary sources:

1. Census of India;
2. Statistical Abstracts of India and various states;
3. Handbook of Statistics –of various states;
4. Reports of Central Pollution Control Board;
5. Reports of Central Board for the Prevention and Control of Water Pollution; and
6. Report of National Environmental Engineering Research Institute.

I.7 LIMITATIONS OF DATA

The scarcity of environmental data available has affected the quality of work. The number of metropolitan cities has recently increased to 35 in 2001 from 23 in 1991; hence there was not much data available with respect to the newly made metropolitan cities.

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[30] Husain, M.

The quality of the data generated by the various organizations may have certain limitations regarding probability of variation, biases due to involvement of large number of agencies, personnel, and equipment for sampling, analysis and data reporting.

The published air quality statistics of various urban areas in the country are more indicative rather than absolute and perfect due to various limitations. The data on the pollution levels (air, water, and noise pollution) for all the metropolitan cities of India according to the 2001 census was not available. The apex body for collecting data for pollution levels in various cities, Central Pollution Control Board has 290 monitoring stations in the country, which do not cover all the metropolitan cities. Moreover, the board relies on the State Pollution Control Boards (SPCBs) for preparing its reports. These SPCBs though work under the same apex body but the reports they prepare generally do not show any similarity in the parameters taken for collection of data. Also, the annual reports and other publications by Central Pollution Control Board which are released annually, use different set of variables each time, either by changing the variables or by not taking the same variables as were taken earlier. All this makes it difficult to compare the pollution level data on a temporal basis.

Data pertaining to the per capita consumption or per capita GNP is also unavailable. CPCB in 1989 had published data on the consumption of petrol and diesel in the metropolitans of India, but the same not being available for subsequent years poses hindrances. Data related to the type and numbers of units of industries were also unavailable.

Data on the people experiencing poverty are generally hard to find and are subjective at very least. The data on slums is generally not taken by the Census; it was only in 1991 census, that the data on slums was collected. Hence, its comparison over a decennial period is a problem. The Census had published an occasional paper on the civic amenities in the year 1994, based on the 1991 census, but any such work that also gives data on the type of census households (kutcha, pucca, etc.) is not available for the previous years.

I.8 METHODOLOGY

Most of the debate on population growth's impact on the environment, or lack of it, has been conducted in an unscientific manner, in a vacuum of evidence, deprived of the oxygen of hard data. But things become much clearer when they are looked at quantitatively, and in terms of physical mechanisms. Then population tends to take its proper place as one of the key direct factors.

Assessing the conventions among population, resources and environment is a complex and a frustrating exercise, marred by the differences in the approaches, the biases of different methodologies, and the complexities of the linkages.[31]

The methodology of the present study includes tabulation and analysis of data and depiction of information through suitable cartographic techniques. The two ways in which population impacts the well-being of the people of the metropolitan cities of India, namely, through the human issue of poverty and the environmental effects of consumption. To measure the relative impact of population, affluence and technology in environmental degradation, Ehrlich model has been used. Under this view, population size is a "multiplier" of the effects of other factors that influence the environment. It emphasizes population's direct and indirect effects on the environment.

Paul Ehrlich's **Formula: 1.**

Impact = Population x Affluence x Technology.

Where, I = environmental impact, i.e., the numerical value of some pollutants;

P = population size;

A = affluence, usually measured as GNP per capita and

T = technology usually measured as the amount of pollution per unit of GNP.

IPAT implies that, although population, consumption, and technology might each have an independent effect on the environment (I), their combined effect is probably the most important. Though it has been criticized because it oversimplifies the relationships among the variables.[32] Although the approach is highly simplified, it allows us to take a first step

[31] Rodenburg, Eric. *Population Change, Resources and the Environment.* Population Bulletin, Vol.53, No. 1, March 1998. Washington D.C.: Population Reference Bureau, 1998

[32] Anne R. Pebley, "Demography and Environment," *Demography* 35, No. 4, November 1998, pp377-389.

toward disentangling the effects of population growth, income growth, and technical change on pollution.

This is often used to discuss the connections. It has the appearance of mathematical rigour, but it does not help towards greater precision. The term `affluence' demands a value judgment about what is `affluent' and what is not. It implies that subsistence consumption has no impact on the environment, when in fact all levels of consumption, even of hunter-gatherers, have some impact.

The above identity in a modified form can be taken as:

Log pollution =Log population + Log (Goods/ population) + Log (pollution /goods)

This formula has been used to know the relative importance of population size, affluence, and level of technology in deteriorating urban environment of the Metropolitans of India.

I.9 ORGANISATION OF CHAPTERS

The study has been broadly divided into four chapters, which would cover the entire spectrum of population growth and the state of urban environment in the metropolitan cities in India:

1. The first chapter is introductory in nature, deals with the statement of problem relating to environmental degradation in the urban areas, and reviews the available literature, it gives a clear picture of the choice of study area, objectives of the study, sources of data & its limitations, methodology used in the study and the scheme of chapters.
2. The second chapter discusses the process of population growth and urbanization in the metropolitan cities in India.
3. The third chapter deals with the state of the urban environment in the Metropolitan cities in India with special reference to the level of Pollution (Air, Water & Noise), and
4. The fourth chapter examines the availability of basic civic amenities, etc. in the metropolitan cities in India, the slums & living conditions therein.
5. Finally, the last chapter summarizes the previous work and draws conclusions from the study.

REFERENCES

1. Acharya, Sarthi. 1988. "Bombay's Weaker Sections – A Survey of their level of living." The Indian Journal of Social Works, Vol. XLIX(2), April 1988, pp99-125.
2. Agarwal, Shobhit, Agarwal, Sunil & Puri, Anuj. "Impact of new technologies on urban planning in developing and developed nations." Spatio-Economic Development Record, Vol. 8, No. 2, March-April, 2001.
3. Agbo, V., Sokpon, N., Hough, J., & West, P. C. "Population –Environment Dynamics in a Constrained Ecosystem in Northern Benin", In: Population- Environment Dynamics: Ideas and Observations, edited by Gayl D. Ness, William D. Drake, and Steven R. Brechin. Ann Arbor, Michigan, University of Michigan Press, 1993. : 283-300.
4. Ahmad, S. S. 1996. " The crisis of Municipal Services." In: Seminar 445, September 1996, pp 25-29.
5. Anne R. Pebley, "Demography and Environment," *Demography* 35, No. 4, November 1998, pp377-389.
6. Arizpe, L., Stone, M. Prisicilla, & Major, D. C. (Eds.) "Rethinking the Population-Environment Debate." Boulder, Colorado, Westview Press, 1994. : 1-9.
7. Asit K. Biswas & Qu Geping (eds.), "Environmental Impact Assessment for Developing Countries," Published for United Nations, University by Tycooly International, London. 1987.
8. Badami, J. V. 1976. "Slums of Kanpur poor man's struggle for shelter"' Kanpur Development Authority, pp 53-66.
9. Basavanappa, G. 1976. "Problems of Slum Areas and their Eradication." The Civic Affairs, December 1976. pp117 –131.
10. Berry, B. J. L. et. Al. 1974. "Urban Environmental Management in India: Some Policy Issues." Paper for the Technical Group on Urban Perspectives and Policy, Planning Commission, Government of India, December 1995.
11. Bhattacharya, Debesh. "Critique of Zero Population Growth Theory." Indian Journal of Economics, Vol. 73, No. 4, April 1993. 513-544pp. Allahabad, India.
12. Biswas, Kalyan (1995), "Urban Environmental Management in India: Some Policy Issues." Paper for the Technical group on Urban perspectives and Policy, Planning Commission, Government of India, December 1995.
13. Bongaarts, John. 1992. "Population Growth and Global Warming," Population and Development Review, Vol. 18, No. 2, pp299-319.
14. Bose, Ashish. 1992. "Social and Economic Indicators of the Quality of Life in the Metropolis." Paper presented in Indo –German Symposium on 'Quality of Life in the Indian Metropolis', 17th March 1992, New Delhi.
15. Brockerhoff, M.P. "An Urbanizing World." Population Bulletin. Vol. 55(3): 44. Washington, D. C., Population Reference Bureau. Sep. 2000.
16. Burgess, 1939. "The growth of city." In: 'The City', ed. Robert E. Park, Chicago, University Press.
17. Chaing, C. H. 1990. "The Environmental Pressure of High Growth." Paper presented in 1990 National Outlook Conference, held at Malaysian Institute of Economic Research. Kuala Lampur, 5-6 Dec 1990 (mimeo).

18. Chakrabarti, P. G. Dhar. 2001. "Urban crisis in India: new initiatives for sustainable cities." In: Practice Reader Development and Cities, Volume 11, Numbers 2 and 3. 2001.
19. Charles, Abraham 1946. "The Future of Housing", Harper and Row, New York.
20. Commoner, Barry. 1992. "Population, Development, and Environment: Trends and key issues in the developed countries." In: Population, Environment and Development: proceedings of United Nations Expert Group Meeting on Population, Environment and Development, January 1992, United Nations, New York, pp64-80.
21. Danfulani, Ahmed. 1991. "Environment and Development Policy," Journal of Rural Development, Vol. 11, No. 2, 1991, pp127 –139.
22. Dirzo, R. & Garcial, M. C. 1992. Rates of Deforestation in Los Tuxtlas, a Neo-Tropical area in S. E. Mexico. Conservation Biology, 6, 84 –90.
23. Dubey, K. K. 1976. "Use and Misuse of Land in 'KAVAL' Towns of Uttar Pradesh", N.G.S.I. Dept. of Geography, B.H.U.
24. Edesio Fernandes (ed.), 1998. "Environmental Strategies for Sustainable Development in Urban Areas: Lessons from Africa and Latin America." Aldershot: Ashgate' Publishing Ltd.
25. Ehrlich, P. R. & Ehrlich, A. H. 1970. "Population, Resource and Environment: Issues in Human Ecology," W. H. Freeman and Company, San Fransico.
26. Faludi, Andreas, (1987), "A Decision Centred View of Environmental Planning," Urban and Regional Planning Series, Vol. 38pergamom Press, Oxford, 1987.
27. Gelbard, A., Haub, C., & Kent, M. "World Population beyond Six Billion." Population Bulletin. Vol. 54(1): 3-40. March 1999.
28. Ghosh, Pradip K. 1984. "Population, Environment and Resources and the Third World Development," Greenwood Press, Westport.
29. Ghosh, Sumita. 1998. "Introduction to Settlement Geography", Orient Longman Limited, Calcutta.
30. Gopal Bhargava. 1992. "Environmental Challenges and Ecological Disaster: Global Perspective", Mittal Publications, New Delhi, India.
31. Gregory, Ken. 1979. " Man and the Physical Environment." In: 'Geography' edited by Whiteley, Peter. Sussex Publications Ltd., 62 Queen's Grove, London NW8 6ER.
32. Grossman, Gene M. & Krueger, B. 1995. "Economic Growth and Environment." The Quaterly Journal of Economics, May 1995, pp147 –162.
33. Gupta, J. K., "Urban Infrastructure Development: Some Innovative Approaches," Spatio-Economic Development Record, Vol. 8, No. 6, Nov.- Dec. 2001.
34. Gupta, Sunit, & Gupta, Mukta. "Environment, Population, and Resources: Critical Challenges. 1997. viii, 346 pp. Anmol publicatioons: New Delhi, India.
35. Habitat II (1996), "Second United Nations Conference on HumanSettlement: India National Report," Government of India.
36. Hamilton, Clive & Turton, Hal. "Population Policy and environmental degradation: sources and trends in greenhouse gas emissions." People and Place, Vol. 7, No. 4, 1999. 42-62pp, Clayton, Australia.
37. Hamza Ahmed, "Urban Settlement and the Environment in the Developing World: Trends and Challenges." In: Population, Environment and Development:

proceedings of United Nations Expert Group Meeting on Population, Environment and Development, January 1992, United Nations, New York, pp151-158.

38. Harrington, 1996. "Effect of Population on Land & Environment," Geographers' Journal, New York.
39. Helmut Haberl, Fridolin Krausmann, "Changes in Population, Affluence, and Environmental Pressures during Industrialization: The Case of Austria 1830–1995. Population and Environment, 23 (1): 49-70, September 2001
40. Holtz-Eakn and Selden, Thomas M.1992. "Stocking the fires? CO2 Emissions and Economic Growth." NBER Working Paper No. 4248, 1992.
41. Jacobi, Pedro, (1992), "Urban Environmental Issues and Social Impact." In: Population, Environment and Development: proceedings of United Nations Expert Group Meeting on Population, Environment and Development, January 1992, United Nations, New York, pp166-172
42. Jolly, Carole I. 1994. "Four Theories of Population Change and the Environment." In: Population and Environment, Vol. 16, No. 1, September 1994, pp61 –90.
43. Jones, R. (ed.) 1975. "Essays on World Urbanization," George Philip & sons limited, London.
44. ***Kalipeni, Ezekiel.*** "Population Growth and Environmental Degradation in Malawi." Africa Insight, Vol. 22, No. 4, 1992. : 273-282. & Kalipeni, Ezekiel. "Demographic Response to Environmental Pressure in Malawi," Population and Environment, Vol. _____
45. Khalatbari, Parviz. "Population and Under-development—thoughts on the Cairo International Conference on Population and Development," Asien, Afrika, Lateinamerika, Vol. 24, 1996. : 1-16.
46. Kumra, V. K. 1985. "Environmental pollution and management", In: Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi. Pp 325-328.
47. Malkani, H. C. 1957. "A Socio Economic Survey of Baroda City," M.S. University of Baroda.
48. Mathur, Om Prakash. 1994. " The issue of Resources in the context of growing Urbanisation." In: Growing Numbers and Dwindling Resources, edited by Rekha Krishnan. Tata Energy Research Institute [TERI]: New Delhi, India. Pp23-30.
49. Mazumdar, D. N. 1960. "Social Contours of an Industrial City- Social Survey of Kanpur," Asia Publishing House, Bombay.
50. McLaren, Digby J. "Population growth—should we be worried?" Population and Environment, Vol. 17, No. 3, Jan 1996. : 243-259.
51. Mukherji, Shekhar. 1995. "Poverty-induced migration and urban involution in ESCAP Region," Proceedings of UN-ESCAP Expert Group Meeting on Linkages between Population and Poverty, Bangkok, Sept. 1995.
52. Muzammil, M. & Srivastava, B. P. 1991, "Population, Environment and Development." Series C. Occasional Paper No. 43, Population Research Centre, Department of Economics, Lucknow University, Lucknow, June 1991.
53. Myers, Norman. "Population, Environment, and Development." Environmental Conservation, Vol. 20, No. 3, Autumn 1993. : 205-216.

54. Nagpaul, Hans (1987), " India's Giant Cities." Reproduced from Mattei, Dogan and Johan D. Kasarda (eds.), "The Metropolis Era," Vol. 1, A World of Giant Cities, Sage, California.
55. Nambier, P. K. 1970. "The Slums of Madras City." In: 'Slums and Urbanization' (edited), Desai and Pilai, Popular Prakashan,
56. Ness, G. D. 1993. "The long view: Population-Environment Dynamics in Historical Perspective." In: Population-Environment Dynamics: Ideas and Observations, edited by Gayl D. Ness, William D. Drake, and Steven R. Brechin. Ann Arbor, Michigan, University of Michigan Press, pp33-55.
57. Nyati, K. P. 1994. "Technology in the Population–Environment Nexus." In: Growing Numbers and Dwindling Resources, edited by Rekha Krishnan. Tata Energy Research Institute [TERI]: New Delhi, India. Pp61-66.
58. O'MEARA, M. "Reinventing cities for people and the planet." Washington D. C., Worldwatch Institute, Jun 1999. (Worldwatch paper no. 147).
59. Orians, C. E., & Skumanich, M. "The Population- Environment Connection. What does it mean for Environmental Policy?" Seattle, Washington, Battelle Seattle Research Centre, 1995 Dec. xi, 79p.
60. Pachauri, R. K. 1994. "Addressing Population-Environment-Development Issues: An agenda for the future." In: Growing Numbers and Dwindling Resources, edited by Rekha Krishnan. Tata Energy Research Institute [TERI]: New Delhi, India. Pp9.
61. Pachauri, R. K., & Qureshi, Lubina F. 1997. "Population, Environment, and Development." Tata Energy Research Institute [TERI]: New Delhi, India. xi, 357pp.
62. Panayotou, Teodore. "An Inquiry into Population, Resources and Environment." In: The Impact of Population Growth on well-being in Developing Countries, edited by Dennis A. Ahlurg, Allen C. Kelley, and Karen O. Mason. 1996. : 259 –298.
63. Pathak, C. R. 1983. "Environmental Hazards and the Low Income Groups in the Slums of Calcutta Metropolis", Indian Journal of Regional Science, XV (1), 89-95.
64. Phantumvanit, D. and Liengcharensit, W. (1989), "Coming to terms with Bangkok's Environmental Problems," Population and Environment, Vol. 1, No.1, April, 1989, pp31- 39.
65. Pradeep, S. Pal. "Environmental Crisis," The Hindustan Times, 3rd April 1985.
66. Prasad, P. 1995. "Urban Slums: Health, Education and Development." Delta Publishing House, New Delhi.
67. Rodenburg, Eric. *Population Change, Resources and the Environment.* Population Bulletin, Vol.53, No. 1, March 1998. Washington D.C.: Population Reference Bureau, 1998: pp5-6.
68. Savage, Victor R. 1995
69. Schelkle, W. et. Al. 1992. "Low income –housing in two Metropolises: Integrated Housing project and the supportive role of Development Cooperation," German Development Institute (mimeo).
70. Selden, Thomas M. & Song, Daqing. 1994. "Environmental Quality and Development: Is there a Kuznetz Curve for Air Pollution Emissions?", Journal of Environmental Economics and Management, XXVIII, 1994, pp147 –162.

71. Shekhar, S. 1996. "Public Services and the Urban Poor: Reflectionson an innovative approach." Public Affairs Centre, Bangalore.
72. Simon, Julian L. 1986. "Theory of Population and Economic Growth." Basil Blackwell ltd. 108, Cowley Road, Oxford, OX4IJF, UK. p232
73. Singh, H. H. (1972), "Kanpur: A Study in Urban Geography," Indrashani Prakashan, Varanasi, 79- 82.
74. Singh, M. B. 1998. "Urbanization and Industrial Development: A Threat." In: Urban Environment in India: Problems and Prospects, edited by Dube, K. K. & Singh, A. K. (eds.), Inter-India Publication, New Delhi, pp333 –338.
75. Sivarama Krishnan, K. C. 1978, "Indian Urban Scene," Indian Institute of Advanced Study, Shimla.
76. Spain, Dapen. 1988. " The Effect of changing household composition on neighbourhood satisfaction." Urban Affairs Quarterly, Vol. 23, No. , June 1988, Sage Publications Inc. pp 581-600.
77. Srivastava, A. and Kumar, R. 2002. "Economic Valuation of Health Impacts of Air Pollution in Mumbai" In: Environmental Monitoring and Assessment, Vol. 75, No. 2, April (II) 2002, pp135 –143.
78. Stolnitz, George J., 1991. "population and environment: Patterns, problems, some pathways to solutions." Working paper No. 92-8, population institute for research and training, March.
79. Swamy, M. C. K. 1992. "Urban Ecosystem and Environmental Indicators." Paper presented in Indo –German Symposium on 'Quality of Life in the Indian Metropolis', March 1992, New Delhi.
80. United Nations (1977), "Indicators of the Quality of Urban Development." Report of the meeting of the Ad hoc Group Of Experts held at United Nations Headquaters, 8th to 12th December 1975, United Nations, New York, 1977.
81. United Nations (1993), "State of urbanization in Asia and Pacific," United Nations, New York.
82. United Nations (1994), "Agenda 21", Report on Rio Summit, New York, 1994.
83. United Nations, "The Global Partnership for Environment and Development," UNCED, Geneva, April 1992.
84. United Nations. Secretariat (New York). "Population and Environment." Population Bulletin of the United Nations, Washington D.C.: Population Reference Bureau. No. 21-22, 1988. 32-44pp.
85. UNITED NATIONS DEPARTMENT FOR POLICY COORDINATION AND SUSTAINABLE DEVELOPMENT. "Critical Trends: Global Change and Sustainable Development". New York, UN, 1997.
86. UNITED NATIONS POPULATION DIVISION. "World Urbanization Prospects: The 1999 Revision". New York, UN.
87. UNITED NATIONS POPULATION DIVISION. "World Population Prospects: the 1994 Revision." In: Demographic Yearbook: 1995, Department for Economic and Social Information and Policy Analysis, Statistics Department Division, Publishing Division, United Nations, New York.
88. UNITED NATIONS POPULATION DIVISION. "World Population Prospects: the 2000 Revision." In: Population and Development Review 27(2), June 2001.

89. UNITED NATIONS POPULATION FUND (UNFPA). "The state of world population 1999. Six billion: A time for choices". Marshall, A., ed. New York, UNFPA, 1999.
90. V. Ganeshwar, "Dimensions of environmental pollution", ITPI, *Journal*, Vol. 1 (139), September 1989.
91. World Bank, 1992. "World Development Report 1992: Development and the Environment." Oxford University Press, New York.

CHAPTER II

POPULATION GROWTH AND URBANISATION

-- "Maximum welfare, not maximum population, is our human objective."
■ *Arnold Toynbee "Man and Hunger," 1963.*

-- "The Generations pouring
From times of endless date,
In their ongoing, in their flowing,
Ever from the steadfast State;
And Humanity is growing
Toward the fullness of her fate."
■ *Herman Melville (1819-1891)*

II. 1 INTRODUCTION

The chapter analyses the recent trends and pattern of population growth and urbanization in the metropolitan cities in India, using the data from the Population Census of India.

II. 2 POPULATION GROWTH IN INDIA

Growth of population is the change in the number of people living in a particular area between given points of time. The net change between two points of time is expressed in percentage and is described as the growth rate of population. The growth of population is positive if there is an increase in population and negative if there is a decrease in population between two given point of time.

The year 1872 marked the beginning of the census taking in India. Although it marked an auspicious beginning, it was neither a synchronous project nor did it cover the entire country. The first complete, synchronous and a comprehensive census of India covering the entire nation and providing vital demographic data was conducted in 1881, which recorded the population of the country as 210.9 million. It rose to 1.02 billion by 2001. The share of Indian population in the world increased from 15.2% in 1981 to 16% in 1991. In 2001 the country was home to as much as 16.7% of the world's total population even when it covers barely 2.4% of the total land area of the world. Table 2.1 and figure 2.1 show the population of India since 1901.

Table 2.1

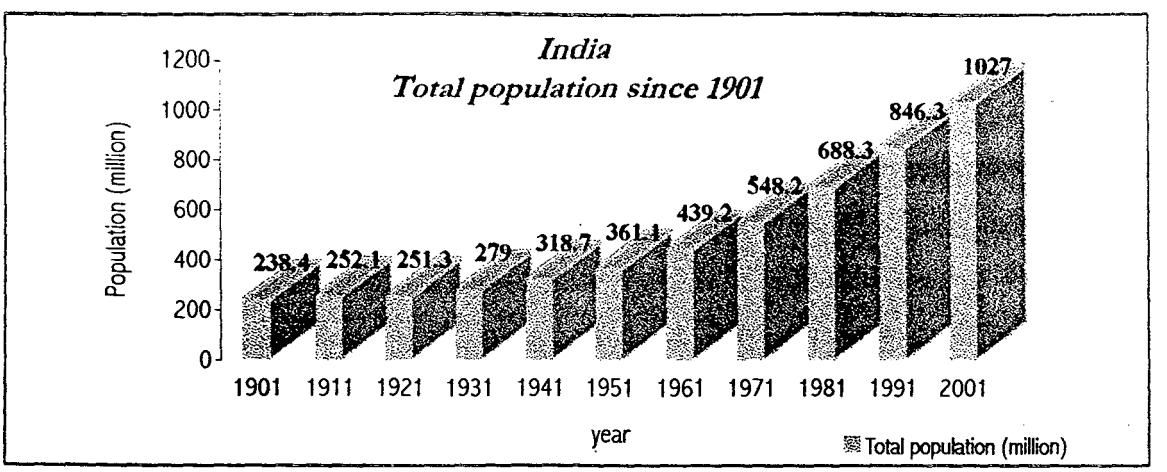
India: Decadal growth of population since 1901.

Census Year	Total population (million)	DECADAL GROWTH		Average annual Exponential Growth Rate (%)
		Absolute (million)	%	
1901	238.4	--	--	--
1911	252.1	13.7	5.7	0.56
1921	251.3	-0.3	-0.3	-0.03
1931	279.0	27.7	11.0	1.04
1941	318.7	39.7	14.2	1.33
1951	361.1	42.2	13.3	1.25
1961	439.2	78.1	21.5	1.96
1971	548.2	109.0	24.8	2.20
1981	688.3	135.1	24.7	2.22
1991	846.3	161.0	23.5	2.11
2001	1027.0	180.6	21.34	1.93

Source: Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

India has had a chequered demographic history with a massive growth in population from 238 million in 1901 to 1,027 million at the turn of the twenty first century showing a five –fold increase in the period of a century. This statistic is more impressive when one considers that most of it occurred following 1950. In absolute terms, the population of India has increased by 180.6 million during the decade 1991–2001. Although, the net addition has increased consistently, the change in the net addition has shown a steady declining trend over decades starting from 1971.

Figure 2.1



Source: Table 2.1

Distinct phases of population growth can be discerned in the demographic history of India in the 20th century:

1901 – 1921: Stagnant population,

1921 – 1951: Steady population,

1951 – 1981: Rapid & high population growth,

1981 – 2001: High growth but with signs of slowing down.

Source: Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

The percentage decadal growth has registered the sharpest decline since independence during 1991 –2001. The population of India has grown over a billion, as the rate of population growth could fall below 2% only by the turn of the new millennium. Though the average annual growth rate of population is declining, the net impact remains more or less the same, as the base of population is quite large.

The growth rate of population in the Indian context is fairly in tune with & can also be expressed through different stages of the classical theory of demographic transition. According to Dr. Premi (1991), "*India seems to have entered the third stage of demographic transition since 1971.*"[1] But since there are widespread differences among different authors and people about the number of stages of demographic transition, it is left to the readers to decide, on which stage of demographic transition India is going through.[2]

Table 2.2

India: Crude Birth Rate, Crude Death Rate & Natural Increase since 1901.

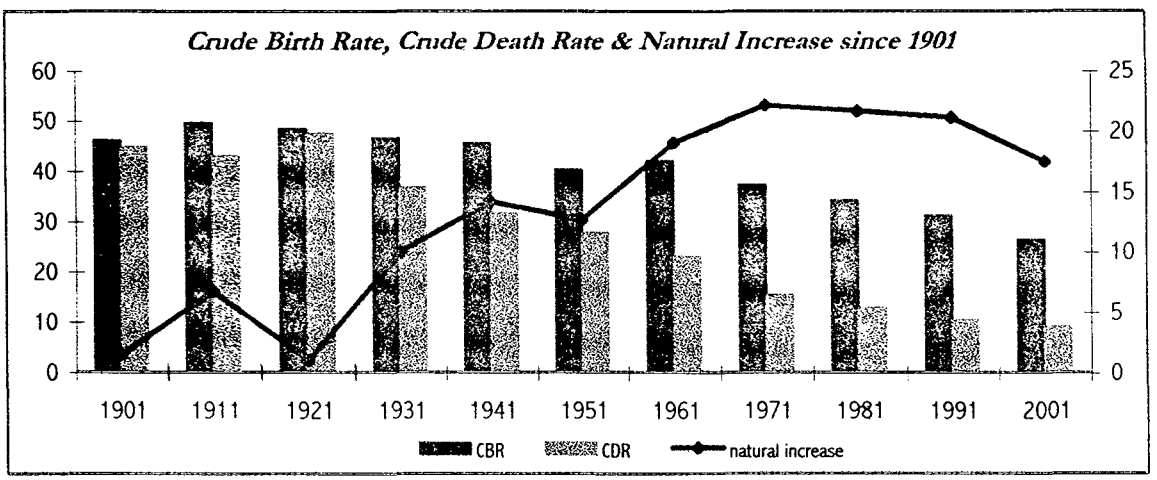
Census Year	Crude Birth Rate	Crude Death Rate	Natural Increase
1901	45.8	44.4	1.4
1911	49.2	42.6	6.6
1921	48.1	47.2	0.9
1931	46.2	36.3	9.6
1941	45.2	31.2	14.0
1951	40.0	27.4	12.6
1961	41.7	22.8	18.9
1971	37.0	15.0	22.0
1981	34.0	12.5	21.5
1991	31.0	10.0	21.0
2001	26.1 (99 SRS)	8.7 (99 SRS)	17.4

1 Premi, M. K. (1991), "India's Population Heading Towards A Billion." Pp23.

2 United Nations (1973), "The Determinants and consequences of population trends." Vol. 1, New York, pp 58-59.

Table 2.2 shows the crude birth rate, crude death rate and natural increase of India for the year 1901-2001. Crude birth rate has come down marginally, but the decline in the crude death rate has been more spectacular. This has been reflected in the steady increase in the natural growth of population. Though there was a decline in natural increase in 1921 & 1951, the overall population growth can be attributed to a national decrease in crude death rate, with no concomitant decrease in birth rates in the period 1951 to 1971. Though 1971 onwards, natural increase has witnessed a downward trend, it is still high.

Figure 2.2



Source: Table 2.2

This is unfortunately typical of many developing countries – they have access to Western medical technology, which reduces death from contagious and other diseases, without the accompanying economic and social development that reduces the demand for large families. Thus, the second, rapid growth, stage of demographic transition is prolonged. Even though, the natural increase of population in India has stabilized but its net impact in terms of addition of total population however remains very large.

"We shall see finally appear the miracle of an animal society, a complete and definitive ant heap."

-- Paul Valery (1871-1945)

The phenomenon of rapid population growth is related with the cascading effect of one activity upon another.[3] That is why, the urban centers once established tend to influence the whole socio-economic milieu of the region and emerge as centers of power.

3 Hagget, Peter (1975), Geography: A Modern Synthesis, Harper International Edition, New York. Pp326.

This has given rise to the continuing process of transformation of a rural society into an urban society.

II. 3 URBANIZATION IN INDIA

Urbanization is the process of city establishment and growth; the term commonly connotes population increase in the urban areas, resulting from internal growth and immigration, as well as spatial expansion of the city. One of the oldest of all the demographic trends is towards urbanization. *"Demographically, urbanization is a process of increase in proportion of urban population to the total population over a period of time of one year."*[4] As long as there's an increase in this proportion, there is urbanization. The main factor affecting this increase is assumed to be rural – urban migration. Urbanization is a natural consequence of economic changes that take place as a country develops. At the same time, urbanization helps to contribute to the growth process at large. It indicates the growth of secondary and tertiary activities like manufacturing, trading etc. but threaten the growth of agricultural areas. According to Thompson[5], the movement of people from Small Communities concerned characterizes urbanization solely with agriculture to other Large Communities whose activities are primarily centred in government, trade, manufacture and allied interests. Usually, it takes place in two ways: the expansion of the existing urban units and the appearance of the urban units.

In India, the definition of an urban unit, which was adopted in the 1971 census, has continued in the consequent censuses. In all these censuses an urban area is defined as follows:

1. All the places with a municipality, corporation, cantonment board or notified town area committee, etc.
2. All other places which satisfy the following criteria:
    - A minimum population of 5000;
    - At least 75% of the male working population engaged in non-agricultural pursuits; and

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[4] Bose, Ashish (1973), *Studies in India's Urbanization 1901 –1971,* Tata McGraw Hill Publishing Co. Ltd., New Delhi, pp3.

[5] W. S. Thompson, *Urbanization in Encyclopedia of Social Sciences,* Vol. XV, Macmillan, 1935, p189.

- A density of population of at least 400 persons per sq. km.

Beside, the Director of Census Operation in States/Union Territories were allowed to include, in consultation with the State Governments/Union Territories Administration and the Census Commissioner of India, some places having distinct urban characteristics as urban, even if such places did not strictly satisfy all the criteria mentioned under category (b) above. Such marginal cases include major projects colonies, areas of intensive industrial development, railway colonies, important tourist centers etc.

II. 3. 1 URBAN AGGLOMERATION

The *outgrowths* (OGs) of cities and towns have also been treated as urban. These OGs include "fairly large well organized railway colony, university campus, port area, military camp, etc., which might have come up" around a core city or statutory town... "Since these areas are already urbanized...although a few of them may not satisfy some of the prescribed eligibility tests to qualify themselves as independent urban units...have been termed as outgrowth and reckoned along with Town." Each town together with its outgrowth(s) is treated as an Urban Agglomeration. During 1971 census, a new concept of "*Urban Agglomeration*" was included, replacing the "*Town Groups*" concept of 1961 census, which was not always the contiguous urban unit that formed such a group. Even urban units cut off from one another was taken together ignoring the intervening regions. An "*Urban Agglomeration*" denotes a continuous urban spread and normally consists of a town or more and their adjoining urban outgrowths (OGs), or two or more physically contiguous towns together with contiguous well-recognized outgrowths, if any, of such towns. Thus these were the condition, which an area must satisfy before being treated as an urban agglomeration.

II. 2. 2 URBAN GROWTH & ITS COMPONENTS

The change in the urban population in a given geographical area over a period of time, is the result of-

- Natural increase
- Net rural to urban migration

- Population of new towns added during the decade minus the population of the declassified towns, and
- Population of the area added by the expansion of municipal boundaries.

II. 2. 3. TREND OF URBANIZATION

Out of 1027 million (or 102.7 crore) population of India, as per Census 2001, 742 million live in rural areas and 285 million in urban areas comprising of 72.2% and 27.8% of the population respectively. In 1991 India's urban population was 217.7 million, constituting 25.72 % of the total population, which grew from a level of hardly 11% of urbanization in 1901 with an urban population of 25.8 million only. While, the number of cities with over 50,000 population has increased from 24 in 1901 to 296 (1991). The number of UAs in the country increased from 381 at the 1991 Census to 384 at the Census 2001. The corresponding number in 1981 was 276. If urban agglomeration is counted as one urban unit then the number of Urban Agglomerations/towns are 4378 as compared to 3768 in 1991.

Table 2.3
India: Trend of Urbanization

Census Year	Number of UAs / Towns	Total population (million)	Urban population (million)	Urban population as % of the total population	Growth Rate	
					Decennial %	Annual Exponential
1901	1811	238.4	25.8	10.84	--	--
1911	1754	252.1	25.9	10.29	0.35	0.03
1921	1894	251.3	28.0	11.18	8.27	0.79
1931	2017	279.0	33.4	11.99	19.12	1.75
1941	2190	318.7	44.1	13.86	31.97	2.77
1951	2795	361.1	62.4	17.29	41.42	3.47
1961	2270	439.2	78.9	17.97	26.41	2.34
1971	2476	548.2	109.1	19.91	38.23	3.21
1981	3245	688.3	159.4	23.34	46.14	3.83
1991	3696	844.3	217.1	25.72	36.19	3.09
2001	4378	1027.0	285.3	27.78	31.20	2.70

Source: Census of India 1991, Paper 2 of 1991, Provisional Population Totals, Rural – Urban Distribution. Pp 13, 22, 23 & 30. & Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

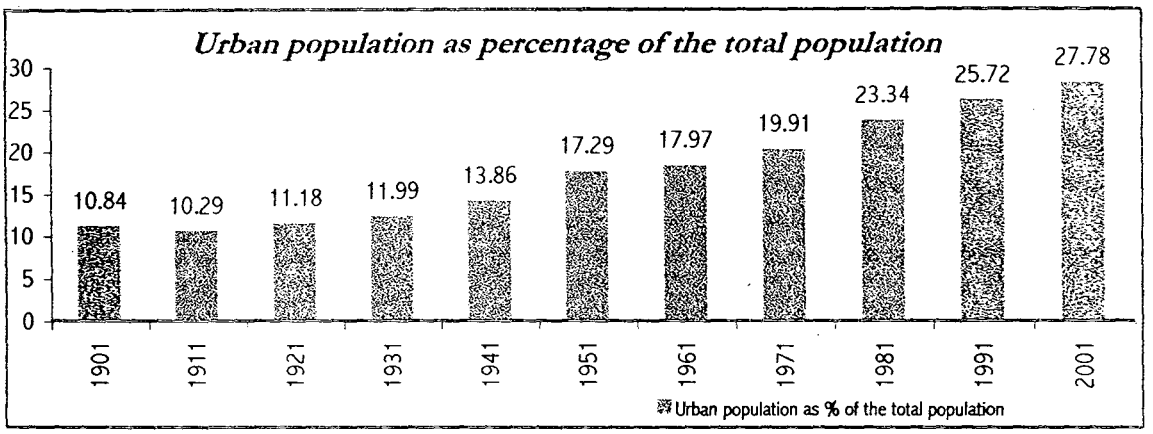
Note:

1. Urban Agglomerations, which constitute a number of towns and their outgrowths, have been treated as one unit.
2. The total population and urban population of India for the year 2001 includes estimated population of those areas of Gujarat and Himachal Pradesh where census could not be conducted due to natural calamities.
3. The total population and urban population of India for the year 1991 includes interpolated population of Jammu & Kashmir where census could not be conducted.
4. The total population and urban population of India for the year 1981 includes interpolated population of Assam where census could not be conducted.

Trend of urbanization from 1901 to 2001 is illustrated in table 2.3. It shows that the number of towns/ UAs has more than doubled and has increased from 1811 in 1901 to 3696 in 1991 and to 4378 in 2001. There was steady increase in number of towns till 1951. Thereafter it registered a sharp drop during the decade 1951-1961 due to more rigorous tests applied in 1961 to determine whether a place qualified to be treated as a town or not, many urban places were declassified and hence, the number of towns declined from 2795 (1951) to 2270 (1961).

The total population increased 4.3 times between 1901-2001, while the urban population increased nearly 11 times during the same period. The percentage of urban population to the total population of India increased 2.5 times from 10.84% in 1901 to 27.78% in 2001, even after an initial decline to 10.29% in 1911 (Figure 2.3). But, the absolute increase has been as high as 68.2 million in 1991–2001, which is much greater than that in 1981–91 (57.71 million) and 1971–81 (50.35 million). Such an absolute increase in the urban population has been the main factor putting pressure on the urban infrastructure.

Figure 2.3



Source: Table 2.3

The table 2.3 also shows that the growth pattern of urban population has been varying in different inter-census periods. The percentage variation during 1901-31 was slow. It was a period of loss, recovery and slow growth. After this urban population recorded a very high growth rate. The percentage decadal growth rate of urban population grew at a faster pace from the decade 1921-1931 until 1951. There was a sharp drop during 1951-61 that was mainly due to declassification of a very large number of towns during the period. The decades 1961-71 and 1971-81 showed significant improvement in the growth rates, thereafter it steadily dropped to 31.2% in 2001.

The annual average exponential growth rate increased steadily over the decades, but it started declining from 3.83% in 1971–81 to 3.09% in 1981–91 and further to 2.70% in 1991–2001. The country recorded the fastest urban growth rate of the twentieth century during the 1970s. The high rate of 3.8 per cent has been attributed to an increase in population in the existing urban centres and also to the emergence of a large number of new towns – about 1,000 in number. In contrast, the Census of 1991 recorded a decline in the growth rate of urban population. The rate came down to 3.1 per cent during 1981-91, which is one of the lowest of the century. *It is important to note that natural population growth has remained stable during the past three Census decades at about 2.1 per cent.*[6]

[6] Kundu, Amitabh. "Urban Development, Infrastructure Financing and Emerging System of Governance in India: A perspective." In: the Scout Report for Social Sciences Selection: Internet Scout report. Vol. 4, number 15, April 2001.

Since 1971, the urban population has doubled, increasing at twice the rate of doubling of rural population. The following table 2.4 shows the doubling schedule of India's urban population.

Table 2.4

India:

Doubling schedule of Urban Population

Urban Population (million)	Years taken to double
25.8 – 51.6	43 (1901 – 1944)
51.6 – 103.2	26 (1944 – 1970)
103.2 – 206.4	20 (1970 – 1990)
206.4 – 412.8	17 (1990 – 2007)

Source: Census of India 1991, Population Tables: Paper 2 of 1991 &Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

From 25.8 million in 1901, it took nearly 43 years to reach 51.6 million and another 26 years for it to increase to 103 million persons. After that it has taken merely 20 years for the Urban Population to double. With the current rates of growth of the urban population it is estimated to be doubling itself by the year 2007 and reaching a total of 400 million persons.

II. 2. 4 GROWTH OF THE METROPOLITAN CITIES

Urban agglomeration/ city with a population of one million and above has been defined Metropolitan city by the Census of India. They are also known as million plus cities. A metropolis is a distinct form of settlement, characteristically with sprawling of its built-up area and includes its inter-dependent nearby villages and even towns. The metropolitan centers are a class by themselves, characterized by large-scale consumption and a large quantum of flows of people, goods, services and information.[7] Metropolitan cities generally consist of people from different states. India's urban scene is no longer one of towns and over grown villages. *Now 2/3rd of the urban population lives in genuine cities with population over 1,00,000.*[8]

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[7] Prakasha Rao, V. L. S. (1983): Urbanization in India: Spatial Dimensions, Concept Publishing Co., New Delhi.

[8] Mathur, O. P. "the issue of resources in the context of our growing urbanization." In: Growing Number and Dwindling Resources, Teri, 1994, pp25.

A striking feature of the present trend of urbanization is the increase in the relative share of metropolitan cities. According to the Census of India, 2001, there were thirty-five metropolitan urban agglomerations/ cities in the country with a population of one million each. In 1901, there was only one such city, namely, Calcutta (Kolkata). The number of million cities remained two (Calcutta, Bombay) from 1911 till 1941 (Table 2.5). In 1951, their number increased to five, in 1961 to seven, in 1971 to nine, in 1981 twelve and in 1991 to twenty-three, and after 2001 there are 35 cities, having more than one million population each.

Table 2.5

Percentage of population of metropolitan cities

Census Year	Number of metropolitan cities	Population (millions)	% of population of metropolitan cities to	
			Total population	Urban population
1951	5	11.75	3.25	18.81
1961	7	18.10	4.12	22.93
1971	9	27.83	5.08	25.51
1981	12	42.12	6.16	26.41
1991	23	70.66	8.37	32.54
2001	35	105.58	10.28	37.00

Source: Census of India 1991, Provisional Population Totals: Rural – Urban Distribution, Paper 2 of 1991. pp 38. & Census of India 2001, Provisional Population Totals, Paper 1 of 2001.

As shown in table 2.5 about 37% of the total urban population as per the Census of 2001 lives in these Million Plus UAs/Cities in India. One third of urban population lives in cities of a million inhabitants or more, which has increased from one quarter in 1971. The population of the metropolitan cities increased nearly 9 times from 11.75 millions in 1951 to 105.58 millions in 2001. The percentage share of population metropolitan cities to the total population has more than trebled from 3.25% in 1951 to 10.28% in 2001, while the same in relation to the total urban population in India has nearly doubled.

Table 2.6

Growth in population of metropolitan cities since 1901

Rank	Metropolitan city	Population of metropolitan cities in million										
		1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001
1	Greater Mumbai	0.83	1.04	1.28	1.31	1.74	3.21	4.51	6.59	9.42	12.59	16.36
2	Kolkata	1.51	1.74	1.88	2.13	3.62	4.66	5.98	7.42	9.19	11.02	13.21
3	Delhi	0.21	0.23	0.30	0.44	0.69	1.43	2.35	3.64	5.72	8.41	12.79
4	Chennai	0.59	0.60	0.62	0.77	0.93	1.54	1.94	3.16	4.28	5.42	6.42
5	Bangalore	0.16	0.18	0.24	0.30	0.41	0.78	1.20	1.66	2.92	4.13	5.68
6	Hyderabad	0.44	0.50	0.40	0.46	0.73	1.13	1.25	1.81	2.60	4.34	5.53
7	Ahmedabad	0.18	0.21	0.27	0.31	0.59	0.87	1.20	1.76	2.55	3.31	4.51
8	Pune	0.16	0.17	0.19	0.25	0.32	0.60	0.79	1.13	1.72	2.40	3.75
9	Surat	0.13	0.13	0.13	0.11	0.18	0.23	0.31	0.49	0.92	1.51	2.81
10	Kanpur	0.20	0.17	0.21	0.24	0.48	0.70	0.97	1.27	1.63	2.02	2.69
11	Jaipur	0.16	0.13	0.12	0.14	0.18	0.30	0.41	0.63	1.01	1.51	2.32
12	Lucknow	0.26	0.25	0.24	0.27	0.38	0.49	0.65	0.81	1.01	1.66	2.26
13	Nagpur	0.12	0.10	0.14	0.21	0.30	0.44	0.64	0.86	1.21	1.66	2.12
14	Patna	0.17	0.17	0.15	0.19	0.23	0.32	0.41	0.55	0.91	1.09	1.70
15	Indore	0.10	0.05	0.10	0.14	0.20	0.31	0.39	0.56	0.82	1.10	1.63
16	Vadodra	0.10	0.10	0.09	0.11	0.15	0.21	0.30	0.47	0.78	1.12	1.49
17	Bhopal	0.08	0.06	0.05	0.06	0.08	0.10	0.22	0.38	0.67	1.06	1.45
18	Coimbatore	0.08	0.05	0.08	0.10	0.18	0.28	0.44	0.73	0.92	1.10	1.44
19	Ludhiana	0.05	0.04	0.05	0.07	0.11	0.15	0.24	0.40	0.60	1.04	1.39
20	Kochi	0.84	0.09	0.06	0.13	0.16	0.21	0.33	0.55	0.82	1.14	1.35
21	Vishakhapatnam	0.04	0.04	0.04	0.06	0.07	0.10	0.21	0.36	0.60	1.05	1.32
22	Agra	0.19	0.18	0.18	0.22	0.28	0.37	0.50	0.63	0.74	0.94	1.32
23	Varanasi	0.22	0.21	0.21	0.22	0.27	0.36	0.51	0.63	0.79	1.03	1.21
24	Madurai	0.10	0.13	0.14	0.18	0.24	0.37	0.49	0.70	0.90	1.09	1.19
25	Meerut	0.13	0.12	0.13	0.14	0.18	0.24	0.29	0.38	0.54	0.84	1.16
26	Nasik	0.02	0.03	0.06	0.06	0.07	0.15	0.21	0.27	0.44	0.72	1.15
27	Jabalpur	0.09	0.10	0.11	0.12	0.17	0.25	0.36	0.53	0.75	0.88	1.11
28	Jamshedpur	N.A	0.01	0.06	0.09	0.16	0.21	0.32	0.44	0.68	0.82	1.10
29	Asansol	0.01	0.01	0.03	0.05	0.10	0.15	0.25	0.31	0.50	0.76	1.09
30	Dhanbad	N.A	N.A	0.01	0.02	0.04	0.07	0.23	0.45	0.68	0.81	1.06
31	Faridabad	0.01	0.01	0.01	0.01	0.01	0.04	0.06	0.12	0.33	0.61	1.05
32	Allahabad	0.17	0.17	0.16	0.18	0.26	0.33	0.43	0.51	0.65	0.84	1.04
33	Amritsar	0.16	0.15	0.16	0.26	0.39	0.33	0.39	0.45	0.59	0.70	1.01
34	Vijayawada	0.03	0.04	0.05	0.07	0.10	0.13	0.26	0.39	0.61	0.84	1.01
35	Rajkot	0.04	0.03	0.05	0.06	0.07	0.13	0.19	0.30	0.44	0.65	1.00

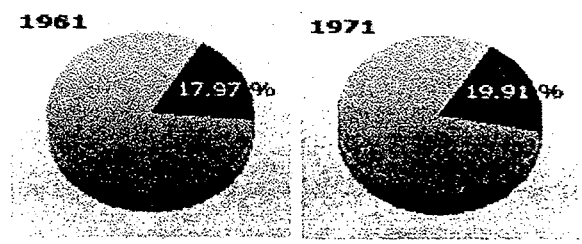
Source: Census of India, 1991, Town directory; Census of India 2001, Provisional Population Totals, Paper 1 of 2001

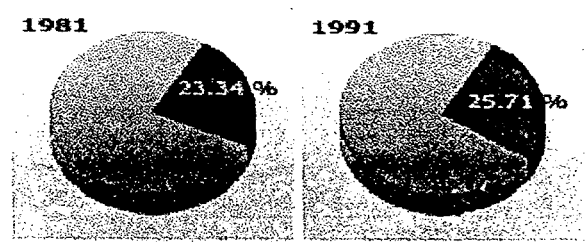
The following figures give the proportion of urban population to total population between 1961-2001:

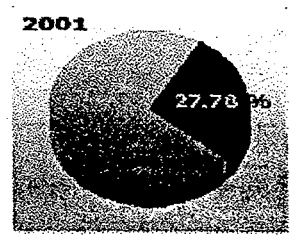
1961	17.97 %
1971	19.91 %
1981 @	23.34 %
1991 *	25.71 %
2001	27.78 %

@ The 1981 Census figures have been interpolated for Assam where Census could not be held.

* The 1991 Census figures include interpolated population of Jammu & Kashmir where census could not be held.







Growth of metropolitan cities in India since 1901 is shown in table 2.6. In 1901, Calcutta (Kolkata) was the only one city with a population of one million. From 1911 –41 there remained just 2 metropolitan cities. By 1951 there were five such cities –Kolkata, Mumbai, Chennai, Delhi, and Hyderabad. Thereafter, the number of million plus cities rose to 7 in 1961, 9 in 1971, 12 in 1981, and 23 in 1991. In 2001, there were as many as 35 metropolitan cities as listed in the table 2.6. Nearly 13.1 million people (4.59%) were added to the total urban population of 2001 due to 12 new cities getting the status of metropolitan cities in the Census of India, 2001. Greater Mumbai, Kolkata, Delhi, Chennai are the most populous metropolitan cities. Their combined population accounts for 48.78 million (17.09%) out of the 285.3 million urban population of India in 2001. though their share has marginally declined from 17.24% in 1991. Kolkata had the maximum population till 1971; in 1981 Greater Mumbai overtook it to become the most populous city in the country. Greater Mumbai has experienced 19.7 times increase in its population over the century. Delhi has experienced a decadal growth of 50% in 1950 and 57% in 1981 in comparision to 30.8% in Kolkata, 38.2% in Greater Mumbai, and 35.3% in Chennai. Although the natural increase in not much, greater immigrants' influx could contribute substantially to population growth and increase the density of population. This favours congestion of houses and heavy pressure on the limited resources available to the metropolitan city.[9] In 1911 many cities witnessed decline in their population like Jaipur, Lucknow, Nagpur, Indore, Bhopal, Coimbatore, Ludhiana, Kochi, Agra, Varanasi, Meerut, Amritsar, and Rajkot. Such a decline was not witnessed in the later years. The population growth of the cities that were late entrants in the list of metropolitan cities has been slow in comparision to those, which were included since long. There is a pronounced tendency for the urban population to concentrate in large cities and towns. The population of Nasik increased 2.14 times in the decade 1941-1951. Vijaywada's population doubled during 1951-61. For Dhanbad, the population increased 3.28 times in the decade 1951-61, which could be because of the fact that soon after independence much emphasis was laid on industrialization and development of heavy industries & mining especially in resource rich regions. Faridabad experienced 1.8 times increase in

[9] Mandal, R. B. 1999. Urban Geography

the decade, the reason for such an increase could be its proximity to the national capital, New Delhi.

The pace of this growth became more rapid with every passing decade although the pattern of urbanization remained more or less unchanged. The causes of such a huge concentration of population are commercial, administrative and port facilities found in these metropolitan cities besides industrial and educational development. Table 2.7 shows the ranks of metropolitan cities in different Census years.

Table 2.7

Ranks of metropolitan cities in different Census years.

Rank in 2001	Rank in 1991	Rank in 1981	Metropolitan city	State / UT	Year*
1	1	1	Greater Mumbai	Maharashtra	1911
2	2	2	Kolkata	West Bengal	1901
3	3	3	Delhi	Delhi	1951
4	4	4	Chennai	Tamil Nadu	1951
5	6	5	Bangalore	Karnataka	1961
6	5	6	Hyderabad	Andhra Pradesh	1951
7	7	7	Ahmedabad	Gujarat	1961
8	8	8	Pune	Maharashtra	1971
9	12	-	Surat	Gujarat	1991
10	9	9	Kanpur	Uttar Pradesh	1971
11	13	11	Jaipur	Rajasthan	1981
12	11	12	Lucknow	Uttar Pradesh	1981
13	10	10	Nagpur	Maharashtra	1981
14	18	-	Patna	Bihar	1991
15	17	-	Indore	Madhya Pradesh	1991
16	16	-	Vadodra	Gujarat	1991
17	20	-	Bhopal	Madhya Pradesh	1991
18	15	-	Coimbatore	Tamil Nadu	1991
19	23	-	Ludhiana	Punjab	1991
20	14	-	Kochi	Kerela	1991
21	21	-	Vishakhapatnam	Andhra Pradesh	1991
22	-	-	Agra	Uttar Pradesh	2001
23	22	-	Varanasi	Uttar Pradesh	1991
24	19	-	Madurai	Tamil Nadu	1991
25	-	-	Meerut	Uttar Pradesh	2001
26	-	-	Nasik	Maharashtra	2001
27	-	-	Jabalpur	Madhya Pradesh	2001
28	-	-	Jamshedpur	Jharkhand	2001
29	-	-	Asansol	West Bengal	2001
30	-	-	Dhanbad	Bihar	2001
31	-	-	Faridabad	Haryana	2001
32	-	-	Allahabad	Uttar Pradesh	2001
33	-	-	Amritsar	Punjab	2001
34	-	-	Vijayawada	Andhra Pradesh	2001
35	-	-	Rajkot	Gujarat	2001

Source: Census of India, 2001 Note: Year* : year of the city being ranked as a metropolitan city.

The table 2.7 shows that cities to join the elite group of million plus cities in 1991 were Surat, Kochi, Coimbatore, Vadodra, Indore, Patna, Madurai, Bhopal, Vishakhapatnam, Varanasi and Ludhiana. The decade 1991-2001 recorded a phenomenal growth and as many as 12 cities join the list of metropolitan cities were- Agra, Meerut, Nasik, Jabalpur, Jamshedpur, Asansol, Dhanbad, Faridabad, Allahabad, Amritsar, Vijaywada, and Rajkot. The first few metropolitan cities have managed to remain in the topmost bracket, though, because of the varying degree of growth, the population ranks of these metropolitan cities have been changing from one census to another. Kolkata, which occupied the first position in 1901 till 1971 relegated to second position in 1981 when Greater Mumbai alleviated to the 1st position. Mumbai, the prime urban centre in India, is definitely the commercial and financial capital of the nation. It is a cosmopolitan and dynamic city with multi-religious and multi-lingual culture.[10] Kolkata, the capital of West Bengal has the advantage of being the financial stronghold of India, nerve centre of regional economy, higher education and port location, which has been reaped well since times immemorial, especially by the British. Historical background of the cities has played a major role in the growth of population of the cities. Delhi is the political, social, economic, and cultural capital of India. It is now the 3rd largest metropolitan city, and owes its growth to the increase of industries and diversification of economic base. Bangalore and Hyderabad swapped places to the benefit of Bangalore to the 5th position. Surat elevated from 12th position in 1991 to 9th position in a period of a decade. Patna experienced a similar elevation from 18th rank in 1991 to 14th rank in 2001. With Jaipur rising back to the 11th rank, Lucknow lost its rank by one position & had to settle at the 12th position, while Nagpur stepped down three ranks to the 13th position. There were other cities also, which had to face relegation in ranks like Kochi, Varanasi, etc.

[10] Mandal, R. B. 1999. Urban Geography

Table 2.8

Population growth rate in metropolitan cities

Population growth rates			
Metropolitan cities/year	1901-11	1951-61	1991-2001
Greater Mumbai	25.30	40.50	29.94
Kolkata	15.23	28.33	19.87
Delhi	9.52	64.34	52.08
Chennai	1.69	25.97	18.45
Bangalore	12.50	53.85	37.53
Hyderabad	13.64	10.62	27.42
Ahmedabad	16.67	37.93	36.25
Pune	6.25	31.67	56.25
Surat	-3.10	34.78	86.09
Kanpur	-15.00	38.57	33.17
Jaipur	-18.75	36.67	53.64
Lucknow	-1.56	32.65	36.14
Nagpur	-16.67	45.45	27.71
Patna	-0.58	28.13	55.96
Indore	-44.33	25.81	48.18
Vadodra	-1.00	42.86	33.04
Bhopal	-27.27	115.69	36.79
Coimbatore	-43.37	57.14	30.91
Ludhiana	-8.33	60.00	33.65
Kochi	24.29	57.14	18.42
Vishakhapatnam	7.50	110.00	25.71
Agra	-4.26	35.14	40.43
Varanasi	-4.55	40.28	17.48
Madurai	30.00	32.43	9.17
Meerut	-0.80	20.83	38.10
Nasik	29.17	40.00	59.72
Jabalpur	11.11	44.00	26.14
Jamshedpur	-	52.38	34.15
Asansol	0.00	66.67	43.42
Dhanbad	-	215.07	30.86
Faridabad	-5.56	59.46	72.13
Allahabad	-0.58	30.30	23.81
Amritsar	-7.41	18.18	44.29
Vijayawada	32.26	100.00	20.24
Rajkot	-5.56	46.15	53.85

Source: Table 2.6

Table 2.8 depicts the population growth rates in the decades 1901-11, 1951-61, and 1991-2001. In the decade 1901-11, there were 18 metropolitan cities that showed negative growth rates that were not repeated in the future decades for any of the metropolitan cities. In contrast to that there were 4 metropolitan cities, which had growth

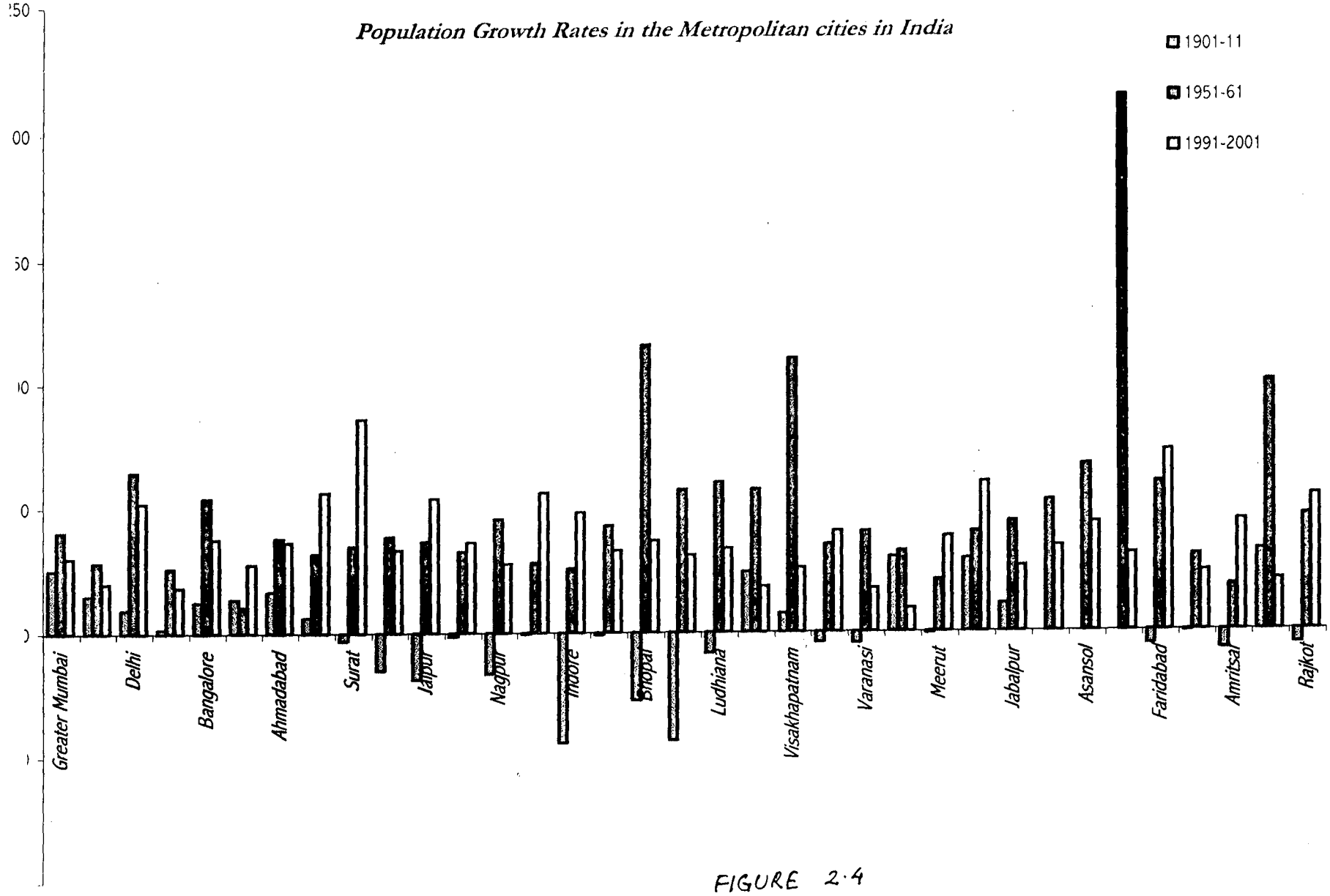

Population Growth Rates in the Metropolitan cities in India
1901-11
1951-61
1991-2001
Greater Mumbai
Delhi
Bangalore
Ahmadabad
Surat
Jaipur
Nagpur
Indore
Bhopal
Ludhiana
Visakhapatnam
Varanasi
Meerut
Jabalpur
Asansol
Faridabad
Amritsar
Rajkot

FIGURE 2·4

rate more than 100%, which were Bhopal, Vishakhapatnam, Vijaywada, and Dhanbad. As such the growth rates were high in the decade 1951-61 for all the metropolitan cities. Dhanbad in particular showed a very high growth rate of 215.07%, because of the development of transport system and Mining Industry soon after the independence of the country (Figure 2.4). In 1951-61 and 1991-2001, there were nearly 20 cities that had their growth rate ranging between 25-50 %. In 1991-2001, there is no city that had a population growth rate more than 100%. In 1901-11, there were 11 cities having growth rate between 0-25%, in 1951-61 there were hardly 3 cities in the group. But again in 1991-2001, the number of cities in the group rose to 7.

II.4. CONCLUSIONS

Urbanization is a process of population growth in urban areas. Viewed in a longer time perspective, a fast pace of urban spread is inevitable.

To conclude the chapter it can be said that:

1. There has been a five –fold increase in the population since 1901, most of which has occurred during 1950.
2. Population growth can be attributed to decrease in national crude death rate, with no concomitant decrease in birth rates in the same period.
3. The percentage decadal growth registered the sharpest decline since independence during 1991 –2001. The population growth could be brought down to less than 2% only by the turn of the new millennium, but the population of India has already grown over a billion.
4. Population growth rate is still high but is showing significant signs of slowing down. The decadal population growth was as high as 24.8% in the decade 1961-71, which slightly came down to 23.5 in 1981-91. It has further declined to 21.34% in 1991-2001.
5. The pace of urbanization in India was picking up and reached its maximum during 1971-81, after which it has slowed down substantially. In fact the growth in urban population during the eighties has been less than expected.
6. Due to varying degree of growth, the population ranks of the metropolitan cities have been changing from one census to another.

7. Increasing concentration of the urban population in large cities is due to progressive increase in the numbers of both the cities and the million-plus cities. Increase in the administrative boundaries of the cities, natural increase and rural to urban migration are also the reasons for high population growth.
8. There has been a high and increasing growth rate of urban population: from a decennial growth rate of 0.35 in 1901-11, it rose to 41.42 in 1941-51 but then it fell slightly to 36.19 in 1981-91 and further to 31.20 in the decade 1991- 2001.
9. The total population increased 4.3 times between 1901-2001, the urban population increased nearly 11 times, while the percentage of urban population to the total population of India increased 2.5 times during the same period.
10. In 1901 the level of urbanization in India was just about 11%, i.e., of 238 million people, only 25.8 million lived in towns and cities of the country. In 2001, 285.3 million people lived in towns and cities that constituted 27.78% of the total population. Therefore, though the total number of urban population grew by nearly 11 times, the level changed by only 2.5 times. The urbanization level of the country has been increasing consistently since 1971.
11. The big cities of India are exploding in their population while the small towns are stagnating. There is a pronounced tendency for the urban population to concentrate in large cities and towns.
12. The current rate of growth of the cities does pose a challenge to the urban authorities. The absolute increase in the urban population has been the main factor putting pressure on the urban infrastructure.
13. At the 1991 Census, there were 23 UAs /Cities with Million Plus population. This number has rose to 35 in 2001.
14. One third of urban population lives in million plus cities, which has increased from one quarter in 1971.
15. The percentage share of population metropolitan cities to the total population has nearly trebled from 1951 to 2001, while the same in relation to the total urban population in India has nearly doubled.
16. Greater Mumbai, Kolkata, Delhi, Chennai are the most populous metropolitan cities. Their population taken together, accounts for nearly 17% of the urban population in 2001. The Indian urbanization has poly-metropolitan apex in which

the million cities dominate the entire urban scheme accounting for more than one-third of India's total urban population.

17. Due to 12 new cities getting the status of metropolitan cities in the Census of India, 2001, nearly 13.1 million people (4.59%) were added to the total urban population of 2001.
18. In 1951-61 there were 4 metropolitan cities, which had growth rate more than 100%, which were Bhopal, Vishakhapatnam, Vijaywada, and Dhanbad. In 1991-2001, there is no city that had a population growth rate more than 100%.

The Indian urban experience in the recent past has not always been pleasant, it was unexpected and therefore unplanned to a large extent. As a result it brought with it a large number of problems, which include squatter settlements, unplanned layouts and an unhealthy environment. Though there have been seminars held to discuss these problems a firm and effective urban policy is required to set right the process of urbanization in the country.[11]

[11] Ghosh, Sumita. 1998. "Introduction to Settlement Geography", Orient Longman Limited, Calcutta

CHAPTER – III

STATE OF URBAN ENVIRONMENT

-- "A low-grade civil war is being fought every day in the urban centres...
the overwhelming speed at which the world is urbanizing leaves little time to adapt.
We are witnessing daily urban catastrophes.
Drugs are rampant, crime and terrorism is increasing.
We risk a complete breakdown in cities."
■ *Wally N'Dow*

-- "He will manage the cure best who foresees what is to
happen from the present condition of the patient."
■ *Hippocrates (ca. 460-377 B. C.)*

III. 1 INTRODUCTION

This chapter will comprehensively explain the state of the urban environment in the metropolitan cities of India. For that matter the chapter has been subdivided into the following sections:

- Level of Pollution:
  - Air Pollution,
  - Water Pollution, and
  - Noise Pollution;

III. 2 POLLUTION

To have a better of understanding of 'Pollution' it is important to have an understanding of the term 'Environment'. Environment is the total of the external conditions that surround an organism, community or object.[1] Though, Environment may also be defined as – "The sum total of all the external and internal factors – Physical, Chemical and Biological, which affects the structure and function of the living organism, association or a community of the organism, condition of building exposed to it or any visual enjoyment."[2] Environment with all its components has to be viewed and considered in its totality. It is the sum total of the conditions within which an organism

[1] Goodall, Brian. 1987. The penguin Dictionary of Human Geography. Penguin Books. Pp, 155.
[2] Odum (1976), "Pollution and its Control," Saunders College Publishing, San Francisco.

lives. There are, indeed, a wide range of physical, biological and man-made components that interact in building up an environment.[3]

Thus, the word "environment" means "*all the physical, social and cultural factors and conditions influencing the existence or development of an organism or assemblage of organisms.*"

Pollution is equated with environment erroneously at times. In fact, pollution is one of the aspects of environment. Any change in the environment, which contributes to its deterioration is called pollution of the environment. With respect to the environment, pollution may be defined as the "modification" of the environment by release of noxious materials, making it harmful or unpleasant to life." Pollution may be defined as an undesirable change in the Physical, Chemical and Biological characteristics of our air, land, and water that may or will waste or deteriorate our material resources.[4] Pollution is the condition, which ensues when environmental attributes become inimical to the normal existence of living organisms. The normal laws and capabilities of nature of absorbing the pollutants have been upset. This has resulted in pollution of air and water much beyond human tolerance capacity.[5]

"Don't drink the water and don't breathe the air." -- *Tom Lehrer,* Pollution, *1965.*

Pollution is the condition of being physically unclean or impure; when defined as a process, it is- "the direct or indirect change in one or more components of the environment with actual or potential adverse, harmful, unpleasant or inconvenient effects." Pollution of air and water caused by human habitat and his economy has, of late, created an alarming situation. The pressure of population along with increasing exploitation of our natural resources has aggravated the situation.

Thus, the phenomena of pollution that is predominantly associated with urban and industrial areas is embedded in the following prepositions; pollution means:

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[3] Kayastha.
[4] Odum (1971),
[5] Dutt, G. K. 1985. "Issues and Challenges." In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi. Pp 6.

1. The presence of anything in the environment that is in excess of what is needed.
2. Anything that is in the environment but not in the natural state.
3. The direct or indirect change in one or more component or the ecosystem, which are harmful to the system or at least undesirable to the human beings.
4. Intentional or unintentional release of any chemical or geochemical substance into the environment with adverse effects.

A contaminant is foreign to an environment and capable of pollution within it. It has a source from which it is dispersed, usually by means of an atmospheric or aquatic pathway. During this process it may be rendered harmless by transformation or dilution. If this does not occur, the contaminant becomes a pollutant that has a target.[6] The agents that cause pollution are called pollutants. On the basis of the sources, pollutants can be categorized into two broad groups:

1. Point source pollutants; and
2. Non-point source pollutants.

While gases and particulate matters such as dust, lead, Sulphur dioxide (SO_2), Carbon monoxide (CO) etc., are Point source pollutants; the Non-point source pollutants are mostly sources which results in run-off, seepages and percolation via diffusion and unidentified routes. However, gases and particulate matters emitted from any "moving point source" are also considered as Non-point pollutants. Due to the fast growth of urban population and inadequate arrangements for collection and disposal of liquid and solid waste generated, large application of chemicals in agriculture, fast industrialization results in indiscriminate disposal of wastes. All these activities contribute the Non-point source pollution into both surface run-off and groundwater.[7] Wastes also qualify as pollutants because they impair and harm the natural resources in which they are located. Indiscriminate disposal of waste is the major source of non-point source of pollution.

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[6] Holdgate, M. W. 1979. "*A perspective of environmental pollution.*"Cambridge: Cambridge University Press; and Newson, M. 1992. "*The geography of pollution.*" In: M. Newsons ed., Managing the human impact on the natural environment: patterns and processes. London and New York: Belhaven Press. Pp 14-36.

[7] Central Pollution Control Board, "Parivesh: Highlights 2000." Central Pollution Control Board, Ministry of Environment and Forests, March 2001. pp8.

Odum (1971), a pioneer in pollutant studies has given another classification from the ecological point of view, namely

1. Non-degradable pollutants,
2. Biodegradable pollutants.

The former are matters like Aluminum, Organic Phenol compounds and pesticides that do not degrade or that which degrade very slowly. Such pollutants not only accumulate but also get magnified with their subsequent movement in "Bio-geo-chemical cycle" along food chain. On the other hand, Biodegradable pollutants get degraded very easily. Thus, a pollutant is a component, which changes the balance of the environment, and nature cannot take it.

(a) POLLUTION CONTROL AGENCY IN INDIA

Measures for ensuring the maintenance of air, water and noise quality are entrusted to the Central Pollution Control Board and SPCB under the Ministry of Environment and Forests. The present air quality regulation was created under the Air (Prevention and Control of Pollution) Act of 1981 as well as the Environmental Protection Act of 1986. These acts empower the agencies to set and uphold Minimal National Standards (MINARS) for effluents from industries and National Ambient Air Quality Standards (NAAQS), as would be described later in the chapter. Central Pollution Control Board has been assigned various functions under the Air Act, 1981 to plan nationwide programme for prevention, control and abatement of air pollutants. Accordingly, National Air Quality Monitoring Programme (NAMP) had been initiated during 1984-85 at the national level to identify areas in need of restoration of air quality, identification of nature and the extent of pollution control and to regularly assess the effectiveness of pollution control programme. The CPCB is also responsible for the National Ambient Air Quality Monitoring (NAAQM) network, which presently includes 290 monitoring stations in 90 cities across India.

(b) URBAN ENVIRONMENT

Urbanization is posing a threat to environment. Urban environment is being degraded with the onslaught of population growth.[8] The deterioration of the environment, both physically and aesthetically, is most apparent in our cities.[9] The rapid industrialization in urban centres is costing the environment and thus in turn is also affecting the population in one or the other way.

The problems of environmental pollution are more complex in character in large metropolitan cities. It is not necessarily the result of industrial and economic development alone. The existing urban authorities of large urban agglomerations of underdeveloped countries have not been able to cope with the rapid urban growth. They are not able to provide adequate facilities like water, housing sewage, transportation, and employment. The metropolitan cities have grown disproportionately to the services laid out in the past. Where cities are expanding very fast the services such as water supply, sewerages, road network, electricity and other municipal services cannot be extended without redeveloping the central part, whereas such redevelopment of the central part requires huge financial investment and large organization for development management.[10]

The Urban areas, are not enthusiastic in generating adequate sources of Income for the provision of the essential services and for maintaining the same consequently there is an evident deterioration in physical environment and quality of life in the urban areas aggravated by widening gap between demand and supply of essential services and infrastructure and increasing population pressure on urban centers. The worst sufferers are the poor, whose access to the basic services like drinking water, sanitation, education and basic health services is shrinking. The finer values of human life and society in the urban areas are being polluted by the appearance of slums, improper solid waste disposal, water, air, noise pollution etc.

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[8] Singh, J. 1985. "Population, Pollution and the Urban Environment." In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi. Pp139.

[9] Ehrlich, P. R. & Ehrlich, A. H. 1970. "Population, Resource and Environment: Issues in Human Ecology," W. H. Freeman and Company, San Fransico.

[10] Pathak, C. R. 1985. "Man, Environment and Settlements" In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi. Pp 14

Human impacts on the natural environment are ancient and extensive. Even hunters- gatherers were suspected of massive faunal extinction. Agricultural and industrial growth accelerated population growth rate and increased the intensity of impact on environment. Davis rightly observes that the process of transformation of society is giving rise to a number of problems due to fast changing pattern of spatial interaction.[11] The innovation of new products and consumerists life style put even more pressure on the natural resources and the environment.

The major environmental problems of India can be categorized into two broad categories: (1) those arising as negative effect of the very process of development; (2) those arising out from conditions of poverty and under development.

III. 2. 1 AIR POLLUTION

The section on air quality examines the problem of air pollution in the metropolitan cities of India. Ambient air quality has a significant localized impact and the percentage of population exposed is much higher in urban areas and in particular metropolitan cities. Therefore since these areas have emerged as greatly stressed, the emphasis is on studying the causes for air pollution and the state of ambient air quality in the urban areas.

"The air nimbly and sweetly recommends itself unto our gentle senses."
– William Shakespeare ('Macbeth').

Air, which is a mixture of gases, moisture and some inert material, controls life of earth. It is a reservoir of oxygen needed by man and other animals and of carbon dioxide essential for plants. Any contamination on air may disturb the whole atmospheric system, which is an insulating blanket around the earth. Without air there would be no life on earth. Air pollution may be defined as the imbalance in the quality of air so as to cause ill effects. The industrial, automotive and domestic activities have resulted in increasingly outrageous insults to the atmosphere and are removed by natural processes of cleansing. But when pollution exceeds the atmosphere's self-purification capacity, accumulation of pollutants occur causing harm to humans.

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[11] Davis, Kinsley (1967), *The origin and Growth of Urbanization in the World.* In: H. M. Mayor and C. F. Cohn (eds.), *Readings in Urban Geography*, University of Chicago, Chicago, pp59.

According to American Medical Association, "Air pollution is the excessive concentration of foreign matters in the air which adversely affects the well being of the individual or damage to property."[12]

Expanding urbanization has influenced the atmosphere in different ways, such as growth of vehicle population, sanitation, multiplying industrialization, power consumption, etc. Urbanization has spelt out greater comfort in luxurious living with dramatic improvements in technology used. However, this development in technology accentuates the problem of air pollution.

Air pollution has been a steadily growing problem since Industrial Revolution began. The revolution started with the invention of technology that could use new sources of energy- particularly coal, oil and gas, which in turn helped the large scale industries to develop. There is a rapid increase in the level of air pollution due to the rapid expansion of the urban and industrial activities. Addition of material to the atmosphere by industrial and other human activities change atmospheric composition and perhaps the energy balance in localized areas. India's reliance on low –grade coal with high carbon content is the prime cause for large-scale carbon emission. Carbon emission had been exacerbated by low energy efficiency of coal –based plants.

Air pollution is caused by the emission of Aerosols (minute suspended particles, most of which are created by the combustion of fossil fuels (coal, oil, etc.). The combustion of fossil fuels releases a number of pollutants into the atmosphere notably Carbon Monoxide (CO), various Sulphur and Nitrogen oxides (SO_X and NO_X compounds) and Smoke, and as industry expand, so does the pollution. It is at its worst in heavily industrialized regions and can lead to health hazards (Smog) and to serious damage to crops and vegetation.[13] Virtually every major metropolitan city of the world has serious air-pollution problems.

The unprecedented growth in the use of fuel-driven road vehicles, made air pollution more and more difficult to avoid. Emissions of Nitrogen Oxide, Carbon monoxide, hydrocarbons and lead often severely reduce the quality of urban life. "Air pollution has been exacerbate by four particular development that typically occurs as

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[12] Trivedi, P. R. "International Encyclopaedia of Ecology and Environment." Vol. 11, Indian Institute of Ecology and Environment, New Delhi, 1995, pp2-3.

[13] Whittow, John B. 2000, The Penguin Dictionary of Physical Geography, Second Edition. Pp, 407.

regions/ countries become industrialized: growing size of cities; increasing traffic; rapid economic development and higher levels of energy consumption."[14]

III. 2. 1. 1 COMPOSITION OF NORMAL DRY AIR

The typical composition of unpolluted dry air has been given in table 3.1

Table 3.1

Concentration of Gases comprising Normal Dry Air

Gases	Percent by Volume	Concentration (ppm)
Nitrogen	78.08	78,9000
Oxygen	20.95	209,400
Argon	0.95	9,300
Carbon-di-oxide	0.03	315
Neon	0.001	16
Helium	0.0005	5.2
Methane	0.0001	1.0-1.2
Krypton	0.0001	1
Nitrous oxide	-	0.5
Hydrogen	0.00005	0.5
Xenon	0.000009	0.08
Nitrogen oxide	-	0.02
Ozone	variable	0.01-0.04

Source: Stern, Arthur C. 1968. "Air pollution" second edition, Vol. I. Air pollution and its effect, Academic Press, New York; State of Environment 1995, Ministry of Environment and Forests.

The table 3.1 above shows the typical composition of normal unpolluted Dry Air. Any change in the composition of air reduces its quality. In most cities of the world, the composition of normal dry air has changed. Gases like Carbon Monoxide, Nitrogen Oxide and Ozone are found in excess due to various activities of human being. As the composition of air changes, its quality deteriorates and become dangerous for human use.

III. 2. 1. 2 SOURCES OF AIR POLLUTION

Sources of air pollution are many and we are all a part of air pollution –causing process in our everyday life. To study these sources scientifically, these can be divided into two broad categories:

[14] UNEP, "Urban Air Pollution", UNEP/GEMS Environment library, No. 4, p7.

(i) Natural Sources,

(ii) Man-made Sources.

Natural sources, which cause pollution in the air, are volcano that releases suspended particulate matter, Sulphur dioxide, Methane, etc. Forest fires, biosynthesis and dust storms also cause air pollution. Oceans emit aerosols to the atmosphere in the form of salt particles, which are corrosive to metals and paints.

Man-made sources are generally predominant over natural sources and by far the most important to air pollution, since they occur in the close vicinity where we live. Anthropogenic activities result in air pollution on account of three broad sources, viz.,

- ❖ Industrial or Stationary sources (use of fossil fuels in industries and thermal power plants),
- ❖ Mobile sources (vehicles), and
- ❖ Domestic or In-door sources (burning of bio-mass, residential heating etc.).

The relative contribution of these sources varies across cities. Of them, the In-door sources are a major source of air pollution in the rural areas, caused by the burning of unprocessed cooking fuels in homes. On account of the pollutants released in closed and unventilated places is, perhaps, more dangerous than air pollution outdoors. Although small in quantity, domestic sources using wood and coal are in the respirable size fraction (<3.5 um) and high concentration is likely to occur in residential neighbourhoods. Mobile source is the largest source of air pollution in our urban centres.[15]

Man-made sources activities of human beings that pollute the air are listed in table 3.2.

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[15] Central Pollution Control Board. "Parivesh newsletter", Central Pollution Control Board, Ministry of Environment and Forests, june1995, No. 1, Vol. 2.

Table 3.2

Man-made sources of Air Pollution.

Sl. No.	Class	Aerosols	Gases and Vapours
1.	Combustion process (domestic burning, thermal power plants, vehicles etc.)	Dust, fumes, smoke.	SO_2, NO_2, CO, organic vapours, odours.
2.	Chemical process (paper mills, cement, fertilizers, etc.)	Dust, fume, mist.	Process- dependent (SO_2, CO, NH_3, NO_2, organic vapours, odours.
3.	Petroleum operations	Dust, mist.	SO_2, H_2S, NH_3, CO, hydrocarbons.
4.	Metallurgical processes (aluminium refineries, steel plants)	Dust, fume.	SO_2, CO_2, fluorides, organic vapours.
5.	Mineral processing	Dust, fume.	Process- dependent (SO_2, CO, fluorides, organic vapours)
6.	Food and feed	Dust, mist.	Odorous materials.
7.	Agricultural activities		
	⌖ Crop spraying	Dust, mist.	Organic Phosphate, chlorominated hydrocarbons.
	⌖ Field burning	Smoke, fly ash.	Sulphur oxides, organic vapours.
8.	Nuclear Energy Programmes		
	⌖ Fuel fabrication		Florides.
	⌖ Ore preparation	Dust.	Iodine-131 and Argon-41, Radioactive gases (Sr-90, CS-137, C-14, etc.)
	⌖ Bomb explosion		

Source: Trivedi, P. R. 1995. "International Encyclopaedia of Ecology and Environment." Vol. 11, IIEE, New Delhi.

The table 3.2 clearly shows how various human activities release gases that pollute the environment. Air Pollution is already a serious problem in many cities. It is mainly restricted to the urban areas. An increase in such activities puts more pressure on the environment.

Air pollutants in the atmosphere can stay in all three forms –gaseous, liquid, and solid; physical forms generally considered for air pollutants are:

1. *Particulate:* small discrete masses of solid or liquid matter. Eg. Dust, smoke, mist and fly ash.
2. *Gases:* widely separated molecules in rapid motion. They lack definite shape and volume. Eg. Carbon Monoxide, Sulphur dioxide and Hydrocarbons vapours.

Air pollutants can also be classified as Primary and Secondary sources based on their characteristics at the time of emissions and physical / chemical changes they undergo while in the atmosphere.

1. *Primary Pollutants:* emitted into the atmosphere directly from the identifiable sources. They are found in the atmosphere in the same chemical form as at the time of emission from the source.
2. *Secondary Pollutants:* undergo chemical changes in the atmosphere as a result of reactions among two or more pollutants.

SPM (Suspended Particulate Matter): SPM is a subset of particulate matter, which comprises particles with sizes less than 100 um (1um = 10^{-6}m) and is likely to remain suspended in atmosphere for a long time. Health effect of SPM is a function of particle size. Particulate matters enter the human body through respiratory system, and fine particles with less than 1 um size even reach the lungs.

Sulphur dioxide (SO_x): Sulphur dioxide arises during combustion, where the Sulphur present in the fuel gets oxidized emitting Sulphur dioxide with the exhausted gases. It is emitted in significant amounts from thermal power plants, smelters, and petroleum refining process and from vehicular sources. Sulphur dioxide is scavenged from the atmosphere due to Sulphuric acid formation, conversion to Sulphate salts and during photochemical oxidation process. Sulphur dioxide is highly soluble and consequently is absorbed in moist passages of upper respiratory system. SO_x causes significant broncho-constriction in asthmatics at relatively low concentrations (0.25 and 0.5 ppm).

Oxides of Nitrogen (NO_x): NO_x compounds in the atmosphere are Nitric Oxide (NO) and Nitrogen dioxide (NO_2), Nitrous Oxide (N_2O) and salts of nitrate (NO_4), Nitrite (NO_3) and Ammonia (NH_4^+). Nitric oxide is formed during combustion as a result of oxidation of atmospheric Nitrogen, while NO_2 is formed at low temperatures, when nitric oxide combines with excess oxygen in the combustion system. Oxides of nitrogen are scavenged from the atmosphere through formation of nitric acid, nitrates or nitrites and through their dry deposition. NO is rapidly converted to NO_2 which has considerable health effects. There are no available evidences supporting the preposition that nitric oxide is a health hazard at levels found in urban air. NO_2 is a toxic gas and a highly corrosive.

Carbon Monoxide (CO): The most severe problems occur in cities where vehicle emissions are concentrated between rows of tall buildings. Carbon Monoxide is produced due to incomplete combustion, industrial processes, solid waste disposal and refuse burning. In urban areas, Carbon Monoxide corresponds with traffic volume on roads and follows two peaks in a day i.e., morning and evening correlated with traffic rush of vehicles. The effects of Carbon Monoxide exposure are reflected in the oxygen –carrying capacity of the blood. It interferes with the oxygen by Haemoglobin. Haemoglobin molecule has chemical affinity for CO about 210 times as great as that of Oxygen. CO is relatively insoluble and easily reaches the alveoli (lungs) along with oxygen. It affects brain, central nervous system and the heart.

Hydrocarbons: comprise of a broad class of organic compounds containing carbon and hydrogen. Lower molecular weight compounds causes eye irritation, coughing and sneezing. Higher molecular weight compounds have carcinogenic or mutagenic effects.

The main cause of air pollution is man-made sources that consist of industrial concentration, thermal power plants and fuel driven vehicles. It is becoming worse as urban population grows and the number of fuel driven motor vehicles is increasing, which play an important role and of recent is the major contributor in polluting the urban atmosphere. Air Pollution also affects atmospheric properties as well which includes visibility reduction, fog formation and precipitation, solar radiation reduction and temperature and wind distribution alteration. Reduced visibility can interfere with road traffic and aviation.

III. 2. 1. 3 AIR QUALITY STANDARD

Deterioration in the air quality is globally one of the major and the more wide spread environmental problem in urban areas. The ambient air quality has deteriorated all over the country; especially in semi-urban and urban areas[16] India's urban areas represent complex environmental problems. In particular, the quality of the ambient air in these areas has been deteriorating rapidly over the past few decades, due to vehicular, thermal, and industrial emissions.

According to Stern (1973), "Air quality standards are legal limits placed on levels of air pollutants in the ambient (outdoor) air during a given period of time. As such they characterize the allowable levels of exposure permitted to the population and/or to ecological system."[17] The author further argues that air quality standards have evolved differently in different countries depending upon the exposure condition; the socio-economic situation and the importance of health relate problems.

The Central Pollution Control Board has given minimum standards for the quality of air for the Indian cities. If the quality of air deteriorates beyond the minimum standard it will be called polluted. Central Pollution Control Board adopted the following air quality standards for the first time in the 47th meeting on November 11, 1982 in an exercise of its Jurisdiction under section 16(2)(h) of the Air (Prevention and Control of Pollution) Act, 1981 to arrest the deterioration in the air quality.

Table 3.3

CPCB's Air Quality Standards (24 hour mean)

AREA	Category	Concentration (ug/m^3)		
		SPM	SO_2	NO_2
A	Industrial and Mixed use	500	120	120
B	Residential and Rural	200	80	80
C	Sensitive	100	30	30

Source: NEERI (1994), "Air Quality Status." No. 6, p 220.

Note:
SPM = Suspended Particulate Matter;
SO_2 = Sulphur dioxide;
NO_2 = Nitrogen Oxide

[16] National Human Development Report, 2001.
[17] Stern, Arthur C. 1977. "Air pollution" third edition, Vol. V. Air Quality management, Academic Press, New York, pp40.

These standards were revised on 11th April 1994 and were replaced with more detailed standards, National Ambient Air Quality Standards (NAAQS) and notified in the Gazette of India. The new standards have been listed in table 3.4.

According to the procedure specified by CPCB, at least 95% of the time one observes the concentration of the above pollutants exceeding the limit prescribed in table 3.4. It is applied to any monitoring station, when monitored uniformly over 12 months of a year with a frequency of not less than once a week, with sampling time of eight hours for any sample. The primary aim of the ambient air quality standards is to provide a basis for protecting public health from the adverse effects of Air Pollution and for eliminating or reducing to a minimum, those contaminants of air that are known to be hazardous to human being, animals, vegetation and historical monuments. Ammonia has recently been added to the standards list, though it's monitoring not being done at present.

III. 2. 1. 4 AIR QUALITY STANDARD IN THE METROPOLITAN CITIES

Being the engine of economic growth and development, large agglomerations in their process of higher production and consumption exert pressure on the environment. The situation is aggravated due to the interplay of two factors namely size of population and level of consumption. That is to say if the size of population remains constant and the level of consumption increases or vice-versa, the negative impact on the environment is not substantial. But, *ceteris paribus*, if both the factors show an upward movement the negative impact on the environment is devastating. Such interrelationship between, population size, level of consumption and technology would be dealt later.

Table 3.5

Quality of air in the metropolitan cities, 1991 – 1998.

Quality of Air in Metropolitan Cities of India

Metropolitan cities	SPM (ppm)				Oxides of Nitrogen (ug/m^3)				Sulphur dioxide (ug/m3)			
	Industrial		Residential		Industrial		Residential		Industrial		Residential	
	1991	1998	1991	1998	1991	1998	1991	1998	1991	1998	1991	1998
Greater Mumbai	199	226	267	103	30.9	24.9	28.3	22.1	33.4	21.7	21.4	16.1
Kolkata	496	286	338	275	39.8	DI	41.2	30.9	73.7	DI	58	31
Delhi	349	367	330	341	24.9	34.7	28.4	28.6	15.1	20.2	12.4	15.8
Chennai	147	126	118	116	20.3	15.7	19.4	22.3	22.9	13.1	7.6	10.5
Bangalore	99	134	60	239	11.4	23.2	12.1	28.4	20.4	35.3	18.3	41.6
Hyderabad	89	259	184	167	12.2	28.3	22.4	33.3	13.9	13.0	9.5	10.6
Ahmedabad	306	NA	307	NA	35.0	NA	32.9	NA	21.9	NA	31.5	NA
Pune	207	374	188	247	18.4	59.6	25.7	56.6	18.4	50.2	15.7	48.1
Kanpur	484	441	424	404	15.4	25.9	12.7	21.8	10.4	16.5	8.8	17.7
Jaipur	184	248	306	209	13.6	22.8	16.4	20.9	11.4	13.3	6.7	8.5
Nagpur	245	138	252	149	19.7	13.8	13.7	17.1	6.2	8.3	6	6.1
Patna	NA	NA	234	359	NA	NA	15.0	12.9	NA	NA	9.4	17.1
Bhopal	274	234	153	287	10.1	26.3	5.5	26.2	13.2	17.5	6.4	17.2

Source: Central Pollution Control Board, "Air Quality: Status and Trends in India" Central Pollution Control Board, Ministry of Environment and Forests, October 2000.

Note:
DI: Data Inadequate.
NA: Not Available.

Virtually every major metropolitan city of the world has serious Air Pollution problems. Today, however, it is not only the air over our cities that is polluted. The entire atmosphere of our planet is now afflicted to some degree.[18] The ambient air quality in some of the major metropolitan cities of India as listed in table 3.5 present the following picture:

- Kolkata had the highest concentration of SPM in industrial areas in 1991 (496 ppm), but it was over taken by Kanpur in 1998 with a concentration of 441 ppm, which was the highest for that year.
- Kolkata, Chennai, Kanpur, Nagpur, and Bhopal have shown a slight decline in their SPM concentration, but metropolitan cities like, Greater Mumbai, Delhi, Bangalore, Hyderabad, Pune, & Jaipur have shown an increase in the concentration of SPM from 1991 to 1998 for the industrial areas.

[18] Ehrlich, P. R. & Ehrlich, A. H. 1970. "*Population, Resource and Environment: Issues in Human Ecology*," W. H. Freeman and Company, San Fransico.

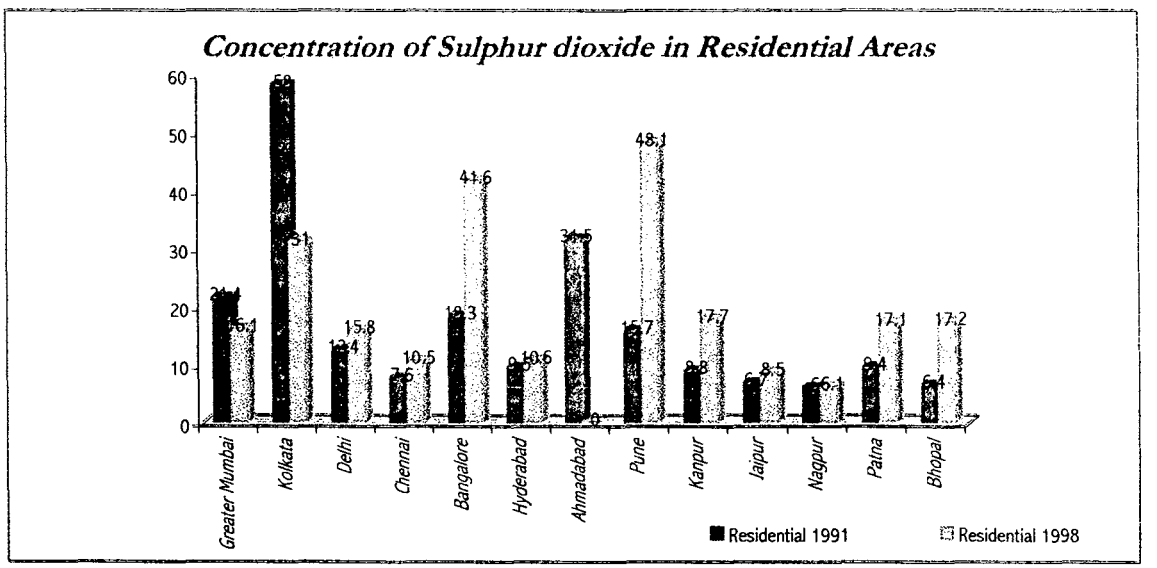
- The SPM concentration in Residential areas was the highest for both the years in Kanpur, 484 ppm (1991) & 441 ppm (1998). Though for Kanpur itself had registered a decline in the concentration.
- In general there has been a declining trend in the concentration of SPM in the residential areas. Though Chennai and Kanpur show only a slight decline. But in metropolitan cities like Bangalore, Delhi, Pune, Patna and Bhopal have registered an increase.
- Kolkata has the highest concentration of the oxides of Nitrogen in 1991 (39.8 ug/m^3) followed by Ahmedabad (35.0 ug/m^3) and Greater Mumbai (30.9 ug/m^3) in the industrial areas of the metropolitan cities. While that for the year 1998 was Delhi (34.7 ug/m^3).
- There has been an increase in the concentration of the oxides of Nitrogen in the industrial areas in 1998, especially in Pune, where it rose from 18.4 ug/m^3 to 59.6 ug/m^3. Only Greater Mumbai, Chennai and Nagpur have registered a decline.
- For the Residential areas, the maxima for the concentration of the oxides of nitrogen was registered at Kolkata in 1991 and Pune in 1998 with levels reaching as high as 41.2 ug/m^3 and 56.6 ug/m^3, respectively.
- Like the industrial areas, the residential areas also depict a general upward trend in the concentration level of the oxides of nitrogen in the urban air from 1991 to 1998. Only Greater Mumbai, Kolkata, and Patna have recorded a marginal decrease in their concentrations.
- The concentration for Sulphur dioxide for industrial areas was highest for Kolkata (73.7 ug/m^3) in 1991, while Ahmedabad supported the highest concentration of Sulphur dioxide in residential areas (31.5 ug/m^3). The statistics for the year 1998 reveal that Pune had overtaken in both the areas, & supported the maximum concentrations of 50.2 ug/m^3 (industrial areas) and 48.1 ug/m^3 (residential areas). In general there has been an increase in the concentrations of Sulphur dioxide in 1998 in nearly all the metropolitan cities. Except, Greater Mumbai (both industrial and residential), Chennai (both industrial and

residential) and Hyderabad (only industrial), which show a slight decline; all other metropolitan cities follow the trend.

- The data for concentration of all the pollutants in the Industrial areas of Patna (1991 & 1998), and for Ahmedabad (1998) is not available. While the data available for concentration of Sulphur dioxide & Oxides of Nitrogen in Kolkata in 1998 is inadequate.

Though, Sulphur dioxide and oxides of Nitrogen levels have registered an upward trend, they remain well within the National Ambient Air Quality Standards in all the cities. The SPM levels at Indore, Ahmedabad, Patna and Ludhiana are high In addition to these common air pollutants; some of the toxic and carcinogenic chemicals are being detected in urban air. Very little monitoring, if any, of these pollutants is currently being done.[19] The figures 3.1 to 3.6 clearly illustrate more the scenario described above.

Figure 3.1



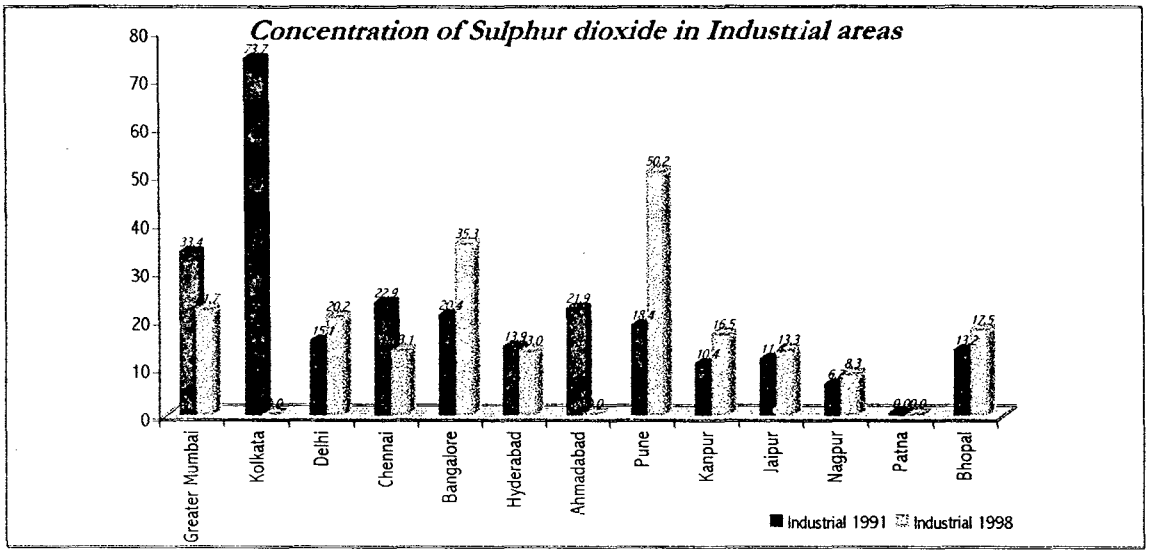
Source: Table—3.5

Figure 3.1 shows that in 1991 Kolkata had the highest concentration of Sulphur dioxide in Residential areas, followed by Ahmedabad. But in 1998, Pune followed by Bangalore led the metropolitan cities in the concentration levels of Sulphur dioxide. Though in general there was a rising trend in the level of concentration of Sulphur

[19] National Human Development Report, 2001.

dioxide in residential areas, except for Greater Mumbai and Kolkata. The data for residential areas of Ahmedabad in 1998 was not available.

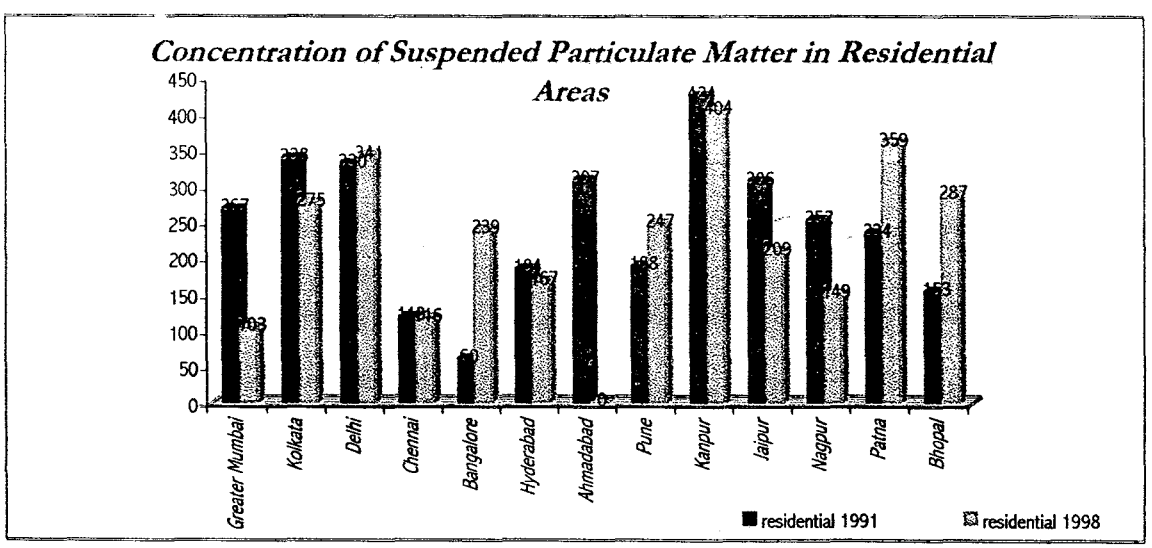
Figure: 3.2



Source: Table—3.5

From 3.2 it is evident that in general there has been an increase in the concentration of Sulphur dioxide in industrial areas except in Greater Mumbai and Chennai, which have shown only a minor decline in the concentration levels. Kolkata had the maximum concentration in 1991 while the concentration levels for 1998 are available for Kolkata the highest is shown by Pune followed by Bangalore.

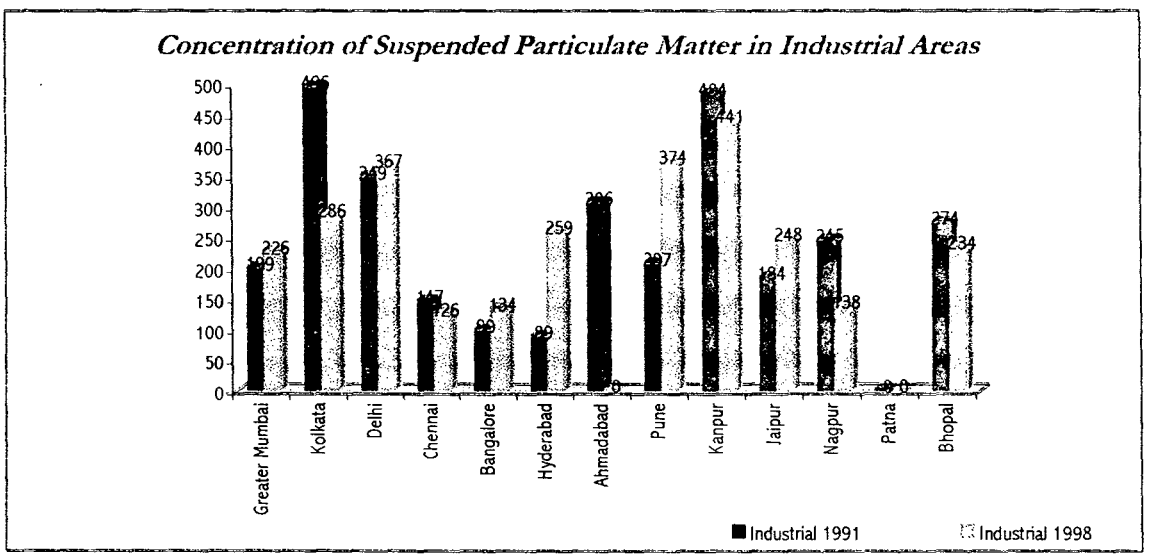
Figure: 3.3



Source: Table—3.5

Figure 3.3 shows that the concentration of SPM was high in residential areas in 1991 with maximum being at Kanpur, though in 1998 the SPM concentration lowered for Kanpur but still it the highest value amongst the selected metropolitan cities. The concentration levels have increased since 1991, maximum for Bangalore- from 60 ppm in 1991 to 239 ppm in 1998. Delhi, Pune, Patna, and Bhopal also supported the increased concentration levels of SPM in 1998. While, the other metropolitan cities had a decline in the concentration levels of SPM.

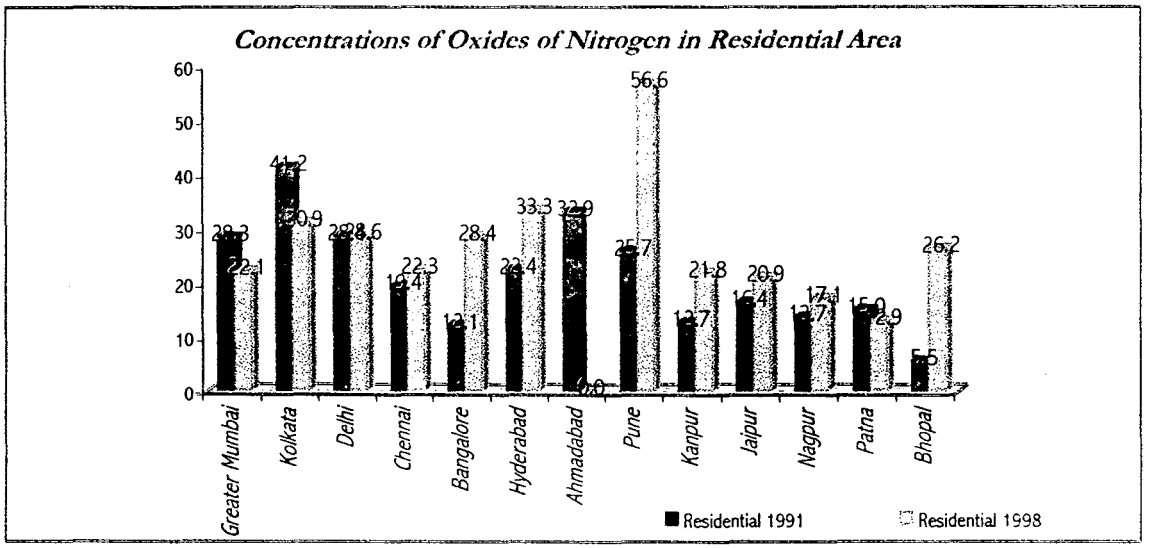
Figure: 3.4



Source: Table—3.5

Figure 3.4 shows that there has been a general increase in the concentration of SPM in Industrial areas in 1991-1998 among the selected metropolitan cities of India. While the maximum increase in the SPM concentration in 1998 was witnessed by Hyderabad from 88 ppm in 1991 to 259 ppm in 1998; Kolkata had the maximum SPM concentration (496 ppm) in 1991, followed closely by Kanpur (484 ppm). But in 1998, Kanpur overtook Kolkata to have the maximum SPM in the industrial areas. SPM concentration in the ambient air of Kolkata reduced nearly to half (from 496 ppm in 1991 to 286 in 1998).

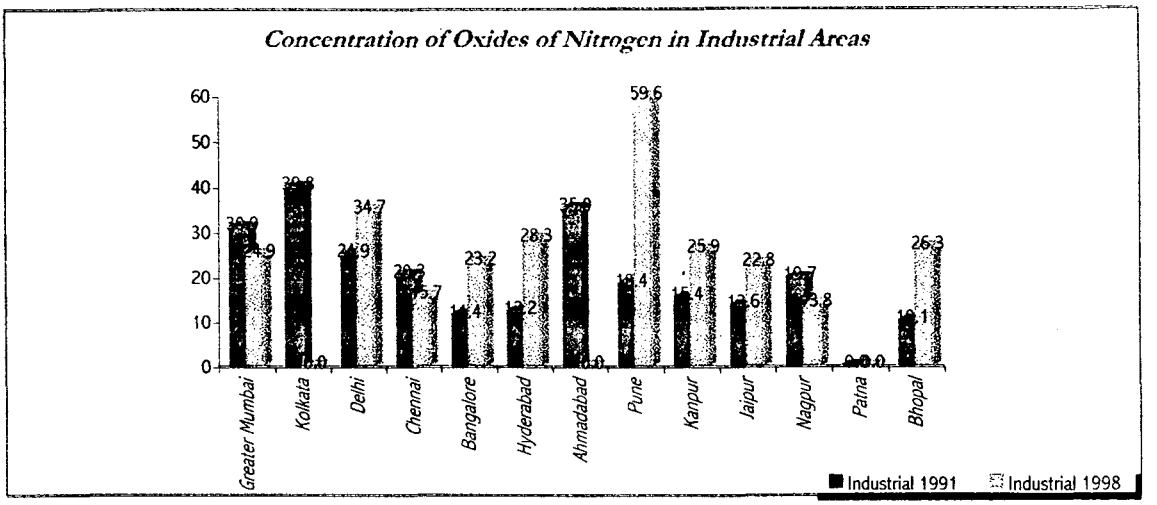
Figure: 3.5



Source: Table—3.5

Figure 3.5 shows that in the residential areas, Kolkata had the maximum concentration of the Oxides of Nitrogen in 1991 (41.2 ug/m^3) but Pune overtook its position in 1998 (56.6 ug/m^3). There has been a general increase in the concentration of the Oxides of Nitrogen in the selected metropolitan cities. Pune, Bhopal, and Bangalore showed a substantial increase in their concentration levels. Though Greater Mumbai and Kolkata have managed to bring down their NOx levels. The data for the concentration levels of NOx in 1998 for Ahmedabad is not available.

Figure: 3.6



Source: Table—3.5

Figure 3.6 shows the concentration of Oxides of Nitrogen in the selected metropolitan cities of India. Kolkata had the highest concentration in 1991 with a concentration of 73.7 ug/m^3, but Pune took its place in 1998 with a substantial increase in its concentration levels from 18.4 ug/m^3 to 59.6 ug/m^3. Though there has been a general increase in the concentration levels of the Oxides of Nitrogen in the metropolitan cities but, Greater Mumbai, Chennai, and Nagpur did manage to bring down their concentration levels to some extent.

The ambient air quality in Delhi with respect to Nitrogen dioxide, Sulphur dioxide, and respirable particulate matter showed improvement in 2000 as compared to the levels in 1999.[20] An estimated 2000 metric tonnes of air pollutants are emitted into the atmosphere every day in Delhi. Table 3.6 shows the variations in the concentration of pollutants in the ambient air of Delhi in ug/m^3:

Table 3.6

Air Pollution in Delhi

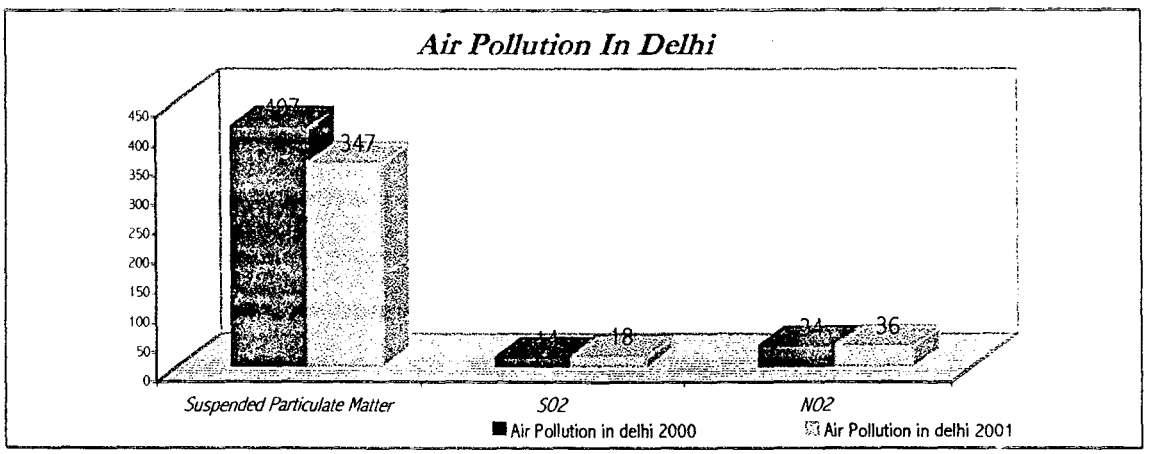
	2000	*2001*
Suspended Particulate Matter	407	347
SO_2	14	18
NO_2	34	36

[20] Central Pollution Control Board, "Parivesh: Highlights 2000." Central Pollution Control Board, Ministry of Environment and Forests, March 2001.

The comparison of ambient air quality for the year 2000-2001[21] reveals that:

- ❖ Annual average SPM concentration for all monitoring sites in Delhi came down from 405 ug/m^3 in the previous year to 347 ug/m^3 in 2001.
- ❖ Concentration of the annual average value of Sulphur dioxide and Nitrogen dioxide in the ambient air of Delhi decreased to 14 ug/m^3 from 18 ug/m^3 and to 34 ug/m^3 from 36 ug/m^3 respectively. However, at some places there has been an increase in the values of Nitrogen dioxide from the previous years.
- ❖ Decreasing trend in Sulphur dioxide levels was observed which is attributable to low Sulphur diesel introduced in Delhi, while the observed decreasing trend in the levels of Nitrogen dioxide might be due to prohibition in plying of more than 15 year old commercial vehicles in Delhi.
- ❖ Concentrations of all regulatory pollutants in ambient air have reduced. This may be attributed to the increased use of cleaner fuels like low Sulphur diesel and compressed natural gas (CNG) in motor vehicles.[22]

Figure: 3.7



Delhi has managed to shake off the dubious distinction of being the most polluted city in the country. It may no longer be the most polluted city but that is a small comfort to the urban residents, as; the capital is still far from meeting the ambient air quality standards laid down by Central Pollution Control Board. Delhi, which has experienced a massive growth in small-scale industries in the last 15 years, has been directed by the

[21] Central Pollution Control Board, "Parivesh: Highlights 2001." Central Pollution Control Board, Ministry of Environment and Forests, January 2002.
[22] Ibid.

Supreme Court to relocate its 114 highly polluting stone crushers to outside the city boundaries. Consequently, many of these offenders have moved into the neighboring state of Haryana, where the environment is better able to assimilate particulate matter released from crushed rocks.[23]

The Sulphur dioxide levels have generally attained air quality standards in the country except some cities of dense urban and industrial activities like Dhanbad, Ahmedabad, Vadodra, and Surat. The Nitrogen dioxide violation had been observed at Vishakhapatnam, Jabalpur etc. due to the combined effect of Vehicular and industrial pollution. The range and mean of combined site averages SPM at Kanpur, Kolkata and Delhi had exceeded the NAAQS. However, mean annual average SPM at Chennai and Bangalore had been well below the annual average air quality standard.[24]

Air Pollution due to Transport

Transportation is a major source of air, water, land and noise pollution in the urban areas. More than 70% of air pollution in urban areas is due to transport related emissions.[25] Vehicles produce concentrated pollution and high noise levels. These have seriously affects the health of the people, their quality of life and the productivity of the economy.[26] Auto pollution and traffic congestion are major factors in making today's city an unpleasant place in which to live.[27] As an urban area grows, so does the number of vehicles, which in turn means pollution. The number of vehicles is increasing day by day and has become a cause of air pollution and degradation of environment. The number of metropolitan cities in India increased from 1 in 1901 to 5 in 1951 to 35 in 2001; while the urban population, which was 25.8 million in 1901 rose to 62.4 million in 2001. Unfortunately, this rapid urbanization has been accompanied by an even faster growth in

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[23] Worldwide Fund for Nature, 1995. *Delhi Environmental Status Report, An Information Handbook for Citizen Action.* Sponsored by Dept of Environment, Government of NCT, New Delhi.
[24] Central Pollution Control Board, "Air Quality: Status and Trends in India." Central Pollution Control Board, Ministry of Environment and Forests, NAAQMS/14/1999-2000. October 2000.
[25] Padam, Sudarsanam. "Bus Transport and Environment: Challenges and Opportunities." In: Indian Journal of Transport Management, October –December 2001. pp 531-532.
[26] Agarwal, O. P. "Towards a National Urban Transport Policy." In: Indian Journal of Transport Management, October –December 2001. Pp 593 –614.
[27] Detwyler, Thomas R. and Marcus, Melvin G. 1972. "Urbanization and Environment." Duxbury Press. Pp 73.

the number of motor vehicles on our roads, manifesting itself in the form of severe congestion and air pollution. Growth of vehicles and of population is shown in table 3.7

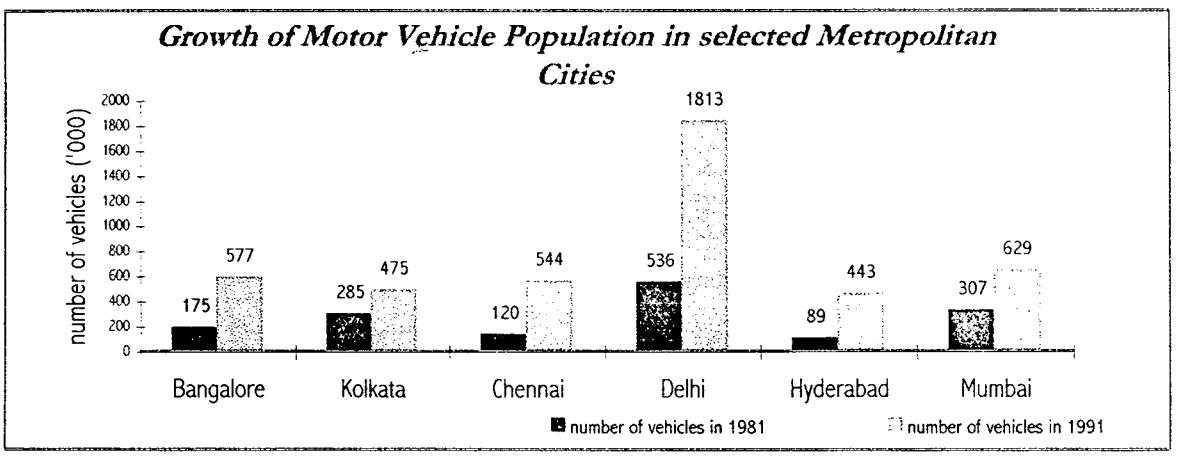
Table 3.7

Growth of Population and Vehicles (in millions)

Metropolitan city	1981		1991		Absolute Increase		Growth '81- '91	
	Vehicles	Population	Vehicles	Population	Vehicles	Population	Vehicles	Population
Bangalore	175	2.91	577	4.11	402	1.2	5.6	1.8
Kolkata	285	9.19	475	10.86	190	1.67	2.1	1.3
Chennai	120	4.28	544	5.36	424	1.08	7.4	1.4
Delhi	536	5.71	1813	8.37	1277	2.66	5.3	1.9
Hyderabad	89	2.53	443	4.27	354	1.74	8.6	2.4
Mumbai	307	8.23	629	12.56	322	4.33	2.6	2.0

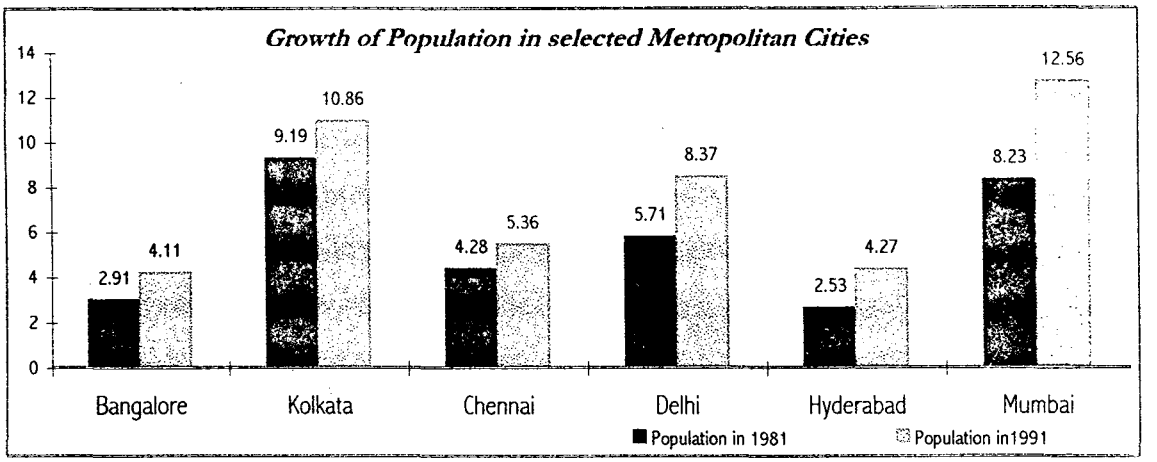
Source: Handbook of Transport Statistics in India, Ministry of Surface Transport, 1999.

Figure: 3.8



Source: Table 3.7

Figure: 3.9



Source: Table 3.7

Figures 3.9 & 3.10 show an increase in the vehicular population in all the selected metropolitan cities. The vehicular population in Bangalore more than trebled but the population grew only 1.4 times during 1981-91. Kolkata's vehicles increased 1.66 times while the population grew 1.18 times. Chennai witnessed a 4.5 times increase in its vehicular population, while the population grew 1.25 times only. Delhi's vehicular population has more than trebled in a decade. Though the population during the same time period could barely double. Hyderabad's vehicular population grew nearly 5 times while the population could barely double itself during the same time –period. In Mumbai, the population grew only 1.5 times from 1981 to 1991, while the number of vehicles doubled while the population grew one and a half times only.

Traffic noise in large cities pose a threat to human health and hearing causing both physical and mental stress. The automobiles with its internal combustion engine, emits poisonous gases that are harmful to human health and is the most serious pollution of the technological age. Air quality in an urban area is not only a reflection of escalating number of vehicles, but also of the changing urban landscape.

For the first time, a major initiative for vehicular emission control and auto fuel quality improvement was taken in the country when emission standards for vehicles were notified under the Environment (Protection) Act, 1991. Also, efforts for improving the vehicular emission control Technology were introduced to meet the progressive tightening of vehicular emission standards, which were enforced from 1996 and 2000 respectively. Fuel Quality Standards were notified first time in 1996 under the

Environment (Protection) Act, 1986. Within a span of less than 5 years, significant improvements in vehicular emission norms and Auto Fuel Quality has been achieved particularly through total phasing out of lead additive in petrol and reduction of Sulphur in diesel.[28]

The main pollutants emitted from the automobile are particulate matter (PM), Sulphur dioxide (SO_2), oxides of Nitrogen (NO_x), Hydrocarbons (HC), and Carbon Monoxide (CO) and lead compounds. Elevated PM concentrations in urban locations have normally been associated with local traffic emissions.[29] Table 3.8 presents the estimated emission load in some metropolitan cities.

Table 3.8

Estimated Vehicular Emission Load in Metropolitan cities, 1994.

S. No.	Name of metropolitan city	*Vehicular Pollution Load (Tonnes per Day)*					
		Particulates	Sulphur dioxide	Oxides of Nitrogen	Hydrocarbons	Carbon Monoxide	Total
1.	Delhi	10.30	8.96	126.46	249.57	651.01	1046.36
2.	Mumbai	5.59	4.03	70.82	108.21	469.92	659.57
3.	Bangalore	2.62	1.76	26.22	78.51	195.36	304.47
4.	Kolkata	3.25	3.65	54.69	43.88	188.24	293.73
5.	Ahmedabad	2.95	2.89	40.00	67.75	179.14	292.73
6.	Pune	2.39	1.28	16.20	73.20	162.24	255.31
7.	Chennai	2.34	2.02	28.21	50.46	143.22	226.25
8.	Hyderabad	1.94	1.56	16.84	56.33	126.17	202.84
9.	Jaipur	1.18	1.25	15.29	20.99	51.28	88.99
10.	Kanpur	1.06	1.08	13.37	22.24	48.42	86.17
11.	Lucknow	1.14	0.95	9.68	22.50	49.22	83.49
12.	Nagpur	0.55	0.41	5.10	16.32	34.99	57.37
	Grand Total	35.31	29.84	422.88	809.96	2299.21	3597.20

Source: Central Pollution Control Board. "Parivesh newsletter", Central Pollution Control Board, Ministry of Environment and Forests, June1995, No. 1, Vol. 2.

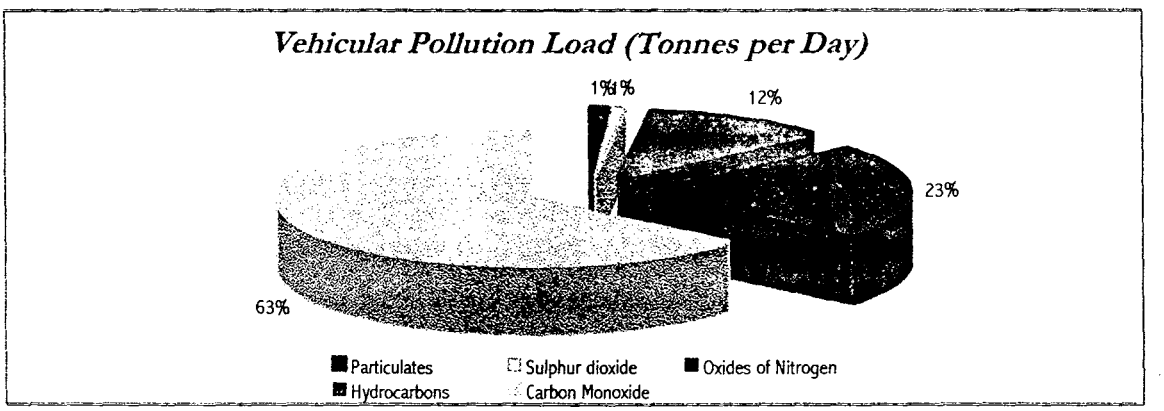
It may be noted from the table 3.8 that CO has the largest emission followed by Hydrocarbons; Oxides of Nitrogen come next as illustrated in figure 3.11. In 1994, Delhi exceeded in all the vehicular emissions with Greater Mumbai following next to it. In Kolkata 70% of air pollution is caused by auto emissions. In Kolkata, only the

[28] Central Pollution Control Board, "Vehicular Pollution Control in Delhi- Initiatives & impacts." Central Pollution Control Board, National Ambient Air Quality Monitoring Series, NAAQMS/18/2001-2002. October, 2002.

[29] Grima, Ramon; Micallef, Alfred; Colls, Jeremy J. "External contribution to Urban Air Pollution." In: Environmental Monitoring and Assessment, Vol. 73, No. 3, Feb. (I) 2002.

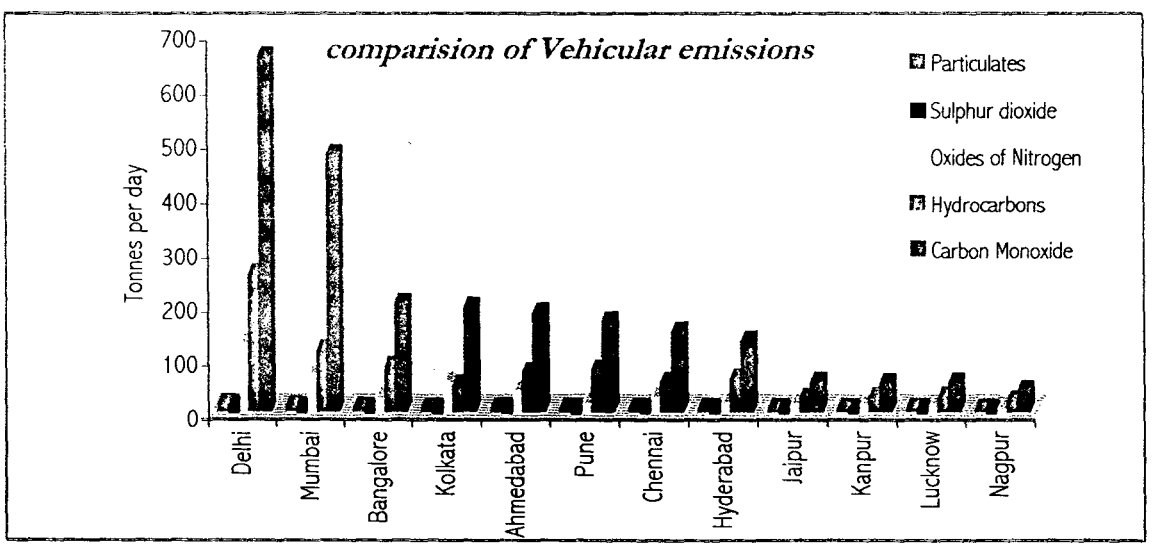
Hydrocarbons load is lesser than that of Bangalore and Ahmedabad while the other concentrations are higher than these two metropolitan cities. Bangalore has lesser load of Oxides of Nitrogen than Ahmedabad, Kolkata, and Mumbai. Also it has lower loads of Sulphur dioxide and Particulate matter in its ambient air. Nagpur has the minimum load of all the vehicular emissions. Delhi has nearly double the amount of particulates, Sulphur dioxide, and Hydrocarbons than the nearest follower, Greater Mumbai. This is well illustrated in figures 3.12 to 3.15.

Figure: 3.10



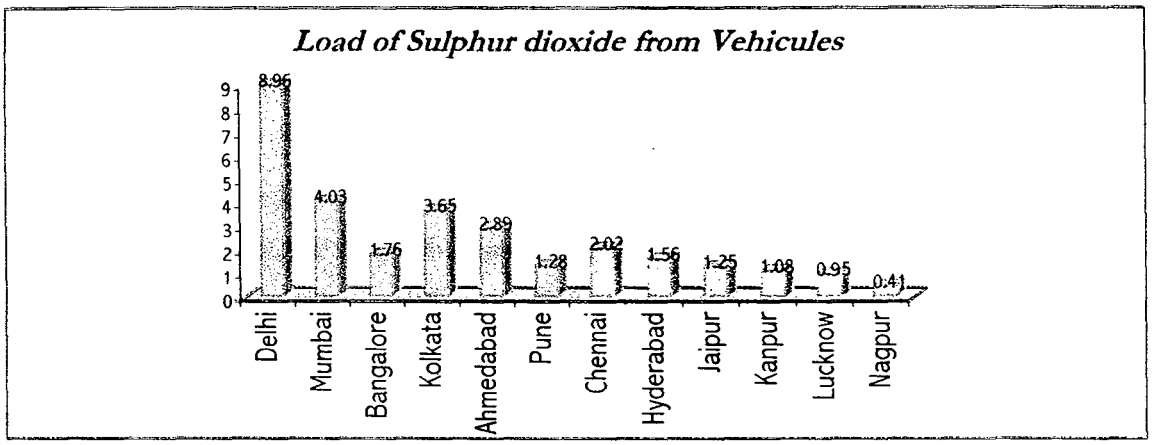
Source: Table 3.8

Figure: 3.11



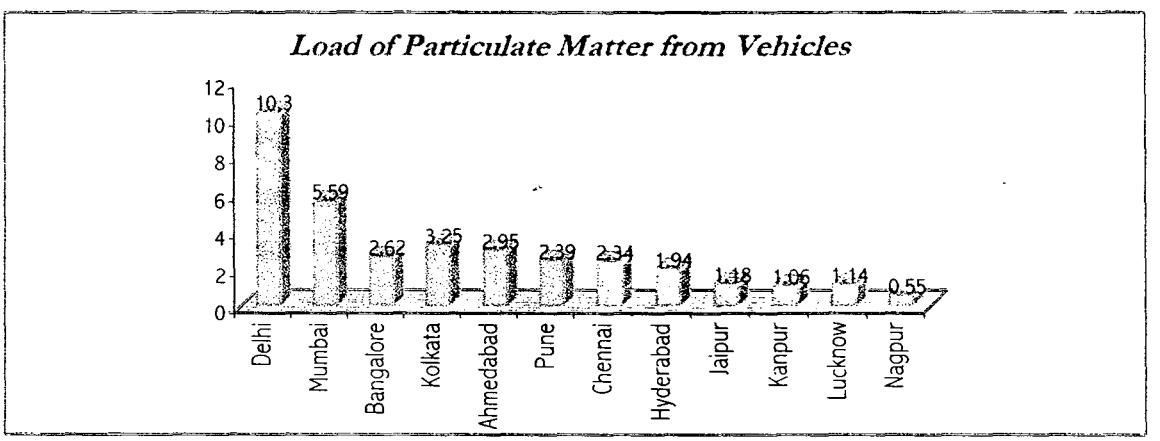
Source: Table 3.8

Figure: 3.12



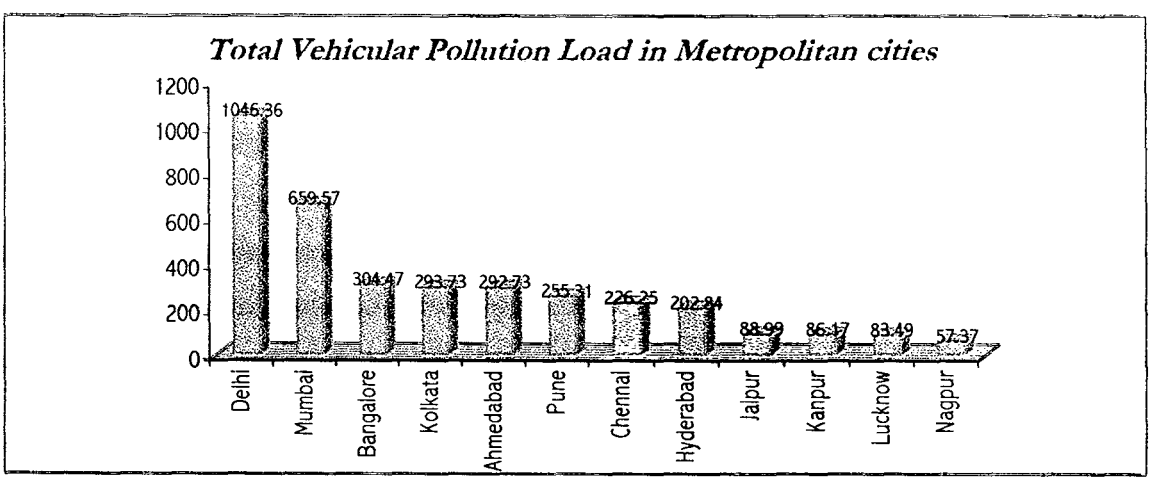
Source: Table 3.8

Figure: 3.13



Source: Table 3.8

Figure: 3.14



Source: Table 3.8

Exhaust emission from diesel engines include Carbon Monoxide, hydrocarbon oxides, organic acid, etc. also affect the ambient air quality. The two primary pollutants are Carbon Monoxide and Nitrogen dioxide, both of which are poisonous gases are hazardous to health.

India: Between 1970 and 1990, the number of vehicles has grown 11.5 times, from about 1.9 million to more than 21 million.[30] At the same time, the figure per 1000 population has increased from 3.4 to 25.31, and is expected to exceed 40 by the year 2000. The bulk of this vehicular population is found in urban centers, with about one-third concentrated in the 23 metropolitan cities (as of 1991) of the country. Furthermore, of the total 25 million vehicles registered in 1993, 82 percent are personal modes of transport, with the share of two-wheelers and cars at 70 percent and 12 percent respectively. During the period 1971-1991, the share of 2-wheelers had grown from 30 percent to 66 percent, while that of automobiles had fallen from 36.5 percent to 14 percent.[31] Although 2-wheelers are generally more fuel efficient than passenger cars, they often exercise little pollution control, thereby contributing greatly to carbon monoxide, Sulphur dioxide and Nitrogen Oxides' emissions.

The total length of Indian roads has increased from 917,000 kilometers in 1970-71 to 2,103,000 km in 1990-91. However, this increase in road capacity is inadequate in comparison to the number of vehicles just mentioned. The marked increase in vehicles per person has been evident in the growing problem of road congestion in Indian cities. While 'traffic jams' are a problem typically associated with developed country cities, India is now beginning to experience similar gridlocks.

A study of 12 Indian cities by the Central Institute of Road Transport found Delhi to clearly be the most congested city, followed by Calcutta.[32] In addition to the great inconvenience caused by this, over-congestion tends to degrade the roads and causes

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[30] Ministry of Surface Transport, Transport Research Division, 1993. *Pocket Book on Transport Statistics.* GOI, New Delhi.
[31] ibid.
[32] Tata Energy Research Institute (TERI), 1996. TERI Energy Database and Directory Yearbook (TEDDY), 1996-96. New Delhi.

decreases in vehicle fuel efficiency. Furthermore, such road congestion exacerbates the problem of certain types of air pollution, e.g. ozone pollution, which tend to be localized in nature. However, several cities, most notably Madras and Coimbatore, have relatively little congestion.

At the same time as the rapid growth in vehicular traffic, India has also seen an impressive expansion of the thermal power and industrial sectors. Since Independence, the amount of thermal power capacity has grown from about one gigawatt (GW), to a present level of almost 60 GW.[33] In the last three decades, the number of registered industries in India has increased by a factor of seven, to over 100,000 industries, with particularly large growth in the production of steel, aluminum, and chemical fertilizers.[34] Although there has been a movement in these industries to adopt pollution control measures, many of these continue to emit large quantities of air pollutants.

Delhi: The capital of India has the highest Air Pollution due to vehicular emission because of the maximum number of vehicles. Delhi's vehicle population is more than the combined vehicle population of three major cities –Chennai, Kolkata and Mumbai.[35]

Table 3.9: The number of Vehicles (in millions)

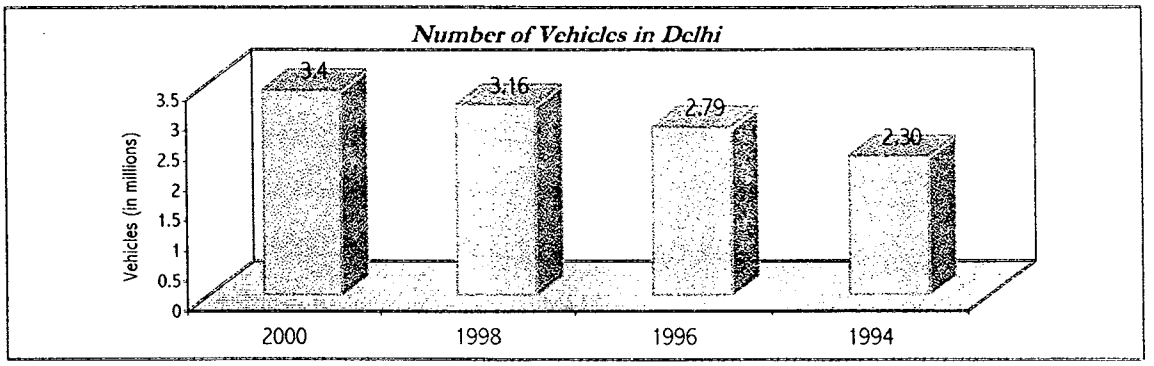
	2000	1998	1996	1994
Delhi	3.4	3.16	2.79	2.30

Source: Central Pollution Control Board, "Vehicular Pollution Control in Delhi: Initiatives & impacts." Central Pollution Control Board, Ministry of Environment and Forests, October 2001.

The number of vehicles has increased from 2.30 million in 1994 to 3.4 million in the year 2000. Also illustrated in the following figure:

[33] Ministry of Finance, Government of India, 1996. *Economic Survey, 1995-96.* New Delhi.
[34] Ministry of Industry, 1994. *Handbook of Industrial Statistics, 1993.* Office of Economic Advisor, New Delhi.
[35] Padam, Sudarsanam. "Bus Transport and Environment: Challenges and Opportunities." In: Indian Journal of Transport Management, October –December 2001. pp 531-532.

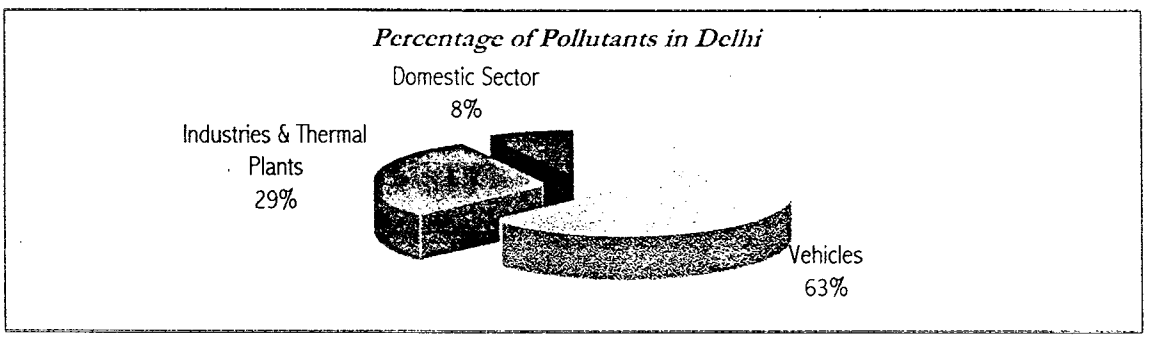
Figure: 3.15



Source: Table 3.9

Vehicular sources contribute about 63 % of total pollutants emitted, followed by industries and thermal power plants, 29 %, and 8% from the domestic sector.[36] This is illustrated in figure 3.17:

Figure: 3.17



In the recent years, several important initiatives have been taken to control pollution from the transport sector, as a result over the years the concentration of various pollutants have showed a downward trend. The campaign for vehicular pollution control gained momentum in 2000. With the introduction of Euro –II equivalent emission norms for passenger cars and Euro –I norms for all other types of vehicles the levels could be brought down so much so that Delhi is no longer the most polluted city of the nation.

[36] NEERI, 1991. *Annual Report, 1991*. National Environmental Engineering Research Institute,New Delhi.

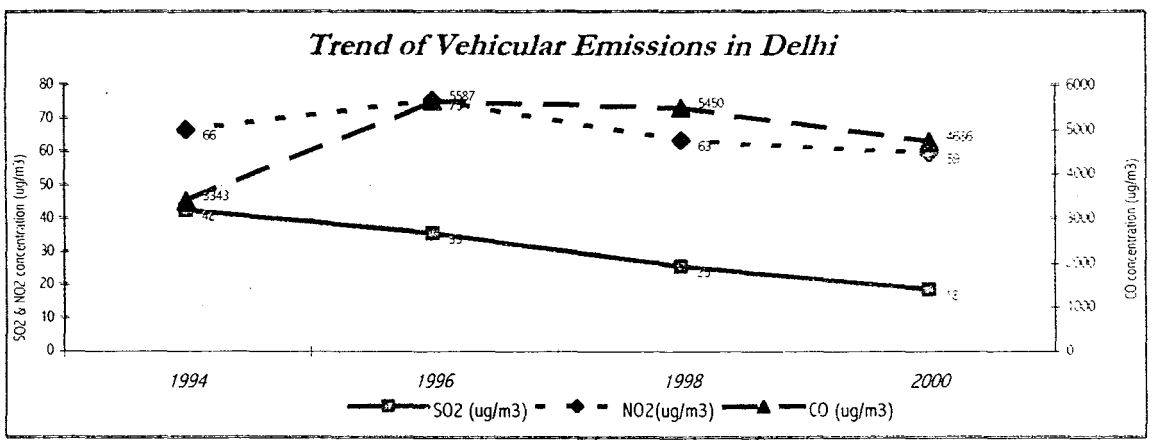
Table 3.10

Change in Concentration of pollutants from Vehicular Emissions in Delhi, 1994-2000

	SO_2 (ug/millions3)	NO_2 (ug/millions3)	CO (ug/millions3)
1994	42	66	3343
1996	35	75	5587
1998	25	63	5450
2000	18	59	4686

Source: Central Pollution Control Board, "A Report on the State of Environment: Lucknow." Central Pollution Control Board, Ministry of Environment and Forests, January 2002.

Figure: 3.17



Source: Table 3.10

The reduction of concentration of RSPM, CO and SO2 by 15%, 34% and 11% respectively with respect to 2000 values, indicates the cumulative impact of various measures including CNG as a transport fuel.

Lucknow: Lucknow is a rapidly growing commercial, industrial and trading centre. Steady increase in number of vehicles every year is creating problem of traffic congestion on roads. The city has no adequate mass transport system, and the people depend on tempos and 10seater mini buses. Bus services were sparingly used in the city.[37] Of lately, there has been a significant improvement in the traffic flow and ambient air quality, which may be due to banning of the tempos in many areas of the city on the directives from the Hon. High Court restricting their movement and strict pollution control measures enforced. The tempos now plying are either fitted with scrubbers which reduce

[37] Central Pollution Control Board, "A Report on the State of Environment: Lucknow." Central Pollution Control Board, Ministry of Environment and Forests, January 2002.

the emission load by about 75% or battery operated, constructions of fly-overs have also eased the pressure of traffic congestion to a large extent.

There has been a steady increase in most of the categories of vehicles. The total number of vehicles registered in 1990-91 was 22246, which rose to 27565 in 1999-2000. The number has increased by 10.09% in last two years. The number of vehicles till March 2002 was 4.22 lakh, which reached close to five lakhs by 2002. Over 70% of these are two wheelers. The road network has not been increasing proportionally, and has resulted in traffic congestion thus, depressing the ambient air quality despite tightening of the enforcement measures.

Figure: 3.18

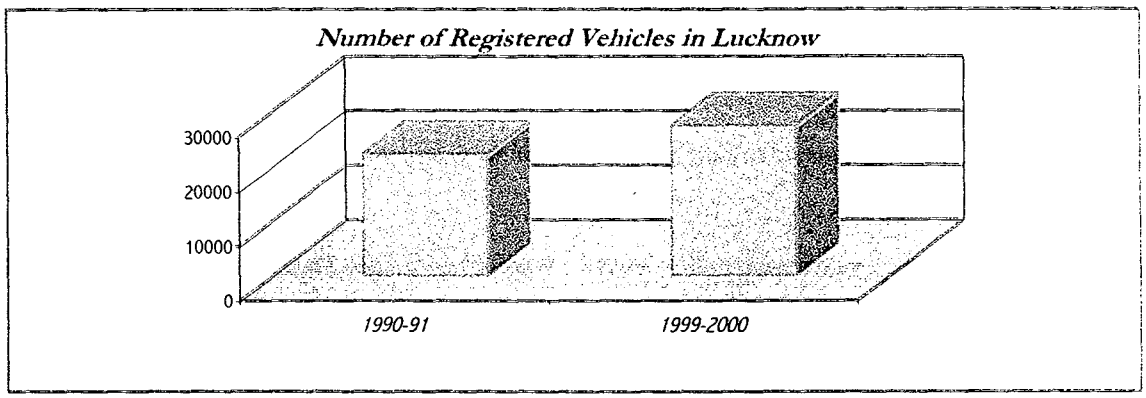
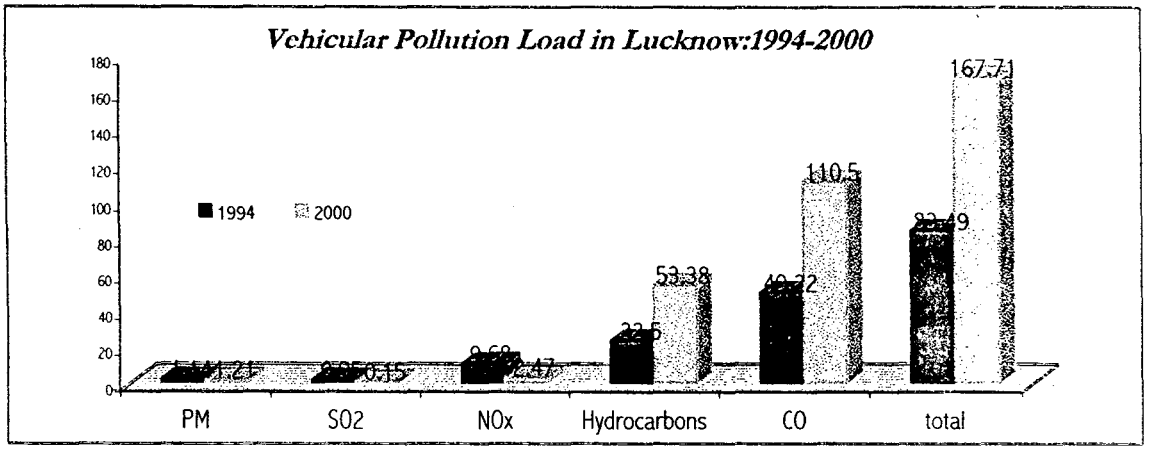


Table: 3.11

Vehicular pollution load (tonnes per day) in Lucknow						
Year	PM	SO2	NOx	Hydrocarbons	CO	Total
1994	1.14	0.95	9.68	22.5	49.22	83.49
2000	1.21	0.15	2.47	53.38	110.5	167.71

On comparison of the Vehicular pollution loads of the city between 1994 and 2000 it can be said that the load of Particulate Matter (PM), & Sulphur dioxide in the ambient air increased marginally. Hydrocarbons and the total load of pollutants in the air, more than doubled during the same period. It was only the amount of load of NOx compounds, which showed any downward trend. This is illustrated in the following figure 3.12-

Figure: 3.19



Source: Table 3.11

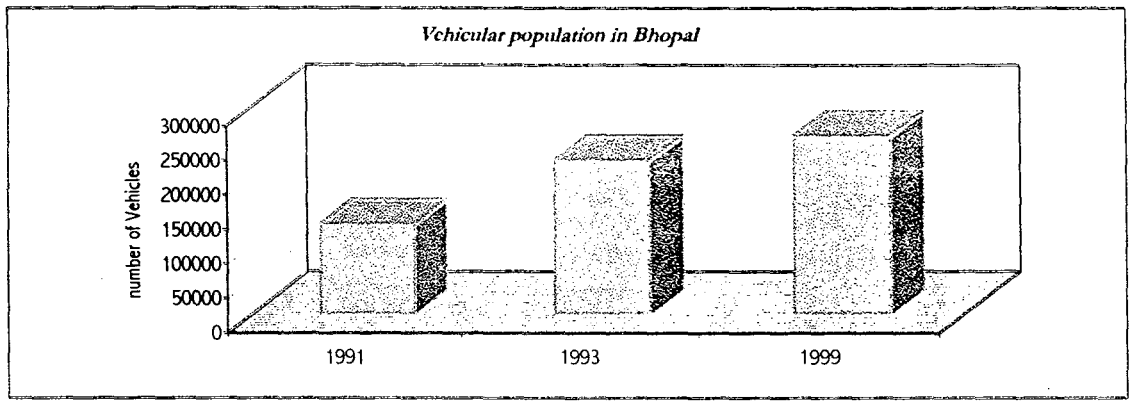
The major problem of Lucknow is the rising vehicle population, absence of emission level checks, large number of two wheelers, and allowing old vehicles to ply.

Bhopal: The major cause of Air Pollution in the city is exhaust gases from automobiles. There are a few industries, and no thermal power plant to contribute to pollution. Exhaust from petrol driven vehicles are equally hazardous as it contains more CO, Hydrocarbons and lead.

Bhopal witnessed rapid urban growth both in terms of population and vehicles. A total of 2,22,784 vehicles were registered by March 1993.[38] In 1999, the total number of vehicles registered in Bhopal was 2,59,171 for a population of approx. 14 lakhs. In addition to these vehicles, there were 25,652 other vehicles, registered as Govt. vehicles. The vehicular growth has registered annual growth rate of 13.6% during the last eight years and the number of vehicles have nearly doubled from 1,30,317 (1991) to 2,59,171 (1999). The highest growth was witnessed in two-wheeler category (109.5%) followed by cars and jeep (87.8%) and passenger vehicles (79.8%).

[38] Central Pollution Control Board, "Pollution Statistics: Bhopal." November 2001.

Figure: 3.20



It is estimated that the total vehicular pollution load in Bhopal city is 326.2 MT per day, contributed by both diesel and petrol vehicles in the ratio of 7% and 93% respectively. Out of the total pollution load of 326.2 tonnes per day, the major constituent is Carbon Monoxide with quantity of 215.6 tonnes per day followed by Hydrocarbons 92.1 tonnes per day and NO_x tonnes per day. The light tonnage vehicles (LTV), including two wheelers were found contributing 84.4% of the total pollution load i.e., 275.2 tonnes per day. The Heavy tonnage vehicles (HTV) are responsible for emitting large amount of NOx ninety percent of SO_2 emissions were found due to HTV & MTV.[39] The percentage of vehicular emission load in the city up to November 2001 is given in table 3.12:

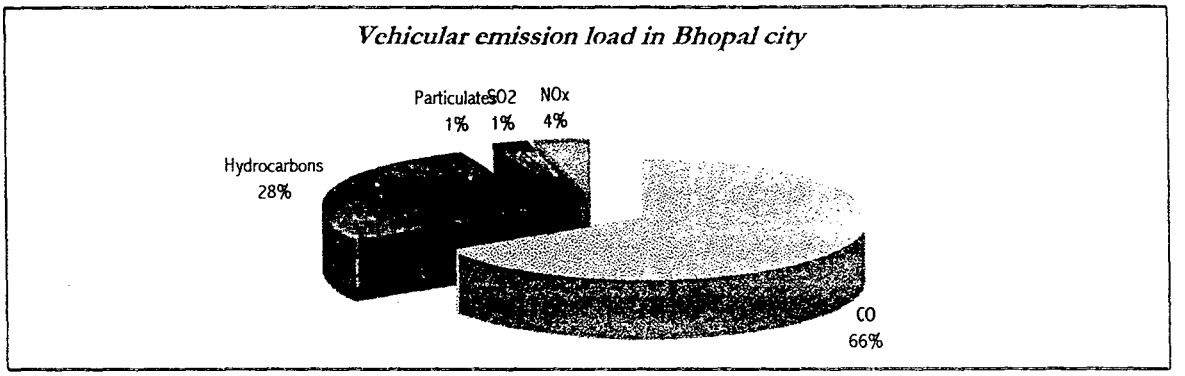
Table 3.12

Vehicular emission in Bhopal

CO	Hydrocarbons	Particulates	SO2	NOx
66	28	1	1	4

[39] Central Pollution Control Board, "Parivesh: Highlights 2000." Central Pollution Control Board, Ministry of Environment and Forests, March 2001. pp47.

Figure: 3.21



Source: Table 3.12

Agra: The number of registered vehicles in the city has gone up from 1.88 lakh in 1995 to 3.10 lakh in 2002. There are no effective pollution checks for the vehicles and despite restriction on renewal of registration of old vehicles, many continue to ply. The vehicular population is rising by 5.5 % annually.

Varanasi: The city is a renowned religious place, and thus has a number of pilgrims coming to the city. The holy city is under a cloud of harmful air pollutants from vehicle. The traffic pattern is characterized by intermixing of slow and fast moving vehicles, passing of inter and intra city traffic through the busy portions of the city erratic driving and violation of the traffic rules and regulations. Typical characteristics of the roads are improper road geometries, inadequate road widths and road networks. All these cause long traffic jams in the city. The vehicular population of Varanasi has increased from 145592 in 1993-94 to 193155 in 1996-97 thus registering a growth of 9.35% per annum. The city has already registered 15,579 vehicles from January 2002 to June 2002. In absence of adequate mass transport system and space constraints in the main city area, auto rickshaws are automatically a part of the city transportation system. The number of registered vehicles and the vehicles on road are increasing steadily, as correspondingly road network is not being expanded, and the congestion is bound to increase.[40]

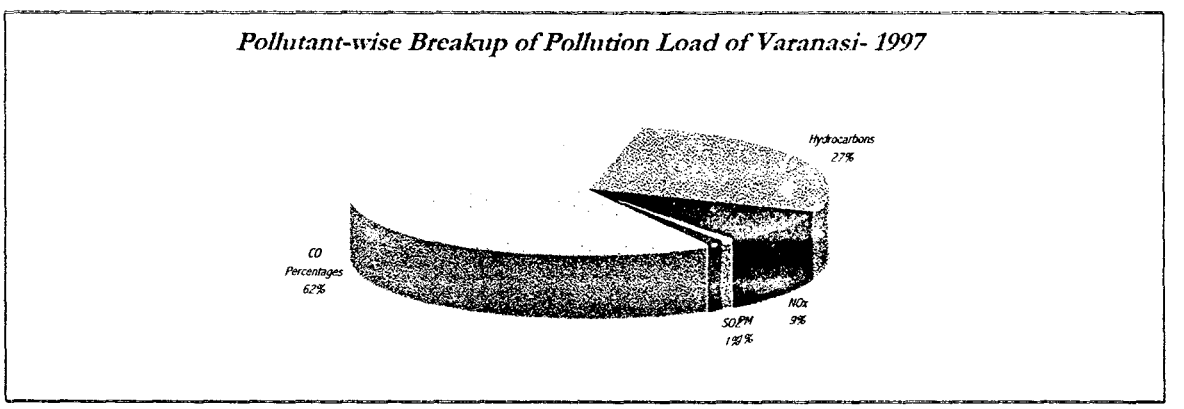
[40] Central Pollution Control Board, "A Report on the State of Environment: Varanasi." Central Pollution Control Board, Ministry of Environment and Forests, October 2000.

The estimation of the vehicular pollution load was made by applying WHO emission factors based on per thousand kms. running/ per tonne of fuel consumed by different categories of vehicles inside the municipal boundaries of the city. The estimated total vehicular pollution load of the city during December 1997 was approx. 55.27 MT/day. The quantities of major pollutants i.e., CO & Hydrocarbons, emitted by all the vehicles put together were estimated as 34.3 MT & 15 MT respectively. Petrol driven vehicles, mainly 2 wheelers & 3 wheelers were found chiefly responsible towards these emissions. This was followed by NOx emissions as 4.9 MT mainly due to diesel driven vehicles. 0.54 MT of Particulate matters were contributed equally by both the fuel categories of vehicles but SO_2 0.53 MT emissions were mainly because of diesel driven vehicles. The table shows the percentages of major pollutants in 1997.[41]

Table 3.13: The percentages of major pollutants in 1997 in Varanasi

1997	*CO*	*Hydrocarbons*	*NOx*	*PM*	SO_2
VARANASI	62.1	27.2	8.81	1	1

Figure: 3.22



Source: Table 3.13

Pollution is, of course, only one of the unfortunate by –products of the automobile –oriented transport systems.

[41] Ibid.

WATER POLLUTION

"Water is the best of all things," said the Greek poet ***Pindar.***

Water is an essential for the survival of human organism and for this purpose safe and adequate quantum of water is pre-requisite. It is also, in the broad sense, a renewable resource. But like air, it is also contaminated. On one hand with rapid growth of population and industries, the requirement of water is increasing; while on the other hand, water is being polluted in the same proportion by the consumer itself.

Increased demand of water consequent upon increasing population and industrial expansion has degraded the quality of water considerably. Though water like other natural substances has self-purifying capacity during recycling processes but when the amount of foreign undesirable substances added by the man to the water exceeds the tolerance level and self-purifying capacity of water, it gets polluted.

Prompted by the International Drinking Water Decade of 1980's, safe water supply has risen towards the top of the international development community's agenda. According to a recent United Nations assessment, a global water crisis is being caused because 'the capacity of the hydrological cycle to supply water is being outstripped by the volume of human demands of water resources and management.'[42]

Water Pollution simply means contamination of water due to any external material, or in other words, introduction of something to natural water, which makes it, unfit for human consumption. WHO has defined Water Pollution as "any foreign material either from natural or other sources that may contaminate the water supply and makes it harmful to life, and because of their toxicity lead to reduction of normal oxygen level of water which causes aesthetically unpalatable effects and spread of epidemic diseases.

Water pollution may be defined as "alteration in physical, chemical and biological characteristics of water which may cause harmful effects on human and aquatic life."
→ Report, 1965, Restoring the Quality of our Environment, President's Science Advisory Committee, Washington, USA.

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[42] Panos, 1998. *"Liquid assets: is water privatization the answer to access?"* Panos Media Briefing No. 29 (http:// www.oneworld.org/panos/briefing/water.htm).

The term Water Pollution "refers to deterioration in chemical, physical and biological properties of brought about by human activities and/or by natural (e.g. hydrological processes which induce decomposed and vegetable materials and weathering products of rocks etc."

→ *C.S. Southwick, 1976, Ecology and the Quality of Our Environment, New York.*

Two types of problem related to water supply. There is a large section, which does not have such facilities, while other one facing the shortage as well contaminated water with their own game.

III. 2. 2. 1 SOURCES OF WATER POLLUTION

Water Pollution is caused by several sources, which are not independent in nature but interact with one another. Generally, one or two factors become and may be considered the primary source of Water Pollution. The several sources of Water Pollution are:

- Natural sources,
- Human sources / Anthropogenic sources,

Certain Natural elements that cause water pollution are –gases, soil erosion, landslides, coastal and cliff erosion, volcanic eruption, mineral, humus material, waste created by animals and other living organisms present in water are termed as natural sources of Water Pollution. Water Pollution is the conclusion of human action. The natural water system is capable of taking care of natural pollutants and therefore it is the anthropogenic sources, which are the real sources of Water Pollution. The rapid growth of population, urbanization, industrialization and increasing use of chemicals have resulted in Water Pollution and this problem is increasing becomes clear sometime. The anthropogenic sources of Water Pollution include industrial source, urban source, agricultural source, cultural source (congregation of large number of people during pilgrimage, religious fairs etc.). Urban source contributes water pollutants such as sewage, huge quantity of municipal and domestic garages, industrial effluents from the industrial units located in the urban centres, fallout of particulate matter of automobile exhaust. In India, Water Pollution comes mainly from the following sources, i.e., Domestic Sewage and Sullage, Industrial effluents, leachates, and Run-off from solid waste dumps, agriculture and aquaculture runoff etc. as the populations of many

municipalities grow, their sewage treatment facilities, though once adequate, are quickly outgrown. This provides one of the classic examples of diseconomies of scale accompanying population growth.

Water pollutants may be classified as:

1. On the basis of sources of pollutants—
   - Domestic Effluents and Sewage,
   - Industrial Effluents
   - Agricultural Effluents,
   - Thermal pollution.
2. On the basis of physical and chemical properties—
   (a) Water pollutants are divided into two categories:
   - *Physical pollutants*- e.g. colour, taste, turbidity, sediments, volcanic dust, oil and grease, dissolved and suspended solids, total solids.
   - *Chemical pollutants*- e.g. chlorides, sulphides, carbonates, ammonical nitrogen, nitrites, nitrates, pesticides, insecticides, herbicides, several other synthetic chemical compounds etc.

   (b) Water pollutants are also divided into:
   - *Degradable*: Pollutants that are broken down and decomposed by biological means. These pollutants are also known as *Organic Pollutants.* E.g. leaf litters, sewage, garbage, plants and animals, human and animal excreta.
   - *Non-degradable*: Pollutants that cannot be degraded by biological means. These are also called *Inorganic Pollutants.* E.g. All of the chemical pollutants and toxic solid substances.

In India, more than 15% of the urban population lives without proper water facilities. The per capita water consumption in urban India varies between 40 and 400 litres per day. The thirst of urbanites for water is not only depleting the sources by the means of pollution. The poor urban dwellers are the most affected by the deteriorating quality and availability of the supply, which cause many water borne diseases. Water supply by state agencies, which has been largely subsidized, is becoming an

unsustainable basic service due to lack of proper pricing policies and cost recovery. Even the aspects of water conservation and reuse or recycling are not being encouraged. [43]

III. 2. 2. 2 WATER QUALITY CRITERIA/ STANDARDS

The importance of water quality as a factor constraining water use has often gone unacknowledged in the analyses of water scarcity. Water scarcity is a function not only of volumetric supply, but also of quality sufficient to meet the demand. The drinking water is perhaps the largest demand for high quality water and many industrial uses also require high quality water. Agriculture, by far the largest consumer of water also suffers when the water supply becomes saline.

India has had environmental legislation dealing with water pollution since the Indian Penal Code in 1860. However, this law and similar laws over the next 100 years deal with only public springs and reservoirs used for the purpose of drinking. It was not until the 1974 Water (Prevention and Control of Pollution) Act, that water quality was considered legally as an environmental issue. This act, and the Environment Protection Act which followed in 1986, empowered the Central Pollution Control Board to lay down and maintain ambient water standards, to demand information regarding effluent emissions, to shut down polluting activities, and to prevent new discharges of effluent and sewage.

Central Pollution Control Board promulgates water quality criteria/ standards on the basis of which nationwide pollution control programmes are implemented. The water quality criteria evolved in the country during late seventies were based on "Designated Best Use" concept of water. According to this concept, out of several uses a water body is put to, the use that demands highest quality of water has been recognized as best use. Over a period, it has been realized that there are some practical problems in its implementation.

The water quality monitored by Central Pollution Control Board in the country's water resources between 1990 and 2000 indicates that the organic and bacterial contamination continues to be critical, mainly because of the discharge of untreated or

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[43] Reddy, B. Sudhakara, "The Urban Challenge." In: India Development Report.

partially treated domestic wastewater from the urban centres. The increase in oxygen demand and bacterial pollution load is also attributed to inadequate flow in water-courses.

Non-point pollution contribution is significant particularly during rainy days when surface run-off occurs. Unsewered urban areas, solid waste dumps, industrial waste dumps, leakages and losses during handling of chemicals and other materials, application of fertilizers and pesticides in agriculture, mass bathing, disposal of human and animal dead bodies in the rivers are major contributors of non-point pollution.

Perhaps the most significant environmental problem and threat to public health in both rural and urban India, today, is inadequate access to clean drinking water and sanitation facilities. According to official reports, by early 1993, 42.9 percent of urban India had sanitation facilities available to them. Of the urban population, 84.9 percent had access to clean drinking water in 1993 as compared to 69 percent in 1985.[44]

Discharge of the untreated sewer water into the water bodies is the main source of water pollution in cities. Biological oxygen demand (BOD) and most probable number (MPN) coliform are direct measures of the extent of organic pollution of any water body. Regular monitoring of the water quality of many rivers and wells in the country reveals that the total coliform counts far exceeds the desired level in water fit for human consumption. Domestic sewage and Sullage is the main source of water pollution in India, especially in and around large urban centres. The characteristics of sewage effluent in respect to Bio-chemical Oxygen Demand (BOD) tell the gravity of pollution level in sewage water. The high BOD load of sewage water ultimately joins the water bodies, which in turn deteriorates the quality of water. The toxic wastes from the factories are also dumped into the water bodies. In India about 78% of the urban population has access to safe drinking water and about 38% of the urban population has access to sanitation services.

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[44] World Resources Institute, 1995. *World Resources, 1994/95.*

III. 2. 2. 3 WATER SUPPLY STATUS

The surface water is the major source for organized water supply in the metropolitan cities. The proportionate percentage contribution of water supply from surface, ground and both surface and ground (combined) sources is 10.9, 3 and 86.1 for cities located in major river basins respectively, while 32.4, 2.1 and 65.5% respectively for metropolitan cities. All the 23 metropolitan cities 0f the 1991 census has organized water supply. Six metropolitan cities have 100% coverage. In 14 cities there is 75% & above and the remaining metropolitan cities have 50% & above population coverage. The per capita water supply ranges from 341 lpcd to 74lpcd. Delhi has the highest per capita supply of 341 lpcd and Madurai has the lowest supply of 74 lpcd. The national average for metropolitan cities is 214 lpcd, which is higher than 189.4 lpcd observed in 1988 (CUPS/30/1989-90).

The prime cause of critical insanitary conditions in many cities in India is due the lack of facilities to collect wastewater and to dispose off after treatment. Data on wastewater generation is less when compared information on water supply. Owing to this it is difficult to access the total pollution potential. The status of wastewater generation, collection, treatment and disposal in metropolitan cities is given in the table 3.14. The total wastewater generated by the 23 metropolitan cities is 9275 mld. Out of this, about 58.5% is generated by the first four metropolitan cities, viz. Mumbai, Kolkata, Delhi and Madras. The city of Mumbai generates the maximum wastewater to the tune of 2456 mld and Madurai generates the least with 48 mld. Out of the 23 metropolitan cities, 19 cities have sewerage coverage for more than 75% of the population and the remaining 4 cities have more than 50% coverage. On the whole 78% of total metropolitan population is provided with sewerage facility, compared to 63% in 1988. The maximum volume of wastewater, 2210 mld, is collected in Mumbai, while the minimum of 33.6 mld is collected in Madurai.

Table3.14

Water supply in selected metropolitan cities

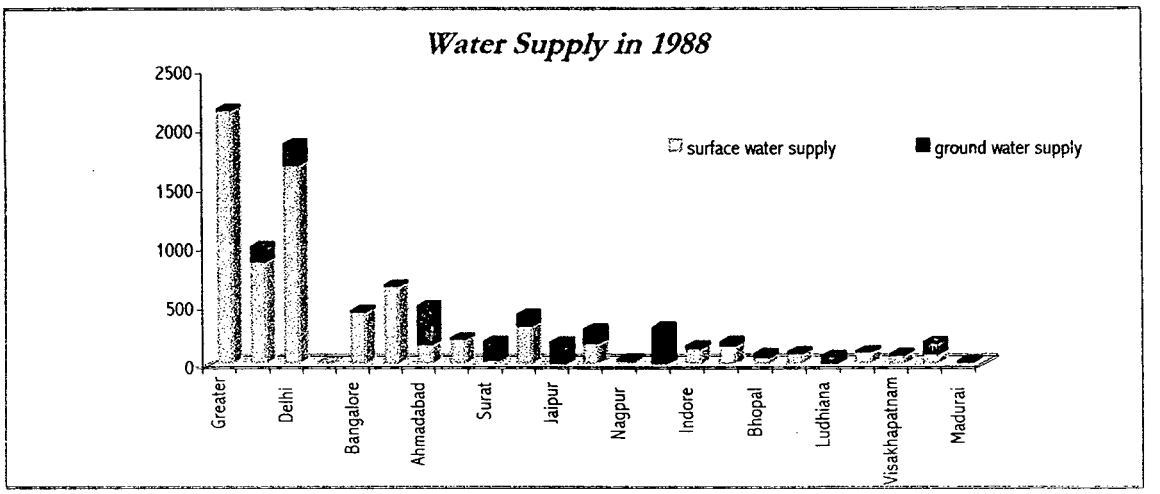
	Surface (mld)		Ground (mld)		Total (mld)		Per capita covered (mld)		Population Covered (%)	
	1988	**1995**	**1988**	**1995**	**1988**	**1995**	**1988**	**1995**	**1988**	**1995**
Greater Mumbai	2143	3070	0	-	2143	3070	207.84	272	99	92
Kolkata	862.5	1449.1	113.6	284.1	976.1	1733.3	226.7	200	95	90
Delhi	1680	2370	168	240	1848	2610	258.04	341	96	91
Chennai	-	273	-	72	250	345	75.79	81	85	90
Bangalore	435	499	0	10	435	509	113.86	137	100	90
Hyderabad	652.5	409.5	0	57.2	652.5	466.7	241.61	127	100	90
Ahmedabad	159	208	318	315	477	523	200.09	182	90	100
Pune	202.3	540	0	-	202.3	540	169.82	241	78	100
Surat	27.24	131	145.28	45	172.52	176	198.05	178	80	66
Kanpur	315	190	92	110	407	300	307	200	75	80
Jaipur	0	67.5	168	202.5	168	270	155.46	195	80	95
Lucknow	171	220	106	180	277	400	262.25	252	100	98
Nagpur	24	256	0	-	24	256	206.51	158	75	100
Patna	0	-	292.37	272.4	292.37	272.4	246.48	297	100	100
Indore	127	172.3	9	9	136	181.3	127.27	208	98	80
Vadodra	150	166.5	22	13.5	172	180	170.69	233	100	75
Bhopal	47.67	223	22.7	13.6	70.37	236.6	79.2	234	90	95
Coimbatore	81.27	75	4	-	85.27	75	138.32	104	75	88
Ludhiana	0	118.4	52.48	-	52.48	118.4	117.62	175	55	65
Kochi	90	106.8	0	1.6	90	108.4	154.54	231	90	70
Vishakhapatnam	67.96	79.1	0	5.7	67.96	84.8	136.83	113	60	100
Varanasi	75	112	95	110	170	222	243.67	215	84	100
Madurai	4.5	60	0	-	4.5	60	26.55	74	87	86

Source: Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities, 1988. Central Pollution Control Board, CUPS/30/1989-90; and Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities. Central Pollution Control Board, CUPS/44/1999-2000.

The surface water supply is the major source of water supply in the metropolitan cities its supply in mld has increased in general from 1988 to 1995 in the selected metropolitan cities except in Hyderabad, Surat, Kanpur, and Coimbatore where there has been a marginal decline in the surface water supply. The ground water supply contributes less to the total water supply of the metropolitan cities except in Ahmedabad, Surat, Kanpur, Patna, Ludhiana, and Varanasi where the ground water supply marginally exceeds the surface water supply. The total water supply has actually increased in the metropolitan cities, but some metropolitan cities like Hyderabad, Kanpur, Patna, and

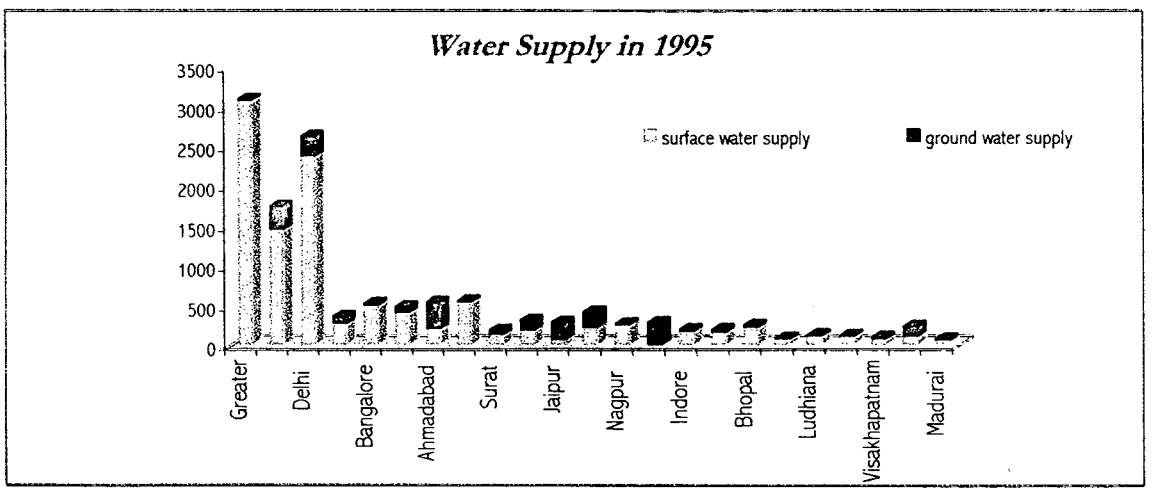
Coimbatore show a slight decline in the availability of the water supply. These have been well illustrated in the figures 3.24 & 3.25 given below.

Figure: 3.23



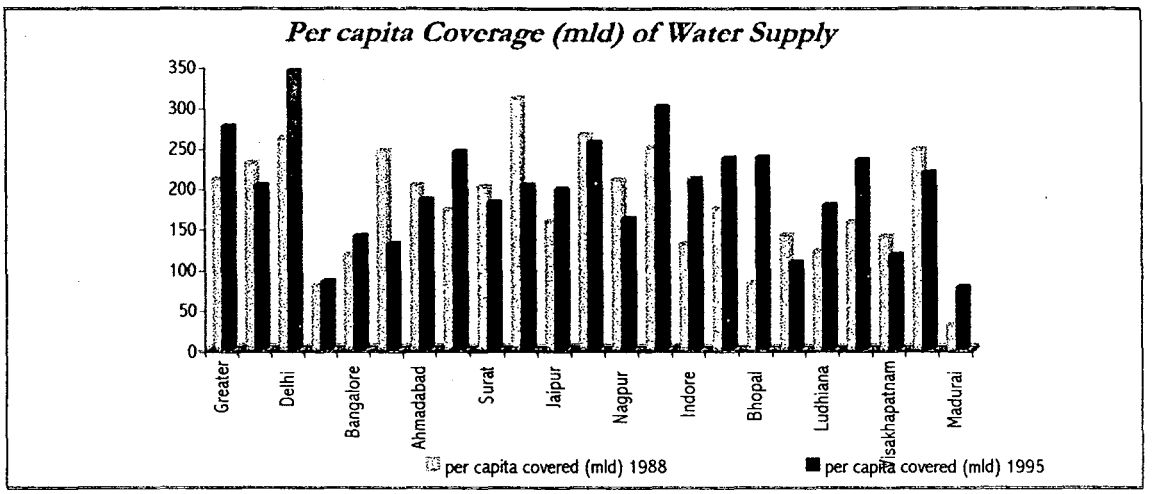
Source: Table—3.14

Figure: 3.24



Source: Table—3.14

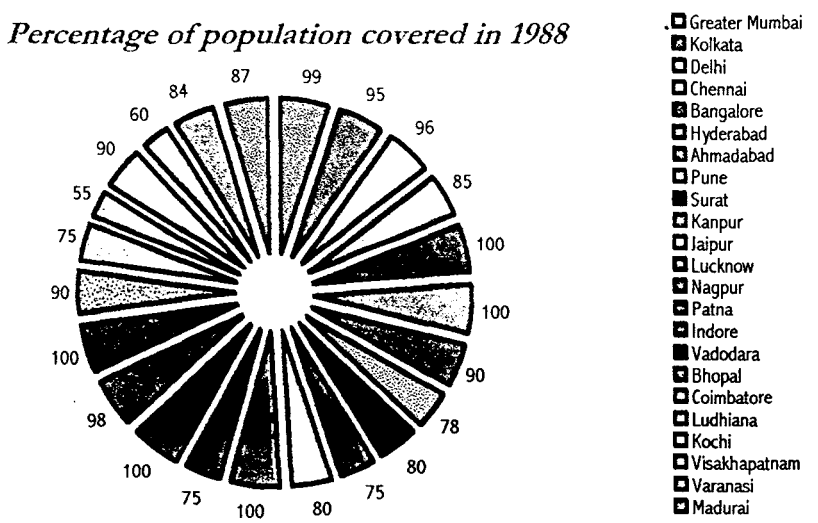
Figure: 3.25



Source: Table—3.14

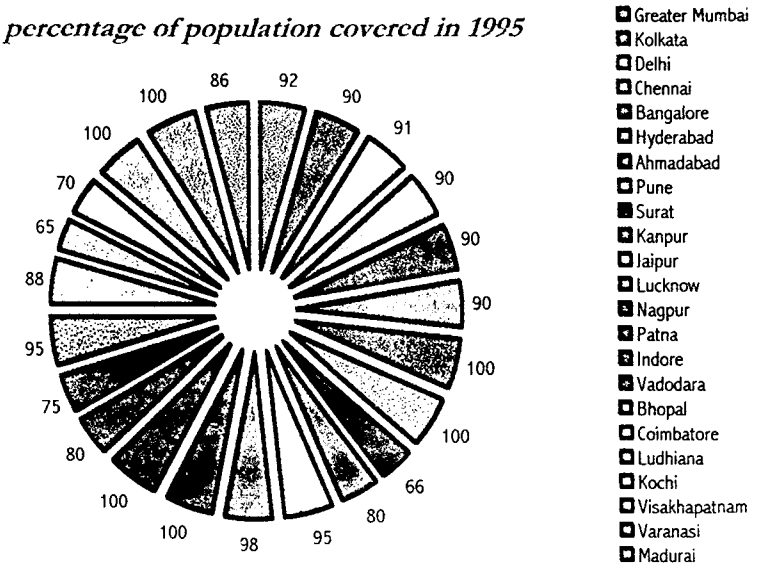
From table 3.14 & figure 3.26 it can be well said the state of availability of water supply has not improved significantly over the years. Except Bhopal, Delhi, and Kochi there has not been much improvement in the state of per capita water supply. Instead metropolitan cities like Kolkata, Hyderabad, Ahmedabad, Surat, Kanpur, Lucknow, Nagpur, Coimbatore, Kochi, and Varanasi have registered a decline in per capita coverage of water supply. With increase in population the pressure on the water supply has also increased which is seen in the decline of per capita availability of water in the metropolitan cities.

Figure: 3.26



Source: Table –3.14

Figure: 3.27



Source: Table –3.14

Table 3.14 & figures 3.26 & 3.27 show that as a general rule there has not been much increase in the percentage of population covered from 1988 to 1995. Besides an overall decrease in the per capita availability of water supply, the percentage population covered has also registered a decline among the metropolitan cities. The major metropolitan cities like Greater Mumbai, Kolkata, Delhi, Bangalore, Hyderabad, Lucknow etc., have recorded a decline in the percentage population covered.

Table 3.15

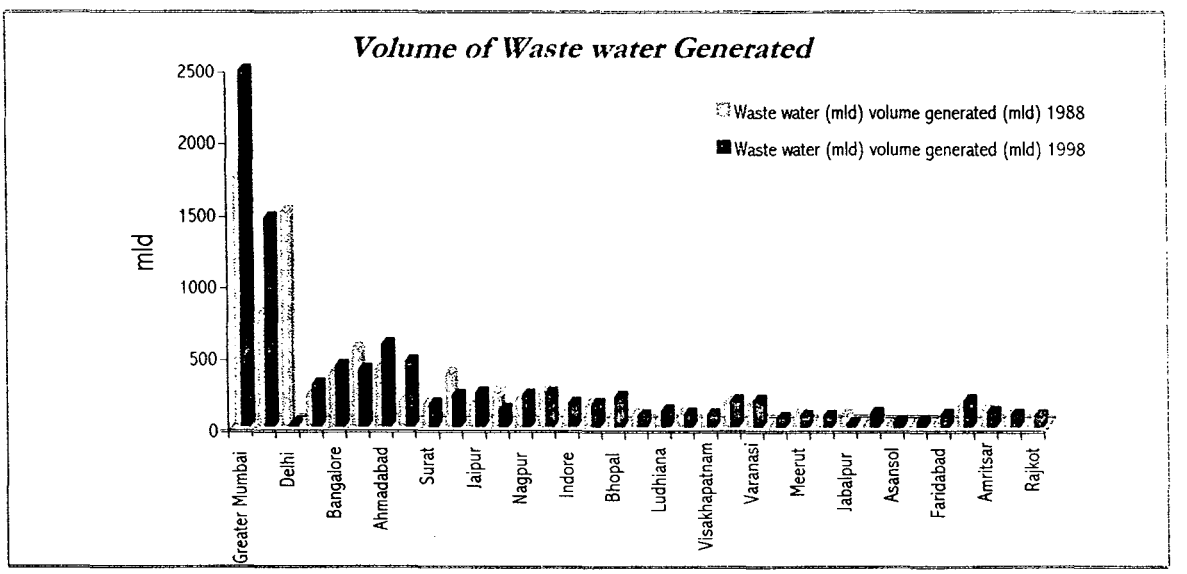
Waste Water Generation and Sewerage coverage in metropolitan cities.

	Volume of Waste Water				Percentage Sewerage Coverage (%)	
	Generated (mld)		Collected (mld)			
	1988	1998	1988	1998	1988	1998
Greater Mumbai	1714.4	2456	-	2210	80	90
Kolkata	780.88	1432.2	-	1074.9	-	75
Delhi	1480	DI	745	-	75	-
Chennai	200	276	-	257	77	93
Bangalore	348	400	348	300	85	75
Hyderabad	522	373.3	140	299	75	80
Ahmedabad	381.6	556	-	445	75	80
Pune	161.84	432	100	367	53	84
Surat	138.02	140	88	112	39	80
Kanpur	352.6	200	160	150	60	75
Jaipur	134.4	220	-	165	-	75
Lucknow	221.6	106	-	80	-	75
Nagpur	192	204.8	-	163	66	80
Patna	233.9	219	-	164	20	75
Indore	108.8	145	40	116	30	80
Vadodra	137.6	140	98	105	75	75
Bhopal	56.3	189	-	94.6	-	50
Coimbatore	68.21	60	10.44	45	40	75
Ludhiana	41.98	94.4	45	47	40	50
Kochi	75	75	4.25	45	7	75
Vishakhapatnam	54.37	68	-	55	-	81
Agra	157.99	168	15	84	25	50
Varanasi	136	170	-	127	75	75
Madurai	3.6	48	-	33.6	-	70
Meerut	68.34	59.2	-	29.6	-	50
Nasik	50.4	60	-	45	25	25
Jabalpur	65.37	8.5	-	604	-	75
Jamshedpur	--	80	--	60	--	75
Asansol	7.2	22.6	-	18.1	33	80
Dhanbad	4.36	25	-	12.5	-	50
Faridabad	25.46	69.2	23.87	-	90	-
Allahabad	130	168.8	80	125.1	30	75
Amritsar	96.27	87	92.2	65.2	-	75
Vijayawada	65.52	70.6	18.36	56.4	25	80
Rajkot	38.4	65	-	48.7	0	75

Source: Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities, 1988. Central Pollution Control Board, CUPS/30/1989-90; and Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities. Central Pollution Control Board, CUPS/44/1999-2000.

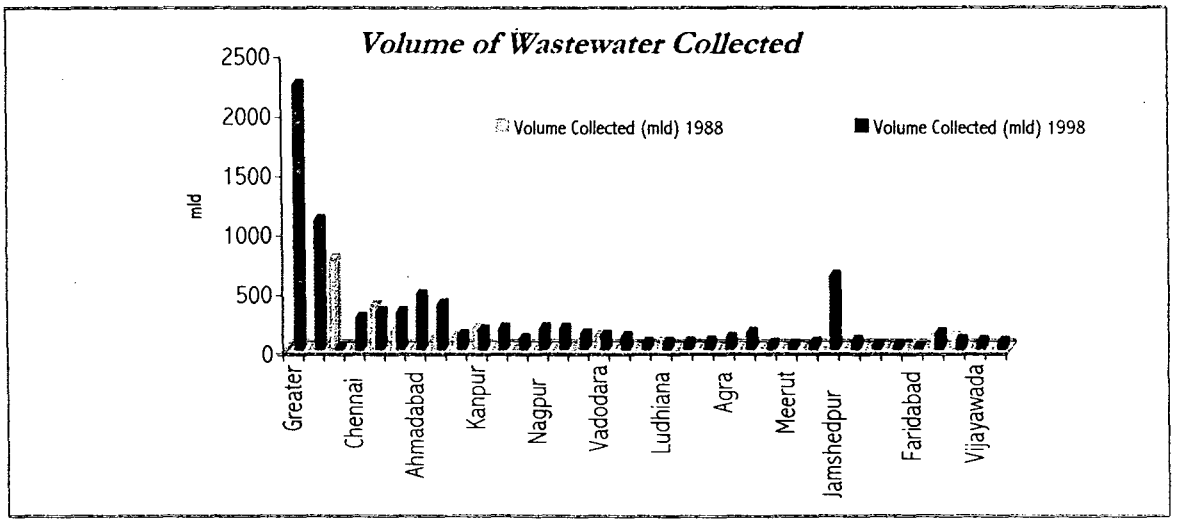
Table 3.15 gives the picture of the state of Waste water generation, Collection and the percentage of sewerage coverage. There has been an increase in the volume of the waste water generated, except in some metropolitan cities like Hyderabad, Kanpur, Lucknow, Patna, Coimbatore, Meerut, Jabalpur, and Amritsar where there has been only a slight decline in the volume of waste water generated, which is well illustrated in figure 3.28. As far as the collection of waste water is concerned data is not available for many metropolitan cities for the year 1988, but from whatever is available it can be easily comprehended that there has been an increase in the volume of waste water collected over the decade, except, Bangalore and Kanpur that registered a marginal decline in the volume of waste water collected. This is also shown in figure 3.29.

Figure: 3.28



Source: Table –3.15

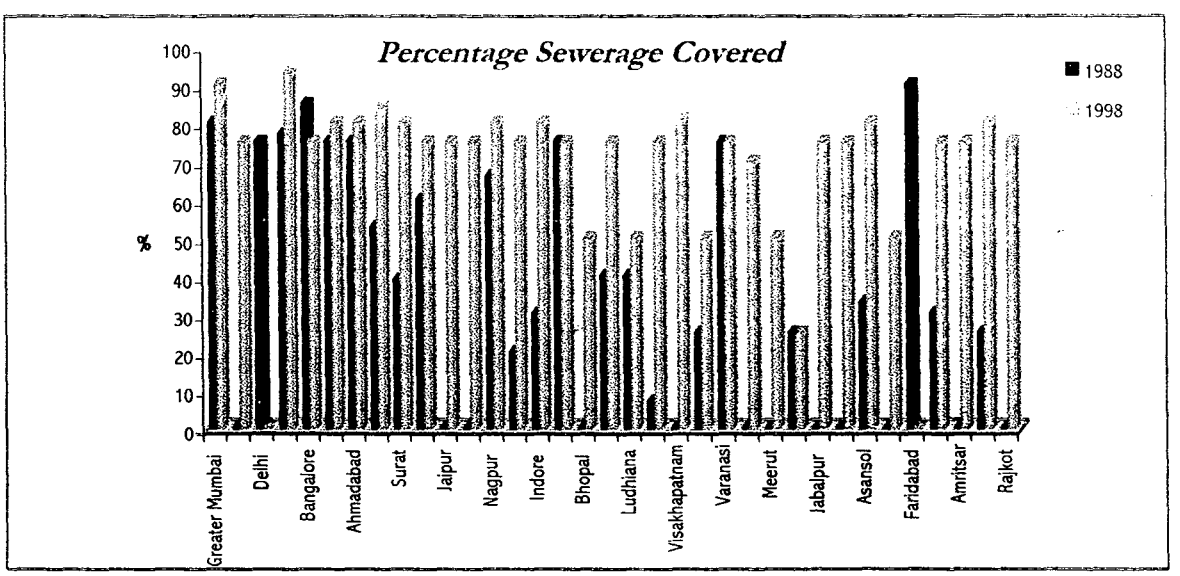
Figure: 3.29



Source: Table –3.15

Table 3.15 & figure 3.30 show that even after a decade the percentage sewerage coverage has not reached the 100% mark in any of the metropolitan cities. The coverage still ranges between 75-80%, though there has been an overall increase in the percentage sewerage coverage. There has been a significant increase in the sewerage coverage in Patna, while Bangalore has registered a decline.

Figure: 3.30



Source: Table –3.15

population growth and rising use per capita are creating water shortages

III. 2. 3 NOISE POLLUTION

From the days of the earliest cities, noise has been an invisible but integral part of the urban environment. Ever since the Industrial Revolution began, but especially in the last 50 years, the accelerating growth of technology and population has been accompanied by a steady escalation in the urban noise levels. People everywhere have recently become aware of a new kind of pollution –noise pollution. Recognition of the scope and significance of this phenomenon has far been much slower than the growth of the noise itself.[45] The problem has been thrown intro sharp focus by the discovery that some teen-agers were suffering from permanent hearing following long exposures to amplified rock music, and by public concern about the effects of the sonic booms that will be caused by the Federal Aviation Agency's Supersonic Transport (SST) project.[46]

Noise is, typically defined as unwanted sound. Sound, which pleases the listeners, is music and that causes pain and annoyance is noise. At times, what is music for some can be noise for others.

Sound /Noise is a physical phenomena consisting of a succession of alternating compressions and expansions of an elastic medium such as air, which propagates in all directions from a source. These alternating compressions and expansions can be described as small changes in pressure around atmospheric pressure.

Noise pollution may be defined as the state of discomfort and restlessness caused to humans by unwanted high intensity sound known as noise. One of the best descriptions of the sound –production process is that given by *Theodore Berland*[47]*:*

> *"As the sound source vibrates –be it violin string, tuning fork, loudspeaker, auto muffler, or whatever –it pushes against the air, then returns to its original position. Then it pushes again, and so forth, until it is spent or is turned off. This vibration produces alternating dense and sparse bands of air. The result is cordon after cordon of dense air spreading outward from the sound source, much as ripples do on water after you throw a pebble... it is important to understand that it is not the air that moves in waves; it's the* ***Sound*** *that moves in waves through the air."*

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[45] Detwyler, Thomas R. and Marcus, Melvin G. 1972. "Urbanization and Environment." Duxbury Press. Pp 195.

[46] Ehrlich, P. R. & Ehrlich, A. H. 1970. "Population, Resource and Environment: Issues in Human Ecology," W. H. Freeman and Company, San Fransico. Pp139.

[47] Berland, T. 1970. "The fight for quiet." Englewood Cliffs, N.J.: Prentice-Hall. Pp 4-5.

Physically, sound is a mechanical disturbance propagated as a wave motion in air and other elastic or mechanical media such as water or steel. Physiologically, sound is an auditory sensation evoked by this physical phenomenon. However, not all sound waves evoke an auditory sensation, e.g., ultrasound has a frequency too high to excite the sensation of hearing.

The physical properties and perception of sound / noise are expressed and measured in different concepts and units.

Noise has two major dimensions: *Pitch (i.e., Frequency)* and *Amplitude (i.e., intensity)*. *Pitch* is determined by how rapidly the sound source vibrates. The number of sound waves passing a given point in one second measures it. Therefore, *Pitch/ Frequency* is defined as the number of compressions and rarefactions per unit time (sec). i.e., the number of complete oscillation that a sound undergoes per second. The frequency of the alternations [expressed in cycle/sec or Hertz (Hz.)] determines the pitch of a sound.

1. A high-pitched tone (eg. 4000 Hz) – Squeaking Sound.
2. A low-pitched tone (eg. 200 Hz) – Humming Sound.

Human hearing is sensitive to frequencies in the range of about 20,000 Hz (the audio frequency range).

In contrast to Pitch (or Frequency), *Amplitude* (or *intensity*) reflects the depth or height of the Sound waves above and below a median line. *Weighted Sound Pressure Level (SPL)* or very commonly known as *dB (A)* in abbreviated form, is used as the fundamental measure of sound (amplitude) as it is measurable directly by instruments. It is a measure of air vibrations to make up sound.

Because human ear can detect a wide range of sound pressure levels [10 – 102 Pascal (Pa)], they are generally measured on a logarithmic scale with units of Decibels (db), used to indicate the loudness of sound.[48] Therefore, the amplitude of sound/noise is measured in decibels (dB), on a decimal Scale that was named in honor of Alexander Graham Bell. A 10-fold increase in the strength of a sound adds 10 units on the decibel scale, a 100-fold increase adds 30. This compresses the sound pressure range of interest

[48] Kempen, et. Al. "The Noise Exposure and Blood Pressure and Ischemic Heart Disease: A Meta Analysis." In: Environmental Health: Perspectives, Journal of National Institute of Environmental Health Sciences, March 2002, Vol. 110, No. 3.

compressed from 0 to 150, a range convenient to use. Silence, an arbitrary threshold level of detectable sound by normal young ears, is represented by zero decibels. The formula definition of the decibel scale is decibels $10\log_{10}$ (measured intensity / average human hearing threshold intensity). The fundamental difference between the two noise level measurements, decibel (dB) and dB (A) is that- dB is the measure of sound intensity but dB (A) is the measure of sound pressure. dB (A) scale is more commonly used because it is quite easier to construct instruments to measure the pressure of sound waves rather the intensity of sound waves. The table below gives the decibel values of some representative sounds.

Table 3.16

Noise levels

Threshold of hearing	1
Normal breathing	10
Leaves rustling in breeze	20
Whispering	30
Quiet office	40
Homes	45
Quiet restaurant	50
Conversation	60
Automobile	70
Food blender	80
Niagara Falls at base	90
Heavy automobile traffic, or jet aircraft passing overhead.	100
Jet aircraft taking off, or machine gun at close range	120

Source: Ehrlich, P. R. & Ehrlich, A. H. 1970. "Population, Resource and Environment: Issues in Human Ecology," W. H. Freeman and Company, San Fransico. Pp140.

Equivalent Continuous Sound Pressure Level, (Leq) is the level of that steady sound which over the same interval of time contains the same total energy (or dose) as the fluctuating sound. It has gained widespread acceptance as a scale for the measurement of long –term noise exposure.

III. 2. 3. 1 SOURCES OF NOISE

Noise is the main pollutant of noise pollution, which may be both natural and artificial. Natural noise pollution results from natural sources such as cloud thunder, high intensity rainfall, hailstorms, waterfalls etc. It may be sporadic, frequent or rare. On the other hand artificial noise pollution is caused by high intensity sound created by human activities and therefore artificial or simply called as noise pollution is increasing in both dimension and intensity with increasing urbanization and industrialization.

A variety of sources of noise cumulatively lead to noise pollution. Though the sources of noise seem to be infinite, but the various sources of noise to which a person is exposed can be categorized as follows:

1. Industrial Noise,
2. Non- industrial Noise

The industrial process such as drilling, grinding, riveting, hammering, forging, compressing, vaccumising, pumping etc. create the most serious af all lartge scale noise problems, subjecting a significant fraction of the working population to potentially hazardous noise levels.

Some of the important non –industrial sources are:

- *Community Noise:* Use of loudspeakers and amplified music in an unrestricted way at restaurants, clubs or in various activities of community during religious festivals, fairs, marriages, or public functions.
- *Traffic:* surface vehicles have increased tremendously and use of pressure horns has become a constant source of noise pollution. The rising environmental noise level because of appreciable growth of scooters, motorcycles, passenger cars, tempos, heavy trucks, buses and highway buses. Today metropolitan cities have become noisiest cities in the world due to increasing growth of vehicles. Noise can be from individual vehicles or from continuous flow of vehicles of all types. Vehicular noise can be classified into two distinct categories: (1) those relating to engine speed; (2) those relating to road speed.

- *Aircraft Noise*: aircrafts generate various types of noises. Higher the speed of aircraft, greater would be noise pollution. Taking off and landing of an aircraft produces unbearable noise. Supersonic aircrafts have added more noise to the plight of persons living near aerodrome.

Most of the machines that have been developed for industrial purposes, for high-speed transportation, or to make life more enjoyable, by furnishing additional comforts, reducing the drudgery of everyday living, speeding up our daily routines to provide additional leisure hours, are accompanied by noise. Noise prevention and control is important as noise affects us in hearing, ability to communicate and behaviour. Undoubtedly, lesser noise can make the environment friendlier and life, more pleasant!

Noise pollution is increasing due to rapidly increasing population, growth of industries and transport system. Noise pollution causes annoyance, interferes with communication and poses health hazards. Though the effects of noise pollution are not seen directly, the effect may be long term, leading to hearing loss, behavioural change, and impairment of physical and mental development.

III. 2. 3. 2 AMBIENT NOISE LEVEL STANDARDS

Noise standards for the ambient air quality, automobiles, domestic appliances & construction equipment, generation sets, firecrackers have been notified earlier under Environment (Protection) Act, 1986. Noise was included in the definition of air pollutant in Air (Prevention and Control of Pollution) Act by the amendment in 1987. Noise standards for motor vehicles have also been prescribed in the Model Rules framed under the Factories Act, 1948.[49] Revision of noise standards for vehicles taken up through National Committee on Noise Pollution Control.

The Ministry of Environment and Forest, has recently notified Noise Pollution (Regulation and Control) Rules, 2000, given below, covering various aspects of noise pollution -

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[49] Central Pollution Control Board, "Noise Pollution Regulations in India." Pollution Control Law Series, Central Pollution Control Board, Ministry of Environment and Forests, 2000-01

Table 3.17

The ambient air quality standards in respect to noise for different areas/zones

S. No.	Area[+]	Limits in L. equivalent dB (A) Leq[#]	
		Day Time[*]	Night Time[**]
1	Industrial	75	70
2	Commercial	65	55
3	Residential	55	45
4	Silence Zone[***]	50	40

Source: Central Pollution Control Board, "Noise Pollution Regulations in India." Pollution Control Law Series, Central Pollution Control Board, Ministry of Environment and Forests, 2000-01.

Note:

[*] Day Time: from morning 06:00 to night 21:00 hours (15 hours)

[**] Night Time: from night 21:00 to morning 06:00 hours (09 hours)

[***] Area up to 100 meters around certain premises like Hospitals, Educational Institutions and Courts may be declared as silence zones by the competent authority; honking of vehicles' horns, use of loud speakers, bursting of crackers and hawker's noise should be banned in these zones.

[+] Mixed area should be declared as one of four aforesaid areas by the competent authority and corresponding limit be applied.

- [#] dB (A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.
- A "decibel" is a unit in which noise is measured.
- "A", in dB (A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
- Leq: it is an energy mean of noise level over a specified period.

(a) Noise Limits for Motor Vehicles: The existing noise limits are as notified under Central Motor Vehicles Rules, 1989, by G.S.R. 338(E), dated 26th March 1993 (w.e.f. 26th March 1993). Every motor Vehicle shall be constructed and maintained so as to conform to noise standards as indicated therein. As notified under Environment (Protection) Rules, 1986, by G.S.R. 742(E), dated 25th September 2000; the new noise limits for vehicles would be applicable from the 1st day of January 2003.

III. 2. 3. 3 NOISE POLLUTION IN METROPOLITAN CITIES

Noise pollution has already reached at a high in most of the metropolitan cities in all the residential, commercial, industrial, and silence zones. The increasing noise pollution may be attributed to increase in number of vehicles, urbanization, and industrialization.[50]

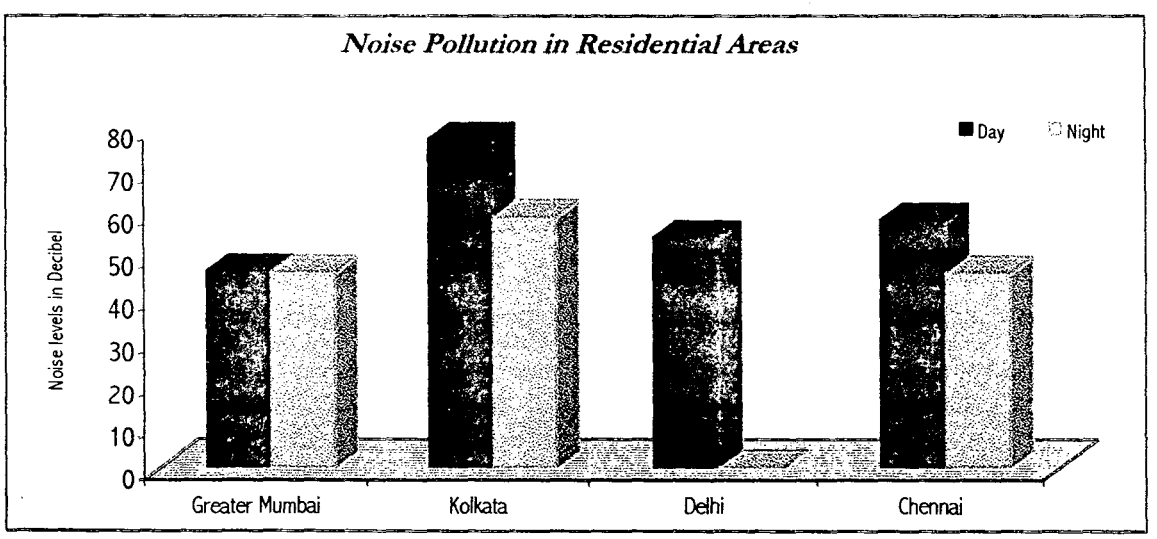
Table 3.18

Noise level in Selected metropolitan cities, 1991 (in decibel)

Metropolitan city	Residential		Commercial		Industrial		Silence	
	Day	Night	Day	Night	Day	Night	Day	Night
Greater Mumbai	45.81	45.68	63.81	60.75	78.79	56.72	58.77	46.66
Kolkata	76.86	58.76	70.9	57.78	75.82	58.7	69.89	65.7
Delhi	53.71	-	63.75	-	65.81	-	62.68	-
Chennai	57.87	45.5	74.8	69.71	69.76	63.69	46.7	47.5

Source: Central Pollution Control Board, 1996: "Parivesh: the Newsletter",, Central Pollution Control Board, Ministry of Environment and Forests Vol.3 (iv) December 1996.

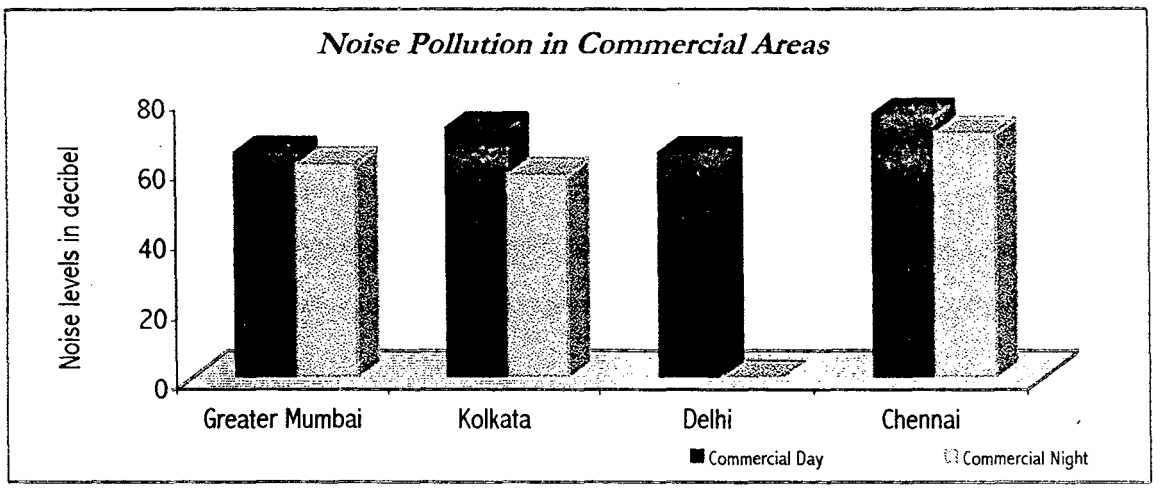
Figure 3.31



Source: Table 3.18

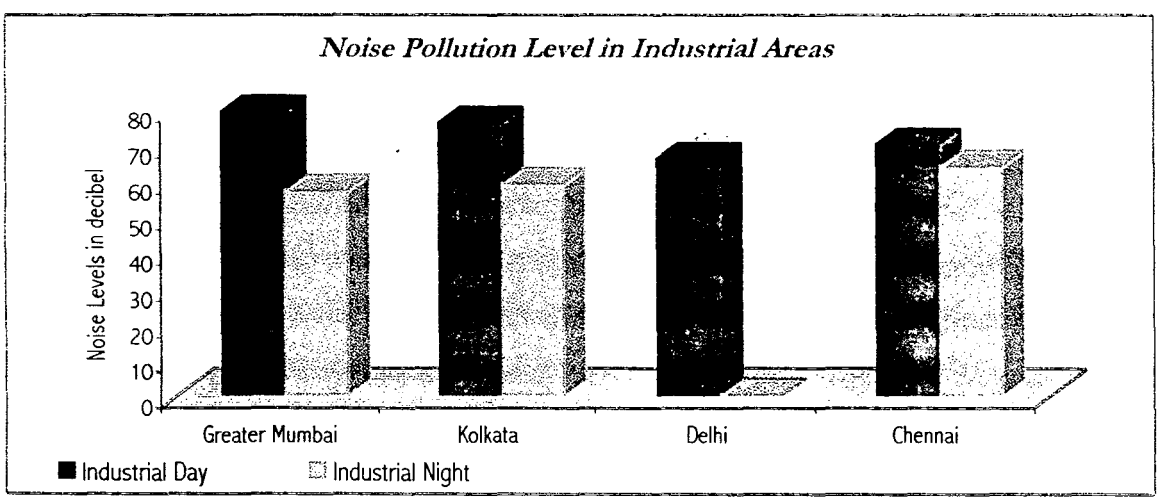
[50] State of Environment, 1995, Ministry of Environment and Forests.

Figure 3.32



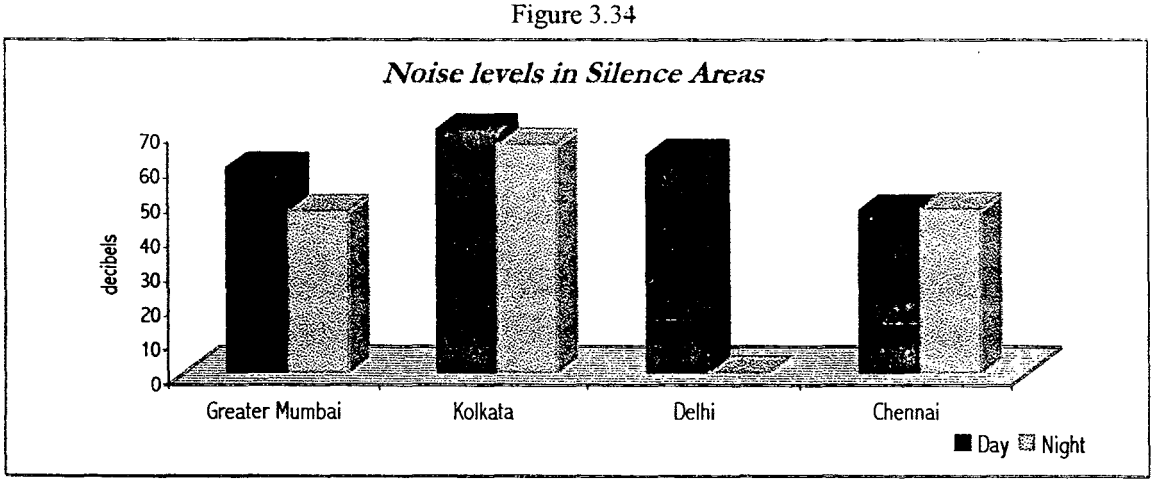
Source: Table 3.18

Figure 3.33



Source: Table 3.18

Figure 3.34



Source: Table 3.18

Greater Mumbai: was having a problem of noise pollution for all the categories of area for both the day and the night time, except for industrial areas at night time where the noise levels were below the permissible limits. This may because of the fact that the industries don't function at night –time.

Kolkata: the noise levels in the industrial areas at the night time are below the standards set by Central Pollution Control Board. Kolkata seems to be the noisiest city according to data above

Delhi: noise levels are higher than the prescribed limits. The daytime noise level was higher except for industrial areas. The data for night ambient noise level was found higher than the prescribed limit during peak traffic hours.[51]

Chennai: the noise levels for the industrial areas during the day –time were below the Central Pollution Control Board standards

Bhopal: Vehicles were found as a major source of noise in residential, commercial, silence and institutional areas while running machines were found as major source of noise level in industrial area. The average ambient noise levels in Bhopal city is exceeding the prescribed standard during the daytime under all the categories -residential, commercial and silence zones. The average ambient noise level in industrial area has been found below the prescribed standards due to low level of industrial activities. The average ambient noise levels are listed in the table below:[52]

Table 3.19: The average ambient noise levels in dB (A) in 2001.

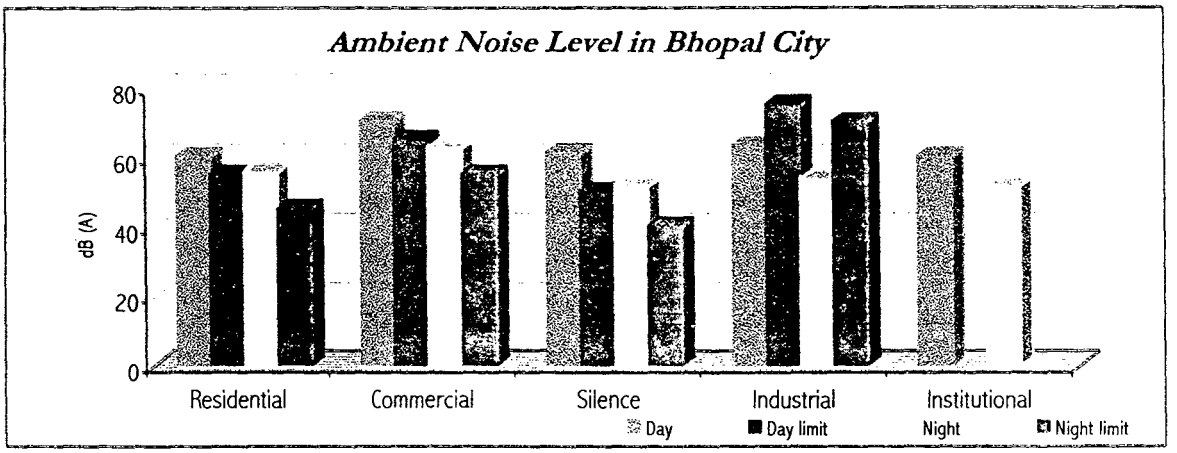
	Residential	Commercial	Silence	Industrial	Institutional
Day	60	70	61	63	60
Day limit	55	65	50	75	
Night	56	63	52	54	52
Night limit	45	55	40	70	

Source: Central Pollution Control Board , "Pollution Statistics: Bhopal." Central Pollution Control Board, Ministry of Environment and Forests, November 2001

[51] Central Pollution Control Board, "Parivesh: Highlights 2000." Central Pollution Control Board, Ministry of Environment and Forests, March 2001.

[52] Central Pollution Control Board, "Pollution Statistics: Bhopal." Central Pollution Control Board, Ministry of Environment and Forests, November 2001.

Figure 3.35



Source: Table 3.18

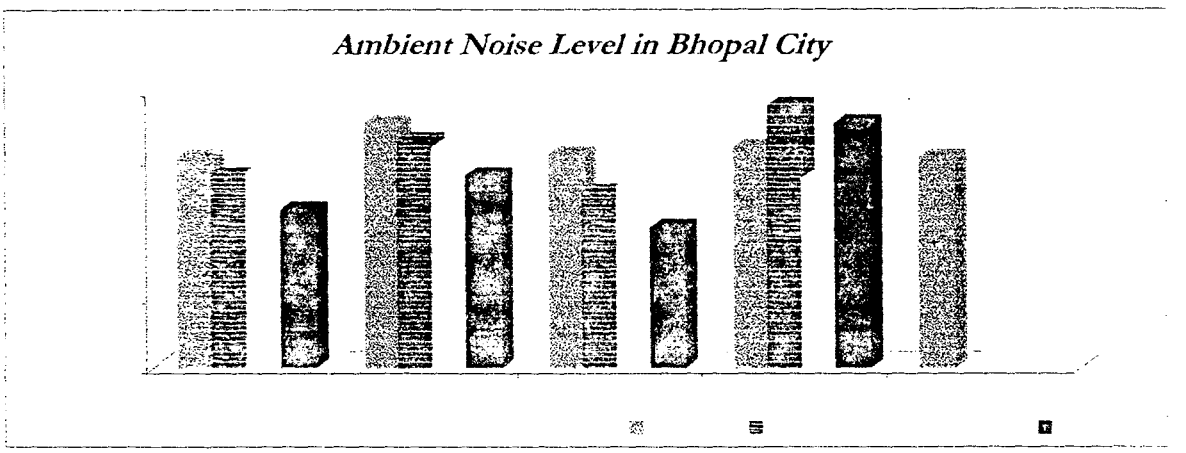
III. 3 CONCLUSION

Ever imagined of a technical conference of brain wizards in a smoky environment.

From the above discussion it can be conclude that:

1. There has been a general increase in the concentration levels of pollutants in the metropolitan cities. But the recently there has been a decline in the concentration levels due to the various initiatives taken by the government.
2. Since 1980 Air Pollution has increased in all the metropolitan cities, except, Kolkata, Chennai, Kanpur, Nagpur, and Bhopal have shown a slight decline in their SPM concentration. Chennai and Kanpur show a declining trend in the concentration of SPM in the residential areas.
3. Kolkata had the highest concentration of SPM in industrial areas in 1991 but it Kanpur registered the highest concentrations in 1998. Though Kanpur registered a decline in SPM concentration, still the levels exceeded the limits.
4. Kolkata has the highest concentration of the oxides of Nitrogen in 1991 followed by Ahmedabad and Greater Mumbai in the industrial areas. While, in 1998 Delhi topped the list.
5. The oxides of Nitrogen in the industrial areas in 1998 recorded an increasing trend, especially in Pune, only Greater Mumbai, Chennai and Nagpur registered a

Figure 3.35



Source: Table 3.18

III. 2. 3 AVAILABILITY OF HOUSEHOLD AMENITIES

The Chapter –6 of the Agenda 21 of Rio Summit states that, "Urban growth has outstripped society's capacity to meet human needs, enslaving hundreds of millions of people without adequate incomes, diets, housing and services."

III. 2. 3. 1 HOUSING AND ENVIRONMENT

The single most important change inhuman settlement in the 20th century is manifested in the growing proportion of population living in urban centres and cities as compared to those in rural areas. Construction technology and land constraints have changed the housing typology in the urban areas from single –unit plotted development to vertical structure and multi-household complexes. This changing pattern is seen in mega & metropolitan cities as well as in large towns.

The access of quantity housing and urban basic services directly influence the quality of life of people, their productivity levels and growth potential. "As urban settlement of developing world grow in size, problem arises at two environmental level. The first is the internal living environment and its immediate surrounding. The second is the outer environment that cities provide for their inhabitants. Although the deteriorated environmental condition and inefficient –services of substandard housing may be cause

of high incidence of disease, it is low income and inadequate diet in poorer communities that are the main cause of poor health and inability to attain better living condition."[1]

III. 2. 3. 2 AVAILABILITY OF HOUSEHOLD AMENITIES IN THE METROPOLITAN CITIES

The data on household amenities related to electricity, toilet and safe drinking water was available since 1981. The provision of such facilities improves the living standards of households. It has been observed that there has been an increase in the income of municipal corporation also are directed towards these ends, the living conditions of the cities are expected to be better off than before.

Table 3.19

Proportion of households having Electricity, Safe drinking water and Toilet facilities.

Metropolitan cities	Electricity		Safe Drinking Water		Toilet	
	1991	1981	1991	1981	1991	1981
Greater Mumbai	89.77	77.57	95.68	92.36	75.45	73.41
Kolkata	77.17	83.66	92.24	90.92	89.19	92.97
Delhi	81.37	74.94	96.27	94.91	66.81	68.02
Chennai	81.91	67.83	59.5	79.75	77.25	76.14
Bangalore	81.82	71.5	80.89	76.38	81.54	72.51
Hyderabad	87.88	73.25	81.73	79.54	80.7	73.03
Ahmedabad	80.26	75.13	92.01	92.55	72.66	70.79
Pune	87.46	75.2	94.56	92.6	73.1	65.32
Surat	78.77	70.13	90.66	83.22	69.78	60.51
Kanpur	75.49	60.98	88.74	75.63	74.14	62.56
Jaipur	82.73	73.4	89.72	83	78.46	68.86
Lucknow	76.25	65.02	88.21	78.1	73.02	63.88
Nagpur	82.18	68.36	73.81	70.65	71.44	56.06
Patna	80.68	58.67	84.97	74.04	83.64	69.38
Indore	83.22	69.96	88.62	86.05	67.68	65.15
Vadodra	85.52	76.25	92.56	91.8	77.6	71.71
Bhopal	85.91	70.52	93.26	86.41	71.31	72.72
Coimbatore	83.93	67.49	89.97	78.02	58.29	51.21
Ludhiana	96.14	87.69	95.85	92.09	86.55	70.62
Kochi	75.3	56.75	73.01	62.83	81.13	62.46
Vishakhapatnam	70.26	50.3	65.76	56.98	52.17	41.48
Agra	79.26	60	85.85	80.83	66.23	63.04

[1] Hardoy, J. and Satterthwaite, D. 1984. "Third World Cities and the Environmental of Poverty." In: Robert Repetto (eds), *The Global Possible Resource, Development and the New Century*, Yale University Press, Connecticut.

Varanasi	79.48	65.55	84.53	72.15	79.66	67.35
Madurai	85.66	61.25	88.12	79.39	67.47	47.05
Meerut	84.13	58.54	92.26	80.92	78.34	60.2
Nasik	88.38	69.17	87.83	86.53	69.42	50.42
Jabalpur	81.79	57.88	81.93	64.62	61.53	54
Jamshedpur	71.54	-	66.45	-	67.9	-
Asansol	63.17	-	80	-	80	-
Dhanbad	66.6	63.1	78.61	68.32	78.61	47.04
Faridabad	78.22	76.49	94.5	89.83	94.5	51.39
Allahabad	84.07	58.65	91.23	77.69	91.23	61.47
Amritsar	95.72	88.76	95.37	91.41	95.37	65.49
Vijayawada	72.07	-	86.6	-	86.6	-
Rajkot	88.75	79.26	81.68	85.62	81.68	61.59

Source: Census of India, 1981. "Percentage of households having Electricity, Safe drinking water, Toilet facilities and no literate members by State /UTs , Districtwise", 1981; Census of India, 1991. Occassional Paper No. 5 of 1994, "Housing and Amenities: A database on housing and amenities for districts, cities and towns."

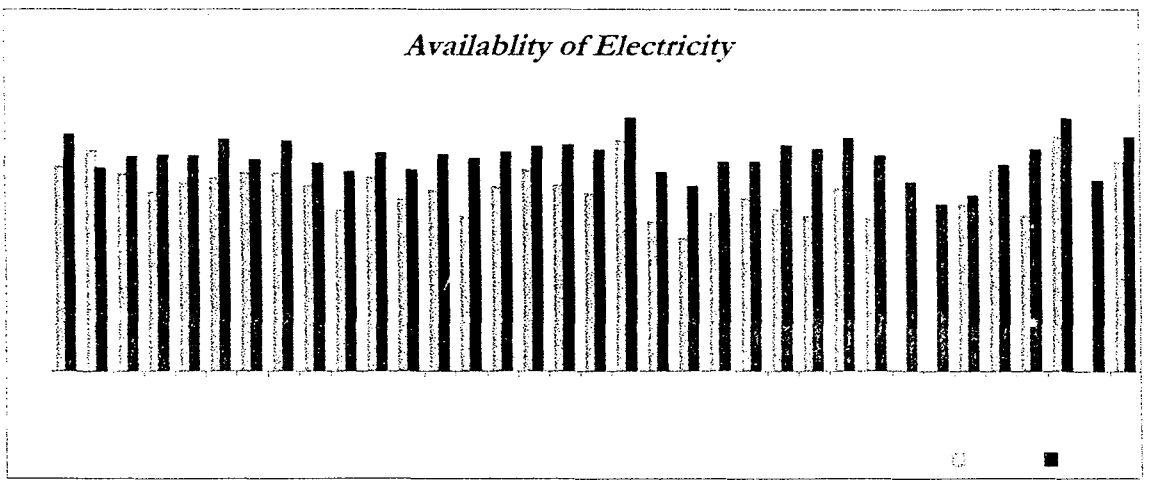
The provision of electricity for households, in 1981 for Amritsar was 88.76% followed by Ludhiana (87.69%), Kolkata (83.66%); Greater Mumbai (77.57%) holds the 5th position, Delhi (74.94%) ranks 10th, while Chennai (67.83%) holds the 19th position. Vishakhapatnam (50.3%) ranks last amongst the 35 metropolitan cities in provision of electricity. The household amenities with respect to electricity have shown an increase in 1991 over 1981 for all the metropolitan cities, except Kolkata (Figure 4.1). In 1991, the provision for electricity was maximum in Ludhiana (96.14%), followed by Amritsar (95.72%); Greater Mumbai (89.77%) ranked 3rd, Rajkot remained 4th (88.75%), Nasik improved its rank to the 5th place with 88.38% of provisions for electricity. Delhi slided down to 20th position, Kolkata slid to 27th position (77.17%); while Chennai (81.91%) improved a little to the 17th position amongst the 35 metropolitan cities. Asansol was placed last in 1991 for providing electricity to 63.17% of households.

Delhi had 94.91% provision of safe drinking water for households in 1981, followed by Pune (92.60%), Ahmedabad (92.55%), Greater Mumbai (92.36%), Ludhiana (92.09%); Kolkata (90.92%) ranked 8th, Chennai (79.75%) occupied the 18th place. Bangalore (76.38%) was placed 24th. Vishakhapatnam (56.98%) stood last among the metropolitan cities in 1981. Household amenities with respect to safe drinking water have generally increased in 1991, except Rajkot where the proportion of households having

safe drinking water marginally declined from 85.62% to 81.68% (Figure 4.2). In 1991, Delhi (96.27%) still maintained its 1st rank, while Ludhiana rose from with 5th rank to 2nd with 95.85% households having safe drinking water. Greater Mumbai (95.68%), Amritsar (95.37%) followed it. Unfortunately, Chennai (59.90%) slid down to the last position in 1991.

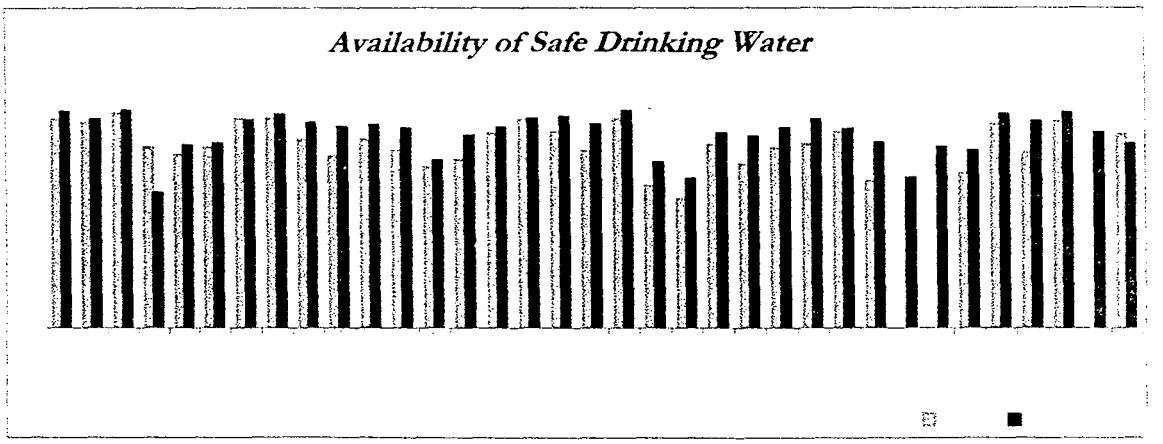
In 1981, Kolkata had provision of toilets for 92.97% of it households, followed by Chennai (76.14%), Greater Mumbai (73.41%), Hyderabad (73.03%). Bangalore (72.51%) was placed 6th; Delhi (68.02%) was placed 12th. Vishakhapatnam (41.48%) stood in the end of the ladder. Household amenities with respect to toilet facilities have increased in general in 1991, except Kolkata, Delhi, and Bhopal (Figure 4.3). In 1991, Kolkata (89.19%) maintained its 1st position. Ludhiana (86.55%) follows it, Patna (83.64%) stands 3rd, Amritsar (95.37%) was 4th.Greater Mumbai (75.45%) slid down to 13th position, Chennai (77.25%) was placed 12th, & Delhi (66.81%) to 27th place, while Dhanbad (47.30%) was at the bottom of the list.

Figure 3.35



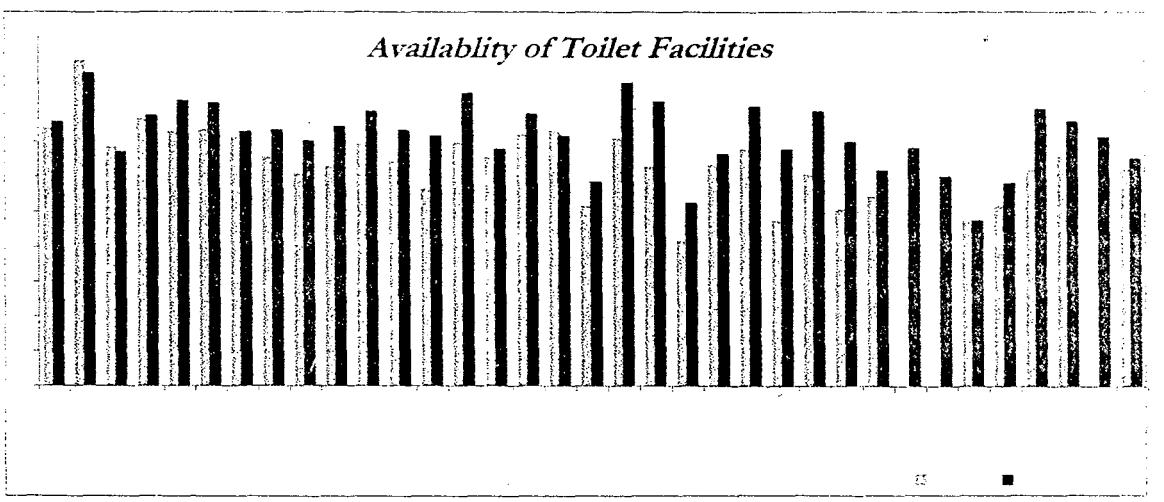
Source: Table –3.19

Figure 3.36



Source: Table –3.19

Figure 3.37



Source: Table –3.19

From the above discussion it may be well concluded that during the period of 1981-91, the availability of civic amenities with respect to electricity, safe drinking water, and toilet availability have increased, there has been only a slight decline in the proportion of availability of electricity in Kolkata, safe drinking water in Rajkot, and toilet facilities in Kolkata, Delhi, & Bhopal. The country is facing serious problems of unsanitary conditions especially in urban areas.

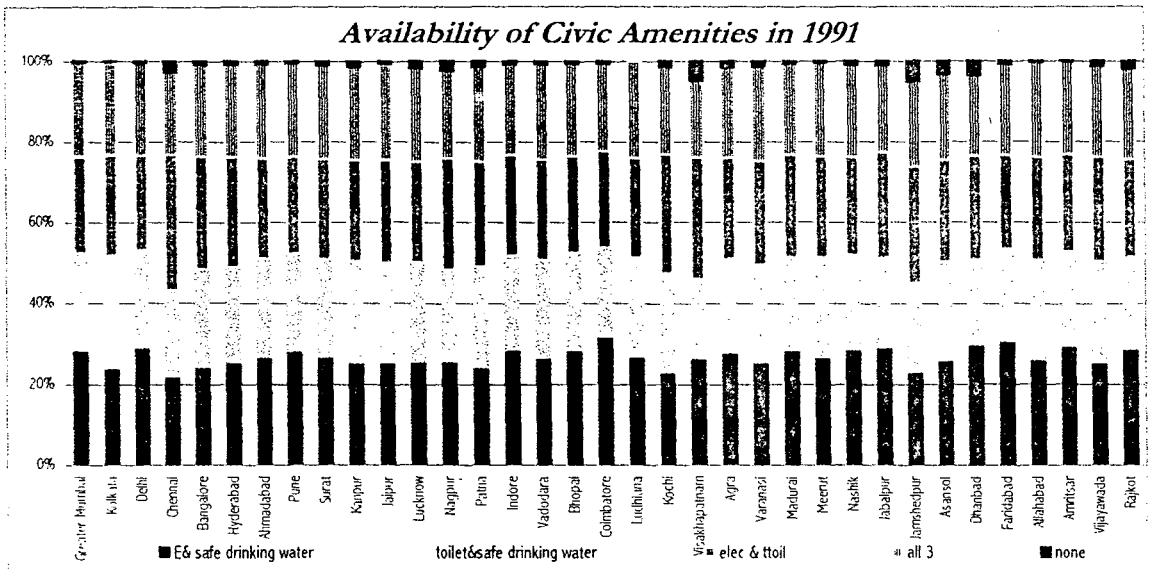
Table 3.20:

Proportion of households having Electricity, Safe drinking water and Toilet facilities in 1991.

	Electricity	Safe drinking water	Toilet	Electricity & safe drinking water	Toilet & safe drinking water	Electricity & toilet	All three	None
Greater Mumbai	89.77	95.68	75.45	87.02	73.42	73.55	71.69	1.4
Kolkata	77.17	92.24	89.19	71.16	82.27	74.58	68.8	0.62
Delhi	81.37	96.27	66.81	78.93	64.93	63.96	62.17	1.19
Chennai	81.91	59.5	77.25	48.76	46.38	74.34	44.95	6.08
Bangalore	81.82	80.89	81.54	66.5	66.2	76.5	62.29	2.66
Hyderabad	87.88	81.73	80.7	72.74	67.07	78.43	65.31	2.61
Ahmadabad	80.26	92.01	72.66	74.64	67.72	69.95	65.35	2.04
Pune	87.46	94.56	73.1	83.36	70.72	70.87	68.62	1.21
Surat	78.77	90.66	69.78	72.17	64.27	67.59	62.33	2.48
Kanpur	75.49	88.74	74.14	68.63	67.69	68.19	62.44	3.69
Jaipur	82.73	89.72	78.46	74.79	71.85	75.99	69.74	1.98
Lucknow	76.25	88.21	73.02	69.9	67.39	68.56	63.37	5
Nagpur	82.18	73.81	71.44	63	55.36	68.55	53.69	5.78
Patna	80.68	84.97	83.64	71.5	73.77	77.79	69.48	4.29
Indore	83.22	88.62	67.68	74.39	60.22	65.77	58.71	2.15
Vadodra	85.52	92.56	77.6	79.92	72.97	75.92	71.42	1.7
Bhopal	85.91	93.26	71.31	81.09	67.92	68.49	65.41	1.61
Coimbatore	83.93	89.97	58.29	75.39	52.18	57.39	51.37	1.4
Ludhiana	96.14	95.85	86.55	92.24	82.98	85.71	82.22	0.16
Kochi	75.3	73.01	81.13	55.19	59.2	71.16	52.19	3.92
Vishakhapatnam	70.26	65.76	52.17	44.76	33.02	51.09	32.32	8.36
Agra	79.26	85.85	66.23	69.84	58.27	63.62	56.03	4.13
Varanasi	79.48	84.53	79.66	75.65	71.68	76.4	69.27	4.16
Madurai	85.66	88.12	67.47	73.58	59.24	66.04	57.98	1.78
Meerut	84.13	92.26	78.34	78.32	72.54	73.69	68.55	1.26
Nasik	88.38	87.83	69.42	79.16	64.7	67.66	63.25	2.65
Jabalpur	81.79	81.93	61.53	66.69	50.32	60	49.09	2.67
Jamshedpur	71.54	66.45	67.9	51.28	48.88	64.37	47.33	11.31
Asansol	63.17	80	80	51.86	48.83	51.12	42.19	6.77
Dhanbad	66.6	78.61	78.61	52.03	36.23	45.13	34.68	6.21
Faridabad	78.22	94.5	94.5	74.92	55.65	57.01	54.95	2.07
Allahabad	84.07	91.23	91.23	76.75	72.31	75.22	68.72	1.1
Amritsar	95.72	95.37	95.37	91.67	72.11	74.99	71.77	0.5
Vijayawada	72.07	86.6	86.6	62.79	62.2	63.96	55.95	3.32
Rajkot	88.75	81.68	81.68	75.76	59.74	64.3	59.34	5.14

Source: Census of India, 1991. "Housing and Amenities: A database on housing and amenities for districts, cities and towns."

Figure 3.38



Source: Table –3.20

From the table 3.20 and figure 3.38 a picture of the availability of civic amenities in the metropolitan cities can be well –painted. The availability of all the civic amenities in combined form also is best provided in Ludhiana. It stands 1st in the provision of electricity & safe drinking water (92.24%), toilet & safe drinking water (82.98%), electricity & toilet (85.71%), and all the three amenities together (82.22%). Ludhiana has the minimum percentage (0.1%) of households without any kind of civic amenity; in this respect, Amritsar also holds a comfortable position, as only 0.5% of its households do not have any kind of civic amenity. The worst position is of Vishakhapatnam, which supports the minimum proportions of availability of any kind of civic amenity to the households. Instead, Vishakhapatnam (8.36%) follows Jamshedpur, which does not provide any amenity to 11.31% of the households.

III. 3 SLUMS AND THEIR ENVIRONMENT

Underemployment, landlessness and poverty draw many people to the towns and cities. Many end up eventually in major urban agglomerations. Most of the large agglomerations of the underdeveloped as well as the developed nations encounter a gap between the demand and supply of quality housing for their residents. Urban over-

crowding is growing into a major problem due to this migration and due to the inability of the metropolitan cities to cope. The urban poor who are most affected by this problem provide for themselves housing by constructing clusters of substandard dwellings. The result has been the mushrooming of slums and squatter settlements.

With the increasing awareness of physical environment, sanitational measures, and rising economic standards of the people all over the world, new residential enclaves and business centres are coming up. The newly developed colonies, government or private exhibit a superiority of sanitational means and architectural quality. But in spite of all the progress and new heights in the field of urban development, slums are increasing both in numbers and size in and around large urban centres. These slums are considered as one of the major social and economic problems of the present day urban society because of congestion, filth and blight in such areas. A general lack of civic amenities and environmental hygiene, inadequate approach roads are characteristic feature of slums.

A number of definitions are given for slums by various authorities. The United Nations, in their report on Urban Land Policies, refer to slums as "... a building or group of buildings, or area characterized by over-crowding, deterioration, unsanitary conditions or absence of facilities or amenities which because of these conditions or any of them, endanger the health safety or morals of its inhabitants or the community."[54]

Slum Areas (Improvement and Clearance) Act, 1956 enacted by the Centre defines Slums as (a) Areas where buildings are in any respect unfit for human habitation; or (b) are by reasons of dilapidation, crowding, faulty arrangement and design of such buildings, narrowness or faulty arrangements of streets, lack of ventilation, light or sanitation facilities, or any combination of these factors, are detrimental to safety, health or morals.[55]

III. 3. 1 GROWTH OF SLUMS IN METROPOLITAN CITIES

Though housing facilities are increasing in the metropolitan cities yet it had failed to keep pace with the rising demands. Slums are increasing because of two reasons:

1. There is gap between demand and supply of housing. That is to say demand is quite higher than the supply.
2. The price of land and housing are beyond the reach of poor people. So they resort to self –financed housing in the marginal lands of the city, lacking in all sorts of amenities.

There are not many studies dealing with the physical and social aspects of slum – dwellers and pavement dwellers in the Indian context. Moreover, there is a dearth of comprehensive data on slum population, types of households (pucca, kutcha, etc.) and the availability of basic amenities. The first ever-published data on slums was by NSSO (National Sample Survey Organization) in 1980. Census of India collected data relating to slums for the first time in 1991. The Census had published an occasional paper on the civic amenities only in the year 1994, based on the 1991 census. NSSO, NBO (National Building Organization), TCPO (Town and Country Planning Organization) and the data available from different survey reports on slum mainly of metropolitan cities reveal that about 69% of the total slum population resides in class –I cities.[4]

The pace of urbanization in India in the recent past has given a fillip to the growth of slums in India. About 20% of the population is found to be living in the slums in 1991.[5]

Unchecked growth of population, industrialization and urbanization leads to heavy influx of rural and urban labour class families to the cities. Being from lower income strata, these families cannot afford costly settlements and higher rents, and are forced to live in marginal land, in slum and squatter settlements. Slums generally present the most unhygienic, ugliest, nauseating scene. During rainy seasons the whole area gets flooded, the pathways become swampy and the entire colony becomes a fertile breeding place for mosquitoes, exposing the slum dwellers living in the area to all sorts of diseases. During summer, the thatched huts are prone to fire accidents. Thus, the slum

TABLE 3.21 : ESTIMATED SLUM POPULATION IN METROPOLITAN CITIES

(Population in lakhs)

Sl. No.	Name of City	1981			1991			2001*		
		Total Population	Slum Population	%age	Total Population	Slum Population	%age	Total Population	Slum Population	%age
1	Calcutta UA	91.940	30.280	32.9	110.219	36.262 @	32.9	131.147	43.147	32.9
2	Greater Mumbai UA	89.887	30.831	34.3	125.962	43.205 @	34.3	170.701	58.550	34.3
3	Delhi UA	57.228	18.000	31.5	84.191	22.480	26.7	122.204	32.628	26.7
4	Chennai UA	42.893	13.769	32.1	54.220	15.251	28.1	69.823	19.620	28.1
5	Hyderabad UA	25.500	5.000	19.6	43.444	8.593	19.8	62.964	12.466	19.8
6	Bangalore UA	29.218	3.650	12.5	41.303	5.162	12.5	63.597	7.949	12.5
7	Ahmedabad UA	25.480	5.172	20.3	33.122	6.724 @	20.3	43.629	8.859	20.3
8	Pune UA	17.222	2.807	16.3	24.940	4.065 @	16.3	35.299	5.753	16.3
9	Kanpur UA	16.391	6.140	37.5	20.299	4.172	20.6	24.875	5.124	20.6
10	Lucknow UA	10.076	2.850	28.3	16.692	2.778	16.6	22.581	3.748	16.6
11	Nagpur UA	12.195	3.890	31.9	16.640	5.308 @	31.9	23.212	7.405	31.9
12	Jaipur UA	10.152	2.958	29.1	15.182	4.418 @	29.1	22.108	6.433	29.1
13	Surat UA	9.239	2.347	25.4	15.190	3.858 @	25.4	22.916	5.821	25.4
14	Coimbatore UA	9.204	0.801 +	8.7	11.007	0.958	8.7	13.283	1.156	8.7
15	Cochin UA	8.249	2.046	24.8	11.406	2.829 @	24.8	15.364	3.810	24.8
16	Vadodara UA	7.449	1.182	15.9	11.268	2.063	18.3	17.074	3.125	18.3
17	Indore UA	8.293	1.263	15.2	11.091	1.686 @	15.2	15.430	2.345	15.2
18	Patna UA	9.189	5.837	63.5	10.996	6.982 @	63.5	15.273	9.698	63.5
19	Madurai UA	9.077	1.634 +	18.0	10.859	1.953	18.0	13.134	2.364	18.0
20	Bhopal UA	6.710	0.568	8.5	10.628	1.487 **	14.0	15.327	2.145	14.0
21	Vishakhapatnam UA	6.036	1.520	25.2	10.571	2.664	25.2	16.683	4.204	25.2
22	Varanasi UA	7.972	2.600	32.6	10.309	2.074	20.1	13.314	2.676	20.1
23	Ludhiana	6.071	3.104	51.1	10.427	3.687	35.4	16.342	5.785	35.4
	Total	**515.671**	**148.249**	**28.7**	**709.966**	**188.659**	**26.6**	**966.280**	**254.811**	**26.4**

Source : T.C.P.O., Ministry of Urban Affairs & Employment

Note :

Classification of the size of cities is based on 1991 census.

@ Based on the percentage identified slum population of 1981.

\+ Based on the percentage identified slum population of 1991.

Estimated

** Based on the no. of identified Jhuggi collected by the State Govt. in 1991-92

dwellers' life is the most miserable one, devoid of all basic amenities. The growth in the slum population in the 23 metropolitan cities in India is shown in table 3.21.

It may be well said from the table that there has been a substantial increase in the slum population but the percentage of slum population to total population increased in 1981-91, but the same has remained same for 1991-2001 to a great extent. In 1981, Patna had the highest percentage (63.5%) of slum population followed by Ludhiana (51.1%), Kanpur (37.5%), Greater Mumbai (34.3%), Kolkata (32.4%), Chennai (32.1%), Delhi (31.5%). In 1991, Patna & Ludhiana retained their positions with 63.5% and 35.4% slum population respectively; followed by Greater Mumbai (34.3%)and Kolkata (32.9%). In 2001, the same ranks are maintained.

It can also be inferred from the table that the percentage share of the slum population in the decade 1981-1991 increased only for Bhopal (from 8.5% to 14%) and Vadodra (from 15.9% to 18.3%), while it decreased for the metropolitan cities like, Delhi, Chennai, Kanpur, Lucknow, Varanasi, and Ludhiana. For the decade 1991-2001, the percentage share of the slum population to the total population in each metropolitan city has remained the same. Yet, the level of pollution has been increasing in most of the cities and the ambient air quality is deteriorating significantly.

The sprawling slums have become common in cities not only in large metropolitan cities but also in medium –sized towns.[6] Slums are lacking in sanitary facilities and other basic civic conditions. This in turn affects the environment of the urban areas.

III. 3. 2 MEASURES FOR IMPROVING SLUM CONDITIONS

The galloping population pressures exert increasing demands for higher agricultural productivity, increasing demands for industrialization and urbanization, and fuller exploitation of natural resources. Only pragmatic utilization of these resources through reorientation of developmental policies could lead to the alleviation of present economic impasse.

As slums remain as a necessary evil of urbanization the focus of planners have shifted from eradication of slums to provision of basic urban amenities since 1972. For the same purpose **EIUS (Environmental Improvement of Urban Slums).** The scheme envisages the following minimum facilities for the improvement of living environment of the slum dwellers:

1. *Water Supply:* 1 tap for 150 persons.
2. *Sewer:* Open drains for normal outflow to avoid water accumulation.
3. *Storm Drains:* For quick draining out of the storm water.
4. *Community Baths:* 1 bath for 20-50 persons.
5. *Community Latrines:* 1 latrine for 20-50 persons.
6. *Widening and paving of existing lanes:* for easy floe of pedestrians, bicycles, and handcarts thereby avoiding mud and slush.
7. *Street lightening:* 1 pole 30 metres apart.

The EIUS with an emphasis on Social Justice aimed at improving the living conditions of the urban poor. Initially this programme was extended to 20 cities and later on, to all the cities having 3 lakhs population or more. The EIUS programmes were taken as a part of the Minimum Needs Programme in the state. The programme was extended to all urban centres in the year 1978. In the 5^{th} plan, the outlay of EIUS Programme was Rs. 50 Crore, which increased to151.45 crore in the 6^{th} plan and further to Rs. 269.65 crore in the 7^{th} plan during which 9 million slum dwellers were expected to benefit from the scheme.

Sites and Service schemes

The site and service scheme came up as an alternate housing option for low-income families. The basic objective of this scheme was to provide low-income families with land and public utilities. One of the components of this scheme includes provisions of residential plots, toilets, and bath units. Loans were granted to the weaker sections for construction of low cost housing units. The eligibility criterion for the economically weaker section to get HUDCO loans under this scheme is that a household income should not exceed Rs. 700 per month.

Urban Community Development (UCD) Programme

The Urban community development programme had strategies to combat urban problem in general and of the depressed areas in particular. The UCD programme emphasized self-help, community organization and support from the government for self-help activities. The components of UCB programmes were:

a) Child-welfare activities: Pre-school classes, immunization, mid-day centres, medical check-up and crèche.
b) Youth welfare activities: typewriting classes, youth rallies, auto-rickshaw driving, civil defence.
c) Women's welfare activities: dispensaries, exhibition, basti committees, cooperatives, film shows, anti-mosquito drive.

In 1985, the UCD merged into a new programme called Urban Basic Service programme discussed as below.

Urban Basic Service (UBS) Programme

In 1985, the UBS programme was launched in the country w. e. f. the 7th Plan as a scheme sponsored by the central govt.

The programme of Urban Basic Service was a multi-dimensional and a community oriented programme involving the integration of services of Central Govt., the state Govt., local bodies and the UNICEF. Central govt., state govt., and UNICEF shared the cost of programme to the extent of 20%, 40%, and 20%, respectively. The main components of the programme were as follows:

a) Primary Health Care: The emphasis being on preventive health care, immunization, improved infant feeding practice, child –growth monitoring, home –based diarrhoea management, drinking water supply, environmental sanitation, Family Planning and Birth Spacing;
b) Early childhood learning facilities, which include establishment of pre-school and crèches;
c) Women's economic upgrading by providing skill training for women;

d) Water supply: extension for community taps and the installation of hand pumps as well as rehabilitation;
e) Sanitation, which covers construction of low cost poor flush latrines and providing environmental sanitation facilities.

"The UBS programmes has been taken up in all the urban centres of 25 UTs in the country."

Self Employment Programme for Urban Poor (SEPUP)

The GOI implemented the SEPUP programme in 1986. The aim of the programme was to assist the urban poor to take self-employment in ventures by ear-marking a sum of Rs. 200crores. The programme was implemented by selected branches of public sector banks in all the urban centres with a population exceeding as per census.

Under SEPUP the urban poor households each with an income of less than Rs. 600 per month are eligiblre for loans upto Rs. 5000. the amount of loan to be sanctioned depended on the typoe of work undertaken from among 33 categories of self-employment venture, such as rickshaw pulling, weaving,shoe-mending, tailoring, carpentry, book binding, etc. loans under the programme carry on interest of 10% p. a. The loan amount is to be repaid in 33 equal monthly installments, after a grace period of 3 months.

Nehru Rozgar Yojana

The Nehru Rozgar Yojana has been designed to provide employment to the under employed and unemployed among the urban poor. The cost of programme is shared by the central govt. and the state govt. on 60% and 40% basis. The NRY has the following 3 components: -

1. Scheme of Urban Micro-Enterprises (SUME): assists eligible beneficiaries to secure technical /vocational training and to set up micro level enterprises. The urban poor, household each with an annual income of less than Rs. 11850 are eligible for assistance under the scheme. This scheme is applicable to all urban settlements excluding areas falling under cantonment board.
2. Scheme of Urban Wage Employment (SUWE): seeks to provide wage employment opportunities to urban poor through the creation of socially and

economically useful and productive assets. Any poor person residing in urban areas willing to take up manual work on al casual basis on payment of the statutory minimum wages is eligible for assistsance under this scheme. Within this scheme, special attention will be paid to low cost sanitation and drainage works. This scheme is applicable only to urban settlements with a population below 1 lakh.

3. Scheme of Housing and Shelter Upgradation (SHASU): provides technical training in construction activities and assists beneficiaries belonging to economically weaker sections. Housing and Urban Development Corporation (HUDCO) assisted govt. in providing loan and subsidies to the beneficiaries. All families belonging to economically weaker sections having a household income of less than Rs. 1250 per month are eligible for assistance under the scheme. This scheme is applicable to all towns, cities with a population between 1 &2020 lakhs.

The failure or success of these programmes cannot be assessed, since there is not enough data for the recent years of civic amenities to the slum dwellers.

III. 4 CRITICAL LINKAGES

There are several linkages at work between environment and population. There is no doubt about the fact that population growth put pressure on the resources and consequently on the environment. But at the same time, technologies of production differ considerably in their relative impact on economic development and environmental quality. E. g. while a nuclear power plant and a hydroelectric dam may contribute equivalent amount of electricity, the nuclear power plant is likely to have much greater environmental impact. A third factor viz., affluence measured as per capita consumption exerts an effect on environmental degradation. If the consumption good, happen to be an automobile with obsolete technology its impact on environmental degradation is massive.

Ehrlich and Ehrlich (1991) has stated the problem as follows: "the role of over population and population growth in causing environmental degradation is summarized in the equation I= Px Ax T. The impact (I) of any group or nation on the environment can

be viewed as the product of its population size (P) as measured by consumption, in turn multiplied by a measure of damage done by the technologies (T) employed in supplying each unit of that consumption."[7]

Under this view, population size is a "multiplier" of the effects of other factors that influence the environment. It emphasizes population's direct and indirect effects on the environment. Paul Ehrlich's **Formula: 1.**

Impact = Population x Affluence x Technology.

Where, I = environmental impact, i.e., the numerical value of some pollutants;

P = population size;

A = affluence, usually measured as GNP per capita and

T = technology usually measured as the amount of pollution per unit of GNP.

IPAT implies that, although population, consumption, and technology might each have an independent effect on the environment (I), their combined effect is probably the most important. Though it has been criticized because it oversimplifies the relationships among the variables.[8] Although the approach is highly simplified, it allows us to take a first step toward disentangling the effects of population growth, income growth, and technical change on pollution.

Table 3.22:

Factors in relative change in Carbon Monoxide emissions from vehicles

	CO emission change	Population	Vehicles / population	Carbon Monoxide/ vehicles
Greater Mumbai	3.1855	1.9062	2.2675	1.5223
Kolkata	10.2143	1.4711	3.2661	2.1260
Delhi	6.6375	2.2964	4.1018	0.6936
Chennai	27.5833	1.6914	7.1975	2.2676

Table 3.23

factors in relative change in emissions of Oxides of Nitrogen from vehicles

	NOx emission change	Population	Vehicles / population	Carbon Monoxide/ vehicles
Greater Mumbai	2.2782	1.9062	2.2675	0.5266
Kolkata	14.7057	1.4711	3.2661	3.0596
Delhi	7.5301	2.2964	4.1018	0.7985
Chennai	23.3750	1.6914	7.1975	1.9221

Using the data from the above tables in a modified form can be taken as:

Log pollution =Log population + Log (Goods/ population) + Log (pollution /goods)

The following results can be obtained—

Table 3.24

Percentage contribution of population affluence and technology in Environmental degradation

Relative increase in pollution (log value)	Percentage share of- population	Percentage share of- Affluence	Percentage share of- Technology
Carbon Monoxide (1.1)	27.3 (0.3)	54.5 (0.6)	18.2 (0.2)
Oxides of Nitrogen (1.1)	27.3 (0.3)	54.5 (0.6)	18.2 (0.2)

From the above table it can be clearly observed that in case of both Carbon Monoxide and Oxides of Nitrogen emissions, the main responsible factor is Affluence, which is due to higher level of consumption. Affluence was most responsible for occurrence of Carbon Monoxide emissions than population and technology. Similar was the case with Oxides of Nitrogen.

It is evident that environmental degradation in the metropolitan cities was mainly due to high per capita income, followed by population growth and then by use of technology.

III. 5 CONCLUSION

Ever imagined of a technical conference of brain wizards in a smoky environment.

From the above discussion on pollution (air, water, and noise) it can be concluded that:

1. There has been a general increase in the concentration levels of pollutants in the metropolitan cities. But the recently there has been a decline in the concentration levels due to the various initiatives taken by the government.
2. Since 1980 Air Pollution has increased in all the metropolitan cities, except, Kolkata, Chennai, Kanpur, Nagpur, and Bhopal have shown a slight decline in their SPM concentration. Chennai and Kanpur show a declining trend in the concentration of SPM in the residential areas.
3. Kolkata had the highest concentration of SPM in industrial areas in 1991 but it Kanpur registered the highest concentrations in 1998. Though Kanpur registered a decline in SPM concentration, still the levels exceeded the limits.
4. Kolkata has the highest concentration of the oxides of Nitrogen in 1991 followed by Ahmedabad and Greater Mumbai in the industrial areas. While, in 1998 Delhi topped the list.
5. The oxides of Nitrogen in the industrial areas in 1998 recorded an increasing trend, especially in Pune, only Greater Mumbai, Chennai and Nagpur registered a decline. For the Residential areas, Kolkata in 1991 and Pune in 1998 had the highest levels of Oxides of Nitrogen.
6. In the residential areas also there was increase in the concentration level of oxides of nitrogen from 1991 to 1998. Only Greater Mumbai, Kolkata, and Patna recorded a marginal decrease.
7. Kolkata had the highest concentration for Sulphur dioxide for industrial areas in 1991, while Ahmedabad had maximum concentration of Sulphur dioxide in residential areas. In 1998, Pune overtook both of them.
8. In general there has been an increase in the concentrations of Sulphur dioxide in 1998 in nearly all the metropolitan cities except, Greater Mumbai, Chennai, and Hyderabad (only industrial areas) show a slight decline.

9. Vehicular emissions were the main cause of Air Pollution in the metropolitan cities.
10. Carbon Monoxide is the main constituent of vehicular emissions in all the metropolitan cities.
11. Among the metropolitan cities, Delhi has the largest vehicular population followed by Greater Mumbai.
12. Delhi also has the highest load of pollutants in its ambient air from vehicular emissions. But since 1996, there has been a decrease in the load of pollutants in the air of Delhi.
13. During 1981-91, Hyderabad registered the highest vehicular growth, followed by Chennai, Bangalore.
14. Though, Sulphur dioxide and oxides of Nitrogen levels have registered an upward trend, they remain well within the National Ambient Air Quality Standards in all the cities. The SPM levels at Indore, Ahmedabad, Patna and Ludhiana are high. In addition to these common air pollutants; some of the toxic and carcinogenic chemicals are being detected in urban air.
15. The availability of surface water supply (mld) that is the major source of water supply in the metropolitan cities has increased in general from 1988 to 1995.
16. The total per capita availability of water supply has increased in some of the metropolitan cities. Yet there has been a decline in the percentage population covered in the metropolitan cities.
17. There has been an increase in the volume of the waste water generated. Also, there has been an increase in the volume of waste water collected, with Greater Mumbai leading in both the categories.
18. The percentage sewerage coverage has yet not reached 100% in the metropolitan cities.
19. Patna registered an increase in the sewerage coverage, while Bangalore registered a decline in its coverage.
20. Noise pollution has already reached high in most of the metropolitan cities in all the zones –residential, commercial, industrial, and silence.

21. The noise levels are higher than the prescribed limits during both day & night in the residential areas. While for the commercial areas in the metropolitan cities, the night time levels were higher than the allowed limits.
22. Vehicles are a major source of noise pollution.

A recent report of Central Pollution Control Board has named the 12 most polluted cities of India. The report has also revealed that Delhi no longer holds the place of the most polluted city of the country, instead four cities –Kolkata, Ahmedabad, Pune and Kanpur have overtaken Delhi to take their place as the most pollutes cities in the country. The seven cities named after Delhi include Agra, Lucknow, Varanasi, Patna, Jharia, Jodhpur, and Faridabad.

Since 1980's there has been a sharp increase in the number of vehicles in the metropolitan cities. It is very important for policy makers to understand these problems, assess their implications and formulate policy guidelines. However, the present research is based on the assumption that development should take place without destroying the environment. What is important is the sustainability of development over a long drawn period of time rather than the ephemeral nature of development the gains of which will only be available by the present generation.

The following conclusions can be drawn from the above discussion on the availability of the civic amenities in the metropolitan cities in India:

1. Number of slums and slum population has increased since 1980s in the metropolitan cities of India.
2. Kolkata shelters the highest slum population among the metropolitan cities.
3. the percentage share of the slum population to the total population in each metropolitan city in general has remained the same. Though, in the years 1981 & 1991, there was an increase in the share for Bhopal and Vadodra, there were a few metropolitan cities like, Delhi, Chennai, Kanpur, Lucknow, Varanasi, and Ludhiana, which experienced a decrease also.
4. The condition of the slums in terms of availability of civic amenities in the metropolitan cities in India has deteriorated.

5. Provision of household amenities (electricity, safe drinking water, and toilet facilities) were in general good for Ludhiana, followed by Amritsar, Greater Mumbai.
6. Vishakhapatnam had the worst provision of household amenities.
7. The provision of household amenities has overall improved since 1981
8. Among the 3 factors, population size, affluence and technology; affluents emerged as the main factors that deteriorates the urban environment of the metropolitan cities.
9. The slum population has increased substantially in absolute numbers.
10. The percentage of slum population to total population increased in 1981-91, but the same has remained same for 1991-2001 to a great extent.
11. In 1981, Patna had the highest percentage of slum population followed by Ludhiana, Kanpur, Greater Mumbai, Kolkata, Chennai, Delhi. In 1991 & 2001, Patna & Ludhiana retained their topmost positions for having highest % of slum population to total population, followed by Greater Mumbai and Kolkata.

As the population of many municipalities grows, their sewage treatment facilities, though once adequate, are quickly outgrown. Though the overall picture for India in terms of percentage below the poverty line has gotten only slightly better.[9]

According to Habitat II (1996), " Development of housing infrastructure and services have not kept in tune with growth of housing, the nagging problem of Upgradation and renewal of basic services like potable water and sanitation is serious in Indian cities."

CHAPTER 4

CONCLUSION AND SUGGESTIONS

The purpose of the present study has been to know the state of urban environmental quality and their correlates in the metropolitan cities. There are mainly three factors viz., population size, level of consumption and technology level, which deteriorate the natural environment. Due to the interplay & inter linkages between these three, urban areas create more pollution (air, water and noise). Air, water and noise pollution that are concentrated mainly in the urban areas originate from transportation, fuel consumption, industrial processes, domestic solid waste generation and disposal.

Rapid population growth, migration and associated urbanization, make large areas urban. Urbanization leads to concentration of population in any region. There is large concentration of population in the metropolitan cities. The positive role of urbanization is often over-shadowed by the evident deterioration in the physical environment and quality of life in the urban areas caused by widening gap between demand and supply of essential services and infrastructure. These results from increasing population pressure on urban centres, most of which are financially and organizationally ill equipped to respond to infrastructural needs. Due to large size of population total consumption of food and water, use of vehicles etc. are also high.

Differential rates of population growth degrade the environment at different levels. A faster growth of population puts more pressure on the resources and consequently on the environment, than a slower growth of population.

In metropolitan cities like Greater Mumbai, Kolkata, Delhi, Chennai, Bangalore, Ahmedabad, Kanpur, Pune, Patna, and Bhopal have a poor state of ambient air. The pollution levels are high especially in the industrial areas. Industrial pollution has increased more. Though the govt. has taken many initiatives to tackle the problem of pollution, and to some extent they have managed to bring down the pollution levels though a lot need to be done in the field so that the effect reach other metropolitan cities also, besides Delhi.

Delhi, which has successfully brought down pollution levels, is being held as the model for tackling pollution. Some metropolitan cities like Dhanbad, Jamshedpur have large –scale pollution owing to underground fires that steadily burns up huge reserves of coal spread over a large area of the Chotanagpur plateau. This results in the large –scale pollution in the coal belt. In Jodhpur, Rajasthan, hot and arid conditions -especially in summer –lead to higher SPM levels. Considering the polluted cities of UP –Lucknow, Kanpur, Agra and Varanasi, power failures have contributed to pollution because people use cheap generator sets that are both noisy and polluting.

More and more cities are becoming urban. Though the rate of urbanization has fallen during 1981-91, the actual growth of urban population growth has been massive. Though the population growth rate in Delhi, Kolkata, Chennai and other metropolitan cities have started declining since 1981-91, but the absolute increase in the population has been more in the decades following it. Though Greater Mumbai showed a higher growth rate in 1981-91 rather than 1971-81 because of inclusion of a vast area of five new towns in the physical limits of the metropolitan city.

The only question to be asked is: "How to make the process more compatible with the overall economic development pattern and environmentally less damaging"? A widely dispersed urban growth will prevent the push of large numbers towards metropolitan cities and will also be beneficial to rural development. This implies vastly dispersed infrastructure, reaching out even to smaller urban and rural areas. A push to such a strategy needs to he given through creation of communication, transport, health and educational infrastructure in large number of small towns and in rural areas.[1]

According to the report published by National Commission on Urbanization, the management of metropolitan and other big cities puts a formidable challenge before the planners, administrators and the people of the country. However, the most demanding of the urban challenges, unquestionably, is the challenge posed by urban poverty and housing facility.[2]

The commission felt that:

1. Urbanization should be tackled from a regional leveling order to identify and establish a hierarchy of urban centers from rural service centers to metropolitan or other major cities serving the region as a whole.
2. That economic planning should be oriented, if we have to achieve anything meaningful in urban development. Such re-orientation should recognize the enormity of urbanization and the consequent problems.
3. The importance of democratically elected local bodies in the management of urbanization should be recognized and they should be assigned adequate powers to enable them to carry out their development and maintenance functions.
4. Development of the medium and small towns should be given priority to stem the growth of metropolitan centers and other major cities.

The overall Air, water, and Noise Pollution has increased overtime in the metropolitan cities, the main cause being the increasingly growing vehicular demography. Delhi has the largest number of registered vehicles and hence has more vehicular emissions. In metropolitan cities, steps have been taken to tackle Air Pollution, like phasing out old vehicles. But, in turn they are shunted out to smaller cities. This, according to the Environment Ministry officials, is why cities with fewer vehicles like Lucknow, Hyderabad, and Nagpur have high vehicular pollution.

The Sulphur dioxide concentration had been increasing during the past several years, though these were within the NAAQS limit, they showed a decline from 1992 onwards.[3] The ambient Sulphur dioxide concentrations have been well within the annual average limits mainly because of low generation of Sulphur dioxide in the city due to enhanced use of clean fuels like LPG, CNG etc. for domestic and industrial purposes, limiting the Sulphur dioxide generation within the assimilation and absorption capacity of the environment.

The per capita water consumption was highest in Greater Mumbai, followed by Delhi, Kolkata, Chennai etc.The total wastewater generated by the 23 metropolitan cities is 9275 mld. Out of this, about 58.5% is generated by the first four metropolitan cities, viz. Mumbai, Kolkata, Delhi and Madras. The city of Mumbai generates the maximum wastewater to the tune of 2456 mld and Madurai generates the least with 48 mld. Out of the 23 metropolitan cities, 19 cities have sewerage coverage for more than 75% of the population and the remaining 4 cities have more than 50% coverage. On the whole 78% of total metropolitan population is provided with sewerage facility, compared to 63% in 1988. The maximum volume of wastewater, 2210 mld, is collected in Mumbai, while the minimum of 33.6 mld is collected in Madurai.

The noise level in the metropolitan cities are showing different levels. Daytime noise levels are higher than the night time levels of noise. Greater Mumbai aand delhi have higher noise levels in industrial areas during daytime, while Chennai has higher values during daytime in the commercial areas, though its noise levels in industrial areas are lower than the standards fixed by Central Pollution Control Board. Kolkata has the highest noise levels during daytime in the residential areas.

Urbanization leads to concentration of population. The urban areas having a relatively higher level of income also have a higher level of consumption. Thus, both large population and higher level of consumption exert pressure on the environment. Hence the urban environment is deteriorated due to three basic factors namely – population size, affluence and the level of technology.

Slum dwellers of the metropolitan cities are still devoid of the basic amenities necessary for living. Though the provision of safe drinking water, electricity & toilet facilities have increased but the per capita coverage needs to be improved in the metropolitan cities in India.

Govt. initiatives

"The world's growing population, combined with unsustainable production and consumption patterns, is putting increasing stress on air, land, water, energy, and other essential resources. Development strategies will have to deal with the combination of

population growth, ecosystem health, technology, and access to resources. Meeting the unmet need for Family Planning and reproductive health care services should be a part of the national sustainable development strategies."

In the long run, slowing population growth would help ease the pressure on the cities, buying time to make improvements in technology. Municipalities also can take a number of steps now – building better transportation systems, promoting recycling, and encouraging water conservation.

Public investment in urban infrastructure has also been less than adequate. The challenge of reorienting the urbanization process, thus, lies in overcoming the infrastructural deficiencies and taking the best advantage of economic momentum inherent in urbanization.

Since 1980's there has been a sharp increase in the number of vehicles in the metropolitan cities. It is very important for policy makers to understand these problems, assess their implications and formulate policy guidelines. However, the present research is based on the assumption that development should take place without destroying the environment. What is important is the sustainability of development over a long drawn period of time rather than the ephemeral nature of development the gains of which will only be available by the present generation.

Initiatives taken to reduce vehicular pollution

High population growth has driven the communities particularly in metropolitan cities to expand outwards esp. towards airports. There's a need for strengthening measures for controlling the pollution caused by vehicles and curbing the *ad lib* extension of habitation towards the airports.[4] Several initiatives have been taken to reduce vehicular emissions during the past few years. In the recent years, the impacts of pollution control initiatives are reflected on the air quality. Ambient air quality in metropolitan cities, especially in Delhi indicates decreasing trends with respect to regulatory pollutants over the years. Important steps taken for vehicular pollution control during the year are as follows:

Vehicle Technology & Emission Norms

- Bharat Stage-I norms (Euro-I norms) have been implemented for all categories of vehicles throughout the country w.e.f. 1.4.2002.
- Bharat Stage-II emission norms (Euro-II norms) for new private non-commercial vehicles were made effective in National Capital Region from 1.4.2000, in Mumbai from 01.01.2001 and in Chennai and Kolkata from 01.07.2001.
- Bharat Stage-II emission norms for new commercial vehicles were implemented in NCT-Delhi, Mumbai, Kolkata and Chennai from October 2001.
- Introduction of 4-stroke two wheelers replacing 2-stroke two wheelers increased in 2001.
- Phasing out of vehicles over 15 years old.

Fuel Quality

- Diesel with 0.25% Sulphur has been introduced throughout the country from 1.1.2000.
- Diesel with 0.05% were introduced in National Capital Region for private non-commercial vehicles from 1.4.2000 and i
- Diesel Sulphur content reduced to 0.05% in NCT-Delhi from 01.03.2001, in NCR from 30.06.2001, in Kolkata and Chennai from 01.07.2001.
- Leaded gasoline phased out throughout the country from 1.1.2000.
- Gasoline with Sulphur content reduced to 0.05% from 0.1% max. in Greater Mumbai from 01.01.2001 and Chennai from 01. 07.2001.
- Benzene in gasoline with 3% has been introduced in metropolitan cities from 1.4.2000

Alternative Fuels & Vehicles

- Emission norms for CNG & LPG powered vehicles notified during 2001.
- Number of CNG dispensing stations increased to 87 in Delhi.
- Number of registered CNG vehicles in Delhi increased during the year 2000-2001.

- Over 80,000 petrol –run auto rickshaws have been replaced with 45,000 of those run on CNG. The taxis too are now either Euro –II compliant and meeting stipulated emission standards or are being run on CNG.

Though, Sulphur dioxide and oxides of Nitrogen levels have registered an upward trend, they remain well within the National Ambient Air Quality Standards in all the cities. The SPM levels at Indore, Ahmedabad, Patna and Ludhiana are high In addition to these common air pollutants; some of the toxic and carcinogenic chemicals are being detected in urban air.

A recent report of Central Pollution Control Board has named the 12 most polluted cities of India. The report has also revealed that Delhi no longer holds the place of the most polluted city of the country, instead four cities –Kolkata, Ahmedabad, Pune and Kanpur have overtaken Delhi to take their place as the most pollutes cities in the country. The seven cities named after Delhi include Agra, Lucknow, Varanasi, Patna, Jharia, Jodhpur, and Faridabad.

END REFERENCES

1. Agarwal, O. P. "*Towards a National Urban Transport Policy.*" In: Indian Journal of Transport Management, October –December 2001. pp 593-614.
2. Berland, T. 1970. "*The fight for quiet.*" Englewood Cliffs, N.J.: Prentice-Hall. Pp 4-5.
3. Census of India, 1981. *"Percentage of households having Electricity, Safe drinking water, Toilet facilities and no literate members by State /UTs , Districtwise", 1981.*
4. Census of India 1991, *Civic and other Amenities in the Notified Slums of Class I & II towns: India.*
5. Census of India, 1991. *"Housing and Amenities: A database on housing and amenities for districts, cities and towns."*
6. Central Pollution Control Board, "*Air Quality: Status and Trends in India.*" Central Pollution Control Board, Ministry of Environment and Forests, NAAQMS/14/1999-2000. October 2000.
7. Central Pollution Control Board, "*Annual Report: 2000-2001.*" Central Pollution Control Board, Ministry of Environment and Forests.
8. Central Pollution Control Board, "A Report on the State of Environment: Lucknow." Central Pollution Control Board, Ministry of Environment and Forests, January 2002.
9. Central Pollution Control Board, "A Report on the State of Environment: Varanasi." Central Pollution Control Board, Ministry of Environment and Forests, October 2000.
10. Central Pollution Control Board, "Noise Pollution Regulations in India." Pollution Control Law Series, Central Pollution Control Board, Ministry of Environment and Forests, 2000-01.
11. Central Pollution Control Board, "*Parivesh: Highlights 2000.*" Central Pollution Control Board, Ministry of Environment and Forests, March 2001.
12. Central Pollution Control Board, "*Parivesh: Highlights 2001.*" Central Pollution Control Board, Ministry of Environment and Forests, January 2002.
13. Central Pollution Control Board. "*Parivesh newsletter*", Central Pollution Control Board, Ministry of Environment and Forests, june1995, No. 1, Vol. 2.
14. Central Pollution Control Board, *1996: "Parivesh: the Newsletter"*, Central Pollution Control Board, Ministry of Environment and Forests Vol.3 (iv) December 1996.

15. Central Pollution Control Board, "*Parivesh Newsletter: Environmental Management plan Kanpur Urban Area.*" Central Pollution Control Board, Ministry of Environment and Forests, May, 2001.
16. Central Pollution Control Board, "Pollution Statistics: Bhopal." November 2001.
17. Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities", 1988. Control of Urban Pollution, CUPS/30/1989-90.
18. Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Metrocities (1994-95)." Control of Urban Pollution, CUPS/42/1997-98. August 1997.
19. Central Pollution Control Board, "Status of Water Supply and Wastewater Collection, Treatment and Disposal in Class I Cities". Control of Urban Pollution, CUPS/44/1999-2000.
20. Central Pollution Control Board, "Vehicular Pollution Control in Delhi- Initiatives & impacts." Central Pollution Control Board, National Ambient Air Quality Monitoring Series, NAAQMS/18/2001-2002. October 2002.
21. Davis, Kinsley (1967), *The origin and Growth of Urbanization in the World.* In: H. M. Mayor and C. F. Cohn (eds.), *Readings in Urban Geography*, University of Chicago, Chicago.
22. Detwyler, Thomas R. and Marcus, Melvin G. 1972. "*Urbanization and Environment.*" Duxbury Press.
23. Dutt, G. K. 1985. "Issues and Challenges." In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi.
24. Economic Survey, 1993-94, GOI, Ministry of Finance, Economic Division.
25. Ehrlich, P. R. & Ehrlich, A. H. 1970. "*Population, Resource and Environment: Issues in Human Ecology*," W. H. Freeman and Company, San Fransico.
26. Ghosh, A. R. "Air Pollution and Health in Calcutta: A Geographical Analysis." In: Geographical Review of India, Vol. 62, No. 4.
27. Goodall, Brian. 1987. The penguin Dictionary of Human Geography. Penguin Books.

28. Grima, Ramon; Micallef, Alfred; Colls, Jeremy J. *"External contribution to Urban Air Pollution."* In: Environmental Monitoring and Assessment, Vol. 73, No. 3, Feb. (I) 2002.
29. Handbook of Transport Statistics in India, Ministry of Surface Transport, 1999.
30. Hardoy, J. and Satterthwaite, D. 1984. "Third World Cities and the Environmental of Poverty." In: Robert Repetto (eds), *The Global Possible Resource, Development and the New Century*, Yale University Press, Connecticut.
31. Holdgate, M. W. 1979. *"A perspective of environmental pollution."* Cambridge: Cambridge University Press; and Newson, M. 1992. *"The geography of pollution."* In: M. Newsons ed., Managing the human impact on the natural environment: patterns and processes. London and New York: Belhaven Press.
32. Kayastha.
33. Kempen, E. E. M. M. Van; Kruize, Hanneke; Boshuizen, Hendriek C.; Aunling, Caroline B.; Staatsen, Brigit A. M.; Augustinus E. M. de Hollandes. "The Noise Exposure and Blood Pressure and Ischemic Heart Disease: A Meta Analysis." In: Environmental Health: Perspectives, Journal of National Institute of Environmental Health Sciences, March 2002, Vol. 110, No. 3.
34. Ministry of Finance, Government of India, 1996. *Economic Survey, 1995-96.* New Delhi.
35. Ministry of Industry, 1994. *Handbook of Industrial Statistics, 1993.* Office of Economic Advisor, New Delhi.
36. Ministry of Surface Transport, Transport Research Division, 1993. *Pocket Book on Transport Statistics.* GOI, New Delhi.
37. National Human Development Report, 2001.
38. NEERI, 1991. *Annual Report, 1991.* National Environmental Engineering Research Institute,New Delhi.
39. Odum (1971),
40. Odum (1976), "Pollution and its Control," Saunders College Publishing, San Francisco.

41. Padam, Sudarsanam. "Bus Transport and Environment: Challenges and Opportunities." In: Indian Journal of Transport Management, October –December 2001. pp 531-532.
42. Panos, 1998. *"Liquid assets: is water privatization the answer to access?"* Panos Media Briefing No. 29 (http:// www.oneworld.org/panos/briefing/water.htm).
43. Pathak, C. R. 1985. "Man, Environment and Settlements" In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi.
44. Reddy, B. Sudhakara, "The Urban Challenge." In: India Development Report.
45. Singh, J. 1985. "Population, Pollution and the Urban Environment." In: *Geography and Environment: Issues and Challenges.* Prof. S. L. Kayastha Feliciation Volume, Concept Publishing House, New Delhi.
46. State of Environment, 1995, Ministry of Environment and Forests.
47. Stern, Arthur C. 1977. "Air pollution" third edition, Vol. V. Air Quality management, Academic Press, New York.
48. Tata Energy Research Institute (TERI), 1996. TERI Energy Database and Directory Yearbook (TEDDY), 1996-96. New Delhi.
49. Trivedi, P. R. "International Encyclopaedia of Ecology and Environment." Vol. 11, Indian Institute of Ecology and Environment, New Delhi, 1995.
50. UNEP, "Urban Air Pollution", UNEP/GEMS Environment library, No. 4.
51. Whittow, John B. 2000, The Penguin Dictionary of Physical Geography, Second Edition.
52. World Resources Institute, 1995. *World Resources, 1994/95.*
53. Worldwide Fund for Nature, 1995. *Delhi Environmental Status Report, An Information Handbook for Citizen Action.* Sponsored by Dept of Environment, Government of NCT, New Delhi.