Environmental Status Report 2009-10

Pune Municipal Corporation

Compiled by

The Energy and Resources Institute

Declaration

- The photographs and maps incorporated in the following report are only for representational purposes and are not as per scale.
- Environmental Status Report of Pune Municipal Corporation for the year 2009-10 has been compiled by TERI (The Energy and Resources Institute), a not-for-profit research organization.
- This report is based on the authentic data sourced from various government agencies like the PMC, MPCB, MSEDCL, BPCL and so on. The data sourced has been duly acknowledged at relevant sections in the report.

Acknowledgements

The compilation of the ESR (Environmental Status Report), 2009-10 for PMC (Pune Municipal Corporation) has been a memorable experience, which TERI owes to the cooperation and support extended by corporators, senior officials, and the head of departments of PMC.

TERI would like to especially acknowledge the constant encouragement and support extended by Shri. Mahesh Zagade, Honorable Commissioner, PMC. We would also like to thank Shri. Ramakant Dangat, Addl. Municipal Commissioner (Spl) and Shri. Machindranath. S Devanikar, Addl Municipal Commissioner (General) for their support.

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Most significantly we would like to mention and thank the senior citizens, NGO's, and SHG (Self Help Groups) from Pune city for their enthusiastic support, valuable inputs and providing data for the ESR.

TERI would like to appreciate the help extended by the nature lovers, aware citizens and the NGO's for sharing information on the pro environment initiatives and projects undertaken and implemented by them across the city. We also thank our associates who helped us in compiling the report by helping us in data collection/analysis, translation, typing, proof reading and many such similar tasks.

The Energy and Resources Institute

Pune
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Introduction

Life is dependent on biotic and abiotic factors. Anthropogenic activities and over exploitation of natural resources leads to imbalance in the natural cycles. Population explosion is another key factor adversely influencing the environmental status of large cities. It has been observed that in most of the urban areas, air quality and water are the most affected resources.

Importance of Environmental Status Report

ESR (Environmental Status Report) of a city is regarded as an important tool for the governing body as well as the citizens', serving both as a resource for information and education, as well as a way for tracking improvements. Moreover, the ESR is very useful because it highlights the following.

- The health status of the population linked to the state of services and the environment.
- Information for investment and management decisions for the ULB (Urban Local Body)
- Important inputs for the annual budgeting and planning exercises
- Assessment of various natural resources, level of pollution, and its direct or indirect impact on human beings and other life forms.

As per the BPMC's (Bombay Provincial Municipal Corporations) Act 1949, section 67 (A), it is mandatory for all the ULBs of the state of Maharashtra, to submit an annual ESR to the General Body on or before 31 July.

The PMC (Pune Municipal Corporation) publishes an ESR every year, since 1997, since this has been made compulsory in the state-level legislation (the BPMC Act), following the 74th Constitutional Amendment Act and the Twelfth Schedule.

ULB's in Maharashtra have been publishing ESRs since the past 12 years. These ESRs discuss the state of various natural resources, urban services, and the environmental issues faced by respective cities. In order that the ESRs emerge as a more comprehensive document and play a better role in aligning environmental policies, the MPCB (Maharashtra Pollution Control Board) has proposed an indicator-based framework. This framework of indicators, follow the international practice with an adaption to Indian cities. A quantitative approach is being incorporated to objectively compare and assess trends between two cities in terms of their environmental performance.

Some quantifiable parameters related to the environment have been given a certain percentile (scores) and the cumulative of the scores is known as the EPI (Environmental Performance Index)[1].

[1] http://mpcb.gov.in/images/pdf/Evaluation_of_ESRs.pdf

Environmental Performance Index

The MPCB, upon discussion with the Department of Environment, Government of Maharashtra, in June 2009, released guidelines to prepare an ESR. The guidelines suggest the preparation of ESR as per the DPSIR (Driving force, Pressure, State, Impact and Response) format. MPCB has given a paradigm format, which could be followed while drafting the ESR. Further, the guidelines also provide 65 data variables, which are to be analyzed as a preliminary step. The data output gets aggregated to give the score of four thematic indicators, which is further used to calculate the EPI. The four thematic indicators are as mentioned below.

- Growth of city
- State of resources
- Urban services
- Initiatives taken to improve the city environment

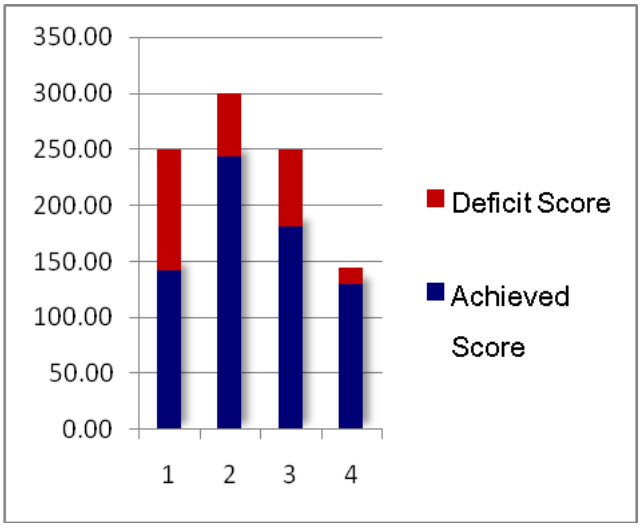
A definite score has been allotted to the 65 data variables depending upon the benchmarks set according to the national, state or the defined average as per international standards. For example, the population growth is one of the key indicators of the environment and if it exceeds the limits, it creates an unfavorable situation for the environment and, hence, the score given would be less in such a situation. Vice-versa, a pro-environment initiative is given better score. Hence, better the EPI score better is the state of environment of that city.

To calculate this EPI, the MPCB had developed computer-based software programmed in MS™ Excel. This EPI takes into account the 65 data variables of which 57 questions have to be answered and fed into the software, which then reveals the EPI of the city. This software is primarily used to calculate the score for the four thematic indicators.

The following report has been prepared as per the DPSIR format after analyzing the 65 data variables. Perhaps PMC is the first municipal corporation to prepare an ESR for the year 2009–10 as per the DPSIR format and also calculate the EPI for the city.

According to the following graph, the EPI of Pune city is 695.60.

Gap analysis		
Environmental Performance Index		**695.60**
Thematic Indicators		
1. Growth of cities	250	141.50
2. State of resources (Air, water, and land)	300	243.00
3. Urban services	250	181.50
4. Initiatives for improving city environment	144	129.60



Three main conclusions, which can be drawn from the above graph are as follows.

- Holistic analysis of the environmental parameters and reasonably high score achieved through initiatives taken towards protection of the local environment
- The maximum achievable score
- Scope for further improvement in order to minimize the extent of deficit score

A comprehensive analysis of the ESR and EPI revealed that, the maximum achievable score under the thematic indicators is 944, out of which, Pune city has achieved a score of 695.60. Thus, the difference of 248.40 score can be attained by adopting approaches, which may ensure sustainable development of the city. Some of the key environmental issues identified for Pune city are enlisted and elaborated below.

Key Environmental Issues

1. Air Pollution

Image No. 1: Precautions taken by alert citizens in Pune city in response to air pollution

While preparing this report, an analysis of the data collected clearly revealed that the increasing numbers of vehicles, industries as well as construction sites in the vicinity of Pune city release SPM (Suspended Particulate Matter), which is one of the major concerns for air pollution. The recorded RSPM (Respiratory Suspended Particulate Matter) in the city is 1.5 times more than that of the National Standards. The rising levels of SPM and RSPM within city limits are key concerns for Pune city.

Air pollution can cause serious respiratory disorders, increasing the incidence of respiratory diseases. It has also been observed that the precipitation levels in the month of July and August 2009 were the highest as compared to the other months, thereby indicating high humidity levels. Incidentally, the H1N1 epidemic had also been recorded at a peak during the same months.

[Please refer to chapter 3 for more details about air pollution.]

2. Water Pollution

Image No 2: Release of untreated sewage water in Mutha river

According to Department of Water Supply and Sewerage, PMC, out of the total sewerage generated in the city, only 55% is treated. The remaining 45% is released untreated into the rivers. At six sampling locations along the Mula river, the recorded BOD (Biochemical Oxygen Demand) levels are much higher than the permissible limits set by the MPCB. The COD (Chemical Oxygen Demand) levels are also above the permissible limits. [Please refer to chapter 4 for more details about water pollution.]

3. Encroachment

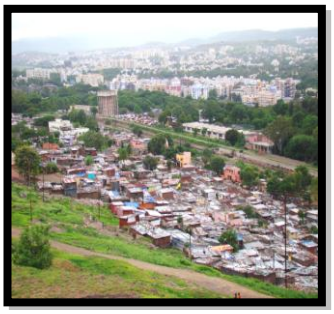


Image No. 3: Encroachment on hill slopes in Pune city

It has been estimated that more than 40% of Pune city's population stay in slums. If the development of slums grow at the same pace, then very soon 50% of the population of the city will reside in the slums. The boundries defined by the hill top and hill slopes department have to be followed strictly. The foothpaths built for pedestrains have also been encroached. The gravity of this issue must be realized and addressed while making future plans for the city.

Preparation Process of ESR 2009–10

The ESR is an important document for the Municipal Corporations, as the report comprehensively documents the changes in the environment, the initiatives taken to address the environmental concerns, the estimate of the budgetory allocations, and the expenses for the infrastructural facilities of the city.

PMC has been publishing an ESR consecutively for the past 13 years. This year the responsibility of preparing the ESR was awarded to TERI (The Energy and Resources Institute), an internationally renowned, not-for-profit, independent research institute.

As per the proposal, TERI was bestowed with the work order in the last week of June 2010 to prepare the ESR in Marathi and to submit a report on carbon footprint estimate of the city (transport and energy) by March 2011. The ESR is presented to the Hon'ble General Body and is open for discussions. Comments are sought from the renowned institutions, experts, citizens, and NGO's of the city to enhance the quality of the report, which could become a benchmark and the framework could then be followed thereafter in the consecutive years.

Data collection: This report is based on the data obtained from governmental institutes, non-govermental institutes, and also from the HOD's (Head of the Departments) of the respective departments in the PMC. An attempt has been made to involve all the stakeholders while compiling the data and drafting the report. Subsequently, periodic meetings were held for Hon'ble members of the ESR committee wherein their comments and valuable suggestions were incorporated. To compile a comprehensive report, inputs/ suggestions received through different deliberations mentioned below, have also been incorporated.

- Meetings and consultation with Hon'ble Commissioner and Head of the Departments of the PMC.
- One-to-one and general interactions with senior citizens, representatives of various NGO's, and experts.
- Majority of the correspondence was done via email to promote use of softcopies and reduce the use of paper. A dedicated email account was initiated, especially for the ESR-related correspondence, with govermental and non-governmental organizations.
- The content to be incorporated in the report and the framework of the report were discussed with the heads of NGO's on a regular basis.
- Review of the previous ESRs were carried out.

ESRs of various other cities like Delhi, Kolhapur, Navi-Mumbai, Thane, along with the previous ESR of Pune were reviewed and analysed while preparing the current ESR 2009–10 for Pune city. In comparison with the thematic categories of the current report, a qualitative assessment of the parameters considered in the previous reports were also carried out. Similarly, other reports published by the PMC were also studied and analysed for their salient features.

Summary

The present ESR 2009–10 for Pune city is the first report submitted by a municipal corporation from the state of Maharashtra, prepared as per the MPCB guidelines issued in the year 2009. The DPSIR framework indicates the following.

D = Drivers

P = Pressure

S = Status

I = Impacts

R = Responses

The estimation of carbon footprint at the city level is also one of the pioneering initiatives undertaken by the PMC. The present ESR 2009–10 has been divided into nine chapters.

The first section highlights the importance, the methodology, and the framework adopted while preparing the report. ESR reports submited by the PMC for the previous years were critically reviewed for the qualitative and quantitative incorporations. The salient features of the respective reports have been documented.

Chapter 1 briefly emphasizes on Pune city's profile, geographical coordinates, and climatic conditions. Chapter 2 addresses the crucial factors affecting the environment of the city, incorporated under the heading, "Drivers", as per the guidelines released by the MPCB.

Population growth, industrial growth, economic growth, and spatial growth collectively form the driving forces resulting in the growth of the city. These drivers directly or indirectly exert pressure on the natural resources leading to an adverse impact on the local environment. To have a holistic analysis for Pune city's environment, assessment of resources like water, air, energy, and land have been taken into consideration while preparing the report. Utilization of the resources, its impact on the resource management, and the initiatives taken to mitigate the adverse impacts have been documented and analyzed in the subsequent chapters of the report.

In addition to this, the details about the basic urban amenities, such as water supply, sewage treatment, solid waste management, traffic, and transportation have also been taken into consideration. Given the rapid transformations in urban life style, resource consumption patterns and projected gap in the demand and supply of various resources have also been incorporated.

The state government has made an appeal to all the municipal corporations and municipalities of the state to follow the MPCB guidelines while preparing the ESR and also while deriving the respective EPI values.

Considering the fact that there is a lot of awareness about global warming and climate change, the concept of estimating the carbon footprint is gaining importance across the world. Government bodies and private entrepreneurs are more conscious about assessing their level of green house gas emissions and accordingly strategizing the action plan for mitigation. A chapter describing the concept, methodology, and applications of carbon footprint estimation for the city, based on its fuel consumption pattern in the transport and energy sector has been included in the present report.

Having analyzed various parameters in detail and assessing the environmental performance index for the city, a set of recommendations have been proposed. The budgetary provisions made towards various developmental works in the context of the present ESR has been reviewed. Based on the financial projections and resource availability, the way forward has also been suggested.

Chapter 1: Pune City: A Brief Profile

Introduction

Pune is among the top seven cities in India, and after Mumbai, it is the second largest city in the state of Maharashtra. Spread across about 5 sq. km in 1818, Pune has now grown into a metropolitan city covering more than 243.84 sq. km. Pune city has a glorious past and a promising future. The city is a continuously growing centre of IT (Information Technology), automotive technology, and BT (Biotechnology).Over the years, the city has been acknowledged/recognized by many and also earned a reputation for being the “Student Capital of India", the “Oxford of India", the “Queen of the Deccan”, the “Pensioner’s Paradise”, the “Cyber City”, and the “Upcoming IT-BT Hub”, and so on.

1.1 Geographical Location

Situated to the west of the Deccan plateau, the city stands at the confluence of the rivers Mula and Mutha, which are tributaries of river Bhima. The Sinhagad-Katraj-Dive ghats range forms the southern boundary of the urban area. Geographically, the city is surrounded by hills on three sides, which make the climatic conditions more pleasant. Table No. 1.1.1 depicts a brief on geographical and general information about Pune city.

Table No. 1.1.1: Basic details of the city

Longitude	18°25’ and 18° 37’ North
Latitude	73°44’ and 75° 57’ East
Mean Sea sea level	560 m
Total area	243.84 sq. km
Population (According to census 2001)	25.38 lakhs
Approximate population[2] (2010)	35 lakhs
Slum population	Approx ~ 14.2 lakhs
Average rainfall	722 mm
1979–2008 recorded maximum and minimum temperature	Max: 42.5°C (April 1983) Min: 2.8°C (January 1991)

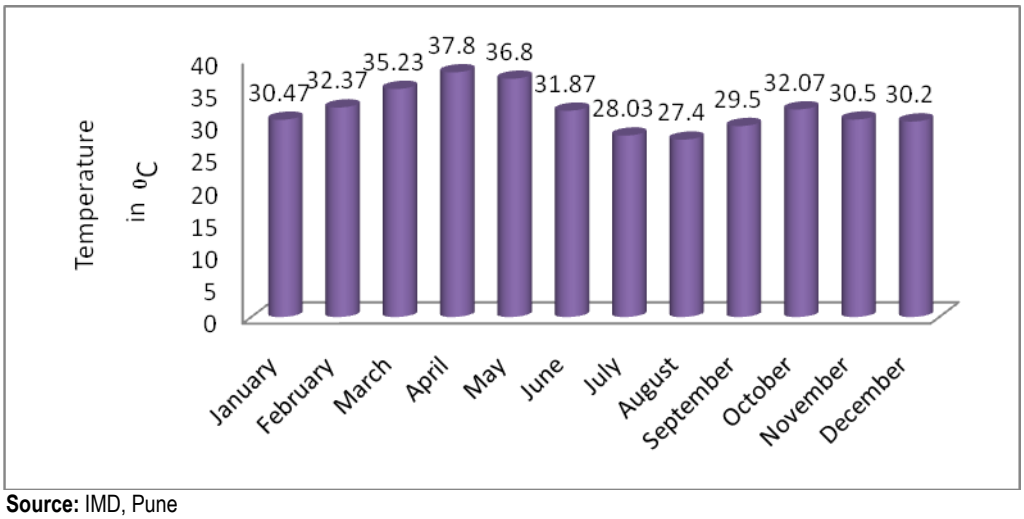
Source: PMC & IMD, Pune

[2] Gokhale Report. 2009. Demographic Projections for Pune Municipal Corporation, 2002–2027

1.2 Climate

Pune has a tropical wet and dry climate. Pune experiences a healthy weather with three distinct seasons, namely summer, monsoon, and winter. The summer season lasts up to four months from February to May, during which the city's average temperature is between 30 °C to 38 °C. The maximum temperature is recorded in the month of April as shown in Figure No. 1.2.1. Even during the months when summer is at its peak, the nights are usually cool due to Pune's high altitude.

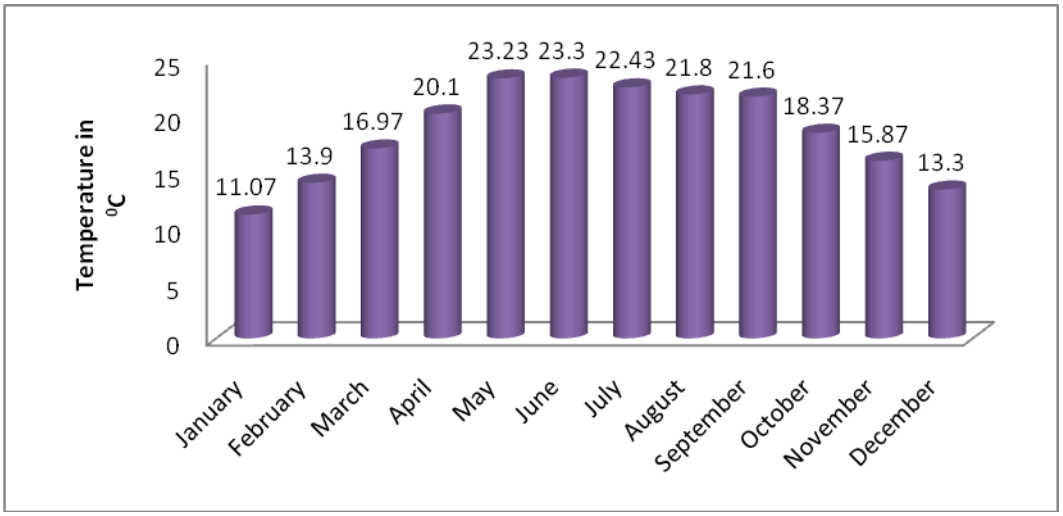
Figure No. 1.2.1 Average maximum temperature, 2006–2009



Source: IMD, Pune

Winter season starts in the month of November and is referred to as Rosy Cold. During this season, the temperature in the day rises to 28 °C and at night goes below 10 °C, and sometimes even 5 °C to 6 °C in December as well as during the initial days of January. As per the average temperature analysed during the year 2006–09, the lowest temperature recorded is 11.07 °C in the month of January as shown in Figure No. 1.2.2.

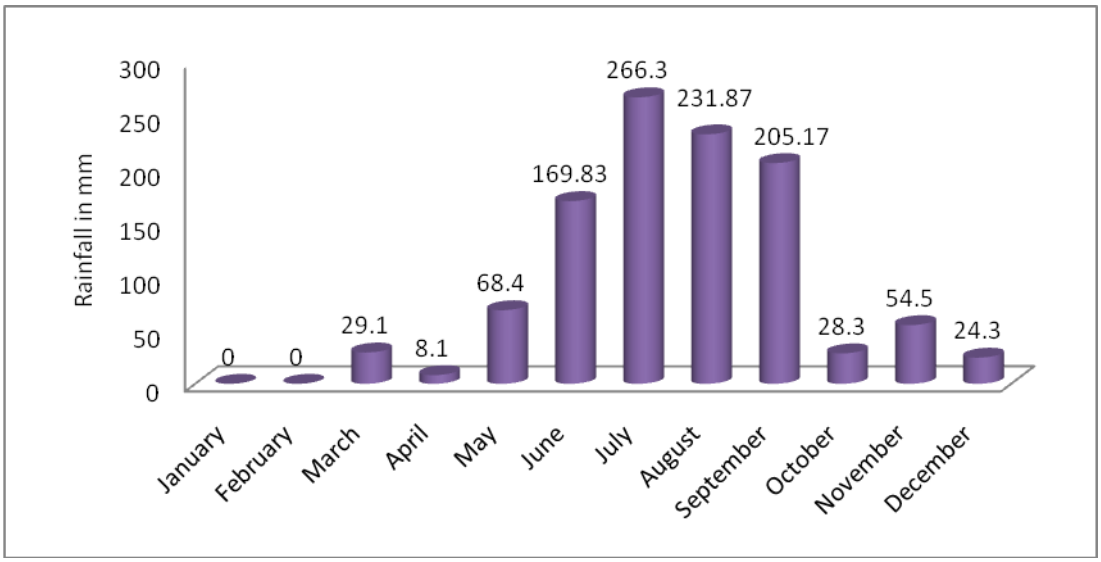
Figure No. 1.2.2: Average Mean Minimum temperature from 2006–2009



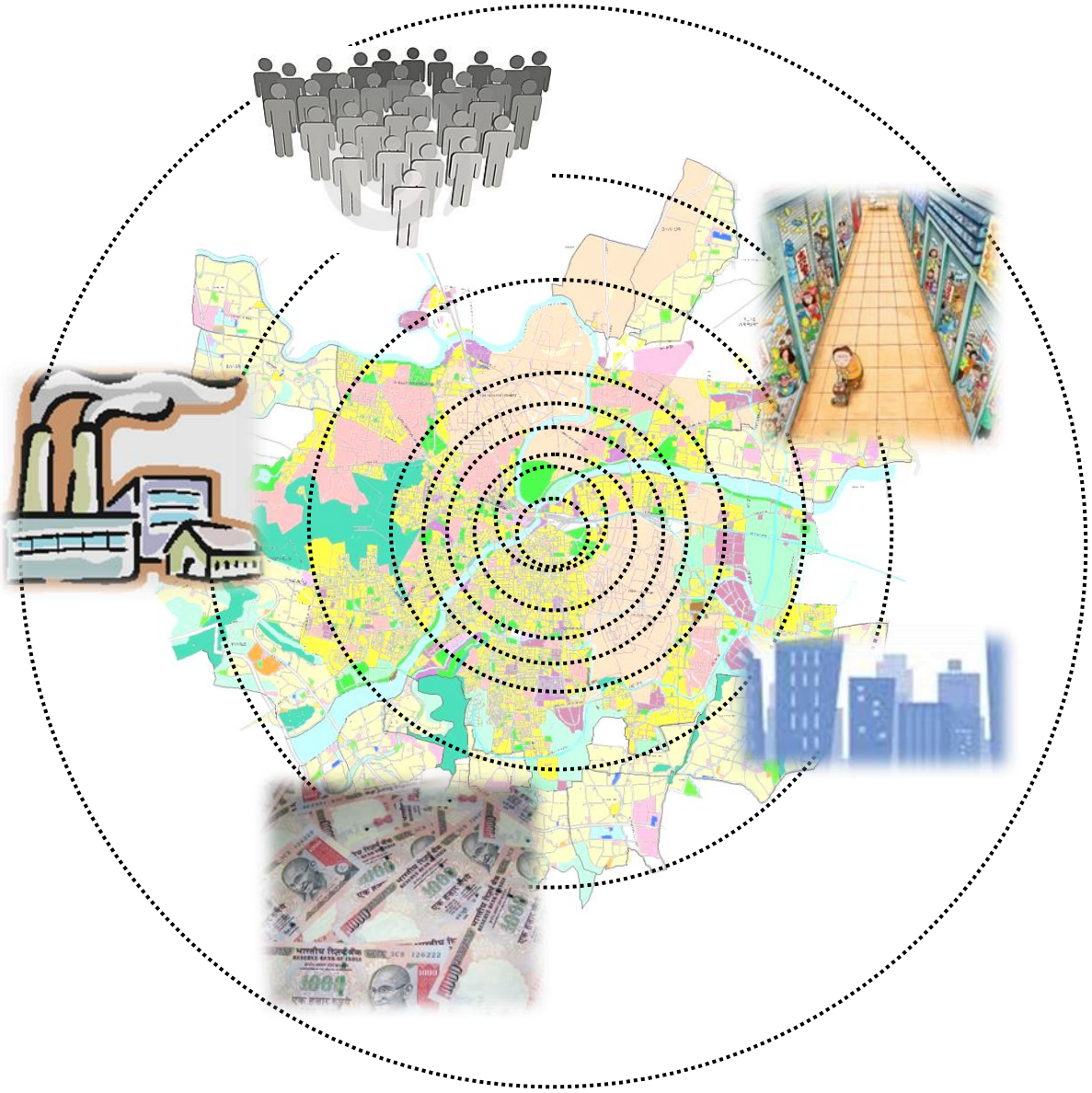
Source: IMD, Pune

The rainfall is unevenly distributed in the city, mainly due to the southwest monsoon winds. Eighty seven per cent of the annual rainfall occurs during the monsoon season, which starts from June. The maximum rainfall is experienced from July to September. Figure No. 1.2.3 depicts average annual precipitation pattern in Pune city.

Figure No. 1.2.3: Average Mean Maximum rainfall from June to October



Source: IMD, Pune



Chapter 2
Growth of Cities
(Drivers)

Chapter 2: Growth of Cities: Drivers

Urbanization, which indicates growth and transformation of villages to towns and to cities, and then cities into megacities, is an ongoing process. Although each and every city has its own identity, the main drivers for this development include population growth, demand for market places and growth of markets, increase in the demand for means of transportation and its infrastructure, luxurious lifestyle associated with urbanization, and so on. Population growth is one of the most crucial drivers of urbanization. Moreover, to meet the growing demands imposed by the population, parallel development of allied business sectors, such as manufacturing units of commodities and construction industry catering to the needs of housing, businesses, and infrastructure required for transport, also takes place. It is interesting to note that these days educational institutions are also regarded as industry set ups. The growth of these industries result in proportionate expansion of the business sector and economic growth of the city, which, in turn, attract the inflow of population from other towns, villages, or even developed cities. Thus, growth of population leading to development of urban areas sets a continuous and ever expanding cycle rolling.

The growth and expansion of the city is highly dependent on availability of natural resources as well as on manmade resources. Population, industrial, economic and spatial growths are all interlinked as well as interdependent. They are the primary driving forces in the growth of any city and hence these topics have been clubbed together under the topic “Drivers”, while compiling the environmental status report for Pune city.

Similarly, availability of resources like Air, Water, Land, and Energy are the key factors in growth of cities and have been analyzed in separate chapters in terms of the “Pressure” been exerted on it, the current “State” of the resource, its “Impact” on the environment, and the “Response” and initiatives taken to address the pressure and reduce the adverse impacts.

Furthermore, it is essential to get an overview of the following to ensure sustainable development of urban areas.

(1) Impact of urbanization on resource availability in the context of the surrounding environment of the city. For instance, the extent of forest land, land use and land cover pattern, agricultural areas around the city, and water resources need to be assessed.

(2) A correlation between resource availability and growth of cities.

The present chapter describes various drivers determining the growth of Pune city.

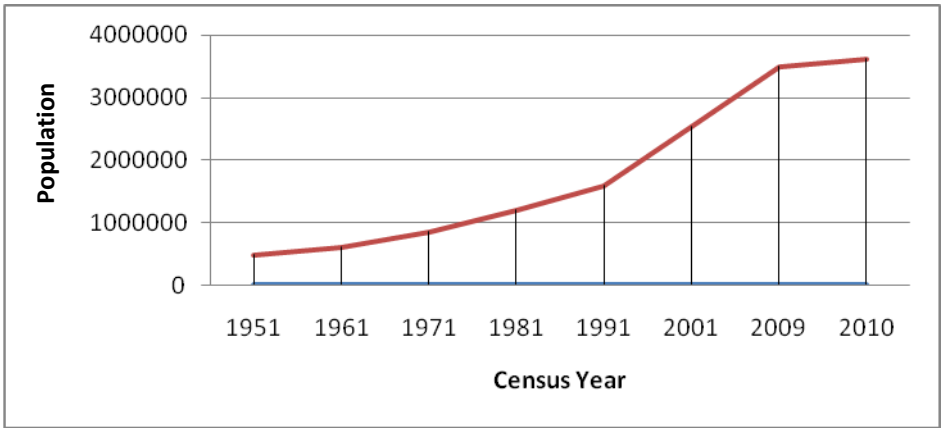
2.1: Demography

Introduction

The population of Pune city as per the Census 2001 was 25.38 lakh. In the last 10 years, the city's population has grown almost 1.5 times than the population recorded in 2001 (Figure 2.1.1). The population growth rate in Pune city is very high and could be attributed to ample job opportunities, higher income leading to better lifestyle, and other facilities available in the city, which encourages the influx of migratory population. Pune is also getting internationally recognised as a hub for sectors like IT and education.

As seen in the figure 2.1.1, it is estimated that the population of Pune in the year 2010 is close to 35 lakh.

Figure No. 2.1.1: Trend in decadal growth of population in Pune city[3]



Source: Census, 2001 and Gokhale Report, 2009

According to the Karve Socio and Economic Survey Report[4] 2008–09,

- In Pune, 72.91% of the total population is under the age of 40 years and 32.68% of the total population is under the age of 20 years.
- As per the Census, 2001, Pune city has a sex ratio of 921 females per 1000 males. Comparison of the sex ratio between major cities of Maharashtra has been shown in the figure 2.1.2.

Table No. 2.1.1: Projected population and sex ratio[5]

Year	2001	2007	2012	2017	2022	2027
Population	25,38,473	31,48,041	37,29,694	44,55,574	51,37,671	57,14,890
Male	13,21,338	16,42,049	19,51,413	23,40,923	27,08,460	30,20,329
Female	12,17,135	15,05,992	17,78,281	21,14,651	24,29,211	26,94,561

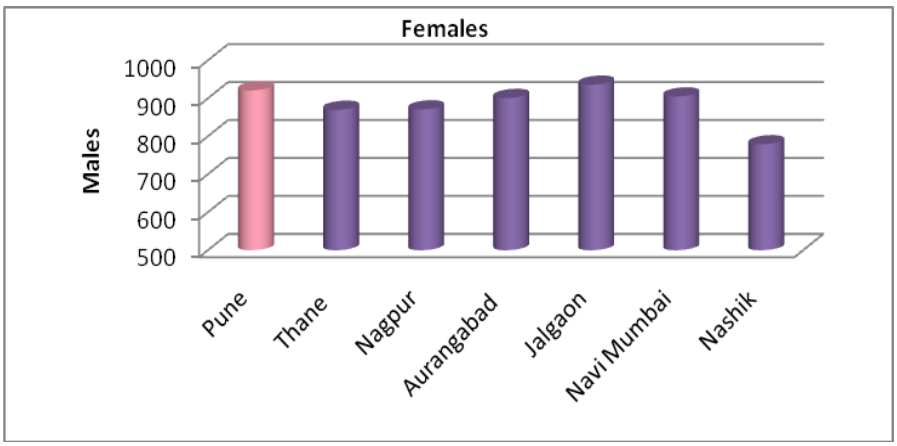
Source: Gokhale Report, 2009

According to table no. 2.1.1, the population in 2007 was 31.48 lakh and in 2012 it is expected to be 37.29 lakh. The table shows that every year there is an increase in the population by 1 lakh and based on the

[3] Census, 2001 and Gokhale Report, 2009
[4] Socio Economic Survey of Pune City 2008–2009, Karve Institute of Social Service B D Karve Research and Consultancy Cell
[5] Gokhale Report, 2009- Demographic Projections for Pune Municipal Corporation, 2002-2027.

above analysis, population in the year 2010 is estimated to be 34.96 lakh.

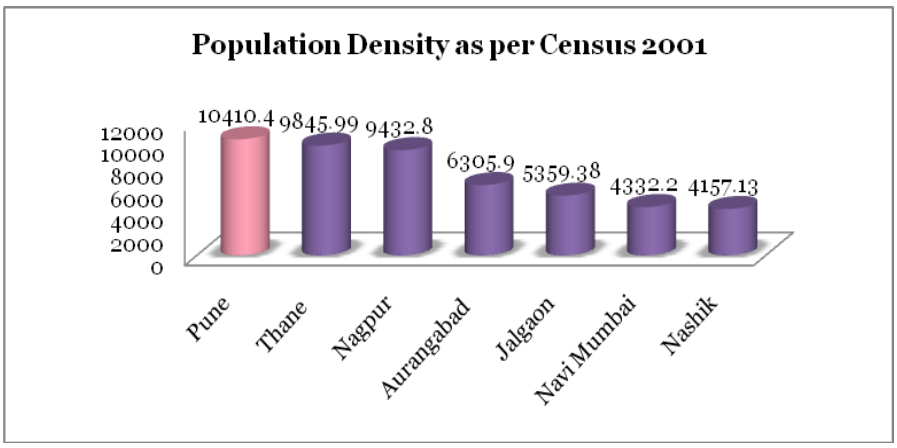
Figure No. 2.1.2: Comparison of the sex ratio between major cities of Maharashtra



Source: Census, 2001

As evident from figure 2.1.2, as compared to other major cities of Maharashtra, Pune stands second in the context of the sex ratio.

Figure No. 2.1.3: Comparison between the population densities of major cities of Maharashtra[5]



Source: Census, 2001 and Karve Socio and Economic Survey Report, 2008–09

Figure 2.1.3 illustrates that Pune city has the highest population density among the major cities of Maharashtra state. As per Census 2001, the population density of Pune city was 10,400 persons/sq. km. Estimated population density of Pune city in the year 2010 would be about 14,404 persons/sq. km. Accurate information of Pune city's demography shall be available soon after the release of the census report of 2011.

2.2: Industrial Growth

Introduction

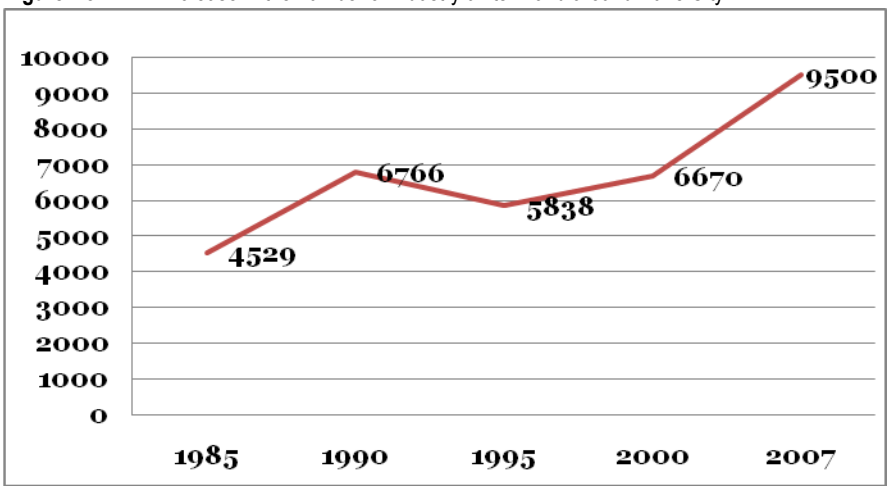
The migratory population in Pune city is increasing because of the business and business-related opportunities. There is a huge scope for industries to grow in and around Pune city because of better connectivity and accessibility to Mumbai, and moreover due to the rapid development of the industrial belt in the Pimpri-Chinchwad area, which is in the vicinity.

Availability of better infrastructure and provision of resources like skilled labor, land, electricity, water, and so on favors the growth of industries in the suburban areas like PCMC (Pimpri Chinchwad Municipal Corporation) and Hinjewadi. In the late 1990s, due to inclusion of few neighboring villages, the city limits of Pune were officially expanded to a total of 243.84 sq. km and the city is fast leading towards being one of the largest metropolitan cities of the country.

Industrial Areas

There are a total of 12 large- and-medium scale as well as about 829 small-scale industries in Pune city (PMC limits). Some of the major industrial sectors, which contribute to the growth of the city are discussed below. Market yard, Hadpsar, and Laxmi Road area are few of the popular commercial zones of the city. The growth of industries in and around Pune city has been depicted in figure no. 2.2.1.

Figure No. 2.2.1: Increase in the number of industry units in and around Pune City

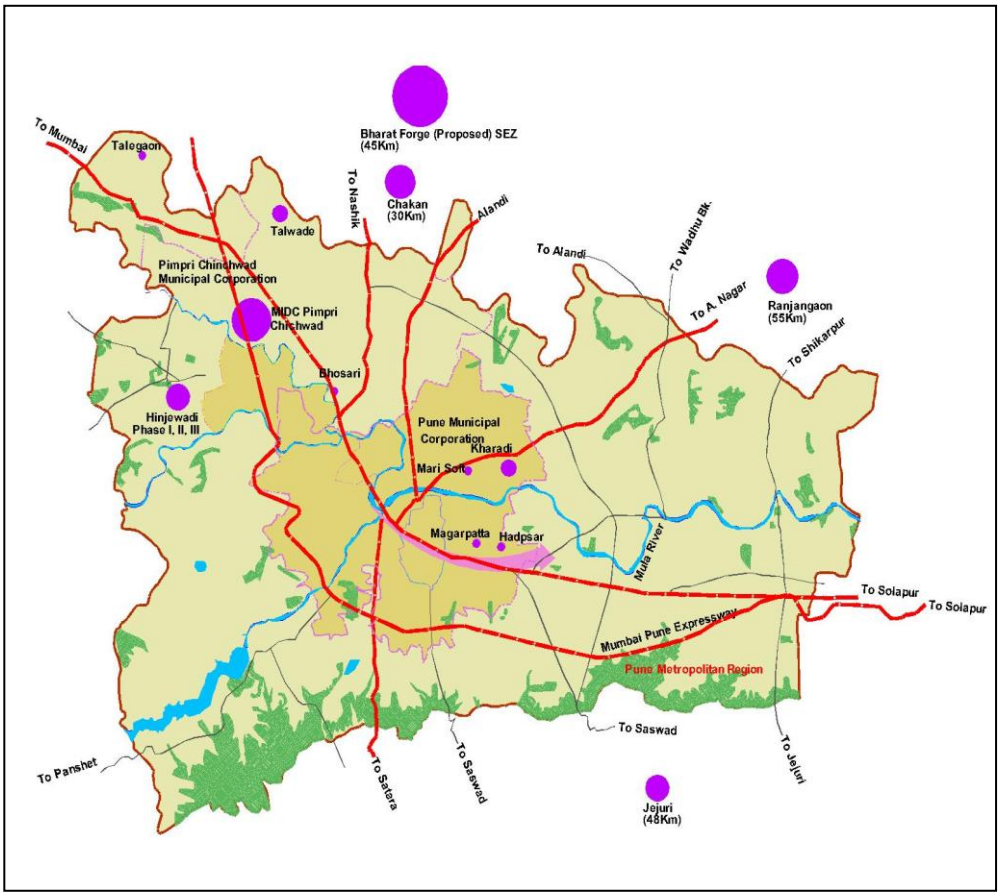


Source: MCCIA, 2005-06[6] & 2008[7]

The growth of business centres in Pimpri-Chinchwad and Hinjewadi is completely dependent on the planning and supply of the basic infrastructural facilities like energy, water, and so on. Industrial/ service clusters in and around Pune city have been depicted in figure no. 2.2.2.

[6] Pune IT, one stop guide to the IT world, MCCIA, 2005–06
[7] Profile and analysis of Pune Mfg. Inc, An intelligence report on growth of Pune Industries, MCCIA Feb, 2008

Figure No. 2.2.2: Pune's industrial/service clusters



Source: MCCIA, 2008[8]

Markets

The area around Pune city is mainly agrarian. Therefore, Pune city is regarded as one of the most important market place for the trade of agri produce. Similarly, the city is also considered an authentic market for the trade of grains, clothes, leather goods, gold and silver ornaments, not only for the urban residents, but also for the peri-urban customer base. This impacts the prosperity and growth of the market.

For example: Shri. Chhatrapati Shivaji Market Yard, established by the APMC in the Gultekdi area near Swargate, is one of the most famous fruit and wholesale markets in Pune. Villagers from Alandi and Urali Kanchan who engage in agriculture as their predominant profession, find it very convenient to travel to the APMC market. Similarly, Laxmi road is famous for a variety of readymade clothing and jewelry shops that attract shoppers from all across the state. It is also considered a shopper's paradise.

[8] Profile and analysis of Pune Mfg. Inc, An intelligence report on growth of Pune Industries, MCCIA Feb, 2008

Food Processing Industry

The food and food processing industry is one of the fastest growing clusters contributing to the city's growth and prosperity. This cluster produces a range of products comprising spices and pickles, fruit and vegetable processing, and RTE (Ready-to Eat)/ RTC (Ready-to-Cook) products. Several main food producing companies have their manufacturing plants in and around Pune city.

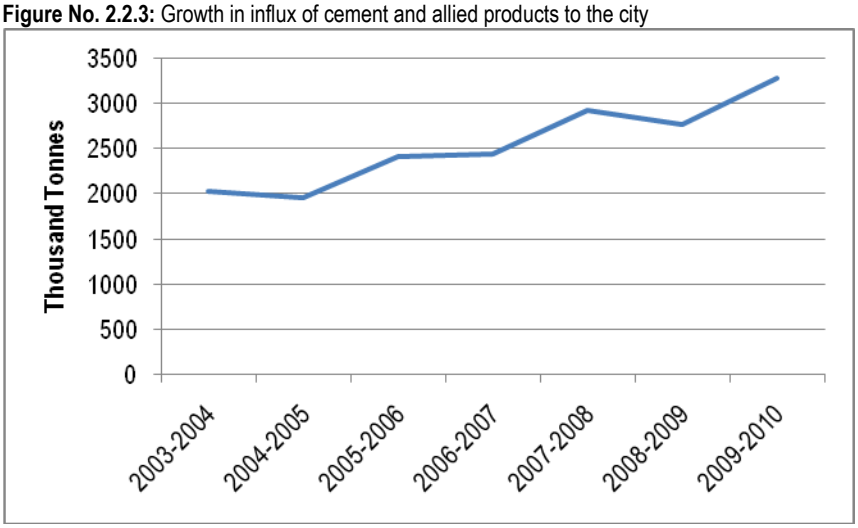
IT (Information Technology) Industry

In the last decade, Pune has become an IT hub with speedy expansion of the IT industry. The setting up of an Info-Tech Park at Hinjewadi in 1999 gave an impetus to the growth of the IT sector in Pune. As a vibrant business centre, Pune started offering incentives to multinational IT companies, which, in turn, has played the role of a catalyst for the SME units to proliferate and generate businesses and employment. According to the Gokhale Report 2001–2007, about more than 250 IT industries would be established in and around Pune city in the next few years.

Construction Industry

Owing to urbanization and increasing demands, the construction industry has seen a tremendous growth. The quantity of cement and steel used for construction activities in the city during the last five years has been depicted in figure 2.2.3, which clearly reveals the utilization of these materials in the last five years has increased by 10 lakh tonnes, that is, by almost 1.5 times.

Figure No. 2.2.3: Growth in influx of cement and allied products to the city

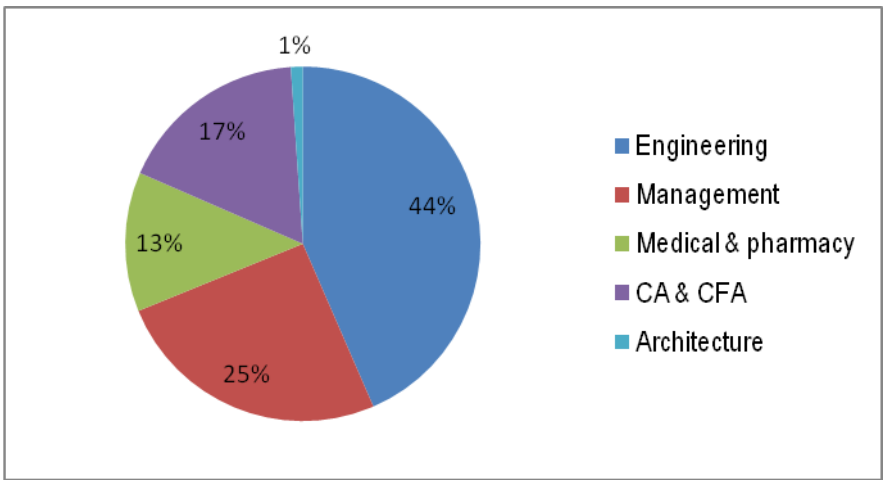


Source: Octroi Dept.; PMC, 2010

Education Industry

Pune has more than a hundred educational institutes and six universities, and has acquired a reputation as "The Oxford of the East", with students from all over the world studying at colleges in the city and the University of Pune.

Figure No. 2.2.4: Percentage split up of students registered for various academic courses in Pune city



Source: MCCIA Hand Book, 2008

It is evident from figure no. 2.2.4, that majority of the students opt for professional courses. The city attracts students not only from the country, but also from across the world. This has led to a positive impact on the city's economy and, thereby resulted in an increase in employment as well as business opportunities. At the same time, this phenomenon also exerts pressure on the city's resource and infrastructure facilities.

2.3: Economic Growth

Introduction

Pune has witnessed very fast growth in terms of commercialization, urbanization, and industrialization. This has directly resulted in the high influx of migrants, in addition to the increase in footfalls in the city. Pune is not only one of the fastest growing cities of the state of Maharashtra, but also of the country.

Industrial Economy

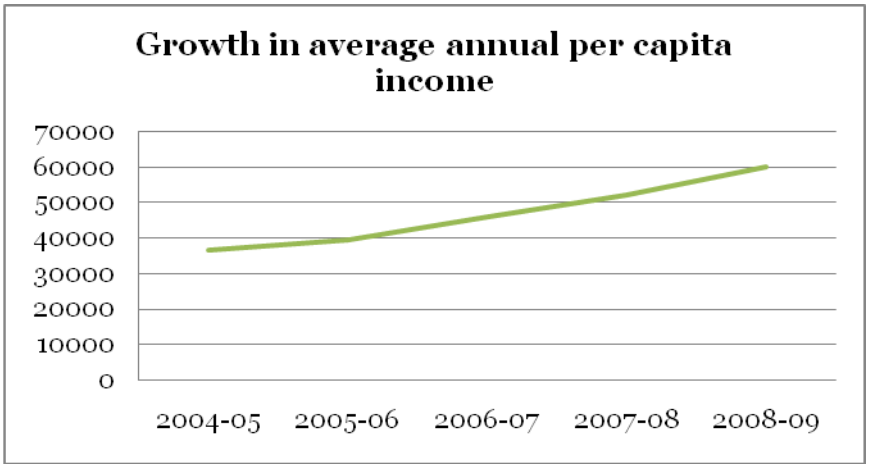
The industrial sector of Pune city is the main driving force behind the growth of the city's economy. For instance, the annual turnover of Pune's manufacturing hub has grown by 18 times in the last two decades. The SME cluster in Pune contributes almost 60% to the total turnover of Pune city[9].

The IT and the BT (Biotechnology) industries have emerged as the new driving force of the economy and have significantly grown by almost 26 times, from Rs 250 crore to Rs 6500 crore, in a span of just eight years. The IT sector from Pune contributes Rs 349 crore, which accounts for nearly 10% of the state's software exports[10].

The annual transaction of the horticulture and floriculture market, including fruits, vegetables and groceries is approximately Rs 730 crore[11].

Per capita income

Figure No. 2.3.1: Increasing trend in annual per capita income in INR



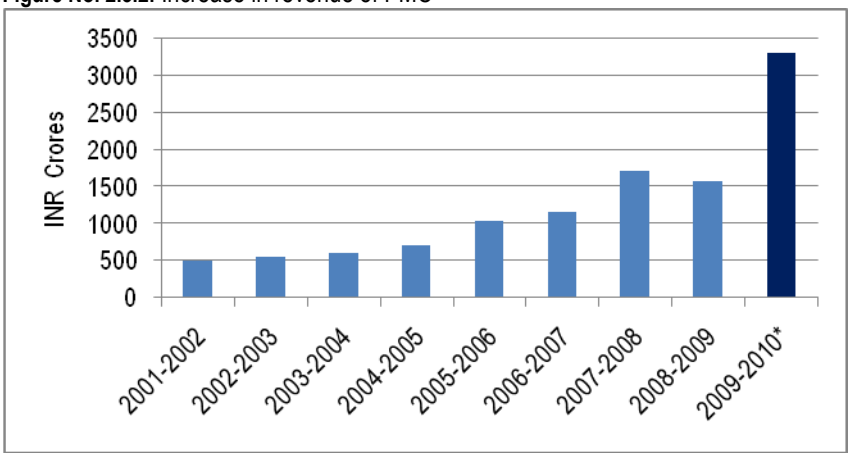
Source: PMC, 2010

The average per capita annual income of Pune city was estimated to be Rs 36,500 in 2004–2005. The figure has increased almost by 1.8 times in five years, to about Rs 60,000 in 2008–2009 [12](Figure no. 2.3.1).

[9] Profile and analysis of Pune Mfg. Inc, An intelligence report on growth of Pune Industries, MCCIA Feb, 2008
[10] Pune IT, one stop guide to the IT world, MCCIA, 2005–06
[11] Socio-Economic Survey of Pune City: 2008–09, Karve Institute Of Social Service, B D Karve Research And Consultancy Cell
[12] Socio-economic Survey of Pune City: 2008–09, Karve Institute of Social Service, B D Karve Research and Consultancy Cell

Increase in revenue of PMC

Figure No. 2.3.2: Increase in revenue of PMC



** Estimated budget for the year 2009–2010*

Source: PMC Budgetary Provisions, 2010–2011

It is evident from the figure no. 2.3.2, that the total revenue for PMC obtained through tax collection for the year 2001 was Rs 496 crore, while in the year 2008–2009, the amount collected was Rs 1575 crore. This shows that there has been an increase in tax collection of almost three times in a span of eight years. In the year 2001, the per capita per annum income in PMC was almost Rs 24,000, while in the year 2008–2009. it was close to Rs 60,000. The increased revenue from tax indicates the economic growth of the population as well as that of the city.

2.4 Spatial Growth

Introduction: Growth trends and projections for Pune city

The spatial growth is the result of a combination of the increase in urban population and the net settlements in urban areas. The spatial growth of Pune city has been influenced mainly due to the growth in population, induced mainly due to industrialization. The two factors that broadly influence urban growth are 1) the land availability and 2) the transport facilities. A detailed discussion on the spatial growth of Pune is given below.

Land Price

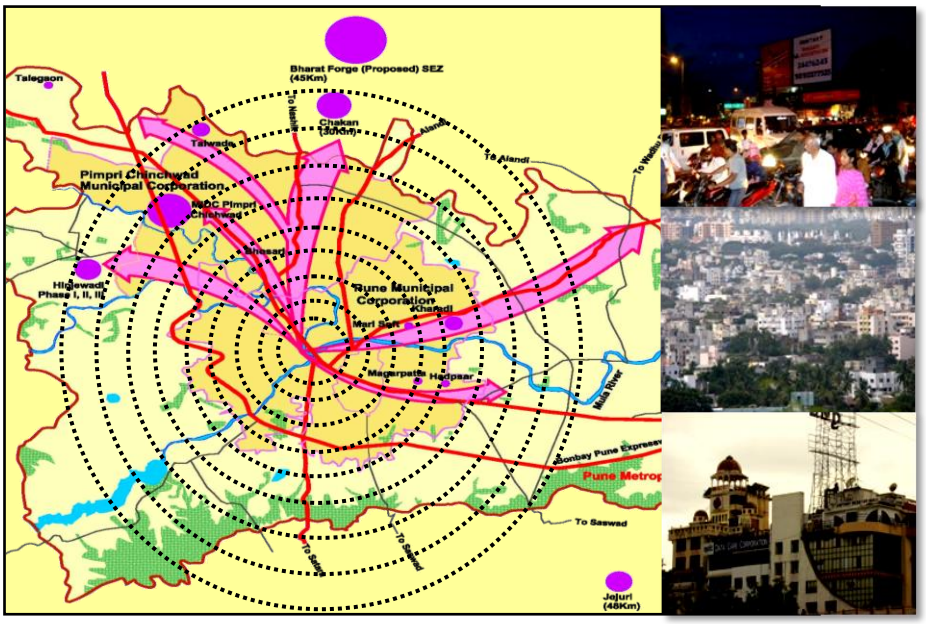
The land prices in Pune city have increased tremendously since 2001. It is believed that improvement in infrastructure facilities like water supply, electricity supply, transport facilities, and so on, have contributed to the increase in land price. According to the Gokhale Report (2008–2009), the average density for Pune city is about 14,404 persons/sq. km.

Road accessibility

A connectivity network of the city is another important factor influencing the spatial growth. For any city to grow and develop, advancement in the transportation sector is very vital. Pune is well connected to Mumbai, state capital and the commercial hub of the country, by means of a state-of-the-art expressway. Moreover, Pune is also well connected through rail and roadways to all other major cities within and outside the state of Maharashtra. However, due to the tremendous population growth, direct pressure is being exerted on the city's road and rail network. It is projected, that Pune's population would grow to about 57 lakh in 2027[13]. Higher the number of persons living in a particular area, the more shall be the number of trips required by the public transport system, thereby exerting stress on the available resources. The mounting population's mobility needs to be met through proper planning of the traffic and public transport systems.

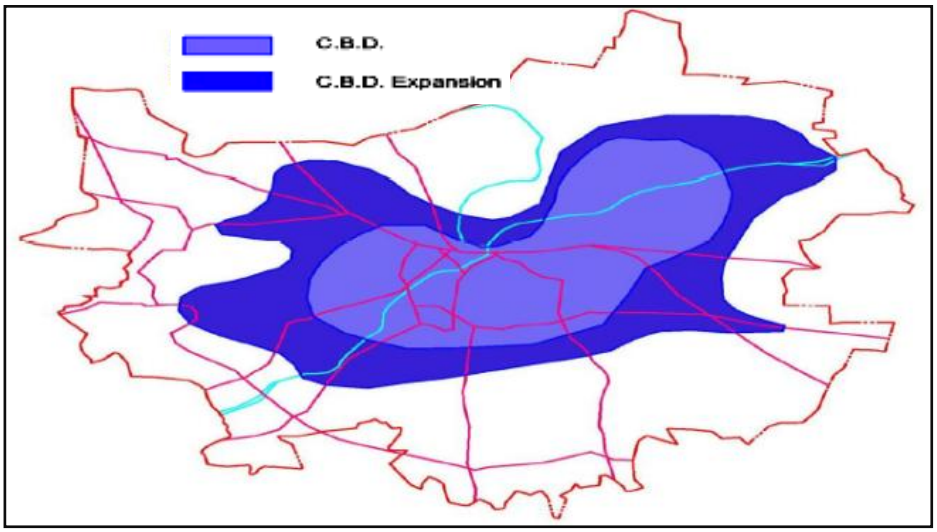
[13] Gokhale Report 2009: Demographic Projections for Pune Municipal Corporation, 2002–2027.

Figure No. 2.4:1: Spatial growth of Pune city



Source: PMC, 2010

Figure No. 2.4:2: Expected CBD expansions



Source: PMC, 2010

Future expansion of the city boundary will largely depend on the existing transport corridors, existing industries, and future industrial development plans in and around the city. The expansion of the CBD (Central Business District) will also contribute to the future growth of the city. Predominantly, the spatial growth will take place towards employment nodes, areas which are closer to these nodes and the areas, which are well connected with these nodes. Owing to the industrial growth in and around Pune, the city's economic growth has been growing exponentially. In compliance with the growth, Pune city has maintained its quality and has now become a brand name, as a result of which, migration into Pune city has increased substantially.

Chapter 3: Air, Noise, and Transport

Introduction

Any pollutant spreads across the city and its surrounding areas mainly through two mediums—air and water. Both these resources are critical for life and have a direct impact on the wellbeing of all living organisms. Worldwide, air pollution is known to affect human health. PM2.5 (particulate matter size less than 2.5µm) alone causes about 0.8 million (1.2%) premature deaths and 6.4 million (0.5%) years of life lost (YLL). This burden occurs predominantly in developing countries and especially in Asia. (Cohen *et al* 2004)[14]. Urban air quality is rapidly becoming a major issue in India. Indian cities suffer from some of the worst air quality problems in the world, which continue to be a major public health issue, and Pune is no exception with its air quality deteriorating over the years. Various factors, namely migration of population towards Pune, increased use of vehicles, greater travel demands, and demand for more power and manufactured products, have led to emission of pollutants within Pune and around the city (wherever the source may be).

The population of Pune has risen from 17 lakh to almost 35 lakh during 1991–2010. With the road space/capacity remaining almost the same, the number of vehicles has increased phenomenally. This has led to problems of congestion along with air pollution. The increasing demand for electricity has led to power cuts and subsequent increase in the usage of DG (Diesel Generator) sets, which also emit pollutants at a low height, thereby implying greater exposure to humans.

The major causal factors, the state of air quality, and the impacts as well as the response of the government to address the impacts, are presented in this chapter.

[14] Aaron J. Cohen, H. Ross Anderson, Bart Ostro, Kiran Dev Pandey, Michal Krzyzanowski, Nino Künzli, Kersten utschmidt, C. Arden Pope III, Isabelle Romieu, Jonathan M. Samet and Kirk R. Smith, 2004

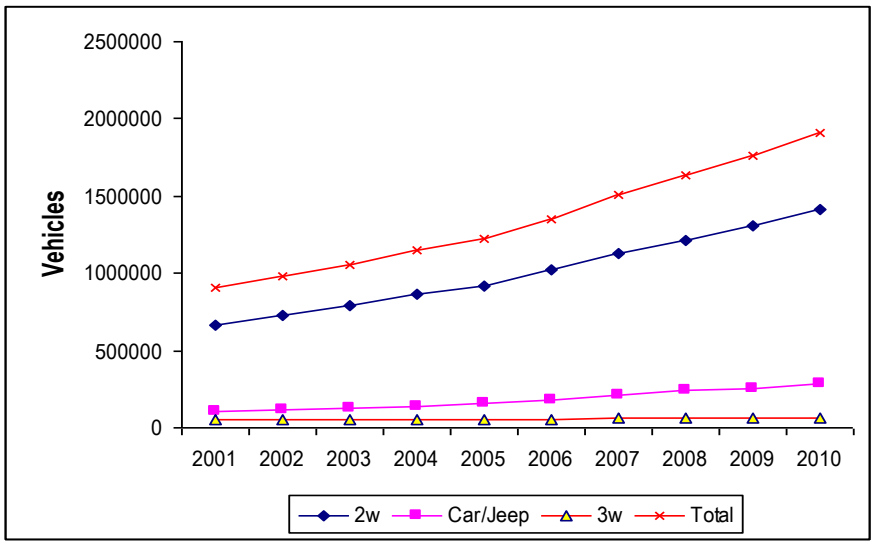
Pressures – Causal factors

Pune is presently dealing with the problem of severe air pollution. There are several sources, which exert pressure on the air quality of Pune city.

Vehicular growth

The increasing population and economic activities have fuelled the demand for mobility, which in turn have led to the growth of private vehicles. In the absence of an efficient public transport system, the total registered vehicles have increased from 9 lakh in 2001 to about 19 lakh in the year 2010. This trend of increase in vehicles and the share of different types of vehicles (out of the total number of vehicles) in Pune have been shown in figure nos 3.1 and 3.2. While the total annual average growth (CAGR) of vehicles was 9%, the number of cars increased at the rate of 12% per year. On a daily basis (only working days), about 500 vehicles added up to the vehicular fleet during the last year.

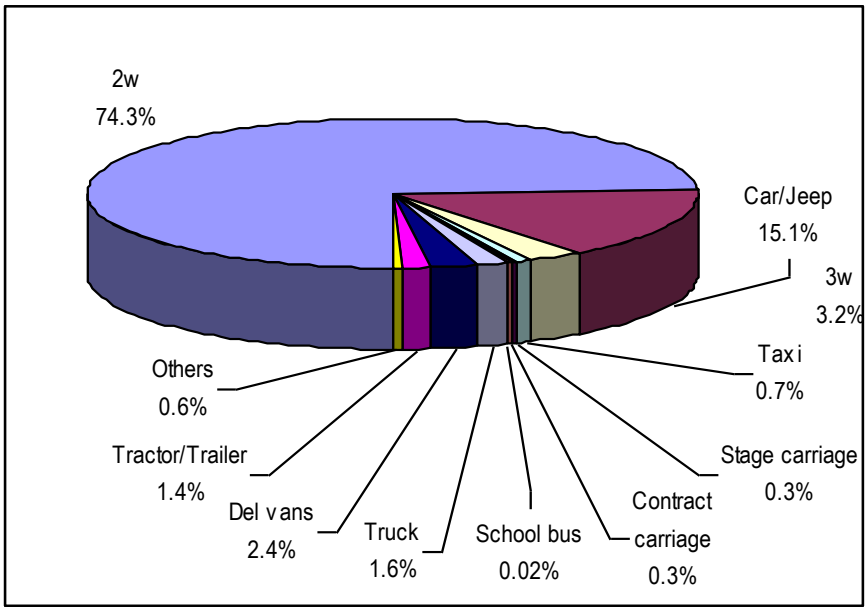
Figure No. 3.1: Trends of vehicular growth in Pune during 2001–2010



Source: Pune RTO

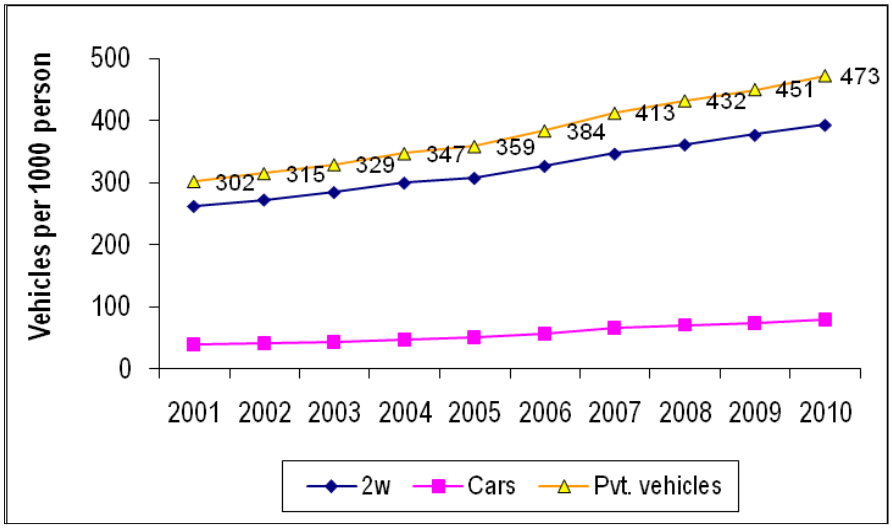
Out of the 19 lakh registered vehicles, two-wheelers account for 74% and private cars/jeeps account for about 15%. A high dominance of private vehicles indicates that there is very high number of private vehicles per 1000 persons in Pune city. As per the estimates, for every 1000 persons, there are 473 private vehicles in the PMC, which implies that there are about two vehicles per family of four people. Figure No. 3.3 also depicts the fact that the increase in the number of vehicles has been far greater than the increase in human population.

Figure No. 3.2: Share of different categories of vehicles in Pune



Source: Pune, RTO

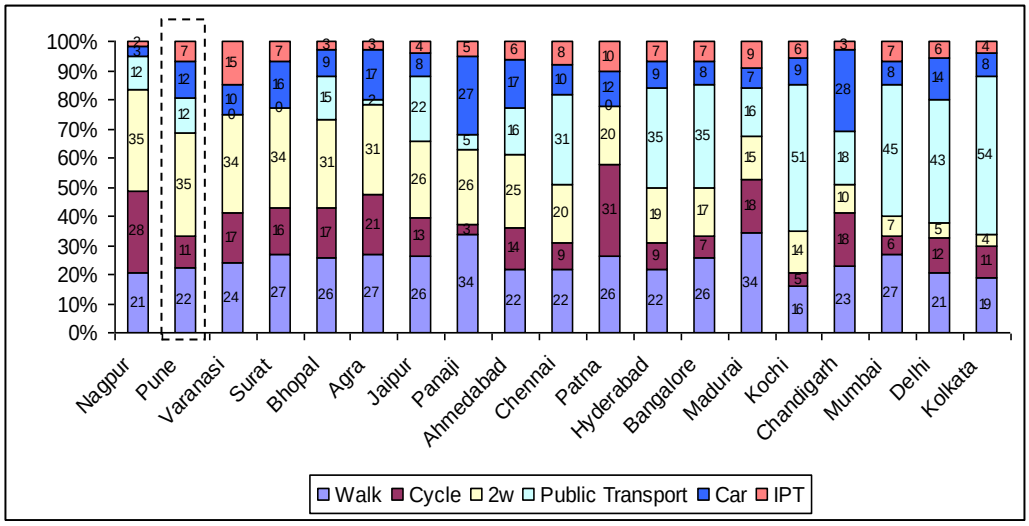
Figure No. 3.3: Vehicles per 1000 persons in PMC during 2001–2010



Source: RTO, Pune and PMC, 2010

According to WSA (Wilbur Smith Associates) 2008, Pune is one of the cities that have the highest trip share based on two wheelers (Figure No. 3.4). On the other hand, a city like Mumbai is highly dependent on public transport, such as local trains and buses.

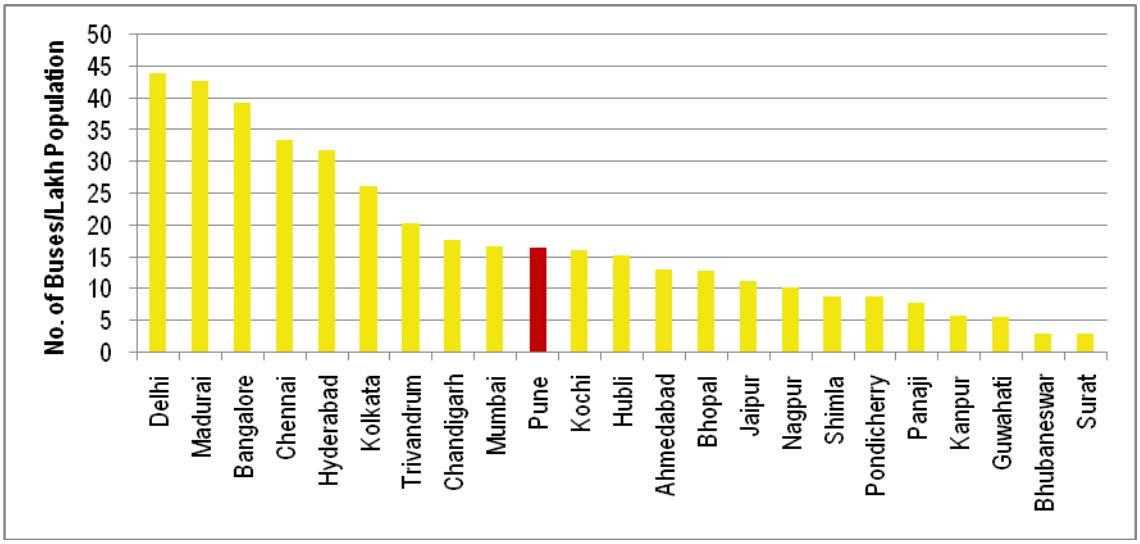
Figure No. 3.4: Transport modal share observed for prominent Indian cities



Source: WSA, 2008[15]

WSA 2008 formulated a city bus supply index, which shows that in Pune there are merely 16 buses per lakh of population, which is about two times less than Hyderabad and three times than Delhi (Figure No. 3.5). Hence, there is an urgent need to enhance the public transport system in the city.

Figure No. 3.5: Number of buses per lakh of population in various cities of the country

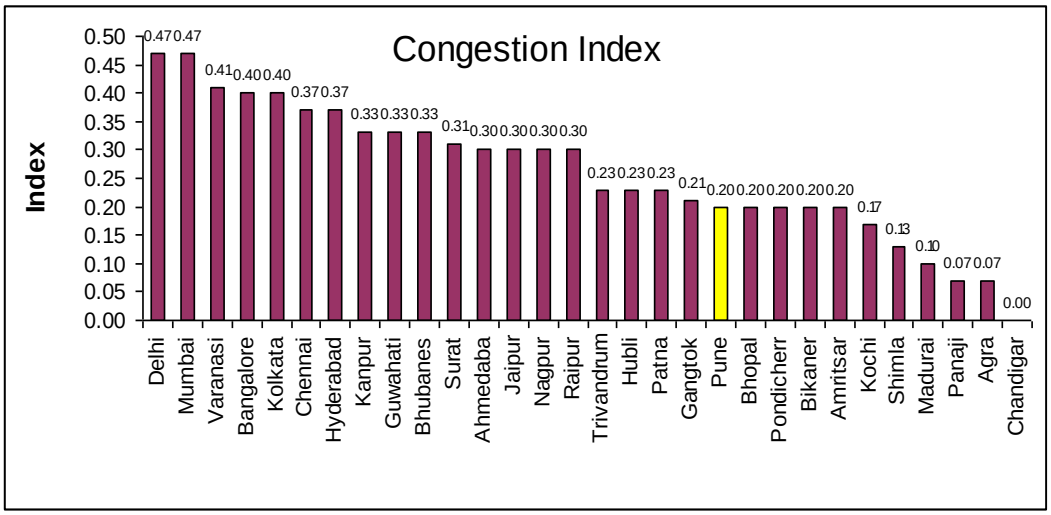


Source: WSA, 2008

[15] WSA 2008. Traffic and Transportation Policies and Strategies in Urban Areas in India. Wlibur Smith Associate. URL: http://urbanindia.nic.in/programme/ut/traffic_transportation.pdf

With road space remaining almost the same and the use of private vehicles increasing by the hour, Pune city is becoming extremely congested. The congestion index calculated by WSA 2008 for various cities, including Pune, is depicted in figure no. 3.6.

Figure No. 3.6: Congestion index for various cities of India



Source: WSA, 2008

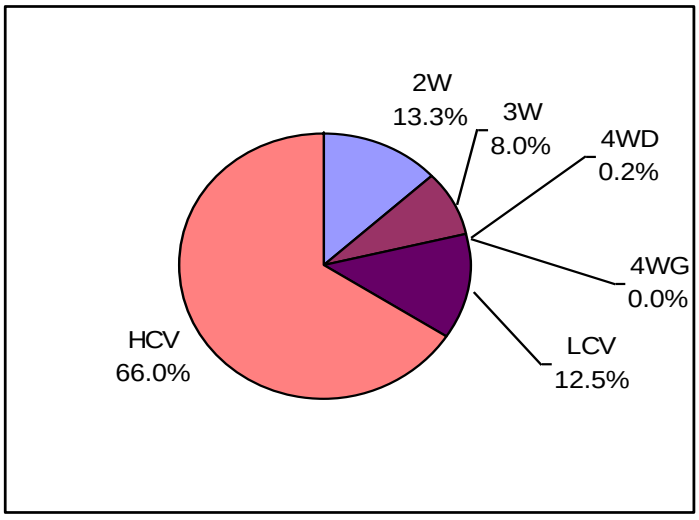
Pollutant wise contributions of different vehicles to the emissions loads are given in Table 3.1. The share of different vehicles in the total vehicular PM10 emission loads are presented in figure no. 3.7. Diesel operated HCVs have the maximum share of 66%, followed by two-wheelers and LCVs.

Table 3.1: Emission load from different category of vehicles (Tonnes/Year)

	2W	3W	4WG	4WD	LCV	HCV
PM	125.6	76.2	0.4	1.6	118.8	625.3
CO	7785.5	5082.2	136.1	7.9	915.1	2309.3
HC	5441.5	1321.4	25.1	6.8	337.5	151.2
NOx	2930.0	2541.1	20.9	12.8	530.1	3938.1

Source: PMC, 2010

Figure No. 3.7: Share of different vehicles in the total vehicular PM10 emission loads



Source: PMC, 2010

Vehicular emissions norms

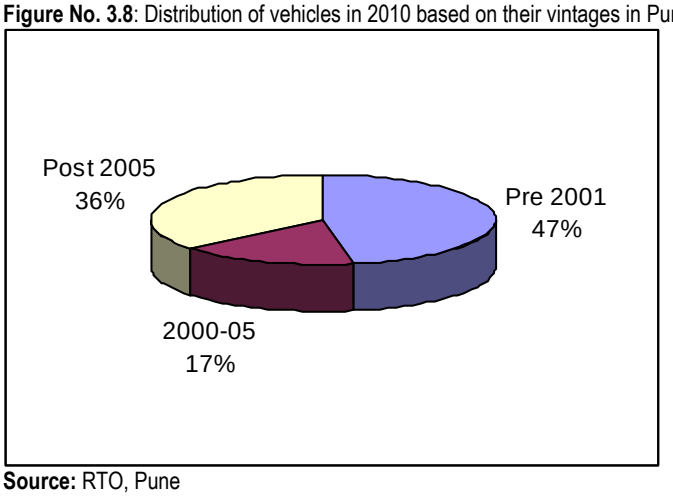
Introduction of emission norms has resulted in a substantial decrease in the emissions from vehicles. Pune is among the 11 cities where the improved vehicle emission norms have been first adopted across the country.

In 2009, TERI estimated that, in India, the total vehicles increased from 37 million to about 98 million from 1997 to 2007 (2.6 times), while the total emission increased by merely 1.8 times the load in the year 1997. This was due to the adoption of the improved emission norms, that is, BS-II and BS-III during the period (TERI, 2009). Similar reductions could be attributed to the introduction of advanced vehicular emission norms in Pune.

Old vehicles

Figure No. 3.8 shows the distribution of vehicles based on their vintages. Close to 47% of the vehicles are of pre-Bharat stage norms and have higher emission rates.

Figure No. 3.8: Distribution of vehicles in 2010 based on their vintages in Pune

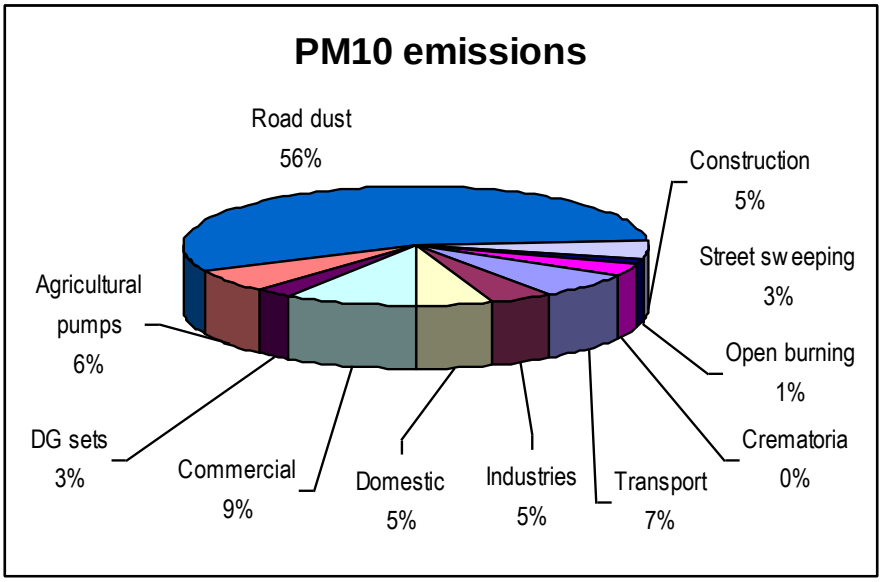


Source: RTO, Pune

Road dust re-suspension

Road dust emissions have a major share in the total PM10 emissions in Pune. However, other sources like transport, industries, commercial, and domestic sector also contribute about 5%–9% to the emissions index. The sectoral distribution of PM10 emission loads is presented in figure no. 3.9.

Figure No. 3.9: Sectoral distribution of PM10 emission in Pune city



Source: PMC, 2010

The inventory prepared by the NEERI-AQM cell of PMC also shows a major contribution from the paved and unpaved roads in Pune. In the overall inventory, although the contribution of the transport sector is not very large, the re-suspension of dust due to the movement of vehicles has been enormous. Re-suspension of dust emissions from the paved road dust is estimated to be 6,456 T/yr and from the unpaved road dust is estimated to be close to 1,229 T/yr (PMC 2010). However, the tail-pipe vehicular pollution has been reduced by the introduction of the Bharat Stage norms, not much has been done to address this emerging issue of road dust.

Industrial growth

Over the years, Pune has become a major industrial centre of the state, with a number of heavy engineering industries, such as the motor vehicle manufacturing plants (buses, cars, and motorcycles) located in and around the city. The industrial spread has extended mainly in the direction of the main Pune-Bombay highway, enabling better transport of the manufactured goods to other parts of the country, and thereby avoiding the congestion in the centre of the city. Moreover, recently the city has also attracted the Information Technology and Communication industries, which does not generate pollution directly, but surely has implications over the energy demands. The major industries are not within the PMC limits; nevertheless, based on the meteorology there would be an impact of the emissions from these industries on the air quality in Pune city.

Coal burnt in the brick kilns of the city is one of the sources of air pollution. However, in due course of time, traditional brick kiln makers have moved to other businesses. For instance, the Sinhagad road, which had 42 brick kiln units at one point of time, now possess barely one or two major units, which contribute to PM10 emissions of 182 T/yr (PMC EI report).

Most of the industries within the Pune City limits of study fall in the category of engineering and allied activities and they may not be responsible for air pollution as a direct source. The industries and their types are presented in Table 3.2.

Table 3.2: Number and types of industries in Pune and Pimpri-Chinchwad area

Area	Industry-type	No. of Industries
Pune	Large	12
	Medium	
	Small	876
Pimpri-Chinchwad	Large	41
	Medium	35
	Small	629

Source: PMC, 2010

The contribution of different sizes of industries (small, medium, and large) was estimated to be 140, 45, and 118 tonnes/year, respectively. Additionally, PM10 emission from industrial generators is 303tonnes/year.

Domestic and Commercial

While organized areas of the city are dependent on cleaner fuel, such as LPG for cooking, people living in slums continue to use polluting fuels like firewood, biomass, and so on. The total emission load in T/year from the slums and the rest of the city are presented in Table 3.3.

Table 3.3: Total emission load in tons/year from the slums and the rest of the Pune city

Area and Fuel	PM	SO_2	NO_x	CO
Slums Kerosene	62	128	80	1979
Others Kerosene	2	4	3	67
Slums LPG	25	5	21	3
Others LPG	43	8	37	5
Slums Wood	597	8	55	4505
Total Slums*	685	140	156	6487
Total Others#	45	12	39	72

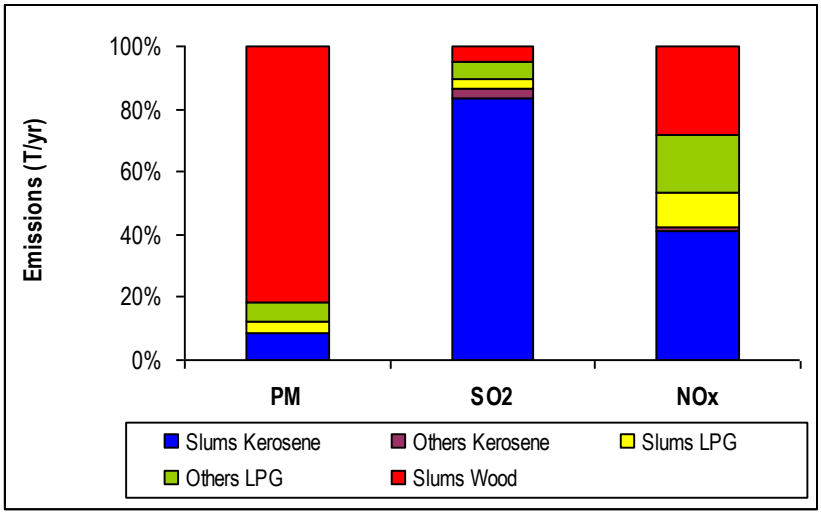
Source: PMC, 2010

* Fuel consumed in slums

Fuel consumed by other sections of the city

Figure 3.10 represents the share of various fuels and slums in the total emission loads generated from the domestic sector. Up to 82% PM is generated due to wood burning in the slums.

Figure 3.10: Total emission loads generated due to fuel usage in slums and other sections in Pune's domestic sector



Source: PMC, 2010

In addition to this, there are close to 93,000 trading establishments in Pune city (ESR, PMC 2005–2006), including canteens, hotels, malls, hospitals, and so on, all of which add to the emissions in the air. Moreover, burning of waste material mainly constituting biomass in open space is another factor affecting the air quality. It has been estimated that 204 T/yr of PM10 emissions are emitted through this activity (PMC, 2010).

DG sets

There are no thermal power plants within Pune city; however, the industries and other commercial users in Pune and Pimpri-Chinchwad cities have set up DG sets to meet the power requirements, particularly during power cuts and load shedding. Non-industrial generators are most commonly found in apartments, shopping malls, and commercial areas. It has been estimated that DG sets in non-industrial areas emit about 379.61 T/yr of PM10 (PMC, 2010).

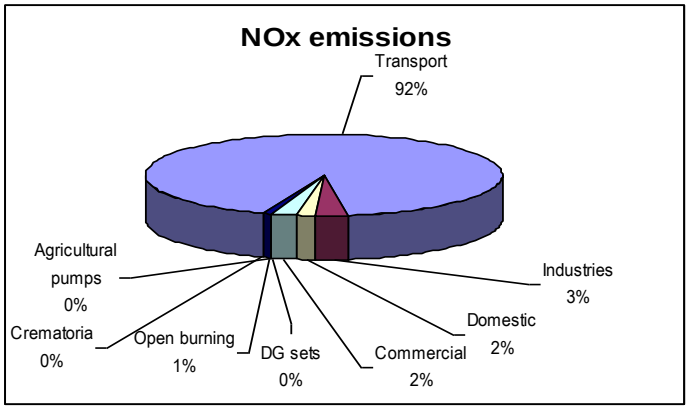
Construction activities

With the growth of the city, infrastructural development is high on the agenda and the real estate sector has grown tremendously in Pune. Construction of residential complexes, shopping malls, commercial buildings, and so on is commonly observed in the city. Construction activities are linked with emissions of particulate matter. Based on the data obtained from the buildings department of the Pune Municipal Corporation, the construction sector emission load for PM10 has been estimated to be close to 697.2 T/yr (PMC, 2010).

Total emission loads

The sectoral distribution of NOx emission loads is presented in figure no. 3.11.

Figure No. 3.11: Sectoral distribution of PM10 emission in Pune city



Source: PMC, 2010

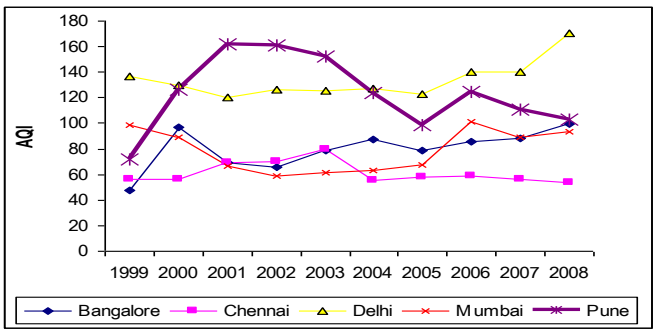
Although the vehicular traffic is the main source of the particulate emissions and for the increase in PM10 levels in air, workshops, industries, domestic applications, and similar sources also contribute to the increase in PM10 levels. The contribution of PM10 level from commercial and industrial sources is 5%–9%. However, the transport sector may be regarded as a sole contributor of NOx emissions (92%), followed by industrial emissions (3%).

State of Air Quality in Pune

The annual average SO_2 (Sulphur-di-oxide) concentrations across Pune city have been declining since the year 2000, mainly on account of reduced sulphur-levels. The concentrations, which once reached about 55µg/m³ in 1997, have gone down to 22µg/m³ during the last few years. However, the concentrations have been higher in comparison to other major cities like Bangalore, Chennai, Delhi, and Mumbai.

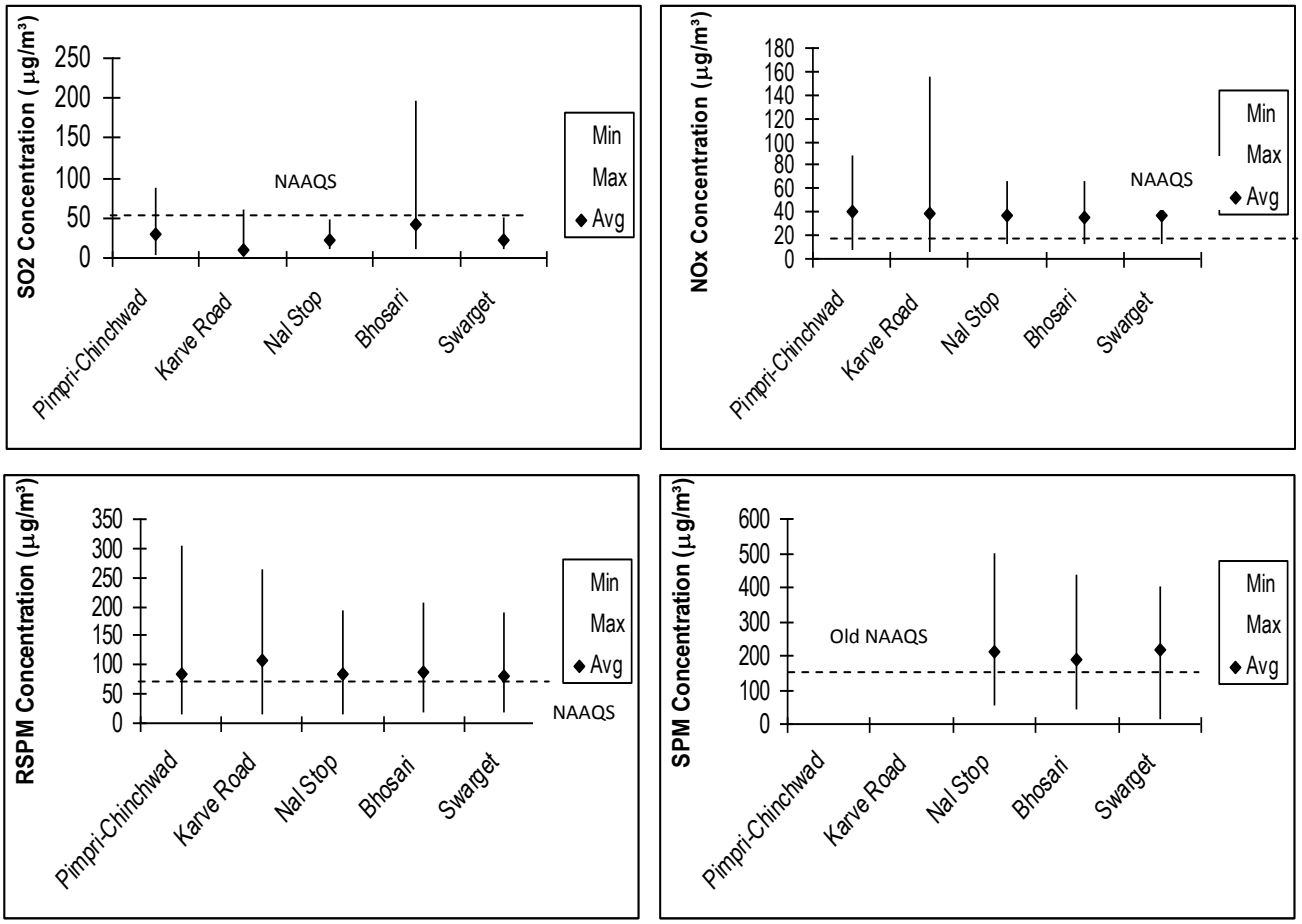
The SPM (Suspended Particulate Matter) concentrations in Pune have been recorded to exceed the standards during most of the years. Over the years, the finer fraction of particulate matter RSPM (Respirable Suspended Particulate Matter) has been high and exceeded the National Ambient Air Quality standard by more than 1.5 times (Figure Nos 3.12, 3.13, and 3.14).

Figure No. 3.12: Depiction of air quality in Pune during 1999–2008 using AQI (Air Quality Index) [16]



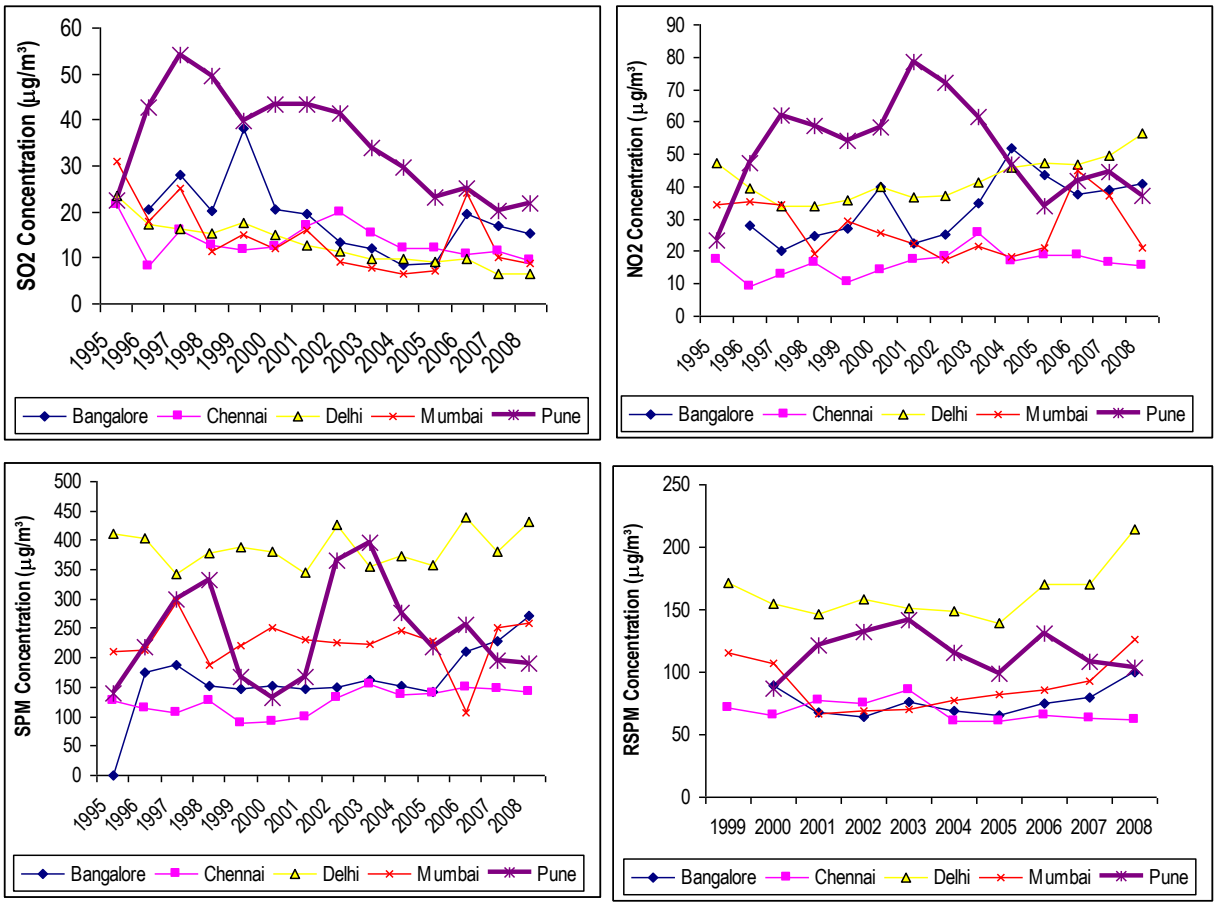
[16] AQI = 1/3 x (SO_2/Std + NO_X/Std + RSPM /Std)

Figure No. 3.13: Air quality data (minimum, maximum, and average) for five stations in Pune during June 2009–June 2010



Source: http://mpcb.gov.in/envtdata/demoPage1.php#station2

Figure No. 3.14: Trends of annual average SO_2, NOx, SPM, and RSPM concentrations (average for all the stations) in Pune as compared to other cities like Delhi, Mumbai, Bangalore, and Chennai for the years 1995 to 2008



[17]**Source:** CPCB, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004a, 2004b, 2005, 2006, 2007, 2007a, 2008, 2009

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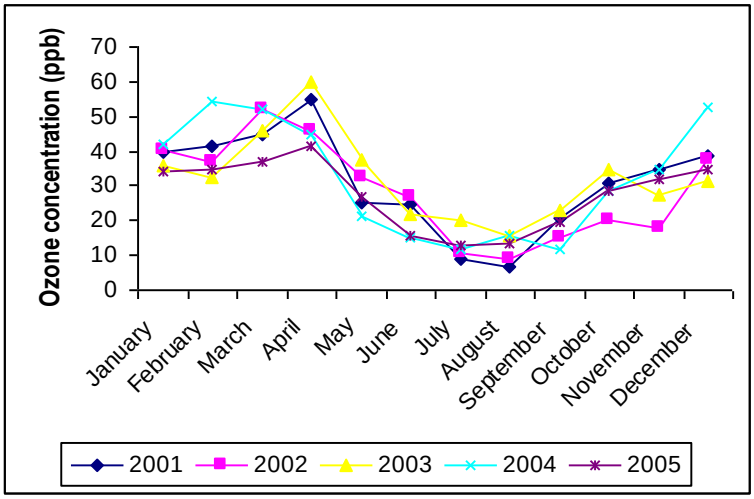
- CPCB. 2000. **National Ambient Air Quality-Status & Statistics 1998**, National Ambient Air Quality Monitoring Series: NAAQMS/15/2000–2001, 120 pp. New Delhi: Central Pollution Control Board.
- CPCB. 2001. **National Ambient Air Quality- Status & Statistics 1999**, National Ambient Air Quality Monitoring Series: NAAQMS/21/2001-2002, 148 pp. New Delhi: Central Pollution Control Board.
- CPCB. 2002. **National Ambient Air Quality- Status & Statistics 2000**, National Ambient Air Quality Monitoring Series: NAAQMS/22/2001–2002, 161 pp. New Delhi: Central Pollution Control Board.
- CPCB. 2003a. **National Ambient Air Quality-Status 2001**, National Ambient Air Quality Monitoring Series: NAAQMS/23/2003–2004, 157 pp. New Delhi: Central Pollution Control Board.
- CPCB. 2004a. **National Ambient Air Quality- Status 2002**, National Ambient Air Quality Monitoring Series: NAAQMS/24/2003–2004, 167 pp. New Delhi: Central Pollution Control Board.
- CPCB. 2006. **National Ambient Air Quality Status 2004**. New Delhi: Central Pollution Control Board.
- CPCB. 2007. **National Ambient Air Quality Status 2005**, NAAQMS/30/2006–2007.
- CPCB.2007a. **National Ambient Air Quality Status 2006**, NAAQMS//2007–2008. New Delhi: Central Pollution Control Board.
- CPCB. 2008. **National Ambient Air Quality Status 2007**, NAAQMS//2008–09. New Delhi: Central Pollution Control Board.
- CPCB. 2009. **National Ambient Air Quality Status 2008**. New Delhi: Central Pollution Control Board.

Other pollutants

The ozone concentrations have been monitored at the IITM (Indian Institute of Tropical Meteorology) campus, Pune during the period 2001–2005. The concentrations are the highest during the month of April and lowest during the month of August. A seasonal variation of the ozone concentration has been depicted in figure no. 3.15.
(Note: As this kind of study is not an annual feature, the ozone concentration of 2009–2010 has not been mentioned.)

Figure No. 3.15: Seasonal variation of ozone concentration in Pune during 2001-2005



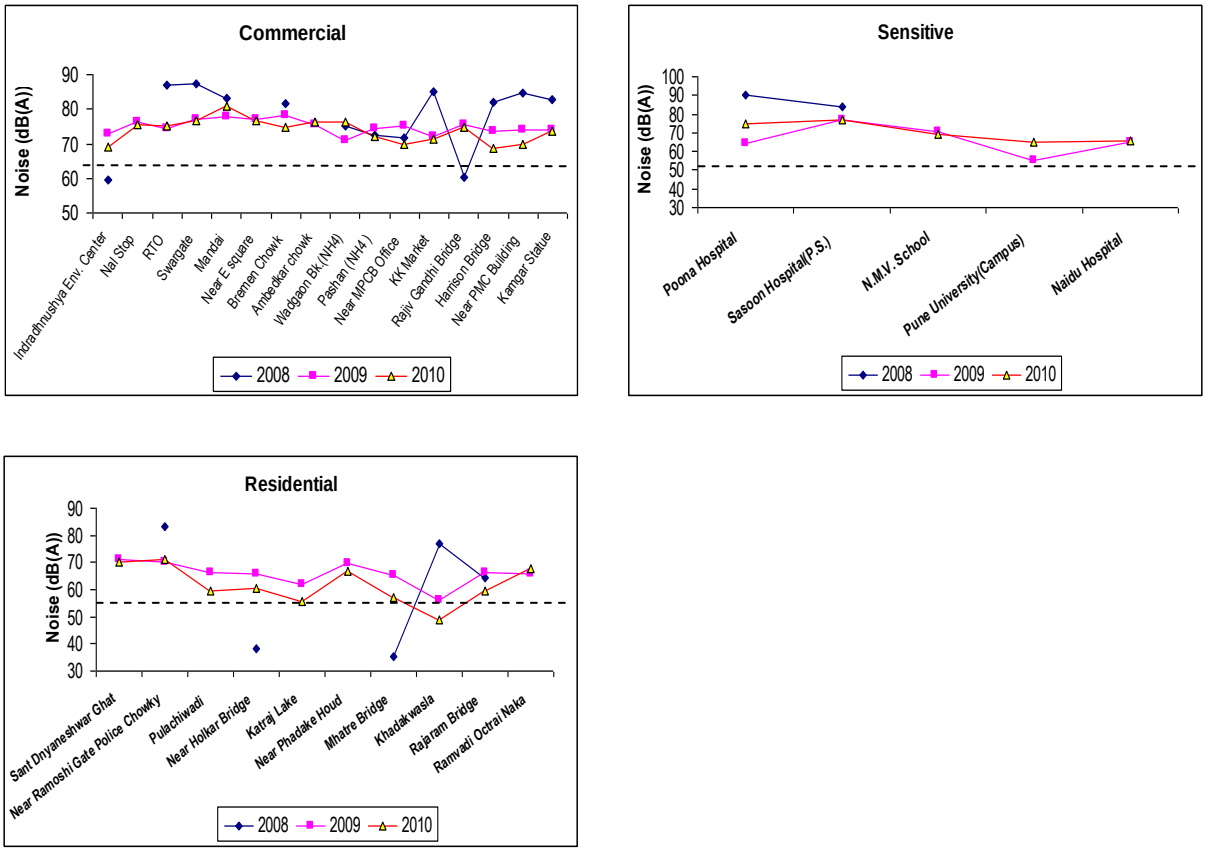
Source: Debaje[18], 2008

[18] Debaje S B and Kakadeb A D. 2008. **Surface ozone variability over western Maharashtra, India**. *Journal of Hazardous Materials* **161** (2009): 686–700.

Noise

Noise levels in Pune have been very high in comparison to the prescribed standards. The data of noise levels recorded at selected locations during 2008–2010 has been presented in figure no. 3.16. Most of the monitoring stations in various area categories have violated the prescribed standards on most occasions.

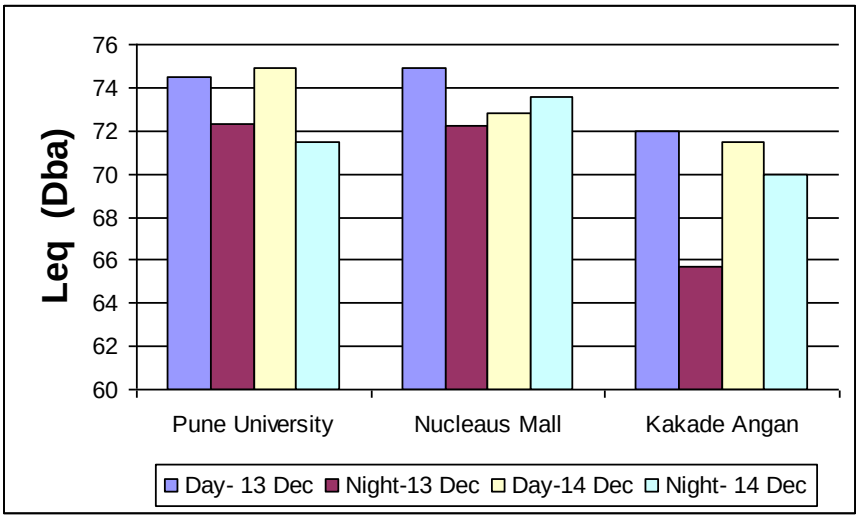
Figure No. 3.16: Noise levels at commercial, residential, and sensitive locations in Pune as observed during 2008–2010



Source: PMC, 2010

The MPCB (Maharashtra Pollution Control Board) conducted noise monitoring in a few major cities of the state. In Pune, monitoring was conducted at three locations, for two days, 13 and 14 December 2009, for 24 hours. In the identified silence zones, the noise levels varied between 65.9 dB(A) and 79.6 dB(A). In the commercial area, the minimum sound level was 67.6 dB(A) and maximum sound level was 78.7 dB(A) whereas in the residential area the variation was between 61.9 dB(A) and 81.1 dB(A) (Figure Nos 3.16 and 3.17).

Figure No. 3.17: Results of noise monitoring during 13–14 December 2009 in Pune [19]



Source: MPCB, 2009

It has been observed that the use of loud-speakers, fire-crackers, and musical instruments during festivals, such as Diwali, Ganesh Festival, Dahi Handi, and Navratra results in significant increase in the decibel levels. During the Ganesha Festival, the sound levels were recorded at 20 locations for five days. The levels ranged between 53.3 and 101.8 dB(A), which are above the permissible noise levels (residential zone: 55 dB(A) during day and 44 dB(A) at night). The highest sound level of 101.8 dB(A) was recorded at Alka Chowk on 3 September 2009, the day of the immersion, between 10 p.m. and 11 p.m.

The MPCB has emphasized on raising public awareness on the issue and conducting programmes to build the capacity of the regulatory agencies for effective implementation of noise standards.

Impacts of air pollution

The CRF (Chest Research Foundation) studied the health impacts of air pollutants during Diwali in Pune city. It was found that 25% of the population suffered from inhaling gaseous pollutants generated during Diwali. The study was conducted on 510 residents of the Kothrud locality and it was observed that during Diwali, the burning of firecrackers increased the pollutant concentrations and resulted in adverse health effects on the residing population. About 31.2% of the respondents complained of cough, while 13.3% said they experienced breathlessness.

[19] MPCB. 2009. Ambient Noise Level Monitoring of Metropolitan Cities, 13 and 14 December 2009.

Measures taken by the government to control air pollution

In Pune city, increasing levels of air pollution, due to continuous increase in the number of vehicles, is a key area of concern. As per the budget, 2010–2011, PMC has allocated Rs 677 crore for developing better transport infrastructure (Budgetary Provisions, PMC 2010–2011).

Of the total budgetary provision, Rs 44.30 crore has been set aside for implementation of short-term plans. Similarly, some long-term plans are also been proposed, which include execution of Metro Project in Pune city and 100% implementation of the projects pertaining to improvement of roads and transport infrastructure proposed under the Urban Development Plan. Given this, it is obvious that transportation is a priority sector for development for the Pune Municipal Corporation. (Table 3.4)

Table 3.4: Performance indices, based on Pune City's exhaustive Comprehensive Mobility Plan

Index	Formulation	Existing	Target
Network Speed	Average running speed for all vehicles	18 km/hr	30 km/hr
PT Mode Share (motorized)	Public transport trips/ Total motorized trips	18%	30%
NMT Mode Share	NMT trips/ Total trips	33%	50%
Volume capacity ratio	Road traffic volume/ Road capacity	1.4	0.8
Accessibility	Work trips with travel time less than 15 min / Total trips	33%	60%
Bus Supply	Bus fleet / Lakh population	28	55
IPT	Registered IPT vehicles / Lakh population	1890	1000
Provision for pedestrians	Footpath length / Road length	53%	100%
Bicycle lanes	Cycle track length /Road length	0%	100%
Fatality	No. Of Fatalities / Lakh population	11	0
Parking	Park able road length/ road length	23%	0 - 5%

Source: WSA, 2008 and Transport Department, PMC, 2010

Transport

Introduction of vehicular emission norms

- The first norm was implemented in the year 1991.
- The second emission norm was introduced in 1996.
- Norms for "catalytic converter" vehicles were implemented 1998 onwards.
- Euro-I equivalent norms were implemented 2000 onwards.
- Bharat Stage-II norms have been implemented since 2004.
- Bharat Stage-III norms implemented 2005 onwards.
- Bharat Stage-IV norms to be implemented in the year 2010.

Improved fuel quality

- Low-leaded petrol (0.15 g/l) + unleaded petrol introduced in 1995.
- Petrol with 5% benzene was introduced in 1996 and with 3% benzene since 2000.
- Diesel-sulphur levels standards—0.5% since 1996 and 0.25% since 2000.
- Low smoke 2-T oil was introduced in 1998.
- Petrol with 1% benzene and diesel with 0.05% sulphur was introduced in April 2003 by BPCL (Bharat Petroleum Corporation Limited).

Introduction of CNG (compressed natural gas) for vehicles

CNG is being supplied as a cleaner fuel in Pune to reduce air pollution. The first CNG facility of MNGL (Maharashtra Natural Gas Limited) in the city of Pune was inaugurated in 2008. The total investment envisaged for the overall project is Rs 460 crore that spans over a period of 10 years. Close to 40,000 vehicles, including buses, autos, and taxis are expected to be converted to CNG compatible vehicles in the first phase.

The Government of India has allocated 0.4 MMSCMD (Million Metric Standard Cubic Meter Per Day) of natural gas for Pune. The total potential of natural gas for the City Gas Distribution network for Pune is estimated at 2.5 MMSCMD.

In all, there are 2719 vehicles running on CNG, including auto-rickshaws, LMVs, and buses. At present, only 85 of the 1,466 PMPML (Pune Mahanagar Parivahan Mahamandal Ltd) buses use CNG. The total consumption of CNG by the existing fleet and rickshaws is 23,000 kg/day; although the installed capacity of MNGL (Maharashtra Natural Gas Ltd) is nearly 1.10 lakh kg.

Retrofitting autos to LPG

At present there are 35,851 auto-rickshaws, which work on LPG. PMC has been providing assistance for retrofitting of autos with LPG kits.

Improvement of public transport system

PMC has been working on enhancing the public transport system in the city by purchasing new buses.

Pune was the first city in India to have a BRTS (Bus Rapid Transit System). PMPML implemented the first phase of the project, which consists of 17 km-bus lanes along the Pune-Satara Road using more than 500 air-conditioned, low-floor Volvo buses. The funding for the project comes from the Government of India under the JNNURM (Jawaharlal Nehru National Urban Renewal Mission)

The Metro rail project has also been proposed for the city of Pune. The first phase of 31.5 km will have two routes—Pimpri Chinchwad Municipal Corporation to Swargate and Vanaz to Ramvadi. The second phase would be for 44 km with four corridors.

The implementation of these projects will not only impact the mobility, but will also reduce the dependence on private vehicles as well as the resulting emissions.

Infrastructure development for the transport sector

There are a number of initiatives taken to develop infrastructure for providing safe and smooth mobility to the residents of Pune. The traffic police department has started developing pedestrian walkways on some of the narrow, congested, and busy roads of the city. The construction of the Eastern by-pass road is also an ongoing project to divert the transit traffic from the city limits. Proposals are also being considered to build bus terminals in the outskirts of the city rather than in the congested zones.

I&M (Inspection and Maintenance) of old vehicles

Special efforts have been made to implement the PUC (Pollution Under Control) norms of 2004 in Pune city. In Pune, there are 99 PUC centres for petrol, 15 for diesel, and 53 for petrol and diesel. In Pimpri- Chinchawad itself, there are 53 PUC centres. On an average, out of 50% of vehicles that come for inspection, only about 5% fail the PUC test. Penalties are laid on vehicles if they are found exceeding the emission limits. For better I&M of vehicles, the ARAI (The Automotive Research Association of India) has been asked to submit a proposal to establish an inspection and maintenance centre for the old vehicular fleet.

Traffic management

Restrictions have been placed on goods, vehicles, and passenger buses entering the city by the PMC and the Police Commissionorate. Other traffic management measures include the pay and park schemes on major roads, one-way traffic movement on few roads, construction of multi-storied parking complexes, installation of countdown timers at signal junctions, and ATCS (Area Traffic Control System) using signal synchronizations on major corridors located in the centre of the city.

Ban on open burning

In view of air pollution caused by open burning of trash material, the practice has been banned by the PMC. Citizens are sensitized by PMC to carry out vermi-composting in their housing societies, institutions, and hospitals. Moreover, installation of vermi-compost pits has been made mandatory in the newly constructed housing societies.

DG (Diesel Generator) sets

With the rising power demands, the number and usage of DG sets is also increasing in the city. Special attention is being given to controlling the numbers and also monitoring the use of the type of fuels in the DG sets. Efforts have been made to effectively enforce the notified emissions standards for the generator sets.

Control of Noise Pollution

- Area within a range of 100 m near hospitals, educational institutions, and courts are declared as “silence zones”.
- Restrictions have been imposed on the usage of loudspeakers at night.
- The usage of loudspeakers (with limited noise) has been permitted only after mandatory written permissions from the concerned department have been obtained/duly complied with.

Conclusions

Pune is a city in which vehicles, road dust, DG sets, and so on are some of the major contributors towards air pollution. Therefore, to improve the air quality, management strategies should focus on a few necessary measures that include the following.

- Conversion of diesel-based buses to cleaner fuels
- Enhancement of public transport
- Construction of sky walks
- Timely implementation of PMC’s notification pertaining to improved vehicle norms like Bharat Stage-IV
- Checking fuel adulteration
- Proper inventories of industrial emission loads
- Strengthening of inspection and maintenance system required for regulating pollution from the large fleet of in-use vehicles
- Strengthening of air quality monitoring network (both in terms of number of stations as well as parameters monitored)
- Control of non-point sources of pollution, such as generator sets, waste burning, and so on
- Provision of incentives for environmentally benign substitutes, technologies, and energy conservation
- Public awareness campaigns to involve, inform, and educate the public about implementation of necessary measures.

Chapter 4: Water

Introduction

Of all the endowments bestowed by Mother Nature, water truly stands out as a magical resource! Although 70%–75% of the earth's surface is covered with water, only less than 1% is fresh water suitable for human consumption. Being the driver of life itself, it has, more often than not, been over-exploited to fuel economic growth and progress.

Overview of the Water Resources

A general outline of the surface and groundwater sources that are available in the city of Pune is presented in this section.

Surface water

Mula and Mutha are the main rivers that pass through the city. Mula-Mutha later empty into the Bhima river.

Lakes

Pune has two lakes—Pashan and Katraj. Pashan is a natural lake with a catchment area of 40 sq. km and is situated near the Mumbai-Bangalore expressway. This water is mainly used for irrigation. Katraj is a manmade lake built in the 19th century with an area of 0.82 sq. km. It is located near the Pune-Satara road, about 7 km from the main city. The lake attracts a number of tourists, especially for activities like boating and bird watching.

Groundwater

According to the 2006–2007 report of the GSDA (Groundwater Surveys and Development Agency), Govt of Maharashtra, groundwater can be found in the weathered and fractured zones of the basaltic formations and under semi-confined conditions. It can also be found in the groundwater table and phreatic conditions under lateritic and alluvial formations, respectively. Dug wells and bore wells are the primary water abstraction structures. The depth for dug wells and bore wells in the basaltic aquifers vary in the range of 4–20 m and 30–100 m, respectively. In Pune city, the average depth of the bore wells is 11.75 m. The average static pre-monsoon water level is 6.2 m, while the post-monsoon water level remains close to 4 m. Only 10% of the industrial water demand is met through municipal water supply. The remaining demand of water for industries and agriculture is being met through groundwater. There are about 399 tube wells and 4820 bore wells, operational in the city.

Pressure

The water demand of Pune city is met through combined water supply from four dams, namely Khadakwasla, Panshet, Varasgaon, and Temghar. The total storage capacity of these dams is 29.05 TMC (Thousand Million Cubic feet), which is sufficient to cater to the current annual requirement of 15 TMC. Refilling of these catchment areas is highly dependent on the rainfall, in the area as well as upstream of the dams and catchment. However, the rainfall pattern has been uncertain, especially in the last two years. On the other hand, the demand for water is increasing day by day and to meet the increasing requirements of the rapidly growing city is a real challenge. Both these scenarios together are exerting tremendous pressure on the water resources.

State of water resources

The description of the dams near Pune city is summarized in Table No. 4.1.

Table No. 4.1: Water capacity of dams near Pune

Dam	Total capacity (TMC)	Usable Capacity (TMC)
Khadakwasla	3.03	1.97
Panshet	10.96	10.65
Warasgaon	13.25	12.82
Temghar	3.72	3.61
Aikoon	30.96	29.05

Source: Water Supply Department, PMC

The government has agreed to 11.5 TMC of water storage for Pune city. Details regarding the water purification plants, their location, and capacity are summarized in Table No. 4.2.

Table No. 4.2: Details of the WTP (water treatment plants)

Water Treatment Plant	Location	Capacity (MLD)	Year
Parvati	Sinhagad Road	500	1969
Cantonment	Pune Cantonment	360	1893
Holkar	Holkar Bridge	25	1919
Warje	Near Kakade City	100	2006
Warje Praadeshik Yojna	Warje	10	1999
Vadagaon	Vadagaon	125	2007
Total	-	**1120**	

Source: Water Department, PMC, 2010

A periodic analysis of the physico-chemical and bacteriological parameters for raw and treated water from all the WTPs, is carried out at the laboratory established at Parvati. Other samples from overhead and service reservoirs, intermediate connections in the distribution network, and consumer taps are also tested at this laboratory. The quality of drinking water is regularly maintained as per ISO 10500, 1991 standards.

Status of Water Resources

Water Supply

The water distribution network in Pune is divided into seventeen zones. Each zone has its specified area and service. The total water supplied to the city amounts to 1050–1095 MLD. The city receives daily water supply to the tune of 229 lpcd (litre/capita/day). According to CPHEEO (Central Public Health and Environmental Engineering Organization), the minimum water supply is 135 lpcd. According to above statistics, the annual water requirement for the city should be 7–7.8 TMC. However, in the year 2009–2010, approximately 14.5 TMC of water was consumed by the city, which is twice the amount that the city requires.

Some parts of the city receive water through gravity, while others receive water through pumping stations. There are 20 pumping stations and 53 storage reservoirs (including gravity storage and elevated service reservoir). The total length of the distribution pipeline of drinking water is 2400 km. The water supply pipeline network in Pune city is mainly underground.

Surface water

The water quality of the Mula River and the lakes at Pashan and Katraj is monitored regularly. In 2009, Ultra-Tech organization[20] conducted a study, which included the examination of water quality at 19 different locations throughout the stretch of the river Mula, and Pashan and Katraj lakes, during and after the Ganesh festival. Parameters, such as DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), and COD (Chemical Oxygen Demand) were monitored. Results from the same have been discussed in the following section. Water quality standards for best-designated usages prescribed by MPCB[21] have been used for assessing the compliance.

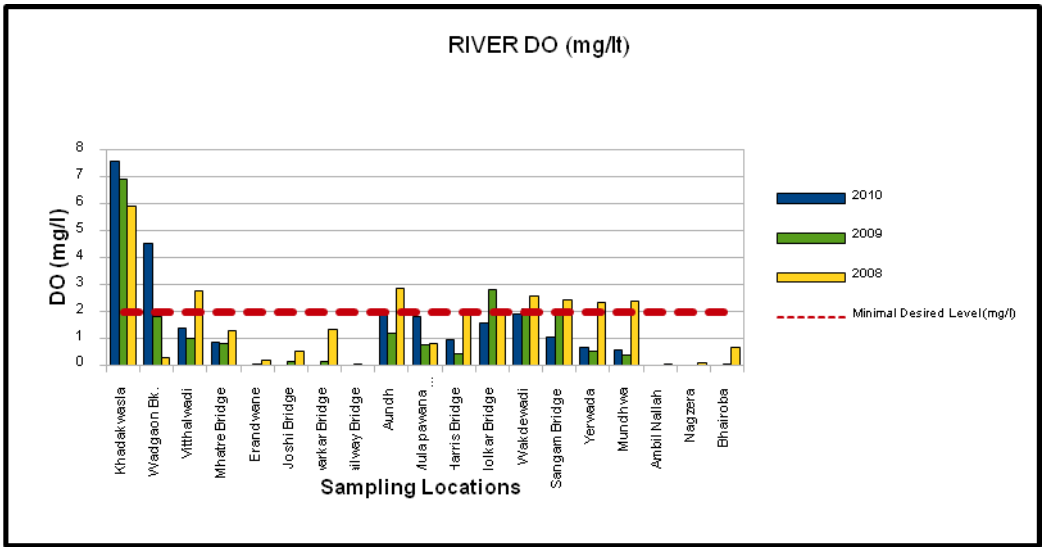
DO (Dissolved Oxygen)

The amount of DO in a water body is one of the most commonly used indicators to assess the health of water. The annual dissolved oxygen trend for three consecutive years for river Mula is shown in Figure No. 4.1. It was observed that only two out of 19 locations met the desired requirement of 2 mg/l prescribed by MPCB[1], which indicated poor water quality. Anaerobic conditions were observed at locations, namely Ambil nallah, Nagzera, and Bhairoba nallah and may be attributed to increased levels of organic pollution.

[20] Ultra-Tech Environmental Consultancy & Laboratory, 2009. Report on Ganesh Festival Water Monitoring, Ref. No. UT/P/LAB/18/09

[21] http://mpcb.gov.in/envtdata/waterquality42.php

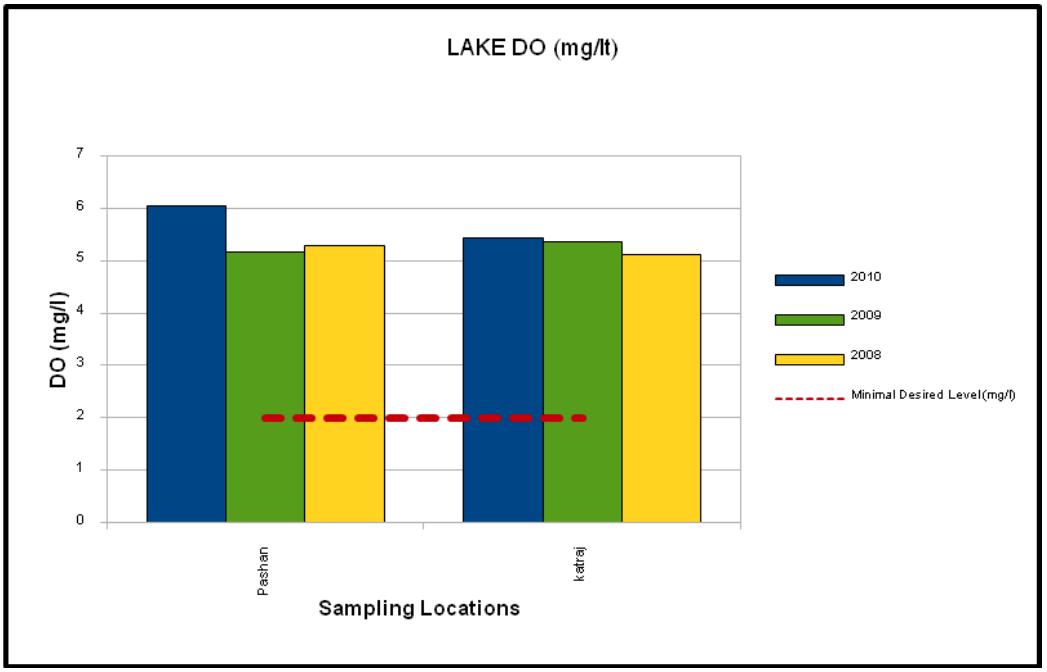
Figure No. 4.1: Annual dissolved oxygen trend for river Mula



Source: Environmental Laboratory, PMC, 2010

Lake Pashan and Katraj were also monitored for dissolved oxygen content. The observations for last three years are depicted in Figure No. 4.2. The increase in the dissolved oxygen content over the past three years is a sign of improved water quality.

Figure No. 4.2: Annual dissolved oxygen trend in the lakes



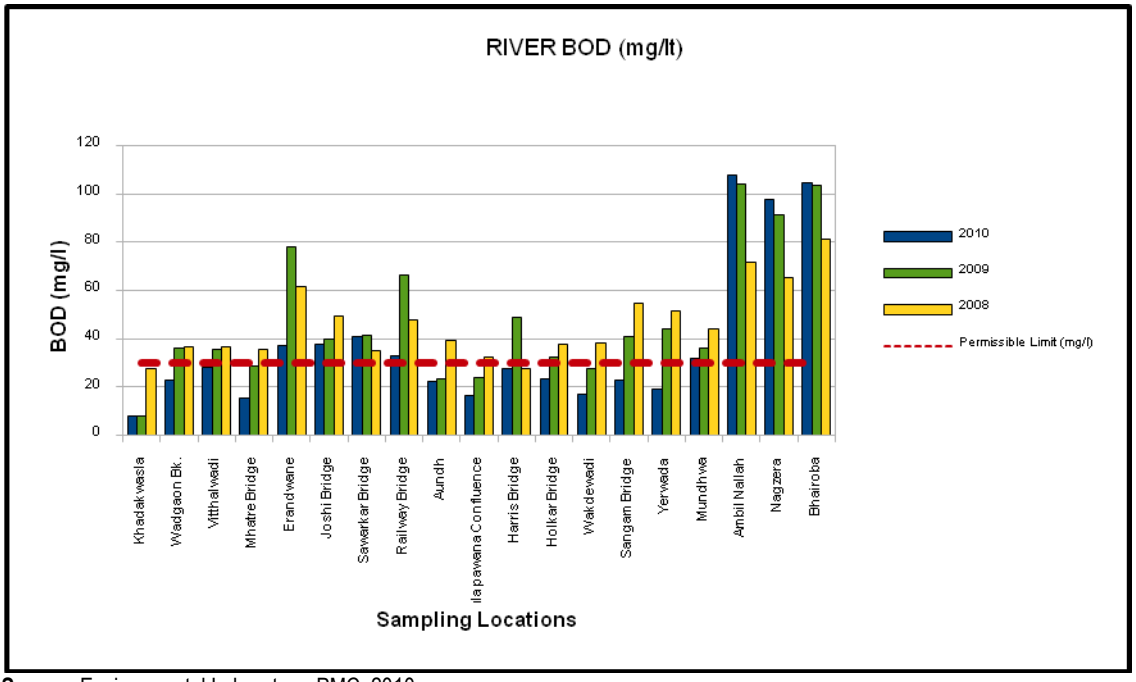
Source: Environmental Laboratory, PMC, 2010

BOD (Biochemical Oxygen Demand)

BOD is a measure of the uptake rate of dissolved oxygen by the micro-organisms in a water body. The more the organic pollution, the greater are the BOD values. The BOD trend over three years— 2008, 2009, and 2010—for river Mula is presented in Figure No. 4.3. It was observed that at six locations the water quality for BOD exceeded the permissible limits for the year 2010. From the available data, it can be concluded that locations, such as Ambil Nallah, Nagzera, and Bhairoba are highly polluted. The source of the pollution could be discharge of untreated sewage and waste water.

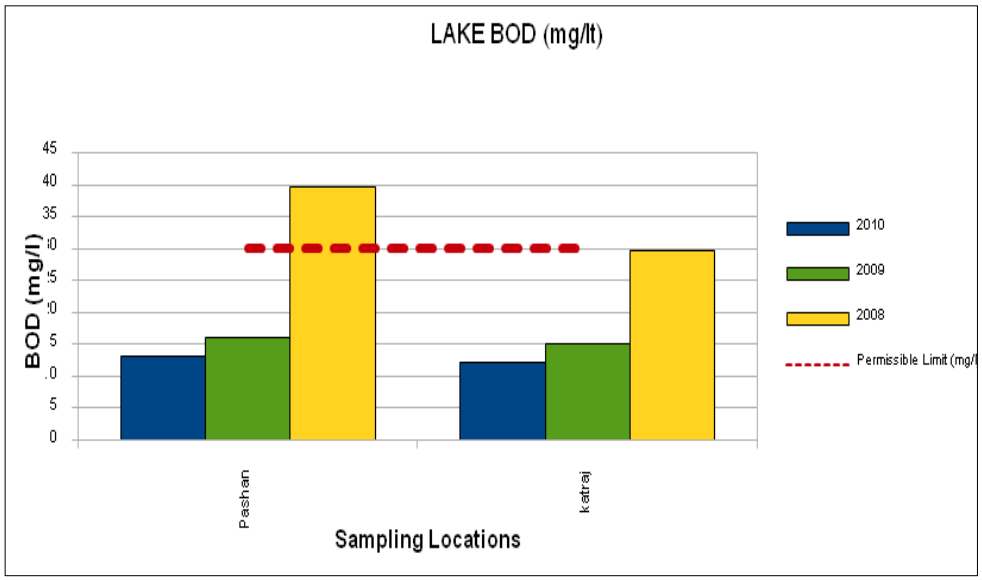
A positive trend of decrease in the BOD values in last three years was observed in case of the lakes. The current BOD values are in compliance with the standards and are shown in Figure No. 4.4. Pashan and Katraj lakes have low BOD and comparatively high DO, indicating good water quality.

Figure No. 4.3: BOD trend over three years for river Mula



Source: Environmental Laboratory, PMC, 2010

Figure No. 4.4: BOD trend over three years for lakes in Pune

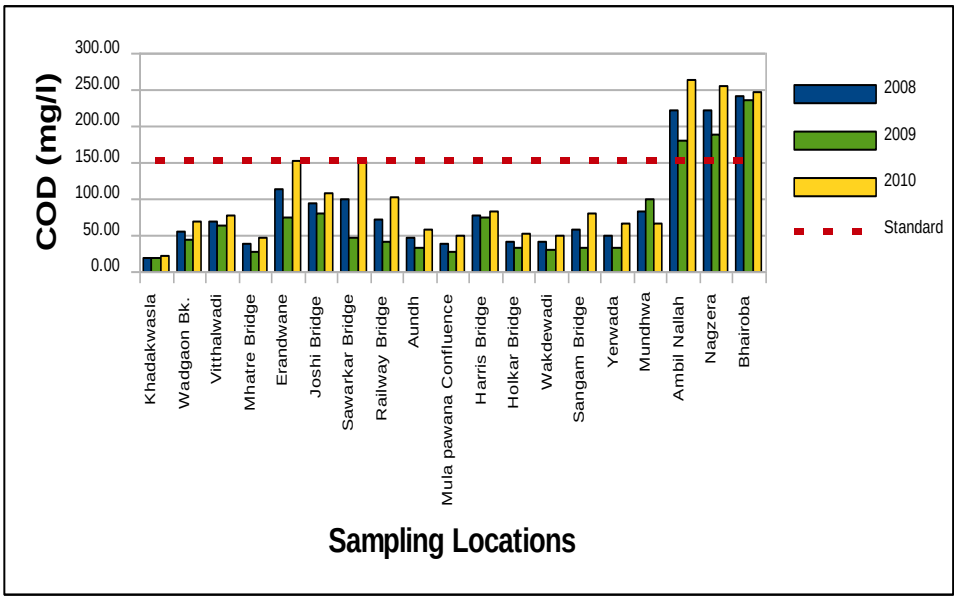


Source: Environmental Laboratory, PMC, 2010

COD (Chemical Oxygen Demand)

COD is commonly used to indirectly measure the concentration of inorganic pollutants in the surface water. It is expressed in mg/l (milligrams/litre), which specifies the mass of oxygen consumed per litre of solution. Comparative analysis of the last three years, of the annual COD data, for river Mula is shown in Figure No. 4.5. For the locations, Ambil nallah, Nagzera, and Bhairoba, it was observed that the values did not comply with the standards, thus, indicating pollution above the permissible limit. It is important to note that the readings have been provided by environmental laboratory of PMC. As per the report published by MPCB (2009), the COD levels in Mula river, violated the permissible MPCB standards, only at a location near the Sangam bridge, while the rest of the locations were reported to have COD levels well under control.

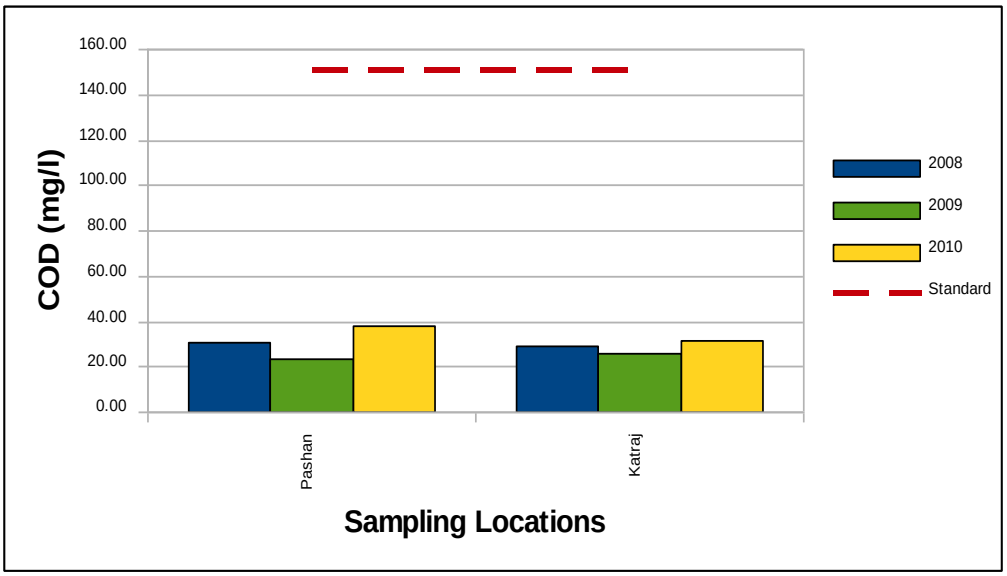
Figure No. 4.5: Comparison of COD values with standards for river



Source: Environmental Laboratory, PMC, 2010

Figure No. 4.6 reveals that for the Pashan and Katraj lakes, the COD values were well within the permissible limits for the last three years. However, there is an increase in the COD values as compared to last year, indicating increase in pollution levels.

Figure 4.6: Comparison of COD values with standards for lakes



Source: Environmental Laboratory, PMC, 2010

Groundwater

Groundwater is extensively used for domestic and irrigation purposes in Pune. GSDA report (2006–2007) indicated that due to lower infiltration rate and over-exploitation, there is a fall in the groundwater table. The fall is in the range of 0.10 to 8.75 m. An observation well at Awtadewadi recorded a drop of 8.75 m, while areas like Bibewadi, Holkarwadi, and Shevlewadi showed a drop of 3 m. This situation is a serious threat to the future availability of water. Artificial recharge through rainwater harvesting is suggested for these locations.

Water connections

All the water connections in the city are not metered and many illegal connections have been recorded in the city. Moreover, water bills have been clubbed with property tax and, hence, it is difficult to keep systematic records and control on the usage of water (PMC, Pune).

Impacts

Over exploitation of water resources will have serious implications on water security in the future. This grave situation should not be ignored.

Response

Measures undertaken to improve Water Quality

- Water supply connections have been provided as part of the slum rehabilitation scheme, covering 100% of the population of the urban poor.
- PMC has metered 100% of its commercial water connections and has recovered pending bills amounting to INR 55 crores.
- Rainwater harvesting has been made mandatory and is an important clause in the building byelaws.
- PMC has already installed eight Sewage Treatment Plants (STPs) (Table No. 4.3).
- To reduce the release of the untreated sewage, PMC has installed 811 pay-and-use public toilets for appropriate channelizing of the sewage, to maintain good sanitary practice within the city. PMC spends INR 900 lakh annually for operating and maintaining these toilets. It is estimated that close to six lakh people use these toilets per day.
- Awareness drives for sensitizing people on water pollution were undertaken.
- To minimize the surface water pollution caused during the Ganesh Utsav, PMC has taken initiatives to provide huge tanks or has created artificial ponds for immersion of idols

Sewage Treatment

In Pune city, 744 MLD (9.50 TMC/day) of sewage is generated, out of which 497 MLD (6.4 TMC/day, [67%]) is treated. The remaining 247 MLD (33%) untreated sewage is let off in the rivers.
A total budget of INR 270 crore is required to develop infrastructure to achieve 100% treatment of sewage. Keeping this in mind, in the current financial year 2010–2011, INR 65 crore (Budgetary provisions, PMC 2010–2011) have been allotted for the same. A target has been set to achieve 100% sewage treatment in the next two years. There are eight STP's (Sewage Treatment Plants) for the treatment of sewage generated in Pune city. Brief information of the same is given in Table No. 4.3. Similarly, a summary of two proposed STP's is given in Table No. 4.4.

Table No. 4.3: Existing STP's in Pune city

Sr. No.	Name of the STP	Capacity (MLD)	Technology used
1	Bhairoba Nala	130	Activated sludge process and anaerobic digestion
2	Erandwana	50	Activated sludge process and anaerobic digestion
3	Tanajiwadi	17	Bio-tower and extended aeration process
4	Bopodi	18	Extended Aeration Process
5	Naidu Hospital (Old)	90	Activated Sludge Process
6	Mundhawa	45	Sequential Batch Process
7	Vitthalwadi	32	Modified Activated Sludge Process
8	Naidu Hospital (New)	115	Activated Sludge Process
TOTAL CAPACITY :		**497 MLD (6.4 TMC)**	

Source: PMC, 2010

Table No. 4.4: Summary of proposed STP's in Pune city

Sr. No	Name of the STP	Capacity (MLD)	Technology used	Status
1	Baner STP	30	Sequential Batch Process	Expected to commission in August 2010
2	Kharadi STP	40	Sequential Batch Process	Expected to commission in June 2011

Source: PMC, 2010

Recommendations/ suggestions

- To ensure equal distribution of water with appropriate implementation of policy, and channelizing of the water supply networks.
- Hundred per cent water supply only through closed pipes.
- Hundred per cent metered water connections to be provided.
- Rectification of worn out pipes and peripherals of water supply.
- Rectification of water leakages in the water network and piping.
- Responsible usage of water to be ensured and "water audits" to be conducted regularly.
- Rainwater harvesting to be implemented largely across the city.
- Sensitization of masses for water conservation and efficient use of water resources.

Chapter 5: Land use and land pattern

Introduction

Almost 70% part of the earth is covered with water and 29.2% of the total surface is land. Due to such a vast expanse of water, the earth is regarded as the blue planet. Taking into consideration the distribution of land under forest cover, agriculture, urban settlements, industrial uses, and so on, as well as the increase in the demand for land due to population explosion, availability of land per capita has become a matter of great concern. Hence, responsible use of land as a resource is of utmost importance.

Significance of assessing status of land use and land cover change

Availability of natural resources, such as land, water, air, and energy sources governs the industrial, spatial, and economic growth of any city. Waste, either biodegradable or non biodegradable could also be regarded as an important resource.

Being an immobile and finite resource, land commands a high value in commercial dynamics. Agriculture, civilization, and urbanization directly impact the pattern of natural land cover. According to the Food and Agricultural Organizations (FAO), land use has been defined as the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change or maintain it[22]. Considering the demands of the growing population, the land resources are often under tremendous stress. It is important to establish and maintain a balance of open spaces, paved surfaces, agricultural land, forests/green cover, and land allotted for construction. Change of land use and land cover patterns could lead to unfavourable consequences, which may hamper the sustainable development of the city. For instance, reduction in forest cover could lead to microclimatic changes leading to increase in local temperatures; whereas conversion of agricultural land into non-agricultural land could directly have implications on food security.

Preservation and utilization of land cover in an appropriate pattern offers several advantages in the development of the city. While preparing the development plan for the city, it is important to consider land as an essential resource to ensure its sustainable use.

[22] http://www.fao.org/docrep/T0715E/t0715e03.htm#the land use plan

Pressure

Population Growth

Due to population explosion and migration to cities, the expanse of urban areas has increased dramatically in the past 20 years (1990–2010). Urbanization to fulfil the requirements of a growing population and its demand for food has directly impacted the land use–land cover pattern. For instance, in the year 1950, close to 60% of the total land in Pune city was dedicated to agriculture; however, by the year 2006, only about 5.95% of the land is available for agricultural practices.

Land requirement for solid waste management

The amount of liquid and solid waste generated in the city has a direct impact on the land and, hence, it is necessary to dispose of the waste in a scientific manner. The following section offers an overview of the issues pertaining to solid waste in Pune city and the strategies devised by the PMC for its effective management.

All sectors, i.e. residential, commercial, and industrial create waste in some or the other form, which has a direct impact on the land in the region. Further, to increase the sale of the products, attractive packaging and printing is done; these materials are difficult to decompose and, moreover, the waste generated from these materials are more complicated to dispose.

The production of solid waste in the city mainly depends upon the population of the city. The projected population of Pune city in the year 2010 is approximately 35 lakh. The spatial growth of the city and the volume of generated waste are increasing proportionately. The modern and jet-setting lifestyle is one of the main causes of ever increasing solid waste in the cities. The new trend of “use and throw” packaged goods from malls change the composition of solid waste, making it enriched in non-biodegradable components, such as plastic, polymer fibres, Styrofoam, and metals.

Moreover, as the expanse of the city increases, collection of waste from distant areas and its transportation to the processing plants becomes more resource intensive and complicated, exerting pressure on the waste management infrastructure.

It is observed that construction of high-rise buildings in the city leads to not only an increase in the population density of those areas, but also waste generation. The rising quantities of waste, along with decreasing waste land area for disposal, create the problem of providing suitable waste disposal sites.

The waste generated from the city is collected at a specified location in the outskirt areas. Further, processing of this waste directly affects the quality of land. The leachate, a liquid rich in environmentally undesirable materials like ammonia, is produced from degrading waste, which percolates in the top soil contaminating the groundwater table and deteriorating the quality of soil in the nearby areas. The leachate also overflows through the nearby drains (nallahs), polluting the aquifers. Waste and leachate also pose serious health problems to the residents of nearby localities.

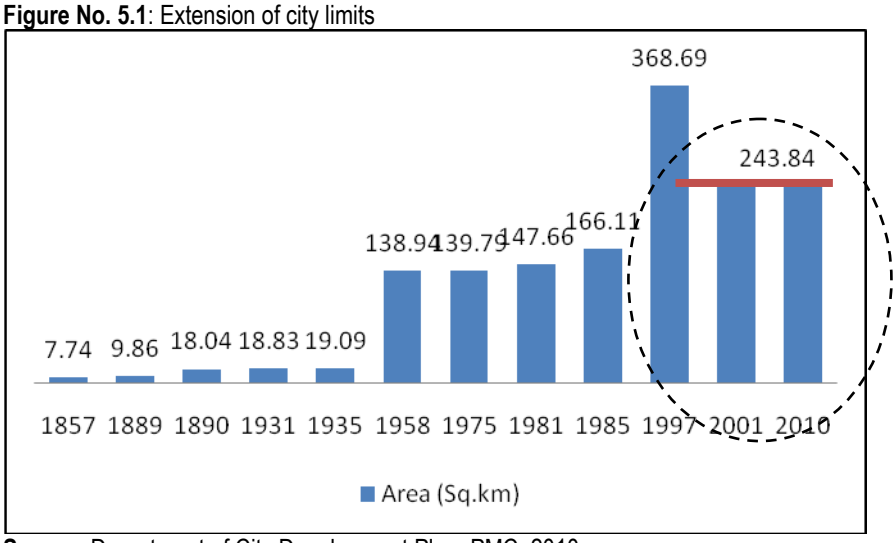
Status

Land is used for various purposes like developing residential areas, roads, agricultural lands, forestry, and so on. In urban areas, some part of land is secured for solid waste management and it has severe impact on other factors like soil and water. Various uses of land and its status are discussed below.

Land availability

As shown in Figure No. 5.1, in 1985, the area of Pune city was spread across 146.11 sq. km. In the year 1997, 23 fringe villages/villages from the outskirts of the city were added to the old municipal limit that increased the city area to 368.69 sq. km. In 2001, few villages were again excluded from the city limits, reducing the area to 243.84 sq. km. After 2001, no further expansion has been carried out and, hence, the city area is considered constant till date.

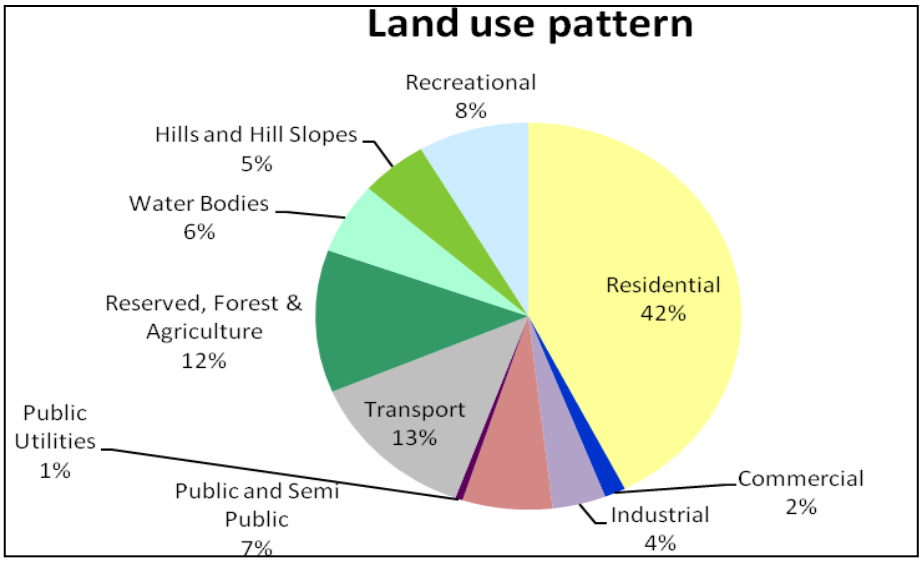
Figure No. 5.1: Extension of city limits



Source: Department of City Development Plan, PMC, 2010

As shown in Figure No. 5.2, 42% land is used for residential purposes and only 4% is available for industries. Green cover and water bodies constitute 12% and 6% of the total area, respectively.

Figure No. 5.2: Land use pattern



Source: Department of City Development Plan, PMC, 2006–2012

Table No. 5.1: Percentage of land use as per the division

	State	**Standard**
Land use	**Percentage as per division (2006)**	***UDPFI standards**
Residential	42.52%	35%–40%
Commercial	1.61%	4%–5%
Industrial	4.05%	10%–12%
Governmental and semi-governmental	6.83%	12%–14%
Transport and civil facilities	13.61%	12%–14%
Reserved forests	11.91%	-
Agriculture	5.95%	-
Water bodies	5.11%	-
Hills and hill slope zones	8.41%	-

Source: City Development Plan Report, 2006

**UDPFI: Urban Development Plan Formulation and Implementations*

Gardens and parks

PMC has developed 83 gardens in an area of 268.2 acres. About 25 gardens are under development, covering an area of close to 51 acres. The Rajiv Gandhi zoo has been established over an area of 165 acres, housing 350 animals belonging to 18 species. Details about the gardens in Pune and its specialities are provided in Annex 1.

Hills and hill slopes

Image No. 5.1: Encroachment on hills

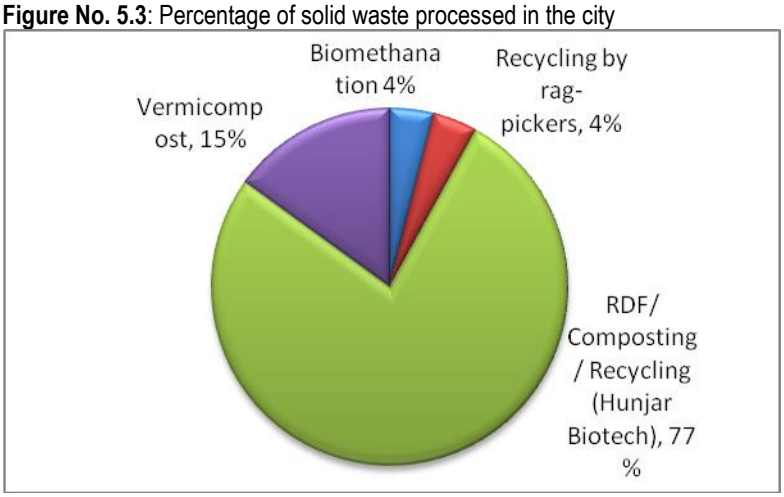
Out of the total available land area of PMC, 11.88% of the land is under the hills and hill slope zone, which is approximately spread across 28.98 sq. km. It is observed that illegal encroachments are cropping up on this land as seen in Image No. 5.1.

Current status of solid waste management

Every day in Pune city, about 1,300 to 1,400 metric tonnes of waste is generated. Out of the 163 acre area of Uruli Devachi and Furusungi, approximately 50–55 acres of open area was used to dump 1200 metric tonnes of waste.

However, from 1 June 2010, open dumping is completely banned in the city. PMC is the first municipal corporation in India, to ban 100% open dumping and has adopted various scientific methods for solid waste management (Figure No. 5.4).

Figure No. 5.3: Percentage of solid waste processed in the city



Source: Solid Waste Department, PMC, 2010

At the Uruli Devachi and Furusungi processing centres, 1000 metric tonnes of waste is processed every day. By adopting this method, environmental problems like fires in summer, leachate produced from the waste in monsoon, and increasing number of mosquitoes and flies breeding in the dumping areas are controlled and prevented. In Pune city, municipal waste is being managed as per the Municipal Solid Waste (Management and Handling) Rules, 2000.

As per the act, the following methods have been adopted.

1. ***Segregation of waste***
   Segregation of waste is done at two stages—first, during collection at source with the help of members of residential complex, rag pickers, garbage vans, hotel trucks, and so on, by making dedicated trips for segregated waste; and second, at the dumping site by using containers and buckets. The PMC has made it compulsory to dispose waste by using decentralized methods like setting up bio-methanation/biogas plants and vermin-composting pits. There are about 135 bio sanitizers, 44 bio-methanation plants, and 454 vermin-composting projects, which are functional at the level of the societies. Waste is collected from about 277,198 colonies, by 89 garbage vans and trained rag pickers from "SWACH", a cooperative organization.

2. ***Storing of solid waste***
   In Pune city, 944 containers of 3.8 cubic metre and 426 compact buckets are placed at various locations and are used as common collection bins. For the collection of household waste comprising wet waste, paper, glass, and metal, a team of 1,695 rag pickers from "SWACH" are employed to collect and segregate wet waste from about 237,056 housing colonies on a daily basis. The waste generated in hotels is being collected through 23 tippers.

3. ***Transportation of solid waste***
   Out of the 296 vehicles deployed for collection of solid waste, only about 250 vehicles are used on a daily basis. It includes 89 garbage vans, 68 dumper placers, 18 compactors, 23 hotels trucks, 50 BRC, and so on. After collection, all the waste from the city is brought to seven centres, from where the waste is put on the ramp and then sent for processing by high capacity BRC vehicle. This decentralized processing helps in fuel conservation as all the vehicles need not travel up to the centralized dumping grounds located on the outskirts of the city.

4. ***Capping***
   A detailed technical report has been prepared to permanently close the dumping ground at Urali Devachi and Furusungi. As per this report, it has been proposed to adopt latest scientific methods to effect capping of the open dumping site. After capping, it is suggested that this dumping ground would be converted into an attractive tourist spot.

Impacts

Land Availability

- Increase in population density heightens the competition for land, which directly escalates the land price.
- Significance of Pune's hills cannot be understated. These forms constitute a broad and diverse eco-system, and are also responsible for the city's biodiversity and pleasant weather. Of late, as the green cover is receding from these hilltops, some adverse effects, such as a dramatic rise in soil erosion, decrease in the level of groundwater table, and rise in local ambient air temperatures have been observed.
- Due to rapid urbanization, there has been an alarming decrease in agricultural land, which has direct impacts on availability and cost of fresh agricultural produce and food security of the region.
- It is a challenge to maintain the rapid pace of urbanization, while ensuring sustainable use and conservation of available natural resources in that geographical area.
- Due to urbanization, the water run-off index of surface land is assumed to be 0.30 to 0.95. It means that in an area of 243.84 sq.km, about 6000 TMC (thousand million cubic feet) of water would have been ideally harnessed and left to percolate to the groundwater table per year. However, now, due to increase in hard paved surfaces and concretization, the water is not allowed to get absorbed in the soil.

Solid Waste

During the monsoon, leachate is produced from the degrading waste dumped at the landfill sites. The environmental risks of leachate generation arise from it escaping into the environment around landfills, particularly to watercourses and groundwater table. Moreover, the polluted water provides a breeding ground for the insects like mosquitoes and flies. Dumping waste at open places generates methane gas, which is regarded as a major contributing agent of global warming. It is essential to note that methane gas is known to be 21 times more potent in increasing the global atmospheric temperature compared to carbon dioxide. Given this, PMC has completely stopped dumping garbage at open landfill sites and 100% of the waste is now processed, which has resulted in reducing pollution to a greater extent.

Responses

1. Green zone protection

Land being an important natural resource, it is necessary to ensure sustainable use of the available land. In light of this, the corporation has taken a lead to ban illegal encroachments, which cause changes in the land use pattern. As per the development plan implemented 1987 onwards, reserved lands are divided into 56 types, e.g. schools, educational institutions, gardens, green cover, agricultural markets, museums, public institutions, and so on.

2. Tree census

The Garden Department of PMC has started the tree census programme for Pune city. According to the information collected so far, 20 lakh trees are registered within the limits of Pune city. Areas surveyed under the tree census programme include Aundh, Varje, Karve Nagar, Sahakar Nagar, Bibwewadi, Hadapsar, and Yerwada. This indicates that Pune city has rich green cover. As the city experiences spatial growth, the land used for establishing residential areas increases. Moreover, due to encroachment on green zones, increasing slums, pollution, and so on, the area under the green cover is shrinking rapidly. This severely impacts the biodiversity, variety of flora and fauna, and migration pattern of animals and birds. Various studies, conducted from 2001–2010 reveal that the number of birds within the city limits have declined to one third of the original population. PMC, the forest department, educational institutions, non-government organizations, and nature lovers of Pune are aware of the significance of conserving the green zones of the city. In this context, various programmes are being implemented proactively to increase awareness amongst citizens. Information regarding various programmes initiated by various NGOs (non-governmental organizations) is given in Annex 2.

3. Solid waste management and scientific principles used in waste disposal

- Open dumping ground at Uruli Devachi has been permanently closed and the waste is being processed further.
- Proposal of electricity generation project based on gasification technology has been approved, which will be executed in the next two years. Projects based on bio-methanation / mechanical composting/ vermin-composting of 5 metric tonnes per day capacity, have been implemented at ward level and are proposed to be replicated in the near future.

The Maharashtra government has directed municipal corporations and councils to adopt PMC's initiatives as pilot projects for their administrative areas.

- Taking into consideration the need to segregate waste at source, workshops are conducted to create awareness amongst residents of societies, housing complexes, and other citizens. The awareness programmes include distributing pamphlets, CDs, posters, banners, and performing street plays emphasizing on waste segregation at source.
- PMC has introduced exemption in property tax for the societies, which implement at least one of the programmes like vermin-composting of bio-degradable waste, usage of solar energy, rainwater harvesting, and so on. Five per cent tax exemption is given to those who implement at least one programme, whereas 10% tax exemption is offered to those who implement two or more such programmes.

4. Bio-methanation

Electricity generation using methane gas produced through anaerobic fermentation of biodegradable waste, with the help of anaerobic methanogen bacteria, is well demonstrated in India as well as other countries. Biogas and compost are two important by-products of the bio-methanation process. PMC has implemented 11 projects designed to process 5 tonnes of bio-degradable waste based on bio-methanation technology. The energy derived from this process is used to generate electricity to power the street lights as well as to meet the power requirements of the set up itself. Information regarding these projects is given in Annex 3.

Image No. 5.2: Bio-methanation project implemented at Model colony

Image No. 5.2 illustrates the bio-methanation project established at Model colony. The biogas generated from this project is supplied to run gensets of 40-kVA generating capacity, working on 100% biogas. Till date, the working load has been maintained to 8 kW; sufficient to illuminate 144 street lights daily between 7 p.m. to 6 a.m. PMC has plans to increase the load gradually to 15 kW to enable lighting up of

150–200 street lights. The positive impacts of the bio-methanation project are enlisted below.

- Waste processing: Organic waste gets rapidly degraded in the process of bio-methanation. Furthermore, since the process takes place in a closed container, nuisance caused due to stench, flies, rodents, stray dogs, and so on is easily avoided.
- Waste segregation and decentralized processing of waste reduces burden on the traditional garbage collection and disposal methods. As the efficiency of bio-methanation is high, electricity can be generated from it in a short span of time.

1) Impact on environment
   - Instead of release of methane gas in the atmosphere, it is used for constructive application, such as power generation. Release of toxic leachate from landfill sites pollutes land and water. Bio-methanation technology can be used as a solution to mitigate the spread of toxic leachate.
   - Projects based on electricity generation from waste are successfully implemented by PMC. Not only has it helped in changing the approach of the citizens, it has also motivated other cities to implement similar projects.

Chapter 6: Energy

Introduction

The progress and expansion of any city is highly dependent on the growth of its domestic, industrial, and commercial sectors. Meeting the energy requirements of these sectors is one of the crucial aspects of the development process.[23]

As the demand for energy increases, the supply of the same has to be increased proportionately. However, this is not always possible due to lack of energy and financial resources, environmental concerns, affordability of consumers, etc. Appropriate strategies are to be formulated and implemented depending on the specific requirements. For example, to overcome shortages in the power supply scenario, the "Pune Model: A zero load shedding scheme[1*]" was introduced in the year 2006–2007 by MSEDCL (Maharashtra State Electricity Distribution Co. Ltd). It was envisaged that upon implementation of this model, Pune city could be free of load shedding and power cuts. As the demand for power was ever increasing, the model was accepted and approved across the domestic, commercial and industrial sectors. However, the current scenario is that to sustain the "Pune Model", the city had to procure electricity from other regions of Maharashtra and also from the private energy suppliers. The point to be pondered is to consider if it was really necessary to buy electricity at such a high price? And, is it possible to save electricity instead of procuring it at high costs? Moreover, the consumers have to bear the burden to pay for the increase in the electricity charges.

The present chapter discusses the pressures exerted by the ever-increasing energy demand on various energy sources, the entire supply chain, and on the environment in Pune city[24]. Moreover, impacts of the energy crisis on the growth of the city and on various aspects of socio- economic development are also discussed.

[23] With the help of captive power plants of 33 local industries, MSEDCL proposed the zero load-shedding model in all revenue division headquarters of Pune in September 2006. But as Pune's power demand grew, the existing arrangement proved to be inadequate. While the earlier model had provision to recover reliability charge of INR 0.48 per unit from consumers having monthly power consumption of over 300 units, the still upgraded model later proposed by MSEDCL in 2009 had suggested recovery of reliability charge from all consumers at the rate of INR 0.24 per unit.

[24] Including peri-urban and rural areas

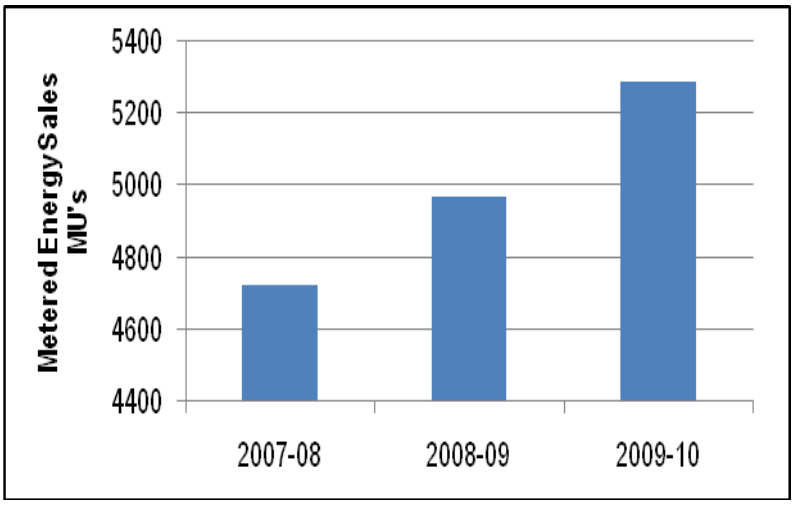
Pressure

Different energy sources such as coal, petroleum products, wood, electricity, and so on are used for various applications to meet the daily energy requirements of the city. In the following section, availability of various energy sources, impact of its usage on the environment, growth of cities, industries and in general on the entire energy supply chain is discussed.

Electricity

As the city grows, increase in demand for energy supply and especially electricity is inevitable. Residential complexes, commercial sectors, business centers, malls, and so on have huge energy demands. Moreover, during celebration of festivals (for example, Diwali and Ganeshotsav), a huge increase in energy including fuel, LPG, kerosene and power demand has been recorded. Although for a very short duration, the power requirement is higher than normal during the festive season. In addition, another peak is recorded during the day-night sports matches organized in the city as constant supply of electricity is provided to the flood lights in the stadium. These matches are telecast live, which attracts more number of viewers and television sets are kept on for longer duration. Taken together, this further adds to the power consumption, directly exerting pressure on the source. The increasing energy consumption pattern of Pune city is depicted in Figure No. 6.1.

Figure No. 6.1: Energy consumption pattern of Pune city[25]



Source: MSEDCL, 2010

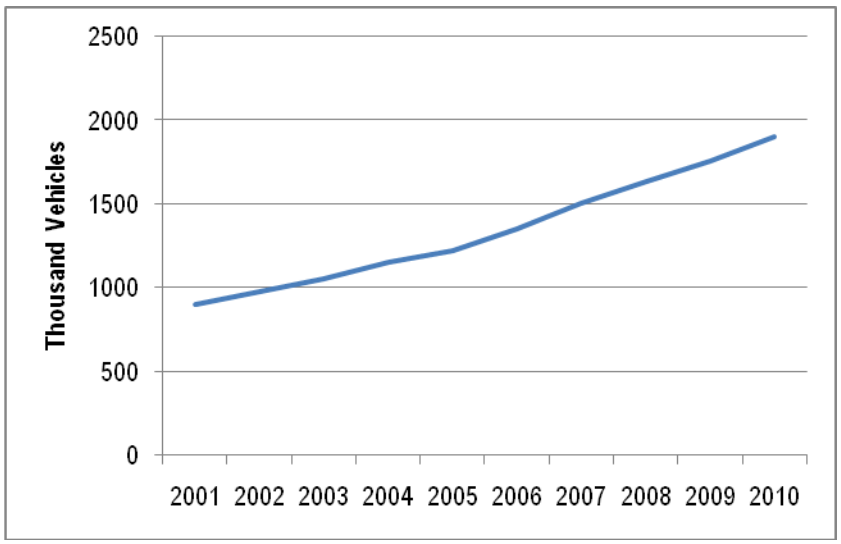
According to Figure No. 6.1, the consumption of electricity has increased by about 500 MU (million units) during the last three years. Moreover, Pune city's per head energy consumption is almost 2.5 times more than the national average of per head energy consumption, and 1.5 times that of the average of per head energy consumption in Maharashtra (MSEDCL 2010).

[25] This excludes captive power consumption.

Fuel

There has been a tremendous increase in the demand for fuels like diesel, petrol due to increase in the number of vehicles and increase in demand for the LPG sources due to the development of new malls, hotels, and residential zones. High number of existing vehicles and increasing number of new vehicles every day make the situation even worse in terms of demand for fuel.

Figure No. 6.2: Increase in the number of vehicles in Pune city over the last ten years



Source: RTO, Pune, 2010

In the last ten years (2001–2010), the number of registered vehicles in Pune city has almost doubled (Figure No. 6.2). As per the information provided by PMC, the number of vehicles running on CNG has increased 2.5 times in the last two years.

Based on the information given by the Octroi department, PMC, the average supply of petrol and diesel was to the tune of 516 thousand kL whereas the supply of kerosene between the years 2003- 2010 has remained constant to an average of 50 thousand kL. It is also important to note, that if the supply is not in proportion with the demand, it puts considerable stress upon the supply chain and may in turn affect the socio-economic aspects and growth of the city. For example, IT companies depend completely on the supply of electricity. Even if the supply is cut off for few hours, the work comes to a stand-still, impacting the productivity and indirectly affects the financial growth. Hence, as a backup for the same, diesel generator sets are installed and used to avoid interruption in the work.

The current status of the energy consumption in the city has been analyzed as per the data available from relevant sources. Due to lack of appropriate data, comprehensive analysis of energy requirements has been carried out to the extent possible.

Status: Energy Supply

The current status of energy supply is discussed in the following two sections, namely, supply of electricity and fuels

Supply of electricity

According to the data obtained from MSEDCL, the total number of metered connections of electricity in Pune city is 13, 41,016. A sector wise breakup of the metered connections in Pune is given in Table No. 6.1.

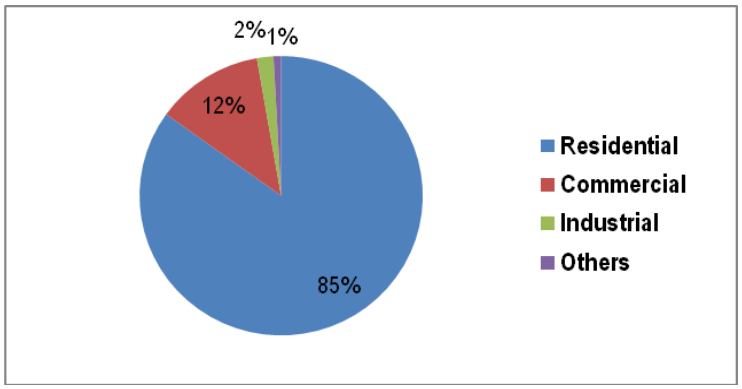
Table No. 6.1: Break up of electricity consumers in Pune by sector

	Residential	Commercial	Industrial	Others	**Total**
No. of Consumers	1,138,720	165,496	25,227	11,573	**1,341,016**

Source: MSEDCL, 2010

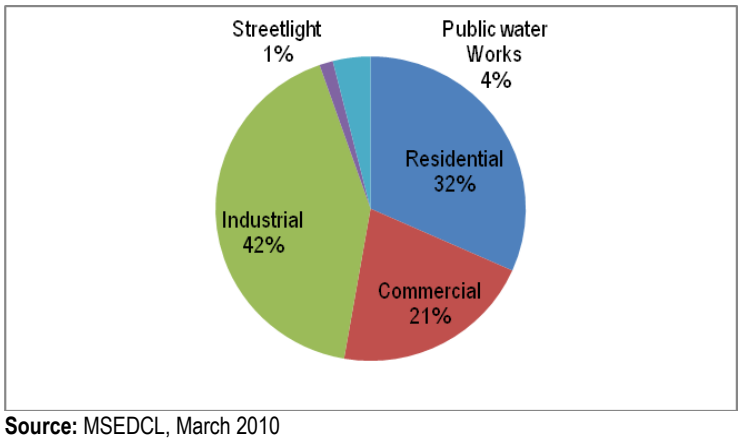
According to Figure No. 6.3 and 6.4, it is evident that although consumers from the residential sector account for almost 85% of the total number, they consume only 32% of the total energy supplied. Further, it is interesting to note that the industrial consumers account for only 2% of the total number of consumers, but their total energy consumption accounts to almost 42% (maximum among the three sectors) of the total energy consumption. Similarly, commercial sector accounts for 21% of the consumption, while the other categories (public water works and street lights) account for 5% of the total electricity consumption.

Figure No. 6.3: Sector wise percentage of consumers in Pune city



Source: MSEDCL, March 2010

Figure No. 6.4: Sector wise percentage consumption of electricity in Pune city

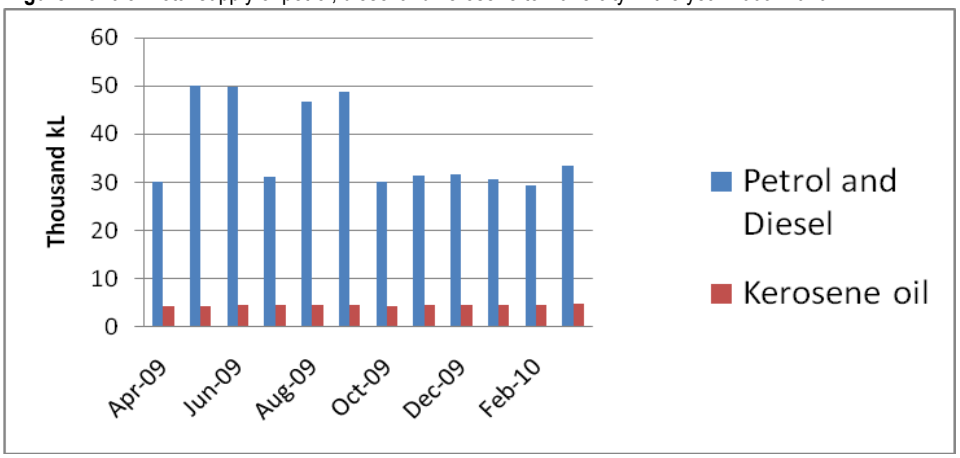


Source: MSEDCL, March 2010

Supply of fuels

According to the Octroi Department, PMC (Figure No. 6.5), , the supply of petrol, diesel and other petroleum products in the year 2009-10 to the city amounted to almost 443 thousand kL (0.4 billion litres), whereas consumption of kerosene is around 21 thousand kL (0.02 billion litres).

Figure No. 6.5: Total supply of petrol, diesel and kerosene to Pune city in the year 2009–2010.

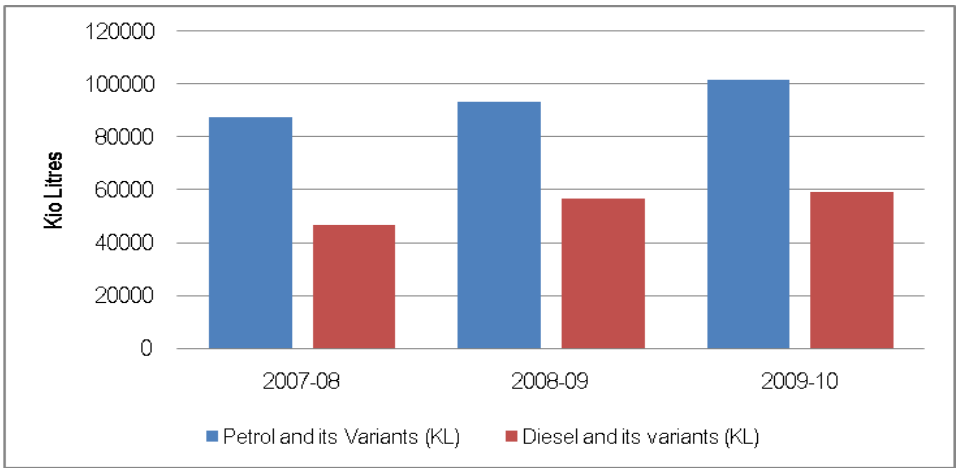


Source: Octroi department, PMC

As per a survey conducted by TERI[26] it has been estimated that around 27 thousand tons of coal was used in the city during the year 2009-10. It was used as a domestic source of energy by the low income households, small and medium entrepreneurs and local street vendors and food stalls.

Fuel supply by BPCL (Bharat Petroleum Corporation Limited), one of the leading petroleum companies catering to the needs of Pune city for the last three years has been depicted in Figure No. 6.6, which reveals that in the last three years, BPCL supplied a quantity of petrol and its variants in the range of 80 thousand kL to 100 thousand kL, and diesel and its variants between 40 to 60 thousand kL to Pune city. Out of the total supply of petroleum products to the city of Pune, supply from BPCL accounted for around 160 thousand kL, which is almost 36% of the total supply.

Figure No. 6.6: Supply of petrol, diesel, and its variants to Pune city by BPCL.



Source: BPCL, 2010

[26] A survey was conducted by TERI in Pune city in 2010 by interacting with the prime wholesale dealers and vendors of coal.

Pune city's per capita oil equivalent energy consumption

(Energy usage/capita/yr)

As per the data provided by MSEDCL, Pune city consumes a total of 5,286,638,000 kWh (5286.638 MUs) electricity per annum. It is possible to derive an estimate of per capita (oil equivalent) energy consumption using the given data, which could also be termed as energy usage/capita/year and can be calculated using the following formula and derivation. (However, for Pune city, the energy usage/ capita/ year have been calculated based on the available values of electricity and petroleum products to get an idea of the energy usage. The value of energy usage is not inclusive of other energy sources, such as coal and hence, it does not indicate a comprehensive value).

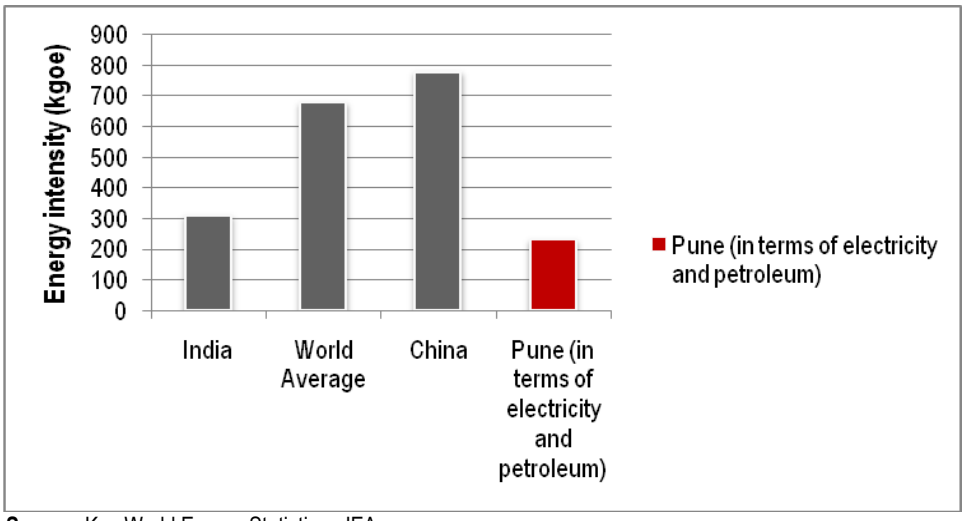
Calculation of Energy Intensity for Pune based on electricity and petroleum consumption

Consumption of electricity in Pune in the year 2009–2010		: 5,286,638,000 kWh
Total population of Pune city in the year 2010		: 3,500,000
Tons of oil equivalents (A)	=	5,286,638,000 X 860 X 10^7
	=	**454,650.8 MTOE** (Million tons of oil equivalent)
Consumption of petroleum (petrol + diesel+ kerosene)		: 493 thousand kL
Sp.Gravity of petroleum (average)		: 0.82 kg/lit
Tons of oil equivalent (B)	=	493,000,000 X 0.82
	=	407365.9 X 10^3 kg
	=	**407,365 MTOE**[27]
Total tons of oil equivalents	=	A (Electricity) + B (Petroleum)
	=	454650.8 + 407365
	=	**862005 MTOE**
Per capita energy intensity of the city	=	Energy intensity/ total population
	=	862005/ 3500000
	=	0.2462 MTOE
	=	**246 kgoe**

Per capita energy consumption (electricity and petroleum) in Pune city is estimated to be 246 kgoe (Kg of oil equivalent). A comparative analysis of the same with other countries and the national consumption is depicted in Figure No. 6.7.

[27] 1 Kg of oil equivalent = 10,000 k-cal
1 metric tonne of oil equivalent (MTOE) = 10 × 10^6 Kcal

Figure No. 6.7: Comparative analysis of energy intensity



Source: Key World Energy Statistics - IEA

United States of America ranks highest in terms of energy consumption (8780 kgoe) and India's average consumption is 310 kgoe.

Impacts

The gap in the demand-supply of energy sources have major impact on city's growth, as well as on

- City's basic/fundamental needs
- Socio- economic status and
- Environment

Variety of fuel types are used daily in urban, peri-urban, and rural areas of Pune city. In urban areas, the availability of fuel choices is limited to electricity and LPG gas as compared to rural areas. In rural areas, agricultural residues, cow dung, and fire wood are commonly available. Thus, if there is shortage of the available energy sources, it directly impacts the day-to-day activities in the urban set up, which includes its residential, commercial, and industrial areas. Moreover, in case of power cuts, invertors or diesel-based generators are used as alternate energy supply systems. In reality, these options are not only less efficient, but also contribute to air pollution and, hence, are not environment friendly.

Electricity is supplied to the state of Maharashtra mainly from coal-based power plants. From the reports published by MSEDCL in the previous years, it could be estimated that to provide electricity to the state more than hundred thousand (100,000) tonnes[28] of coal is used on daily basis. Since incineration of 1 kg of coal in a power plant emits about 1 kg of carbon dioxide in the atmosphere, coal-based power plants contribute substantially to emission of greenhouse gases. When diesel-based generators are used as an alternative to electricity, it adds to the local air pollution which is more harmful for the environment.

[28] http://www.mahagenco.in/genstats/data2005-n.pdf (Page number.14.)

Saving electricity is the need of the hour. For instance, even if conservation of at least 5% of the generated electricity could be achieved, it would reduce stress on the power generation system and have positive impacts on the environment (MSEDCL 2010).

The average annual electricity consumption of Pune city is around 5000MU. Energy conservation of 5% implies saving of 250MU of electricity. It is estimated that in the supply chain of electricity from the point of source (power plant) to the end users/consumers, there are almost 9%-10%[29] losses. Conservation of 5% electricity at the level of the end user would imply saving almost 100 MU at source which means conservation of 350MU in the entire power supply chain.

As per the statistics, it could be estimated that, per unit of electricity generation requires 0.75 kg of coal. According to this equation, for generating 350MU of electricity, 262 thousand tons of coal would be required. Thus if the city could achieve conservation of 5% electricity it would correspond to saving of 262 thousand tons of coal and emission of 262 thousand tons of carbon dioxide.

It is thus desirable to take proactive steps/ initiatives to conserve electricity not only by the municipal corporation but also by individuals.

Light Pollution

One tends to correlate the word pollution to some commonly known types, such as air, water, and noise. However, scattering of light through artificial sources where it is not needed causes light pollution, which is considered as a new type of pollution in urban areas. Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment through sources like street lights, sky glow, hoardings, light reflectors on highways, and so on (National Geographic 2008 [30]).

City dwellers are witnessing a drastic change in lifestyles. Just a few years back, the streets would be deserted beyond 8 pm in the evening. Owing to increasing number of educational institutions, mushrooming BPO (Business Process Outsourcing) centres, the service sector operational round the clock, and hotels, the traffic on the streets is on the rise leading to light pollution. The impacts of such kind of pollution are as below.

[29] http://www.mahagenco.in

[30] http://ngm.nationalgeographic.com/geopedia/Light_Pollution

Direct effects on human beings

- The high intensity light projected by traffic on the streets, during the night time, could be/is disturbing to the eyes.
- Working on computers for long hours could have a direct impact on our vision due to the radiation from computer screens.
- Blinking lights displayed in malls and light fittings used on the hoardings, especially in the urban areas, radiate high intensity light, which can damage our vision.

Effects on other living organisms

- Effect of light pollution is also experienced as an impact on other animals, mainly in urban and peri-urban areas. Various studies reveal that biological cycles of animals are disrupted due to exposure to light at night time. Other effects include impacts on body temperature and behavioral responses.

According to the guidelines prepared by International Commission on Illumination, a standard lux level has been ascertained for street lights on highways and main roads in Delhi city[31]. As per this report, desired lux levels vary from 20 lux to 35 lux depending upon the classification of roads. However as per CIE-115, level of 50 Lux is recommended on the main road junctions.

In the spatial area under PMC, there are a total of 112,200 street lamps. To keep these lamps working for 11 hours, 130,000 units of electricity is required. The PMC has been successful in maintaining an average level of 25 lux, which has helped them to save considerable amount of energy, thus, reducing the light pollution.

Based on these, the lux level standards have been assigned for street lights on the main roads and junctions in Pune city and should be upto 50 lux. This is not followed in the case of certain roads, for example, the lux level of the street lights on Mumbai–Pune Expressway (65.35 lux) and Goodluck Junction (56.81 lux) exceeds the assigned standard level. But, in case of Karve Road and Sinhgad Road (48.31 lux and 30.15 lux, respectively) the lux levels are lower than the assigned levels.

Individuals can contribute towards minimizing light pollution. For instance, when street lights are illuminated, the car headlights can be dimmed. Similarly, while working on the computer, protective screens should be installed on the monitors to avoid impact on our vision. Following such measures, the impacts of light pollution could be avoided.

[31] http://www.delhitransco.gov.in/EnergyEfficiency/lighting%20standards_rev_1.pdf

Response

PMC has been awarded the National Conservation Award 2009.

The Bureau of Energy Efficiency, Government of India, has awarded the Second Prize to The Street Lighting Department, PMC for their energy conservation initiatives.

Since the year 2000, PMC has initiated projects pertaining to energy conservation. Considering the growth of the city and its spatial development, the energy demand towards water supply, industry, sewage treatment, and street lighting has increased over the years. The power supply department of PMC is responsible for the electricity supply and maintenance of street lights, playgrounds, buildings, arts centres, health clinics, auditoria, and crematoria. The electricity consumption of the above are as follows.

1.	Street lights	–	338.13 (lakh kWh per year)
2.	Building Department	–	36.68 (lakh kWh per year)
3.	Gardens and playgrounds	–	10.46 (lakh kWh per year)
	Total	–	385.27 (lakh kWh per year)

In the past two years almost 150 new metered connections have been installed for the electric supply of street lights. The load has been increased to around 1500kWh.

Given that the electricity bills for Pune city amounts to Rs 15 crores, the power supply department of PMC has taken into consideration the following points while implementing the energy conservation measures.

- For the first time, the street lights are set-up with a timer to switch on and off according to the timing of sunrise and sunset.

- As compared to the total electric consumption of Pune city, the electricity consumed by street lights is only 1%. Energy conservation on roads has resulted in saving of 114.86 lakh units of electricity.

- Similarly, if such energy audit could be extended to the entire city, conservation of electricity could be achieved to a greater extent. In the year 2002, energy saving feeder-pillars' (100 nos.) were installed on trial basis, based on BOT (Build-Operate-Transfer) principle.

- From the year 2007–2008, instead of HPSV (High Pressure Sodium Vapor Lamp) street light, T-5 lighting and fitting are being used.
    - 250 watt HPSV lamps were replaced with 96 watt T-5 lamps.
    - 150 watt HPSV lamps were replaced with 76 watt T-5 lamps.
    - 70 watt HPSV lamps were replaced by 56 watt T-5 lamps.

- Similarly, 150 HPSV lamps have been replaced by multi-layered basalt fittings. Owing to all these measures, considerable reduction is seen in electricity consumption by street lights, playgrounds, and buildings of PMC. In addition, the electricity conserved in the year 2008–2009 due to implementation of the above mentioned strategies is about 114.86 lakh kWh.

- An energy audit has been carried out for the main building of PMC and Balgandharva Rangmandir, wherein if the suggestions from the audit are followed, about 340.37 mWh electricity could be conserved.

Use of Non-Conventional Energy

Pune city is taking the lead in demonstrating the applications of solar energy for its various activities, such as for heating water. Taking advantage of the various schemes and subsidies provided by MNRE/ MEDA, the residential, commercial, and industrial sectors are using solar energy on a large scale. In India, 50% of the solar and hydro power equipment manufacturers are located in Pune district. To promote the usage of non-conventional energy among the housing projects, the municipal corporation has introduced “eco-housing” projects, the details of which are attached in Annex 4.

Chapter 7: Health

Introduction

The health status of the residents is one of the most crucial indicators of the environmental status of a city. But, in addition to good environmental conditions, a city also needs to have good healthcare facilities. Owing to the pleasant climate and ample greenery in and around the city, Pune has always been regarded as a popular destination for medical tourism. However, due to the recent urbanization, widespread construction activities, and increasing vehicular traffic, the city is unfortunately getting associated with deteriorating environment and increasing levels of pollution.

Given below (Table 7.1) is the list of healthcare facilities in Pune city provided by the PMC.

Table 7.1: Healthcare facilities in Pune city

Sr. no.	Categories	2006–2007	2007–2008	2008–2009	2009–2010
1	No. of private hospitals registered with PMC	528	530	551	552
2	Ayurvedic and Homeopathic clinics	2	2	2	2
3	Maternity Homes	14	15	14	14
4	Family Welfare Centres	19	19	16	16
5	Mata Bal Sangopan Centres (Day Care Centres)	7	7	5	5
6	ICDS (Integrated Child Development Scheme)	7	7	7	7
7	OPD (Outpatient Department) Centres	29	43	43	43
8	Medical staff working at government hospitals	823	857	984	935
9	Rabies Control and Vaccination Centres	2	2	7	7

Source: Department of Health, PMC, 2010

Epidemics in Pune

According to Department of Health, PMC, epidemic diseases in Pune spread through the three main sources described below.

Water borne diseases

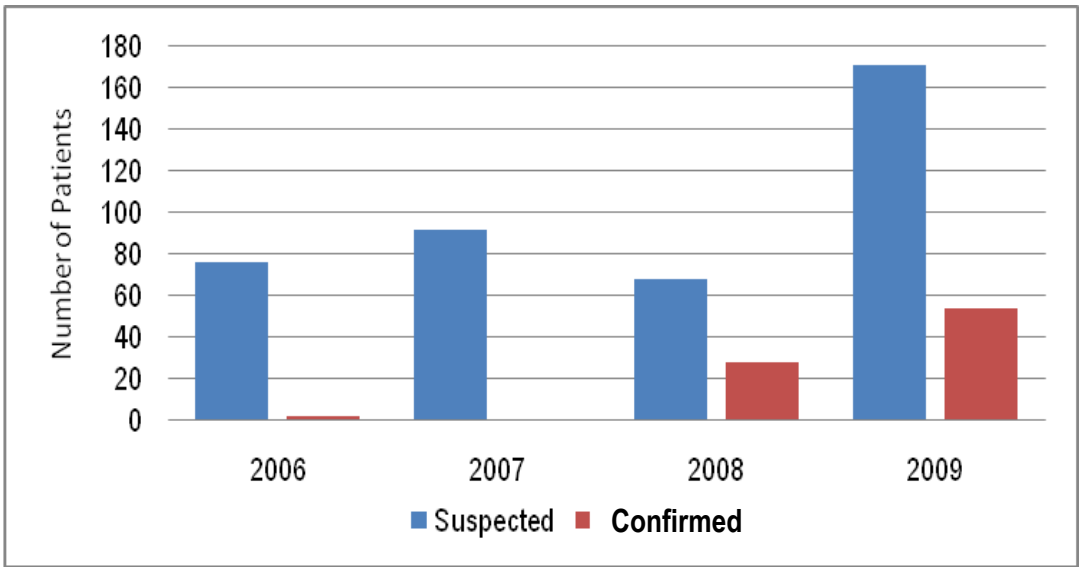
Water borne diseases are caused by pathogenic microorganisms, which are directly transmitted when contaminated fresh water is consumed. Gastroenteritis, Cholera, Jaundice, Typhoid, and so on are some examples of the commonly occurring water borne diseases in Pune.

Vector borne diseases

Accumulation of waste and stagnation of water are two main causes of the mosquito menace. The species of *Plasmodium*, a causal parasite of malaria resides in the body of *Anopheles* mosquito, which act as a vector in transmission of the malarial infection, whereas the *Aedes* sp. of mosquito acts as a vector for transmission of dengue infection. As seen in figure no. 7.1 and 7.2, there is a rise in the number of patients showing symptoms of dengue and malaria, but the patients showing actual development of both the diseases is much less than the number of suspected cases.

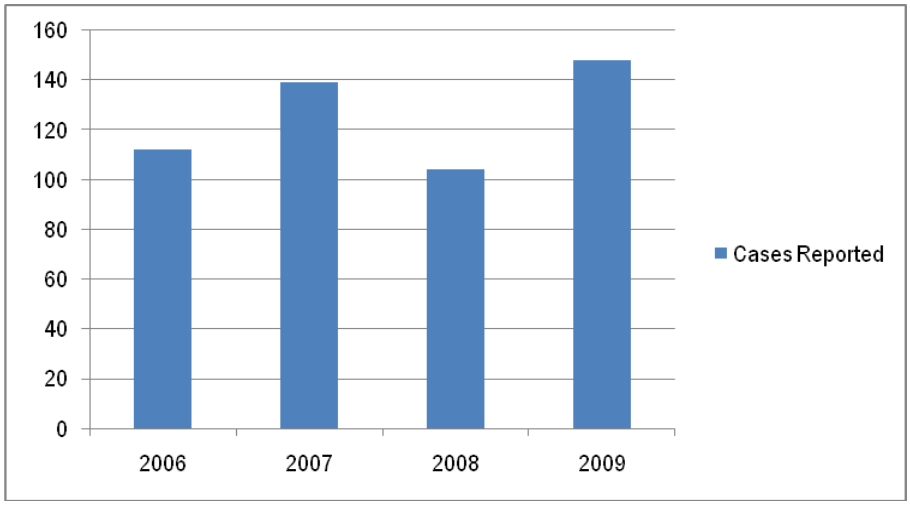
Similarly, the nuisance caused because of stray dogs in Pune city is on the rise. Figure No. 7.3 reflects that there is a continuous increase in the number of recorded dog bite cases. The above information is based on the data recorded till December 2009 by the Department of Health, PMC.

Figure No. 7.1: Dengue cases recorded in Pune city



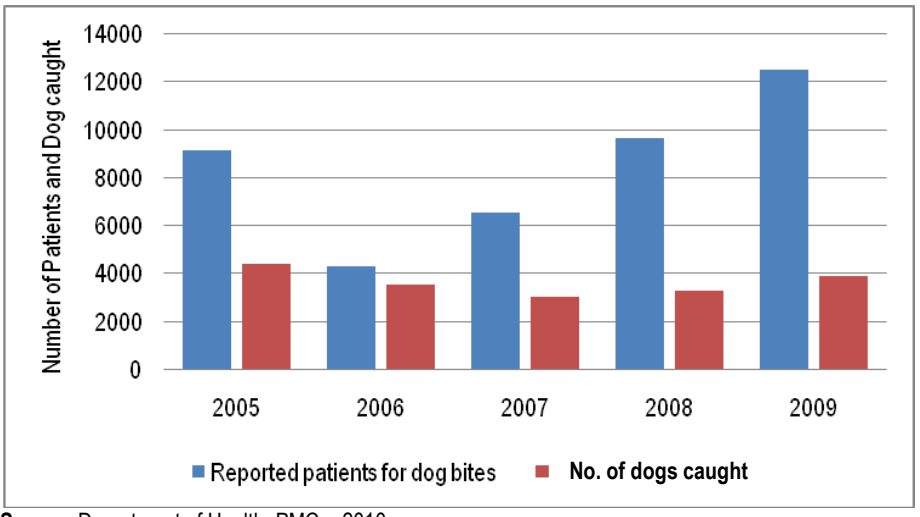
Source: Department of Health, PMC, 2010

Figure No. 7.2: Malaria cases recorded in Pune city



Source: Department of Health, PMC, 2010

Figure No. 7.3: Number of dog bite cases reported in Pune city



Source: Department of Health, PMC, - 2010

Air borne diseases

The incidences of air borne diseases are under control in Pune city. However, the recent outbreak of the H1N1 Influenza virus in the year 2009 was a major concern and, hence, detailed information pertaining to the spread of the disease and measures taken by the PMC to control H1N1 infection is provided in the present report.

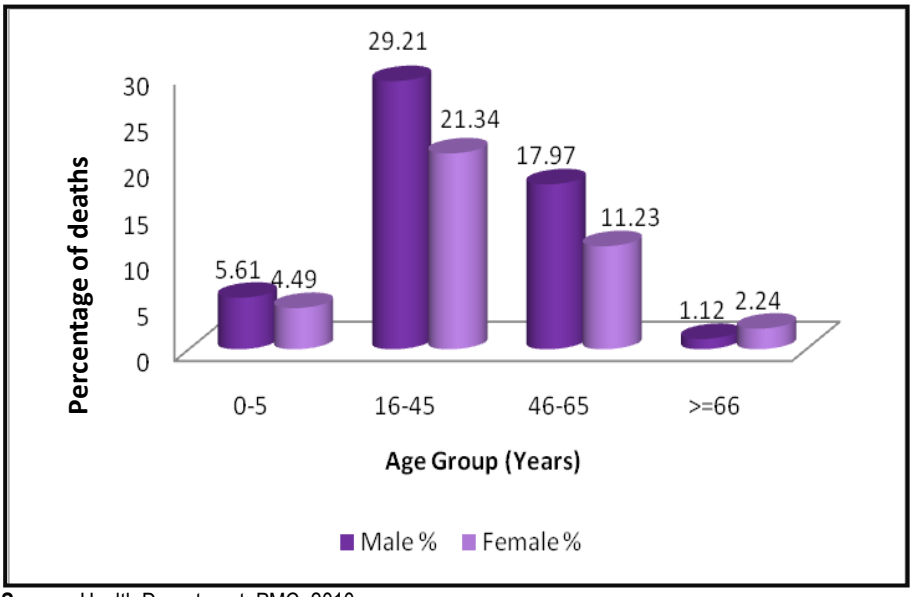
Infection of H1N1 Influenza virus

On 3 August 2009, Pune city recorded the first H1N1 victim of the country, which created panic amongst the citizens. With the help of the media, such as print (newspapers), radio, and television, a widespread awareness campaign was immediately launched by PMC to sensitize masses about the risks of the disease and the precautionary measures to be taken. Similarly, considering the risk of the epidemic, orders were issued to schools, colleges, and offices to remain closed and avoid large public gatherings for few days.

It is evident from the epidemic records of Pune, that several times in the past, the city had been severely affected by the epidemic of influenza virus. In the years 1918, 1955, 1957, and 1987, epidemics like influenza and plague had hit the city. It is reasonable to argue that in the years around 1950s, the city was not well equipped with proper healthcare facilities and, hence, the impacts were severe. However, in recent years, diagnosis of H1N1 infection and its rapid spread across the country proved that provision of modern healthcare facilities are not adequate to avoid a panic situation that the city had to face in the year 2010. Although the first case of H1N1 infection and the victim was recorded in Pune, the rapid spread of the disease across the country led to an alarming situation. In a short span of just one month after the outbreak was announced, 19 patients in Pune were diagnosed positive for H1N1 infection and were admitted in city hospitals.

In a span of almost one year, from May 2009 to March 2010, the hospitals in Pune city carried out diagnostic tests for about 469,707 H1N1 infected suspects and the medicine, 'Tami-Flu' was administered to 63,242 patients. To address the severity of this epidemic, the municipal corporation launched a programme entitled "PMC Model". As seen in Figure No. 7.4, the patients of age group 16–45 were vulnerable, whereas the susceptibility of the disease was predominantly higher in male patients.

Figure No. 7.4: Age and gender-wise percentage of deaths due to H1N1 till 30/07/10.

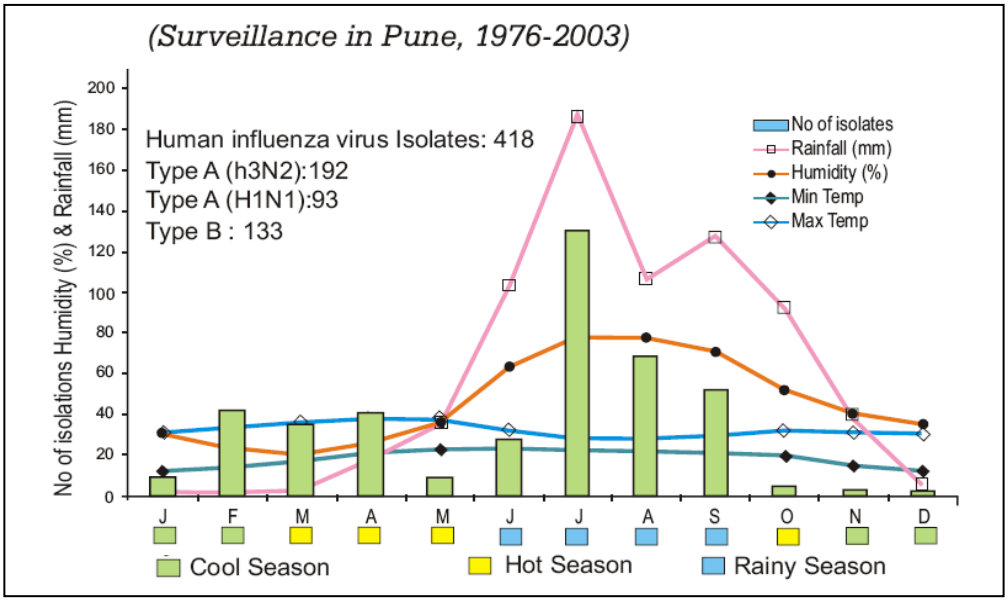


Source: Health Department. PMC, 2010

Climate of Pune and H1N1

Pune's climatic conditions are mainly cold and dry, but the percentage of humidity increases during the rainy season. Figure No. 7.5 depicts noticeable increase in rainfall and humidity levels in the months of July and August. It is observed that the incidence of Influenza infection increases with the increase in rainfall and relative humidity. During the same period, the average temperature ranges between 20°C to 30°C. This creates the most conducive climatic condition for the spread of infections by pathogens, which may survive outside the host body for a longer period. In Pune, which has a tropical monsoon climate, H1N1 Influenza outbreak occurred predominantly during the rainy season.[32]

Figure No. 7.5: Rainfall, humidity, and occurrence of Influenza in Pune



Source: NIV, Pune[33]

Symptoms of H1N1 Influenza infection

Symptoms include fever, cough, sore throat, body aches, headache, chills, and fatigue. The 2009 outbreak has shown an increased percentage of patients also reporting diarrhoea and vomiting. The symptoms are similar to normal Influenza infection and, hence, appropriate diagnosis and treatment is of utmost importance. In order to provide an orientation to the concerned medical professionals, the health department of PMC had organized training programmes for doctors and other staff from private and government hospitals.

[32] http://www.icmr.nic.in/pinstitute/niv/INFLUENZA.pdf

Diagnosis

Swine flu was presumptively and clinically diagnosed by the patient's history of association with people known to have the disease and their symptoms listed above.

According to the CDC (Centre for Disease Control, Atlanta, USA), RT-PCR (Real-Time Polymerase Chain Reaction) is the most appropriate method for diagnosis of H1N1. However, as the spread of the infection was acquiring pandemic status, to get an accurate diagnosis, it is essential to analyse throat swabs from the patients admitted in the ICU (Intensive Care Unit). The suspects were, therefore, categorized in the following three types—A, B, and C. Depending on the symptoms and diagnosis of the suspects, the drug, 'Tami-flu' was administered.

Initiatives taken by PMC in the year 2009 to control the pandemic of H1N1 virus

PMC had issued guidelines for schools and educational institutes to control pandemic Influenza H1N1 infection. The clauses of the guidelines were famously known as *"Panch Sutri"* (Five Clauses), which are as follows.

- To avoid overcrowding and public gatherings.
- To maintain hygienic conditions, for example, covering the mouth with handkerchief while coughing and sneezing, washing hands regularly.
- To have balanced diet and rest.
- To immediately contact the nearby doctor when symptoms like coughing and sneezing are noticed.
- To avoid public meetings and contacts for 4–5 days if returned from foreign travel. To greet with joined hands "Namaste" and avoid handshake.

Initiatives taken to control H1N1 infection in future

- PMC has decided to strengthen healthcare facilities in the city.
- To convert Dr Naidu Hospital, run by the PMC, into a central communicable disease control hospital.
- Taking into account the anticipated infrastructure requirements and its improvement, PMC has made a provision of Rs 98.88 crore for the health department in the year 2010.
- For diagnosis of the suspected patients of H1N1 virus, the PMC has started screening facilities at 43 centres and 15 private hospitals. Out of these, eight centres also work on Sundays and the centre at Dr Naidu Hospital shall be open for 24 hours for H1N1 suspected patients.
- To enable effective isolation of suspected H1N1 patients and to establish a separate ward, specific guidelines have been proposed by the technical committee of the state government. Similarly, the number of beds for patients suffering from communicable disease has also been increased to 210.
- A 24-hour help desk and help line has been established at Dr Naidu Hospital.

Other facilities provided by PMC

Vaccination drives

Free vaccination for diseases like DPT (Diphtheria, Pertussis, and Tetanus), Polio, Measles, BCG (Bacillus Calmette-Guerin), DT (Diphtheria and Tetanus Toxoid), and TT (Tetanus Toxoid), is made available at PMC's primary health clinics. In order to keep the spread of the above mentioned diseases under control, PMC has undertaken many successful initiatives and implemented health programmes.

National health programmes

PMC has implemented the following enlisted programmes.

- National Immunization Programme (UIP)
- National Blindness Control Programme
- School Health Programme
- National Leprosy Eradication Programme
- National Malaria Control Programme
- Revised National Tuberculosis Control Programme
- National STD Control Programme
- National Reproductive and Child Health Programme
- Integrated Health and Family Welfare Programme
- Provision of special medicines
- Special health programmes
- A special insurance scheme for the urban poor: Savitribai Phule Insurance Scheme was implemented for groups with annual income of below Rs 1 lakh. Janani Suraksha Yojana was also implemented.
- At least three lakh devotees/pilgrims gather in Pune city during the religious procession, which culminates at Pandharpur. During this period, it is essential to avoid contamination of water and air and also to contain the spread of communicable diseases, which are likely to occur through, such large gatherings. Similarly, precautions need to be taken to keep contagious diseases under control on occasions like Ganesh festival and Navratri, which attract masses. On such occasions, PMC makes special provision of medical facilities, first aid treatment, vaccination, and so on. Special emphasis is placed on vaccination against Rubella.

Chapter 8: Significance of Carbon Footprint Estimation

Introduction

Carbon footprint is a measure of the impact human activities have on the environment. It relates to the amount of GHGs (greenhouse gases) produced in our day-to-day lives through burning of fossil fuels for electricity, heating, transportation, and so on. The footprint is often expressed in terms of the amount of carbon dioxide (CO_2), or its equivalent of other GHGs, emitted.

Burning of petrol, diesel, and coal at thermal power plants are some of the key sources responsible for CO_2 generation. As a thumb rule, it is considered that one unit of energy consumption releases one kilogram of CO2 in the atmosphere. Thus, it is discernible that at the level of the city, various sectors like industrial, commercial, domestic, transport (vechicular emissions), construction industry, and so on contribute heavily to the total CO_2 emissions. A total aggregate of CO_2 emissions, along with other GHGs released, is known as carbon footprint.
Many developed countries have already calculated their carbon footprints and have taken steps to mitigate the same by taking concrete initiatives. Each and every individual contributes to the carbon footprint of the city. Pune city is developing rapidly and, hence, it is significant for the city to calculate its carbon footprint. PMC is the first ULB in the country to undertake such a study at city level and aspires to take initiatives to curb the total emissions and reduce its carbon footprint.

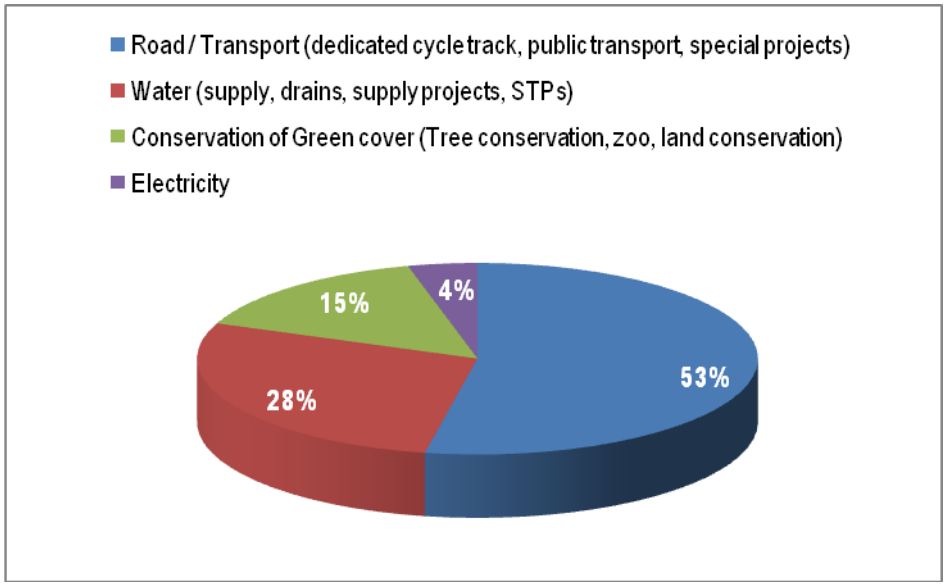
The study will help to analyse the major sources of carbon release, and accordingly devise strategies to reduce the levels of emissions and mitigate the negative impacts of global warming. Listed below are some anayltical details, which would benefit PMC to achieve the following.

1. To determine baseline for the energy and fuel consumption for Pune city
2. To create awareness among citizens of Pune
3. To devise energy and fuel conservation strategies in consultation with the local citizens
4. Encourage applications of renewable energy whereever applicable
5. The PMC may avail the CDM benefits in the long term through implementation of clean energy technologies.
6. To enhance the image of the PMC as an environment-friendly city at the national and international level.

Chapter 9: Budgetary Provisions—an overview and Way Forward

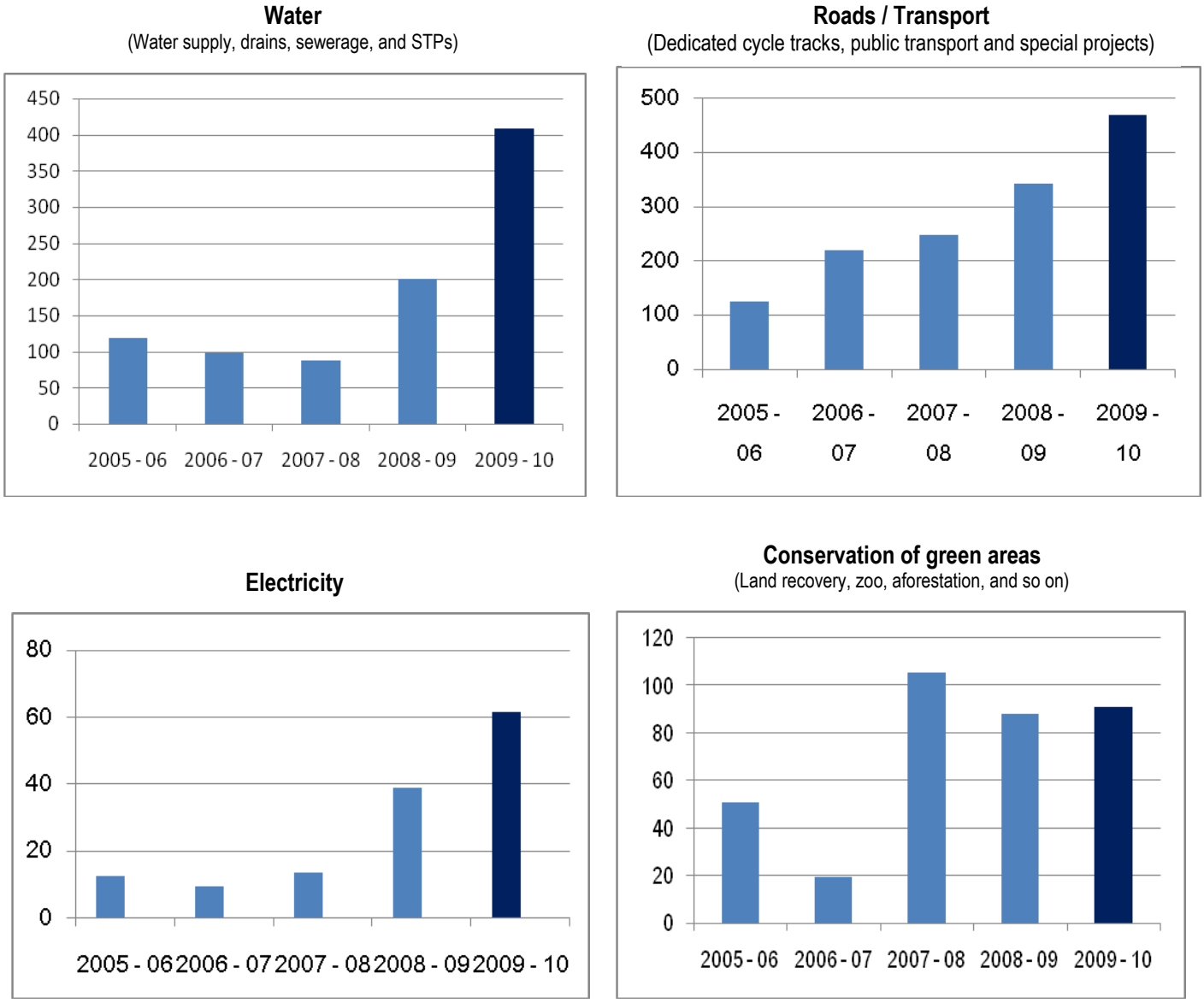
An overview of the budgetary allocations for Pune city towards infrastructure (roads and public transport) and other facilities (drains, borewells, and sewerage treatment), for the past five years has been presented in this chapter. It can be observed that, close to 53% of the total allocated budget has been utilized for improving the transport-related infrastructure and public transport in the city. Similarly, 28% of the budgetary provision has been spent on improving the water supply network and for sewage collection and treatment. As per the pie chart (Figure No. 9.1), 15% of the total budget has been utilized for development and conservation of green cover and open land spaces, including parks and the zoo. Only 4% of the expenditure has been towards supply of electricity. Figure no. 9.2 presents the expenses incurred by various departments of PMC in the last five years. The figure also represents the budgetary allocations for the year 2009–2010 and the actual expenditure for the remaining four years. Significant amount of the yearly budget is allotted and spent on developing transport infrastructure and facilities.

Figure no. 9.1: Pie chart depicting expenditure of various PMC departments in the past five years



Source: Budget 2010–2011, PMC, 2010

Figure no. 9.2: Bar graph depicting actual expenditure (2005–2008) and budgetary allocation (2009–2010) for the priority sectors



Source: Budget 2010–2011, PMC

** Year 2005–2006 to 2008–2009: Actual expenditure, Year 2009–2010: Budgetary allocations*
** X axis: Financial years; Y Axis: INR (crore)*

Given the budgetary allocations of the previous years, in the present ESR 2009–2010 submitted to the Hon'ble General Body of PMC, some key environmental issues have been specially identified. It is necessary to develop a concrete action plan to address the key issues to ensure sustainable development of Pune city. Moreover, to further emphasize upon the priority sectors, a list elaborating on the suggestions and recommendations is given below.

Change in land use and land cover pattern

While land is one of the most important resources for the growth of a city, it is of great importance to conserve city's green areas, green cover, and also the hill top and hill slope zones, as they are appropriately regarded as the lungs or breathing spaces of the city. As per the data provided by the PMC, in the past few decades, agricultural land of the city has reduced by more than 40%. Impacts of decline in agricultural area and agri practices on the environment and growth of the city are discussed below.

- A reduction in the number of birds like common sparrow and migratory birds has been recorded in the city due to loss of natural habitat and food material.
- This severely impacts the ecological balance and biodiversity of the surrounding areas.
- If the agricultural land within the PMC limits and around Pune city is converted to non-agricultural land, and further to urban set up, it will directly impact the availability of locally grown fresh vegetables, milk products, fruits, and so on, which would then have to be sourced from far off areas/cities. This would have severe implications on prices of vegetables and increased fuel demands for the transportation of fresh greens.
- Pune city has many food processing centres for processing of fruits and vegetables produced in areas around the city. It is necessary to provide infrastructure and facilities to ensure sustainability of the food processing sector and, ultimately, the agriculture zones around Pune.
- Green zones act as carbon sinks of the city. Reduction in the extent of green cover and increase in the consumption of fuel and electricity directly correlates to higher emission levels of CO_2, thus, increases the carbon footprint.
- Open spaces in and around the city help in circulating cooler breeze and, hence, lowering the average city temperature.

Taking the above observations into consideration, it is strongly recommended that agricultural land should be conserved on high priority.

Water

Nature has bestowed Pune city with abundant water resources. However, owing to lack of adequate rainfall, delayed monsoons, and increasing water demand, Pune city faced acute water crunch in July 2010, during the peak of the monsoon season. To address the issue, a circular was released by PMC in local newspapers in July 2010, informing the citizens about restricted water supply on alternate days until normal water levels were restored in the catchment areas. It is quite ironic that this crisis was faced by the city during peak monsoon season. Taking this into account, it is important to practice rainwater harvesting and water recycling on a large scale. Similarly, other decentralized sources of water like groundwater, wells, ponds, and lakes should be recharged using harvested rainwater. This shall help in appropriate utilization of decentralized sources of water, and further help in avoiding water shortages in future.

Transport

Increasing vehicular traffic not only increases levels of air pollution, but also causes traffic congestion. It is extremely important to take active steps to address this issue. PMC had installed real-time pollution level indicators at some of the prime locations in the city. Such indicators and probes should be reinstalled for appropriate monitoring and recording of pollution levels. Efficient public transport facilities should be emphasized and projects supporting the concept of mass rapid public transport need to be implemented on priority basis. A detailed estimate of carbon footprint shall be provided separately. Given the limited availability of fossil fuels and negative impacts of fossil fuel usage on the environment, it is important to promote renewable energy applications. Use of battery operated vehicles and bicycles needs to be encouraged and octroi charges and toll tax should not be levied on eco-friendly vehicles.

Energy

MNRE (Ministry of New and Renewable Energy), Government of India supports and facilitates the implementation of projects pertaining to energy efficiency and energy conservation. ULB's and citizens can take advantage of such schemes and grants provided by the MNRE. Some of the projects supported by the MNRE have definite objectives, which are as follows.

- Promotion of solar energy technologies and appliances
- Achieving energy efficiency in buildings
- Promotion of green buildings and eco-friendly infrastructure
- Use of alternate fuels like biogas and ethanol

Some of these schemes have been implemented in Pune to some extent; however, it is necessary to encourage implementation of these schemes on a very large scale. For the effective demonstration of the energy efficiency and building retrofitting projects, PMC should identify old buildings from the following sectors.

1. Educational buildings
2. Government-owned buildings and offices
3. Social organizations
4. IT offices
5. Malls and hotels

To facilitate energy efficiency in buildings, awareness programmes emphasizing on the schemes, policies, subsidies, financial benefits, ROI (Return of Investments), and so on should be organized for the owners as well as professionals like builders, architects, and developers. Moreover, they should be sensitized about the long-term benefits and sustainability in this sector.

PMC should encourage and support such projects and also organize stakeholder meetings to provide a forum for discussion on eco-friendly concepts and to highlight the projects implemented in Pune city.

Environmental Awareness

Considering the present status of the environment and its rapid deterioration, it should be noted that protection of the environment is not just the responsibility of the government, but of every citizen and individual. Towards this, it is essential to impart necessary knowhow on environment protection.

In this regard, the efforts made by the local NGOs and corporators should be duly acknowledged by the PMC and awareness programmes should be conducted at schools, colleges, educational institutions, and also through social and religious groups.

It is suggested that PMC should formulate and publish the guidelines for environmental protection as well as ensure its strict implementation.

Annex 1: List of Gardens in Pune city

Total No. of Gardens: 83

Gardens with Some Specialty:

Japanese Garden	Sinhagad Road
Garden in Mine	Maharshi Nagar
Ayurvedic Garden	Kondwa
Nakshatra Garden	Erandwana
Nallah Park	Sahakarnagar
Lake Garden	Model Colony
Rose Garden	Sahakarnagar

Proposed Gardens- 25 (Duration-3 years)

Proposed Gardens with Some Specialty's:

Palm Park	Alandi Road
Devrai Garden	Yerewada
Moughal Garden	Sinhagad Road
Butterfly Park	Sahakarnagar
Jai-Jui Park (Night Garden)	Gultakdi
Jasvandichi Baug (Hibiscus Garden)	Bhairav Nagar
Adventure Park	Peshawe Energy Park
Environment Park	Hadapsar
Beautification of Katraj and Pashan Lake	
Beautification of River and Nallah	

S. no	Garden Name	Area of Garden (acre)	Place
1	Ch. Sambhaji Raje	12	Deccan Gymkhana
2	Late Rajiv Gandhi Zoo/snake park	165	Katraj
3	Kamla Nehru	4	Erandwane Botonical Garden
4	Chitranjan Watika	5	Shivaji Nagar
5	Dr. Jayprakash Narayana	1	Near Railway Stn.
6	Dr. Babasaheb Ambedkar	0.5	Sasoon Road
7	Mahatma Gandhi	5	Bund Garden
8	Dr. Gadda Singh Chima	2	Yerawada
9	Jijamata Udyan	1.5	Kasba Peth
10	Saras Bagh	8	Sadashiv Peth
11	Shrimanta Bhairao Singh Ghorpade Peth	4	Ghorpade Peth
12	Shahu Udyan	2.5	Somwar Peth
13	Late Tatyasaheb Thorat	4	Kothrud
14	Kamalnayan Bajaj	1.5	Mumbai-Pune Road
15	Late Marutrao Gaikwad	2	Aundh
16	Ch. Shivaji Udyan	1	Bopodi
17	Late Vitthalrao Namdevrao Shivarkar	1.5	Vanawadi
18	Maharana Pratap Udyan	2.5	Sadashiv Peth
19	Late Kakasaheb Gadgil Udyan	1	Padmavati
20	Sadhvi Smt. Savitribai Phule	1	Tadiwala Road
21	Samarth Ramdas Udyan	1	Wadarwadi
22	Sant Rohidas Udyan	3	Gurunanak Nagar
23	Late Yashwantrao Chavan Udyan	2	Parvati Darshan
24	Late Parshuram Appa Saheb Rajiwade Udyan	2	Sahakarnagar-2
25	Hutatama Memorial	2	Yerawada
26	Limca Jogging Park	3.5	Bund Garden
27	Shri. Akkalkot Swamisamartha Baludyan	1.5	Bhavani Peth

28	Late Vasantrao Eknath Bagul Udyan	4	Survey No. 43/A Sahakarnagar
29	Dr. Rammanohar Lohia	4	Hadapsar
30	Lokmanyanagar Jogging Park	3	Lokmanyanagar
31	Late Raja Mantri Udyan	1	Near Erandwane Fire Brigade Stn.
32	Lumbini Udyan	2	Yerawada
33	Late Anusaya Bunkar Udyan	2.5	Matang Vasti Hadapsar
34	Kantishalaka Aruna Asaf Ali Udyan	1.5	Maharshinagar, Housing Board
35	Late Haji Rasoon Pansare Bal Udyan	1.5	Maharshinagar, Gultekedi
36	Gul Poonawalla Udyan	2.5	Gultekedi Sailusburry Park Plot No. 467
37	Late Shankarrao Ramchandra Karve Udyan	1.5	Taware Colony Sahakarnagar
38	Shri Sachin Tendulkar Jogging Track	0.5	Rajendranagar
39	Sanjay Mahadev Nimhan Udyan	4	Someshwarwadi Pashan
40	Hazarat Siddhique Shababa Udyan	3.5	B.J. Medical Welesly
41	Dr. Shamrao Kalmadi Udyan	1	Ek Bote Colony
42	Shahu Modak Udyan	1.5	Koregaon Park
43	Late Damodar Raoji Galande (Patil) Udyan	4	Kalyani Nagar
44	Late Menatai Thakare Udyan	1.5	Mangalwar Peth
45	Bharat Ratna Mother Teresa Udyan	1.5	Dattawadi
46	M. Jotiba Phule Udyan	2	Phule Nagar
47	Jagatguru Maharshi Valmiki Udyan	2.5	Mohanwadi
48	Vijayanagar Colony Udyan	0.5	Sadashiv Peth
49	Sant Gyaneshwar Udyan	1	Survey No.37 Erandwane
50	Late Jayawantrao Tilak Gulab Pushpa Udyan	2	Sahakarnagar
51	Shri. Sant Gajanan Maharaj Udyan	8	Gokhalenagar
52	Late Madhavrao Shinde (Jogging Track)	1	Vakdewadi Sangamwadi
53	Major Shahid Pradeep Tathavade	3	Survey No. 61/1A/1 Hingane Khurd
54	Tarabai Udyan	0.1	Ward No. 97 Survey No. 98/99 Vetalnagar (Gokhalenagar)
55	Late Prakash Narayan Bahirath	1	Plot No. 66 Shri. Shi. Co-op Hsg Soc. Gokhalenagar

56	Indraprastha	6	Yerawada
57	Sathe Colony	0.5	Shukrawar Peth
58	Late B. D. Vartak	4	Omkareshwar
59	Late Dhondiba Bhivaji Sutar	0.5	Mayur Colony, Kothrud
60	Late Vithabai Pujari	4	Maharshinagar
61	Peshawe Energy Park	7	Sadashiv Peth
62	Late Shakuntala Narayan Nikam	1	Gokhalenagar
63	Ekata Udyan	0.5	Salisburry Park
64	Dr. Shyamprasad Mukharjee Udyan	2.5	Patwardhan Baug
65	Pune Okayama Maitri Udyan/Late P. L. Deshpande	10	Sighgad
66	Model Colony Lake Garden	5.5	Model Colony, Shivaji Nagar
67	Samajbhushan Baburao Bhaurao Phule	0.75	Dattawadi, Wadacha Ganpati, Ganeshmala
68	Maharashtra Housing Board Udyan	1	Ward No. 11 Survey No. 191 Yerawada
69	Late Abdul Hamid Ayurvedic Udyan	1	Survey No. 12, Kausar Baug, Kondhwakhurd
70	Late Vitthalrao Shivarkar (Jogging Track)	4	Ward No. 16, Vanawadi
71	Late Ramchandra Keshav Taware	4	Ward No. 37 Sant Nagar, Mitramandal Parvati
72	Late Sentibaba Mukinda Alagude	0.5	Pandavnagar
73	Durgamata Garden	0.16	Apar Indira Nagar, Bebavewadi
74	Late Bapusaheb Patole	0.5	Ghorpade Peth, PMC Colony
75	Late Smt. Gangubai Bhimale	0.5	Ekopa society
76	Bharatratna Bhimsen Joshi		Bhusari Colony
77	Aai-appa Garden	1.25	Tingare Nagar, Pune
78	Major Bhaskarrao Sakhojirao Shinde Garden	0.4	S. No. 46, Bombay Sappers Colony , Vadgaonshri, Pune
79	Chandannagar Garden	1	Chandannagar, Pune , Near Aurvadik Hospital
80	Pankuvar Firodiya Garden	0.15	Model Colony
81	Sahakar Garden	0.17	Ward No. 66, Near Dinanath Mangeshkar Hospital

Annex 2: Initiatives taken by Non Governmental Organizations

Participation of NGO's citizens

Citizens and NGO's in Pune city have always been taking proactive initiatives to benefit the environment in and around Pune city. However these initiatives are either not been appropriately documented or often go unnoticed. Towards this an appeal was released in the news papers, inviting information from the NGO's, SHG's and citizens on the pro-environment initiatives taken by them. A brief list of the information obtained in presented in the table below.

Sr No	Name of the organization	Initiative(s)
1	Environment First	1. Celebration of special days like World environment day, water day, forest day and so on. 2. Training and awareness programme for high school students on topics related to environment. 3. Programs for residential societies members to sensitize them on the importance of segregation and appropriate processing of waste.
2	Winter Green Creation	Annually organise Environmental awareness programs through entertaining mediums (examples: puppet shows, games, audiovisuals)
3	Green Hill tops	Tree plantation drives on slopes of Chaturshungi and Hanuman hills
4	Youth to youth foundation – Pune hill top and hill slope greening project	1. Plantation of 200 saplings using continuous contour trench method 2. Aspire to plant 1200 saplings on hill and hill slopes in the next two years. 3. PMC presented the "Jayant Tilak Rao" award to acknowledge their efforts in the sector of environment.
5	Beyond Horizons Health and Social Circle (BHHAS)	1. A dedicated group of 200 medical students. 2. Till date more than 50 pro environment programs at community level have been organised. 3. Distribution of saplings through every program 4. Help & support extended to various institutions who aspire to establish Nakshatra farms, Herbarium cultivation and laboratories. 5. Creating awareness about extinct plant species
6	Clean earth Movement	1. River restoration project and hill slope aforestation in Baner and other area from the last four years 2. Tree plantation drives on Baner hill and slopes. Similarly 6000 trees have been planted along the banks of river Pawana.

7	Parisar	Residents of Dahanukar colony and members of Vikas Mitra mandal jointly made efforts for more than 19 Sundays to clean drains in the city.
8	Maharashtra Arogya Mandal (DEWATS – Decentralised waste water treatment system)	1. Contribution in facilitating decentralised sewage water treatment plants through. - sustainable and alternative energy sources - decentralized processing of sewerage while avoiding use of chemicals, complex mechanism and high end technical energy inputs
9	Praj Foundation and Praj Industries	1. Since last two years, Praj foundation is implementing the Decentralised Biodegradable Waste Management project through 9 Satellite centers located in different parts of the city. 2. The Satellite centre heads conduct extension meetings to sensitize citizens on need of waste management and also organise demonstration of the techniques 3. Impress complete technical information pertaining to composting 4. Training of personnel's as 'Master Composter' and act as 'Service provider' to facilitate composting at Housing society and institution level. 5. '***Garden from Waste***' competition was organized for citizens who are regularly practice composting of bio degradable waste and grow vegetables and flowers in their backyard or terraces. 6. Praj Silver Jubilee Bio Diversity Park (BDP) 7. Tree plantation was initiated in the year 2009. So far 240 plants of 25 native species have been planted along the bank of Pashan Lake (2 acres).
10	Bhawalkar Ecological Research Institute	Presented paper on the topic "*Ecological water treatment and sanitation in crisis situation*" at a national conference on Cost Effective Sanitation in New Delhi.
11	Nisarg Sanwad	Took proactive initiatives to deliberate information on environmental awareness, rainwater harvesting, tree plantation and conversation and so on
12	Shailaja Dnyaneshwar Molak	1. Treats domestic waste to produce compost using E M solution 2. Uses biogas at home 3. Reuses household products to the fullest. 4. Uses water responsibly.
13	Mr. Sanjay Bhosale	1. Distributes free seeds on occasion of "Environment Day" 2. Rally to create awareness about environment. 3. Gives guidance on Rain water harvesting

Moreover to the list above, the citizens of Pune and NGO's in the city have always taken keen steps in ensuring a healthy environment in the city. Local print and electronic media also publishes and covers many such efforts taken in Pune city.

Annex 3: Bio-methanation projects implemented by PMC

Sr. No	Project Location	Date of commissioning	Technology used	O & M (Operation & Maintenance) / Contractor	Capacity (tons/per day)	Total biogas production (m^3/day)	Total energy generation (electrical units/ day)	Status
1	Model Colony	November 2009	'Nisargruna'- two Stage bio-methanation process (patented by BARC's)	M/s. Enprotech Solutions	5	300-350	300-350	Commissioned
2	Shinde nagar society, Bhawdhan	February 2010			5	300-350	300-350	Commissioned
3	Hadapsar ramp	February 2010			5	300-350	300-350	Commissioned
4	Ghole road, ward office, ramp	July 2010		Deccan Environmental	3	125-200	-	Commissioned (Steam generation)
5	Aundh ward office	April 2010	UASB technology developed by MAILHEM™ Engineers Pvt. Ltd & Dr Latting infrastructure facilities (Netherlands)	MAILHEM™ Engineers Pvt. Ltd	5	300-350	300-350	Commissioned
6	Maharashtra Housing Board, Yerwada	May 2010			5	300-350	300-350	Commissioned
7	Peshwe Udyan	January 2010	Technology developed by M/S. Green Leaf Bio-methanation Process.	M/S. Green Leaf. Bio-methanation Process	5	300-350	300-350	Commissioned
8	Katraj Ramp 1, Dhanakwadi	May 2010			5	300-350	300-350	Commissioned
9	Katraj Ramp 2, Dhanakwadi	May 2010			5	300-350	300-350	Commissioned
10	Hadapsar dumping ramp	May 2010	Technology developed by Aadya Environments.	Aadya Environments.	5	300-350	300-350	Commissioned
11	Wanwadi crematorium, Bibwewadi	February 2010	Technology developed by M/s. Vivam	M/s. Vivam	5	300-350	300-350	Commissioned

Annex 4: Eco- Housing Details

Sr No	Name of the Developer	Property Details	Total Built Up Area Sq.Mtr.	Eco-Hsg Certificate Provisional/Final	Date of Issue	Star Rating	Total Concession in Premium %	Total Amount of Premium	Total concession Amount of Premium	Concession Amount of Premium	
										At Commencement 50%	After Completion 50% refundable
1	Nyati Group ,	Nyati Environs-Phase I, II & III Tigare Nagar,Dhanori,Pune	64010.19	Provisional	22-Aug-08	5	50	10000000 (Approx)	5000000 (Approx)	2500000 (Approx)	2500000 (Approx)
2	Kumar Builders,	Kumar Sublim,Phase I (Bldg A & B) S.No 37, Kondhava Kh.,Pune	9064.72	Provisional	22-Aug-08	5	50	2276880	1138440	569220	569220
3	Reptan Properties Pvt.Ltd.	Kool Homes-Solitiare Project (Bldg A,B,&C) S.No.11, Hissa No 9+14a/2, Kondhava Kh	10780 (Approx)	Provisional	13-Jan-09	3	30	2216752	665025.6	332512.8	332512.8
4	Darode Jog Lagad Ventures	Crossover County S.No.12(prt)+25(prt), VadgaonKhurd, Near Lokmat Press, Sinhgad Road,Pune	23966	Provisional	9-Jul-09	5	50	11106279	5,553,139.50	1388284.88	1388284.88

Annex 5: Carbon inventory of Pune city

Background

India faces the challenge of providing massive infrastructure to its growing population, while achieving low carbon growth. It is estimated that the current level of per capita CO2e (carbon dioxide equivalent emissions, 1 tonne per capita) in the country will increase to about 3 to 5 tonnes by 2030. The total CO2e emissions from the country are expected to rise to about 7 billion tonnes by the same year. Cities are key contributors to these CO2e emissions. The growing residential, commercial, industrial, and transportation activities in cities have led to a rapid growth in energy consumption, primarily energy drawn from fossil fuels. Fossil fuels are one of the primary contributors of greenhouse gas emissions (GHGs) like carbon dioxide (CO2), methane (CH_4), and nitrous oxide (N2O).

In the context of increasing concerns about the impact of the increasing levels of carbon emissions on the climate, cities are starting to realize the importance of reducing these emissions. Many interventions are being undertaken by city governments in order to curb carbon emissions. In order to understand the impact of these interventions in terms of their ability to reduce carbon emissions, it is important to estimate the current levels of emissions. Pune city is one of the first few cities, which has expressed its desire to get a carbon inventory prepared. The city aims to understand its current pattern of emitting carbon emissions, in order to plan specific strategies/interventions to reduce the same. This section of the study describes the approach that is being adopted to estimate the carbon emissions of Pune city.

Objective

The objective of this part of the study is to carry out the carbon inventory of Pune city.

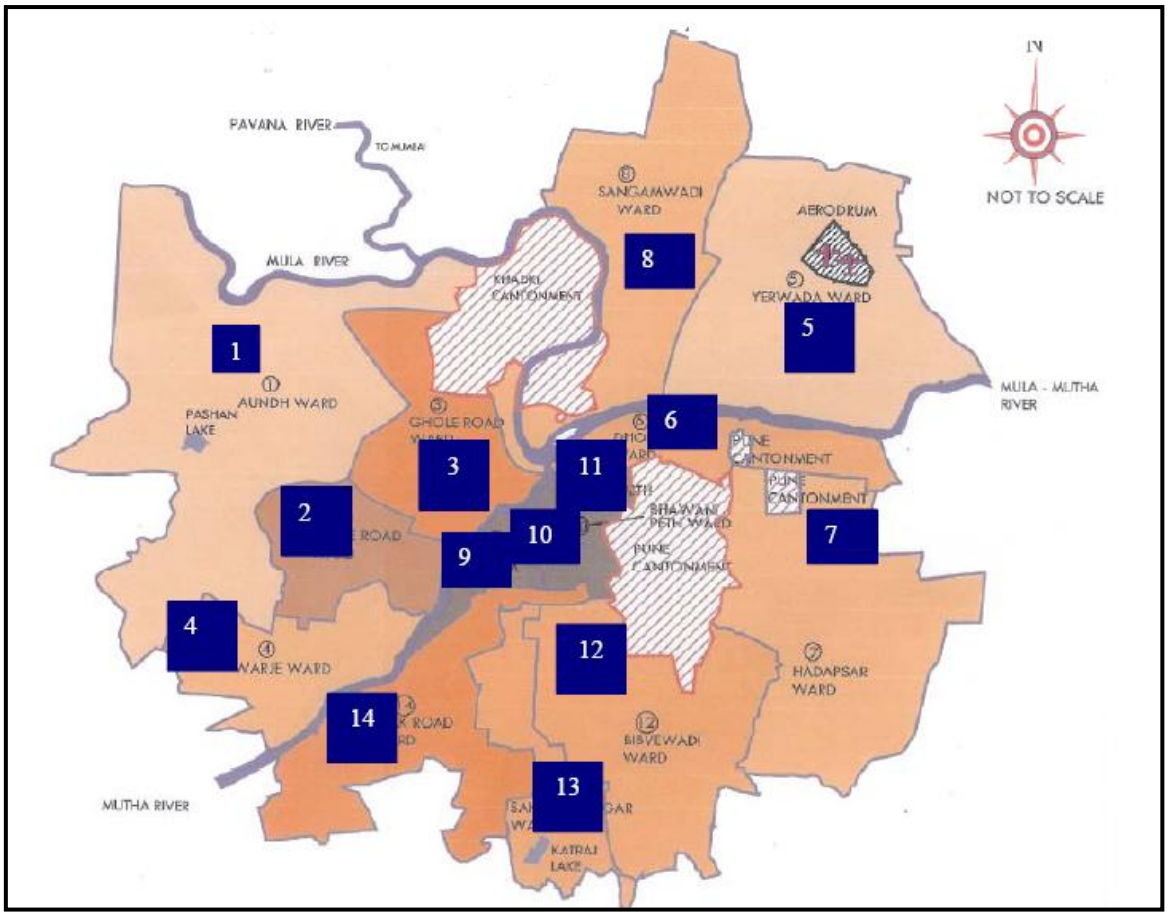
Scope of carbon inventory

Defining study area

The carbon inventory will be carried out for the Pune Municipal Corporation (PMC) area. All urban activities taking place within the administrative boundaries of PMC will be considered while estimating carbon emissions. The ward map of PMC is given in Figure No. 1. The key characteristics of PMC area as per Census, 2001 are as follows.

- Area – 243.84 sq.km
- Population – 25 lakh
- Density – 10,412 persons per sq. km.

Figure No. 1: Ward map of PMC area



Source: PMC, 2006

Inventory will include carbon emissions from energy consumption, municipal waste disposal sites, and sewage transport by pipelines.

The inventory will focus on estimating the carbon impact of energy consumption within PMC limits. Carbon emissions are released on combustion of fossil energy. Almost all urban activities make use of some form of fossil energy to meet their energy requirements. The fossil energy consumed for all urban activities in Pune city (for example, residential, commercial, institutional, industrial, and

transportation activities) will be accounted to estimate the carbon emissions from the city's activities (Table No. 1). In addition to this, emissions from municipal waste disposal sites and sewage transport by pipelines within the city will also be included.

It is acknowledged that there may be a few other activities within the city (apart from energy consumption, municipal waste disposal sites, and sewage transport by pipelines) that may contribute to carbon emissions. However, the contribution of these activities is understood to be very small. Hence, it is decided to consider only energy consumption, municipal waste disposal sites, and sewage transport by pipelines, while estimating the carbon emissions from Pune city.

Table No. 1: Example of energy consumption in different sectors within cities

S. No.	Sector	Possible sources of energy consumed
1	Residential	LPG, natural gas, biogas*, kerosene, fuel wood, other biomass, charcoal, coal
2	Commercial	LPG, natural gas, biogas, kerosene, fuel wood, other biomass, charcoal, coal
3	Industrial	LPG, natural gas, kerosene, diesel, fuel oil, fuel wood, other biomass, charcoal, coal
4	Institutional	LPG, natural gas, biogas
5	Transportation	Petrol, diesel, CNG, LPG, petrol/diesel mixed with biofuels
6	Utilities	Petrol, diesel
7	Municipal services	Petrol, diesel

* Biogas is not a fossil fuel. However, it is included in the table above as the combustion of biogas leads to carbon dioxide emissions.

Carbon inventory will be carried out for 2009–2010

Annual carbon emissions will be estimated for 2009–2010 subject to the availability of data for this year.[34]

Carbon inventory of energy consumption to include only CO2 (carbon dioxide) emissions

The carbon inventory of energy consumption will include CO2 emissions only. It will not include methane (CH_4) and nitrous oxide (N2O) emissions. In a recently conducted study by TERI on estimating carbon footprint of urban energy use, it was observed that the CH_4 and N2O emissions released due to urban energy consumption activities are insignificant as compared to CO2 emissions (TERI 2009). As per this study, the share of CH_4 and N2O in the per capita carbon dioxide equivalent emissions from urban energy use in Jaipur city is less than 4%. This shows that the CH_4 and N2O emissions are insignificant as compared to CO2 emissions from urban energy consumption activities. IPCC (2006) also states that CO2 emissions account typically for 95% of the energy sector emissions with methane and nitrous oxide responsible for the balance.

Carbon inventory of municipal waste disposal sites and sewage transport by pipelines to include CH_4 (methane) emissions

The carbon inventory of municipal waste disposal sites and sewage transport by pipelines within the city will include CH_4 emissions[35]. These activities release significant amount of CH_4 on account of anaerobic digestion or fermentation of biodegradable materials.

Embodied carbon in goods and services not included in carbon inventory

The embodied carbon in consumption goods and services, which is present on account of their production/delivery, is not accounted in the carbon inventory to avoid any double accounting. It is understood that if the goods are being produced within the city limits, the carbon emissions due to their production and delivery will be reflected in emissions of the manufacturing and transportation sectors of the city. If goods are being produced outside the city, their carbon impact will be accounted in the inventory of their place of production and not in Pune city's inventory.

Methodology

The tier 2 approach, outlined in IPCC guidelines for National Greenhouse Gas Inventories (2006), will be adapted to estimate CO2 emissions from energy consumption activities in Pune city. Method recommended in tier 2 is a fuel-based method that estimates CO2 based on the total carbon content of fuel combusted, irrespective of the technologies used for combustion[36] and uses local (country-specific) emission factors. It is indicated in the IPCC guidelines that for estimating CO2 emissions, tier 1 and 2 methods will suffice. Since we are focusing

[34] In case, all the required data is not available for 2009–2010, carbon emissions will be estimated for 2008–2009.

[35] CO_2 will be included if the amount of CO_2 released is significant.

[36] Since, the CO_2 emissions are estimated based on the total carbon content of fuel combusted, there is no question of not accounting the carbon content of non-CO_2 gases like CO (carbon monoxide), NMVOCs (non-methane volatile organic compounds), and so on that may be released due to fuel combustion.

only on CO2 emissions from energy consumption, we are using the tier 2 approach in this case. The tier 2 approach will also be used to estimate CH_4 emissions from municipal waste disposal sites and sewage transport by pipelines within the city. In the tier 2 method, emissions are estimated from all sources of combustion and added to obtain the total emissions. Emissions are classified as follows.

- Emissions from stationary sources
- Emissions from mobile sources
- Fugitive emissions

The critical data requirements to perform carbon inventory using IPCC approach are as below.

- Fuel combustion statistics
- Municipal waste disposal information
- Information on sewage transport by pipelines within city
- Country-specific emission factors, wherever possible[37]

Framework to estimate carbon emissions (adapted from IPCC, 2006)

Step 1: In line with IPCC (2006) methodology, city activities where carbon emissions are being released will be classified into the following categories:

Stationary:

- Residential
- Commercial
- Institutional
- Industries and construction
- Energy industries/Energy generation activities (if any in the city)
- Municipal solid waste disposal

Mobile

- Transportation[38]
  - Road transport (road transport by different modes like cars, two wheelers, buses, taxi, trucks, and so on)
  - Rail transport
  - Off-road transport
  - Air transport
  - Pipeline transport[39]

Step 2: Annual fuel consumption statistics for the city activities listed in step 1 will be collected/estimated for 2009–2010. The range of fuels that will be accounted in the carbon inventory of the city are listed in Table No. 2. Municipal solid waste disposal and sewage transportation information for 2009–2010 will also be collected.

[37] In case country-specific emission factors are not available, IPCC default emission factors will be used.

[38] There is no water transport in Pune. We therefore, do not include the same.

[39] Pipeline transport in a city uses electricity as the source for energy. Since electricity is a clean form of energy at end use, we do not expect any carbon emissions due to pipeline transport within the city, except for CH_4 emissions from sewage transport by pipelines (which occur due to anaerobic digestion of biodegradable materials). These CH_4 emissions from sewage transport are included in the carbon inventory of Pune city.

Table No. 2: Fuels that will be accounted in the carbon inventory of the city

Residential sector	Commercial sector	Institutional sector	Industries and construction sector	Energy industries (if any in the city)	Transportation
LPG	LPG	LPG	LPG	Municipal waste	Petrol
Natural gas	Natural gas	Natural gas	Natural gas	Biogas	Diesel
Biogas	Biogas	Biogas	Biogas	Natural gas	Aviation gasoline
Kerosene	Kerosene	Others	Kerosene	Coal	Compressed Natural gas (CNG)
Coal	Coal		Coal	Diesel	Jet gasoline
Others (specify)	Others (specify)		Diesel	Fuel oil	Jet kerosene
			Petrol		LPG
			Fuel oil		Bio-diesel
			Others (specify)		Bio-ethanol

Step 3: Data on country-specific emission factors and calorific values will be collected from agencies like Ministry of Environment and Forests (emission coefficients used in NATCOM), Ministry of Petroleum and Natural Gas, Central Pollution Control Board, Automotive Research Association of India, and so on.

Step 4: Estimation of carbon emissions (total and sectoral) from Pune city will be carried out based on data collected in step 2 and 3. The carbon estimation results will be broadly analysed to suggest areas where city authorities need to take action in order to curb carbon emissions from the city.

Assumptions

Fuel sales data is equal to fuel combustion

In order to calculate CO_2 emissions, data on fuel combusted in different sectors is needed. Since, it is difficult to obtain the data on actual fuel combusted; it will be assumed that the fuel sold in the city is equal to fuel combusted.

There may be cases where fuel sold within the city is used outside the city. Ideally, this fuel consumption should be discounted from total fuel consumption, but since it is difficult to estimate this amount of fuel, we assume all fuel sold within the city is being used for city activities only. Also, it may happen that some part of the fuel used in the city is bought from outside the city limits, but used within the city. Ideally, this fuel consumption should be added to the fuel consumption data for the city, but since it is difficult to estimate this data, we do not include this fuel in city estimates. This approach is also recommended in IPCC (2006) where it is mentioned that the emissions from fuel should be attributed to the place where the fuel is sold.

Petrol and CNG sold at petrol pumps is used for transportation sector only

It is assumed that the petrol and CNG sold at fuel stations (petrol pumps) will all be used by the transport sector only. There may be cases that some part of these fuels sold at fuel stations is used for purposes other than transport. However, we feel that this share of fuel will be very small and, hence, assume that 100% of petrol and CNG sold at fuel stations is used for transport sector.

Diesel sold at petrol pumps is used in diesel engines (mobile and stationary) that have similar emissions profile

In addition to its use in the transport sector, some part of diesel sold at petrol pumps may be used in diesel generators used for power backup. Since it is difficult to segregate the diesel sales, we assume that all diesel sold at petrol pumps is used in diesel engines (mobile and stationary) that have similar emissions profile.

Status of data collection and next steps

TERI has approached several agencies to collect data on fuel consumption in Pune city. Although we have received some information from agencies, a substantial amount of data remains pending.

Next steps in estimating carbon emissions from Pune city

- Completing data collection
- Estimating carbon emissions
- Identifying areas in which city authorities need to undertake interventions in order to curb carbon emissions from the city

Abbreviations

^{0}C	: Degree Celsius
^{0}F	: Degree Fahrenheit
2W	: Two Wheelers
3W	: Three Wheelers
4WD	: Four Wheelers Diesel
4WG	: Four Wheelers Gas
AQI	: Air Quality Index
ARAI	: Automotive Research Association of India
ATCS	: Area Traffic Control System
BOD	: Biochemical Oxygen Demand
BOT	: Build-Operate-Transfer
BPCL	: Bharat Petrochemical Limited
BPL	: Below Poverty Line
BPMC	: Bombay Provincial Municipal Corporations
BPO	: Business Processing Output
BRT	: Bus Rapid Transit
BRTS	: Bus Rapid Transit System
BS II	: Bharat Stage II
BS III	: Bharat Stage III
BT	: Biotechnology
CBD	: Central Business District
CDC	: Centre for Disease Control
CDP	: City Development Plan
CIRT	: Central Institute of Road Transport
Cl	: Chlorine
CMP	: Comprehensive Mobility Plan
CNG	: Compressed Natural Gas
CO	: Carbon Monoxide
COD	: Chemical Oxygen Demand
CPCB	: Central Pollution Control Board
CPHEEO	: Central Public Health and Environmental Engineering Organization
CRF	: Chest Research Foundation
dB	: Decibel
dB(A)	: Decibel Adjusted
Dept	: Department
DG	: Diesel Generator
DHS	: Director of Health Services
DMRC	: Delhi Metro Rail Corporation
DO	: Dissolved Oxygen
DPSIR	: Driving force, Pressure, State, Impact and Response
EC	: Electrical Conductivity
EPI	: Environmental Performance Index
ESR	: Environmental Status Report
F & V	: Food and Vegetable
FRL	: Full Reservoir Level
Ft	: feet

GDP	: Gross Domestic Product
GOI	: Government of India
GOM	: Government of Maharashtra
GSDA	: Groundwater Surveys and Development Agency
HC	: Hydrocarbons
HCV	: Heavy Commercial Vehicle
HFL	: High Flood Level
HMV	: Heavy Motor Vehicles
HOD	: Head of the Departments
HPSV	: High Pressure Sodium Vapour Lamp
HVAC	: Heating, Ventilation and Air Conditioning
I&M	: Inspection and Maintenance
ICDS	: Integrated Child Development Scheme
ICU	: Intensive Care Unit
IITM	: Indian Institute of Tropical Meteorology
IMD	: Indian Meteorological Department
IT	: Information Technology
JNNURM	: Jawaharlal Nehru National Urban Renewal Mission
Kg	: Kilogram
kgoe	: Kilogram of Oil Equivalent
km	: Kilometre
kWh	: Kilo Watt Hour
LCV	: Light Commercial Vehicle
LMV	: Light Motor Vehicle
lpcd	: litres per capita per day
LPG	: Liquefied Petroleum Gas
m^3	: cubic meter
Max	: Maximum
MCCIA	: Mahratta Chamber of Commerce, Industries and Agriculture
MEDA	: Maharashtra Energy Development Agency
MHFW	: Ministry of Health and Family Welfare
MIDC	: Maharashtra Industrial Development Corporation
Min	: Minimum
MLD	: Million Liters per Day
MMSCMD	: Million Metric Standard Cubic Meter Per Day
MNGL	: Maharashtra Natural Gas Limited
MNRE	: Ministry of New and Renewable Energy
MPCB	: Maharashtra Pollution Control Board
MSEDCL	: Maharashtra State Electricity Distribution Co. Ltd
MTOE	: Metric Tonnes of Oil Equivalent
MU	: Million Units
mWh	: Mega Watt Hour
NAAQS	: National Ambient Air Quality Standard
NCL	: National Chemical Laboratory
NEERI	: National Environmental Engineering and Research Institute
NGO	: Non- governmental Organization
NH	: National Highway
NIV	: National Institute of Virology
NMT	: Non- Motorized Transport
NOx	: Oxides of Nitrogen

NUTP	: National Urban Transport Policy
OPD	: Outpatient Department
PCMC	: Pimpri Chinchwad Municipal Corporation
PM 10	: Particulate Matter less than 10 microns
PM 2.5	: Particulate Matter less than 2.5 microns
PMC	: Pune Municipal Corporation
PMPML	: Pune Mahanagar Parivahan Mahamandal Limited
PT	: Public Transport
PUC	: Pollution Under Control
Pvt.	: Private
RSPM	: Respiratory Suspended Particulate Matter
RTC	: Ready-to-Cook
RTE	: Ready-to Eat
RTO	: Regional Transport Office
RT-PCR	: Real-Time Polymerase Chain Reaction
RWH	: Rain Water Harvesting
SIV	: Swine Influenza Virus
SO_2	: Sulphur-di-oxide
S-OIV	: Swine- Origin Influenza Virus
SOx	: Oxides of Sulphur
SPM	: Suspended Particulate Matter
STP	: Sewage Treatment Plant
T/Yr	: Tonnes/year
Temp	: Temperature
TERI	: The Energy and Resources Institute
TMC	: Thousand Million Cubic feet
UDPFI	: Urban Development Plans Formulation and Implementation
ULB	: Urban Local Body
UNO	: United Nations Organization
USA	: United States of America
WQS	: Water Quality Standards
WSA	: Wilbur Smith Associates
WSD	: Water Supply Department
WTP	: Water Treatment Plants
WTP	: Water Treatment Plant
YLL	: Years of Life Lost