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INTERNATIONAL CONFERENCE FOR
INTEGRATING URBAN KNOWLEDGE & PRACTICE
GOTHENBURG, SWEDEN. MAY 29 - JUNE 3, 2005

Final Programme





LIFE IN THE
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Title of paper

A DESIGN FOR ECO-SUSTAINABILITY: LESSONS FROM A STRESSED
ENVIRONMENT IN MUMBAI

Paper (maximum 4000-5000 words including references)

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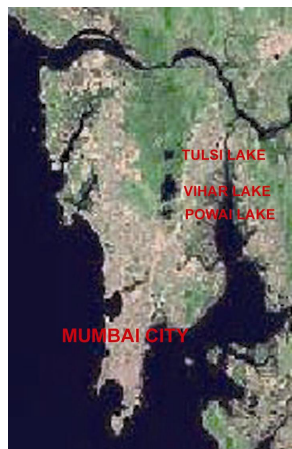
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A DESIGN FOR ECO-SUSTAINABILITY: LESSONS FROM A STRESSED ENVIRONMENT IN MUMBAI

Introduction:

The importance of environmental sustainability is now well recognized even by the developing countries. However, the economic compulsions that have become even stronger in the face of the globalization, the cities are facing intense competitions to attract international capital and corporate offices leading to policies where environmental well being gets a lower priority. The current focus of planning in the city of Mumbai on the proposals like creation of new Central Business Districts, Information Technology parks, luxury housing townships, flyovers and freeways, shopping malls, golf clubs, multiplexes and other high-end entertainment centers, all designed to project an up market and global image illustrates the point. In the process, the city environment is under strain as never before, but unfortunately that does not figure in any calculation. Assessment of the impact of development projects on the ecosystems is now absolutely critical besides the technical, economic and political factors.

In this regard a study for the conservation of a natural landscape and valuable water resources in a part of Mumbai in the face of the onslaught of the building activities was recently completed by the Design Cell of Kamla Raheja Institute for Architecture and Environmental Studies and commissioned by the MMR Environment Improvement Society. The paper presents its salient features and the recommendations for promoting eco-sustainability. The concept of environmental planning developed in this paper is natural evolution of a more comprehensive and strategic approach to environmental management.



THE GREEN ZONE IN QUESTION



THE TRANSPORTATION NETWORK OF THE CITY

THE ABOVE SATELLITE IMAGE SHOWS THE LAKES AS A PART OF A DENSE GREEN ZONE, ALMOST THE ONLY ONE FOR THE CITY OF MUMBAI. A CLOSER LOOK AT THE NATURAL FEATURES, REVEAL THE FACT THAT ALL THE LAKES ARE A PART OF ONE LARGE ECO-SYSTEM.

THE SECOND IMAGE SHOWS THE TWO MAJOR TRANSPORTATION CORRIDORS OF THE IN THE NORTH SOUTH DIRECTION FOR THE WESTERN AND EASTERN SUBURBS OF THE CITY.

Introduction to the stressed environment –Mumbai’s fresh water lakes region

The almost contiguous lakes of Tulsi, Vihar and Powai and their immediate surroundings constitute the study area. This region, which is about 50 sq. km. in area, serves as the vital lungs of suburban Mumbai. It comprises a rich natural landscape bestowed with sweeping valleys, dense vegetation and an interweaving of streams and rivers evolving into an ecosystem of significant value to the city. The study area is in fact the last link to a larger ecosystem of fresh water lakes of the city. Mumbai, originally a cluster of seven islands inhabited by small fishing and farming communities, was taken over by the East India Company in 1668. This marked the beginning of its development as a city. Residents at that time drew water from wells and tanks but this limited supply failed to keep up with the rapid increase in demand. In the absence of perennial rivers, harnessing of surface water became inevitable. In 1845, a committee was appointed by the government to search for a suitable site to impound the monsoon run-off. The lakes - Tulsi, Vihar and Powai - as they exist today in the geomorphic set-up are a result of impounding River Mithi by constructing masonry dams across hillocks.

Vihar was Mumbai’s first piped water supply scheme and was commissioned in 1860. Three earthen dams and stone masonry overflow sections were constructed to impound the Mithi River 20 km north of then Mumbai city. The impoundage is now called Vihar Lake. It has a surface area of 700 hectares and a catchment of 1896 hectares. With an average depth of 23 m, it has a gross storage of FSL of 9200 million gallons. The Lake has a maximum depth of about 34 m and minimum of 12 m and supplies 12 million gallons per day to Greater Mumbai. The catchment and water spread area of Vihar is largest among the three lakes, but the forest density is much lesser than that of Tulsi Lake, making it more prone to soil erosion. The major part of the Lake inflow is from seasonal precipitation, i.e. rain water collected directly or streams and run-offs that flow in during the monsoons. The overflow during the monsoons joins to form the Mithi River. Although a large area of the catchment is protected, intrusions by human settlements are frequent, with people from surrounding squatters using the lake water for washing, bathing and other domestic use.

In 1873, it was decided to develop a back up of the Vihar Lake, thus the **Tulsi Lake**, again on the River Mithi and upstream of Vihar, was envisaged. Located up-stream of Vihar, Tulsi stores the water of streams and monsoon runoff of the surrounding hills. It has a surface area of 135 hectares and a catchment of 676 hectares. With an average depth of 12 m, it has a gross storage at FSL of 2294 million gallons and supplies 4 million gallons per day to Greater Mumbai. Tulsi was designed to allow its overflow into Vihar Lake located to its south. Its watershed characteristics are marked by hillocks on all sides. The vegetation on the hill slopes is thick and lush. The vegetation in the catchment is undisturbed and Tulsi forest is a near-ideal condition of mixed moist deciduous. The entire catchment is protected by the Municipal Council of Greater Bombay and Sanjay Gandhi National Park authority.

The **Powai** valley scheme was taken up in 1890 on a tributary of the Mithi River as an emergency measure to mitigate the anticipated water famine in 1891. Located immediately to the south east to Vihar, has a surface area of 210 hectares and a catchment of 668 hectares. With an average depth of 5 m, it has a gross storage at FSL of 1200 million gallons. The lake has a maximum depth of about 6 m and minimum of 3 m and stores water of non-potable purpose. The Powai Lake surround is not a part of Sanjay Gandhi National Park and as a result has been rapidly urbanized. Today the Powai catchment consists mainly of built-up-land. Water depth in the Lake has reduced to

*) Including illustrations and references

as little as 1 ft in some places, due to the large amount of sewage and silt received from surrounding residential and industrial areas, along with a considerable amount of domestic waste water that enters into it. The overflow of Powai forms the Mithi River.

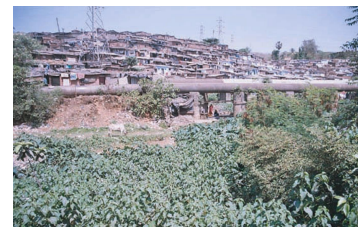
It is evident from varied physiographic studies that Tulsi, Vihar and Powai are part of one ecosystem. They are a series of connected lakes, one overflowing into the other, and not isolated water masses. The original catchment areas of the lakes were highly undulating with few strips of plain land, with lateritic soil which is extremely vulnerable to erosion and laterisation. The unique geomorphologic terrains of three lake systems provide varied habitats ranging from hilly mountains to aquatic region. This supports diverse fauna and rich avifauna, not only resident, but migratory species as well. All of the flora and fauna thriving here are rich and diverse enough to require special protection.



VIEW OF DEVELOPMENT IN CATCHMENT AREA OF POWAI LAKE



DEVELOPMENT ON WETLANDS IN BETWEEN THE LAKES



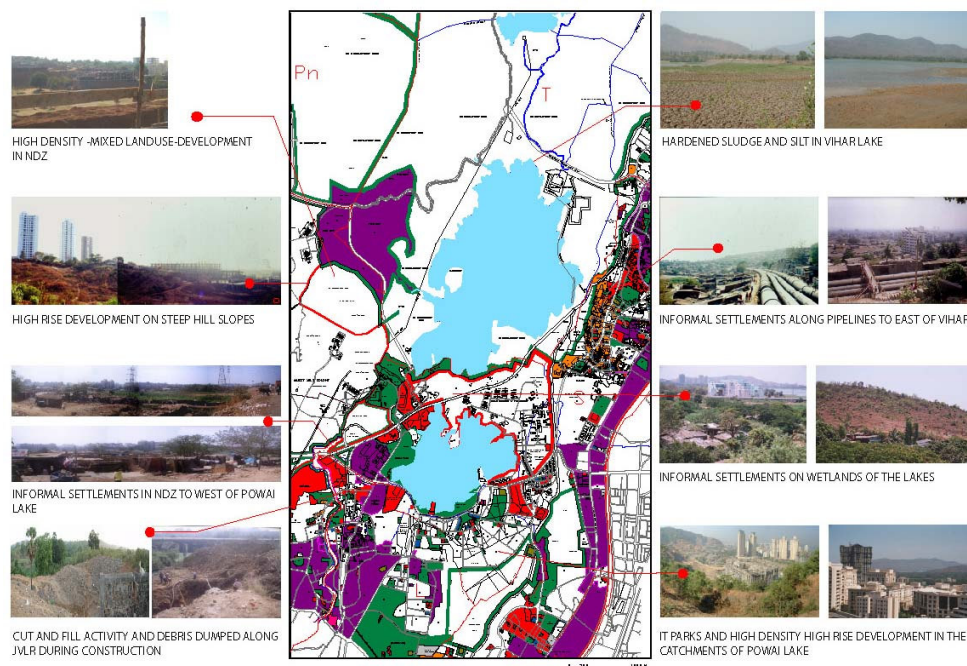
INFORMAL SETTLEMENTS ON HILL SLOPES

This major green belt of the city lies sandwiched in between the two transport corridors the Western Express Highway on the West and the Lal Bahadur Shastri road on the East. This area is under severe threat today with pressures of rapid haphazard development, high and growing population density, relaxation of the building restrictions of no-development zones, and the development of fast moving traffic systems through this area – along with the growth of pollution, encroachments, deforestation for fuel and economic gains, and destruction of natural landforms for real estate development -- all leading to the catastrophic depletion of this, the largest and most precious of the vanishing green zones of the city. The lakes of this region are obviously in especial danger, for the susceptibility of freshwater bodies in urban areas to extensive and accelerated deterioration (eutrophication), especially in watersheds undergoing intense development, is well known. Though Powai lies on the outskirts of forested land and forces of urbanization have altered surroundings of Powai to a great extent, the region yet has potential to support a rich and bio-diverse ecosystem as in the Sanjay Gandhi National Park (the only national park in a city towards the north of Vihar lake). Developmental pressures have however resulted in irreversible destruction of the hills nearby, altering the topography of the catchment and stripping it off its fertile soil and natural vegetative cover. The lakes and their catchments form key factors of the natural rainwater harvesting system. The reduction in the water holding capacity of the lakes due to siltation is an imminent threat. While the Tulsi lake may still appear relatively

*) Including illustrations and references

undisturbed thanks to the protected forest land around it, the Vihar catchment area is under increasing pressure today -- the rapid deterioration of Powai in recent years, its sharp decrease in size and water quality, as also the expansive building developments all over its catchment area is a warning that it may soon be too late to save the lakes.

With huge amounts of public investment having already gone into these water bodies, they cannot be allowed to die; but furthering their life demands the utmost importance being placed on protecting the surrounding catchment areas (wetlands, forests, hill slopes etc) with adequate soil and water conservation and forestation methods. Protection of these catchments is a must to protect our water, both qualitatively and quantitatively.



Critical analysis of the existing situation:

The initial surveys through the area revealed an ecologically incongruous pattern of land uses around the lakes. Development totally oblivious to the principles of landscape conservation continues with exponential speed in this eco-sensitive zone. Hence developing a tool to evaluate the impact of these land uses in relation to the natural resources of the region became the prime concern for the study. For this it was essential to first examine the land to reveal the intrinsic opportunities for and constraints on urban development. 'Physiographic determinism' was employed as a tool to evaluate the extent of the negative impact on the environment, by superimposing the various physiographic features on the land use plans and simultaneously extracting and delayering to establish the intrinsic suitability of land for various land uses.

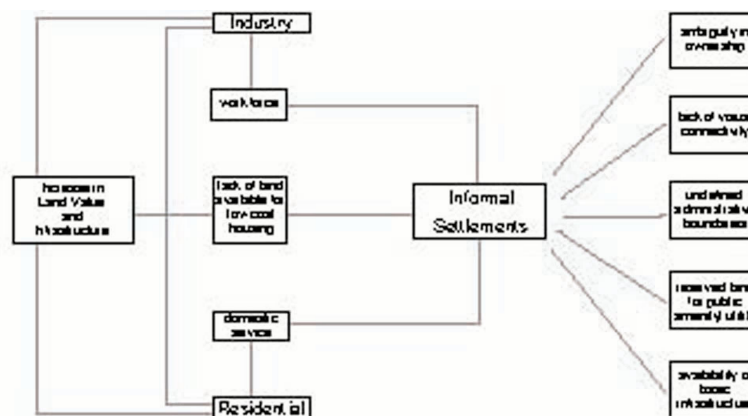
After the study area was delineated, various maps like the Development Plan (DP) and the Topographic features of the area were studied in detail and analyzed. Maps for the

*) Including illustrations and references

area were generated by superimposing the various physiographic features like water bodies, streams, catchments, landforms and vegetation covers and each studied and analysed with respect to the development plans on each other. These generated maps, thus revealed various facts about the inherent qualities of the region regarding landforms, tree covers etc. and also showed the uniqueness of the delineated study area as compared to the rest of the areas within city limits. This whole study area has unique eco-sensitive physiographic features which should have been protected, but because of the lack of natural features in the DP, developments have come not only in the lake surrounds, but some even abutting the lake edges. This development trend has had negative impacts on the lakes themselves and their ecology.

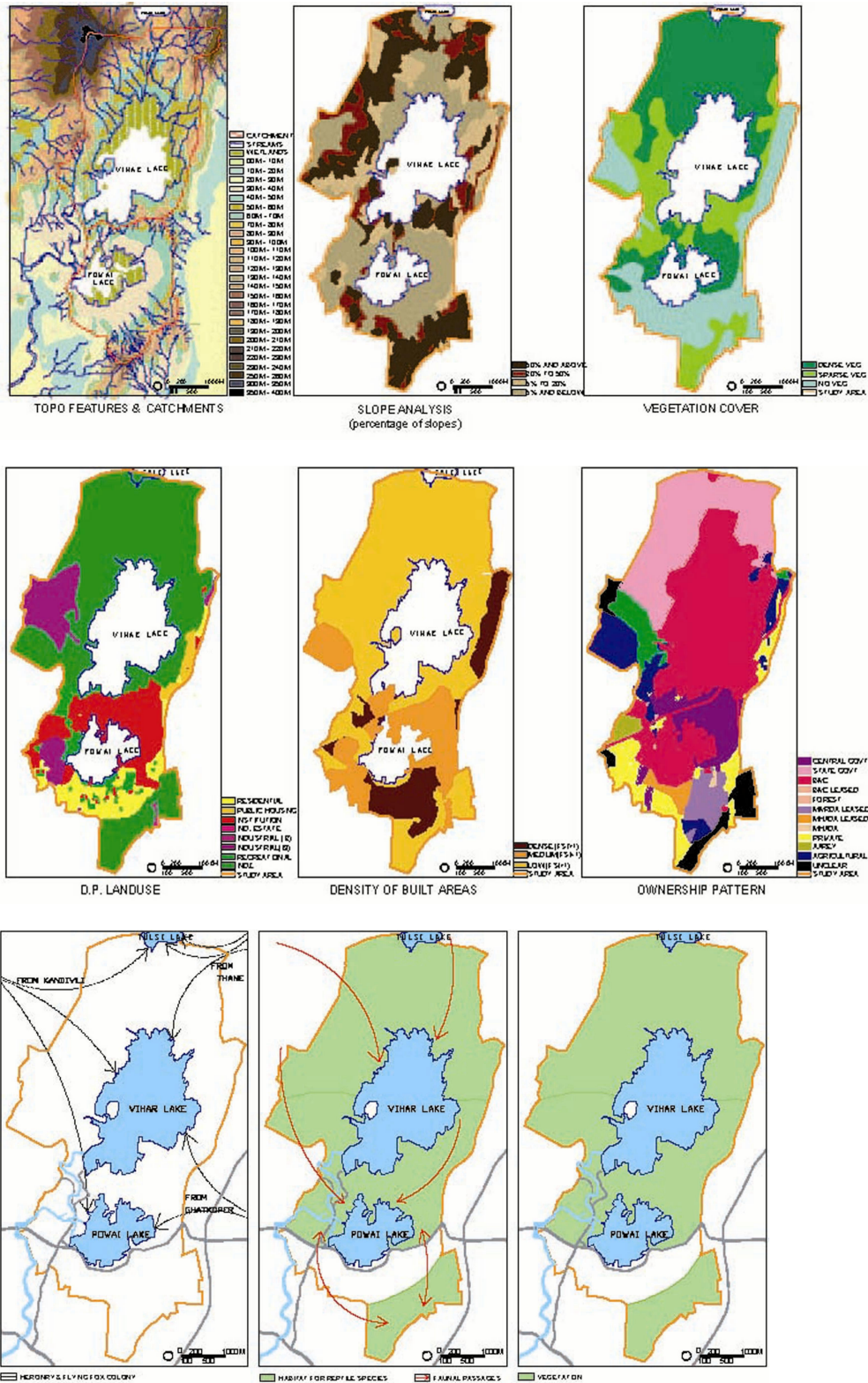
The use of such an ecological base map for impact assessment is in direct contrast to the current bulk planning and assessment process. The study clearly identifies the interfering elements that have had negative impacts on the visual and spatial qualities in the region and have disturbed the ecological cycles that hold great value in this eco-zone. Environmental systems are composed of complex inter-relationships of linked individual components and subsystems. Consequently, impacts on one component may have effects on other components, some of which may be spatially distant from the component immediately affected. This particular study emphasizes on the environmental impacts only on the immediate peripheral region of the lakes.

Although there have been many apparently beneficial socio-economic trends generated by recent urban development in this area, like the increase in housing stock (though primarily for the upper income groups), increase in job opportunities, increase in per capita incomes, and increased generation of foreign exchange, the study has had to assess the potential adverse effects of this same development on the environment. The causes of environmental impacts have been identified, and any specific causes of likely future ones have also been identified and assessed. The assessment carried out has been of the cumulative effects rather than for individual projects because the established use of EIA excludes the additive impacts or the impacts of secondary developments, for example, the proliferation of retail and informal housing developments which follow on from the opening of a new Information Technology Park or hotel. The Project level EIA tend to focus on specifically defined types of large projects, which by virtue of their size and location are considered likely to have significant environmental impacts. This approach has the disadvantage of ignoring smaller developments which may in themselves have relatively minor impacts but which add up to a significant collective effect.



ANALYTICAL DIAGRAM SHOWING GROWTH OF INFORMAL SETTLEMENTS

*) Including illustrations and references



*) Including illustrations and references

Critical review of the existing legal provisions related to the lake region

Through the study of the lake region a critical review of the existing legal provisions for the environmental protection and conservation and the development control regulations is undertaken too. The shortcomings and limitations of the Development Control Rules (DCR) have made it easy for developers to ignore environmental concerns while not actually violating the law, which in turn has caused catastrophic damage to the lake ecology. The present approaches to land use planning primarily through zoning ordinances and subdivision regulations have led to a lot of shortcomings and our failure to address these shortcomings which have been the major causes of the detrimental effects on the environment. The policy framework in place needs to be addressed.

Over the past decades, the local government and their implementing agencies have had only peripheral involvement in the environmental protection strategies devised by the Central and State Regulators, even though these local bodies are more responsible for the resultant quality of our natural environment than all the Central and State environmental regulations combined. Long before the Central and the State agencies actually review projects and issue regulatory measures the local government is well ahead prescribing almost every kind of developmental detail, like how residential, commercial buildings, info-tech parks etc. are to be located, which water supplies are to be used for these developments and where the local roadways are to be placed, all of this determining the resulting landscape. According to the Supreme Court directive passed in 1996, it is the responsibility of the developer to ensure that the construction is environmentally benign. Despite this, environmental considerations are almost always overlooked.

The Development Control Rules and Regulations do incorporate measures to minimize the environmental damage. And these are certainly well intentioned. But there is a dark side to their application. The scope of the measures rarely extends beyond the boundaries of each individual project site. These mitigation measures embodied in the local ordinances are directed towards on-site control of acknowledged negative environmental impacts. These mitigations give a false sense of assurance that such impacts can be readily ameliorated on each site; and even if they cannot, the effects on the natural environment are alleged to be inconsequential.

Over the years, several concerned citizens have formed varied interest groups to protect the Powai Lake and/or its environment. The work of these groups clearly indicates there is will amongst the local citizens to protect the environment. But without an overall master plan for the lake region, these measures remain isolated and inevitably limited. Hence it becomes all the more important to get the entire region under one head or one command centre, which would be sensitive to the environment and the conservation and survival of the lakes and its surroundings. The prime concern would be to see that development and environment do not conflict with each other but go hand in hand.

A step towards integrating the ecological principles into planning

The entire initial surveys of the study area indicate that it is imperative to develop predictive tools to discriminate between alternative plans and assess them with respect to conservation aims, sustainability and effectiveness. The integration of the ecology of natural and man-made structures in the planning process remains to be explored. Evaluating environmental losses and gains is one important aspect of planning that is increasingly in need of further elaboration.

Present land use regulations neither recognize natural processes, nor allocate responsibility to the developer. The Environment Impact Assessment (EIA) for projects, today reduced to the simplest terms like height, volume, density, alignment, etc. along with a thorough cost benefit analysis, needs to urgently incorporate resource values, social values and aesthetic values based on natural processes.

*) Including illustrations and references

Conservation of natural values is usually a function first disrupted by the intensification of human land use. Incorporating environmental concerns into planning is not easy; complex problems get thrown up, resolving which can pose a massive challenge for the authorities. But mandatory and effective Environment Assessment and taking into account environmental concerns in local land use planning is the critical need of the hour. The situation is exacerbated by the fact that social attitudes towards nature are marked by ignorance, negligence and often downright callousness. The result is that despite nature's many warnings, the pollution and destruction of the natural environment continues intensively and extensively in this region.

The recent spate of leopard attacks in the surrounding residential areas is testimony to the fact that development has been ecologically incongruous to the environmental boundaries. The Development Plan has not taken into consideration or incorporated the eco-sensitivity of the area before allotting land uses for it.

There is an urgent demand for an informed and long-sighted management of the natural environment and resources within the city, and a need for concerted efforts to radically improve pertinent knowledge, methods and techniques. The recently published works of Ian Mcharg, Lars Nyberg, William Honachefsky, Lyle and Roy Winter continue to demonstrate that there is considerable wisdom in planning our land use around the ecological constraints of the land. Problems of modern landscape management also ask for an ecological resource approach, planning for flows of energy, water nutrients and materials as an integrated part of land use and physical planning. (Tjillanji, Landscape Ecology of a Stressed Environment, ed. by Claire C vos and Paul Opdam, 1993)

One Eco-Region, one integrated approach: Need for a lake management plan

The objective here is not to oppose change, but rather to prevent the depletion of the natural wealth of the region, which unplanned and disorderly development would surely bring about. Despoliation of the environment at the present rate is unlikely to be sustainable for even a short period in the future. Intrusion into relatively undisturbed landscapes in an arbitrary manner may produce short-term values in terms of upmarket residential and entertainment spaces, and of course high returns in profits, but it is also resulting in considerable and almost irreversible environmental damage. It is doubtful whether most of the damage already inflicted in the lake region so far can ever be remedied. The growing population must however be planned for; this growth along with accompanying land use needs to be directed to areas that are better suited for it. Development of the Growth Projection Models for the region had to take into account existing and future urban pressures and demands, the patterns of growth that might occur in the presence and absence of an integrated plan have been simulated. The study of the area deals with various issues of ecology on one hand and developmental issues on the other hand. The GIS software aided this analysis by permitting various aspects to be overlaid simultaneously. The outputs gave an insight into the ways the development in the area has affected the lake ecology. It also revealed the areas which are sensitive and prone to despoliation and hence which need to be preserved and protected. It was also helpful in the quantitative analysis of the area.

The study area has a fragmented pattern of plots, wards and villages, owing to which monitoring, survey and administration of the area as a whole is difficult. Hence it becomes important to get the entire region under one command centre which would be sensitive to the environment and the conservation of the lakes and their surrounds. This approach has already been implemented globally as seen in the 16 lakes of the Lake District of Britain, the Lake Victoria in Kenya and the McRitchie Reservoir of Singapore (refer case studies in annexure). In fact, this concept is not alien to our country either.

*) Including illustrations and references

Under the Green Hyderabad Environment Programme, the Hyderabad Urban Development Authority has proposed to preserve and conserve 87 water bodies in the region. Similarly a Lake Conservation Authority is proposed to be formulated for the conservation and management of the Upper and Lower Lakes of Bhopal and for executing the remaining activities under the Lakes Bhopal Conservation and Management Project and maintenance activities thereafter. There is thus a clear need to have a single Lake Management Authority to impart a holistic approach to the protection of the lake region delineated in our study, through a single integrated Lake Management Plan/Zonal master plan for the region. The prime concern of a Lake Management Plan would be to see that development and environmental protection do not conflict with each other but go hand in hand.

Besides the formation of a Lake Management Authority and several other recommendations in the form of long term and short term measures proposed through the study, one of the major recommendations include the lake Buffer protection system

To understand the impact that development has on the quality of the lake water and their wetlands, it was important to study the lake edges in detail. Development has not only threatened the catchments areas, but has come right up to the lake edges and in most cases has eaten up the wetlands. It is very difficult to replace the wetlands once they are wiped out, but certain functions of the wetlands can be taken care of by artificial methods. One very important function of the wetlands is to filter the water entering the lake and maintain water quality. The limit of the edge was taken as that ribbon of land which is critical for the lake. This strip is distinguished from the rest of the watershed basin in terms of its role as a buffer to the lakes and the wetlands.

The 200m periphery is divided into two zones, each distinguished by function, width, vegetative target and allowable uses. The inner 100 m would protect physical and ecological integrity and is the minimum required to introduce any kind of biological filter. Here the vegetative target will be high and allowable uses limited to soil control measures and measures to ensure water quality. These measures will include contour trenching, pitching, retention and detention basin and boulder drains etc only. The next 100m is to act as a crucial engineered buffer between the vegetative inner buffer and outside development. Here the usage, in addition to those of the inner 100m, will be promotion of environmental awareness through nature trails. The outer 100m zone will prevent encroachment, and development beyond this 200m of the lake edge will follow the recommended guidelines. The lake periphery is thus divided into 7 sections based on important environmental issues in each section. Proposals have been developed on the base of this study, to work as corrective as well as preventive measures to help improve water quality, enhance the lake edges aesthetically and help save the biodiversity of the wetlands.

Development of effective institutions

It is essential for the development of effective institutions for biodiversity conservation. Institutions are the humanly devised constraints that shape human interaction .They structure incentives in human exchange, whether political, social, or economic and shape the way societies evolve through time. Institutions provide the framework for human actions but to be effective they have to be adaptive. That is it is necessary to frame the level of economic activity in a way that minimizes the risk of irreversible damage to the systems on which human activity depends.

This means that science's most effective contributions to sustainable consumption problems are likely to come not only from technical and natural sciences laboratories but also from practical insights of pedagogy and social psychology. In other words, our inability to deal with ecological limits is not determined by insufficient understanding of natural science of sustainability. Solid analysis and documentation of the challenges is

*) Including illustrations and references

undoubtedly required for meaningful action. However, the principal stumbling block for dealing creatively, effectively and humanely with limits are shaped by significant socio-psychological characteristics of our dominant culture. These perceptual stumbling blocks require more attention if we are to learn to live in ways that are compatible with Nature's limited capacity to regenerate itself.

The problem to be addressed in developing a strategy for biodiversity conservation is that current institutions in society, including markets do not respond to environmental feedbacks. That is many of the most important environmental factors are not recognized in the set of market prices. A value based system or market based solutions for the conservation of our natural resources would be most effective. In order to motivate the conservation of natural resources and biodiversity, the creation of economic incentives that reduce the difference between the value of biological diversity to the private individual and its value to society would be essential. To do this it is necessary to identify the major social and economic forces that are currently driving the loss of functional diversity and to create incentives to redirect those forces. Forces which result in direct reduction of biodiversity because of land use changes, landscape fragmentation. And also those forces which include inappropriate government policies, the structure of property rights, pressures of human population growth and poverty, and values of society.

In conclusion, political commitment, community action, education and awareness at all levels will be a key to more sustainable patterns of water conservation and use. The study has attempted to address the above issues in relation to Mumbai's lake region, through an in depth examination of the environment with respect to development. The integration of ecological knowledge with spatial planning is further required for sustainable environs. Economic development is inevitable and must be accommodated. But observance of conservation principles and planned growth can avert further destruction and even ensure enhancement of existing natural resources.

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**International Conference for Integrating
Urban Knowledge & Practice**
Gothenburg, Sweden. May 29 – June 3, 2005