CONSERVATION ACTION TRUST

Mumbai Carrying Capacity Draft Report

FOREWORD

July 26th 2005 the day when Mumbai was marooned was a day that no Mumbaikar shall forget. The Conservation Action Trust (CAT) convened a Concerned Citizens Commission which conducted an enquiry on the Mumbai Floods looking to find what went wrong in order to avoid/ mitigate such events in the future. This enquiry focussed on a variety of issues including drainage, sanitation and waste management, public health, housing, electricity and other infrastructural requirements of the city of Mumbai. During this study it was clearly highlighted that the need of the hour was a detailed study on the Carrying Capacity of Mumbai which will help understand the requirements of the city and help plan better for the years to come.

Carrying capacity is defined as the population level that can be supported, given the quantity of food, habitat, water and other infrastructure present. In context of the human population, carrying capacity refers to the number of individuals who can be supported in a given area within natural resource limits, and without degrading the natural social, cultural and economic environment for present and future generations. The carrying capacity for any given area is not fixed. It can be altered by improved technology, or by importing resources and exporting wastes, but mostly it is changed for the worse by pressures which accompany a population increase. For a city like Mumbai which has a continuously growing population and limited options for growth the need to study the carrying capacity is critical.

CAT took the decision to start work on this study and begun efforts to bring in a number of experts in January 2006. Since funds to support this study was not readily available CAT approached experts who were friends of the organization and who agreed to help the study voluntarily. Each one of the team selected for this exercise are experts and could be considered as authorities in their area of specialization. CAT is extremely grateful to each and every one of them for their contribution in shaping this report . They include Dr. Janki Andharia , Mr. S.D. Chawathe, Mr. Ajit Kumar Jain, Dr. Rakesh Kumar, Dr. Prasad Modak, Mr. Vidyadhar K. Phatak, Mr. Chandrasekhar Prabhu and Dr. Mahesh Datta Zingde. CAT attempted to involve members of the State Government, the Municipal Corporation of Greater Mumbai as well as the Ministry of Environment and Forests, departments for whom

a study of this nature would be essential for future planning and effective functioning. Unfortunately they were unable to participate in this study. Over seven meetings were held over the course of this study with members of this expert panel where progress on the study was periodically discussed and suggestions and guidelines on the study were also provided. The data collection for the purpose of this study was a process that took some time. Due to no ready access to data and the diverse issues that were looked at as parameters for this study the report has taken three years to put together. All data referred to in this report are secondary data collected from a variety of sources. Sources for the data have been mentioned in the references to each section. CAT also had a number of people assisting in gathering the required data as well as analyzing the same and preparing the report. They include Anand Kothari, Sneha C Prabhu, Alex Lewin and Roopali Raghavan.

This report is a draft that is being circulated amongst the authorities involved in planning and mismanaging Mumbai as well as the common man, the Mumbaikar. We invite comments and suggestions on this report from all parties before we complete the same. We sincerely hope that the authorities who were unable to participate in the study would provide some meaningful contribution at this stage to this report. This report hopes to educate the common man on the number of issues that affect their daily life in this city. We hope this will help start a discussion amongst Mumbaikars on the state of affairs of their city, what is in store in the future and to enable them be a part of the planning for their future. Will the attitude of 'Business As Usual' continue to work or do we seriously need to look for alternatives? Given the knowledge that we have we need to take a step back and decide - Are the provisions for Key Infrastructure for the comfortable daily life of an individual in this city sufficient for now? Sufficient for the future? Critical issues such as climate change and the impact that it will have on Mumbai - are they being given reasonable importance? The common man needs to decide whether Mumbai is headed in the right direction and help ensure a safe and sustainable future.

We request you to go through this report and get back to us with your comments, suggestions, thoughts and feedback on the same.

Looking forward to hearing from you.

Debi Goenka

Conservation Action Trust, 6E-1, Court Chambers, 35, New Marine Lines, Mumbai 400020

Executive Summary

- Carrying capacity
    - From ecology, how many organisms can be supported in a given area? For humans there is also the 'acceptable standard of living' component.
- Collating information from a wide range of sources
    - Academic papers, government reports, international agencies
- …for different aspects of Mumbai's carrying capacity.
    - By examining a wide range of data, it is possible to judge whether the carrying capacity of Mumbai has been exceeded for a range of issues – this is more appropriate than assigning a single figure, because there are few constants in terms of resource consumption and the availability of infrastructure.

Acknowledgements

Dr. Janki Andharia – Professor and Chairperson, Jamsetji Tata Centre for Disaster Management, Tata Institute of Social Sciences.

Mr. S.D.Chawathe – Former Honorary Director (Technical), Indian Water Works Association

Mr. Debi Goenka – Executive Trustee, Conservation Action Trust

Mr. Ajit Kumar Jain – Senior Advisor, Solid Waste Management Cell, All India Institute of Local Self Government

Dr. Rakesh Kumar – Scientist & Head, National Environmental Engineering and Research Institute

Dr. Prasad Modak – Founder Partner, Environmental Management Centre

Mr. Vidyadhar K. Phatak - Former Principal Chief Town and Country Planning Division, MMRDA

Mr. Chandrasekhar Prabhu - Architect and Former President – MHADA (Maharashtra Housing and Area Development Authority)

Dr. Mahesh Datta Zingde – Scientist-in-Charge, Regional Centre-National Institute of Oceanography

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

Mumbai, since independence, has seen dramatic change. What is currently the hub of India's commerce and finance industry, has evolved from a fishing hamlet into a colonial node, through the cradle of the textiles industry into its present state. Despite reported declines in manufacturing, the most widely held perception of Mumbai is that of a city of opportunity. Opportunity not limited to only Indians but for people from across South Asia and now even beyond. The 2001 Census of India found that there were approximately 11.9 million people living in Mumbai (16 million in the entire Mumbai Metropolitan Region)[1]. Population growth has been a key feature of Mumbai's development since independence. This growth has been attributed to both natural increase as well as migration into the city. , This ever increasing population; projected to reach between 14.1 and 15.3 million people by 2011, according to projections by the MMRDA[2]; is situated in an 'Island City' where the constrictions on space serve to limit the physical expansion of the city. The role of the municipal government in ensuring that the basic needs of Mumbaikars are met is a difficult task that requires effective planning and policy implementation. This is especially important in the context of 'Vision Mumbai', which states that the city aims to become 'World Class' by the year 2013, in terms of economic performance and the provision of public services[3].

In such a planning context, the concept of carrying capacity can be a highly useful tool. It enables an evaluation of different aspects of Mumbai's infrastructure and resources which are critical for any planning venture. The term "Carrying Capacity" originates from ecology, where it is used to define the maximum stable population of a species that can be supported within an area in the long term[4]. An increase in the population exceeding the carrying capacity of an area typically leads to environmental deterioration as a result of increased demands on habitat and resource, causing the population to eventually fall. The concept, when applied to human populations, is used to denote, the maximum population, given a certain amount of resource consumption and waste generation that can be supported within a given area, without any adverse environmental effects or without compromising the quality of life of the people living there. This basic definition also relates to the concept of sustainable development, or 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [5]. If the population

of an area consumes resources faster than they can be replenished, the environmental degradation that occurs will reduce the availability of resources in the future. Such resource scarcity is associated with increasing costs due to rising demand, which can lead to a fall in living standards as people have less disposable income. In particular, it means that poor people can suffer disproportionately if carrying capacity is exceeded, because they are less capable of adjusting to price rises in basic commodities. Due to the ability to import resources it may not be apparent within the city that carrying capacity is being exceeded [i.e. like sourcing water from outside the city, or the load shedding the rest of Maharashtra experiences to ensure power availability to Mumbai]. However, these are not ideal solutions. Such actions only serve to increase the ecological footprint of the city and spreads, its negative influence beyond its boundaries.

Carrying capacity relates therefore, to the ability of an area to support the population living there. In practice this encompasses the resources available there or those that can be realistically imported from elsewhere, the infrastructure that exists to enable a basic standard of living for the population; and the environmental condition of the area which may deteriorate due to resource exploitation or the generation of waste and pollution. Aspects that must be considered in an investigation into the carrying capacity of a region therefore include water supply, sanitation, housing provision, energy provision and environmental quality. Analysis of such issues helps identify and prioritise future planning and policy goals required to ensure that the needs of the population can be met.

This investigation seeks to identify, and where possible quantify, the extent to which the different aspects of Mumbai's resources and infrastructure are capable of supporting the population. This is of particular significance for the organisations entrusted with providing such infrastructure such as the Municipal Corporation of Greater Mumbai (MCGM). Formed in 1888, as per the Mumbai Municipal Corporation Act, MCGM has a range of statutory requirements, including 'the construction and maintenance of works for water supply and drainage… protection of the environment and planning for social and economic development' [6]. An understanding of how close these different aspects of Mumbai's infrastructure are to their respective carrying capacity is a valuable indicator of how

effectively the MCGM and other statutory bodies are providing for the needs of the population, and what is necessary to ensure that the future needs are met.

References:

1. Census of India, 2001
2. MMRDA Regional development plan 1996-2011: http://www.regionalplan-mmrda.org/
3. Bombay First; McKinsey and Co. (2003) Vision Mumbai: transforming Mumbai into a World-class city.
4. Khanna, P; Babu, R; George, S. (1999) Carrying-capacity as a basis for sustainable development: a case study of National Capital Region in India. *Progress in Planning* 52 pp101-166
5. UN (1987) Report of the World Commission on the Environment and Development
6. MCGM : Greater Mumbai City Development Plan 2005-2025(Viewed on 15May,2009):<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>

2. THE AIM OF THIS REPORT

An evaluation of the carrying capacity of different aspects of Mumbai's infrastructure will determine the existing status of the resource / infrastructure and identify the need for investment or changes in the policy governing them. By framing research around the following aims, this report seeks to evaluate the current situation, and also identify how future trends are likely to impact Mumbai's carrying capacity:

2.1. To determine whether the infrastructure of, and resources available to the city are sufficient for the needs of the current population.

It will be possible to determine whether Mumbai's carrying capacity has exceeded with reference to of different resources, as well as identify the consequences if this is the case. The 'current population' is taken to be 11.9 million people, according to the most recent census of 2001. Data is taken from this base year, although subsequent trends and events (for example if funding has been allocated to infrastructure projects) are also considered.

2.2. To determine whether the infrastructure of, and resources available to the city will be sufficient for the needs of the future population, by taking into account population growth, economic growth and climate change.

It is important to understand what aspects of Mumbai's infrastructure are most likely to come under pressure due to the projected population growth. Change consumption patterns, as well as the change in economic growth and development of the city. It is also anticipated that climate change will affect the city in a range of direct and indirect ways. Although there is much uncertainty surrounding this subject, it is an important consideration for carrying capacity.

2.3. To identify the steps that must be taken to ensure that the needs of the current and future populations can be met.

If the carrying capacity of any particular aspect of Mumbai's infrastructure / resources has been exceeded, or is likely to be exceeded in the future due to the trends noted above then action will need to be taken to avoid a fall in living

standards. This is essential to also ensure that further environmental degradation does not take place. Hence the study aims to examine the current as well as future policy measures that will best ensure that the requirements of the population can be met in a sustainable manner.

3. METHODOLOGY

A group of experts was requested to help CAT with this exercise. This expert group comprised of the following –

Dr. Janki Andharia – Professor and Chairperson, Jamsetji Tata Centre for Disaster Management, Tata Institute of Social Sciences.

Mr. S.D.Chawathe – Honorary Director (Technical), Indian Water Works Association

Mr. Debi Goenka – Executive Trustee, Conservation Action Trust

Mr. Ajit Kumar Jain – Senior Advisor, Solid Waste Management Cell, All India Institute of Local Self Government

Dr. Rakesh Kumar – Scientist & Head, National Environmental Engineering and Research Institute

Dr. Prasad Modak – Founder Partner, Environmental Management Centre

Mr. Vidyadhar K. Phatak - Retd Principal Chief Town and Country Planning Division, MMRDA

Mr. Chandrasekhar Prabhu - Architect and Former President – MHADA (Maharashtra Housing and Area Development Authority)

Dr. Mahesh Datta Zingde – Scientist-in-Charge, Regional Centre-National Institute of Oceanography

In addition, invitation letters were sent to the Secretary, Ministry of Environment and Forests, Government of India, to the Chief Secretary, Maharashtra Government, and to the Municipal Commissioner of Mumbai, requesting them to depute representatives of their organisations to help CAT with this exercise. Several meetings were held over a period of three years, and members of the CAT team, particularly Roopali Raghavan,

Senior Conservation Officer, and Sneha Prabhu, Legal Intern, were of great help with this research. Alex Lewin, an AISEC intern from UK, also helped draft this report. The assistance of the entire team is greatly appreciated, more so since it was done on a totally voluntary basis.

This investigation focussed on the collation of secondary data from a wide range of sources relating to the different aspects of Mumbai, its footprint, as well as its carrying capacity. These sources include official government publications, academic papers, as well as material from NGOs, corporations and media and journalistic sources where verified and found appropriate. The different issues covered relate to two different aspects of carrying capacity:

- ***Supporting Capacity***: This is based on the ability of both natural and capital resources (i.e. public service infrastructure) to meet the requirements of the population
- ***Assimilative Capacity***: This is based on the ability of the environment to absorb the waste produced by the population without incurring adverse effects.[1]

In practise, generating a single, absolute value for the carrying capacity of an area is not feasible. This is primarily due to the complex interrelating factors that account for human wellbeing, and the fact that it is dependent on the variable consumption levels of the population. It is further complicated by the fact that determining levels of resource exploitation that are 'sustainable' in the long term is challenging. This report therefore, deals with the ability of a range of different aspects of Mumbai's supporting and assimilative carrying capacity. The following parameters, together contribute to a basic standard of living for ordinary Mumbaikars, were selected. Justification for the selection of these parameters is mentioned in the subsequent Chapters.

- Land-use and housing
- Water supply and quality
- Transport
- Sewage and MSW
- Energy
- Education
- Healthcare

For each aspect, data was collected on its current status; for example the amount of water currently being supplied to the city. Then, by examining this in context of whether the current population of Mumbai is adequately served by the supply (both in terms of absolute quantity available and the extent of service provision across Mumbai's population), it is possible to judge whether the carrying capacity has been exceeded or not. However, this judgement remains highly subjective in some cases as there is much debate over what constitutes an 'acceptable' standard for each issue. Wherever possible, guidelines on acceptable standards have been adopted from international agencies (such as the World Health Organisation), or benchmarks comparisons have been made between Mumbai and other cities in India and the rest of the world.

In the entire exercise, 'Mumbai' is taken to be Greater Mumbai (which falls under the jurisdiction of the MCGM). A brief synopsis of the characteristics of Mumbai is provided below.

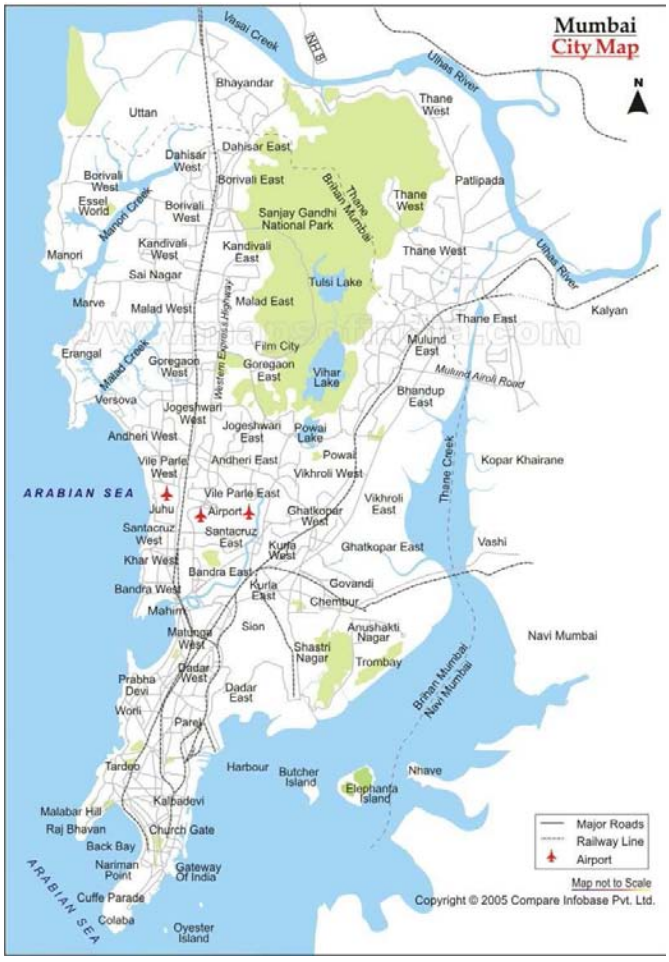


Figure 3.1 (left): Map of Mumbai

Source: http://www.mapsofindia.com/maps/maharashtra/mumbai-map-city.jpg

Figure 3.2: Facts about Mumbai

- Population: 11.9 million
- Area: 437km^2
- Population density: 19,900 people per km^2
- Generates 30% of India's GDP
- Declining manufacturing employment
- Average wages
- 54% slum dwellers
- 2166mm rainfall per year
- Port handles 50% of India's foreign trade

To make a judgement on whether the Mumbai will exceed its carrying capacity in the future with respect to the various parameters, a number of considerations were made. Three trends of population growth, economic growth and climate change were considered. Despite limitations on arriving at an accurate quantitative prediction, the effects of the three trends have been used to qualitatively describe whether carrying capacity may be exceeded.

3.1. Population Growth

The most recent census of 2001 found the population of Mumbai to be approximately 12 million. It is growing due to a combination of natural increase (i.e. there is a higher birth rate than death rate), and migration to the city. As a consequence, the MMRDA expect the population increase to between 14.1 and 15.3 million by 2011 [2]. This increase will increase the demand on Mumbai's resources and infrastructure, and therefore must be taken into account when planning for the future.

3.2. Economic growth and increased living standards

Economic growth is associated with an increase in living standards: as people have more money they have a greater amount of disposable income to spend on more luxurious items. Furthermore, it is associated with the expansion of businesses that also place additional demand on resources[3]. It therefore leads to increasing consumption levels, placing demand not only on supportive capacity but on assimilative capacity, as more waste is generated. Put very simply, with all other things being equal, the carrying capacity of a place will be lower where the average consumption levels are higher. Hence if economic growth and consequently increasing consumption is predicted, then careful planning is required to ensure that the needs of the population can still be met, and that environmental deterioration which is bound to occur is curbed. For the whole of India, it has been estimated that per-capita economic growth will be approximately 5.3%, which over a 40 year period will increase incomes 8-fold.[4]

3.3. Climate change

After looking at the credible evidence that the global climate change due to green house gases is here to stay, it has been observed that the thirteen warmest years of the last century occurred within the last 15 years according to National Climatic Data Center (NCDC) and the years, 2001, 2002 and 2003 were the hottest years ever recorded. Mega coastal cities like Mumbai and similar areas could be facing the consequences of the changes that climate change can bring. Therefore, there is a need for the city to take necessary steps for adapting, preserving and strengthening itself. Whilst there are many scientific uncertainties relating to the specific consequences of global warming at the local level, there are some trends that are widely accepted. By 2050, average annual temperatures are expected to rise by 1.25°C - 1.75°C, depending on which 'scenario' is used, At the global level, international climate researchers have predicted an average annual temperature increase of 1.75°C by 2050, accompanied by trends of rising sea levels; increasing frequency of extreme weather events; and increasing variability in weather patterns[5]. As an island with plenty of low-lying land, the prospect of sea-level rises (of up to 38cm by 2050 [6]) is of particular concern. This situation would result in making some of the populated areas of the city uninhabitable and therefore reduce the available land resource. It was recently suggested that: 'Mumbai's topography, the geology, mudflats, wetlands, flood prone areas, poor sanitation, poor water management and poor buildings conditioned together, make a lethal combination which makes Mumbai perhaps the most vulnerable city in the world' [7]. The innumerable complexities relating to futuristic predictions make planning increasingly difficult. This is clearly demonstrated in the following example. Depending on whether the international community pursues a 'business as usual' or a 'sustainability focussed' pathway to development, rainfall in Mumbai is expected to marginally increase, as the figure 3.3 below demonstrates. However, it has been predicted that by 2050 there will be a 20% increase in rain during the monsoons[8].

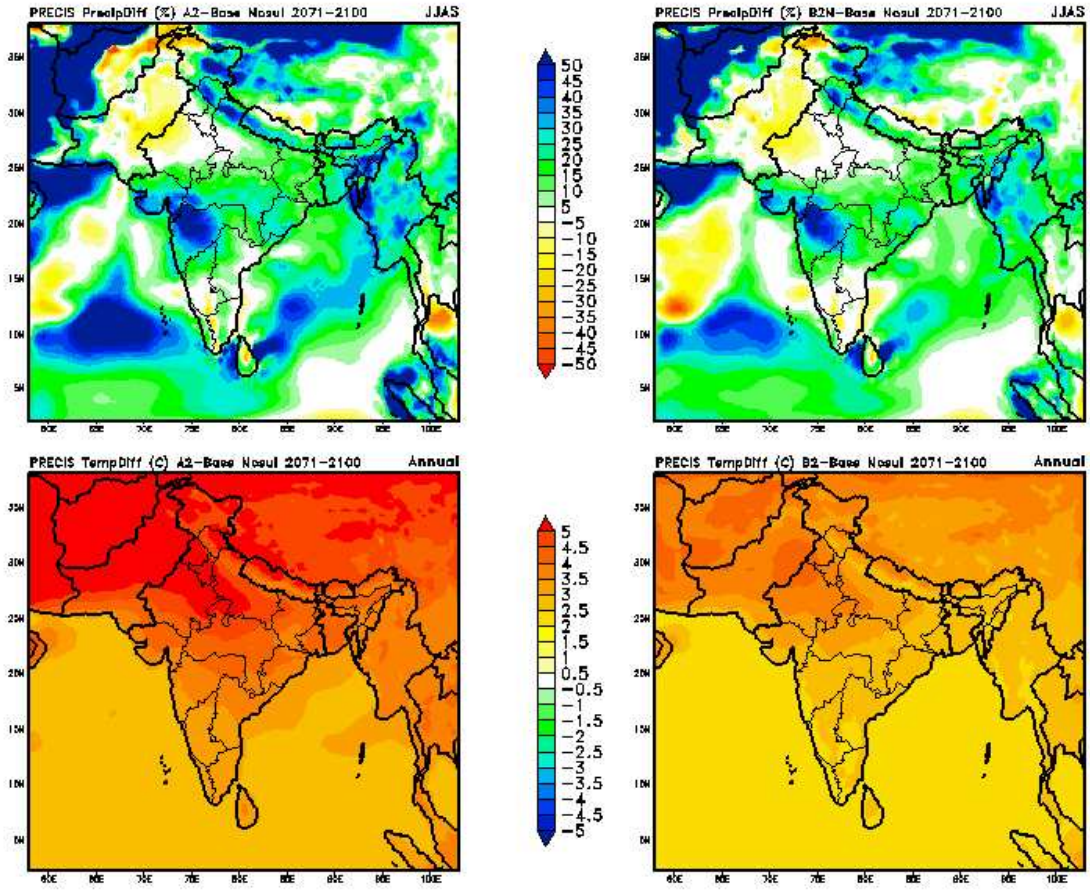


Figure 3.3: Precipitation and air surface temperatures for 2070-2100 based upon the A2 and B2 scenarios Source: Kumar et al, 2006 [9]

The findings of a detailed study conducted by National Environmental Engineering Research Institute on climate change and its economic impact on Mumbai has been provided below.[6]

Mumbai with high exposure level due to high population density, major industrial installations, financial institutions etc faces threat from the change in the climate. Factors which make the city vulnerable to the impact of climate change include its location as coastal city, reclaimed land, low lying areas and high population of urban poor with increased vehicular density. If vulnerability index is calculated for Mumbai city based on indicators such as Demographic vulnerability (density of population), Occupational vulnerability (total workers, labourers etc), and the climate based risk would be very high. As per one of the earlier estimates, damage to Mumbai, the country's financial capital, could be over Rs 2 lakh crore. This is according to a study that's a decade old. Since then urbanization and investments have only gone up in Mumbai. The sea level is expected to

rise at the rate of 2.4 mm per year in India. This means that by the middle of the century the rise will be 38cm based on the report submitted to UN. This would inundate low lying areas, drown coastal marshes and wetlands, erode beaches, exacerbate flooding and increase the salinity of rivers, bays and ground water.

An attempt has been made to address each of the major areas of concerns of climate change which can impact the city including health. An economic analysis has been performed to understand these impacts with a view to plan out adaptability strategies for the city for the period up to 2050. Major factors considered for these purposes are impacts due to rains-flood, building damages, health and tourism, though impacts are likely to be all encompassing a much larger domain.

I Impact on Rains and floods

Increase in temperature will lead to an increase in rainfall both intensity and frequency. Extreme precipitation is found to increase substantially over the western coast and west central India. Overall, the summer monsoon rainfall shows a 20 per cent increase over the present, and the increase is seen in all the States except Punjab, Rajasthan and Tamil Nadu. Simulations with climate models and observations indicate that rainfall extremes such as the Mumbai deluge of 2005 could become more frequent in India under the impact of climate change.4 Both 2005 and 2006 had spells of excessive rainfall that normally would have occurred once in a hundred years or so. It has been observed that till 1989 the average rainfall of Mumbai was 2129 mm.5 In the year 2005/2006 the average annual rainfall was found to be 3214mm. Hence, already there has been an increase of 50%. If we consider 2800mm as the average then the increase is about 14% and a further rise in the temperature would only worsen the scenario.

Increase in rainfall and rise in the mean sea level in addition to the poor drainage of the city will increase the frequency of floods leading to damage to life and property. As almost $1/4^{th}$ of Mumbai areas are low lying (below or at MSL) as shown in Figure 1, low-income groups and poor residents living in vulnerable locations will be affected more (accounts for nearly 50 percent of Mumbai population). Smaller drainage channels, inefficiencies in draining shall compound the problems much more. A conservative estimate shows that about 40% population will get affected. Frequent floods and salt water intrusion will affect the structural stability of high rise buildings which are mushrooming at an increasing rate. As a

result of floods especially in the low lying areas of the city there will be consequent distribution in work, dislocation of people and also death. Monetary loss resulting from such consequences have been calculated and presented in Tables 1, 2 and 3.

The cost of work disruption has been computed as given in Table 1 for different low lying areas in the event of floods. A conservative approach has been used wherein it has been assumed that work disruption would be limited to 5 days in a year and also that the frequency of such extreme occurrences shall be once every 5 years. The computation has been limited to the year 2050. It also conservatively assumes that the population in these areas will not change, though it would change depending upon the local government policy of development in the time frame of 2050. Population figures have been taken from the census for locations shown in Table 1 based on the area and density of population.

Table 1 : Cost of work disruption in the low lying areas due to flooding

	Locations	**Area (km2)**	**Cost of work disrupted for one event, crores**	**Cost of work disrupted for once in 5 years till 2050, crores**
a	Colaba lalit building to Badhwar park	0.022	0.66	6.6
b	Kalbadevi near cotton exchange, ghodaghadi junction	0.095	0.3	3
c	Girgaon khetwadi main road, bank road, Wilson college, nana chowk, grant road junction	1.39	4.8	48
d	Tardeo circle, Mahalaxmi junction, Warden road to American embassy	4.38	15.2	152
e	Byculla junction kalachowkie junction and albert circle	1.06	3.6	36
f	Bhoiwadi Hindmata to Bharatmata Parel to Elphinstone bridge	0.77	2.6	126
g	Worli Poonam Signal, Bavla Masjid to N M Joshi marg, Senapati Bapat marg to Nehru science center	1.06	3.6	36
Total		407.6		

In the event of floods there are casualties which amounts to loss of lives and loss of earnings which is termed as cost of death. Table 2 presents the cost of death till the year 2050 if one event of this kind occurs once in 5 years till 2050. Cost of death has been calculated using useful life

Table 2: Cost of death due to flooding

Deaths per event	Deaths till 2050 @ one event every 5 years	Cost of death per year (in crores)	Cost of Deaths till 2050 @ one event every 5 years (in crores)
700	7000	315	3150

In the event of severe floods there is material damage, the families get dislocated and begin living elsewhere temporarily or permanently. Table 3 shows the summation of cost of material damaged, the cost of living elsewhere and the cost of renovation.

Table 3: Cost of dislocation on account of floods

	Locations	Total cost of material damage, living elsewhere and cost of renovation (in crores) per flooding event	Total cost if occurrence of such a calamity is once in 5 years till 2050 (in crores)
a	Colaba lalit building to Badhwar park	1.6	16
b	Kalbadevi near cotton exchange, ghodaghadi junction	6.7	67
c	Girgaon khetwadi main road, bank road, Wilson college, nana chowk, grant road junction	102	1020
d	Tardeo circle, Mahalaxmi junction, Warden road to American embassy	321	3210
e	Byculla junction kalachowkie junction and albert circle	77	770
f	Bhoiwadi Hindmata to Bharatmata Parel to Elphinstone bridge	56	560
g	Worli Poonam Signal, Bavla Masjid to N M Joshi marg, Senapati Bapat marg to Nehru science center	77	770

Due to sea level rise there will be loss of coastal area and ingress of sea water. Considering that sea water penetrates inland by 200m calculation have been done showing monetaryloss due to buildings getting affected in the region of nearshore as shown in Table 4 .

Table 4: Monetary loss due to buildings foundation damage by sea level rise

Area	Number of buildings affected	Loss at the current levels, crores	Loss by the year 2050, crores
South Mumbai	700	124824	
Western Suburbs	700	4518.51	
Navi Mumbai	400	1129.62	
Mumbai Central Suburbs	200	484.12	
Total	2000	130956	1501725

Current loss has been computed based on present building costs. This is based on the assumption that buildings along the coastline located with in 200 m from the shore will get affected due to the rise in sea level and ingress of sea water. The present property rates calculated are on the basis of glisters.com . Future rates for the year 2050 have been assumed on the basis of average 5% (flat rate) rise per year.

II. <u>Impact on Health</u>

High temperature and hence, increased humidity will increase prevalence of diseases. Increased temperatures can increase the range of vector borne diseases such as malaria.

There could be an increase in fungal infections and asthma associated with *Aspergillus* and *Alternaria.* The Mumbai deluge of 26th July 2005 had resulted in an epidemic of diseases including vector borne diseases and the cost of treatment amounted to one crore . More such frequent episodes occurring as a consequence of increased rainfall and poor drainage would only compound the cost of treatment and suffering. Increase in the incidence of malaria, diarrhoea and leptospirosis would result in loss of income due non-working days and death. The losses have been computed using Disability Adjusted Life Years (DALY) for all the major illnesses likely to impact the population. All these illnesses will increase steadily with increase in the income loss with a sharp increase from 2045 till 2055. By the year 2050 the cumulative income loss due to malaria, diarrhoea and leptospirosis calculated on the basis of disability adjusted life years will be 155, 597 and 2401 crores, respectively. The calculation of disability adjusted life years is based on the WHO guidelines and income levels prevalent for Mumbai.

<u>OTHER HEALTH IMPACTS :</u> Besides frequent disease outbreaks, heat stress caused by the rising mercury would affect the workforce of the city. Episodes of heat cramps, heat

exhaustion, heat stroke would affect the population, primarily the large poor section of the society. As the immune system weakens due to heat stress susceptibility to diseases would further increase. The resulting increased expenses on health care by individuals would excalate leading to greater stress. Hence, this vicious cycle would lead to depreciation of human resources.

Heat stress besides human beings would not spare the cattle sheds. It has been found that there is higher sensitivity of cattle to heat stress and it could impact milk production from cattle sheds in Mumbai. The effect of raised body temperature is an adaptive depression of the metabolic rate associated with reduced appetite. Factors such as water deprivation, nutritional imbalance and nutritional deficiency may exacerbate the impact of heat stress.
Other health impacts as a consequence of climate change would be

- Death and injury due to flooding.
- Reduced availability of fresh water due to saltwater intrusion
- Contamination of water supply by pollutants from submerged waste dumps
- Change in the distribution of disease-spreading insects
- Effect on nutrition due to a loss in agricultural land and changes in fish catch

III. <u>Tourism</u>

With the increase in temperature and humidity there is a possibility that tourism will decline. Hotter and humid summers and wetter monsoons will deter tourists from visiting the city. Tourists from coolers regions who frequent the city during the pleasant winter months will opt to go elsewhere on a vacation due to warmer and humid winters. Hence, there will be a sharp drop in the influx of tourists and an adverse impact on the economy. Monetary loss due to decrease in tourists visiting the city for the year 2025 and the year 2050 with a corresponding loss of Rs. 95970 crores and Rs 1963500 crores, respectively.

<u>Summary of Losses</u>

All computations for loss due to climate change on various sectors have been summrised below in Table 7. First four of costs indicated are for those impacts which are likely to take place due to extreme events. Other two cost figures are for losses likely to be witnessed by the year 2050.

Table 7: Summary of economic losses due to climate change impact in Mumbai

S.no	Sector of Impact	Impact period and type	Cost in Rs.Crores
1	Dislocation due to extreme events of flooding every 5 till 2050 for low lying areas	Cumulative costs over 2005-2050	407.6
2	Material damage due to extreme events every 5 years till 2050 for low lying areas	Cumulative costs over 2005-2050	6413
3	Mortality costs due to extreme events of flooding every 5 years till 2050	Cumulative costs over 2005-2050	3050
4	Disability Adjusted Life Years Loss due to diseases Malaria, Diarrhea, Leptospirosis	Cumulative costs over 2005-2050	3153
5	Building Foundation Damages in the year 2050 due to sea level rise	Single cost by the year 2050	1501725
6	Tourism Loss: reduced tourists coming to Mumbai	Single cost by the year 2050 compared with base 2005	1963500

VI Other Impacts

Other intangible impacts which can not be monetarily evaluated are numerous. With the rise in temperature, there will be an increase in the usage of air conditioners in houses, offices and cars. The affluent population will continue to live comfortably but at the cost of rising energy consumption. The poor will suffer more with increase in heat stress and consequent reduction in work efficiency. Travel by local trains and buses will be tougher and exhaustive. Introduction of air-conditioned mode of public transport will add further to the local heat island effect and cost of traveling by commuters. Some others which are a possibility of climate change are given hereunder:

• Pattern of land sea breeze will also get affected and therefore the natural cooling and mixing within the city will be impacted.

• An increase in ambient temperature by 1 degree C would increase consumption of electricity in domestic, commercial and industrial sectors. A study for Hongkong was conducted where it was found that with 1 °C ambient temperature rise, the electricity consumption would increase by 9.2%, 3.0%, and 2.4% in domestic, commercial and industrial sectors, respectively. The corresponding economic impact on total electricity consumptions was estimated at HK$1.7 billion (in 2004).[11]

• Beaches and seafronts can be eroded and affect the near-shore recreational areas.

• Mangrove swamps and other wetland areas (including salt pans) may absorb the impact of erosion forces minimize the impact in inner parts of the city, but these systems themselves will also get affected.

• Energy needs will increase and that will lead to further warming, though it will be local, its effect could be felt by everyone in the city.

• Habitat losses such as trees shrubs (part of urban ecosystem), birds etc could be significant.

V Responses Needed

Though there are indications of the impacts that could be possibly felt, its micro detailing has not been attempted as yet. Therefore, there is a need to carry out the same for the Mumbai or MMR area to understand the economic implications of these impacts and costs for dealing these impacts effectively. Some of the responses based on the changes anticipated and listed above shall be:

A- Micro levels drainage system planning and improvement, which shall include manmade as well as natural. [the current level topo-sheet will be needed]

B- Building experts and related other experts will need to detail the steps taken for new building construction practices for avoiding increased salt content. For older building, an assessment and remediation plan will need to be prepared. Building very close to sea shore also need to be examined from the point of view of stability of the land due to erosion [near Dadar and Juhu areas].

C- Health sector investment for treating people as also prevention programmers, Epidemiological assessment and readiness to tackle health burden arising due to change in climate. [More health care facilities with R&D support and other infrastructure].

D- Beach and sea fronts anti erosion measures [creation of engineering measures to prevent erosion].

E- Mangrove and other wetland areas protection plan and implementation. Treating all these as “States Infrastructure”

F- Energy Conservation measures at all levels [appliances, building design, energy use pattern etc.alternative sources of energy]

G- Urban ecosystem enhancement [creation of more open spaces, greenery, parks, tree lined roads etc]

H- Others: MSW handling to reduce GHG, Cattleshed GHG reduction, Green building designs etc

References:

1. Definition Carrying capacity
2. MMRDA Regional development plan 1996-2011
3. Ghosh, S. (2002) Electricity consumption and economic growth in India. Energy Policy 30: pp125-129
4. Kakodkar, A. (2005) Energy in India for the Coming Decades. Presentation at the Inter-ministerial Conference on "Nuclear Power for the 21 Century" organized by the International Atomic Energy Agency
5. Schiller, A; Sherbinin, A; Hsieh, W; Pulsipher, A. (2001) The vulnerability of global cities to climate hazards. Megacities pp1-39
6. Kumar, R; Jawale, P; Tandon, S. (2008) Economic impact of climate change on Mumbai, India. Regional Health Forum 12(1): pp38-42
7. Prabhu, C. (2007) Editorial: The vulnerability of Mumbai to climate hazards. http://www.medcindia.org/cgi-bin/May07/EDITORPAGE.HTM
8. Kumar, R; Jawale, P; Tandon, S. (2008) Economic impact of climate change on Mumbai, India. Regional Health Forum 12(1): pp38-42
9. Kumar, K; Sahai, A; Kumar, K; Patwardhan, S; Mishra, P; Ravadekar, J; Kamala, K; Pant, G. (2006) High resolution climate change scenarios for India in the 21st Century. Current Science 90(3): pp334-345

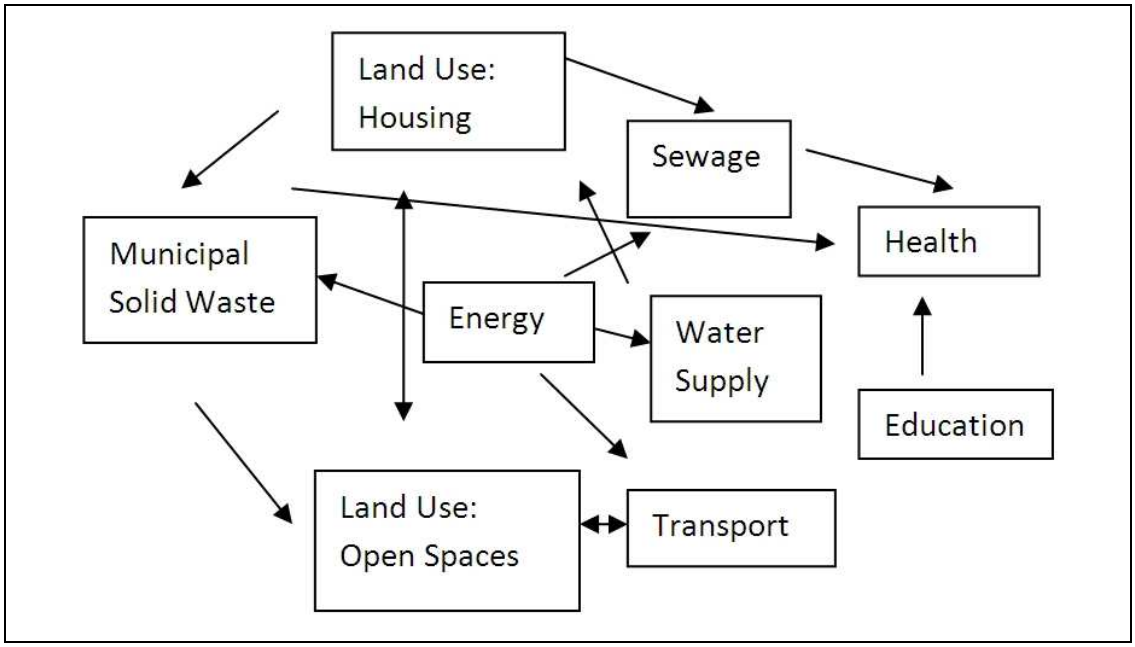
4. FINDINGS

The findings of the investigation are presented below. For each parameter there is a brief justification on why it is an important aspect of Mumbai's carrying capacity, in terms of its link to living standards. A brief summary of the data and key figures is then provided, before a more in-depth discussion in accordance with the aims of the study. For the purposes of uniformity, 2001-02 has been used as a base year for the investigation as this is when the most recent census took place, and the year for which the most data is available across all of the issues. However, wherever subsequent information is available, or substantial investment is planned (for example the Mumbai Urban Transport Project), this has also been taken into account.

As mentioned earlier the following pages will detail the findings with regards to various infrastructure as well as necessary resources, which have a significant effect on the functioning of life in Mumbai city. These include Housing, Open spaces, Water supply,

Sewage management, Solid waste management, Energy, Transport, Education and Health to name a few. These individual points all govern the quality of life of people in the city. These parameters need to be evaluated to determine whether they are sufficient to support the projected future population of Mumbai as well. It is critical to understand that although these parameters appear as standalone issues in reality they form a complex web in determining the sustainability of the city. A simplistic representation of this has been demonstrated in Fig 4.0.1 below. These factors are often interlinked in a number of ways and in order to analyse the same and arrive at an understanding of these issues an integrated picture needs to be considered. The potential solutions to managing the carrying capacity of the city should be by addressing these crosscutting issues. Given this background and recognising this fact we go further into look at these individual themes below.

Fig 4.0.1: Representation of the interlink between various issues covered in this report.



4.1.1. Land-use and housing

As an island city, land is one resource that is definitely limiting parameters for Mumbai as there are minimal chances of expansion available. This section examines land-use to

determine what land is available. In particular, land as a resource for providing space for housing has been considered. It is therefore important to reflect on how well Mumbai can provide adequate housing for the entire population cutting across all of the income groups within the city. In addition to shelter, other essential services, such as water supply, waste disposal and electricity supply are also clubbed along with housing provision.

Summary

2001-02

- Area: 437km^2
- Population density is 19,900
- 55% of population living in slums on 35% of the city's buildable land

Additional Information

- Average rental value is 140% of average income per capita
- FSI needs to be allowed to reach 3-4 in some places to cater for demand
- Problems with planning process lead to issues for water and electricity supply and sewerage.

The Future

- Problems of development in some coastal areas – flooding likely to be an increasingly frequent occurrence

Mumbai's population density of 19,900 people per km^2 makes it one of the most densely populated places in the world, although this alone does not suggest that the city has exceeded its carrying capacity. However, it is clear that with such a small land resource, there is a great deal of demand for space. 48% of Mumbai's total land area is classified as 'built-up', and this figure rises to over 92% in the Island City. 19% comprises forest and scrub land, which provides important ecological services. The remaining 33% can be divided between roads, railway lines, port areas, and a few green spaces.

The Role that development regulation plays with regard to housing and the Carrying Capacity of the city is elaborated below. The development on land in Mumbai is controlled by the Floor Space Index (FSI) norms. FSI is the ratio of the total floor area of buildings on a certain location to the size of the land of that location. Mumbai has strict planning regulations with regard to FSI, which in the Island City is limited to 1.33. This means that the total floor space for new buildings must be limited to 133% of the total floor area of the

plot. This regulation though only applies for the relatively few new buildings on vacant plots and has now been increased substantially to accommodate the interests of the builders. Builders are also able to increase the FSI through development that re-houses slum dwellers. The regulation is designed to ensure that infrastructure can keep pace with development, However it has served to increase rental values to unaffordable levels for many people. With average rental values at 140% of the average wage in Mumbai, the inability of many to afford such costs is a key reason why the large slum population 6.25 million Mumbaikars (or 54% of the population) live in slum accommodation. It was felt that new norms of FSI, permitting 2.00 or existing consumed FSI, whichever was more, should be considered. This would put considerable amount of pressure on the infrastructure. It was however felt that the infrastructure would be augmented and that it would eventually take care of the needs of the existing population, even in the event of reconstruction. It must be borne in mind that the chawls, which formed an overwhelming majority of the old and dilapidated cessed buildings [estimated at about 19,800] had common toilets and no storage tanks for water. As the 19800 buildings occupied most of the lands in the island city the rationalization of FSI would have put more pressure on the fragile infrastructure. Subsequently the FSI for cessed buildings was increased from 2.00 to 2.5 or 50% incentive FSI over and above that which was required to accommodate the existing residents, whichever is more. No study was attempted to assess the impact of this decision which, in effect permitted unlimited FSI in the island city.

In the suburbs, the FSI was increased to 1.00. In areas like Chembur, it was first increased from 0.5 to 0.75 and then to 1.00.

(The FSI in the suburbs has now been increased to 1.5. In many cases, FSI of 4 is now permitted for a wide range of activities. There has been no apparent increase in the infrastructure).

Further the introduction of Transferable Development Rights (TDR) also influenced housing and use of land as a resource in Mumbai city. The law permitted the use of TDR up to 1.00 FSI on most plots. This in effect meant doubling the FSI of the suburbs, without any consideration to the available infrastructure. Now the government has increased the base

FSI from 1.00 to 1.33. The upper limit for usage of FSI however remains 2.00 in the suburbs. For slums, the FSI available is 2.5, and in certain areas such as Dharavi, it is 4.00. There has never been a study to determine whether the increase will be suitably supported by the infrastructure. The ground realities have shown that the living standards of the city in general have been deteriorating rapidly.

Moves are now afloat to further increase the FSI and hence it has become essential to assess whether the infrastructure is adequate to take care of the existing Development Control Regulations, and whether Mumbai can handle further increases in FSI.

The steady migration of people from rural areas to cities brings huge problems. It is estimated that more than half the city's population is poor. [a] The housing options for poor in Mumbai are Slums, Chawls, Patra Chawls, Zopadpattis and Pavement Dwellings. In Greater Mumbai 1,959 slum settlements have been identified with a total population of 6.25 million, which forms 54 per cent of the total population of the city (Census of India, 2001). The Island City Houses only 17 per cent of the slum population. The western suburbs on the other hand, have high concentrations of slums especially in the interior areas where large areas are covered by contiguous slums with hazy boundaries and house 58 per cent of the slum population.

The classic example of slums is found in Dharavi. Once a remote settlement on the outskirts of the city, Dharavi due to Mumbai's rapid northward expansion now finds itself practically in the centre of the Greater Mumbai region. It is strategically located between the city's two main suburban railway lines and a stone's throw away from the Bandra-Kurla Complex, the new financial and commercial centre. Dharavi is home not only to the urban poor, but also to some middle-class professionals unable to find affordable housing elsewhere. Dharavi is not only a residential space, but also a major economic hub representing the city's vast informal business sector. Dharavi's commercial enterprises include recycling industries, leather tanneries, heavy metal work, woodwork, and manufactured goods such as garments, shoes, luggage and jewellery. These industries not only serve all of Mumbai, many products are even distributed in global markets. One conservative estimate places the annual value of goods produced in Dharavi at USD 500 million[1] . Commercial and

manufacturing enterprises provides employment for a large share of Dharavi's population as well as for some living outside Dharavi.

Much of Dharavi's productivity is rooted in a decentralized production process relying on a vast network of small home-based production units. Many shacks here are also little factories. Three women squat on a squalid street outside their tin home to pack savouries into polythene bags at speed that could shame a machine. Some yards down, another two women stir hot dye in huge buckets. These little businesses add up to a turnover of more than a billion dollars, by local estimates. Many of these products from savouries and textiles to handicrafts and watch straps are exported. [2]

The Brihanmumbai Municipal Corporation (BMC) owns most of the land in Dharavi, with private landholders and the central government controlling the rest. An informal real estate market operates in the area, with prices varying by location and building quality. While some residents live in structures with tin walls and plastic sheeting, many have moved up to brick or concrete and have added lofts, upper stories and decorative elements. Some owners also lease spaces to tenants, after having purchased more than one house, or moved out of Dharavi. Although a majority of structures constitute "slum housing," Dharavi also contains other housing typologies. These include the former village structures of Koliwada, planned government *chawls*, transit accommodations, and government-sponsored high-rises.

Dharavi is a highly developed urban area composed of distinct neighbourhoods and bustling with economic activity that is integrated socially, economically and culturally at metropolitan, regional and global levels.

Plans of redevelopment of Dharavi have been received with mixed responses. Residents have protested that the plan to redevelop them will deprive many of their livelihoods. They also state that the proposed redevelopment plan does not allot enough space in light of current tenement sizes, and does not account for Dharavi's sizable population of renters and more recent migrants.

Experts have further warned that the plan to redevelop Dharavi promotes insupportable densities and does not adequately consider environmental impacts or future growth. They also state that the redevelopment does not effectively integrate Dharavi with Mumbai as a whole. Some have also emphasised that the simplistic rezoning or segregation of activities proposed overlooks the deep interconnections between economic activities, social networks and urban form in Dharavi.[3]

Further, increase in living space in Dharavi would attract more influx of people in the city, thereby increasing pressure on the limited water supply, waste water treatment and solid waste disposal. Dharavi is also in a low lying area. Serious consideration needs to be given to what would happen when sea level rises due to climate change occur and in the event of floods, especially when there is an increase in the load on land due to multistoried buildings.

Assuming the redevelopment plan of Dharavi is carried out; subsequent to building homes for the slum dwellers the other share will be prime area at a price that will in turn only attract more people into the area. It is important to consider if this is what the city needs.

The whole of Mumbai cannot have high rise buildings. There are several environmental consequences that need to be well thought-out before comparing Mumbai to other cities like New York and Shanghai. It should be considered that on one hand New York has Manhattan which has high rise buildings with high FSI but at the same time has Long Island which has minimum FSI. Shanghai is sinking because of the pressure on the land. Mumbai definitely does not need to attract more people into the city that will increase the pressure on its land.

4.1.2. Open Spaces

As of the 1960s, open spaces in Mumbai were perhaps adequate for the number of people living in the city. Today, while the population has multiplied, its record in maintaining the existing open spaces and *maidans* has been very poor. As a result, Mumbai today has the lowest ratio of open spaces as compared to any of the other major cities in the world. The

open space availability in Mumbai is only 0.03 acre per population of 1,000 as against 5.3 acres in New York, 4.84 acres in London and 4.4 acres in New Delhi. The lack of open spaces and the despicable state of the existing ones is a shame to the population of Mumbai.

Azad *maidan*, Cross *maidan* and the Oval *maidan* and Jijamata Udyan are all examples of open spaces created in the late 19th century. Since then, the Government has not created any new *maidans* whilst permitting indiscriminate development. Only a few *Nana Nani* Parks in some residential areas have been opened in areas like Shivaji Park, Girgaum Chowpatty as well as some areas in north Mumbai. In fact even the existing open spaces are not properly cared for or maintained. The Cross *maidan* is now practically a big garbage dump and is proposed to be privatised. The Oval *maidan* thanks to the initiative of local citizens has been rescued and is in a better condition. The Jijamata Udyan too is under constant threat due to attempts to convert it into commercial real estate property or into a Singapore type zoo on a BOT basis with a private developer. The Aarey milk colony in North Bombay with its rich forest land is continuously under attack from builders attempt to concretise this area. The most glaring example of the destruction of green space in Mumbai is the uprooting of nearly 500 acres of mangroves at Goregaon for development of a golf club. Builders are now even eyeing the Mumbai Port Trust land, which runs into hundreds of acres. A campaign to convert it into real estate is already ongoing. There is also a campaign to convert the salt pan lands into areas that can be built upon. The developable land in the city is being used for luxury housing, corporate sector offices or built up commercial entertainment sites with complete disregard to the rule of thumb that one-third of the space should in fact be left open for public use and public amenities.

Legal and illegal construction activity has resulted in the depletion of open public places. But it is possible to create good open spaces. A success story is seen in the Mahim Nature Park at Dharavi where a sprawling 15 hectare park which has been created out of a site that was earlier used for dumping garbage. Conceived and created by the members of environmental organisations and other agencies over the last 30 years, it now has 14,000 trees, herbs and shrubs and much bird life. Another good example of a garden created out of reclamation is the Bombay Port Trust garden at Colaba.

Recently, the need of open spaces and their importance has been identified and supported by some citizen groups of the city. There has been an increase in attempts to create open spaces in the last few years in Mumbai mainly by upper class citizen groups in areas like Bandra, Colaba, Cuffe Parade, Juhu and Mulund. Bandra (West) alone has developed four major open spaces in the last few years, the promenades on the seafront at Carter Road, the Band Stand area , Bandra Reclamation and the Joggers' Park. Priyadarshani Park has been developed with land reclamation at Napean Sea Road and an improvement drive of the Marine Drive has been supported by the citizens. While such efforts at creating green spaces are welcome, the real task lies in prevention of further erosion of open spaces. This is getting increasingly difficult as numbers of buildings increase and each of them attract more cars without providing for parking space. The result there is even open space on the road is encroached upon as cars are required to be parked there. [4]

This highlights another aspect of land use linked to infrastructure requirements of the population - Parking. Mumbai's parking tariff is among the lowest in the world. Uniform parking fares are levied across the city irrespective of the location- same price for parking at Nariman Point, Sion and Dharavi. In the West, parking space is priced as per the cost of the real estate in the area. Thus, while in Manhattan you have to pay approximately $2,22,000 (Rs 87.4 lakh) for a parking space, you will be able to afford a three-bedroom house with a pool in Houston, at the same price. In Mumbai the longer you park your car in a lot the less you have to pay. Parking charges drop after the first hour and again after the first three hours. This is the opposite of what happens in cities abroad. In the few streets where you can park in Manhattan, the rates go up every two hours. It is typically $2 an hour for the first two hours, the next two cost $3 an hour, and it shoots up to $4 an hour for the next two. Singapore enforced strict parking and traffic regulations as they were upgrading their public transport in order to promote the use of public transport. Major global cities use high parking tariff as a tool to restrict use of cars.

Another aspect linked to use of public space pertains to the provision for pedestrian access. Vital public space needed for day to day activities like footpaths and subways don't have funds allocated to them. Pedestrians are forced to climb up and down the stairs of the

subways. Often, poor ventilation and lighting, along with numerous commercial establishments makes walking in the subway difficult.

Most existing footpaths are unfit for walking or are encroached upon. In fact, footpath space is being depleted with construction of shrines, stalls, hawkers, telephone booths, police chowkies, public toilets and, of course, the pavement dwellers. Not to be left behind, sometimes, even buildings extend their courtyards several feet onto the road complete disregard to the encroachment on public space.

Mandatory requirements for open spaces and car parking in residential buildings are being increasingly and blatantly flouted in a large number of new luxury apartments. The illegality apart, this has a negative impact on children, as they are denied space to play vital for their mental and physical development. In contrast, the more humble public sector housing colonies built in the 1950s all over Mumbai have large open spaces.

Public/ open spaces such as squares, parks, sea sides, *maidans*, railway platforms, bus stops and streets are badly neglected in Mumbai.

The recent textile mills case is even more appalling. Given an opportunity to redevelop about 600 acres of land in the congested island city, the Maharashtra Government had the opportunity to allow about 1/3rd to be used by the builders, 1/3rd for public housing (including the textile mill workers) and 1/3rd for open spaces. Instead of utilising this heaven sent opportunity to make good the shortfall, the Maharashtra Government instead amended the rule in such a manner that a handful of rich people got even richer – at the expense of the common man.

Further decrease in open spaces would increase the heat island effect and also adversely effect the health of children. Less circulation of air, due the high rise buildings acting as barriers, would lead to spread of air borne contagious diseases in such areas. This reduced dispersion effect poses as a high risk for the community.

Since Mumbai cannot meet the required open space norms for the existing population, it is not surprising that the city is suffering from claustrophobia. Another direct impact of the

loss of open spaces has been the increase in water logging in the city. Construction and concretization in Mumbai is almost continuous throughout the city. Given Mumbai's record of the lowest ratio of open spaces per head of population of any major metropolis on earth, natural 'sinks' for excess rainwater (such as open grounds, ponds, private forest lands, mangroves, marshes) have been reclaimed and built upon, rather than protected. In addition the concrete buildings and roads reduce the seepage of water into the ground and disrupt the natural water courses. These tall buildings with very deep foundations become vertical barriers that fragment the underground water resources of the city into several sub basins that are discontinuous and disconnected from the main natural outflow.[5] The mismatch between the supply and demand of land further leads to the degradation of environmentally fragile land and open space.

4.1.3. Salt pan lands / Mangrove / Reclaimed land

By definition, salt pan lands are low lying areas that lie between the low tide line and the high tide line. Mumbai's salt-pans are surrounded by mangroves and fall under the category CRZ 1 of the Coastal Regulatory Zone Notification. These areas are categorised as the most ecologically sensitive and important zones — on a par with national parks, marine parks, sanctuaries, places close to breeding and spawning grounds of fish and areas rich in genetic diversity. The city's salt pans are located at Ghatkopar, Chembur, Wadala, Kanjur Marg, Bhandup, Mandale, Turbhe, Anik, Nahur, Mulund in the eastern suburbs and Dahisar in the western belt. Salt pans and mangroves serve as natural bulwarks. They are natural holding ponds for rainwater and serve as vital dissipation spaces permitting accumulated waters to drain into the sea. If all the salt pan lands are opened for development, the area that is thrown open will be slightly more than nine times the mill lands in central Mumbai. Geologists are of the view that salt pan lands are unsuitable for reclamation. The continuous production of salt will have weakened the soil and to be able to reach a solid foundation for projects, developers will need to dig very deep. The water table being relatively high in these reasons also limits the stability of deep foundations. The area around will get flooded once these natural holding ponds are filled up.

Taking away the city's salt pan land for construction of homes for more people is going to degrade the environment of the city and affect its carrying capacity. The mangroves and salt pans that protect the city will be gone, leaving behind a mass of concrete ready to crumble at the slightest natural provocation. The flooding like that seen in July 2005 which brought the life of Mumbai to a standstill will become regular occurrences. [6] Building on such land also has several environmental repercussions. [7]

The proposal to have 2,700 Acres of Salt pan land at Bhandup - Mulund to house the slum dwellers will wreak havoc on these areas. These lands naturally experience tidal effects and sea water always enters these mangroves, mud flats and salt pan areas during high tide. Suburban areas like Ghatkopar, Kanjur Marg, Vikhroli, Mulund on the Eastern Express highway of the city will be the most affected as even normal discharge of sewage and storm water will become a problem.

Every city has its share of dissipation spaces – parks, gardens, ponds, wetlands, mangroves, salt-pan lands, etc. Mangroves and wetlands, although often considered to be wastelands, in fact serve a very important role in protecting and maintaining the city. These act like sponges and reduce the pressure of the high tide in the coastal areas. In the past 10 years all these habitats have been indiscriminately destroyed in Mumbai. Mangroves have given way to golf courses and to buildings. Reclamation has been permitted on a wide scale, particularly in places such as the Bandra-Kurla complex, Versova, Goregaon, Malad, etc.

Cities that do not have natural dissipation spaces are required to plan for buffer zones. Mumbai had the advantage of having excellent buffer zones in the form of mangroves and coastal wetlands. There has been complete disregard to the critical role played by these systems and they have been steadily destroyed over time. 60,000 hectares of wetlands were found in Vasai-Virar and Bhayendar, just outside the northern outer limits of the city. But permission was given by authorities to urbanise Vasai-Virar and 20,000 hectares of wetlands were lost to urban development. Another possible buffer was the area of New Bombay; but even the wetlands and low-lying areas of this region were taken over for construction and completely built upon. Another striking example is the Jawaharlal Nehru Port Trust, which itself is built on reclaimed land.

The mouth of the river Mithi and a part of Mahim Bay has been reclaimed under the guise of providing the Bandra-Worli sea link. This sea link could have been built without reclaiming 41 acres (16.4 hectares). This has partially closed the mouth of the Mithi, in a way strangling the river, and has filled in a portion of Mahim bay.

Similar is the case of the Sewri-Nhava Sheva link. This will take over a part of the Wadala-Sewri mangroves. At Cuffe Parade, mangroves have been destroyed by encroachers and slums .The same is the case in Versova, Oshiwara, Lokhandwala complex, Charkop, Gorai and Madh Island. It is happening all over the city's coastline. No buffer or open space is left and the sea has no alternative but to hit the land. [8]

4.1.4. Climate change to affect Mumbai

Mega coastal cities like Mumbai could face profound consequences from effects of climate change. Mumbai has a high exposure level to such changes due to its high population density, and its major industrial and financial investments. Furthermore, the major proportion of its reclaimed land is in low-lying areas and the high population of its urban poor has left it susceptible to face the consequences of climate change. According to an earlier estimate of a study conducted 10 years ago, the economic damage to Mumbai, the country's financial capital, as a result of climate change could amount to over Rs 2 lakh crore. However, since then, urbanization and investments have only gone up in Mumbai. According to the Intergovernmental Panel on Climate Change (IPCC), the sea level is expected to rise at the rate of 2.4 millimeters (mm) per year in India. By the middle of the century the rise will be 38 centimeters (cm). This would inundate low-lying areas, drown coastal marshes and wetlands, erode beaches, exacerbate flooding and increase the salinity of rivers, bays and groundwater.

Increase in temperature will also lead to an increase in rainfall intensity and frequency. Extreme precipitation is likely to increase substantially over the western coast and west central India. Overall, the summer monsoon rainfall will show a 20% increase. [9]

Internationally climate researchers have predicted an annual temperature increase of 1.75°C by 2050. Mumbai is predicted to have an average annual decrease in precipitation of 2%. The predicted sea level rise of 50 centimetres by 2050 can result in damage to Mumbai beyond recognition. Water shortages, health problems due to water-logging and high temperatures would be more common. Drought in the hinterland would also mean more people migrating to Mumbai.[10] All these clearly demonstrate the ill effect climate change would have on the Carrying capacity of Mumbai. These clearly need to be taken account of and provided for in future plans for the city.

References:

1. Economist. 2005. "Inside the Slums." The Economist. 29 January. Available from http://www.economist.com/cities/displaystory.cfm?story_id=3599622.
2. www.fes.de/globalization
3. http://www.dharavi.org/
4. Date V. Understanding Our Civic issues, Open Spaces in Mumbai, BCPT.
5. Mumbai flood report. PDF
6. Khergamker G. (2007), Insomnia at Marine Drive, Hard News Media
7. Times of India
8. Prabhu C. (2005), Why is Mumbai choked, Frontline, Vol 2(17), Aug 13-26
9. Kumar R., Jawale P. and Tandon S. (2008) Regional Health Forum, Vol 12(1) pgs 38-42
10. Economic Digest

4.2. Water

Access to a safe and consistent supply of water is one of the most fundamental components of a basic standard of living. Inadequate supply is associated with a range of negative health impacts, such as the increased prevalence of diarrhoea, cholera and dysentery. [1] Furthermore, if water is not available within a reasonable distance from the home, then a significant proportion of household labour must be used in the collection of this water, thus reducing the time available for wage-earning. Water is also important for many different industries, and therefore to the general economic performance of Mumbai as a whole. Clearly, water supply is an important component of carrying capacity.

Summary

2001-02

- Water supply of 3,025 million litres per day (MLD) versus demand for 3,975MLD
- 15% of 75,000 tested samples of drinking water found contaminated
- 30-35% of water unaccounted for due to leakages and theft from the supply chain

The future

- MCGM to increase supply to cater for a demand of 6,382 MLD by 2021
- Social and environmental consequences of projects sourcing water from beyond the city limits.

There are a range of different estimates for Mumbai's water demand and water supply. The MCGM reports that in 2001 the water supply to the city was 3,025 million litres per day (MLD) against an estimated demand of 3,975 MLD. This represents a deficit of 23.9% [2]. Omitting commercial and industrial uses, an average of 135 litres per capita per day (lpcd) has been suggested as necessary for meeting basic domestic needs. The Central Public Health and Environmental Organisation have since 2005-2006 recommended 172 lpcd [3].

Mumbai is only able to provide an average of 90 lpcd, whilst slum and pavement dwellers have to cope with much less than this. There are a range of estimates of water consumption among the slum population: figure 4.2.1 below displays the average consumption from 3 slum areas and among pavement dwellers. Across the entire sample, consumption of 25-35 lpcd is found to be typical. It has been estimated that just 49% of slum dwellers have easy access to water via standpipes. This means that over 3 million people of Mumbai lack even such basic facilities [4].

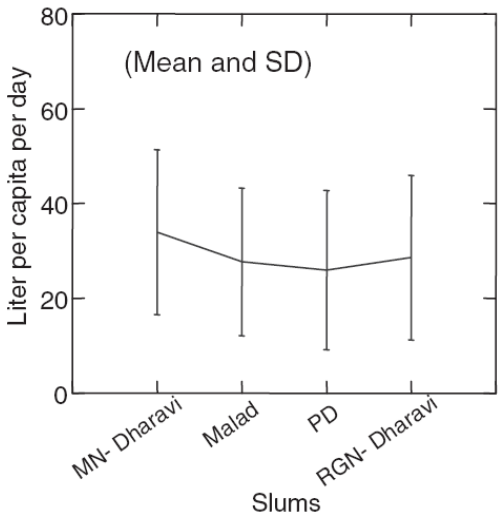


Figure 4.2.1: Per-capita water consumption in 4 slum locations
Source : Karn and Harada [5]

Besides the shortfall in supply, the quality of water supplied has to be of a suitable standard. The water being supplied across the city of Mumbai is known to be treated prior to distribution. Yet despite treatment, it was found that out of 75,000 samples that were tested across the city, 15% were contaminated [6]. In some localities, the level of faecal coliform ('FC' - the bacteria found in excreta and one of the most important indicators of the safety of drinking water) was several hundred times higher than the acceptable norm. At some sites such as Chembur, Mulund and Jogeshwari to name a few, faecal coliform levels approached 1600 per 100 ml of water. The Bureau of Indian Standards' safe norm is 10 FC per 100 ml. The WHO recommends that none at all should be present.[7] This contamination occurs as a result of poor maintenance of old pipelines and valves, resulting in problems of sewage infiltration into the water supply lines in certain localities. Another example of lack of maintenance of water lines resulting in poor water quality is the residents in the Sassoon Docks contracting worms from their municipal water supply. The blame was attributed to contamination due to corrosion of the water pipes.[8] This is unsurprising as the water distribution network in Mumbai is over a century old. Contamination alone is not a problem with the water supply system. It has been estimated that leakages and theft from the supply system result in 30-35% of the total water supplied remaining unaccounted for.[9] Considering the existing the 23.9% shortfall in supply for Mumbai, this figure is significantly large. This simply suggests that improvements in maintenance would greatly improve the ability of the authorities to provide for the needs of the population.

The demand for water is expected to increase significantly over the next 10-25 years. This will not only be contributed by the projected population increase, but also due to a likely increase in average consumption (from both domestic and industrial users) that is expected to accompany economic growth. The MCGM acknowledge that rather than the current 135 lpcd for domestic requirements, 240 lpcd is a more suitable level to plan for. This projected increase is shown in the graph Fig 4.2.2 below. The MCGM has plans to ensure that by 2021, Mumbai can be supplied with 6,382 MLD.[10] This will be achieved by drawing water from the Vaitarna and Ulhas rivers. Five different projects are envisaged for Middle Vaitarna, Gargai, and Pinjal in the Vaitarna basin, and Kalu and Shai in the Ulhas basin. It is projected that over 9,000 hectares of forest land and 27 villages will be submerged. For the first 455 MLD, the mid-Vaitarna dam will be constructed at a cost of Rs.1, 250 cores and by

destroying 600 hectares of good forests. This still does not address the issues of leakages to the ageing infrastructure, which may also be valuable in helping Mumbai to meet the requirements of the population [BCPT paper].

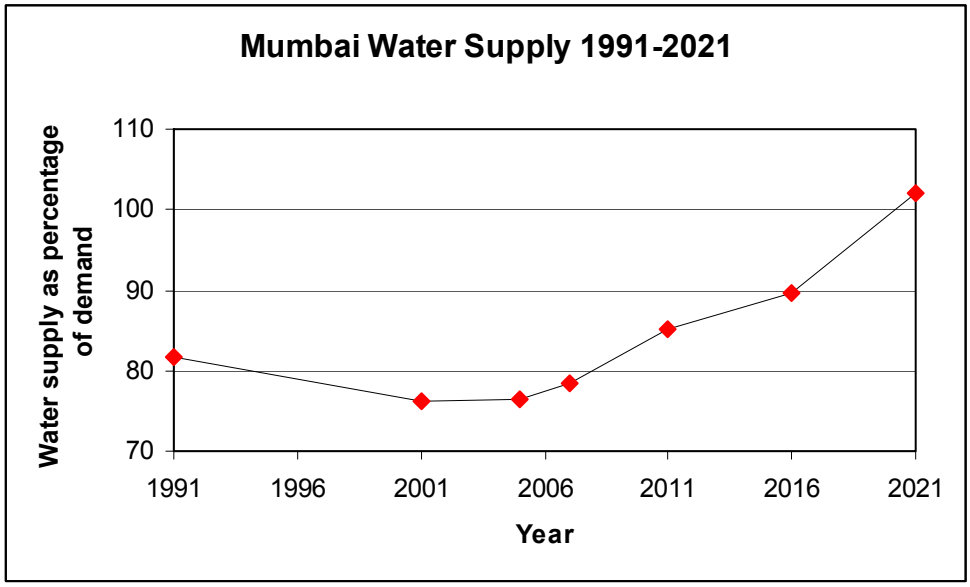


Figure 4.2.2: Mumbai water supply 1991-2021

Source data: Mumbai City Development Plan 2005-2025 (MCGM)

There are a range of other methods that have been suggested to either increase water supply or reduce demand for new water resources:

- **Rainwater harvesting:** This was traditionally how water was collected across Mumbai with storage in tanks such as those at Banganga, Govalia and Manmala. Although these are now largely disused or used only for limited purposes of idol immersion and other practices, their restoration could potentially create a good source of water. This water could be put to purposes other than human consumption such as use for toilet flushing and other purposes that do not require treatment. There is also the potential for individual buildings to collect and store rainwater for similar uses, which would further decrease the demand on potable water, as well as reduce storm water discharge.
- **Water recycling:** This can also reduce demand for water which can be used for purposes other than human consumption. This may also have economic benefits as it can be cheaper for industrial and commercial users to recycle water than to purchase water from the MCGM. A study done by the Bombay Community Public

Trust highlights the case of Chhatrapati Shivaji Terminus of the Central Railway which since 1999 has recycled waste water for the washing of their concrete platforms, and are able to save Rs.8 per 1000 L in operational costs as a consequence.[11]

- **Water conservation.** In addition to making improvements to existing infrastructure in order to prevent water loss through leakages and theft at the municipal level, basic care in individuals' everyday practices can also ensure a significant reduction in water demand.
- **Underground water project.** Whilst proximity to the sea means that there is limited scope for groundwater extraction to increase the water supply for Mumbai, the underground water project aims to increase water supply by 850 MLD. The municipal corporation will be introducing a zero maintenance pipeline to solve Mumbai's water shortage. This project will require digging a tunnel 150 feet below the surface of the earth the pipeline will be built using German technology and will supply the same amount of water. It will use less steel and will eventually result in better water pressure. Currently, Mumbai gets its water from pipelines that are 100 years old and is 16 kilometres long but the new pipeline is only 6 kilometres long and vows to solve the city's water shortage.[12]

As Mumbai relies on rain-fed sources for its water supply, climate change will play a significant role in water availability in the future. There is a great deal of uncertainty about how exactly rainfall patterns will be affected, also because of the range of pathways that the international community considers. Whilst the predicted changes in total rainfall are marginal[13], it is anticipated that rainfall events will become more intense, placing pressure on the storm-water drains. It has also been suggested that potential increases in droughts in areas surrounding Mumbai have the potential to trigger increased migration into the city. This will place further demand on water sources; in addition to reducing the water supply from those drainage basins that provide Mumbai's water.

Further to this discussion, environmental quality is the principal aspect of assimilative carrying capacity. Water quality is a key component of this, as poor water quality

suggests that the environment is unable to absorb the pollutants emitted. Biological oxygen demand (BOD) is the major indicator of water quality, and the Government of India has standards for acceptable BOD levels. For inland waterways, these standards are exceeded in 70% of locations, whilst 12 out of the 14 sampling locations in the sea also exceeded the acceptable levels[14]. This issue is closely related to that of sewage and sanitation: as a result this is discussed further in the following chapter.

References:

1. WHO: Water, sanitation and hygiene. http://www.who.int/water_sanitation_health/en/
2. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
3. Ministry of Urban Development (1999) Manual on Water Supply and Treatment. http://cpheeo.nic.in/
4. Risbud, N. (2003) Urban Slums Reports: The Case of Mumbai, India. Global Report on Human Settlements
5. Karn, S; Harada, H. (2002) Field survey on water supply, sanitation and associated health impacts in urban poor communities – a case from Mumbai City, India. Water Science and Technology 46(11-12) pp269-275
6. MCGM (2002) Environment status of Brihanmumbai 2001-2002.
7. Sekhar, V.C. (2003) Water contamination in city reaches alarming levels, Times of India 10/07/2003 http://timesofindia.indiatimes.com/articleshow/68301.cms
8. Dixit,R. (2002) Ill wind blows city no good Times of India 19/10/2002. http://timesofindia.indiatimes.com/cms.dll/articleshow?artid=25697331
9. Bombay First; McKinsey and Co. (2003) Vision Mumbai: transforming Mumbai into a World-class city.
10. Sule, S. Understanding our Civic Issues: Mumbai's Water Supply Bombay Community Public Trust
11. Sule, S. Understanding our Civic Issues: Mumbai's Water Supply Bombay Community Public Trust
12. NDTV Mumbai 29th may 2008 (Ketan Vaidya)
13. Kumar, K; Sahai, A; Kumar, K; Patwardhan, S; Mishra, P; Ravadekar, J; Kamala, K; Pant, G. (2006) High resolution climate change scenarios for India in the 21st Century. Current Science 90(3): pp 334-345
14. Maharashtra Pollution Control Board (2006) Environment Monitor: activities and achievements of the board 2005-2006.

4.3. Sewage , Storm Water and Municipal Solid Waste

In any city, infrastructure for the removal and disposal of sewage, waste water and solid refuse is essential: Without adequate provision for the same there are a range of negative impacts on the environment and public health. These relate to the assimilative capacity of the environment to absorb pollutants: Without adequate possessing to lessen the harmful impacts of those pollutants, this assimilative capacity is reduced. Consequences for the environment include unpleasant odours, litter and polluted water. As expected majority of the public health issues are associated with poor sanitation. For example, without the adequate provision of toilets, open defecation allows the spread of many diseases. Flies and other vectors are able to transfer bacteria and disease causing germs from faeces to food. As health is such a fundamental part of human wellbeing, it is essential that this issue is addressed in a report on the carrying capacity of Mumbai.

Summary

2001-02

- Drainage network is operating at 80% of capacity
- Only 59% of the generated sewage reaches the drainage network
- 33% of population are provided with sewage collection services
- Of 7500 MTD municipal solid waste produced, 6260 MTD (83%) are collected by MCGM
- BOD of inland and sea water exceeds standards as set by GOI

The Future

- Waste water projected to increase in line with water demand projections
- Total treatment capacity planned for 2025 is 2,600 MLD
- Waste production per capita to grow by 1-1.33% per year
- Existing landfill sites expected to reach capacity by 2010-12
- Need to increase provision of recycling

4.3.1. Waste water:

The drainage network of Mumbai consists of a series of wastewater treatment works (WWTW). There are in total 7 sewage treatment plant operational and catering to the need of Greater Mumbai. The treatment sites process sewage before discharging the water into

the Thane Creek and the Arabian Sea via outfalls at Malad, Bhandup, Bandra and Colaba. In dry weather, the capacity of these outfalls is 2284 MLD and serves to drain sewage levels of 1836 MLD[1]. Overall, currently the drainage system is operating at approximately 80% of its capacity. It is pertinent to note that, the drainage network does not capture all of Mumbai's sewage; nor is all the sewage captured processed by the WWTW. The treatment in these plants involves multiple stages. The floating material is screened and inorganic solids are separated from the waste water stream. Further the organic solids are treated bio chemically to reduce the Bio Chemical Oxidation Demand (BOD). The final effluent would then be discharged to creek or sea. The graph below (Fig 4.3.1) demonstrates the lacunae in the treatment process and how majority of the wastewater is being discharged without any treatment per se. In 2002, although 52% of sewage was given preliminary treatment (i.e. screening and grit removal), only 15% was treated to 'consent standard'. [2]

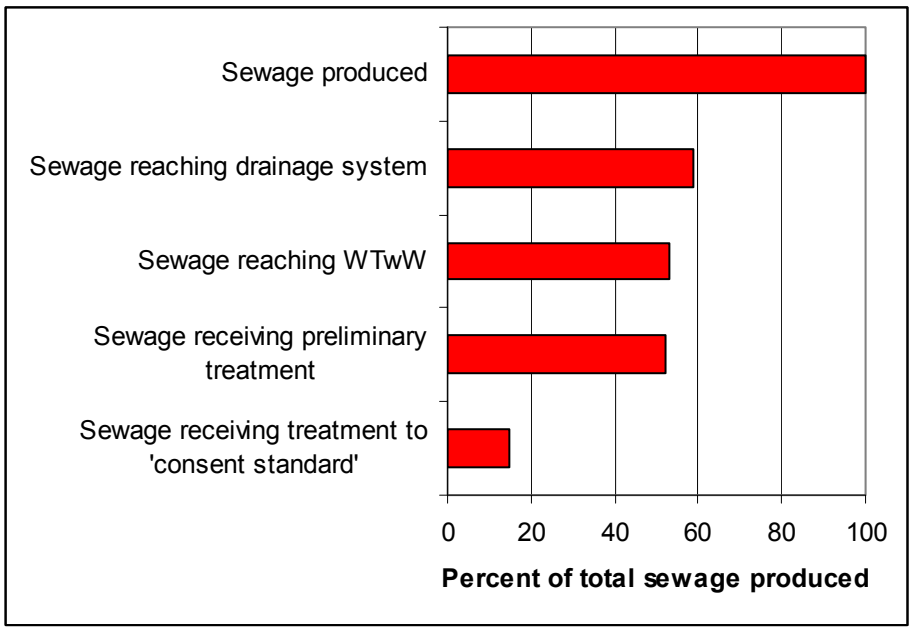


Figure 4.3.1: Treatment of sewage in Mumbai, 2002

Source: BSDP (Stage II) Master Plan

It should however be noted that since this data was collected, improvements to the system have been made. Now almost 50% of sewage is treated to 'consent standard' [3]. It is found that 41% of sewage generated by Mumbai does not enter the drainage network. Majority of this waste is generated by the slum population. The lack of adequate sanitation facilities in

the slum areas leads to 28% of slum dwellers defecating in the open [4] (Fig 4.3.2). The provision of public toilet blocks in such areas is poor, with one report in 2003 suggesting that even if such facilities were present they were in usable condition. If one were to consider that all provided facilities were in usable condition, still they would only meet 50% of the demand in these regions [5].

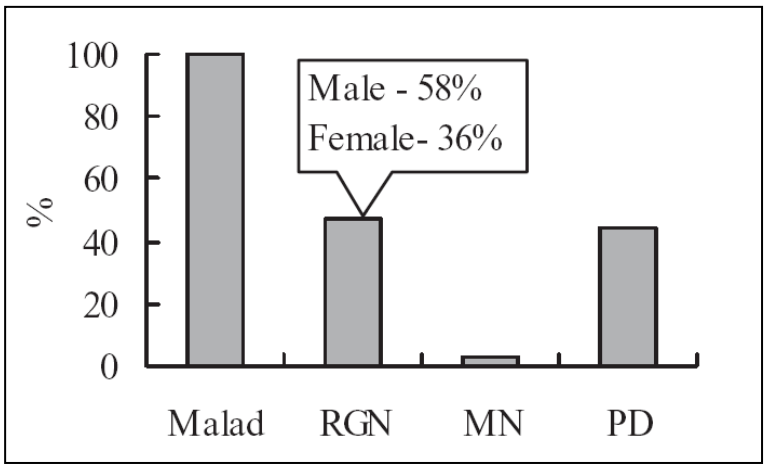


Figure 4.3.2: Percentage of slum dwellers practicing open defecation
(RGN = Rajiv Gandhi Nagar, Dharavi;
MN = Mukund Nagar, Dharavi, PD = Pavement Dwellers)

Source: Harn and Harada, 2002 [6]

The discharge of untreated or inadequately treated sewage and waste water into nallahs, creeks and the sea has had serious environmental consequences for Mumbai. Deteriorating water quality has been observed in many areas: Biological Oxygen Demand (BOD) a key indicator of water quality exceeds the acceptable levels in 12 out of 14 sea water monitoring sites, whilst the poor water quality in many of the nallahs and creeks is well-documented [7].

In the future, it is clear that the drainage network will need to be expanded, to provide adequate facilities to the population of Mumbai. By doing this, as well as increasing the capacity of the WwTW to ensure treatment of sewage to consent standard, it will be possible to improve the quality of inland and sea water. This will as a result also reduce the negative effects on public health. Commissioned in 2003, the Bombay Sewage Disposal Project – Phase one (BSDP I) is expected to yield improvements to the Mahim Bay and Thane Creek areas. Phase II of the BSDP involves progressive improvements to the drainage network and treatment system, with the aim of meeting discharge standards for 2,600 MLD by 2025. In particular, the Master Plan suggests that the 25-30% of the Rs.56 billion budget that is earmarked for improving slum sanitation will bring benefits to over 50% of the population [8]. The plan takes into account projected sewage levels up until 2025: These are

based upon water consumption projections that are in turn based on population and consumption levels.

4.3.2. Storm Water

The failure of the Storm Water Drainage (SWD) System in Mumbai in coping with the torrential rains on 26th and 27th July 2005 has generated lot of interest in the subject. It has been necessary to investigate into the aspect of the capacity of the present Storm Water Drainage System and to forecast the level to which the present capacity needs to be enhanced for the safe collection and disposal of runoff to be generated by rainfall expected with a reasonable frequency of occurrence. The capacity of other infrastructural systems, such as water supply, transportation, housing, electricity, tele communication, etc. to support population is linked to the degree of adequacy of the SWD system in Mumbai.

Summary

Existing

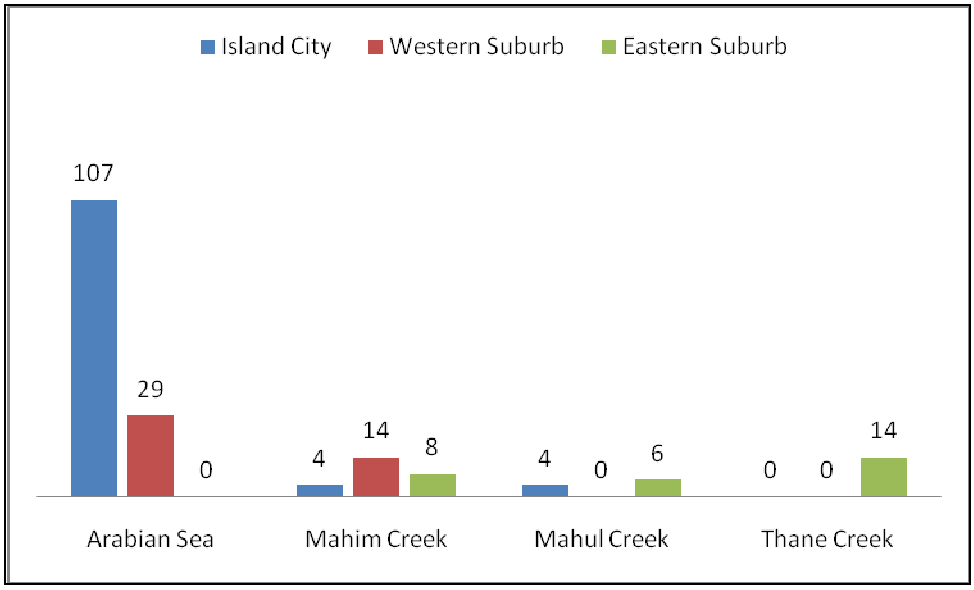
- Greater Mumbai has 38 major nalla systems with 7 in the Island city, 17 in the Western Suburb and 14 in the Eastern Suburb.
- Greater Mumbai has 186 storm water drain outfalls into the Arabian sea, Mahin Creek , Mahul Creek and Thane Creek. The distribution of these outfalls is shown in Fig. 4.3.3

The future

- MCGM now intends to execute Priority works from BRIMSTOWAD in stages and consultants will be updating BRIMSTOWAD

The capacity of a SWD System solely depends upon the volume of run off to be collected and disposed off. Obviously, it has no direct connection to parameters such as population or past or future time. The run off in turn depends upon rainfall intensities and durations of rainfall storms. The pattern of rainfall intensities, durations of rainfall storms and their frequencies of occurrences are expected to fairly remain the same over number of years in the past and future for a given city. The capacity of the various drains in a SWD system is the run off volume they are able to carry for a given frequency of occurrence of rain storms.

Fig. 4.3.3. Distribution of Storm Water Drain Outfalls in Greater Mumbai



The length of Nallas and Drains in the extsting Storm Water Drainage System of Greater Mumbai cover a distance of 2882.91 km and is distributed as shown in Table 4.3.4 below.

Length in Kms				
	Island City	**Western Suburb**	**Eastern Suburb**	**Total**
Major Nallas Width > 1.5 m	8.55	101.51	90.20	200.26
Minor Nallas Width < 1.5 m	20.76	42.10	66.40	129.26
Road side Open Drains	20.00	1297.50	669.48	1986.98
Closed pipe Dhapa Drains	443.18	86.03	36.20	565.41
			TOTAL	**2881.91**

CAPACITY OF SWD SYSTEM IN SOUTH MUMBAI

The existing SWD System in South Mumbai had been designed in the British days to carry run off resulting from a Rain Fall Intensity of 25 mms/ hr for all durations of storms. This rainfall intensity is very frequent and is equaled / exceeded many times in a year with resultant flooding of many areas. The following table illustrates this point.

Drain For	**No. of times per year when 25 mm / Hr. is met or exceeded**	**Concentration Time (Minutes)**
Smallest Catchments	100	10
Small Catchments	40	20
Medium Catchments	20	30
Large Catchments	5	60

The frequent occurrence of the rainfall with an intensity of 25 mms /hr as illustrated above results in frequent flooding and indicates the designed SWD System with inadequate capacity.

The Central Public Health &Environmental Engineering Organisation (CPHEEO) of the Ministry of Urban Development, Government of India has certain norms for design of SWD systems. These norms specify that Residential areas in peripheral regions need a SWD design to accommodate the highest rainfall frequency of twice a year. Similarly in Central residential areas it should be designed for once a year and Commercial / High priced areas should be designed as per occurrence of once in two years. It is seen that the design of South Mumbai SWD System does not satisfy CPHEEO Guide Lines. In fact the CPHEEO Guide Lines themselves need to be revised in the light of the 26/7/2005 situation. The design frequency for Mumbai may be changed to once in ten years.

CAPACITY OF SWD SYSTEM IN NORTH MUMBAI

This system in North Mumbai mostly consists of naturally occurring Nallas though in the last ten years, storm water drains along some roads have been laid. Some Nallas have been rehabilitated and trained. However, the capacity of this system also has to be increased based on Rain fall intensities for 1 in 10 year frequency.

The MCGM commissioned a Technical Report BRIMSTOWAD which was prepared by consultants between 1990-93. The Report formulated proposals for Rehabilitation and Augmentation of SWD System for Mumbai. MCGM now intends to execute priority works from BRIMSTOWAD in stages and consultants will be updating BRIMSTOWAD.

Proposals for very small local drains are out of the scope for BRIMSTOWAD. The design of the local drains would have to be carried departmentally using rainfall intensities based on above safe frequencies of occurrence .

Proposals for larger SWD System are based on a frequency of occurrence of twice in a year in BRIMSTOWAD. The proposals use this frequency for design of all large drains and pumping stations and for widening of Nallas. This satisfies CPHEEO norms. However again

from 26/7/2005 experience, and on the basis of fresh rainfall studies during updating of BRIMSTOWAD, consultants are having a second look at this frequency . If the frequency is updated, it will go a long way towards having an adequate SWD system for Mumbai.

References:

1. Rainfall Analysis for the Design of Storm Sewers in Bombay; S. D. Chawathe et al, Journal of Institution of Engineers (India), EN, Oct. 1977
2. Rainfall Intensities and 26/7 floods in Mumbai; JIWWA, VOL. XXXVII, Jul-Sept 2005
3. Final Report of Fact Finding Committee on Mumbai Floods; Govt. of Maharashtra, March 2006s

4.3.3 Solid waste:

Civic services, including the collection and disposal of solid waste, are provided by the elected local government, the Municipal Corporation of Greater Mumbai (MCGM). MCGM employs over a million people and has an annual budget of approximately Rs. 55 billion ($1.2 billion) [9] The 2006-07 budget of the Solid Waste Management Department of the MCGM was Rs. 7.4 billion ($165 million), and is expected to increase to Rs. 7.8 billion ($174 million) in 2007-08. (10) The municipal corporation spends roughly Rs. 1,160 per ton ($26/ton) on collection, transport, and disposal of MSW. Collection and transport together constitute Rs. 902 ($20) or 78% of the cost, while disposal only costs Rs. 258 ($6/tonne) or 22% of the total cost of one ton of MSW. [11]

In 2001, Mumbai generated an average of 7,025 million tonnes per day (MTD), of which only 5,785 MTD is collected and land-filled [12]. The existing network system for collection and disposal of solid waste involves over visits to around 4,300 waste collection sites and over 1,000 daily trips made by refuse collection vehicles which then transport the collected garbage to the land fill site [13].

As seen from the statistic above 10% of solid waste generated by Mumbai is not disposed of through proper channels. One major gap that has been reported is the lack of collection from slum areas. Only 36% of slums have garbage collection, meaning that the majority of

the 1,240 MTD that is effectively dumped onto the streets of Mumbai comes from this source. The problems faced in Solid waste management in Mumbai are not restricted only to the lack of garbage collection. The municipality of Mumbai does not have a formal recycling program or recycling facilities. However, there is a thriving informal recycling sector that is primarily made up of rag pickers. The rag pickers collect recyclables from MSW and then sell them to recyclers. This sector is considered to be 'informal' because it is not controlled by government agencies and there are no regulations for pricing of recyclable materials or to protect the health and safety of the rag pickers. Nevertheless, their work reduces MSW transportation costs, provides raw materials to recycling facilities, and helps to protect the environment. [14]

There exist serious concerns with the sites of disposal themselves. The issue of landfill site is important for two key reasons. Firstly, as figure 4.3.3 below demonstrates, Mumbai's landfill sites are rapidly approaching the end of their usable life leading to the need for identification and preparation of suitable sites for the future. Although on paper the current landfill sites are shown to be viable and functional for the next few years in certain cases such as in Gorai they have already reached their planned capacity. Accordingly, Gorai has been closed down. Another major concern with the landfill sites is the lack of waste processing facilities, or even basic segregation prior to landfill. The garbage collected is just dumped as is at these sites meaning that the opportunity for possible recycling of waste is lost.

Landfill Site	Years in use*	Years remaining*
Deonar	51	9
Gorai	16	2
Mulund	16	2

Figure 4.3.4:
Landfill sites in Mumbai *as of 2002

Source: MCGM

As is the case with the drainage network, it is clear that the volume of solid waste generated by Mumbai will increase in the future: In addition to population growth, Shekdar predicts that across the whole of India waste production will increase by an annual increment of 1.33% [15]. By combining this estimate with Mumbai's current figure for per-capita waste

production level of 630 g per day and the MMRDA's population projections, figure 4.3.4 demonstrates that the Municipal Solid Waste generation will increase to almost 13,000 MTD by 2021. This figure might be an overestimate since the projections have been based on an over-estimation of the actual waste produced and also because of the way the MMRDA has calculated the population of Greater Mumbai. There may be an over-estimate of approximately 500 MTD. Despite this, the graph demonstrates how additional capacity must be found to augment the current waste disposal infrastructure. Alternatively, sustainable solutions must be found. Separation of garbage at source into biodegradable and non-biodegradable categories would itself lead to a dramatic reduction in the amount of garbage that is required to be disposed of. The MCGM must support efforts to decentralise garbage treatment and must grant incentives to citizens to compost or treat their wastes locally. Recycling of building debris should be a top priority of the MCGM. Above all, utilising existing green spaces, forest areas, areas within CRZ and particularly areas that are covered with mangroves (such as Kanjur Marg), must be actively discouraged.

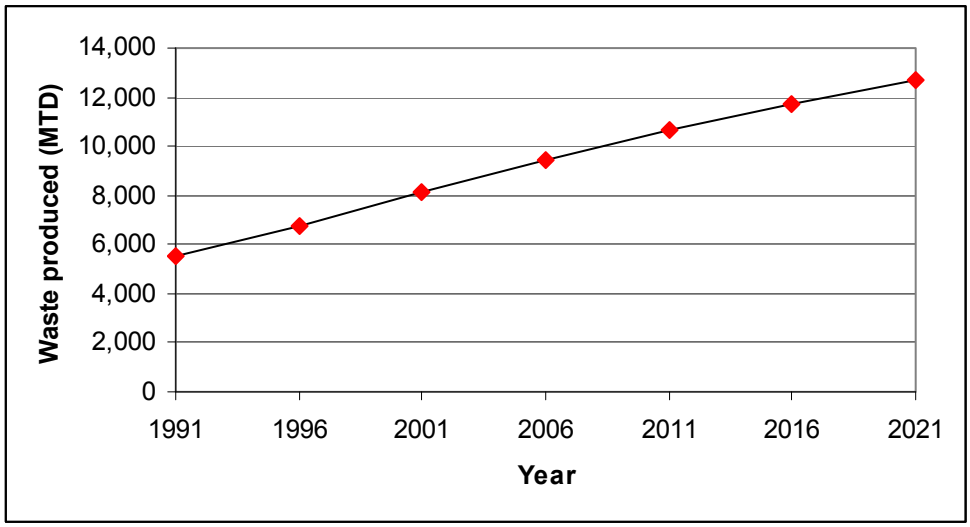
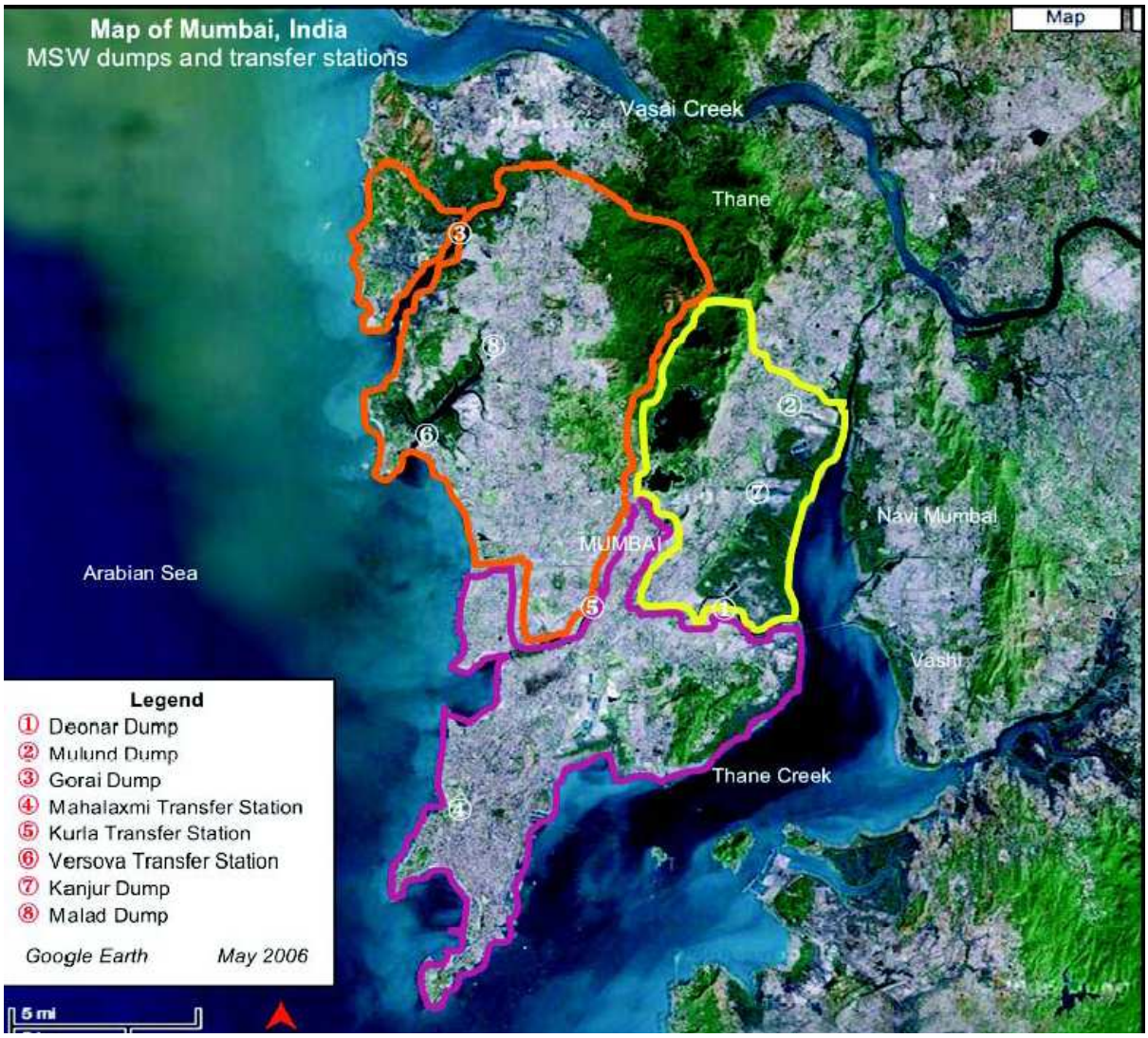


Figure 4.3.5: MSW projections

Source: MMRDA, Singhal and Pandey

The identification of a new landfill site and the preparation of the area are critical. In addition to this in order to utilise the site to its maximum capacity adequate measures need to be taken. Holistic planning is required for Municipal Solid Waste disposal. This cannot be achieved by any single measure or ad hoc decisions. It is very important to recognise the

need for garbage segregation and recycling and incorporate the same in the waste disposal routine. One conservative estimate is that 17.2% of waste reaching landfill is recyclable [16], and if greater efforts are made to implement appropriate policies then diversion of such materials from landfill would alleviate the pressure on them. The issue of waste-to-energy too is a critical point to be considered and implemented. Some experts have also suggested a more community-based approach to waste management. It has been found that when the MCGM disposes of waste without participation from other actors, it costs Rs.1908 per tonne, however when Public Private Partnerships are involved the cost falls to Rs.1797. With community involvement cost reduces further to Rs.1508. Hence involvement of the community would mean that a potential saving of over 20% per tonne, this money could further be reinvested on improvements to the disposal infrastructure [17].



Source : Bhada and Themelis 2008 (18)

4.3.4 Biomedical Waste

Bio-Medical waste (BMW) encompasses a wide variety of waste products generated as a result of human activities in the hospitals, pathology labs, animal houses, in pharmaceutical and other related industries, abattoirs or slaughter houses, diagnostic centers etc. Although not included in the standard definition, the bio-medical waste is also generated at the domestic level in the form of sanitary pads, diapers, cotton swabs and gauges, disposable razors etc. This kind of waste, however, is being mistreated and mismanaged causing serious health hazards not only to the healthcare personnel, but also to the community. Although, BMW includes the waste produced by the living organisms because of human activities, more attention and emphasis is being given on the management of the BMW generated in the healthcare centers or hospitals. [19] Hospitals in Mumbai pay the BMC Rs 18 for every kilogramme that is disposed off. [20]

Mumbai has earned the dubious distinction of being the only metro without a bio-medical waste treatment facility in the country. All the bio-medical waste in Mumbai is disposed in Taloja treatment unit, which, according to MPCB, flouts the Central Pollution Control Board (CPCB) norm. "Mumbai is the only city now in the country without a facility. We can stop sending bio-medical waste to Taloja any day, as the city civic body is supposed to have one for its own. But we cannot force the city into a disaster and purely on humanitarian ground, we are forced to allow this," said regional officer MPCB, Bharat Nimbharte. [21] The Maharashtra Pollution Control Board's (MPCB) status report on biomedical waste management admits little had been done in a long time till an autoclave facility was set up in Sewri. That too has been closed down since November 2003 as people in the vicinity feared that smoke from there was a health hazard. [22] An MPCB proposal to set up three waste management facilities in the city and suburbs has been pending with the BMC. [23] According to a study as many as 16 hospitals in Mumbai have been found to be flouting the norms for disposal of bio-medical waste. These include four government hospitals, seven of the BMC and five private hospitals. [24]

In June 2008, the BMC proposed to set up a bio-medical waste treatment plant (BMWTP) at Deonar dumping ground where the bio-medical waste generated from municipal and private hospitals and medical institutions would be stored and disposed. The BMC said it will soon start developing the common disposal facility over 4,000 sq metre of land at Deonar. The work has been awarded to SMSL-Watergrace Products (joint-venture) on BOOT

(build, own, operate and transfer) basis for 20 years. The Bombay High Court had came down heavily on hospitals not complying with Bio-medical Waste (Management and Handling) Rules, 1998, and had sent notices to erring hospitals, including the civic KEM and Bhagwati hospital and state-government's JJ hospital. The court had stated that such hospitals would be ordered to close down if they failed to comply with the rules within the stipulated time. The facility would be developed in consultation with the Maharashtra Pollution Control Board (MPCB) which had suggested that the BMC review the policy for bio-medical disposal by appointing a separate operator for collection, transportation and treatment system instead of separate agencies. The civic administration also decided to appoint division wise contractors to transport and treat the anatomical waste at Taloja, but MPCB suggested that there should not be separate agencies for collection/transportation and another for disposal. [25]

The residents of Deonar were against the setting up of the BMWTP in the area. The BMC however went ahead with the installation. According to additional municipal commissioner Mr. R.A Rajeev the bio-medical waste treatment plant has been made operational to treat the waste coming from municipal hospitals. Corporator M-east ward Mohammed Farooque said “When we visited the site with ward committee chairman Suresh Patil, we found that the air pollution control meter was missing in the plant.” [26]

References:

1. MCGM (2002) Environment status of Brihanmumbai 2001-2002.
2. Mott MacDonald – R.V. Anderson Associates (2002) Bombay Sewage Disposal Project: Phase II Master Plan
3. Mott MacDonald – R.V. Anderson Associates (2002) Bombay Sewage Disposal Project: Phase II Master Plan
4. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
5. Nitti, R; Sarkar, S. (2003) Reaching the poor through sustainable partnerships: the slum sanitation program in Mumbai, India. World Bank Urban Development Division
6. Karn, S; Harada, H. (2002) Field survey on water supply, sanitation and associated health impacts in urban poor communities: a case from Mumbai City, India. Water Science and Technology 46(11-12): 269-275
7. Maharashtra Pollution Control Board (2006) Environment Monitor: activities and achievements of the board 2005-2006

8. Mott MacDonald – R.V. Anderson Associates (2002) Bombay Sewage Disposal Project: Phase II Master Plan
9. Municipal Corporation of Greater Mumbai. Deliberative Wing – City Government. Online. http://www.mcgm.gov.in/forms/Masterdisplay.aspx?slmno=MQ%3d%3 d-Yh62L2fcsbg%3d, accessed January 28, 2007.
10 & 11. Shrotriya, D.M. 2006-07. Executive Engineer, Municipal Corporation of Greater Mumbai – Solid Waste Management Department. Personal communication.
12 & 13 MCGM: Greater Mumbai City Development Plan 2005- 2025 (Viewed on 15 May,2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
14. Jain, S. 2006. Forgotten caretakers of our cities. The Hindu, January 29.
15. Singhal, S; Pandey, S. (2001) Solid waste management in India: status and future directions. TERI Information Monitor on Environmental Science 6(1): pp1-4
16. Yedla, S; Kansal, S. (2003) Economic insight into municipal solid waste in Mumbai: a critical analysis. International Journal of Environment and Pollution 19 (5): pp516-527
17. Rathi, S. (2006) Alternative approaches for better municipal solid waste management in Mumbai, India. Waste Management 26(10): pp1192-200
18. Bhada P. and Themelis N.J. (2008) Potential for the First WTE Facility in Mumbai (Bombay) India. Proceedings of NAWTEC16, 16th Annual North American Waste-to-Energy Conference May 19-21, 2008, Philadelphia, Pennsylvania, USA
19. Joshi S., Walawalkar V., HajirnisV., Date P. and Kadam R. Managing Municipal Solid Waste: Special Focus On Bio-Medical Waste Management – A Case Study. pdf
20. Iyer M. (2002) Waste management: Tata hospital makes a killing. TNN 24 October
21. Aditya Ghosh (2006). Mumbai lone Indian metro sans biomedical waste treatment plant. Hindustan Times, 8 November
22. Vijapurkar M. (2005). Biomedical waste turns a huge health hazard in Maharashtra. The Hindu, Jul 04, 2005
23. TIMES NEWS NETWORK (2006): BIOMEDICAL WASTE DISPOSAL, Govt told to act against hospitals. Times of India Mumbai; Sep 28.
24. Express news service (2008) '16 hospitals in Mumbai found flouting bio-medical waste disposal norms.' Apr 09.
25. Express news service(2008) By June, common bio-medical waste treatment facility at Deonar, April 09
26. Baliga L. (2009). Deonar fumes over incinerator smoke. DNA, 24th June

4.4 Energy

Energy has been identified as one of the two most important inputs for economic growth [1]. Whilst the link between economic growth and development is often disputed, energy provision is important in determining the future living standards of the people of Mumbai. The supply of energy (and in particular electricity) is an important component of the basic

standard of living, since electricity is linked to the provision of various levels of comfort and convenience at the domestic level. Given the importance of energy for much of the infrastructure of Mumbai, including street lighting, hospitals and public transport, it becomes clear that electricity supply to Mumbai is a key component of Mumbai's carrying capacity. With inadequate supply being faced by the entire state of Maharashtra, there is the potential for Mumbai too to suffer load-shedding. This in addition to the inconvenience for millions of people can be of great cost to the economy. There are very few studies on the cost of such power failures, however it has been estimated that an one-hour power disruption to the whole of the Netherlands (occurring during working hours) would cost the country $ 247million [2].

Summary

2005-06*

- 97.9% of households in Mumbai have electricity supply.
- Supply of 10,822 million UNITS; or 908 kWh per capita, per year.

Additional information

- Summer time shortfall of approximately 600 MW leads to overdrawing from the Maharashtra grid. The consequence is that other areas of the state are subjected to load-shedding.

The Future

- Population growth and increasing consumption levels will lead to further increase in demand for electricity.

Three companies - Tata Power Company, B.E.S.T. and Reliance Energy - have been given the mandate to supply electricity to the Island City and Suburbs respectively. In 2005-06, the two companies supplied a total of 10,822 million units of electricity to domestic, commercial and industrial consumers, effectively 75.7 units per person per month [3]. To put this into context, 300 units per month is the cut off point for the cheapest energy tariff. The coverage of the supply network across the city is widespread, with 97.9% of households having access to electricity [4]. Energy supply to Mumbai is consistent, with rare instances of load-shedding. Problems are faced during the summer months due to high demand from air-conditioning units across the city. Supply capacity between April and June of 2005 was 2,277 MW: with demand of 2800 MW this represents a shortfall of almost 600MW (also an increase from the short fall of 400MW the previous year) [5]. The Times of India reported in

2005 that since 1995, no new power production facilities had been set up despite a 10% increase in demand during this decade [6]. Still, despite the shortfall, Mumbai is able to avoid serious power cuts by over-drawing on the Maharashtra grid. As a consequence of this, the power supply problems of Mumbai are transferred to other areas in Maharashtra. The fact that the rest of Maharashtra is subjected to severe load-shedding at times of peak demand suggests that Mumbai's electricity consumption has far exceeded the capacity of the supply infrastructure. The negative consequences of this however are suffered by the rest of Maharashtra rather than Mumbaikars themselves.

In the future, clearly, population growth will lead to an increase in electricity demand (and demand for energy in general). However, there are many other factors that affect energy demand that must be taken into consideration. Economic growth encourages consumption. With greater levels of disposable income, people are able to purchase luxury goods such as electrical appliances leading to an increase in the demand. The graph below (Fig. 4.4.1) demonstrates how electricity expenditure increases with household income. Although the data is taken from nearly 20 years ago, it demonstrates that as incomes increase, it is likely that electricity demand will grow. This is a trend observed in many developing countries where, in addition to an increase in domestic demand, commercial and industrial expansion places further pressure on the system.

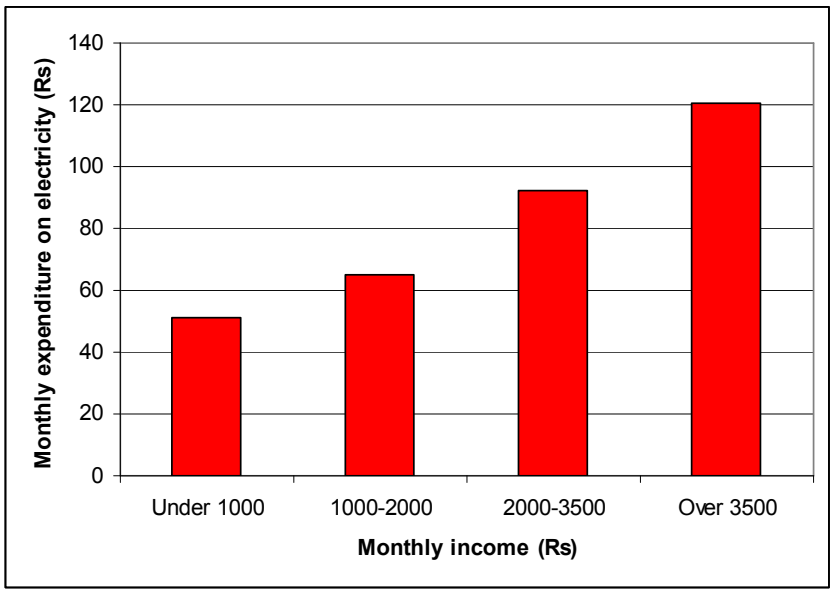


Figure 4.4.1:

How electricity consumption increases with monthly income.

(Source: Tiwari, 2000 [7])

In order to meet the demands of the current population and the future energy demands of Mumbai, there are a range of steps that have been identified. B.E.S.T. and Reliance report distribution losses of 11.5% and 13.4% [8, 9] respectively. Although this compares favourably to the rest of India (23% [10]), it is significantly higher than the global average of 6-9%. Steps have been uninitiated to solve this issue of distribution loss. The need to increase energy efficiency is vital. It has been estimated that producing 1 MW of electricity from new power sources will cost Rs. 3-4 crores. Whilst efficiency increases can offer cost savings to end users at the same time it can also reduce overall demand [11]. The Greenpeace 'Switch for Mumbai' campaign demonstrates this by focusing on low energy light-bulbs: It is seen that if 4 'old style' incandescent light-bulbs are replaced with an equal number of energy saving models, and used for 5 hours per day, monthly savings of 30 units (equating to Rs.120) can be made [12]. Although there are many ways in which energy demand can be reduced, it is clear that new energy sources must be found to ensure that Mumbai has enough electricity for its population. This must be achieved in a cost-effective way that also takes environmental considerations into account. One such source that has been suggested is waste-to-energy plants. These have the dual benefit of providing a source of energy and at the same time diverting waste from landfill. One study suggests that Mumbai has the potential to generate 22 MW of power from 1000 tonnes of municipal solid waste by incorporating waste to energy plants [13]. This, despite the fact that all past efforts to do this, have failed miserably. Additional eco- friendly non- conventional sources of power viz. wind plus solar power should also be considered within the city. During the non- monsoon months solar panels would work effectively and the meet the increased energy demand in these months. Incentives provided to builders and societies would help encourage the use of alternative sources of energy and if implemented successfully can considerably reduce the demand.

References:

1. Kakodkar, A. (2005) Energy in India for the Coming Decades. Presentation at the Inter-ministerial Conference on "Nuclear Power for the 21 Century" organised by the International Atomic Energy Agency

2. Nooij, M; Koopmans, C; Bivjoet, C. (2007) The value of supply security The costs of power interruptions: Economic input for damage reduction and investment in networks. Energy Economics 29: pp277-295
3. Urban Age Mumbai (2007) http://www.urban-age.net/03_conferences/conf_mumbai.html
4. Census of India, 2001
5. DNA Mumbai 23/06/2008 Here's why you escaped power cuts http://www.dnaindia.com/report.asp?newsid=1172899
6. The Times of India 29/04/2008 Finally, power crisis hits city
7. Tiwari, P. (2000) Architectural, Demographic and Economic causes of electricity consumption in Bombay. Journal of Policy Modeling 22(1): pp81-98
8. BEST: www.bestundertaking.com
9. Reliance: www.rel.co.in/default.asp
10. Kakodkar, A. (2005) Energy in India for the Coming Decades. Presentation at the Inter-ministerial Conference on "Nuclear Power for the 21 Century" organised by the International Atomic Energy Agency
11. Ghosh, S. (2002) Electricity consumption and economic growth in India. Energy Policy 30: pp125-129
12. Greenpeace Switch for Mumbai Campaign: http://www.greenpeace.org/india/switch
13. Bhada, P. (2005) Capacity to act in India's solid waste management and waste-to-energy industries

4.5 Transport

The transport infrastructure of the city enables the population to go about their everyday business. Suitable transport provisions are important for the normal functioning of the city and to ensure that their resources are used to maximise the cities' contribution to national income. The economic ability of cities and the wellbeing of urban inhabitants are directly influenced by mobility or lack of it.' [1] By estimating how well the current road network, and public transport systems (buses and trains) allow people to move around the city, it is possible to judge whether the city's transport infrastructure is operating within its carrying capacity.

The Story in 2001-02[footnote]

- 11,00,000 vehicles (696 vehicles per km of road)
- Average peak-hour speeds of 5-8km/h
- As many as 570 people travel per rail carriage during peak hours: the threshold for 'severe overcrowding' is 350 people.

Additional information

- By 2008, MUTP is expected to have reduced some rail journeys below the 'severely congested' threshold of 350 people per rail car.
- However, this is still significantly higher than the target of 220 people per rail car.

The Future

- Vehicle ownership increases 5-10% per annum

4.5.1 Public Transport:

According to a study supporting the Mumbai Urban Transport Project (MUTP), 88% of Mumbai's commuters travel either by rail or bus: Both the railway as well as the bus service operating in Mumbai operate on a large scale and are accepted as efficient systems of public transport especially when compared to the public transport systems available in the rest of India. Data for the public transport infrastructure relates to the entire Mumbai Municipal Region (MMR) rather than being restrictive only to the region of Greater Mumbai due to the extensive connectivity across the entire area. Per year, a total of 2,089 million journeys are taken on the Western and Central Railways, with a further 1,483 million bus journeys. With 88% of the population using the suburban train network and/or BEST buses, the public transport infrastructure of Mumbai is vital to the functioning of the city. On the trains, the capacity of a 9-car rake is accepted to be 1,700 people, yet during peak hours the number of people travelling can exceed 4,700. The accepted carrying capacity for each rail carriage is said to be 220 people, however (as figure 4.5.1 below demonstrates), during peak hours on the busiest stretch of track the number of people per carriage can reach up to 570. In 2005, Baker et al found that 62% of commuters view crowding on the trains as a serious problem. [The other 38% had perhaps died of suffocation!]. For the bus network, the

McKinsey report recommends increasing the number of buses to 1 per 1,000 of the population, from a level of 0.75 per 1000.

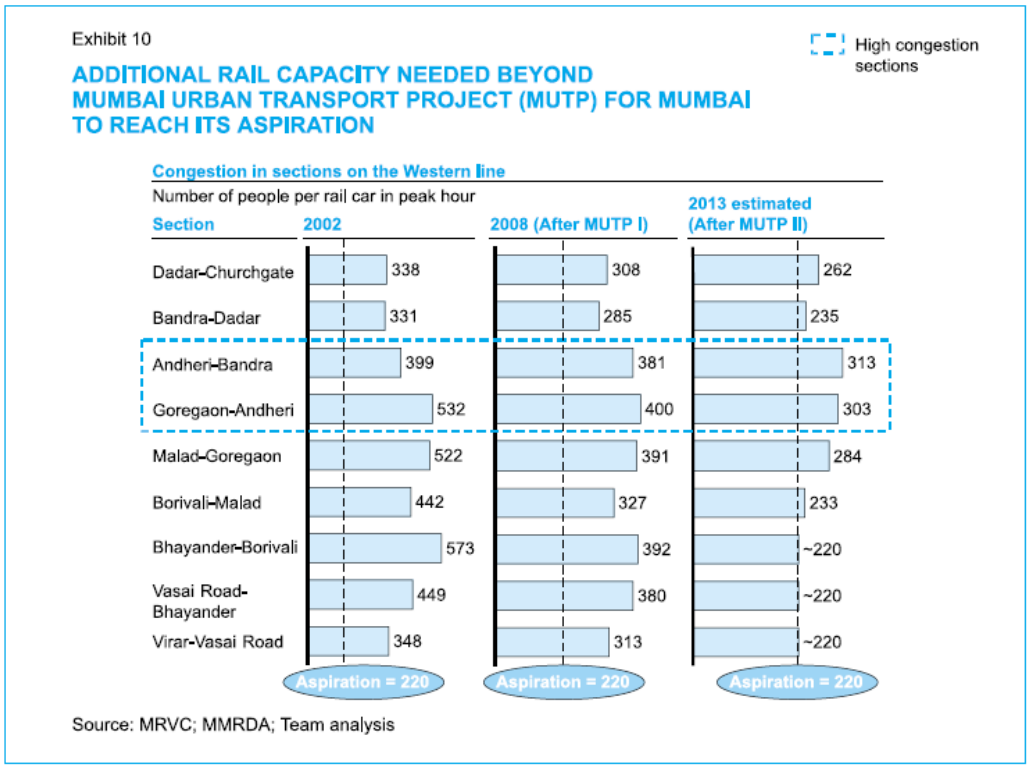
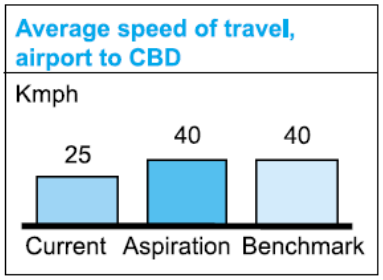


Figure 4.5.1: Overcrowding on the Western Railway Source: McKinsey Report

Mumbai's public transport system is efficient but improvement is an urgent necessity. The city requires large scale movement of people. Good transport promotes better land use; if such large scale movements are based on personalised transport that would involve high costs, excessive energy consumption, and congestion on roads, extended journey times and environmental pollution. To avoid the above mentioned problems the optimisation of the existing road and rail system is crucial. Since the railways offer the most energy efficient, pollution free and rapid mass transit system and that too make the optimum use of scarce land, a well defined strategy needs to be evolved to augment capacity of the suburban railway transport system. [2] It is indeed surprising that no steps are being taken to increase the frequency of trains on the existing suburban network. This step alone will result in achieving more comfortable travel for the train commuters at minimal costs. The introduction of one air-conditioned rake in each train will also encourage car commuters to switch over to trains. People should be encouraged to use public transport. BEST buses do move faster when taxis are on strike. There is therefore a need to reduce the number of

private vehicles on the road so as to enable public transport to move faster. There is no reason why 7% of the people who use private vehicles should be allowed to block 85% of the road space to the detriment of BEST bus passengers. Dedicated bus lanes, particularly BRTS must be introduced on priority basis.

4.5.2 Road Network:



60% trips for work, 31% for education.

45% of households earning more than 20K have a car – as more people join this bracket the demands on the existing road network increases. The access to roads is also limited and skewed.

The road infrastructure in Mumbai is also beyond its carrying capacity. From 1961-2000 there was a 37-fold increase in the number of vehicles in the city, yet the road network only doubled in length during this time. Mumbai has Low vehicle ownership rates in comparison with some cities in the west, but severe congestion problems are seen here – average peak hour speeds seen on the roads of Mumbai are 12-15 kmph. Another issue that is prevalent on the road network of the city is the high accident rate. There is a direct relationship between air pollution and transport network.

MUTP:

Since 2002, the Mumbai Urban Transport Project has been initiated with the aim of alleviating some of the problems described above. The value of this project is to increase the capacity of transport in the city. E.g. by increasing trains from 9- to 12-car rakes. The project is therefore designed as a first step to immediately improve the physical infrastructure in rail and road transportation and strengthen institutional capacity. It also supports the equitable resettlement and relocation of all those affected by these infrastructure works.

Achievements so far:

The World Bank has approved a sum of US $ 542 million for the Mumbai Urban Transport Project (MUTP).The Rail Transport Component aims to improve the capacity and performance of the suburban rail system. This is proposed to be done by providing new

trains and upgrading existing trains, adding some new tracks, and improving signalling, electrical and telecommunication systems. Studies and technical assistance will be provided to improve railway maintenance, financial management, and quality assurance systems in Mumbai. Resettlement of the population dwelling along the railway tracks to permanent or transit housing commenced during the project preparation period itself, and some 10,000 families have already been shifted to permanent or transit housing. [3]

The Road-based Transport Component proposes to support increases in the capacity, efficiency and safety of the road network through construction of two new east-west links across greater Mumbai. In addition to these, better facilities for pedestrians, new advanced traffic signal systems, and improvements to the efficiency and quality of bus services are also objectives of this project. This component will help Mumbai achieve reductions in motor vehicle emission levels and the associated health risks. The project will also enable the relevant agencies to plan, deliver, maintain, and efficiently operate road-based urban transport infrastructure and services. Immediate changes that have been seen as outcomes of this project are: The numbers of trains have been increased during peak hours by about 7 percent; BEST has over 400 new buses, and some of Mumbai's BEST buses began using cleaner diesel instead of regular diesel which cuts down on harmful emissions. The buses use a blended fuel, a bio-diesel which is cheaper than the regular diesel by around Rs. 2 a litre. The new fuel is also being incorporated in the bus fleet of the MCGM. Around 80 buses from the corporation's 3,400-strong fleet are being run on the blended fuel as a pilot project. As part of another project conceived by The Energy and Resources Institute, around half of the 90-odd boat-owners at Mumbai's Gateway of India have begun using this blended diesel in their boats. The boat-owners ply rides to Mandwa and Alibag on the mainland, Elephanta Island and the Jawaharlal Nehru Port Trust, ferry tourists around the harbour [4].This project also foresees the introduction of Bus Rapid Transit System within the road networks where a clear thoroughfare will be established for the buses. This would not only improve the public transport network for the population but also help in reducing emissions from the buses. The conversion of public transport to CNG a cleaner fuel has also been proposed. As measures to improve the infrastructure for pedestrian commuters, they have planned subways at important junctions.

4.5.3 The future:

Population and economic growth are likely to place further demand on the transport infrastructure of the city. Whilst efforts are being made in the form of the MUTP, the McKinsey report finds these inadequate and suggests that further investment must be made to ensure an adequate transport infrastructure according to benchmarks from other global cities. Another significant achievement will be by reducing the need for transport, or reducing the average commuting distance of the population. This will automatically decrease the pressure on the infrastructure. This can be achieved through the development of business districts in the suburbs (such as the Bandra-Kurla complex) that will reduce the need for north-south commuting. It should, however be acknowledged that such developments are sensitive to other issues relating to carrying capacity. In the case of development of the Bandra-Kurla complex a large area of mangroves was destroyed. These mangroves act as natural buffers protecting the city and also serve to reduce the assimilative carrying capacity of the city. Hence adequate planning is required to ensure that while attempting to improve one parameter of the city needs the others should not suffer.

For every extra one million inhabitants in a developing world city, approximately 3.5-4 million public transport trips per day are required to be provided for. [5] The three main factors identified to contribute to increased travel demand are population growth, mobility rate (i.e. change in the number of trips per person per day), and increasing commute length due to physical expansion of the city.

In the future the population needs to be encouraged to shift from the use of privately owned cars to public transport system. In terms of passenger km, a car occupies 38 times more road space than a bus. Buses have been found to be more environmentally favourable making most efficient use of the scarce road space.

The traffic problem in Mumbai can only be reduced if the amount of vehicles plying on the road reduces. The proposed Metro project's main objective is to provide rail based mass transit connectivity to people. This serves the areas not already connected by the existing

Suburban Rail System and connects places within an approach distance of 1 to 2 Km from each other. This project will provide proper interchange facilities for connectivity to areas adjoining Greater Mumbai like Thane, Navi Mumbai, Vasai – Virar etc.[6] The decision to use different gauges for the metro tracks will however result in a situation where it will never be possible to integrate the suburban train services with the metro services. The pricing of the metro tickets, and the frequency at which the metro services will operate are still issues which needs greater clarity.

The existing suburban trains connect the northern and southern parts of the city, but there is huge gap in connectivity between the eastern and western suburbs of the city. The bus services provide connectivity on these routes. The existing public transportation systems viz. suburban trains and BEST buses are saturated though. [7] These systems need upgradation and expansion in terms of service. The new Mass Rapid Transit System will hopefully fill this gap, with improved services lessening the traffic congestion and bridging the gap between eastern and western parts of the city.

Sky walk

Sky walk is an elevated walk way dedicated to pedestrians and connecting the railway Station to commercial areas and such destination points frequented by high concentration of pedestrians. The purpose of the sky walks is for efficient dispersal of commuters from station and such congested areas to strategic locations viz. bus stops, taxi stands, shopping areas, off roads etc. and vice versa. The MMRDA states that this will help decongest the crowded streets of Mumbai. The total estimated cost of the project is about Rs.600 crores. The limitation with the skywalk is that it does not provide facilities for old or disabled people. This could have been simply resolved if adequate thought had been put into the planning of the infrastructure. Allowing hawkers on skywalks also defeats the purpose of having obstacle-free facilities for pedestrians.

Monorail

The monorail system is more environment friendly than other railway or light rail transit systems. It is known to have low visual impact, a narrow guide way structure, stations of pleasing appearance, and rubber-tyre vehicles with low noise and vibration levels. The

MMRDA proposes to implement Monorail Systems in various parts of Mumbai Metropolitan Region (MMR). Monorail as the name suggests is a single rail serving as a track for wheeled vehicles travelling on it. The monorail is a high-speed; high-capacity transportation system. It is not a transit system such as light rail and will operate at speeds in excess of 100 kmph. The proposed routes of this Mono rail system will be from Malabar hill to Bandra Kurla Complex; between Chembur and Mahul; .Lokhandwala Complex to Kanjur Marg; and connecting Thane, Kalyan, and Bhivandi. However, there is no clarity about the date of completion of these projects, or the pricing and frequency of these services.

Station Area Traffic Improvement Scheme (SATIS)

With great numbers using the existing as well as proposed rail network system for their commute, it is important to provide for sufficient infrastructure to cater to the needs of the people around the stations being used by them. The Station Area Traffic Improvement Scheme (SATIS) plans for the same. It provides improved commuter and pedestrian dispersal facilities, transport integration, parking management, intersection improvements, and traffic circulation & management in the areas around the suburban stations. The objective is to provide well planned traffic integration and dispersal system in and around suburban station areas including inter model interchange. The SATIS will also address issues such as parking management, traffic movement around the station and general improvement to the environment. [8] However, in almost all cases, the implementation of these schemes has been delayed.

Sewri-Nhava-Sheva-Sea-Link

One of the world's longest trans-oceanic bridges proposed, the Sewri -Nhava Sheva sea link with an estimated project cost of Rs 6,000 crore has been on the drawing board for more than 25 years. This project has been dogged by controversy from the very beginning and its future is still uncertain.

Another proposed transport connecting Navi Mumbaikars to the city is the passenger ferry service between the New Bombay and south Mumbai mooted by the Maharashtra State Road Development Corporation (MSRDC) found to be technically and economically viable. A study conducted by Dalal Mott MacDonald states that the proposed ferry and ro-ro services between Seawood area in Nerul in Navi Mumbai and ferry wharf off Mazgaon area in South

Mumbai were viable. Dalal Mott MacDonald had been asked to submit 3-4 options of development. While it is proposed that the vessels would be run by private parties, the terminals would be developed by a company formed by the corporation in partnership with other agencies. The proposed ferry craft will have a capacity of 400 passengers each and a ro-ro craft will ferry 40 medium-sized cars, besides passengers, and the distance between Mumbai and Navi Mumbai will be covered in about an hour. [9] As mentioned before, in the implementation of each of these projects it is critical to ensure that all environmental factors are taken into consideration and utmost care is taken to protect the environment.

Bandra Worli Sea Link

The Bandra - Worli Sea link project, which will provide an alternative road link from Bandra in the suburbs to Worli in south Mumbai. The Bandra- Worli Sea Link Project has been one of the most highly recommended projects of all the transport studies done for the metropolitan region during the last thirty years. At present, Mahim Causeway is the only link connecting the western subways with the island city of Mumbai. Therefore this existing North - South traffic corridor is very congested and during the peak hour's frequently results in a bottleneck at Mahim Causeway. This link will hopefully provide an additional fast moving outlet from the island city to the western suburbs. This will also form a part of the western freeway (MSRDC 2005) road network. The problem that dogs this project is that although it will certainly offer high-speed transportation into the city, not much thought has been given to the congestion it could cause. The possibility of there being a bottleneck at both ends of the Bandra-Worli sea link is strong. This problem becomes even more serious when one considers that work on the second phase of the project to extend the Bandra-Worli link into the heart of south Mumbai's old business district – Nariman Point has not even commenced. The island city is considerably narrow at this point. The W. S. Atkins Report (1994) was commissioned by the MSRDC to study the feasibility of the Bandra Worli Sea Link. The result of the report is based on a strategic transportation computer model based on cost and time of travel calibrated for Mumbai. Tests with the model showed that the effect of major new roads in the Island city such as the West Island Expressway (Bandra Worli Sea Link) and the East Island Expressway (Vashi Sewri Sea link) would be to attract considerable additional traffic to South Mumbai. Bringing extra traffic to the South Mumbai area would in turn exacerbate congestion in the Tardeo, Mumbai Central, Opera House,

Nana Chowk and Kalbadevi areas. On the whole it was concluded that these projects would simply tend to shift the bottlenecks around and have little impact on overall system capacity. Persistent congestion in these areas can only be alleviated by managing demand to remain within available capacity. This means that the solution to the traffic problem in Mumbai can only be to reduce the amount of vehicles plying on the road and not by provided more and newer roads. [10] According to the Mumbai Environment Social Group, over 70 per cent of Mumbai's cars carry a single passenger. This amounts to approximately 15 lakh empty seats on the road daily. [11]

Apart from the traffic bottlenecks, the sea link is also affecting the mouth of the Mithi River. In the case of Maneka Gandhi vs. Union of Indian and others, the State of Maharashtra and the MMRDA gave an undertaking that no reclamation would be carried out in the Bandra-Kurla Complex area and no mangrove in the Mithi River and its estuary would be destroyed. There has been a blatant violation of the terms and the conditions of the Environmental Clearance dated 7th January 1999 granted to this project. The ecosystem of which mangroves are an essential part, support a large diversity of flora and faunal elements. The genetic importance of conserving these species for posterity cannot be over emphasized. The mangroves also serve as the lungs for the city. A Report by the Bombay Natural History Society clearly states that reclamation would result in the reduction of the width of the Mahim Bay. [12] The fishing area has been reclaimed causing great hardship to the fishermen who have fished there for centuries. No attempts have been made to adequately rehabilitate and compensate these fishermen for the resultant loss of livelihood. This project has also attracted criticism as improving the road infrastructure benefits only c.10% of the population, many of whom are among the more affluent in society. At what cost should such projects be undertaken? Definitely not at the cost of the larger public and the city in general.[13]

Another approach to reducing the private vehicles plying on the roads can be through making cycle tracks with in the footpaths and maintaining footpaths for short distance commuting. This would encourage people to use bicycles or walk as it would become safer to ride a bicycle on these tracks away from high speed motorized vehicles on the road. This option can also be promoted as an healthier one to the increasingly health conscious population of the city.

Measures To Promote Public Transport

The BEST and the railways have already made improvements in the existing system; the metro will further motivate Mumbaikars to use public transport. Once the public transport system is updated and can provide for the existing people to commute to work easily and comfortably then measures can be taken to dissuade the use of private vehicles. This of course is on the assumption that the population remains constant. If the population increases by the day the city's public transport will not be competent enough provide for the people. New plans such as 'traffic restraint scheme' and congestion tax can be implemented to promote the use of public transport. Singapore has led the way in a similar situation, levying a congestion charge to dissuade individuals from driving to work in busy areas. The toll thus collected is diverted to strengthening its public transport system. The system has been working wonderfully well. In 1995, the Government of Singapore set up the land transport authority (LTA), which merged all the public sector agencies in charge of land transport, previously under different ministries, to spearhead improvements in the land transport system. The LTA's mission established a sustainable land transport system providing commuters with efficient, comfortable, safe and convenient rides at affordable prices. They needed to develop a comprehensive rapid transit network which would transport large numbers of people to their destinations quickly. [14] Hence Singapore first increased and improved public transport and then implemented charges. Other measures implemented in Singapore, have been to cap the total number of private vehicles on the road; to auction number plates for a period of 10 years to owners of private vehicles, and to levy a congestion charge for entry into the CBD areas during specified hours. Other cities such as New York are considering such a move in order to decongest their business and financial hubs. Many of Mumbai's development problems arise from the concentration of the Government offices, business and commercial houses and wholesale markets of all kinds in the southern part of the city. Though initially these provided the impetus for the growth and development of the city, they also aggravated urban problems such as unruly traffic, congested streets and overcrowding. With a view to reducing congestion in South Mumbai, the State Government and the MMRDA decided to shift the wholesale markets located therein. [15] Offices were to be moved to the north. Mantralaya was suggested to be moved into Navi Mumbai. The Bandra Kurla was supposed to have existing offices from South Mumbai to move there; instead it became a new growth area. Mantralaya wasn't moved

despite a Cabinet decision to this effect - perversely, the new Legislative Assembly Building was constructed in front of Mantralaya.

In order to manage the traffic on the roads, bus lanes and car pool lanes, which can be used only by vehicles that are carrying more than three persons, should be promoted. This will allow reducing the number of vehicles on the roads. The government should stop allocating funds that are aimed at building car oriented roads and highways, rather these funds can be used by the cities to build more paths to walk. [16]

The Lal Committee's plan to implement a 'traffic restraint scheme' based on license plate numbers; to impose congestion tax on vehicles; and heavier charges for long term parking will help implement projects like the bus rapid transit system (BRTS) as people will switch to using public transport. Improved public transport could make commutes easier for millions of people. If Mumbaikars can be convinced to adopt public transportation the quality of their lives too will improve and Mumbai will be well on its way in the right direction.

References:

1. Padam, S and Singh, S.K. (2001) Urbanisation and Urban transport in India: The sketch for a policy
2. Bombay suburban railway system -railway board
3. MMRDA: Mumbai Urban Transport Project
   http://www.mmrdamumbai.org/projects_mutp.htm
4. Can good economics clean up Mumbai's air? Rediff news Aug 22 2007
5. Padam, S and Singh, S.K. (2001) Urbanisation and Urban transport in India: The sketch for a policy
6. MMRDA: Mumbai Metro Rail Project.
   http://www.mmrdamumbai.org /projects_metro_rail.htm
7. Mumbai metro one.
   http://www.mumbaimetro1.com/HTML/faqs.html
8. MMRDA: Station Area Traffic Improvement Scheme (SATIS)
   http://www.mmrdamumbai.org /projects_satis.htm
9. Sarngan S.(2006) Ride the waves to Navi Mumbai, DNA, 26 March Anand N. (2006) Disconnecting experience: making world class roads in Mumbai ,Paper 18, presented at the Breslauer Symposium: The Right to the City and the Politics of Space, UC Berkeley. April 14, 2006.
10. Shah G. (2006) Mumbai gears up to drive India's first carpool. DNA, 12 May
11. Short-term project on Eco Assessment of Mangrove Environment of Mahim with respect to current anthropogenic pressures
12. An enquiry into the Bandra Worli sea link project(2001) The Indian People's Tribunal on Environment and Human Right

13. Chew T.C. and Chua C.K. (1998) Development of Singapore's Rapid Transit System and the Environment. Japan Railway and Transport Review 18.
14. MMRDA: Shifting of Wholesale Markets from South Mumbai http://www.mmrdamumbai.org /projects_swm.htm
15. Laffel N. (2006) Promoting Public Transportation for Sustainable Development. WWS 402-S04
16. Baker et al: Baker, J.L. and Denning, W. (2005) Development of a Transport Module for Multi- topic Household Surveys. Transport Papers number TP-5. Washington DC. The World Bank Transport Sector Board.
17. McKinsey Report (2003). Vision Mumbai, Transforming Mumbai into a World class City.

4.6 Education

It is widely acknowledged that education plays an important role in determining a child's future standard of living: Its importance is such that universal primary education is one of the United Nation's 8 Millennium Development Goals [1]. It is also acknowledged that education can play a significant role in helping 'create' the citizens of tomorrow's Mumbai. One such example of this is the role of women's education in developing countries. Numerous studies have demonstrated links of education practices with demographic behaviour, changing consumption patterns and increasing awareness of family planning [2]. The availability and quality of education in Mumbai is therefore an important aspect of Mumbai's carrying capacity. If the infrastructure for education is inadequate it will be manifested in a range of problems in the future. Although secondary and higher education are also important, this report concentrates on primary education as this is a statutory obligation of the MCGM [3].

Summary

2001-02[footnote]

- Literacy rate 77.5%: (above the national and state averages).
- 'Dilapidated and unhygienic' condition of many municipal schools

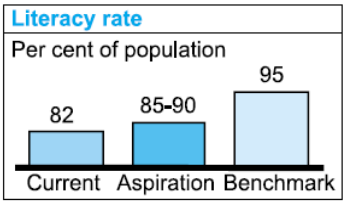
Additional information

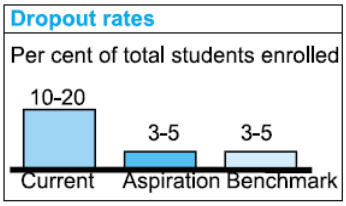
- Student to teacher ratio of 38:1 in municipal schools
- 25% of school dropouts are due to the lack of a school nearby

The future

- Improve quality of education, address social problems behind non-attendance
- Infrastructure needs to follow trends of northward population migration.

At a basic numerical level, the primary education system in Mumbai would appear to be in a healthy condition. Literacy rates for Mumbai are significantly higher than for the rest of Maharashtra and India as a whole [4]. There are 4.85 lakh children being educated in 1188 municipal primary schools by 13911 teaching staff as of 2005, with an additional 4.56 lakh children being taught in another 975 private primary aided and unaided schools [5]. However, there are a wide range of issues that suggest the education infrastructure in Mumbai is inadequate. Literacy rates among the slum population are as low as 60% [6], with numerous factors contributing It is estimated that 25% of dropouts are due to the lack of a school within easy travelling distance from their residence. , This suggests that the infrastructure is not extensive enough to cater for all education demands [7]. However, it should be noted that many of the problems associated with non-attendance are also a product of wider social issues: Juneja identifies the requirement for many children to carry out work for the family, and the lack of a supportive learning environment in the home as two major reasons for this [8].





Figures 4.6.1, 4.6.2:
Literacy and dropout rates for Mumbai
(Source: Mckinsey Report)

The quality of teaching in municipal schools has also been identified as problematic, and this is another key contributing factor to dropout rates as children do not find the learning process interesting or useful. Whilst the overall student to teacher ratio across Mumbai is 38:1, it has been estimated that 39% of classes are of 'unacceptable' size, based on the MCGM's threshold of 55 students [9]. Teaching is difficult in such circumstances. While approximately 30% of non-learning students require special attention to prevent them from dropping out, provision for such attention is lacking. There is a lack of data on class IV pass rates, although there is anecdotal evidence to suggest that these are 'low', and commentators have questioned the extent to which many students make intellectual progress [10].

Information on the future plans for education in Mumbai is limited. It is clear that the demand will increase due to increase in population. However efforts of family planning and birth control may mean that demand does not increase in a linear fashion with population growth. The improvement of the education system is an ongoing process. A number of organisations government aided as well as non governmental are involved in ensuring that the goal of 'every child in school… and learning well' is achieved [11]. The role of NGOs in educating the children of Mumbai is essential. They provide a channel through which innovative techniques can be tried at a smaller scale; as well as instil a desire to learn in many of the children they work with. Despite all of this, it is acknowledged that investment in education has not kept pace with economic growth, meaning that less than 10% of the MCGMs budget is spent on education [12]. Education being a critical parameter not only for the Mumbai of today but also for Mumbai's future should be given the importance it deserves.

References:

1. UN (2007) The Millennium Development Goals Report
2. Montgomery, M; Gragnolati, M; Burke, K; Paredes E. (2000) Measuring Living Standards with Proxy Variables. Demography 37(2): pp155-174
3. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
4. Census of India, 2001

5. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
6. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO
7. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO
8. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO
9. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO
10. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO
11. Ramachandran, V. (2002) Backward and forward linkages that strengthen primary education
12. Juneja, N (2001) Primary Education for all in the City of Mumbai: the challenge set by local actors. Institute for Educational Planning; UNESCO

4.7 Healthcare provision

A good healthcare system is essential to ensure the wellbeing of a city's population. Good health is elemental in the ability of individuals to lead a full and active life. Understanding the carrying capacity of the healthcare system is therefore important. It can enable the identification of aspects of health care that require investment and ensure that these requirements of the population can be met. It relates not only to the availability of hospital beds and doctors, but also to the quality of service received, and the accessibility of facilities to all members of the population.

Summary

2001-02

- One hospital bed per 3000 people, gross shortfall (WHO guideline of one bed per 550 people).
- Healthcare provision planned for up to 7 million people, not the existing 12 million population
- Poor standard of hospital treatment; inadequate provision of intensive care facilities

The future

- Increased public healthcare provision required to ensure that the needs of the current population can be met
- Preventative measures: e.g. those discussed relating to water contamination and sanitation facilities will reduce burden on healthcare services.

The responsibility for the provision of healthcare services in Mumbai is shared between the MCGM and the Government of Maharashtra, whilst private healthcare facilities are also widespread across the city. Public facilities come in the form of a network of general and teaching hospitals, maternity homes, dispensaries and health posts (the latter two catering specifically to outpatient care). There are approximately 40,000 hospital beds available in Mumbai, with the graph (Fig. 4.7.1) demonstrates the breakdown of the three major providers. : The overall figure of approximately 1 bed per 300 people compares favourably with WHO guidelines [1]. The MCGM acknowledges that its healthcare infrastructure, planned during the 1960s and '70s, was designed for use by up to 7 million people, and not the 13 million who currently use the services (including those who use Mumbai's health services but do not live within Greater Mumbai) [2]. Many studies have found that public healthcare provision in Mumbai is inadequate, due to long distances many people are forced to use private healthcare facilities as they are unable to reach the municipal hospitals. Public health facilities beds in Mumbai include both State run hospitals as well as those under the MCGM. A study done in the year 2006 counts 3121 beds in the State Hospitals and 14634 beds in those of the MCGM. [3] Under its programs for public health care, the MCGM runs four major hospitals, 16 peripheral hospitals, five specialized hospitals, 168 dispensaries, 176 health posts, and 28 maternity homes with a staff of over 17,000 employees. The Corporation also runs three medical colleges. Of the total 40,000+ hospital beds in the city, the MCGM run hospitals have about 11,900 beds. As many as 10 million patients are treated annually in the Out-Patient Departments (OPDs) in the MCGM hospitals.[8] The health posts were set up from a World Bank Initiative called IPP-5 (India Population Project 5) which sought to set up primary health care centers in Mumbai from 1988-1996. When the World Bank pulled out, the MCGM took the responsibility of the health posts and dispensaries. However, due to various issues in budgeting, prioritization at the MCGM, and other reasons that are not well-documented, the quality of services offered at these health posts and dispensaries is not quite meeting the needs and demands of the public that accesses this system. The health posts provide medications for DOTS as well as medications for basic ailments (cough, cold, fever, gastrointestinal issues) while the dispensary has a doctor that is there to provide medical check ups. Unfortunately, these dispensaries and health posts don't function at maximum utilization rates due to large scale vacancies, disconnect of the staff and the community, and general ignorance toward quality.

While there are always exceptions, due to the overall lack of facilities and resources given at the primary level, health posts are not universally utilized to access primary health care.[10]

The lack of manpower in the municipal hospitals means that many people are forced to choose private healthcare to avoid long waits [4]. In addition to this, it has also been reported that up to 32% of ailments go untreated in municipal hospitals because of poor service [5].

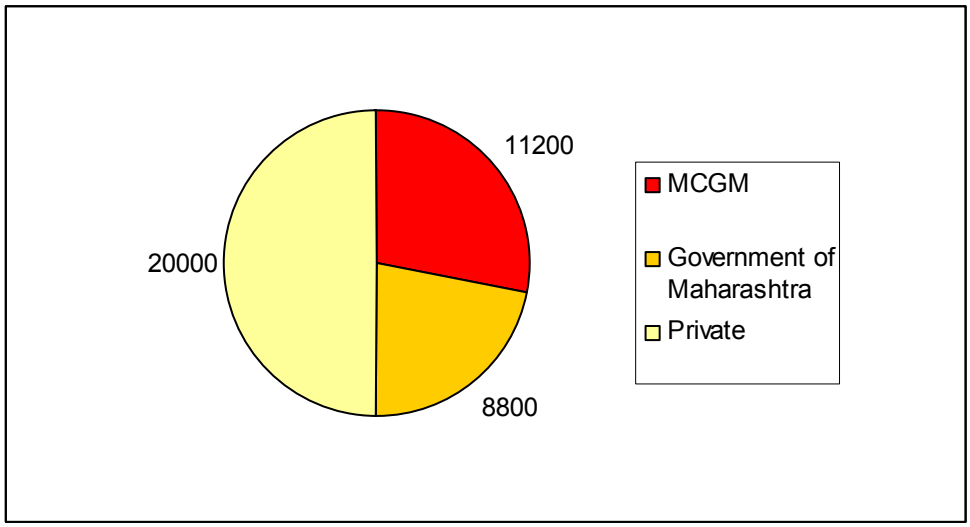


Figure 4.7.1: Responsibility for hospital beds in Mumbai

Source: MCGM [6]

As per the Municipal Corporation Act, the MCGM is primarily responsible for preventing health care majors in the city. However, the current focus of the health services in the city is more on the secondary and Tertiary levels rather than on the primary public health care activities. In Mumbai, more than 50% population lives in slums and especially in low income categories have to depend on the public sector health facilities. It is therefore essential to drastically increase and upgrade the health infrastructure and also prioritizing the improvement of services at the primary level which will include a package of improvement of physical infrastructure trained staff and public private partnerships to ensure quality and responsibility of the services. Studies have shown that there is strong preference to access public sector health infrastructure by most people in Mumbai, largely due to affordability factor. This makes it mandatory to strengthen the public health infrastructure and improve the quality of services and accountability of service providers to the citizens.[9]

The MCGM health programming has no provision to deal with Respiratory Systems Disease though respiratory diseases such as asthma, bronchitis, upper respiratory infections, etc are presenting an increasing health threat for residents of Mumbai

Deaths Reported							
	1997	**1998**	**1999**	**2001**	**2002**	**2003**	**2004**
Respiratory Disease	7270	7377	7332	7223	2412	8293	8174

This table shows the deaths reported by respiratory disease from 1997-2004.[10]

The table above illustrates a disturbing trend in the city, the rapid rise of deaths of respiratory problems. It is important to note that, these are the deaths reported, and most likely represents a fraction of the actual cases of respiratory disease.

Particulate Matter (PM10) and Nitrogen Oxides (NOx) emerge as the critical pollutants in Mumbai with health effects ranging from acute respiratory symptoms like cough, breathlessness and wheezing to chronic diseases like chronic obstructive pulmonary disease (COPD).[11]

For the future, it is clear that investment is required to ensure that public sector treatment is made more readily available to those who need it, and to improve the quality of healthcare in municipal hospitals. Public hospitals need life saving medical facilities like criticare units and neuro surgery units, and high-end diagnostic facilities like sonography, echocardiography and dialysis unit. This is a key aspect of the 'Vision Mumbai' report, which suggests that whilst Mumbai's overall healthcare infrastructure may appear to be 'above average' in some aspects, the quality of treatment is described as 'very poor' [7]. Furthermore, the report suggests that the pressure on municipal hospitals may be alleviated by encouraging better use of tertiary healthcare facilities (the current state of which was described as 'abysmal') so that people do not go straight to hospital. Further to this, as has already been discussed, there are a range of measures that can be taken to improve other parameters such as waste water contamination, cutting of emissions etc, that will have a positive impact on healthcare. This 'prevention' will serve to reduce the burden on the healthcare infrastructures well as directly improve the quality of life of the population of

Mumbai. Whilst a growing population will obviously increase the demand for services, economic growth (especially if coupled with an improvement in environmental quality) would potentially reduce the demand on services, and may even put people in a better position to afford private healthcare.

References:

1. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978; Sakaal Times Article dated 13 November 2008, http://www.sakaaltimes.com/2008/11/13140116/Its-all-private-no-new-publi.html and Times of India Article dated 29th January 2009 http://timesofindia.indiatimes.com/Cities/More_hospitals_better_healthcare_for_city/rssarticleshow/4045082.cms and
2. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978
3. Information from Mr. Prashant Raymus, Research officer, CEHAT, Mumbai
4. Dilip, T; Duggal, R. (2004) Unmet need for public healthcare services in Mumbai, India. Asia-Pacific Journal 19(2) http://www.karmayog.org/publichealth/publichealth_3321.htm
5. Dilip, T; Duggal, R. (2004) Unmet need for public healthcare services in Mumbai, India. Asia-Pacific Journal 19(2) http://www.karmayog.org/publichealth/publichealth_3321.htm
6. MCGM: Greater Mumbai City Development Plan 2005-2025(Viewed on 15 May, 2009)<http://www.mcgm.gov.in/irj/portal/anonymous?NavigationTarget=navurl://095e1c7b9486b1423b881dce8b106978>
7. Bombay First; McKinsey and Co. (2003) Vision Mumbai: transforming Mumbai into a World-class city.
8. Health Services in Mumbai, The Bombay Community Public Trust, 2004
9. Issues In Social Infrastructure: Public Health Infrastructure in Mumbai, Mumbai Transformation Support Unit, March 2006.
10. Meenakshi Verma, Recommended Policy Guidelines for Public Health (Draft dated 1st May, 2006 for discussion) A Report to the MCGM and the NGO Council MPH Public Health Consultant
11. Trivedi P & Patankar A: Monetary Burden of the Health Effects of Air Pollution in Mumbai: Implications for Poverty, Equity and Public Health. Paper presented at SXTH IASSH CONFERENCE ON HEALTH,EQUITY AND HUMAN RIGHTS MARCH 7th & 8th 2009

Given the findings on the various parameters governing the carrying capacity above and recognising the range of requirements it has to be stated that, considering the integrated picture of management of the city of Mumbai as a whole, has to be by a multi faceted approach. The city governance is currently addressed by the various departments of the Government of Maharashtra, Municipal Corporation of Greater Mumbai, Maharashtra Pollution Control Board, Mumbai Metropolitan Region Development Authority, Maharashtra State Road Transport Corporation, and other such bodies. The need is for a holistic and integrated approach between all such stakeholders. The management of the city should not be done in a manner where one authority works oblivious of the efforts or sometimes even counterproductive to the efforts or objectives of another. The management plan of the city tries of address this issue but still has its limitations. This need has to be addressed in order to achieve effective management of Mumbai city.

5. CONCLUSIONS