

NATIONAL BIODIVERSITY STRATEGY & ACTION PLAN – INDIA

FOR

**MINISTRY OF ENVIRONEMENT & FORESTS,
GOVERNMENT OF INDIA**

**BY
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URBAN BIODIVERSITY

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I. INTRODUCTION

About 50% of the world's population now resides in cities. However, this proportion is projected to rise to 61% in the next 30 years (UN 1997a). The developed nations have a more highly urbanised population e.g. about 80% of the US population is urban. However, projections for the 21st century indicate that the largest cities, and the largest growth in city size, will occur in developing nations. Urbanisation trends of the past century also show a dramatic rise in the size of cities. Over 300 cities have more than 1 million inhabitants and 16 mega cities have populations exceeding 10 million (UN 1997b). Thus urbanisation has become a dominant demographic trend and in effect has become instrumental in land transformation all over the world.

The process of urbanisation affects global environmental changes. Urban areas account for only 2% of Earth's land surface, but they produce 78% of greenhouse gases, which contribute to global climate change (Grimm et al, 2000). Fast growing cities also play a major role in alteration of global biogeochemical cycles, changes in biodiversity due to habitat fragmentation, destruction, land use variations and exotic species. These effects go much beyond the boundary of the city.

Urban Ecosystems thus have become the subjects of global environmental concern. Because human societies are an important part of urban ecological systems, ecologists now recognise that "most aspects of the structure and functioning of Earth's ecosystems cannot be understood without accounting for the strong, often dominant influence of humanity" (Vitousek et al, 1997). In 1935, Arthur Tansley wrote: "We cannot confine ourselves to the so-called 'natural' entities and ignore the processes and expressions of vegetation now so abundantly provided by man. Such a course is not scientifically sound, because scientific analysis must penetrate beneath the forms of the 'natural' entities, and it is not practically useful because ecology must be applied to conditions brought about by human activity. The 'natural' entities and the anthropogenic derivates alike must be analysed in terms of the most appropriate concepts we can find." Almost 60 years after this warning, we now know that the earth abounds with both subtle and pronounced evidence of the influence of people on natural ecosystems (Russell, 1993) and cities have been confirmed as the most human dominated of all ecosystems.

During the last two decades, Urban Ecosystems have attracted the attention of scientists, ecologists and naturalists. All over the world, scientists have been studying various environmental and social parameters within cities, while ecologists and naturalists have been studying, documenting and monitoring natural parameters within the cities. The US Long-Term Ecological Research (LTER) network has put more emphasis on the growing cities. Recently, there has been a new trend in the thought process accompanying these studies to differentiate and compare Ecology *in* Cities and Ecology *of* Cities (Pickett et al, 2001, Grimm et al, 2000). A pioneering study in this direction was – 'The Ecology of a City and its People: the Case Study of Hong Kong' (Boyden et al, 1981). The ecological studies of cities have encountered different schools of thoughts: ecology *in* and ecology

of cities, biogeochemical and organismal perspectives, land use planning and biological approaches, disciplinary and interdisciplinary approaches etc. However, urban ecological studies are definitely poised for significant integration. Ecologists highlight the physical environment, urban climate, hydrology and soils. Naturalists study flora, fauna and vegetation including trophic effects of wildlife and pets. Other scientists study soil chemistry, leaf litter quality, exotic invertebrates and their interactions in urban systems. Social scientists study social structure and the social allocation of natural and institutional resources and try to accommodate them in ecosystem models of metropolitan areas. This has provided substantial information for comprehensive understanding of urban ecosystems.

There has been substantial emergence of voluntary groups of naturalists and environmentalists in urban areas all over the world during these last two decades. There has been more emphasis on ecological and environmental studies in the academic field both at graduate and postgraduate levels. Educational institutions have documented considerable ecological information. This trend is quite strong in developing countries and very significant in India. Many organisations and individuals were inspired by the work of the Bombay Natural History Society and the World Wide Fund for Nature and complemented natural history studies with conservation action. This movement has been significant mainly in big cities and that has contributed to the study of these cities. Many voluntary groups have documented ecological information of various cities in India. However, most of this information is of Ecology *in* the cities.

In these comprehensive studies of Urban Ecosystems, Urban Planners are very conspicuous by their absence, even though the urban environment has remained the domain of planners and landscape architects all over the world. This has resulted in the lack of ecological dimensions for land use planning, particularly for growing cities. There is an emerging trend, though small, amongst the planning professionals, particularly landscape architects, to emphasise ecological issues in their designs. However, these efforts have remained at an individual level and mostly as recommedatory in character. The Central Park in New York and other urban parks designed by Frederick Law Olmsted try to link environmental properties to human well being in cities. Ian McHarg's (1969) '*Design with Nature*' alerted planners and architects to the value of incorporating knowledge of ecological and natural features among the usual engineering, economic and social criteria when developing regional plans. Spirn (1984) emphasised the interaction between the built environment and natural processes affecting economy, health and the human community. Michael Hough's (1995) '*Cities and Natural Process*' provided a detailed account of how urban ecology should be the basis for shaping cities. Planning in Germany has been heavily influenced by a national programme of biotope mapping that includes cities. This programme includes descriptions of the flora and fauna of biotopes as a key to identifying types of habitats that are significant for 1) protecting natural resources, 2) quality of life, and 3) a sense of place and identity in the city (Sukopp 1990, Werner 1999). The Polish Academy of Sciences focussed on urban and suburban areas studying soils and abiotic ecosystem components and also included social scientists studying a mosaic of habitats with different degrees of development (Zimny 1990). Based on vegetation classification in cities, Brady et al (1979) proposed a continuum of

habitats from the natural to the highly artificial. Dorney (1977) proposed an urban-rural continuum from a planning perspective identifying six representative land zones each zone characterised by three subsystems. In India, there is neither any serious attempt towards ecological research of urban ecosystems, nor an urban planning effort with ecological dimensions.

It may be noted from the above references that ecological understanding of urban ecosystems has remained the area of researchers and academicians and it has lacked the planning perspective, whereas a few attempts by ecologically motivated individual planners relied on general ecological principles and assumptions, and on the success of prior case histories (Flores et al, 1997). There is a need to evolve and crystallise the insights of urban ecology for the planning purpose in manuals and to transform them into standardised norms and development control rules. Such norms would require constant monitoring and intermittent updating because of the dynamic nature and diverse character of growing cities.

This paper highlights the role of Planners in the studies of Urban Ecological Systems, which would lead to appropriate planning norms for conservation of Urban Ecology and Urban Biodiversity. The role of Planners is very significant in urban development. Their role is very crucial at different stages of development e.g. design, implementation, monitoring, improvement, deconstruction and reconstruction. They are actively involved in the development activities of both government and private sectors. Urban planning and development process has been systematised over the years and there are standard norms and development control rules appropriate to the size of a city. This has resulted in some amount of discipline and control in urban planning and development. Generally, it is not easy to flout these norms and rules. This paper envisages arriving at similar norms and rules for Urban Biodiversity as an integral part of the development control rules. This should bring in ecological dimension to urban planning. It will also encourage urban planners to develop a holistic and integrated concept for their designs with emphasis on the *Ecology of Cities*.

The health of biodiversity depends on the health of the ecosystem. This phenomenon has been well established for natural ecosystems. The principal cause for the loss of species is the alteration of the ecosystem in which they live (Ehrenfeld, 1972). In India, the major conservation project to protect the tiger had the theme of conservation of its habitat. This was strongly emphasised by the first director of the Project Tiger, Kailash Sankhala, “To protect the tiger you must protect its wild forests and if you do that well you will have saved all of nature” (1973). This paper attempts to take a cue from this concept, which could be used for conservation of urban biodiversity. A City is a human-made ecosystem and in the process of its creation tremendous land use change and destruction of natural habitat take place. The impact of such habitat destruction is felt by the surrounding non-urban ecosystems also. To revert the effects of this impact, conscious efforts are required to protect and rejuvenate any natural habitats within a city. This should be complemented with a planned effort to introduce and maintain a maximum ratio of indigenous, diverse and multi-canopy vegetation within a city. The efforts should also be made to have large nature reserves within a city and a planning attempt should be made to create contiguous

natural habitats or corridors to neighbouring forests, deserts, grasslands and other non-urban ecosystems. This paper attempts to create policy norms to be included in the development control rules of the cities to achieve such a near-natural ecosystem within a city. The paper shows special concern for natural ecosystems and differentiates them distinctly from human-made green areas like parks, gardens, farms etc. The entire thought process is based on two major case studies of Mumbai and Bangalore (annexures 2 & 3) and also general case studies of a few other cities in India (annexure 4). The norms and rules derived under recent Development Plans for metropolitan cities have been considered as a starting point for this exercise.

In that sense, this paper is written from the angle of an ecologist, for the use of urban planners and for appropriate implementation by decision makers with the involvement of local people. The strategy is to achieve balance between development and natural environment in the process of urbanisation.

II. URBANISATION

1. URBAN EVOLUTION

Homo sapiens is at least 50,000 years old. For four-fifths of that time, human beings lived the lives of hunters and gatherers, wandering over their territory in search of food. Some 10,000 years ago, development of agriculture on one side and domestication of animals on the other side made a significant impact on human evolution.” (Asimov I, 1989, Foreword: *The Exploding City* by Schiffer RL). Humans became settlers. They became a social animal.

Agriculture brought more food and more food brought more mouths. The spurt in population began. Fertile land and water attracted human settlements. These natural resources were protected on one hand, even through warfare. On the other hand, they were over-exploited. Villages grew into towns – cities – metropoli – megalopoli. They overgrew at the cost of the natural environment. Biodiversity became a victim of ‘civilisation’. However, cities remained relatively small till World War II, when the urban explosion arrived. Even today, in spite of the world population increasing to over five billion, the big cities have remained few in number and the world in general consists of rural areas and villages. But, it is not likely to be so in the third millennium. In 1900, less than 10 % of the world’s population lived in cities. In 1920, it increased to about 14 %. Then there was a sudden ascent, climbing to 40 % by 1980 (Sadik, UNPF, 1988).

In the third millennium, the percentage of the human population inhabiting cities is likely to be over 60 %. That is a real explosion in urban areas. And it will take a serious toll of natural environment. The cities are becoming parasites on the natural resources of the region. The destruction of urban biodiversity is going to have adverse impact not only on urban areas, but also on the surrounding rural areas. This is a cause for real concern.

2. URBAN BIODIVERSITY

A natural ecosystem evolves depending on its geographical location, e.g. latitude, longitude, altitude and related physical parameters, e.g. geology, climate. Human intervention metamorphoses the natural ecosystem into a complex human-made ecosystem. Natural forests change into agricultural / horticultural lands, plantations, pastures etc. Human settlements change into villages, towns, cities, metropoli etc. Natural elements like hills and valleys, streams, rivers and ponds, seashores and beaches are altered. Land use is changed and watercourses get

diverted. Density of population increases, land cover increases. Horizontal development becomes vertical. The few open spaces become gardens and parks. Socio-economics plays a major role in such transformations and land use changes to public, commercial and industrial activities. In spite of adverse impacts of such a revolution, biodiversity keeps evolving within complex micro ecosystems, its ingredients changing, adapting, mutating, vanishing, re-emerging and giving shelter to new arrivals. Some of these elements are adverse to the original natural ecosystem, some elements become beneficial to the human settlements around whereas some become risk factors. The ecology of such systems also becomes very different from natural areas and sometimes unique. It becomes anthropocentric.

Urban biodiversity thus includes that of the human-made environment with its flora, fauna and also human beings along with their domestic animals. Its character changes according to the character and evolutionary stage of the Urban Environment.

A typical large urban agglomeration (large city) will generally have a simple vegetation pattern. Some small areas of remnant natural vegetation, landscaped gardens and parks, playgrounds, gardens associated with institutional and public building complexes, plantation in open spaces around the buildings, road side plantation, cemeteries and graveyards all providing varied character to the cityscape. Along the water bodies, if any, there will be aquatic, semi-aquatic vegetation. The major adverse features of such cities are garbage dumps, sewage, industrial and automobile pollution and slums.

This limited and evolving vegetation in urban environment also supports and shelters diverse fauna, not many mammals but birds and insects that have sometimes considerable ability to adapt, move and migrate. Another interesting dimension to urban fauna is the existence of domestic animals like cats, dogs, horses and also cattle, pigs and goats in Indian cities at least. The urban fauna assumes urban character. Their food and prey pattern changes. Adverse features like garbage and sewage bring in scavenger animals and also support vermin such as rats, flies and mosquitoes.

Urban Ecology assumes a special character with its ingredients displaying new equations.

3. EXPLODING CITIES OF THE WORLD

The ecology of the earth revolves around ‘Producers, Consumers & Decomposers’. The sustainability of natural ecosystem depends on the balance of these three elements. However human population growth has taken this balance

wayward. The proportion of ‘Consumers’ has increased dramatically, humans being the main culprits.

The global population was about 1 billion in 1830. It doubled in the next century and by mid-1987 it touched 5 billion. The speed and the steadiness of population growth is so remarkable that demographers now predict that the world population will reach 7 billion by 2010 and 8 billion by 2020 and then stabilise at around 10 billion by the end of the 21st century. There is another aspect to this growth pattern. For now, the world is growing at the rate of 1 million people every 4 to 5 days, with 90% of this increase in the Third World. The growth rate is under 1% in the rich industrialised world, whereas it is over 2% in the poor developing countries (Sadik, UNPF, 1988). This is happening in rural areas as well as in cities. And even where the fertility rate has dropped, the overall population growth rate is still up. Not only because there are more births but also because there are more survivors.

Poverty, urban-centric development approach and explosion in population are a few important factors resulting in the biggest human migration in history – from villages / towns to large cities. The process of urbanisation of the earth seems to be inevitable. On one hand, people are rushing to the larger cities and on the other hand, a few towns are evolving into larger cities. New cities are emerging. This is happening all over the world, in Egypt, Mexico, Nigeria, Kolkata, Brazil, Tokyo, New York, Beijing etc., in countries separated by oceans and continents. This is happening simultaneously. A megalopolis is no more going to be rarity. In 1950, there were only 10 large cities with over 5 million inhabitants. In 2000, there are around 48 with a large majority of them in the less developed countries. There is a sharp shift in the world’s urban balance. If one looks at the top 25 cities (population over 10 million) of the world in 2000, only six are in the industrialised world whereas 19 are from the Third World (Annexure 1). By 2025, the number is likely to exceed 90, with 80 of them in poor countries (Schiffer, 1989).

All over the world, people are migrating from villages to towns and cities. Can the cities cope with this sudden explosion? Cities have been seen as efficient instruments for socio-economic upliftment of people. They also provide for social absorption, innovation and change. At the same time, the costs are too high in terms of pollution, environmental and cultural degradation, family disintegration etc. The migrating people carry the baggage of rural poverty, which gets perpetuated in the city. The cities cannot grow beyond the carrying capacity of their natural resources. They become unsustainable. Two decades ago, Barbara Ward gave this account (1976, *The Home of Man*):

“ Millions upon millions crowded in the exploding cities, all too often without the minimal provisions for urban cleanliness, offer man’s most concentrated insult to the support systems of air, water and soil upon whose integrity the survival of life itself depends.”

4. THE INDIAN SCENARIO

India has been one of the pioneers in the world in the process of civilisation that began in the Indus Valley about 5000 years ago. Subsequently, several geographical regions developed in isolation under the rules of various dynasties. However a centralised process of development and urbanisation started during the British Raj, more so after World War II. Independent India progressed from 1947 onwards, slow in the beginning and fast but wayward and haphazard after about 1970.

The process of urbanisation concentrated mainly in the regions with economic and political emphasis. Delhi evolved as a centre of political activities and then eventually developed as the political capital of Democratic India, and is an interesting metropolis with the backdrop of a royal cityscape. Mumbai evolved as a commercial centre supported by its geographical location as an excellent port on the Arabian Sea and eventually developed as a commercial and industrial megalopolis, and the financial capital of India. The cities of Kolkata and Chennai evolved into metropoli as political and commercial centres with Kolkata's development strongly linked to its roots as the headquarters of the East India Company. The development of these four large cities in the north, west, east and south of India provided a sort of regional balance for the country. As a democratic country, various state capitals started evolving as political and commercial centres e.g. Jaipur, Hyderabad, Ahmedabad, Bangalore, Thiruvananthapuram and the modern planned city of India – Chandigarh, whereas a few other cities like Kanpur, Jamshedpur, Dehradun, and Panaji started growing with their individual hallmarks such as industries, education, and tourism.

India has been blessed with rich natural biodiversity. The Himalayan mountain ranges, Indo-gangetic plains, Thar desert, delta of the Ganges, Central Indian Highlands, the mountain ranges of the Satpuras, Vindhya, Sahyadris and Nallamalais, eastern and western seashores and creeks, islands of Lakshdweep, Andaman and Nicobar and other bio-geographic macro and micro-ecosystems have sheltered diverse flora and fauna. The insensitive development process destroyed much of the natural biodiversity of these ecosystems. Even today such destruction continues. Today natural biodiversity is preserved mostly within the statutory protected areas of national parks, sanctuaries, and reserved forests with the few exceptions of community-protected areas.

However, this blessing of natural biodiversity helped in the preservation of at least some natural elements in evolving urban centres. The megalopolis of Mumbai is the only large city in the world having a sizable National Park within its centre. Mumbai also has rich mangrove forests within its several creeks. The thorn forests of the Delhi Ridge, spread over 7700 hectares through the heart of capital city provide a welcome contrast to the concrete jungle around it (Kaplavriksh 1991). The Cantonment areas in many Indian cities bear a special

character because of their biodiversity. The Urban biodiversity of Indian cities has been evolving along with development pressures and is threatened. However there is a growth of environmental awareness amongst the urban masses and this people's movement is a major cause for hope with regard to conservation of the urban biodiversity of the Indian cities.

5. DEVELOPMENT / ENVIRONMENT CONFLICT

Urban centres always have a concentration of development activities. Any development activity will always have an adverse impact on the natural ecosystems. During human evolution, agriculture was the first such adverse impact on natural biodiversity. It was inevitable but would not cause real destruction as long as it was moderate and sustainable. Today, with tremendous population growth all over the world and the acceleration of the process of urbanisation, there is over exploitation of earth's limited natural resources. Wanton destruction of natural biodiversity has become a major concern for human society, at the same time there is a never-ending demand for more and more development. This is more visible and damaging in the urban centres and more so because development issues generally become political and commercially oriented. There is very little sensitivity and rational thought behind such activities.

Major issues of development / environment conflict are factors such as large dams, large industries, major infrastructure like highways, railways, mining and deforestation to meet the growing demands of urban population, and power projects. This leads to socio-economic conflicts like displacement of people, urban consumerism, urban slums, and economic disparity. It becomes more and more difficult to achieve the balance of development and environmental conservation in urban centres.

It is obvious that this issue has to be tackled with a rational, objective and broad-based approach. The general policy plan should start at national, if not global, levels and then percolate down to the village level. This should go hand in hand with an action plan initiated at the grassroots level. In-built incentives for conservation and controls on development would perhaps lead us towards a sustainable society.

6. THE STATUS OF A FEW LARGE URBAN CENTRES IN INDIA

Biodiversity is a natural phenomenon and is a result of the bio-geographical and climatic situation of the region. In a country like India with very diverse ecosystems the character of the local biodiversity keeps changing from place to place. Urban biodiversity is more dynamic since it evolves around human

interventions and the development process. This situation becomes more complex in Indian urban centres. The comparison, therefore, has to be seen from these diverse angles. The growth of urbanisation and the status of urban biodiversity move in opposite direction. It is therefore more interesting and useful to carry out a comparative study of large metropolitan cities. The conclusions could be then easily applied to the smaller and growing cities looking at their growth rate and status.

In India, out of the six major metropoli, Kolkata and Mumbai have reached to enormous proportions. They have become megalopoli and are on the verge of exploding. It will be interesting to look at the world cities, which are almost at the same level. Two such cities are Tokyo and New York. Incidentally, all these four cities are located almost in identical geographical situations, i.e. close to the oceans. Therefore many parameters, which are crucial for growth and biodiversity, are quite identical. However the approach of planners / administrators and decision makers differs. Whereas both Indian cities are growing fast beyond control and the authorities have adopted strategies to allow further growth without a holistic plan, the approach in USA and Japan is quite different. The New York planning authorities have controlled future growth. In fact, the city's growth rate in terms of population and commercial activity has slowed down during the last decade. In Tokyo, the growth rate is allowed to increase concomitant with systematic planning and implementation. The Environment and Ecology are issues being looked at very seriously in both these cities. In fact, the plans of cities have large open and green areas, which help biodiversity. At the same time, there is a scientific approach towards handling adverse environmental issues like pollution, sewage / garbage disposal, industrialisation etc. It is true that these cities / countries have gone through the stage of over exploitation and have learnt their lessons. India can also learn from their experiences. The level of pollution (air, water, soil, noise etc.) is comparatively low and kept under strict control. The development strategies and controls are also implemented very strictly. The level of awareness towards environmental conservation and biodiversity is considerable amongst the people and also the decision makers and planners / administrators. Scientific and technical expertise is invested in research and development for environmental technologies. It is interesting to note that a large city like New York has the very large Central Park right in the middle of Manhattan. The city has around 400 species of birds in addition to a moderate number of mammals, reptiles, amphibians and abundant number of fish. The marine ecosystem is relatively unpolluted and quite rich in fauna (Ricciuti, 1984).

Amongst the Indian metropolitan cities, the growth rate of Kolkata and Mumbai is alarming. The others are also on the verge of reaching that stage. The town planning aspects are not considered in a modern context and environmental concern is non-existent. The main and only focus for development is rapid commercialisation and industrialisation. There is tremendous lack of futuristic approach even for necessary infrastructure for such development. There is very

little thinking on comprehensive regional planning, forgetting that these cities are a part of a larger region, which includes the state and the country. This has resulted in the deterioration of the environment and the life of people in the surrounding regions of these cities.

The natural ecosystems have changed in character in all these cities and very little original diversity has remained now except in Mumbai and Chennai. The importance of natural ecosystems even in the urban context is not yet realised by planners and administrators. The solutions to all degradation tend to be minuscule tree plantation and creation of parks and gardens! The health of biodiversity depends on the health of natural ecosystems and this concern is lacking everywhere. Some important natural features available in these cities, like seashores, rivers and lakes are not only neglected but also allowed to be degraded. The town planning concepts and norms also talk only about the proportions of parks and gardens in a city. In spite of universal understanding of the importance of natural ecosystems, this aspect is overlooked by the town planners, even academically.

Parks and gardens find some place in the otherwise heavily crowded cities, mainly just to fulfil the statutory obligations. Even these get assaulted first whenever there is any further demand for land for development purpose mainly as a consequence of political influence. In spite of reasonably strong environmental lobbies in Mumbai and Bangalore, Mumbai's various parks, even the National Park and Bangalore's Cubbon Park are being encroached regularly by political design. Out of the six metropolitan cities, only Delhi, Bangalore and Mumbai have some area for gardens and greenery, including roadside plantations. However, due to a simplistic approach of recreation and aesthetics, these parks do not have much value from the biodiversity angle. But it is true that they provide some respite to the urban environment. It is unfortunate that a city like Bangalore, which evolved as a Garden City is losing its green cover due to indiscriminate cutting under the pretext of developmental needs.

Urban biodiversity cannot be sustained without a holistic development approach and appropriate environmental mitigation of problems. This is a very complex issue and need an integrated approach. Simplistic solutions bring in more problems. Unfortunately, there is no concentrated and serious effort to prepare comprehensive development plans for these growing metropolitan cities. Kolkata and Mumbai are the only two cities where the authorities have at least tried to prepare Regional Plans. The other cities are likely to follow the process. However, the lack of sensitivity to environmental issues is reflected in the regional plans already prepared. Once again, within these plans, as a mandatory provision, one chapter on Environmental Management is included. But the focus of the planning authorities is very strong on development, commercialisation and industrialisation and many of their own suggestions for environmental issues are immediately negated, either by their expressions of helplessness or by their immediate dismissal of such issues and possible solutions. Sometimes the

planners go to the extent of ridiculing the existing environmental laws! The best example is the Coastal Regulation Zone act and the Pollution Control Act. According to the Planning Authorities of these metropolitan cities, these acts are hindrances to development. The worst example is the total turnaround of Mumbai's planning authority from its earlier concept of decentralised development to now centralised and concentrated commercial and industrial development. This is more crucial for Mumbai since land is limited with the possibility of growth only in one geographical direction. This also shows utter disrespect to the natural environment and the quality of human life of the city. The only positive side of Mumbai's regional plan is the consideration of a larger region as an urban influence area and the working out of a zonal strategy for controlled growth in the peripheral region. The other cities must follow this pattern to control unplanned and haphazard development in the rurban (rural region on the threshold of urbanisation) and rural areas on their periphery.

Under these circumstances, when our soil, air and water gets indiscriminately polluted, natural ecosystems, parks and gardens get encroached from all sides, sewage and garbage disposal systems remain primitive and are not priority issues, blind commercialisation / industrialisation growth policies are pushed forward attracting further migration of poor people towards these cities resulting in slum proliferations everywhere, and when infrastructure comes to the verge of collapse, there seems to be no hope for Urban biodiversity to survive, leave aside be healthy.

The documentation of the status of the environment and its biodiversity is important to assess the effects of urban growth. Regular scientific monitoring is necessary for this purpose. The planning authorities of these cities carry out this exercise as a formality and some reports are included in their files. However, ecological documentation is lacking in all these statutory studies. It is interesting that many urban schools, colleges, universities and also amateur nature groups carry out such documentation informally. There is systematic documentation available for at least some ecological parameters for the cities of Mumbai, Bangalore, Delhi and Hyderabad. In fact many small towns like Pune have in proud possession such records entirely as a result of people's initiative.

The cities grow because of the aspirations of people. Therefore it is interesting to look at the environmental sensitivity of the people from these six metropoli. Only in Mumbai, Delhi and Bangalore, one sees interest and active participation of people in environment-related activities and conservation movements. There are small groups and individuals in the other cities also but they seem to be ineffective. Environmental education and awareness also seem to be at low level in the other cities. The media should play crucial role in these issues, however except a few English language correspondents, there is almost total insensitivity in local media. A scientific inclination and efforts for applications are visible more in Bangalore. This is really commendable and needs to be duplicated in the other cities. It is unfortunate that the elected governments, across all political

parties are unanimous in the over-exploitation of our metropolitan cities including their natural resources and people. The fate of our urban biodiversity looks very bleak under these circumstances.

III. BIODIVERSITY – AN INDICATOR OF A HEALTHY URBAN ENVIRONMENT

The biological diversity includes association of flora and fauna of diverse species. In a natural environment this association evolves maintaining the balance of the species population and health of the environment. The biodiversity depends on the habitat i.e. bio-geographical and climatic conditions. Depending on the character of the habitat it is identified as an ecosystem and further as micro-ecosystem. Thus, there are diverse ecosystems having unique biodiversity. This is what creates the complexity of natural ecosystems.

Urban environment is a human-made habitat. Human interventions are generally selfish revolutions and they give emergence to the urban ecosystems, which are totally unnatural. They get distinct characters as fashioned by humans. Various urban centres separated from their suburbs, rurban and rural worlds by only a short distance; show drastically different climate and biodiversity apart from distinct physical and socio-economic character. There are many reasons for such distinct environmental character of the urban centres, mainly the fast development, commercialisation, industrialisation and population growth. All this urban revolution happens in a compact and dense region making the impact more severe. The urban centres become warmer than adjacent regions because of heat generated from automobiles, industries etc. The pollution of air, water, soil and also noise creates foul environment in these urban centres. The demand of space for development and resultant scarcity reduces the open spaces and the vegetation. The built environment and its infrastructure like roads and pavements reduce the natural ground cover of the city resulting in the changes in storm water drainage. The rainwater, which otherwise would be absorbed in soil and then by vegetation, gets drained through sewers. The natural topography is altered for development purpose, which alters the ground water pattern, and the soils get depleted of their nutrients. Sudden changes in land use encourage weeds and vermin to proliferate. The modern control methods, which are not time tested but provide short term solutions become favourite and create more long term problems, the worst example being the use of DDT. In conclusion, the environment of any urban centre becomes a different world from its immediate rurban or rural surroundings.

The biodiversity of urban centres evolves dynamically. The vegetation pattern generally becomes exotic. The fast speed of the development does not provide any opportunity to natural organisms to evolve. They have to adapt to the changed situations or migrate or just vanish. On the other hand, the changed environment attracts alien bio-organisms who not only settle in the new place but also displace the original ones. Some wild animals have great ability to adjust to a variety of surroundings and they survive in urban centres by adapting. There are others, not so adaptable, take advantage of urban greens or the open spaces in the peripheral region. There are still many more who visit the urban ecosystems occasionally as

migrants in different seasons. Some may be local migrants whereas some are ‘foreigners’. Some of them could be just passage migrants. The urban centres test the adaptability of wild animals. If they can survive here, they perhaps can easily survive anywhere. These animals thrive along with the city people around. Crows, pigeons, sparrows, mynas, parakeets, kites, owls, koels, egrets, gulls, squirrels, bats, lizards, and frogs are a few standard species of Indian urban ecosystems. These animals survive because they exploit the resources of the human-made urban environment, be it garbage dumps, sewage outlets or feeding places. Some of them, like pigeons and squirrels, even compete with beggars. Their populations grow because urban people develop kindness towards them and keep on feeding them. Another ability that helps the number of wild animals to grow in the urban centres is their efficiency in scavenging. There is generally no shortage of garbage in the urban ecosystems and crows, kites, vultures and gulls, in fact, help to keep the cities clean. Of course, there could be exceptions like the recent sudden decline in the vulture population in India. These are perhaps ecological accidents. A few animals manage to take advantage of urban architecture to make their homes. Sparrows, swallows, swifts, barn owls, *Pipistrelle* bats, squirrels, and lizards are a few examples. The edible-nest swiftlets nesting in old buildings in a few Southeast Asian cities have become a boon for commercial trade and people are constructing buildings just to attract and breed these birds for commercial gains. City gardens and parks, landscaped with exotic flowering plants, lawns, fountains and ponds support insects like butterflies, moths, bees and consequently also omnivorous birds like warblers, sunbirds, bulbuls, barbets, wagtails etc. Sometimes a few neglected areas like cemeteries, open spaces around city buildings, roadsides, particularly along highways, thrive with wild, unattended vegetative growth. These areas become haven for somewhat unique urban wildlife, like falcons, mongooses, lizards and even snakes. Urban parks are sometimes good examples of socio-environmental evolution, showing how city people may unintentionally contribute for the good or bad of wildlife. People generally do not realise the importance of wetlands and they are used as dumping yards. In Mumbai, most of the creeks, which were once excellent mangrove forests, rich with estuarine fauna and attracting a lot of migratory birds are being converted into garbage dumps. This resulted in destruction of this marine ecosystem and also adverse environmental impacts. With environmental awareness since 1970, some of these dumps were taken up for ecological restoration and they became wonderful eco-parks in a short span of time. Maharashtra Nature Park at Dharavi and Rituchakra Nature Park at Thane are good examples of eco-restoration in urban centres. With these parks emerging on the creek shores, even the original mangrove ecosystem has started showing positive signs of regeneration. We hope that eventually these estuaries will revive and their wildlife will flourish. Both these Nature Parks have been also developed as educational parks. It is true that with the growing environmental awareness, urban biodiversity will improve. Wildlife will flourish in the natural ecosystems protected in the peripheral region of the cities. A few of these wild creatures infiltrate the rural and rurban regions from these natural forests, while the others gradually enter the cities from the suburbs.

There are some other unique facets of urban biodiversity. It is interesting that a few fisheries run on the city sewage in Kolkata and on the estuaries in Mumbai. In the process of urbanisation, humans also felt the need for nature, which they fulfilled by cultivating plants in pots and gardens on one hand and by having pet animals on the other hand. Variety of plants has been grown in city and house gardens, in planters even inside the house, in a form of either bonsai or terrace farming. Humans keep pets like cats, dogs and display animals like fish, birds, some free and some in captivity. Many exotic species of fish and birds are kept in captivity for display. Many of them are hybridised and domesticated. A great variety of dogs is kept as pets and many of them are trained to protect the properties. These pets become family members and are used for communications. This has helped urban society to have at least some close interaction with the plant and animal world. At the same time, zoological parks for wild animals have become a popular educational and recreational concept in almost all major urban centres. On the other hand animals also have become instruments of exploitation for recreation through races, sport and circuses. All this has positive and negative implications while considering biodiversity in a broader sense. However it cannot be denied that such a relationship between domesticated plants, animals and human has created great compassion for nature in urban people.

The process of unplanned urbanisation has also created the potential for adverse natural calamities. Human-wildlife conflict can become a major problem e.g. leopard attacks in Mumbai suburbs or elephant attacks in Bangalore suburbs. Sudden changes in land use pattern for the purpose of development in urban areas has created hazards like floods, tidal impacts, soil erosion, landslides etc. Rampant industrialisation has effected sudden climatic changes. The removal of indigenous green cover and poor waste and sewage management has denuded the urban environment and has given emergence to weeds, pests and vermin, which pose great health hazards to the large urban populations. The fast spread of epidemics and other diseases has become a constant threat. The allergenic weeds like *Parthenium*, *Eupatorium* etc. and animals like rats, flies, mosquitoes and other insects are a few examples. All efforts of quick chemical control have boomeranged due to other adverse and long-term effects. The use of chemical pesticides and fertilisers in urban gardens for quick results has also shown very bad side effects on biodiversity as well as on humans.

If one looks at the issue of urban biodiversity after considering all the above-mentioned factors, a different perspective emerges. Some simple ecological concepts of natural ecosystem can become guidelines even for urban environments. Symbiotic relationships and biological controls become key words in the urban context. The presence of earthworms in the soil in a house garden or public park indicates the availability of nutrients and soil humidity required for healthy vegetation. The presence of indigenous and mix forest-like vegetation attracts wild fauna including insectivorous birds, reptiles, amphibians and bats. Unpolluted wetlands harbour aquatic flora and fauna, which keep the system clean of hazardous insects. If there are lizards around, there will not be those

quintessential pests - cockroaches. Serene, clean and green natural environments refresh human mind and this becomes a necessity for urban humans who are under the strain and stress of urban life. Even the simple chirping of sparrows or the haunting calls of cuckoos can bring relief into drab urban existence. A few natural organisms (lichens, earthworms, and butterflies) are the symbols of a healthy urban environment, whereas some (weeds, pests, and vermin) indicate degraded environments. Many natural organisms (plants, birds, and insects) work as biological clocks indicating seasons or climatic changes.

Natural flora and fauna are good indicators of changes in the ecosystems and provide cautions for adverse effects e.g. the absence of lichens on tree trunks is a sure sign of air pollution. Urban humans should become sensitive enough to understand these warning signals and their importance for their own sustenance.

The health of biodiversity reflects the health of the urban environment including its people.

IV. URBAN PLANNING – A BRIEF VIEW

1. POLICY PLANNING

The democratic country of India has an interesting structure / hierarchy for policy decisions at various levels. Elected representatives of people take policy decisions, which are then implemented by the bureaucracy. This process simultaneously and independently continues at Loksabha and Rajyasabha in the central government, Vidhansabha and Vidhanparishad in the state governments, District / Taluka / Village level as a part of a Panchayat Raj government. A similar provision is made for urban centres through Municipal Councils and Corporations. This policy making process is generally carried out within the framework of the constitution and the budgetary provisions therein. Various ministries plan policies for particular parameters allotted to them.

The Ministry of Environment and Forests (MOEF) plans environmental policies within the framework of relevant Acts. These are applicable for both urban and non-urban areas of the country.

The Ministry of Urban Development generally looks after the policies related to urban development. However, the issues related to urban development are generally very complex in nature and involve several other ministries like Industries, Transport, and Power etc.

Thus the success or failure of urban planning which is responsible for the survival of urban biodiversity depends on the environmental sensitivity of the elected representatives of the people. That indirectly means that it depends on the sensibilities and consciousness of the people themselves. To some extent, partial responsibility lies with the bureaucracy, which is supposed to provide technical guidance to the elected representatives.

2. PLANNING AUTHORITIES

A broad base and long term visualisation for policy planning requires inputs from a multi disciplinary team, consisting of technical experts, sociologists, academicians, economists, planners, politicians and representative of research institutions, universities and also voluntary organisations. Such a team could provide advice and also prepare draft proposals for the consideration of the Ministries. This provision is made in the Indian system by the creation of Central and State Planning Commissions. In their turn, Planning Commissions depend on the inputs from the District Level Planning Boards. This system, if used

judiciously, could provide detailed understanding of the needs of the people and of available resources right at the grass root level. Detailed policy planning for urban centres is visualised and implemented by Municipal Councils and Corporations. Here also there is a combination of elected representatives, bureaucrats and technical experts.

3. STATUTORY AUTHORITIES

Urban Planning is a complex process. Moreover, the implementation of the plan involves many hurdles. Various statutory authorities at the government and municipal level handle this whole process. A major role is played by Town Planning Departments, who are supported by Regional Planning Authorities, Engineering and Development Plan departments of municipal councils and corporations. There are special Boards, Undertakings or Corporations, which look after infrastructure like roads, power and water supply, pollution control, industries etc. Then there are key authorities to look after mass urban housing, its creation and maintenance.

All these planning and implementation authorities are provided support from the Development Control Authorities. These are generally revenue authorities at district level or officials at municipal levels. These authorities approve the development proposals and also supervise and check them so that they are within the Development Control Rules.

4. ROLE OF PLANNERS

Urban Development is not entirely a statutory subject. The government provides most of the infrastructure and services. However, private organisations or individuals carry out a majority of the general development on private lands. These are planned and implemented by the Planners i.e. Architects, Engineers, Town Planners, Landscape Designers etc.

These professionals play a major role in influencing the character of an Urban Centre. Their sensitivity towards environmental conservation could make the urban centres sustainable and could preserve the urban biodiversity.

Unfortunately, even today, this major influential group is ignorant and unaware of the complexities of environmental issues. The education system, which provides

technical education to these technocrats, does not consider Environment and Ecology as a priority subject.

5. ROLE OF VOLUNTARY AND NON-GOVERNMENT ORGANISATIONS

Urban Planning is a very complex exercise, which requires the involvement of multi-disciplinary experts. On one hand there are politicians and elected representatives of the people, and on the other hand there are technical experts from various fields. Additionally there are bureaucrats who interpret and implement the planning policies. There are times when there is absolutely no coordination between various disciplines. Generally there is a lack of a comprehensive and integrated approach. To add to such scenario, there is generally total ignorance about environmental and ecological issues. The issue of urban biodiversity is, in fact, a non-issue in the process of urban planning.

This vacuum of environmental sensitivity needs to be filled by sensible voluntary organisations. This is more crucial since urban development policies involve commercial stakeholders and politically motivated decision makers. This totally unbiased and bold approach could be taken only by independent voluntary organisations. Conservation of urban biodiversity is a long term and non-commercial issue. There cannot be many supporters for this in the greed for urbanisation and attraction to consumerism. This responsibility needs to be taken by environmentally sensitive, broad minded, unbiased voluntary organisations. It is unfortunate that there are few such organisations in the world, leave alone India!

V. STRATEGIC PLANNING OF A ‘NEW’ CITY EVOLVING AROUND URBAN BIODIVERSITY

1. INTRODUCTION

Settlement – village –town – city – metropolis - megalopolis is a standard evolutionary pattern of an urban centre. However, sometimes a new city is suddenly initiated and planned at a particular place for socio-political reasons. In an evolving city, at some stage, the planning component comes in. We have seen that cities grow because of socio-economic reasons and they keep on attracting people in large numbers. This fast development pattern does not allow society to think about planning even for basic infrastructure, leave aside the environment. In spite of such a growth, there is no particular reason for urban biodiversity to get degraded and vanish. This happens in most of the cities because of lack of sensitivity and ignorance amongst the decision makers, planners and people. This is evident even from the recent academic literature on town planning, wherein the concept of consideration for the environment has not gone beyond certain norms for gardens, parks and recreational spaces. For an environmentally healthy city, this planning method requires to be revolutionised and should evolve around urban biodiversity.

Conservation of the natural environment and biodiversity is really a global issue. Any planning strategy therefore should be based on a very broad global perspective and should then percolate down to the local village level. This should go hand in hand with a detailed action plan and implementation strategy initiated at the grassroots level as a participatory effort. The success of planning also lies in the success of good implementation. Therefore the planning strategy must be complemented with an implementation and monitoring strategy and an action plan that evolves with the involvement of local people. The planning process and the implementation strategy should go through the necessary in-depth technical evaluation considering all parameters of the development process.

It is unfortunate that many times urban development plans stand in contrast to environment plans and policies. There is a definite need for inter department coordination in the planning process, so that biodiversity sensitivity is built into the plans, schemes and budgets of each department.

Moreover, once such a plan is finalised it should not be left to the discretion of any individual or agency. All norms should become a part of the design, approval and implementation process. This will encourage planners to work out design solutions for possible environmental problems. Many environmental controls could be successfully achieved by providing interesting incentives complementary to the design solution. This will provide encouragement to invest in the process of

environmental research and development. Today environmental considerations are limited to certain engineering parameters like pollution, sanitation etc. and these require to be broadened to various ecological parameters.

This whole exercise can be efficient and successful if everyone involved opened up their minds and started looking at the broader issues of planning. To begin with therefore, it may be necessary for Town Planners to become Regional Planners, for Architects to become Planners and Landscape Architects to become Landscape Ecologists. Similarly a close coordination amongst the planning authorities at the national, state, district, city and village level becomes essential.

2. GENERAL PLANNING NORMS

Let us look at some of the existing town planning norms and standards for major cities (Ref. Manual: Town & Country Planning Organisation, New Delhi):

Desirable Land Use Pattern (percentage):

No.	Land Use Particulars	Land Percentage
1	Residential	40
2	Industrial	8
3	Commercial	3.5
4	Parks, playgrounds & open spaces	10
5	Transportation & Communication	24
6	Public & semi-public	10
7	Others	4.5
		100

Plot Area Coverage & Floor Area Ratio:

No.	Built Use	Percentage of Coverage	Floor Area Ratio
1	Residential	65 to 40	1.0 to 3.0
2	Commercial	80 to 35	1.0 to 4.0
3	Industrial	50 to 35	0.5 to 1.5

These tables show the old town planning norms, which were based on the British Town Planning Rules. These have become obsolete; however there has been no revision. In any case, different planning and development authorities prepare their own norms, thus creating more chaotic situations.

The first table (Desirable Land Use Pattern) mentions about the basic land use norms for a city. These are crucial from the point of view of natural biodiversity of a city. These give indications of the development pressures and possible

adverse environmental impacts on the total land covered by a city. They tell you about the built and un-built land areas, industrial and infrastructure areas, open green areas. The analysis of this table shows that the total built area could be 66% (1,2,3,6 & 7) out of which areas allotted for Industrial uses could be 8%. Out of the remaining un-built area of 34%, the green area will be 10%. It is quite obvious that these old norms are insensitive to environmental parameters. It may be noted that even the so-called “green area” is defined as a recreational area only and there is no consideration for natural biodiversity.

The second table (Plot area coverage & Floor area ratio) mentions the allowable ground coverage by a building under different land uses and also the allowable total built up area i.e. floor area of all the floors with respect to the land area. This tells you about the extent of possible vertical development. These are important from the biodiversity considerations since it allows you to assess the extent of possible open and green areas in a plot of land. It also tells you about the allowable vertical development, which indicates the environmental pressures (sewage, garbage etc.) on the plot. The table shows that for commercial use, a maximum ground coverage (up to 80%) has been allowed and additionally even extensive vertical development using floor area to the extent of 4 times of the plot area has been sanctioned. It is quite clear that these norms are irrational from the point of view of sustainable development and are insensitive to environmental and biodiversity considerations. These need drastic downward modifications.

Mumbai Metropolitan Regional Development Authority (MMRDA) finalised its **Regional Plan (1996-2011)** very recently and it will be of great interest to look at the most recent planning standards adopted for general zoning of the region:

No.	Land Use Classification	Area – Sq. Km.		Percentage	
		Existing	Proposed	Existing	Proposed
1	Urban Zone – (U-1)	418	939	10	22
2	Urban Zone - (U-2)	NIL	255	NIL	6
3	Industrial Zone -(I)	105	130	2	3
4	Forest zone – (F)	570	913	13	22
5	Recreational zone - (RTZ)	NIL	176	NIL	4
6	Green Zone – (G)	2707	1613	64	38
7	Quarry Zone – (Q)	NIL	72	NIL	2
8	Coastal Wetland	358	69	8	2
9	Water Body	78	69	2	2
	Total Area	4236	4236	100	100

These recent norms for the megalopolis of Mumbai look hopeful from the perspective of urban biodiversity, at least on paper! The built or developable area under Urban, Industrial and Quarry land use is proposed to be restricted to 33% of

the total land area of Mumbai. Out of the remaining 67% of the land area 22% has been proposed as forest zone (no development), 4% as recreational zone (limited development for tourism and recreation), 38% as green zone (agricultural development) and 4% as wetlands. The provision for forest zone and green zone is a commendable concept and the other planning authorities should replicate this.

The MMRDA has prepared general guidelines for development controls in each zone and the implementation of these controls has been delegated to various local authorities.

3. NATIONAL / REGIONAL / LOCAL LEVEL STRATEGY

The process of urbanisation is generally looked upon as part of the development process. It has been always considered a positive aspect for human society. There are many issues in this view, which are debatable, and the whole process of urbanisation and development can be questionable. However, the process of urbanisation appears inevitable and it is going to be more aggressive in developing countries like India.

In this sense, one should not look at the urbanisation process as a conflict of development *versus* environment. One should try to make it a complementary process i.e. development *and* environment, each having equal weightage because the sustainability of one depends on the sustainability of the other and the survival of human society depends on the sustainability of both.

The planning policy considerations from the angle of Urban Biodiversity will have to be at National, Regional and Local levels. Similarly, biodiversity considerations should be two-fold: natural ecosystems and human-made ecosystems. As a major basic policy consideration, biodiversity conservation should be an important ingredient of the process of urbanisation and development.

Biodiversity depends on the habitat, which consists of land, air and water as its main components. Therefore, the basic principle for biodiversity conservation will have to be to make reasonable provision for these components in every habitat. It is more crucial in urban centres since development pressures are always very high. However, a comprehensive approach at national, regional and local level will help in keeping the balance in spite of a few aberrations, particularly in urban centres.

After carefully looking at the global and national scenario in the field of development and environment and the prescribed traditional and modern town planning norms or standards and balancing them with the environmental and ecological needs, some realistic norms could be worked out:

A. National Level

Natural Ecosystems (forests etc) - 33.33 %
Green & Open areas (fields etc) - 33.33 %
Human settlements (cities, towns, villages etc) - 33.33 %

B. Regional Level (for urban centres)

Natural Ecosystem (forests etc., very minimum human intervention) – 33.33 %
Green areas (man-made greens i.e. fields, parks, gardens etc) – 33.33 %
Intensive urban area – 22.22 %
Area with potential of urbanisation – 11.11 %

C. Local i.e. City Level

Natural Ecosystem (forests etc., minimum human intervention) – 10 %
Green areas (parks, gardens etc.) – 15 %
Open areas for infrastructure (roads, railway, services etc.) – 25 %
Residential & Public development – 40 %
Commercial & Industrial development – 10 %

4. BASIC PRINCIPLES FOR POLICY PLANNING

A few basic principles behind this policy planning and its implementation strategy:

- a. The entire planning and implementation strategy will consciously follow all the acts and laws of the Ministry of Environment and Forests.
- b. At any stage, the proportions of land use spaces or zones must be maintained because that will keep the balance of the entire growth process.
- c. Commercial and industrial development particularly, should not be allowed to grow beyond 10% at the local level and beyond 5% at the regional level because this tilts the balance between development and environment due to intense adverse impacts.
- d. It is advisable to provide incentives for the growth of other urban centres, rather than concentrating on one alone. This strategy of decentralisation maintains the regional and national balance of development and the environment. It also retains the socio-economic balance of the nation.

- e. Involvement and coordination of national, regional and local authorities for planning and development control is of utmost importance.
- f. National and Regional authorities should prepare broad guidelines for development and implementation strategies and controls should be delegated to local authorities.
- g. National and state planning commissions should periodically optimise and rationalise the growth pattern of various urban centres to maintain development balance at national and state levels.
- h. If urban centres have to grow they may be allowed to grow outwards and not within.
- i. A participatory approach in the policy planning process would make the policy acceptable to the community.

5. BASIC NORMS FOR IMPLEMENTATION

A few basic norms to be followed during the implementation process:

- a. The Natural Ecosystem is of utmost importance for biodiversity. It consists of natural forests and features like hills, rivers, seashores etc. along with their indigenous flora and fauna. Very minimum human intervention required for protection and management, should be allowed. Preferably, these areas should be managed and controlled by the forest department with specially trained officials who understand the urban context.
- b. The Natural Ecosystem in an urban centre should ideally be a large area at one place. A fragmented natural ecosystem itself remains at stress and soon becomes endangered. However, its existence in the urban centre is crucial.
- c. Development in the peripheral areas of a natural ecosystem has to be appropriately planned and controlled. Utmost care has to be taken to avoid / mitigate any human-wildlife conflict in this region.
- d. Natural ecosystems are basically conservation spaces and not recreation spaces and should not be allowed to be encroached or vandalised at any cost. However, educational institutions, universities and nature study groups may use these spaces as live laboratories for nature studies. This can also help in regular monitoring, documentation and evaluation of the ecosystem.
- e. Green areas will include parks, gardens, recreation spaces, playgrounds etc. These areas should be of reasonable size depending on their use and should be spread out evenly for the easy accessibility of people. Mixed vegetation of diverse and indigenous species should be ensured.
- f. Green areas should be under the control of local authorities e.g. garden department of the municipal corporation, however people's participation in the creation and maintenance of such spaces should be encouraged.

Appropriate built infrastructure / service areas etc. may be allowed in these spaces to the extent of a maximum of 20 %.

- g. Green areas in an urban centre must include a few Nature Parks specially developed to simulate natural ecosystems for nature education and awareness purposes. These could act as centres to provide education through passive recreation.
- h. Open areas for infrastructure mainly include the land under transport facilities like roads, railway, airports etc. Additionally they include spaces required for services like water and electricity supply, sanitation etc. and also spaces for cemeteries, crematoriums etc.
- i. Open areas for infrastructure remain under the control of various government departments or local authorities. Appropriate built infrastructure / service areas etc. may be allowed in these spaces to the extent of a maximum of 20 %.
- j. Open areas for infrastructure have great potential to be maintained as green areas. Since these are large areas well spread out throughout an urban centre, they could be excellent spaces for urban biodiversity and could also help in improvement of the general aesthetics of the surrounding and environmental mitigation of adverse factors like automobile pollution etc.
- k. Residential and Public development zone is a large built space. However the ground coverage in this zone should be limited to 1/3, thus retaining 2/3 of the land area open under the side open spaces, private gardens and neighbourhood gardens.
- l. Residential development generally evolves with private initiatives. In urban centres it may be allowed as community multi-storied apartment housing, community row houses, low neighbourhood and individual housing schemes. These may be appropriate to the socio-economic groups of the urban community. However, in no case should the criteria of ground coverage and side open space be compromised.
- m. Floor Area Ratio (FAR) in the residential zone should be restricted between 0.5 and 2.0 for different areas.
- n. Plantation of trees and development of gardens in side open spaces of these residential zones should be mandatory and should be part of the requirement for approval of a development plan. Various additional incentives may be provided to encourage such private green areas.
- o. Commercial and Industrial zones are the most crucial spaces from the point of the economic growth and environmental status of a city. These areas should be under the strict control and vigilance of both state and local authorities.
- p. The FAR should be not more than 2.0 for commercial development and not more than 0.5 for the industrial zone
- q. The ground coverage for both commercial and industrial buildings should be restricted to 1/3 and creation of greenery and gardens in the remaining 2/3 open areas should be mandatory.
- r. The commercial and industrial zones must strictly follow the environmental norms for pollution control as well as effluent treatment and disposal. Incentives may be provided for efficient implementation of these norms.

- s. Planning and implementation of efficient sewage and garbage disposal systems should be mandatory for the local governing authority of an urban centre before the approval of any development proposals which could attract further growth.
- t. All natural wetlands and waterfronts must be protected and maintained. This could be an excellent participatory exercise involving local people and government officials. The efforts should be complemented with rainwater harvesting experiments in the built areas.

6. GUIDELINES FROM THE URBAN BIODIVERSITY PERSPECTIVE

A few important guidelines for the development from the Urban Biodiversity perspective:

- a. The development process should not disturb the existing landforms and natural features like hills, streams, rivers, lakes etc. Any developments on the hills should be controlled and monitored with strict vigilance. In any case, no development should be allowed on hill slopes having a gradient greater than 30°. Similarly, no industrial development should be allowed on any waterfronts.
- b. Garbage and sewage disposal, quarrying, industrial effluent disposal and pollution are major environmental challenges for biodiversity in an urban centre and the local authorities must work out an efficient strategy for proper control before allowing any further development.
- c. The Regional Plan and the Town plan must include the landscape design strategy for the entire region and it should have emphasis on regional ecology rather than just recreation and aesthetics. This planning should percolate down to the micro-level of neighbourhood planning.
- d. Roads, railway, streams and rivers cover large areas spread out all over the region. An appropriate plantation strategy for these areas with emphasis on biodiversity will be very effective. Appropriate use of mixed vegetation of indigenous species of trees, shrubs, climbers and ground covers will serve a functional, aesthetic and ecological purpose along with the development of important infrastructure. These functional corridors of an urban centre could also act as very effective corridors for biodiversity linking rural, rurban and urban habitats.
- e. A large number of people travel on roads and via the railway. Green road / railway sides complemented with effective environmental signage could contribute greatly towards environmental awareness of the urban population.
- f. Institutional and industrial complexes cover very large areas and they also have large open spaces with a reasonably controlled status. These owners should be encouraged to develop at least a part of their complex as ecological parks / habitats. Various government agencies can coordinate with them and

- provide assistance and incentives. Incentives should be also provided for creation and maintenance of general green cover in these areas.
- g. The parks, gardens, playgrounds and recreational areas in an urban centre should be used to create environmental awareness. Along with greenery, ecological information may be provided through signage and information centres. Local residents' groups or voluntary organisations should be encouraged to adopt such parks.
 - h. The urban centres must have a few Nature Parks with strong emphasis on environmental education. These parks can provide incentives and information of the region's indigenous biodiversity. The development of nurseries of indigenous plants will also encourage people to use these plants in their private gardens.
 - i. At least one large natural ecosystem along with its indigenous flora and fauna, in each urban centre will be useful for the health of biodiversity of the region and thus help the sustainability of the city's development also. These natural ecosystems will be live laboratories of nature for the city's educational institutions. A small part of these areas could be sensitively developed for eco-tourism to create awareness about natural biodiversity amongst the urban people. Such activities could also provide economic benefits to local people.
 - j. Seashores, estuaries, rivers, streams and lakes could be interesting wetlands for urban centres and could conserve marine / aquatic biodiversity. All waterfronts are generally very popular recreational places and could complement environmental awareness. A lot of effort is required by the local authorities to preserve these spaces.
 - k. Every urban centre has necessary evils like garbage, sewage and quarries. Inefficient disposal and management systems generally destroy the local natural environment. With appropriate long term planning, even these spaces could be transformed into large green spaces for urban biodiversity.
 - l. The urban centres have large areas covered under buildings. The terraces, and roofs of these building could be developed as gardens. Residential and institutional buildings can have terrace farming, herbal gardens or nurseries. Special incentives should be provided for such endeavours, particularly to encourage the propagation of indigenous and endangered plants.
 - m. Special efforts should be made through incentives, rewards etc. to encourage the use of environment friendly technology e.g. solar / bio / wind energy, rain water harvesting, sewage recycling, separation and composting of garbage, economical use of energy and water etc. These could be at government and community level.

7. CONCLUSION

The above strategy, a combination of development norms and guidelines for conservation and rejuvenation of biodiversity is broad based and could be detailed out by the local planning authorities with the involvement of the local community,

considering the local conditions and parameters. The basic norms including the zone wise percentage for land use should be made mandatory in the development plans for urban centres and also for non-urban areas.

It may be noted that this plan takes care of balanced development at the national, regional and local level, without compromising on the natural environment. It has been an accepted norm for sustainable land use of the country to maintain an equal ratio for forests i.e. natural ecosystems (1/3), agriculture etc. (1/3) and human development i.e. cities, villages, infrastructure etc. (1/3). The existing forest cover in India is about 19% and the new act proposes to bring it up to 33.33%. This will be of great benefit for the country's natural biodiversity. In turn, this strategy will also help urban biodiversity. At present, there are no norms for agricultural development. This 1/3 area also requires sensitive consideration from the perspective of biodiversity to make our agriculture also sustainable. Similarly, there are no strict norms for the development of cities and villages (i.e. the remaining 1/3). The strategy adopted here for urban planning would ensure additional 45% (10% forests + 15% gardens + 5% roadside plants + 15% greenery in the side open spaces of buildings) of this 1/3 area, thus making it an additional 15% of the urban green area.

The strategy proposed at the regional level is also the same.

At the city level, the proportion for development (residential / commercial / industrial) is maintained at 50%, considering the intensive needs. This is above the existing norms (approx. 40%) of most of the metro cities. This intense development at the city level will be mitigated because of the increased greenery at the regional level. Similarly, open spaces are organised in appropriate proportions as natural forest and human-made parks and gardens giving reasonable allowance for the indigenous biodiversity. This proportion is also retained at 25%, which is above the existing norms (10% to 15%). Over and above this, additional provision for urban biodiversity is organised within the built environment by using the infrastructure of roads and railways as green corridors.

This combination will take the proportion of green spaces much above the normal existing town planning standards, thus giving a chance for rejuvenation to urban biodiversity even in the existing grown up towns. This plan neither compromises development nor the natural environment. This will provide a balanced strategy for sustainable urban growth. An up-to-date assessment will be required for modification of the strategy for existing cities, perhaps minor amendments in the existing development control rules. However, considering the extreme scenario of a megalopolis like Mumbai, which follows similar norms, it should be possible to work comfortably within the slightly modified norms. It will require a sensitive approach towards the natural environment and its conservation which will benefit healthy development. The hidden agenda and adverse alternatives of 'creation' of land, at the cost of ecological factors under the pretext of international standards and modern development must be overruled at any cost.

Cities grow and will keep growing. Even new cities will emerge in the urbanisation process. There is nothing wrong in this process if it evolves taking care of the natural environment both within and around. The above-mentioned broad norms and guidelines should be able to bring in a lot of sustainability to both urban development and its environment. These guidelines could be appropriately modified and used for small growing towns or even for growing villages. What is important is the balance and proportions of man-made development and open land, air and water for the sustenance of the natural environment.

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ANNEXURES

ANNEXURE – 1

THE 25 LARGEST CITIES IN THE YEAR 2000

(Source: The United Nations Population Fund)

1. Mexico City	25.8 million
2. Sao Paulo	24.0
3. Tokyo	20.2
4. Kolkata	16.5
5. Mumbai	16.0
6. New York	15.8
7. Seol	13.8
8. Teheran	13.6
9. Shanghai	13.3
10. Rio de Janeiro	13.3
11. Beunos Aires	13.2
12. Djkarta	13.2
13. Delhi	13.2
14. Karachi	12.0
15. Dacca	11.2
16. Manila	11.1
17. Cairo	11.1
18. Los Angeles	11.0
19. Bangkok	10.7
20. London	10.5
21. Osaka	10.5
22. Moscow	10.4
23. Beijing	10.4
24. Lima	9.1
25. Tianjin	9.1

ANNEXURE – 2

A Megalopolis – Mumbai - Metropolitan Region (MMR), (Semi-circle of approx. 40 Km radius)

1. GEOGRAPHY & ECOLOGY

Geography:

Latitude – 19 °, Longitude – 72 ° 50' (average)

Altitude – Average approx. below 100 m

Location – Peninsular island on the western coast of India, part of the coastal strip of North Konkan in the state of Maharashtra

Geology:

Rock type – Igneous; effusives, basalt, associated lavas and tuff

Soil type – Red loamy soil

Climate:

Equable, hot and humid type. Moderating effect due to the sea.

Temperature – 27 ° (daily mean temperature for year)

Rainfall – Over 2000 mm (mean annual), southwest monsoon from June to October

Relative Humidity – 60% to 70% (average)

Area & Population (Approx-Yr.2000):

Greater Mumbai	466 Sq. Km	13.3 Million
Thane	128 Sq. Km.	1.2
Kalyan Complex	381 Sq. Km.	3.1
Navi Mumbai	344 Sq. Km.	1.2
Rest of the MMR	560 Sq. Km.	1.2
Total	1879 Sq. Km.	20.0 Million

(Source: MMRDA, Regional Plan for MMR, 2000)

Vegetation:

Original natural vegetation – Tropical moist deciduous type and mangrove swamps, presently overtaken by exotic plantations

Natural Features:

Coastline of about 167 km dotted with intermittent creeks, beaches, mangroves, horticultural plantations etc. The coast also has a few islands off shore

Rivers - Ulhas and its tributaries, Bhatsa and Kalu in the northern part, Tansa as a northern boundary, Gadhi in the central region and Patalganga, Amba, Balganga, Bhogeshwari, Bhogwati in the southern region

Hills – Malabar, Worli, Parel, Trombay, hills of the Salsette and Kanheri range, Parsik and Mumbra hills, Bhiwandi Gotara ridge, subsidiary ranges of the Sahyadri namely, Tungareshwar, Matheran, Prabal, Karnala, Kankeshwar

Lakes – Tulsi, Vihar, Powai, Gadeshwar, Chawana, Ransai etc. There are small city lakes in Mumbai island city, Thane, Kalyan, Panvel

Protected Forests – Sanjay Gandhi National Park, Gharapuri Island, Karnala Bird Sanctuary, Matheran

Major Parks / Gardens – Jijamata Udyan, Sagar Upwan, Mahalaxmi Racecourse, Maharashtra Nature Park, Godrej Mangrove Park, Powai Park, Nhava Regional Park, Rituchakra Nature Park

Green Neighbourhoods - Navy Nagar, TIFR, Mumbai University, Raj Bhawan, Doongarwadi, Haffkine Institute, Sewree Cemetery, Parsee Colony, Hindu Colony, VJTI & UDCT, BARC, Pali Hill, Aarey Colony, Juhu- Vileparle Scheme, Bhavan's complex, Marol Police HQ., Jeevan Bima Nagar-Borivli etc., Coastal gaonthans (village settlements) of Versova, Madh, Marve, Gorai, Uttan, Mandwa, Kihim, Alibag etc. (These are residential and mixed land use regions having over 25% tree cover)

Heritage Sites - Banganga, Jogeshwari, Mahakali, Kanheri, Mandapeshwar, Gharapuri, Vajreshwari

2. ENVIRONMENT & ECOLOGY

Mumbai's original natural environment can be visualised from a few remnant natural regions e.g. Sanjay Gandhi National Park, Gharapuri Island, Mahim / Vikroli / Nagla mangroves, Matheran, Prabal hills, Karnala Sanctuary, beaches of Raj Bhawan, Gorai, Uttan, Mandwa, Rewas, Kihim etc. Mumbai evolved from a

cluster of seven islands and then extended to the Salsette Island and the mainland. This development process changed the character of the natural environment of the region. Land reclamation, vegetation clearances, plantations, changes in land use etc. created a new human-made environment. The ecology of the region also adapted to these changes.

Mumbai's environment can be classified in the following geographical categories:

Coastal ecosystem – Sandy and rocky beaches along the Arabian Sea and islands
Estuarine ecosystem – Creeks and coastal lowlands
Coastal hills – Hill ranges coming into the sea and close to the seashore
Coastal lowlands – Flat agricultural / horticultural lands and landfills
Mainland hills – Hill ranges at a distance from the seashore
Mainland lowlands – Flat and gradually undulated agricultural and wastelands
Riverine ecosystem – Along the river valleys
Freshwater wetlands – Lakes and ponds

Similarly these can also be put to the following developmental categories:

Dense Urban Environment
Industrial Environment
Urban slums
Rurban (rural regions on the threshold of urbanisation) Environment
Rural Environment

The diversity in the natural ecosystems provided shelter for diverse natural flora and fauna. The human-made environment created during the process of urbanisation provided another dimension to this diversity. Plantation of exotic species, creation of gardens and parks, change in topography and land use etc. contributed to the destruction of natural habitats including its indigenous flora and fauna on one side, and adding, attracting exotic features on the other side. It created complexity to the urban biodiversity, in spite of several environmental hazards due to urbanisation.

Mumbai's marine ecosystem has remained diverse in spite of the disposal of untreated sewage in the sea. About 32 species of algae are found on the rocky beaches of Mumbai (Source: Blatter Herbarium, 2002). Similarly, over 15 species of mangrove plants are found in the creeks of Mumbai (Source: Dr. Vivek Kulkarni, GMP, 2003). All these seashores and creeks provide shelter to diverse marine fauna (fish, mammals, amphibians, crustaceans etc) and also attract large number of migratory birds.

The original indigenous vegetation on the coastal hills and lowlands has vanished. Plantation of exotic plants in the residential and institutional areas, gardens and parks and on roadsides has provided some green cover (Tree species: Roadside-over 125, Parks & Gardens-over 190, National Park-over 300. Source: Dr.

Jaywant, 2000, Smaranika, Marathi Vidnyan Parishad). The fauna has adapted to this changed situation and many species of birds not only visit urban Mumbai but also breed there. The faunal diversity in Mumbai includes following approximate number of species: mammals-56, birds-276, reptiles-52, amphibians-23, butterflies-150 (Source: Kehimkar, BNHS, 2003).

The mainland hills are under tremendous threat due to indiscriminate quarrying, deforestation and encroachments. This has resulted in soil erosion, ground water depletion and degeneration of the adjoining agricultural lands. Mainland lowlands are also going through a rapid transformation. Estuaries, marshes, mudflats, agricultural lands are vanishing creating space for urban development and large infrastructure. Even in the rural fringes, agricultural land use and pattern is changing. Pollution is taking toll of natural flora and fauna. There is very little replacement.

Rivers are polluted downstream. Both flora and fauna have almost vanished in this ecosystem. Except a few lakes, which supply drinking water, almost all freshwater wetlands have been heavily polluted and their surrounding denuded.

The major highlights of Mumbai's natural biodiversity are the protected forests, namely Sanjay Gandhi National Park, Gharapuri Island, Karnala Sanctuary, Matheran and Prabal range, Tungareshwar range, Barvi forest and a few estuarine mangrove patches. These areas have helped in maintaining the balance of natural biodiversity in the Metropolitan region of Mumbai. Mumbai is the only metropolitan city in the world which boasts of having wild leopards, deer, giant squirrels, crocodiles, snakes, hornbills, eagles, flamingoes as residents and also occasional dolphins, whales and migratory birds as visitors. This is interesting since most of these come under the schedule I and II (rare and highly protected) of the Wildlife Protection Act. The Panvel creek adjoining the old and new port of Mumbai, even today shelters crude pearl oysters.

3. EVOLUTION OF THE CITY

Mumbai evolved from a cluster of seven islands inhabited by Kolis, a fisherman community. Several dynasties inhabited on these islands during the historical period. However, the region's urbanisation started only after the British acquired the islands. It was developed mainly as a port to assist the trading activities of the East India Company. It is interesting to note the chronology of events in this region to understand this evolutionary urbanisation process:

Pre-historic time – Inhabited by Kolis. Sopara and Chaul were prosperous ports

200 BC – Satvahans occupied Salsette Island, Kanheri region

550 AD – Chalukyas established capital at Gharapuri Island and a township at Salsette, Kalyan evolved as an important trading centre

1000 AD – Shilaharas built Walkeshwar and Ambarnath temples

1100 AD – Raja Bhimdev established capital at Mahikawati (Mahim)

1401 AD – Sultans of Gujarat conquered Mumbai islands

1498 AD – Vasco da Gama landed at Calicut

1534 – Treaty of Vasai, islands were handed over to the Portuguese

1661 – Mumbai islands given over to King Charles II of England as dowry

1668 – The islands were leased to the East India Company

1700 – 1800 – **Slow but steady process of urbanisation.** Reclamation, port development, cotton trade, ferry services, civic services started. Marine Board was created and **Colaba was declared as Cantonment area.**

1800-1850 – Development of the region acquired momentum. Cultural activities initiated. Infrastructure work carried out. Khandala Ghat was opened in 1830.

Agri-horticultural Society, Geographical Society were founded. Lovegrove sewage pumping station was established. Railway companies incorporated.

1850-1900 – Trade and industrialisation gathered momentum. First textile mill started in 1854. **Vihar, Tulsi, Powai and Tansa water supply projects were completed. In 1862, Victoria Garden (present Jijamata Udyan) was established as a Botanical Park, which was subsequently converted into a Zoological Park.** Municipal Corporation was established in 1872, Port Trust was established in 1873 and City Improvement Trust was formed in 1898. Development of suburbs on the Salsette islands started. Local and suburban railway service was introduced in 1867, whereas tramway (horse drawn) started in 1874. **In 1883, Bombay Natural History Society (BNHS) was formed.**

1900-1947 – Independence movement gathered momentum. Services and infrastructure achieved priority. Major reclamation carried out at Cuffe Parade, Sewri-Mazgaon, Backbay etc. Western suburbs started developing. First motorcar came in 1905 whereas bus public transport was introduced in 1926. Development Directorate was formed in 1920. Greater Mumbai came into existence in 1945.

1947 onwards – Town Planning Act was prepared in 1954. Suburbs and extended suburbs merged into Greater Mumbai Municipal Corporation. In 1960, Mumbai became capital of newly formed Maharashtra State. Bombay Metropolitan Regional Planning Board (which became MMRDA later on) was established in 1967. New Bombay concept proposed in 1970. International Airport at Sahar was

opened in 1971. City & Industrial Development Corporation (CIDCO) was established for New Bombay's development. Entire Metropolitan Region started developing with the establishment of new port at Nhava-Sheva and efficient communication system to the mainland.

Urbanisation process of Mumbai started randomly around 1700. However, it was not planned to become a big city, leave aside a metropolis. Mumbai's growth has been haphazard depending on the needs of people at a particular time. There was no futuristic Master Plan, which resulted in a sort of chaos. However, it provided some flexibility and opportunity for interventions according to contemporary needs.

Along with the process of urbanisation, biodiversity of the city also evolved. Introduction of exotic vegetation, parks and gardens, roadside trees etc. in the urbanised region added variety to the natural flora existing in the protected forests. Some institutional complexes created green environment, which provided shelter to natural fauna. Colaba cantonment, TIFR, Mumbai University, J.J. College, Willingdon Club, Jijamata Udyan, Haffkine Institute, VJTI, BARC, IIT, Aarey Colony are a few examples. Since 1970, environmental rehabilitation started getting attention. People's environmental movements also became active.

Large denuded areas were rehabilitated by creating parks like Maharashtra Nature Park (MNP) at Dharavi, Nhava Regional Park at Nhava Island, Godrej Mangrove Park (GMP) at Vikroli, Rituchakra Nature Park at Thane. Roadside plantation and greening of the residential areas has become a movement. This greening process has helped Mumbai in conserving its biodiversity to great extent. The large percentage of fauna is sheltered in the protected forests, however there is interesting and changing diversity in urban fauna also. Marine fauna is also adapting dynamically (e.g. *Pecten* oyster in Panvel creek) in spite of large-scale coastal development. (Source: Monitoring records of BNHS, MNP, GMP etc.)

4. PLANNING AUTHORITIES / STATUTORY CONTROLS

Mumbai's growth process has undergone experimentation by various planning and development authorities. Under British Rule, apart from Bombay Municipal Corporation, various district municipalities were constituted to regulate the development in the suburbs. Development Directorate, City Improvement Trust, Bombay Port Trust were a few other complementary authorities. Today there are various planning and development control authorities for Mumbai region, working at different levels.

The Urban Development Department of the Government of Maharashtra is the highest authority to take policy decisions of the development of urban areas in the state.

Maharashtra Housing and Area Development Authority (MHADA) & Maharashtra Industrial Development Corporation look after mainly residential and industrial development in the state. Maharashtra State Road & Infrastructure Development Corporation (MSRIDC) looks after the development of infrastructure in the state. There are other authorities to look after the services like water, electricity, sewage etc.

The state government departments of Town Planning, Architecture, Gardens and Parks, Pollution Control, Forests and Environment etc. also complement in looking after various aspects of planning and development.

The chief planning authority for Mumbai is Mumbai Metropolitan Region Development Authority (MMRDA). The first Regional Plan was prepared by this authority in 1973 and subsequently another proposal (1996-2011) was approved in 2000. MMRDA has proposed the land use plan for the region and broad development control norms. The power of statutory approvals and supervision of development projects has been delegated to the other local agencies.

There are following local authorities which control the development in the Mumbai Metropolitan Region (MMR):

Brihanmumbai Municipal Corporation
Mumbai Housing Repairs and Reconstruction Board
Navi Mumbai Municipal Corporation
Thane Municipal Corporation
Kalyan Municipal Corporation
City & Industrial Development Corporation
Municipal Councils of Ulhasnagar, Ambernath, Badlapur, Panvel, Uran, Bhivandi, Mira-Bhayander, Vasai, Khopoli, Pen, Alibag, Matheran, Virar, Nalasopara, Navghar
Revenue authorities (Collector, Tahsildar etc.), Thane & Raygad districts
Konkan Development Corporation

These authorities prepare development plans for their respective regions based on the Regional Plan of the MMR. They plan for development on government land and also for infrastructure. However, the major development in the region is in the private sector. These authorities give approval to the development plans prepared by architects for the private owners. These authorities also carry out the overall control and supervision on this development.

These authorities prepare all statutory development control rules for their respective regions. They are based on the broad norms provided in the Regional Plan of the MMR and also various Acts of the State and Union government. Some important relevant acts, with respect to Urban Biodiversity are:

Coastal Regulation Zone Act
Forest Conservation Act
Environment Protection Act
Mumbai Tree Act
Mumbai Heritage Act

The Coastal Regulation Zone Act has been quite useful in preserving threatened mangrove forests of Mumbai, whereas the Forest Conservation Act has been very effective in protecting the invaluable Sanjay Gandhi National Park from the development pressures and encroachments. Similarly, the Mumbai Heritage Act could be very useful in preserving and rejuvenating Natural Heritage sites like Banganga, Vasai, Tungareshwar etc. The will for effective implementation of these Acts is crucial and the recent example of Sanjay Gandhi National Park could be a guideline for coordinated efforts of people and Forest Department. The Supreme Court judgment based on these acts prevented all selfish political interventions likely to cause the degradation of this natural ecosystem.

There has been a major conceptual shift in the planning process of MMR.

The Regional Plan – 1973, viewed growing population as the root cause of Mumbai's problems. The Plan recommended restricting Greater Mumbai's population to 7 million, putting a ban on the setting up of new industries, offices and commercial establishments, and relocating certain economic activities to new growth centres. This was based on the principle of decentralisation and the view that unless the growth of population and economic activities are restricted in the large cities, the civic services and infrastructure will collapse and the quality of life will suffer.

The revised Regional Plan – 1996-2011, reflects a totally different approach in the euphoria of economic liberalisation and the desire for making Mumbai an international city. The new concept does not look at the large city as an over grown, unmanageable, sick urban entity but one that can play an important role to generate national wealth. The new approach does not believe in restricting growth but wishes to facilitate further development by providing modern infrastructure and encouraging economic progress.

However, both the plans show lack of sensitivity towards environmental aspects despite existing laws and awareness.

5. ENVIRONMENTAL ASSESSMENT

Mumbai's environment and biodiversity are at great risk due to the hazards of unplanned and indiscriminate development. Let us look at various reasons for some of the major adverse impacts:

- Over population resulting in increasing demands for space and resources
- Growth beyond the carrying capacity of the space
- Indiscriminate and centralised development
- Industrialisation and commercialisation
- Poor land use planning, particularly for Industrial Zones
- Urban consumerism
- Encroachments and slum proliferation
- Poor sewage disposal systems resulting in pollution of soil, rivers, lakes and sea
- Unplanned garbage disposal system
- Indiscriminate disposal of untreated industrial effluents
- Industrial and automobile pollution
- Denudation of hills and open lands
- Indiscriminate quarrying
- Reclamation and changes in land form
- Tremendous development pressure on the remaining natural forests
- People – wildlife conflicts on the periphery of the natural forests
- Emergence of weeds, pests and vermin resulting in health hazards
- Denudation of urban green cover due to development demands
- Urban demands of Mumbai putting adverse impacts on the natural environment of the surrounding rural region
- Lack of sensitivity about natural environment, ecology and biodiversity amongst planners and decision makers

Mumbai has sustained until now in spite of these adverse environmental impacts mainly because of its geographical uniqueness and also its natural forests. The Arabian Sea has been the main saviour of Mumbai. Strong sea winds clear the polluted air over Mumbai and tidal flow cleans Mumbai's creeks to some extent. The monitoring records of the flora and fauna of the region by the organisations like BNHS, Blatter Herbarium etc. do not show any alarming threat to biodiversity of the region. The natural forests of Sanjay Gandhi National Park, Gharapuri Island, Karnala Sanctuary and the hills of Tungareshwar, Matheran, Prabal have maintained the balance of natural biodiversity of Mumbai. Similarly the mangrove forests in Mumbai's creeks and estuaries have maintained stability in marine ecology as observed from the records at the Taraporewala Aquarium. The people-wildlife conflict has become a major concern, particularly on the outskirts of the Sanjay Gandhi National Park, due to leopard attacks on the human population. This indicates the adverse impacts of the development pressure on the natural ecosystems.

6. SUSTAINABILITY OF BIODIVERSITY

Urban biodiversity of Mumbai may be categorised as **Natural**, which includes marine, mangrove, wetland and forest ecosystems and **Human-made**, which includes plantations, parks and gardens and landscaped development.

Natural ecosystems are very precious. Their existence in the city like Mumbai is a blessing and all efforts are needed to conserve these at any cost. At present, their survival is at stake because of encroachments, vandalism, poaching. There are efforts to convert them into safari parks, holiday resorts, picnic spots, gardens etc. Marine and Mangrove ecosystems are likely to die because of sewage/ effluent disposal and garbage dumping, apart from denudation of mangrove plants for fuel and also land fills to ‘create’ more land. These ecosystems have the protection of law. However there seems to be no protectors of the law! The only possible saviours are environmental organisations and individuals.

Human-made ecosystems are relatively safe, in a sense that they are created by the urban society itself. These habitats can afford changes, modifications even in terms of their location. They are a part of the development process. Recent efforts to create Nature Parks, Educational Parks etc. are commendable because they help in bringing back indigenous flora and possibly fauna. But more important is that they have tremendous educational value. These parks can create nature awareness and motivate younger generation towards nature conservation. Creation of such parks and also preserving the existing ones would also reduce the pressure on the Natural ecosystem.

The sustainability of this biodiversity in Mumbai will depend on the quantum and the nature of the growth of development. It will also depend on the sensitivity of planners, managers and the decision makers towards environmental hazards of ‘development’. The sustainability will also depend on the investment for environment by these developers. Even if a simple issue of urban garbage and sewage disposal is tackled efficiently and scientifically, biodiversity will have some hope.

7. AWARENESS AND PEOPLE’S PARTICIPATION IN CONSERVATION

Mumbai has the distinction of having active involvement of several organisations and individuals in the fields of Natural History and Environmental Conservation. The teachers and students from Mumbai’s science colleges have been using Mumbai’s nature reserves as a live laboratory and thus providing scientific monitoring of various natural parameters. Nature Education activity is being conducted through formal and informal methods. Mumbai’s media is also very active in the environmental movement. There are several Trekking and

Mountaineering groups and Nature Clubs who are involved in regular activities of natural history studies and also nature conservation. There are three very active e-groups, which exchange information on Mumbai's natural history and also initiate conservation action.

(See Annexure-5 for the list of voluntary groups)

The efforts and involvement of all these voluntary groups in monitoring and protecting Mumbai's environment through movements, public interest litigations (PILs) and conservation actions has helped to protect some important elements of Mumbai's biodiversity.

8. PAST, PRESENT & FUTURE

The Mumbai Metropolis of today has emerged from those tiny islands in the Arabian Sea and the pristine coast and forested hills of the mainland. The Natural biodiversity of this region had been very rich. Tigers have been recorded in this region even in recent history. The process of unplanned development, spearheaded by wanton industrialisation and commercialisation has taken a substantial toll of this natural biodiversity during the last century. The spread of environmental destruction has not remained just restricted to Greater Mumbai, but has also affected adjoining regions. In fact, the environmental pinch of this destruction is being felt now by the present generation.

The trend has changed slightly since 1970. There is public awareness about environmental hazards and concern for nature conservation. People's participation in environmental movements has started keeping some control over the destruction. Even today, Mumbai is fortunate to have rich biodiversity, perhaps the best in the world for any metropolitan city. The future is in the hands of people and their ability to understand the importance of biodiversity for their own sustenance and insistence for its preservation.

ANNEXURE – 3:

Growing Metropolis – Bangalore (Bangalore Metropolitan Region [BMR] within approx. 25 Km radius from the Core i.e. Mud Fort)

1. GEOGRAPHY AND ECOLOGY

Geography:

Latitude – 13 °, Longitude – 77 ° 35'

Altitude – Average approx. 950 M

Location – Central part of the southern Indian peninsula, an undulated, high plateau of the Deccan, in the state of Karnataka

Geology:

Rock type – Igneous and Metamorphic, unclassified crystalline rocks (mainly Gneisses). On the western periphery – Igneous-Intrusives, Granite, Grano-diorite, Pegmatite

Soil type – Red loamy and sandy soil, patches of laterite soil

Climate:

Moderate and dry type

Temperature – 23.3 ° (daily mean temperature for year)

Rainfall – 860 mm (mean annual), southwest (June – September) and northeast (October – December) monsoon

Relative Humidity – 50% to 60% average

Area & Population (Approx. Yr. 2000):

(Source: BDA, Comprehensive Dev. Plan, 2000)

Bangalore Urban (Mun. Corpn. Limits – 100 wards)	220 Sq. Km	4.5 Million
Bangalore Rural (Conurbation area)	290 Sq. Km.	1.8
Balance BMR (Rural / Agricultural area)	420 Sq. Km.	1.5
Total	1879 Sq. Km.	7.8 Million

Vegetation:

Original natural vegetation – Tropical thorn type on south – Tropical dry deciduous type and aquatic vegetation in many lakes. Presently overtaken by exotic plantation.

Natural Features:

Bangalore is a unique exception to the normal concept of human settlements, which generally begin on the riverbanks or along the seashores. Bangalore has grown on the top of a small hill range on the Deccan Plateau with no major river nearby. However, due to undulations the land provided major opportunity for the development of lakes and Bangalore is dotted with various lakes / tanks.

Rivers/ Streams - Arkavathi on the west, Pinakini (Ponnaiyar) on the east are tributaries of the Kaveri River. River Vrishabhavati, the tributary of the Arkavathi is supposed to originate at the feet of Nandi of the Bull Temple (Basavangudi) and another tributary Suvarnamukhi originates in Anekal Taluk. Many small streams feed major lakes/tanks.

Hills – There are no major hills in the city, however entire region is undulated being a part of a hill range. There are a few geological features in the region like ‘The Bugle Rock’, 3000 million years old ‘peninsular gneiss’.

Lakes – There are around 461 lakes of various sizes in Bangalore. Not all of them are in a satisfactory state. Some important lakes (area over 10 hectares) are Hebbal, Sankey, Nagavara, Yediyur, Kempmbudhi, Ulsoor, Madiwala, Sinivagilu, Byrasandra, Jakkasandra, Mathikere, Bellandur, Lalbagh etc.

Protected Forests –Natural forests in the BMR are Banerghatta National Park (approx. 21 Km from the core) on the south and Savandurga (approx. 15 Km from the core) on the west

Major Parks/ Gardens – Lalbagh Botanical Park, Cubbon Park, Krishna Rao Park, Golf Course, Race course, Shinavagal Grassfarm, Orchards of the Agricultural University, Palace Orchards

Green Neighbourhoods – Bangalore University, Indian Institute of Science, Raman Research Institute, University of Agricultural Sciences, HMT Complex, Cantonment area, Rajmahal Vilas, Jayanagar, Indiranagar, Raj Bhavan & surroundings, Kumar Krupa Park, Palaces and their surroundings, Cemeteries, West End Hotel, Whitefield, Rural Greens on the periphery (Bangalore Rural District)

Heritage Sites – Major Lakes and their surroundings, Bull Temple Hill, Lalbagh, Cantonment, Agram Cemetery, Gavipuram Hill

2. ENVIRONMENT & ECOLOGY

Bangalore's natural environment as originally existed is described as 'dense dry deciduous forest of *Anogeissus latifolia*, *Pterocarpus marsupium*, *Terminalia* type'. However there is no natural forest in the city today. Even the surrounding protected forests have now changed into 'woodland-savanna, scrub and thicket'. These areas are mostly towards the south and west of Bangalore e.g. reserved forests of Badamanavarti, Kalkere, Bannerghatta, Ragihalli, Karadikal, Madeshwara, Savandurga etc. Bangalore region was a cluster of small villages, which evolved because of the initiation of Kempegowda-I, who established a Mud Fort at the present core of the city. The undulating land provided opportunity to harvest water by building lakes and various human-made lakes emerged as the city evolved. The development process also changed the character of the natural environment of the region. Lake reclamation, vegetation clearance, quarrying, plantations, changes in land use etc. created a new human-made environment. The ecology of the region has slowly adapted to these changes to some extent. However the natural ecosystem was destroyed to a large extent because of the unplanned urbanisation.

Bangalore's environment can be classified in the following geographical categories:

Deccan Plateau ecosystem – Gradually undulated, well drained land
Hills – Bouldery areas, rocky outcrops with arid vegetation
Valleys – Natural storm water drains
Freshwater wetlands – Lakes, ponds and fields
Lowlands – Flat agricultural / horticultural lands, grasslands

Similarly these can also be classified in the following development categories:

Dense Urban Environment
Industrial Environment
Institutional Campuses
Cantonment areas
Urban slums
Rurban (rural region on the threshold of urbanisation) Environment
Rural Environment

Bangalore does not have natural forests. The process of urbanisation and also agricultural / horticultural activities in the surrounding region have denuded the natural vegetation. However, the human-made ecosystem that evolved during this process provided different habitats. The rulers of Bangalore, at different stages brought in a lot of greenery, mostly exotic flowering and fruiting plants. Many lakes were constructed. The city developed as a Garden and Lake City. The soil and climate has been beneficial for this exotic vegetation and the city became

green very fast. The biodiversity of Bangalore is following this pattern of habitat evolution. Some original fauna (birds like sparrows and munias) vanished, however the others (snakes and amphibians) adapted and flourished. There have been many new arrivals like warblers, flycatchers, owls and migratory water birds. Surrounding barren region also developed as farms, orchards and grasslands due to the development of irrigation schemes and agricultural innovations. This new habitat on the periphery also provided shelter to the diverse fauna. This evolution also brought in a lot of weeds to Bangalore. (WWF, 1999). The city became notorious for pollen hazards. The recent haphazard process of urbanisation started having adverse impacts on the city's environment and its biodiversity. Greed for land has destroyed existing greenery and also wetlands. Air and water pollution have taken a major toll of city's wetlands and vegetation.

Bangalore's undulated plateau has been taken over by dense development, mainly residential and institutional. Residential localities have almost no open spaces resulting in very poor green cover. The urbanisation process with its high demands for water supply has resulted in rampant sinking of bore-wells, particularly in the dense residential zones on the plateau region. The ultimate result has been a very low ground water table affecting the vegetation and ground organisms. On the other hand, the large institutional complexes have maintained large green open spaces. In fact, many of them have created natural look to the landscape by introducing mixed and canopied vegetation. Excellent examples are Indian Institute of Science (IISc), Bangalore University (BU) and University of Agricultural Sciences (UAS). The biodiversity of these complexes is rich and is well protected and regularly monitored. A very recent agitation by the faculty and students of UAS against the destruction of the habitat under the pretext of the development of Biotech Park is a very good example of the people's participation in the conservation of biodiversity. However, not all such efforts succeed, just as the case of shrinking of Cubbon Park or pollution in Lalbagh. This is the case of most of the parks and roadside trees of Bangalore. The haphazard and unplanned development is destroying this greenery at an alarming rate.

The bouldery hills in and around Bangalore have been a unique habitat for arid vegetation and associated fauna. The Peninsular Rock Agama, *Psammophilus dorsalis* and the Yellow-throated Bulbul, *Pycnonotus xantholaemus* are a few interesting examples found even today in these habitats. Unfortunately these hills are being destroyed indiscriminately for quarrying building materials.

Valleys of Bangalore's undulated terrain had sheltered good and interesting diverse vegetation. A few remnants are evident even today. However, poor planning for urbanisation has turned these valleys into sewage drains today. These valleys with excellent potential of biodiversity have become major environmental hazards today.

There has been a lot of awareness today regarding conservation of Bangalore's wetlands. A few lakes (Ulsoor, Hebbal) have been under the process of

rehabilitation with the help from international organisations and the corporate sector. However the majority of lakes are in a very poor environmental condition due to sewage and industrial effluent pollution. Many lakes have vanished due to reckless, unplanned reclamation for the purpose of ‘creating’ land for development. The study shows that most of the existing lakes are at a high level of eutrophication stage, with very low oxygen level and adverse aquatic vegetation growth. The denudation in the surrounding region has also resulted in soil erosion and silting of these lakes. The present aquatic biodiversity is very poor. The number of water birds visiting these lakes has decreased substantially. The poor status of lakes has also adversely affected the ground water table in the surrounding regions. (Krishna et al, 1996).

Flat and low agricultural lands in the surrounding region have been good habitat for open-land fauna. Development of orchards and grasslands has also provided good habitat diversity. Many of these lowlands also act as seasonal wetlands and shelter interesting fauna, mainly amphibians. However, with the high rate of urbanisation growth of Bangalore, these lands are under development pressure. There are efforts to create a Green Belt in this region and also to restrict the development up to a limit. This is unlikely looking from the earlier experience. Only possible solution is to prepare and implement the comprehensive regional plan for Bangalore, with a strong emphasis on biodiversity.

In spite of all these adverse factors, Bangalore’s biodiversity is still satisfactory. The highlights of Bangalore’s diversity are several parks and gardens lead by Lalbagh, Cubbon Park and institutional complexes. Bangalore corporation limits have around 80 medium to large parks and gardens. Today, 673 genera and 1854 species of plants are found in Lalbagh, whereas 68 genera and 96 species of trees are found in Cubbon Park.(Dept. of Horticulture, 2000). Bangalore’s remaining lakes are also biodiversity assets. The adverse impact on Bangalore’s environment has been reduced to some extent due to the rural greens in the surrounding region and forested areas like Bannerghatta National Park on the outskirts. Insect fauna of Bangalore has been unique with regular occurrence of butterfly migration through the city. The avifauna list includes over 300 species. A small number of mammals are found in select localities. There are a good number of reptiles and amphibians in the region. (WWF, 1999). Bangalore can hope for better biodiversity if the proposal of the BDA to set up the Green Belt around the city and also to constitute about 14 % of the City’s area (approx. 75 Sq. Km.) as parks and gardens (BDA, Comprehensive Development Plan, 2000) comes into reality.

3. EVOLUTION OF THE CITY

Bangalore evolved from a cluster of small villages on a hill range of the Deccan Plateau in the southern peninsula of India. The city of Bangalore (anglicised from original ‘Bengaluru’) was founded in 1537 AD by Kempe Gowda-I, the trusted

chieftain of Vijayanagara emperor Achuta Raya. Kempe Gowda was in charge of Yelahanka (a town existing to the north of Bangalore). However there are ancient inscriptions, which point to the fact that a village called ‘Bengaluru’ existed prior to the 10th Century AD. The Moghuls and British captured the terrain and contributed to the further development of Bangalore city. The city evolved out of several villages (halli) and subsequently from several towns. Basically it evolved as a combination of two cities, original fort on the west and Cantonment on the east. It had been a city of lakes. It is interesting to note the chronology of events in the region to understand this evolutionary urbanisation process:

900-1000 AD – Hoysala King Vira Ballala visits the region. Village ‘Hal Bengaluru’ still exists to the north of modern Bangalore, beyond Kodigehal

1537 – Kempe Gowda-I (1510-70) founded Bangalore, built mud fort (now Pete), Basavangudi and Dharmambudhi tanks

1585 – Kempe Gowda-II (1585-1633) constructed four towers, invited traders, artisans and weavers from the surrounding region

1637 – Bijapur Shahi rulers annexed Bangalore

1638-87 – Shahaji Bhonsale received Bangalore as personal *jahagir* and he and his descendants ruled the region

1687 – Moghuls capture Bangalore

1690 – Chikkadevaraya Wodeyar of Mysore bought Bangalore from the Moghul governor Kasim Khan

1759 – Bangalore awarded as a personal *jahagir* to Hyder Ali by Chikka Krishna Raja Wodeyar

1761 – Hyder Ali built oval stone fort and laid Lalbagh

1791 – British captured Bangalore but returned it to Tipu Sultan as a part of agreement

1799 – Bangalore restored to Raja Wodeyar of Mysore after Tipu’s death

1806 – British formed Cantonment near Ulsoor

1831 – Bangalore taken over by British

1831-60 – Civic services and civil administration began developing

1861- 1900 – Steady urbanisation process, Railway connection in 1864, Jail, Court, Educational institutes, Telephone, Civil Administration Departments were established, **Bangalore's first extensions (Chamrajpet, Malleswaram etc.) by absorbing 26 villages and Towns (Frazer, Richmond etc.) around Cantonment were developed**, Water supply scheme from Hesarghatta started in 1896, the first Textile mill started in 1884, many gardens were established and exotic trees were planted on roadside.

1900-1947 - Development acquired momentum, Cultural activities initiated, Infrastructure work carried out, first Municipal Commissioner was appointed in 1923, Additional water supply provided from Tippagondanhally, several Markets established, All India Radio, City Improvement Board, higher Educational Institutions (e.g. Indian Institute of Science in 1912) were established, major industries (ITC, United Breweries, HAL, ITI etc.) were established, Communication systems like railway, highways and airport were developed, **Bangalore became popular as a Garden City**

1947 onwards – City / Civil / Military cantonments were merged in 1949, Municipal Corporation was constituted in 1950, Department of Town Planning was constituted in 1959, Bangalore Water Supply and Sewerage Board (BWSSB) was established in 1964, City Planning Authority was formed in 1965, Slum Clearance Board was formed in 1975, **Bangalore Development Authority (BDA) was formed in 1976, Bangalore Metropolitan Region Development Authority (BMRDA) was constituted in 1987**, Industrial and commercial development increased since 1985, Major Research Organisation like ISRO were established, political reorganisation took place i.e. in 1956, Mysore State was formed with Bangalore as its capital, the state was renamed as Karnataka in 1973, new Industrial Township emerged just outside the border of Karnataka at Hosur in Tamilnadu, eight huge industrial belts emerged around Bangalore housing over 10000 industries. Bangalore started evolving as ‘Silicon City’ since 1975, with the industries related to Information Technology taking roots in the city.

The urbanisation process of Bangalore started right from the beginning when Kempe Gowda-I, founded it in 1537. In that sense, it was a planned city. Since the city grew around the original fort it evolved in a concentric pattern. There is plenty of land available all around Bangalore and city has good potential to grow. However the phenomenal growth of Bangalore after independence was not planned and it occurred in a haphazard manner. In 1941, Bangalore was the 16th largest city in India, and by 1981 it became the 5th largest metropolis of the country. **Bangalore, which was known as a Hill Station or a Garden City & Lake City, is emerging now as a Hi-tech city.**

Along with the process of urbanisation, biodiversity of the city evolved in a haphazard pattern. The region which was originally dry deciduous forest, degraded into scrub forest and then evolved as a garden city and also as a lake city, due to creation of human-made lakes in the lowlands of the hill range and the

plantation of exotic trees all around. The rulers like Hyder Ali and subsequently British developed several gardens in the region. However, the post-independence period has been the period of unplanned growth resulting in the deterioration of the natural environment. The existing green cover started giving way for the development, lakes either vanished due to reclamation for land or they got polluted due to the disposal of sewage and garbage. A few institutional areas have retained greenery. The habitat destruction affected the diversity of fauna. The once abundant water bird population has gone down considerably along with the vanishing lakes. However the adjoining rural greens provide some respite for the fauna and there is some hope for the rejuvenation of biodiversity.

4. PLANNING AUTHORITIES / STATUTORY CONTROLS

Bangalore's growth process has undergone experimentation by various planning and development authorities. Kempegowda-I, who founded Bangalore built the Mud fort at the present core of the city (1537). Kempegowda-II, erected four towers at four corners to demarcate the limits of the city (1585). Hyder Ali built the oval fort in stone and laid Lalbagh, which was the beginning of the Garden City (1761). The systematic modern development of Bangalore started when Bangalore was taken over by the British (1831).

The city was governed by the British Commissioners through *Dewans* dedicated to the development of the city. The British founded the Civil & Military Station and developed the Cantonment as an independent city. The Civil Administration Department would look after the development of the original city. This administrative separation was merged only after independence (1949). The development during the British rule was rather slow and haphazard. A number of 'extensions' and 'towns' were built randomly to meet the increasing needs of population. Several committees were formed and dissolved without any constructive outcome towards a comprehensive development plan. The first Municipal Commissioner was appointed in 1923 and the City Improvement Trust Board was set up only in 1945. This resulted in chaos. Due to lack of an integrated planning approach, irregular developments appeared in between the 'extensions' and 'towns'. The merging of the city and cantonment and the unplanned development of large industrial areas on the outskirts resulted in an abnormal increase in population and slums. It took three years after the independence for the constitution of the Municipal Corporation for the city and over a decade to form appropriate planning authorities. In between, the haphazard development and wanton destruction of the environment and biodiversity continued.

The Urban Development Department of the Government of Karnataka is the highest authority to take any policy decisions of the development of urban areas in the state.

Karnataka State Urban Planning Organisation, Karnataka Housing Board, Karnataka Slum Improvement and Clearance Board, The Commissioner for Industrial Development look after the residential and industrial development in the state. There are various government departments, which look after the infrastructure development in the state. The Directorate of Municipal Administration looks after the urban areas in the state.

The departments of Town Planning, Horticulture, Forest, ecology and environment, Pollution Control etc. also complement in looking after various aspects of planning and development.

There has been a constant upheaval of various planning authorities for Bangalore. Today there are following major planning and development authorities for Bangalore city:

Bangalore Metropolitan Region Development Authority (BMRDA)- 1987
Bangalore Development Authority (BDA)- 1976
Bangalore Mahanagarpalike (BMP)- 1950
Bangalore Agenda Task Force (BATF)- 1999

Till 2000, there was also the Bangalore Urban Art Commission (BUAC), which was established in 1990 and is now dissolved.

The BMRDA prepared a Comprehensive Development Plan- 2011 in 1984 for the region assuming the extension of the city up to the suburban towns of Doddaballapur in the north, Kolar on the east, Channapatna on the south and Tumkur on the west. However a much smaller area of around 600 Sq. Km. extending up to 8 Km. beyond the corporation boundary was ultimately considered as the planning area and development has been continued based on the revised Outline Development Plan.

Very recently, the government constituted BATF, a high profile authority headed by the management and technical consultants from the corporate sector to decide about the futuristic development of Bangalore. The authority has been carrying out several studies related to modernisation of Bangalore and one has to wait and watch its progress.

At present, there seems to be very little co-ordination amongst these planning authorities. The BMRDA seems to exist only on paper with no controlling authority. The BDA prepares its own town planning schemes and implements them. Outside the BDA areas, BMP is the sole development control authority with no planning expertise at its disposal. The private development in the BMP region is carried out through the development plans prepared by architects within the rules and regulations of the BMP. These rules had become obsolete long back, however new ‘development’ is continued in this growing metropolis!

Except the Acts of the Central Government with respect to Urban Biodiversity (Forest Conservation Act, Environment Protection Act etc.), there are no development control rules in Bangalore, which could control the development and protect the city's environment and biodiversity. The Comprehensive Development Plan shows some lip sympathy towards the environmental issues, however major issues like sewage and garbage disposal are not considered in-depth at all. The environmental sensitivity of the planners is limited to Parks and Gardens only. The important fact is that the plan is unlikely to be implemented! There seems to be deliberate neglect towards the environment from the decision makers across all political parties in Karnataka.

5. ENVIRONMENTAL ASSESSMENT

Bangalore's environment and biodiversity are at great risk due to hazards of the unplanned development. Let us look at various reasons for some of the major adverse impacts

- Over population resulting in increasing demands for space and resources
- Lack of co-ordination amongst the planning & development authorities
- Poor land use planning, particularly for Industrial Zones
- Craze of 'Hi-tech City' approach by the decision makers at the cost of environment
- Encroachments and slum proliferation
- Poor sewage disposal systems resulting in pollution of soil, streams and lakes
- Unplanned garbage disposal system
- Indiscriminate disposal of untreated industrial effluents
- Automobile pollution
- Denudation of hills and open lands
- Indiscriminate quarrying
- Reclamation of lakes and wetlands
- Emergence of weeds, pests and vermin resulting in health hazards
- People-wildlife conflicts in the suburbs (elephant attacks)
- Denudation of existing urban green cover due to development demands
- Urban demands of Bangalore putting adverse impacts on the rural environment of the surrounding region
- Lack of sensitivity about natural environment, ecology and biodiversity amongst planners and decision makers
- Superficial 'beautification' approach of planners and decision makers towards environment

Bangalore has already started showing the signs of environmental degradation. It had sustained until now due to old lakes and greenery and the health of biodiversity was protected due to favourable natural conditions like good soil, well-distributed rain and moderate climate. The growth rate of Bangalore could be manageable now, if the growth and development is coordinated through comprehensive planning with emphasis on environmental conservation, with immediate effect.

6. SUSTAINABILITY OF BIODIVERSITY

The Urban biodiversity of Bangalore is mainly **human-made**. This includes parks and gardens, landscaped developments like institutional complexes and roadside plantations, orchards, agricultural / horticultural plantations and lakes.

The only natural ecosystem on the outskirts of Bangalore is the Bannerghatta National Park. This is precious and is a blessing for the city's environment. The strong efforts are needed to conserve this at any cost. Unfortunately, large part of this natural ecosystem is being developed as a recreational park including zoo and safari. Recently, it has been converted into a shelter for zoo animals! The biodiversity of this national park is at stake today. There are large garbage dumps in the vicinity. Lands on the periphery are being encroached and there is large incidence of poaching and tree cutting. People – wildlife conflict is also taking serious turn, with elephants and leopards attacking the human population. This ecosystem has the protection of law, however the strategy of protection seems to be lop sided. Bannerghatta National Park needs urgent intervention from sensitive ecologists and naturalists.

Human-made ecosystems of Bangalore are also under tremendous pressure, mainly because of poor planning approach and haphazard development. The majority of Bangalore's lakes are transformed into cesspools today due to very poor sewage disposal system. Many have vanished due to reclamation for 'creation' of land for the development of large residential neighbourhoods. There are encroachments on the periphery of surviving lakes and many of them are dying due to eutrophication. This has adversely affected Bangalore's ground water table and in turn Bangalore's biodiversity. The conservation and restoration of these lakes as natural wetland ecosystem should be the priority for the city.

Bangalore is proud of being identified as a Garden City. However the state of its gardens is worrisome. Large precious green areas like Cubbon Park and Lalbagh are under constant threat of development demands, mainly from political circles. Already these green lungs of Bangalore have shrunk considerably. The status of other smaller parks is not any better. Most of them are neglected, some of them

converted into garbage / debris dumps. The Green Belt proposal has been abandoned even before its commencement. The Comprehensive Development Plan – 2011, proudly and ambitiously mentions about the proposal to reserve about 14 % of the area for parks and gardens. However there is no concrete proposal to maintain and restore the existing green spaces, which are on the threshold of environmental death.

Lack of co-ordination amongst the planning and implementing authorities is also resulting in a chaotic situation. The gardens, parks and urban plantations are being looked after by the departments of Horticulture on one side and the department of Forest on the other side with very little interaction. There are inter-departmental conflicts about the responsibility and maintenance of the lakes in the city. Roadside plantation is adversely affected due to constant excavations by departments involved in infrastructure development like electricity, telephones, water supply, sewage and roads. Even existing old trees are under constant threat and new plantation is almost non-existent.

Due to very primitive development control rules, the residential development has no open spaces and no greenery at all. The only solace for urban greenery comes from the institutional complexes. Many of them have retained vegetation diversity, whereas some complexes like IISc have even maintained a natural look with indigenous, multi canopy and mixed vegetation. These large complexes mainly contribute to the city's biodiversity. Many of them serve as live laboratories for ecological studies.

Rural greens on the periphery are in a process of transition under the development pressure. Even villages are going through the urbanisation process. A planned strategy with a strong emphasis on the biodiversity could maintain the balance between the development and environment.

The sustainability of Bangalore's biodiversity will depend mainly on the appropriate planning and implementation process. Involvement of people in this conservation process is crucial. A conscious strategy of nature awareness and education on one side and the insistence of technical and financial investment for environmental conservation from the commercial / industrial establishments and also the government on the other side, could provide some hope for the sustainability of the Urban Biodiversity.

7. AWARENESS AND PEOPLE'S PARTICIPATION IN CONSERVATION

The existence of the Indian Institute of Science in Bangalore since 1912 has provided an emphasis of scientific approach amongst many individuals and organisations not only in Bangalore but also in Karnataka. This has percolated in the issues related to nature studies and environmental conservation. There is a good amount of documentation through the study reports on various

environmental aspects of Bangalore. There is regular environmental monitoring due to the participation and concern of several scientists, research students and amateur naturalists. However this concern does not seem to have percolated down to the people of Bangalore. Even the local media is not yet sufficiently sensitised towards the environmental issues affecting Bangalore. The development of Bangalore as a Garden City has also made a peculiar dent on the general thinking process, which has strong influence of gardens, parks and recreation. The concept of biodiversity or natural ecosystem is not yet accepted in the planning process. There is substantial awareness about the conservation of lakes, but it is broadly oriented towards just creating another recreation space or a park. The people in Bangalore are conscious about the greenery of Bangalore and there is occasional outcry whenever there is onslaught on the green spaces of Bangalore. There are a few small groups involved in nature studies, trekking & mountaineering etc., which also carry out nature awareness. Nature Photographers have been very active in Bangalore and their contribution in the nature awareness is substantial. There are two active e-groups, which exchange information on Bangalore's natural history and also initiate conservation action.

(See Annexure-5 for the list of voluntary groups)

The efforts of these groups and also of some individuals in monitoring and protecting Bangalore's environment are commendable. Many of these groups have provided a strong scientific base for the nature conservation movement, however general awareness is still very low. Bangalore needs more environmental awareness and people's participation.

8. PAST, PRESENT & FUTURE

Bangalore Metropolis of today emerged from clusters of tiny villages along the small hill range on the Deccan plateau. Once the region of dry deciduous forest slowly got converted into woodland-savanna, scrub and thickets of arid vegetation. The evolution of the city, which began in 1537 with the construction of a mud fort, expanded today up to the region of around 20 Km radius on all sides. Over the years Bangalore evolved as a human-made ecosystem. Development of lakes, parks and gardens and plantation of exotic trees etc. provided a different character to Bangalore's biodiversity.

The development process was slow and steady during the pre-independence period. There was no systematic planning process visualising the city's growth, leave aside environmental consideration. However it evolved as a Garden city and retained its biodiversity. The post world war scenario brought in industrialisation and the post independence period brought in euphoria for commercialisation as a Hi-tech city. The development process accelerated without any comprehensive planning process. Random short-term solutions were provided to various

emerging developmental and environmental problems. This has resulted into present chaotic situation in Bangalore, both in terms of development and environment. Since 1970, there is growing awareness for environmental conservation, mainly for urban environment. Bangalore is still lacking this awareness. Particularly, the planning authorities have remained totally insensitive to the environmental issues of Bangalore.

What is the future for Bangalore? The answer to this question remains in the future approach of the decision makers and planning authorities. It hinges on the conservation of Bangalore's natural environment and its biodiversity. Like any other city, the future is in the hands of people and their ability to understand the importance of biodiversity for their own sustenance and insistence for its preservation.

ANNEXURE – 4:

OTHER METRO CITIES OF INDIA (General case study-III)

Over half a century now since independence, India has gone through the democratic rule of diverse governments at the centre and within the states. The development process of our urban centres reflects the aspirations of these elected governments, indicative of the people's desires.

Though ancient India has proud history of capable Town Planning (Mohenjo-daro & Harappa) and literature on the rules of Town Planning, not many of our cities have gone through the process of serious planning. In that sense, the emergence of Indian cities is only about 500 years old, mostly under the influence of a few rulers. The real process of modern urbanisation started under British Rule.

India has been richly endowed with natural biodiversity. However this had negative effect in an urban context as the cities evolved. The administrators and planners never thought of biodiversity with any concern. In fact, the exploitation of natural resources for urbanisation was felt as a major need for the success of the growth and development. Unfortunately, this approach continues even today. Since around 1970, environmental concern achieved universal dimensions. It started having its effect in India, initially through the media and then because of the concern of ecologists and naturalists. It achieved larger attention when it became a social issue. The crunch due to adverse environmental effects of unplanned development, made people aware about possible disasters at their doorsteps. However, natural biodiversity continues to be destroyed in almost all our cities, mainly due to the insensitivity of planners and decision makers. The town planners are handling the environmental issues in a superficial manner only for the purpose of aesthetics, recreation and to fulfil the statutory obligations. This is unfortunately true even for the only modern planned city of independent India – Chandigarh.

A rapid overview of the status of urban biodiversity in a few major fast growing cities of the country may help us in assessment and in proposing the strategy for future development processes.

1. DELHI

Delhi evolved as a political city and the capital of the country. It received the patronage of various rulers, Hindu, Moghul, British and now Indian. The city developed on the fertile plains on the banks of the perennial river Yamuna. The natural ecosystem was arid consisting of small patches of Tropical Dry Deciduous and Thorn forest mainly along the river. New Delhi was planned as the capital city and received all possible favours, whereas Old Delhi remained neglected and deteriorated further. The surrounding region (beyond 30 Km. radius) developed haphazardly as clusters of industrial satellite towns. New Delhi received favourable treatment of large open spaces, landscaped roads and

gardens, protected monuments and heritage sites while all the sewage and garbage generated by this ‘beautiful’ city was thrown into the surroundings, polluting soil, air and even the sacred river Yamuna. The growth of population in the surrounding region and subsequent growth of vehicular movements within Delhi has made it the most polluted city in India. However, New Delhi’s greenery, the natural scrub forest/ thickets on the small hills (Delhi Ridge) and a few patches along the Yamuna provided some shelter to the fauna. The bird diversity is impressive, with over 400 species having been recorded in the city and its immediate surrounds (Kalpavriksh, 1991b). However, Delhi’s natural biodiversity seems to be quite low. Delhi is the major centre of power with all the decision makers and the bureaucrats residing within the city, however only voluntary groups and individuals seem to be interested in the natural environment of Delhi.

2. KOLKATA

Kolkata is today the largest metropolis of the country. It developed as the first capital of the British Raj and is today the state capital of West Bengal. Situated on the banks of the Hooghly river, as a part of the delta of the Ganga joining the Bay of Bengal, the natural ecosystem of the region is typically coastal, with swampy vegetation and a hot / humid climate. Kolkata grew as a dense, heavily populated city. The city was known as an industrial and commercial giant, but grew haphazardly without appropriate development plan. It grew with contradictions. The giant industrial city has crowded slums, traffic jams, floods and power cuts. It is here that hand-drawn rickshaws and the ultra-modern underground metro train co-exist. In the otherwise degraded urban habitat there are a few large green patches. The botanical garden with its rich plant diversity and serene environment shelters interesting fauna. The Maidan spread over 3 Sq. Km. area was once a thick-forested patch, which was cleared and developed as a large park for sports, recreation and gatherings. The region still has some wildlife, the proof of which was seen during a recent cricket test match at the Eden Gardens when a Palm Civet meandered around for quite sometime to supervise the performance of the Indian players! The Calcutta Zoo sprawling over 16 hectares is the largest in Asia. Apart from captive animals, the diverse vegetation shelters a lot of birds. The zoo lake also attracts migratory birds during winter. Rabindra Sarovar, formed by two large lakes and surrounding natural vegetation and palms is also an interesting urban feature. The suburbs and the outskirts of Kolkata present an interesting landscape dotted with coconut palms and small ponds. It is interesting to note that there are fisheries that run of Kolkata’s sewage ponds. The Hooghly River is heavily polluted, however there are a few saline lakes with interesting aquatic vegetation and fauna. Kolkata has potential of rejuvenation with appropriate and planned development strategy. After all, the city is located on the backdrop of the Sundarbans and Jaldapara, which are unique nature reserves in the country.

3. CHENNAI

Chennai is the fourth largest metropolis of the country today and the state capital of Tamilnadu. Situated on the east coast of India, on the Bay of Bengal, it has low and flat terrain and typical coastal climate, hot and humid with a long monsoon. The city evolved during British rule as a major commercial and industrial town of south India. It became

famous for the leather industry. The natural ecosystem used to be interesting with littoral swamp forests along the northern coast whereas tropical dry evergreen forest on the south. The urbanisation process has destroyed most of these habitats leaving a few remnant patches only as specimens. Chennai boasts of having the second largest beach in the world, which still retains a few nesting sites of endangered sea turtles. The interesting natural features are two rivers, Coovam and Adyar flowing through the city. However, poor development strategy has ruined the excellent natural setting of Chennai. Poor sanitation in this low-lying region has resulted in environmental and health hazards. There are a few human-made interesting features, the historic Buckingham canal running from north to south on the eastern side of the city, large green areas on the waterfront of the lagoons on the mouths of both the rivers, a large horticultural park. There is a crocodile bank and a snake park on the outskirts. However, the most interesting feature of Chennai with respect to the biodiversity is the small, protected forest within the city, the Guindy National Park. This semi-natural forest hosts wild animals like spotted deer, blackbuck, civet, jackal, monkeys, reptiles and good number of birds. It also has a snake park and a reptile house. However under development pressure, this forest has shrunk to 270 hectares from the original 500 hectares, resulting in numerous ecological problems for the National Park itself. Some natural patches of the threatened dry evergreen forests of southeast India are found in the campuses of the Madras Christian College, Theosophical Society and IIT Madras. The outskirts of the Chennai metropolis represent rural and natural setting. There are interesting wetlands on the outskirts, Poondi reservoir, Pulicat Lake and Vedantangal waterbird sanctuary (protected since 1798!) which shelters a large number of resident birds and also attracts migrants in winter. The Development of a comprehensive Regional Plan for Chennai with emphasis on biodiversity could help this growing metropolis to become environmentally sustainable.

4. HYDERABAD

Hyderabad, the state capital of Andhra Pradesh is competing closely with Bangalore to be the 5th largest and *the* Hi-tech city of India. Hyderabad – Secunderabad is a twin city configuration evolved during the last around 500 years. However the region shows the archaeological evidence of an earlier civilisation dating back to the megalithic period. Situated on the eastern part of the Deccan Plateau, Hyderabad has an extreme and dry climate with moderate rainfall. The natural ecosystem consists of undulated topography with bouldery hills having tropical thorn forest and tropical dry deciduous forest in the distant surroundings. Like all the big cities, the original natural vegetation has vanished within the city limits. Hyderabad received a boost during the last decade due to the keen attention and professional approach of the government. There has been a concentrated effort for a planned development of the region. General systematic planning strategy by the Hyderabad Urban Development Authority (HUDA) has helped in the improvement of the city's environment to some extent. However, the main focus is on the commercial and industrial development. Not much thought is given to ecology and biodiversity conservation. The important natural features in Hyderabad are Husain Sagar fed by the river Kalavar on the north, the Musi River that separates the twin cities of Secunderabad and Hyderabad, Golconda hill fort on the east, several small bouldery hills and lakes. There are large parks like Nehru Zoological Park, Bagh-e-Aam and Fateh Maidan and

several small parks all around the Husain Sagar. The water bodies and the exotic plantation have provided some biodiversity to the city. A large grass farm and Dulpallli reserved forest on the northern outskirts and Osman and Himayath Sagar (large lakes supplying water to the city) on the southwest outskirts are interesting large spaces important for the city's biodiversity. The fast growing industrialisation of Hyderabad has already started showing the adverse environmental impacts in terms of air and water pollution. Uncontrolled quarrying is destroying natural rocks / boulders of Hyderabad's unique landscape. The sewage/ garbage disposal systems are also not adequate. We can hope that the Hi-tech city will invest at least a part of its expertise and finances to improve the natural environment of the city.

5. OTHER URBAN CENTRES

After independence, the growth of various urban centres, particularly the capital cities of various states, has been tremendous. In most of the cases, it is unplanned and uncontrolled with focus only on commercialisation and industrialisation. The concern for the natural environment and biodiversity is non-existent. The environment in the cities like Guwahati in Assam, Gangtok in Sikkim, Panaji in Goa and Thiruvananthapuram in Kerala are degraded in spite of otherwise excellent natural setting in the states.

Historically important cities like Jaipur, Bhopal, Patna, Surat, Ahmedabad, Pune also face environmental degradation. In contrast, some of the planned industrial towns like Jamshedpur have reasonable green cover and clean environment. There are occasional spurts of environmental concerns from a few dynamic administrators resulting in sporadic improvements like in Surat, Delhi, Thane, Nagpur.

An innovative project, 'Kottayam – Kumarakom Ecocity Project' has been recently proposed jointly by the Kottayam municipality, surrounding 8 gram panchayats, state and central government in Kerala. A comprehensive project hopes to tackle the issues related to socio-economics, environment, land use, sustainable development, eco management of wetlands, infrastructure etc. The ambitious 500 crore project is a good indicator of a novel approach in town planning. We have to wait and watch its progress.

However general apathy of citizens towards environment and development issues is also considerable. The cities of Mumbai and Bangalore have alert groups and individuals who act as environmental caretakers. But otherwise enlightened metropolitan cities like Kolkata, Chennai and Hyderabad show insensitivity and there is hardly any participation of people in the nature conservation movement. The environmental assessment of our fast growing urban centres requires regular, scientific and systematic monitoring of various parameters, which can help in the strategic planning for our diverse ecological situations. The surveys carried out by the government departments like the Zoological Survey of India, Botanical Survey of India generally do not cover the urban areas. Even the studies carried out by various universities and educational institutes rarely cover the urban areas. However, it is interesting that a few amateur groups have been regularly monitoring the natural history of different urban centres. This has helped in knowing the changing pattern of our urban biodiversity. There is interesting documentation available for the cities of Mumbai, Pune, Kolhapur, Bangalore, Delhi, Hyderabad etc. The overall gloomy

environmental scenario in all our cities is mainly due to insensitivity and lack of understanding of biodiversity amongst the planners, administrators and decision makers on one hand and the lethargy and ignorance of the citizens on the other hand.

ANNEXURE – 5

LIST OF A FEW ENVIRONMENTAL VOLUNTARY & NON GOVERNMENTAL ORGANISATIONS IN MUMBAI & BANGALORE

MUMBAI:

Bombay Environment Action Group
Bombay First
Bombay Natural History Society
Clean Air Island
Conservation Education Centre
Friends of Trees
Green Bombay
Hariyali
HOPE
Lokvidnyan Sanghatana
Marathi Vidnyan Parishad
Panvel Nisarg Mitra
Parisar
Save Bombay Committee
Save Sahyadri
World Wide Fund for Nature

BANGALORE:

Ashoka Trust for Research in Environment & Ecology (ATREE)
Birdwatchers' Field Club of Bangalore
Centre for Ecological Sciences (CES) at the Indian Institute of Science
Centre for Environmental Education (CEE)
Centre for Interdisciplinary Studies in Environment & Development
Environment Support Group
Foundation for Nature Exploration & Environmental Conservation
Institute for Natural Resources Cons., Education, Research and Training
(INCERT)
Karnataka Environmental Research Foundation
Local Environment Action Forum
Naturewatch
Wildlife Aware Nature Club
World Wide Fund for Nature (WWF)

REFERENCES

- Abdulali H, 1975, *Checklists of Birds of Bombay/ National Park/ Maharashtra*, BNHS, Mumbai
- Adams LW, Leedy DL, 1987, *Integrating Man and Nature in the Metropolitan Environment*, National Institute of Urban Wildlife, Columbia
- Adams LW, Leedy DL, 1991, *Wildlife Conservation in Metropolitan Environments*, National Institute of Urban Wildlife, Columbia
- Baines C, 1986, *The Wild Side of Town*, Elm Tree Books & BBC Publications, London
- BATF, 2000 onwards, *Study Reports*, Bangalore
- Birdwatchers' Field Club of Bangalore, 1994, *Checklist of Birds of Bangalore*
- BNHS, 1900 onwards, *Journals of the BNHS*
- Botkin DB, Beveridge CE, 1990, *Cities as Environments, Urban Ecosystems*
- Boyden S, Millar S, Newcombe K, O'Neill B, 1981, *The Ecology of a City and its People: The Case of Hong Kong*, Australian National University Press, Canberra
- Bradley GA, 1995, *Urban Forest Landscapes: Integrating Multidisciplinary perspectives*, University of Washington Press
- Brady RF, Tobias T, Eagles PFJ, Ohrner R, Micak J, 1979, *A typology for the urban ecosystem and its relationship to larger biogeographical landuse units, Urban Ecology*
- Breuste J, Feldman H, Uhlmann O, 1998, *Urban Ecology*, Berlin: Springer-Verlag
- CIDCO, 1973, *New Bombay Development Plan*
- Cooke T, 1901(Reprinted 1967), *Flora of Bombay*, Botanical Survey of India, Kolkata
- Correa C, 1985, *The New Landscape*, The Book Society of India
- De Boer J, Dijst M, 1998, *Urban Development and environmental policy objectives*
- Deelstra T, 1998, *Towards ecological sustainable cities: strategies, models and tools*
- Dorney RS, 1977, *Biophysical and cultural-historical land classification & mapping for Canadian urban & urbanising landscapes*, Environ, Canada
- Dwivedi S, Mehrotra R, 1995, *Bombay The Cities Within*, India Book House, Mumbai
- Flores A, Pickett STA, Zipperer WC, Pouyat RV, Pirani R, 1997, *Application of ecological concepts to regional planning*, Landscape & Urban Planning
- Flores A, Pickett STA, Zipperer WC, Pouyat RV, Pirani R, 1997, *Adopting a modern ecological view of the metropolitan landscape*, Landscape & Urban Planning
- Forrest GW, 1903, *Cities of India – Past & Present*, A Constant, London
- Ghosh D, 1993, *Towards sustainable development of the Calcutta wetlands*, The Ramsar Library, Switzerland
- Govt. of Karnataka, 1984, *The Comprehensive Dev. Plan for Bangalore Metropolitan Region*
- Govt. of Maharashtra, 19 , *Gazetteers of Bombay, Thane, Raygad*
- Govt. of Maharashtra, 1990, *District Development Plan, Thane & Raygad*
- Govt.of Karnataka, 19 , *Gazetteers of Bangalore, Karnataka*
- Grimm NB, Grove JM, Pickett STA, Redman CL, 2000, *Integrated approaches to long-term studies of urban ecological systems*, BioScience
- Grove JM, Burch WR Jr, 1997, *A social ecology approach and application of urban ecosystem and landscape analysis*, *Urban Ecosystem*
- Hoover et al, 1959, *Anatomy of a metropolis*

- Hough M, 1995, *Cities and Natural Process*, Routledge, London
- Howard, Ebenezer, 1946, *Garden Cities of Tomorrow*
- Indian Institute of Architects, 1945 onwards, *Journals of the IIA*
- Issar TP, 19 , *Trees of Bangalore*
- Jacobs J, 1962, *The Death and Life of Great American Cities: The Failure of Town Planning*, Random House, New York
- Jaipaul M, 19 , *Bangalore- History*
- Kalpavriksh, 1991, *The Delhi Ridge Forest*, Kalpavriksh, New Delhi
- Karthikeyan S, WWF-Bangalore, 1999, *The Fauna of Bangalore*, WWF-I, Karnataka, Bangalore
- Kothari A, Rao S, 1997, *Saving Delhi's Biodiversity*, State Fauna Series, ZSI, Kolkata
- Krishna MB et al, 1996, *Water Birds & Wetlands of Bangalore*
- Laul A, 2001, *Sustainable City Strategies for Developing Countries*, JIIA, Mumbai
- Laurie IC, 1979, *Nature in Cities*, John Wiley, New York
- Marathi Vidnyan Parishad, 2000, *Smaranika-Mumbai Today & Tomorrow*
- Mayur R, 1985, *The Problems and Future of Bombay*, Urban Development Institute
- MCGB, 1981, *Policy Plan Greater Bombay – 1981-2001*
- McHarg I, 1969, *Design with Nature*, Garden City, NJ
- MMRDA, 1995, *Regional Plan for MMR – 1996 – 2011*
- Monga S, 2000, *City Forest*
- Nagashima K, 2001, *From Decocity Towards Ecocity*, JIIA, Mumbai
- National Atlas Organisation, 1976, *Forest Atlas of India*, Survey of India, Dehradun
- O'Riordan T, Stoll-Kleemann S, 2002, *Biodiversity, Sustainability & Human Communities*, Cambridge University Press
- Pickett STA, Burch WR Jr, Dalton SD, Foresman TW, 1997, *Integrated urban ecosystem research, Urban Ecosystems*
- Pickett STA, Cadenasso ML, Grove JM, Nilon CH, Pouyat RV, Zipperer WC, Costanza R, 2001, *Urban Ecological Systems*, Annual Review Ecological Systems
- Platt RH, Rowan AR, Muick PC, 1994, *The Ecological City*, The University of Massachusetts Press, Amherst
- Rahm B, 2000, *The Pune Green Guide*, Kalpavriksh, Pune
- Rajesh R, Rao S, 1995, *The Little Green Book*, Kalpavriksh, New Delhi
- Ramakrishnan PS, Rai RK, Katwal RPS, Mehndiratta S, 2002, *Traditional Ecological Knowledge for Managing Biosphere Reserves in South & Central Asian Region*, UNESCO & Oxford, New Delhi
- Ramegowda, 1972(Revised 1986), *Urban and Regional Planning*
- RANWA, 2000, *Biodiversity Profile of an Urban Area*, Journal of Ecological Society, Pune
- Rau, 1986, *Report- Preservation of Tanks in Bangalore Metropolitan Region*, Govt. of Karnataka
- Rau et al, 1993, *Report- Beautification of Bangalore*, Govt. of Karnataka
- Rebele F., 1994, *Urban Ecology and special features of urban ecosystems*
- Reddy Y., 1996, *Green Belt for Bangalore*
- Ricciuti ER, 1984, *The New York City Wildlife Guide*, Nick Lyons Books, New York
- Schiffer L., Cooke J., 1989, *The Exploding City*, St. Martin's Press, New York

- Singh, 1964, *Bangalore- an Urban Survey*
- Singh I., 2002, *Biodiversity Strategy & Action Plan for Chandigarh, U.T.*, Dept. of Environment, Chandigarh Administration
- Spirn AW, 1984, *The Granite Garden: Urban Nature & Human Design*, Basic Books, New York
- Spreiregen & Paul, 1968, *The Modern Metropolis*
- Sukkop H, 1990, *Urban Ecology: Plants & Plant Communities in Urban Environments*, SPB Academy, Hague
- Sukkop H, Werner P, 1982, *Nature in Cities*, Council of Europe, Strasbourg (France)
- Tansley AG, 1935, *The use and abuse of vegetational concepts and terms*, Ecology
- The Hindu, 2001, *Cities – Folio*
- The Hindu, 2001, *Earthscapes – Folio*
- The Hindu, 2001, *Survey of Environment-2001*
- Turner BL II, Clark WC, Kates RW, Richards JF, Matthews JT, Meyer WB, 1990, *The Earth as transformed by Human Action*, Cambridge University Press, New York
- U.N., 1974, *Human Settlements-The Environmental Challenge*
- UNPD, 1997a, *Urban and Rural Areas: 1950-2030*, UN, New York
- UNPD, 1997b, *Urban Agglomerations: 1950-2015*, UN, New York
- Vitousek PM, Mooney HA, Lubchenco J, Melillo J, 1997, *Human Domination of Earth's Ecosystem*, Science
- VNHS, 2002, *Draft Report- Nagpur Sub-state Site Biodiversity Strategy & Action Plan*
- WANC, 2002, *Draft Report – Karnataka State Biodiversity Strategy & Action Plan*
- Ward B, 1976, *The Home of Man*, W. W. Norton & Co.
- Whyte WH, 1968, *The Last Landscape*, Doubleday, New York
- Wittig R, 1998, *Urban Development and the integration of nature*
- World Bank, 1980, *The World Development Report*
- Zimmy H, 1990, *Ecology of urbanised systems-problems and research in Poland*, Polish Academy of Science