

Environment Report Card of **BANGALORE** 2012



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Environment Report Card 2012 is an outcome of an effort by the Centre for Sustainable Development (CSD) to present the citizens' perception of Bangalore's environment. It is a result of contribution from various Government departments, experts and other organizations.

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ACRONYMS

1. BBMP - Bruhat Bengaluru Mahanagara Palike
2. BDA - Bangalore Development Authority
3. BESCOM - Bangalore Electricity Supply Company
4. MSW - Municipal Solid Waste
5. LDA - Lake Development Authority
6. KSPCB - Karnataka State Pollution Control Board
7. CPCB - Central Pollution Control Board
8. JNNURM - Jawaharlal Nehru National Urban Renewal Mission
9. MOEF - Ministry of Environment & Forest
10. BWSSB - Bangalore Water Supply & Sewerage Board
11. BMRDA - Bangalore Metropolitan Regional Development Authority
12. GIS - Geographical Information System
13. INAAQS - Indian National Ambient Air Quality Standard
14. NAMP - National Air Quality Monitoring Programme
15. MLD - Million Liters Per Day
16. LPCD - Liters Per Capita Per Day
17. BMRCL - Bangalore Metro Rail Corporation Limited
18. BMTCL - Bangalore Metropolitan Transport Corporation
19. RTO - Regional Transport Office
20. EMS - Environmental Management System
21. RWH - Rain Water Harvesting
22. CAAQM - Continuous Ambient Air Quality Monitoring
23. NBC - National Building Code
24. SPM - Suspended Particulate Matter
25. PM₁₀ - Particulate Matter <10µg
26. µg - Micro grams
27. SO_x - Oxides of Sulphur
28. NO₂ - Nitrogen Dioxide
29. TDS - Total Dissolved Solids
30. dB (A) - Decibels measured on noise scale A
31. LPG - Liquid Petroleum Gas
32. HAM - Hectare-Meter
33. CMC - City Municipal Corporation
34. TMC - Town Municipal Corporation

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Chapter 1

Introduction

Objectives, Scope And Methodology

Environmental Indicators



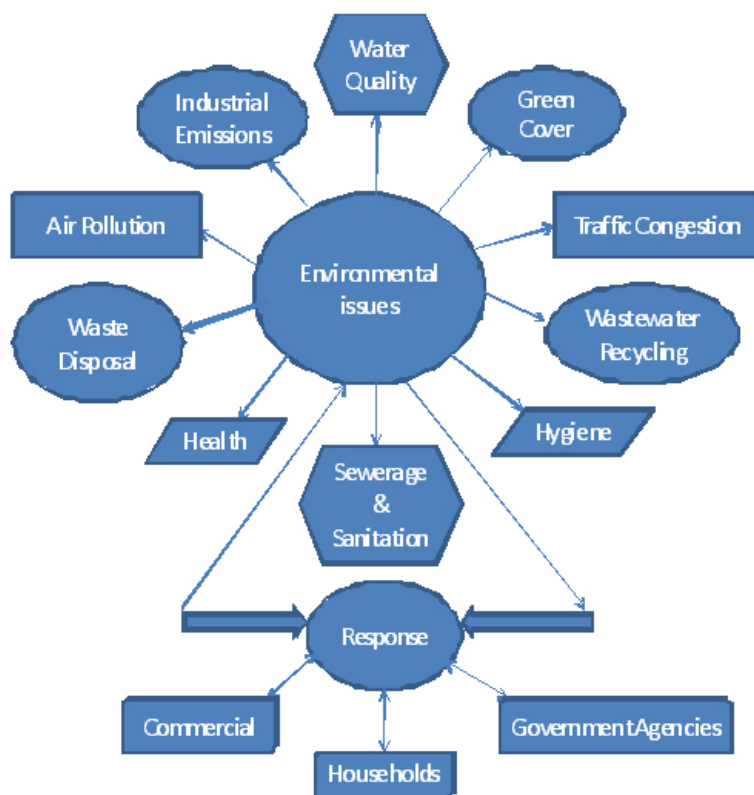
Introduction

The Centre for Sustainable Development has prepared the second edition of its Environment Report Card for Bangalore (2011), at a time when environmental issues are of utmost concern to the citizens. Bangalore has the distinction of being the Silicon Valley of India as it is a hub for major IT and other hi-tech companies. The salubrious climate, quality education and livelihood opportunities, health care facilities etc., have favored and attracted people and investors from across the world. This has led to an unprecedented urban growth causing environmental threats. The environmental problems such as water quality, air and noise pollution, waste and wastewater disposal, loss of green cover, sewerage and sanitation, hazardous and e-waste disposal, traffic congestion etc, are only growing thus seriously affecting the quality of life and the health of the people.

The main objective of preparing the Environment Report Card (ERC) is to capture the citizens' perceptions on environmental issues which closely impact them and stimulate debate on the policies intended to benefit environmental protection. The study has adopted a three pronged approach, which takes into consideration the baseline information on the existing environment, citizens' perception on the environment and the government's efforts to mitigate the environmental problems.

A multi stage stratified sampling was carried out to cover different economic strata of the society. The door to door survey of 1675 households and 108 commercial establishments was conducted using a questionnaire method. Chapter 1 sets out the objectives, scope and methodology of the study along with the environmental indicators. Chapter 2 provides an overview of the environmental issues prevailing in Bangalore. Chapter 3 analyses the citizens' perceptions and gives the overall comparison of the ERC 2005 with that of the new ERC 2011. The last Chapter presents the conclusions and offers suggestions for moving towards a sustainable environment in Bangalore.

This ERC report draws out various view points from the citizens and links the gap between the Government and the public at large. It is thus equally useful to both government agencies and citizens alike because it reflects the ground realities and can help in restructuring of policies and programmes.

Chart 1: Environmental issues of Bangalore

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Zonal Map of Bruhat Bengaluru Mahanagara Palike
(Greater Bangalore Municipal Corporation)¹



Chapter 1

Objectives

The overall objective of the Environmental Report Card is to explore citizens' perspectives on the environment of Bangalore and assess the gap between perceptions and actions by government. In specific terms, objectives of the study are four-fold:

- Assess the perceptions of the citizens of Bangalore with regard to the key environmental issues of the city.
- Compare the peoples' perceptions/findings with that of a similar study undertaken during 2005.
- Create public awareness on environmental issues and stimulate positive action.
- Suggest measures to create a sustainable environment in Bangalore.

Scope

The ERC – 2011 has been prepared to derive statistically significant responses from a cross section of the community of Bangalore city. The scope of the ERC-2011 is enumerated below:

- Spatial coverage: the entire city of Bangalore coming under the jurisdiction of the Bruhat Bengaluru Mahanagara Palike (BBMP) has been included.
- Environmental: Major environmental issues that are endemic to Bangalore such as solid waste, water, air and noise pollution, traffic congestion, tree cover are considered in this study.
- Additional issues like rain water harvesting and e-waste have been added compared to the ERC of 2005.
- The ERC-2005 which was the first of the type probably in the entire country provided the baseline data from which a comparison can be drawn as derived in the ERC 2011.

Methodology

The methodology adopted to explore citizens' perspectives on the environment of Bangalore is through a stratified multistage random sample survey of households and a multistage random survey of establishments. The local body that administers Bangalore is Bruhat Bengaluru Mahanagara Palike (BBMP). BBMP is formed by merger of 8 urban local bodies with erstwhile Bangalore Mahanagara Palike (BMP). BMP had 3 administrative divisions called zones. Now BBMP has 198 wards and 8 administrative zones. The study has attempted to provide estimates to the environmental indicators through household survey for each administrative zone of BMP area (3 zones) and separate estimates for the added area which includes the 5 new zones. Also estimates have been provided separately for general and slum households. The study covers a sample of 1675 households which provide estimates for environment indicators for each zone of BMP at 90 per cent confidence level with error less than 5 per cent. The estimates for the newly added areas (5 zones together) are at 95% confidence with error less than 5%. The information on environment issues through identified indicators was collected through a structured questionnaire. The environmental issues covered in the study pertain to water, sanitation, air quality, open spaces & tree cover and health impact.

Chapter 1

Selection of sample:

In each stratum (selected division) 3 wards were selected based on density of population as population density will have a bearing on the environmental issues. In each stratum, the highest density, the lowest and the median density wards were selected. In each selected ward, the sample was allocated between general and slum households based on the proportion of households living in general and slum areas.

Selection of general households:

In each selected ward, the streets were selected at random from the GIS maps obtained from BBMP. It was decided to select 5 households from each selected street using systematic random sampling procedure. The number of streets to be selected in each ward was obtained from the allocated sample size to the general households and the predetermined number of households per street.

Environmental Indicators

Environmental indicators are a set of essential tools for tracking environmental progress to evaluate and assess the state of the environment. These indicators are flexible instruments that can read multi-faceted problems and issues, diagnose the shortfalls and point out the desirable choice among policy options as indicated by the outcomes of the past interventions as well as non-interventions. They also provide a speedy and adequately reliable approach that can help and facilitate policy makers and others to take decisions on the interventions required. The indicators thus provide inputs reflecting the ground level situation in a diagnostic form to critical problems that policy initiatives need to address.

Environmental indicators can be used at local, state, national as well as international levels. In order to measure the environmental performance of a city, it is appropriate to use the city level indicators. The ERC 2011 which is an improved version of ERC 2005 has the following main indicators to assess the environmental impacts of Bangalore.

Water

- Source
- Quality
- Quantity
- Water conservation
-

Air

- Fuel used for combustion
- Air Quality

Traffic

- Pollution from vehicles
- Traffic congestion
- Mode of transport

Sanitation

- Toilets
- Sewerage
- Storm water drainage

Health

- Air contaminated diseases
- Water contaminated diseases
- Vector based diseases

Waste Management

- Municipal waste
- E-waste

Awareness on environmental issues**Rain water harvesting (RWH)****Open spaces**

- Parks
- Playgrounds
- Tree cover

Community participation



Chapter 2

Environmental issues of Bangalore :
An overview



ENVIRONMENTAL ISSUES OF BANGALORE: AN OVERVIEW

Rapid growth and urbanization have led to a concentration of economic activities in the capital city of Karnataka. The population of Bangalore has reached nearly 8.5 million as per 2011, recording a growth rate of 46% during the last decade. As a consequence, Bangalore, like other metropolitan cities, is threatened by pollution, congestion and other environmental hazards. Deteriorating environmental conditions cannot, however, be attributed solely to urbanization. Unsustainable consumption of resources and lifestyle changes are also a major contributing factor. Following is an overview of the key environmental issues of the city.

Water

The demand for water for domestic as well as non-domestic uses is continuously on the rise. The main sources of water to the city are ground water and river water systems. BWSSB which is responsible for supply of water to the city sources water from two rivers, Cauvery and Arkavathy. The average total quantity of water supplied to the city from these two rivers is 810 MLD and 184 MLD respectively with a total of 994 MLD.² An estimated quantity of another 200 MLD is extracted from the groundwater sources. As such the total quantity of water available from all sources under normal conditions is about 1194 MLD. The requirement of water for Bangalore for a population of about 9 million at the rate of 135 LPCD (National Building Code of India norms) is 1215 MLD. Thus, there is a shortage of 21 MLD. This arithmetical shortage is rather misleading. It may not appear to be a major issue at present, but this will increase with the growth of population and by 2021, we would require a quantity of 1350 MLD for a population of 10 million. Secondly, because of the inequitable distribution of water, some sections of the population get far less water than the average per capita requirement. Today, some of the population particularly in the new layouts depend on private bore well water as well as bought out water. Thirdly water losses, estimated anywhere between 30-50% present a serious problem.

Besides the quantity, water quality has emerged as a major issue in Bangalore as revealed from the findings of this study. The acceptable limits for the quality of water as per IS 10500-1991, the coliform organisms/100ml should be less than 1 and E.Coli to be absent.

Groundwater

Groundwater being a natural source available underneath the earth surface occurs in the hard rock terrains under unconfined and semi-confined conditions. Inadequacy of the piped water supply by BWSSB has resulted on the dependency of groundwater. Complementary to the BWSSB water supply, groundwater helps in meeting the growing water demand. Unfortunately, the groundwater table has depleted due to alarming rate of unscrupulous groundwater extraction by interested parties. In some of the areas of Bangalore it has been reported that the bore wells have dried up with no water or less of water. However, some measures have been taken to mitigate the adverse effects. Rain Water Harvesting has been made mandatory for all households with over 2400 Sq.ft or more, including the government and industrial establishments. At the same time, wastewater recycling has been made compulsory for >1000 dwellings residing at a common apartment block so that the dependency on the groundwater can be reduced to an extent.

Overexploitation of groundwater beyond the rechargeable limit has resulted in the emergence of increasing number of semi-critical, critical, over exploited and over-developed water sheds. Table 1 below shows the exploitation of watersheds in the two basins which comes under the BBMP area.

Table 1: Exploitation of watersheds³

Water shed	Annual recharge (ham)	Net Groundwater availability (ham)	Total utilization (ham)	Stage of GW development in %
Palar basin	10,326	9810	12472.73	127%
Arkavathi basin	4,966	4721	9144.60	194%

Waste Water/Sewerage

About 85% of water supplied gets converted into waste water which needs to be treated before discharging into nallas or receiving bodies of water. The waste water generated in the city is conveyed through sewerage system to 12 sewage treatment plants with secondary treatment facility having a total capacity of 721 MLD and 4 tertiary treatment plants with a capacity of 73 MLD.⁴ The quantity actually treated is much less. The tertiary treated wastewater is sold by BWSSB to agencies like BIAL (Bangalore International Airport Limited), BEL (Bharat Electronics Limited) etc. Some institutions like the Bangalore Golf Course, Karnataka Golf Association, Horticulture department etc have been permitted to draw sewage from the public sewers and treat the same for reuse, mainly for horticulture/gardening purpose. It will not be out of place to mention that some private layouts, apartment blocks also depend on their own sewage treatment facilities.

In most of the sewage treatment plants owned and operated by the BWSSB, the treatment is only up to secondary level before the water is discharged into natural water bodies and nallas. The total treatment capacity of all the treatment plants put together is only about 70% indicating a shortfall of nearly 30% of untreated waste escaping into receiving bodies of water. The city's major drains carry a certain percentage of untreated sewage and sullage from local leakages as well as non connection to the BWSSB sewers. The sewerage system of Bangalore is designed only for sewage which is generated and not for the storm water during heavy rainfall. As such, during stormy weather the sewers are full and the man holes start overflowing resulting in escape of mixed rain water and untreated sewage flowing in the streets adding to the misery of the residents.

The BWSSB along with the supply of water also provides sewerage services. According to BWSSB Officials, there are about 6,56,000 sewerage connections in the city. The coverage of sewer network is 4300kms in the BBMP area and a proposed 2300kms in the former CMC and TMC areas. BWSSB has taken action to prevent blockages by adding 106 service stations with 27 sub divisions. It also has 76 sewer jet cleaning and sucking machines which helps in the removal of blockages.

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Drainage

Bangalore is located at an altitude of 900m above mean sea level. The drainage pattern of Bangalore is dendritic which runs parallel to sub-parallel formed by a number of streams.

The storm water drains are maintained and cleaned by the BBMP. Every street has a drain at the end of the road which is either open or covered. Under the BMP area the extent of storm water drains was 240.40 Kms in the city. However, after expansion the area has increased to 869.83 Kms covering all the 8 zones of the city as shown below:⁵

Table 2

Zones of BBMP	Extent in Kms
BMP zones (South, East & West)	240.40
Rajarajeshwari nagar	144.75
Dasarahalli	89.24
Yelahanka	113.85
Mahadevpura	172.00
Bommanahalli	109.59

Of the 240.40 Kms running inside the core BMP area most pockets of the city have well developed storm drains. These drains collect the storm water and convey it to the nearby streams/lakes. The bursting growth of the city has resulted in the reduction of lakes and tanks due to encroachment and construction activities. This has exerted a pressure on the storm water drains reducing them to gutters of insufficient capacity leading to flooding during monsoon season. If these drains are not maintained properly, it can lead to environmental hazards.

Air Quality

Air quality is one of the indicators of environmental pollution. Pollution of air can be caused from a point source or a non-point source. Point sources are households, industries, hotels or other places where fuel is burnt for cooking or heating. Non-point sources are the vehicular emissions which emit gas, smoke or particulate matter.

Air pollution in Bangalore city is continuously on the increase. While there are no major industries contributing to air pollution, mostly vehicular emissions and dust from construction are responsible for polluting the atmosphere. The number of vehicles on the city roads has exceeded 3.7 million and there has been a consistent increase in the vehicular population at an average rate of 8% per annum.⁶

Karnataka State Pollution Control Board has been carrying out ambient air quality monitoring at 6 stations in Bangalore under the National Ambient Air Quality Monitoring Programme (NAMP). In Bangalore, the air quality monitoring is conducted at these locations which are classified as

- Industrial zone
- Mixed urban zone
- Sensitive zones

Three ambient air quality monitoring stations are set up at Peenya industrial area, KHB industrial area and Graphite India Ltd., The Mixed urban zone includes AMCO Batteries and Yeshwanthpur. The sensitive zone considered is the Victoria hospital, area.

The Board also monitors air quality at some of the waste disposal sites. The parameters monitored are the Respirable Particulate Matter (PM_{10}), Sulphur di oxide (SO_2) and Oxides of Nitrogen (NO_x). The monitoring is being carried out at a frequency of twice a week for 24 hours.⁷

Table 3: Pollutants in Bangalore City as per KSPCB Data for year 2010-11

Locations In Bangalore City	SO2	NOx	RSPM	SPM
	Concentration in $\mu\text{g}/\text{m}^3$			
Graphite India	16.1	30.4	122	264
KHB Indl Area	14.8	29.8	72	330
Peenya Indl Area	15.4	30	92	210
AMCO Batteries	13.9	29	80	158
Yeshwantpur	16.5	30.4	100	222
Victoria Hospital	12.7	27.2	64	131

KSPCB has also commissioned two Continuous Ambient Air Quality Monitoring stations (CAAQM) in Bangalore, one at City Railway station and another at Nisarga Bhavan. The stations are operated all round the year for 24 hours.

The National Ambient Air Quality Standards as prescribed by CPCB is shown in the Table 4 below:

Table 4

SL No.	Parameters	Concentration in ambient air at 24 hourly average
1	Suspended Particulate Matter (SPM) in $\mu\text{g}/\text{m}^3$	200
2	Particulate Matter (PM_{10}) in $\mu\text{g}/\text{m}^3$	100
3	Sulphur Dioxide (SO_2) in $\mu\text{g}/\text{m}^3$	80
4	Oxides of Nitrogen (NO_x) in $\mu\text{g}/\text{m}^3$	80

The Board monitors pollution from commercial and industrial sources which could be in the form of air pollution, waste generation, noise pollution etc to ensure compliance with the Environment Protection Act, 1986.

Solid waste

Rapid urbanization and drastic change in the culture and practices of people has led to huge generation of household Municipal waste. It is estimated that the quantum of municipal waste generated is about 3,000 to 4,000 MT/day. Roughly 60% is organic waste

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and 40% dry waste. The quantum of waste generated far exceeds the existing capacities of the waste treatment facilities at Mavallipura (600 TPD), Mandur (1000 TPD), Terra Firma (600 TPD), Seeghalli (200 TPD).

The primary collection is carried out using 11,000 nos. of pushcarts and 650 nos. of auto tippers. During post collection from households, the waste is transported by about 600 vehicles which include compactors, tipper lorries, dumper placers and mechanical sweepers both by BBMP and private contractors.⁸

As per the MSW Management Rules 2000, BBMP is responsible for collection, handling and disposal of the MSW. In several areas BBMP has resorted to door to door collection of garbage. Street sweeping is manually done as well as mechanically in certain areas. BBMP has accorded permission to 4 major private agencies for handling the MSW based on the PPP model. It has adopted the GPS/GPRS based tracking system for 350 vehicles carrying MSW to various disposal sites. CCTV has been installed at all the processing sites including hand held devices connected to the central server for monitoring and analysis. In a few pockets of the city, there is a decentralized waste treatment system with a simple aerobic composting which reduces the burden on landfill.

However, problems of collection and disposal of waste continue with garbage being thrown on roadside and into drains, and final disposal being still unsatisfactory.

E-waste

Wastes generated from Electrical & Electronic Equipments (WEEE) are regarded as e-Waste. The change in lifestyle patterns and the growth of IT companies has resulted in huge e-waste generation as Bangalore pays a price for being the Silicon Valley of India. Among the metropolitan cities of India, Mumbai ranks first followed by Delhi and Bangalore in e-waste generation. The amount of e-waste generated in Bangalore is approximately about 8,000 tonnes/year. It is essential to dispose of the e-waste in an environmentally sustainable manner. A few agencies authorized by KSPCB have undertaken reprocessing/recycling of e-wastes. Most of the e-waste is however handled in the informal sector.

The e-waste (Management and Handling) Rules, 2011 have come into effect from 1st of May 2012.⁹ These rules not only covers WEEE but also rejects from manufacturing and repairing processes. The producers or manufacturers of the specified electrical and electronic equipments are liable under the principle of Extended Producer Responsibility (EPR) to take care of their goods beyond manufacturing i.e. until environmentally sound management of products' end-of-life. However the producer should ensure that e-waste is channelized to a registered recycler and also have a check on collection and channelization by authorized collection agencies.

Traffic & Transport

Traffic problems in Bangalore have assumed crisis proportions. The number of vehicles registered in the city has been growing rapidly.

Table 5 shows the vehicular population as on 31st March 2011.¹⁰

SL. NO	Vehicle category	Total in Lakhs
1	Two wheelers	26.24
2	Auto rickshaws	0.98
3	Light Motor Vehicles	7.10
4	Buses	0.28
5	Taxis	0.41
6	Trucks	0.71
7	Others	2.19
	Total	37.91

In view of the growing number of vehicles, the carrying capacity of the roads has been severely limited. This has resulted in serious environmental problems such as traffic congestion, air pollution and parking.

It is significant to note that despite the phenomenal growth of private vehicles, public transport or bus continues to be a major mode of conveyance by providing good service to the citizens. 5th of every month is observed as a bus day with the intention of encouraging the general public to use maximum bus service. BMTC ferries more than 4.35 million commuters comprising a fleet of over 6102 buses covering the radius of over 36 Kms from the city centre.¹¹

Traffic and Transport – Some facts

- City has 75,000 LPG auto rickshaws which is one of the most successful auto LPG market in the country.
- Total requirement of auto LPG in the city is approximately 5,300 tonnes/month.
- 40 filling stations with twin dispensers.
- Automated Enforcement system located at 39 police stations.
- 160 surveillance cameras to monitor violation of traffic rules
- 5 interceptors in the city to record all types of traffic violations including drunken driving. The number of cases reported in 2011 are 98,497
- Authorized emission testing centers in Bangalore are 276

Parks and tree cover

Parks and gardens contribute to keeping the environment of the city clean. Bangalore has a large number of parks being spread across the city, numbering 1079 of which 721 are developed parks and 358 are undeveloped parks.¹² The parks are maintained by BBMP, BDA or private organizations.

Bangalore has two major lung spaces located in the heart of the city i.e., Lalbagh and Cubbon park which play a vital role in absorbing air pollutants. Bangalore was well known for its greenery and was regarded as “Garden City”. However, these lung spaces

are shrinking due to anthropogenic activities taking place.

Trees beautify the city and provide fresh air. Tree cover is the area covered by the crown of trees. Trees help in cleansing the air by intercepting airborne particles, reducing heat and absorbing pollutants such as CO, SO₂ and NO₂ which are released by the non-point sources. Thus, trees reduce air pollution by lowering air temperature through respiration, and by retaining particulates. Unfortunately, the number of trees has been diminishing in the city due to a large number of construction, road widening and other developmental activities. For instance, the total number of trees cut for the construction of metro rail along the E-W and N-S corridors is 412 of which 274 trees showed to be healthy and the rest are either aged, stunted or mutilated. The total biomass loss for these 412 trees was of the order of 545.60 tonnes which accounts for 1.32 tonnes per tree.¹³ It must however be pointed out that a number of new trees are also planted every year. About nine lakh trees have been planted during the last five years.¹⁴

Environment & Health

The relationship between the environment and human health is very crucial. A large number of people are exposed to a variety of toxic substances in the environment affecting the human body through skin, respiratory system, etc. Pollution of air and water and undisposed & waste have an adverse impact on health. People in Bangalore do suffer from environment and climate related diseases such as allergy, asthma and other respiratory diseases. The number of mosquito borne diseases such as Dengue and Chickungunya cases in 2010 in the city was 734 and 199 respectively, while in 2011 it is reported to be 68 and 23 respectively.¹⁵ It is significant to note that the outbreak of mosquito borne diseases has reduced since a year.



Chapter 3

Citizens' perception on environmental
issues & analysis

Comparison of data between
ERC 2005 & 2011



CITIZENS' PERCEPTION AND ANALYSIS OF KEY ISSUES

The ERC has identified 13 key issues that affect Bangalore's environment. Citizens' from across the 8 zones of the city covering diverse income groups including slums were asked to rank these 13 issues in a descending order of priority. The issue ranked number 1 is perceived by the citizen to be the most important issue that needs immediate attention. The one ranked 13 requires comparatively less attention. A similar ranking system was adopted for the commercial establishments as well. The aggregate ranking given by citizens' of all zones have been compiled to arrive at the overall rank of each issue at the city level. Thus, the column "All zones" in the table 15 & 16 depicts the overall ranking of each environmental issue by the citizens'.

The top 6 issues have been analyzed in detail to understand the citizens' satisfaction levels of each issue as also the gap between citizens' perceptions and factual situation. A brief analysis of the remaining 7 issues has also been presented. This helps the reader to get an idea of the State of Environment in Bangalore vis-à-vis the perceptions of the citizens.

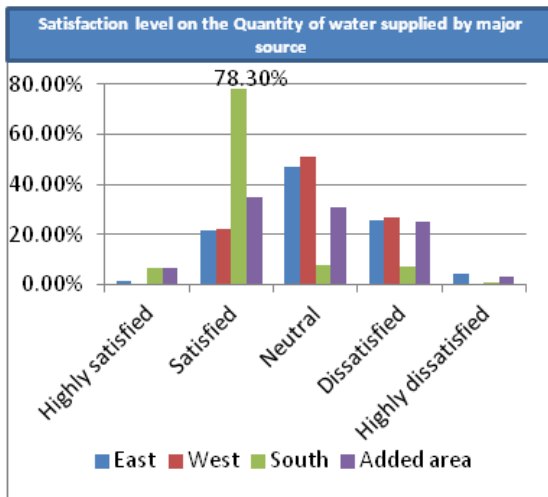
1. Water Adequacy



Going by BWSSB's statistics there seems to be not much of a gap between demand and supply. The use of water is classified into domestic and non-domestic categories. More than 50% is consumed by the domestic sector and less than 20% by the non-domestic (which includes commercial and industrial uses). However it is interesting to note that around 33% is consumed by public fountains. BWSSB

has steadily increased its outreach to the Bangalore metropolitan area to ensure that 85% of the supply is met from its sources.

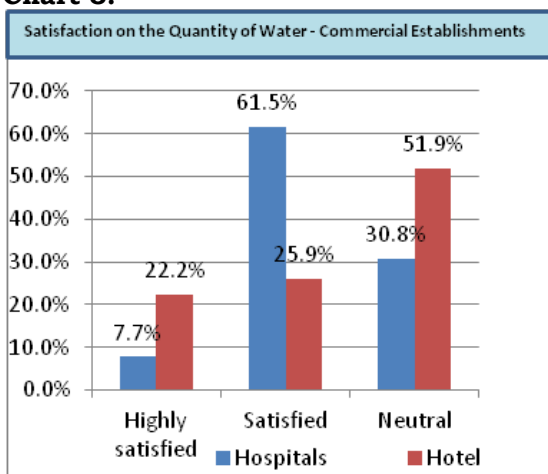
According to the Citizen survey, hardly 50% of water supply comes from BWSSB in the added areas, with dependency on borewells and private tankers being almost 60%. The zonal analysis shows that water shortage is highest in the east zone, even more than the added areas, while south zone faces comparatively less shortage. Supply of BWSSB water is also more frequent in South compared to other areas which is a reason why people here face less shortage of water and therefore satisfaction levels are also high (78.3%). The survey reveals that 40.5% and 42.2% respectively of the general class of people and slum population having reported satisfaction on the quantity of water.

Chart 2:

The per capita level of consumption is highest in west, with a majority of the population consuming more than 135 liters per day. Despite the fact that BWSSB as a source of drinking water is lowest in the west zone, the shortage is filled in through private tankers and package drinking water which is the highest among all the zones (about 36% of the supply is met from these sources). This could also be a plausible explanation for 51% of the citizens in the west zone to express their satisfaction levels as 'neutral' which means that while there is water shortage in the area, the residents are able to meet the gap through supplementary sources even though it means paying more for water.

East zone which faces the maximum water shortage tries to meet the demand through borewells (25%) though its dependency on private tankers and packaged drinking water is comparatively less. The citizens claim that they receive water supply for less than 3 hrs in a day and only for about 3 days in a week. The dissatisfaction levels are therefore highest in this zone. Interestingly, the satisfaction levels in added areas are better (43%) despite the piped water supply being the lowest. This is perhaps because people in these areas have become dependent on borewells and private tankers.

Awareness about the importance of water conservation seems to be low among the citizens. When respondents were asked to choose various options for solving water shortage problems, more than 60% opted to buy water on need basis, while 30% said that they would consider using less water. The use of rain water harvesting in the city is very low at present with only 30,000 houses adopting the system according to BWSSB records (Nov 2011). Even where the system exists, some of them don't use it or not aware of its use.

Chart 3:

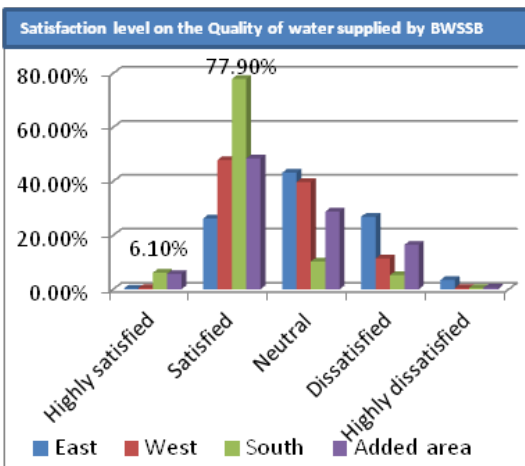
Water reuse is still not a popular practice in Bangalore. BWSSB treats up to approximately 418 million litres of wastewater or sewage every day i.e. less than 60% of the capacity. That is the wastewater that comes from sinks, showers, toilets, and backyard drains. Treated wastewater is then discharged to waterways, or recycled for re-use as bio-solids. Two tertiary treatment plants have been set up to make available 10 MLD of treated water to industries. Here again the actually treated water is about 50% of the capacity.

Conclusion: The overall satisfaction at the household level for quantity of water supplied is about 43% which is higher than the level of dissatisfaction which is 25%. A sizeable percentage falls in the category of Neutral, which is interpreted as those that are not satisfied with the expected frequency of supply by the water board, but are able to meet their requirements through alternative ways and thereby reducing the extent of dissatisfaction.

Reuse of treated water will be a major step that can reduce water shortage in the city, besides adopting and using the rain water harvesting system. Another reason for the shortage, it appears is the Unaccounted for Water (UFW) which is estimated around 37% (but may go up to 45%). BWSSB has to take suitable action to address this problem.

2. Quality of water

Chart 4:



Water samples from different service stations of the city are collected by BWSSB at the rate of 16 samples per month from the distribution network, consumer end, public taps, ground level reservoirs and over head tanks and sent to the water testing laboratory for testing potability. Here, water is tested for physical, chemical and bacteriological characteristics. The results are intimated to the concerned service stations, water supply divisions and sub-divisions for their information and for further remedial action. The quality of water supplied by BWSSB to the citizens is supposed to conform to IS/WHO standards. The Board claims that if any water sample is

not found to be satisfactory for potable use, immediate corrective action is taken by instructing the concerned for remedial measures. Water sampling is repeated at the same spot for further analysis till the water is fit for drinking purpose. Water sample reports for 2011 show that coliform content is high in summer months of April-June. Board officials say that most of water quality complaints come from east and west zones.

The data highlights that only 47% of the general and slum population have expressed satisfaction on the quality of water supplied by BWSSB.

Table 6: Satisfaction levels with the quality of water - commercial establishments

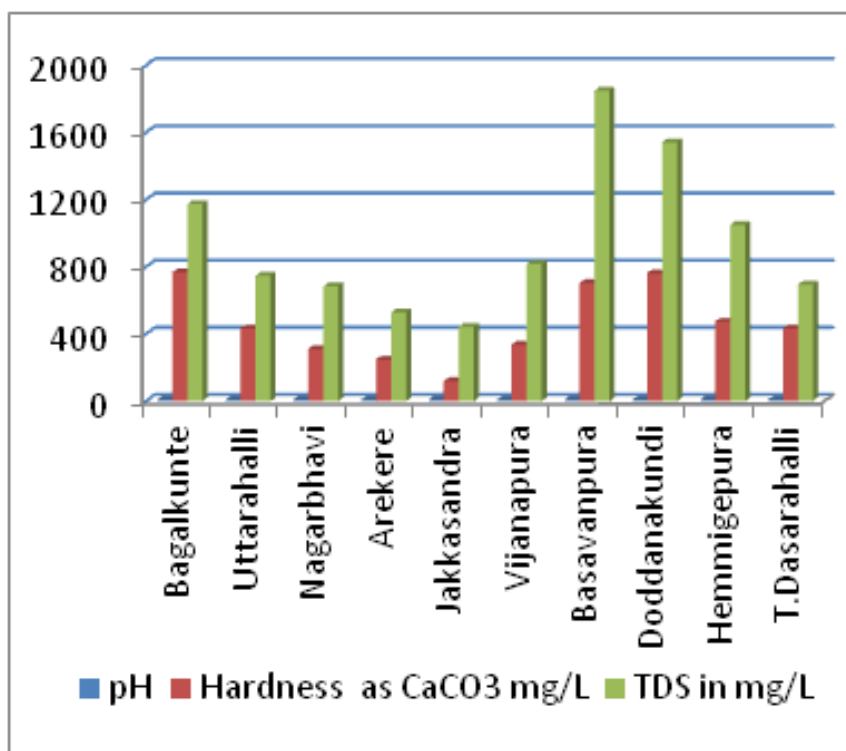
	Establishment type		
	Hospital	Hotel	Total
Highly satisfied	30.8%	0.0%	15.1%
Satisfied	65.4%	100.0%	83.0%
Neutral	0.0%	0.0%	0.0%
Dissatisfied	3.8%	0.0%	1.9%

Highly dissatisfied	0.0%	0.0%	0.0%
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As much as 98% among commercial establishments have expressed satisfaction regarding the quality of water however hotels are completely satisfied followed by hospitals.

CSD has monitored Groundwater quality at some of the locations in the city which is shown in the chart below:

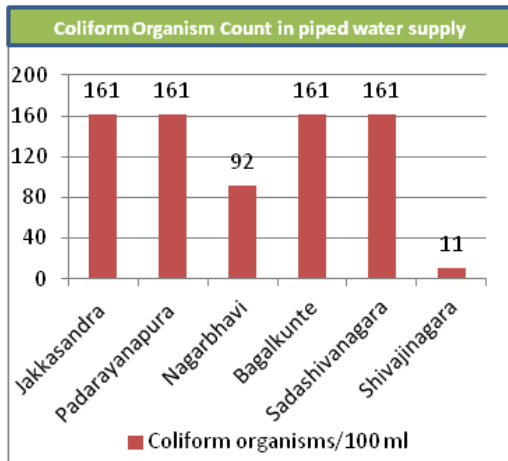
Chart 5:



A total of 19 samples of ground water covering all the zones was tested (for convenience 10 samples have been shown). Almost all ground water samples in added areas had high TDS. This is an indication that ground water contains inorganic and organic solids in excess of the prescribed standards (500mg/l) and therefore unfit for drinking purpose. It was particularly high in Dasarahalli and Mahadevpura zones, probably because of the agricultural and industrial runoffs.

2209 groundwater samples were analyzed by the Dept of Mines and Geology, covering the entire city area and analyzed (March 2011). Nitrate content is in excess of the permissible limit in 29% of the samples, iron in 10%, total hardness in 8.5% and fluoride in 0.6%. After accounting for samples in which more than one parameter was beyond permissible limits, 31% of the groundwater samples were not up to drinking water standards. According to Arghyam, the common contaminants in Bangalore's drinking water supply are bacteriological contaminants, nitrate and Total Dissolved Solids (TDS). Bacteria are usually found in water from Cauvery and borewell water, while nitrate is mainly found in borewell water. TDS too is found in borewell water supply.

Chart 6:



CSD tested 9 samples of tap water covering all the zones. 6 of the 9 samples were found to have high coliform content making the water unfit for drinking. Apart from added areas which have mixed sources of water supply, samples from west and east zone which receive water from BWSSB were also found to be contaminated. Only water from south was free from bacteriological content.

Citizens have complained of foul smell or chlorine smell in the water almost uniformly in all the zones, although majority has said that the appearance of water is clear. Only people from east zone have said that they find the water to be muddy. BWSSB must ascertain whether

this is due to lack of proper maintenance of pipelines or due to non-cleaning of storage tanks.

The survey also covered the extent of water purification systems use in the city. On expected lines, majority of people (67%) in added areas are using these systems. However, the use of water purification systems is only around 50% in east zone which has expressed the least satisfaction levels on the quality of water. While in west zone the satisfaction levels are 48%, majority of households have water purifiers (78%) and in south, satisfaction levels being high, the use of water purifiers is also less. The explanation for the trend in east zone could be either lack of awareness or economic reasons.

An interesting observation is that the levels of satisfaction in slum and non-slum areas regarding water quality is almost the same. In the case of non-slum areas those that have opted neutral are more than in slums indicating that the levels of dissatisfaction among slum population is higher than non-slum. This could be due to the fact that many households in non-slum areas have water purification methods and therefore are not wholly dissatisfied. A point of solace for BWSSB is that a higher percentage of people in the slums have said that the quality of water supplied by BWSSB has improved over the years.

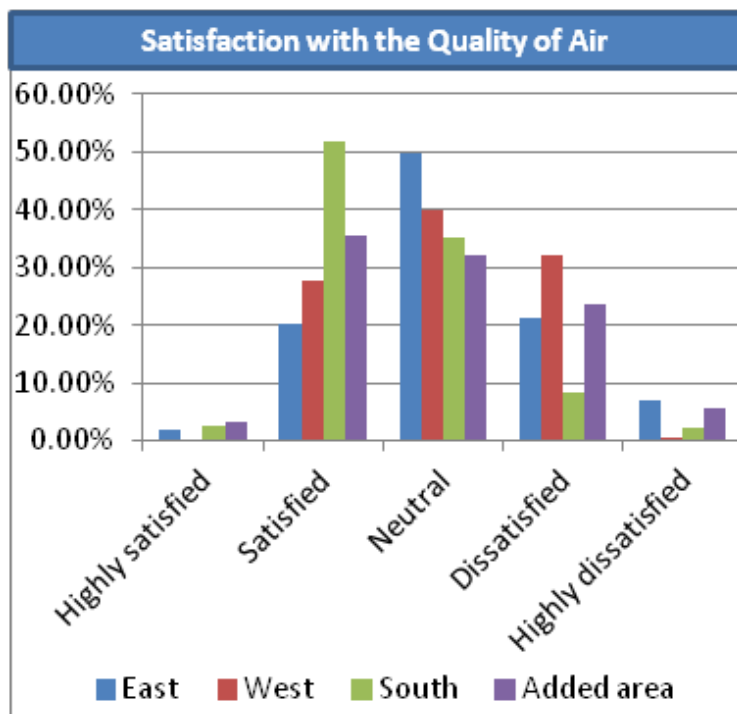
Conclusion: The satisfaction levels on water quality in the old BMP areas of east, west and south have reduced by almost 50% since 2005 (from 89% to 44%). One of the reasons that citizens have quoted is the uncontrolled growth of multistoried buildings and commercial complexes in residential areas. This has not only reduced the quantity of water available in the area but also affected the quality due to depleting water tables and increasing dependency on private water tankers. This is mainly calibrated by the exponential growth of IT sector industry in the east zone.

3. Air quality

Assessment of air quality was done for both - indoor and outdoor. Global studies have brought to light, the importance of indoor air quality given the fact that 80% of our time is spent indoors. Detailed exposure movement studies have been conducted to understand how the human body is subject to various pollutants that are found within our

homes, offices and even the long duration of time spent in travelling which exposes us to pollutants within a vehicle. Health impacts have been found to be more severe than limited exposure to outdoor pollution.

Chart 7:

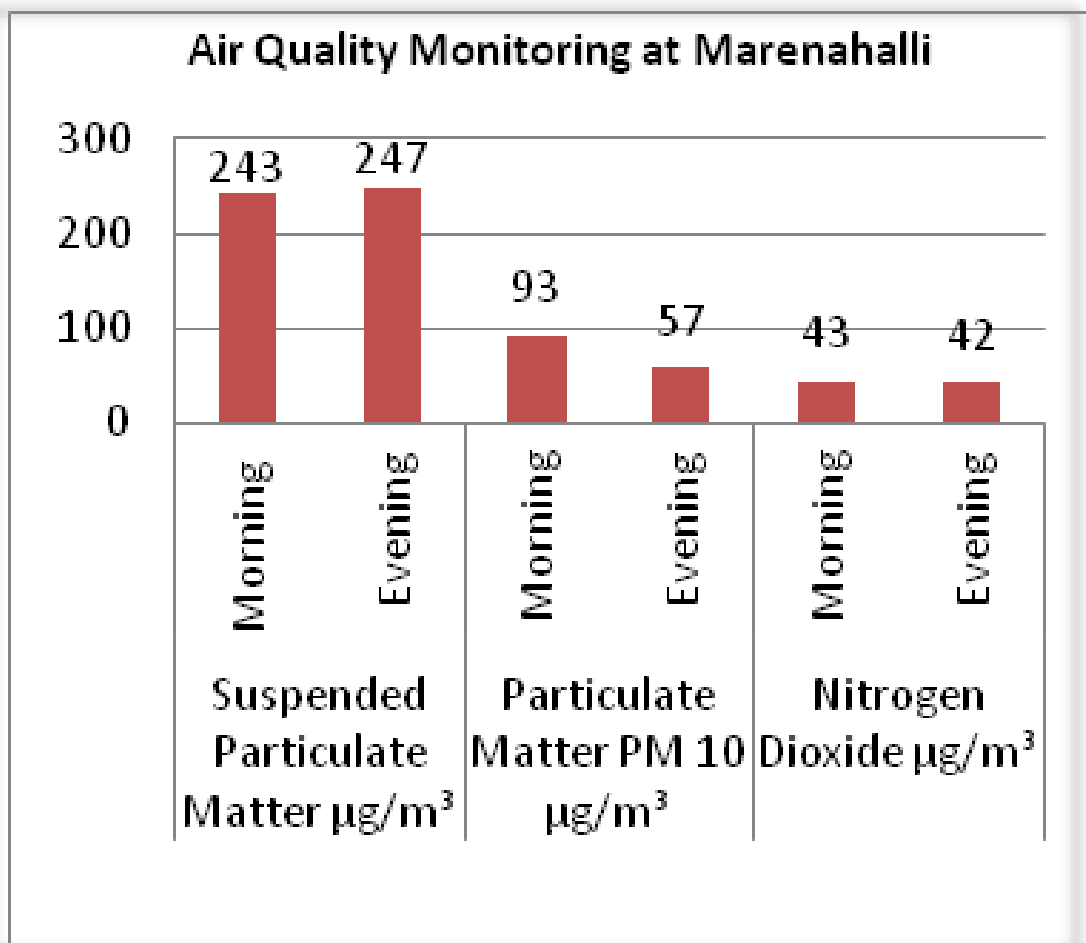


The citizen survey shows that since most people in non-slum areas use LPG for cooking don't have asbestos roofs and many don't own pets, and so they don't perceive indoor air quality as an issue. However, slum dwellers have complained of smoke from wood burning (used for cooking) to be a source of pollution. The people in added areas have said that the quality of air is affected due to heavy vehicular movement, while those in old BMP areas have attributed it to wind. Over 98% of the general population use LPG for cooking. But the fact that 87% of the slum population using LPG is a significant

indicator of their income levels. Only 3% of the slum dwellers have reported using wood for heating.

The satisfaction levels show that majority of people in the east are not satisfied with the quality of air in their surroundings while those in south are most satisfied. A large section of the people have opted for 'neutral' rating especially in east, west zone and added areas. This indicates that by and large the people in all areas except south are not satisfied with the air quality, but may not be individually affected by any health impact and so have not completely expressed their dissatisfaction. The percentage of people suffering from air borne diseases as recorded by the survey reveals about 35-37% least being in the south and highest being in added areas. This could also be attributed to the condition of roads, the proximity of commercial conglomerations and even indoor air pollution. CSD completed air monitoring in 23 residential locations across the 8 zones in the city. In all cases, the parameters of SO₂ and NO₂ were within the prescribed standards.

Chart 8:

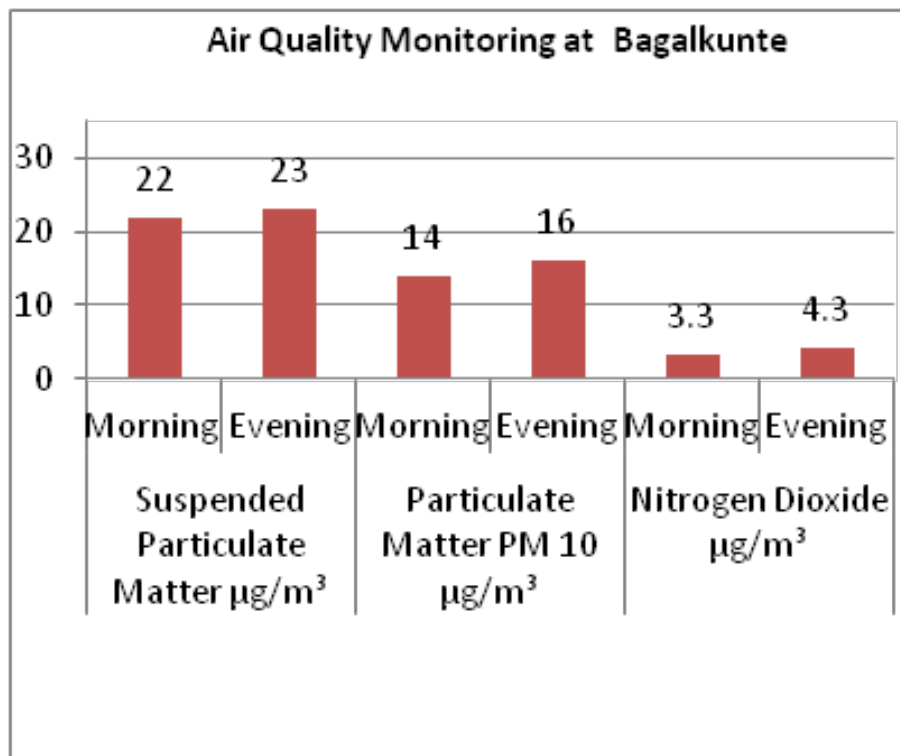


In some areas the particulate matter was marginally exceeding the standards. The highest recorded SPM level in any residential area was $247\mu\text{g}/\text{m}^3$ (Marenahalli) as against the standard of 200. These may be because of construction activities in the added areas.

The data indicates that 32% and 40% of the general and slum respondents have reported that air quality as satisfactory around their premises.

The air quality monitoring carried out during the survey period is indicated in the chart below. The results of ambient air quality monitoring in some of the selected residential areas (Marenahalli – highest, Bagalkunte – Lowest) are shown below in the chart; (Details of other locations are attached at annexure 2)

Chart 9:



The ambient air quality monitoring conducted at Marenahalli show highest Suspended Particulate Matter (SPM) both in the morning and evening which exceeds the National Ambient Air Quality Standards (NAAQS). The other parameters are within NAAQS.

Table 7: Satisfaction level on the quality of air - commercial establishments

	Establishment Type				
	Func Halls	Hosp	Hotel	Shops	Total
Highly satisfied	0.0%	0.0%	0.0%	0.0%	0.0%
Satisfied	22.7%	44.0%	40.7%	0.0%	26.7%
Neutral	9.1%	20.0%	18.5%	51.9%	25.7%
Dissatisfied	68.2%	36.0%	25.9%	48.1%	43.6%
Highly dissatisfied	0.0%	0.0%	14.8%	0.0%	4.0%

The survey reveals that only 26.7% are satisfied with the quality of air however 43.6% express dissatisfaction on the air quality around their establishments. Ambient air quality has also been measured at 15 hotspot locations in the city such as Anand Rao circle, Yeshwanthpur police station, Mekhri circle etc. The scenario seems grim with 8 of the 15 reporting high particulate matter of less than 10 micrograms. These particulate matter cause greater damage to health when compared to SPM because they can enter the respiratory tracts. The source of these emissions is mainly from road trans-

Chapter 3

port, quarrying and also construction activities. The main areas that show high levels are:

Old Madras Road - 542/549

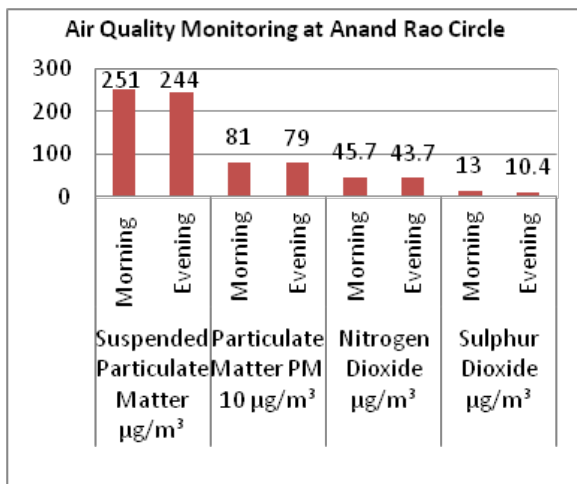
Russell Market - 297/280

Lingarajpuram - 292/297

Mysore Road - 282/318

Jayanagar 4th Block - 279/299

Chart 10



Note: first figure refers to morning recording and second to evening. All are in $\mu\text{g}/\text{m}^3$. CPCB standard is 100.

These figures are a clear indication that increased vehicular movement in these prime roads clubbed with construction of metro/flyover has caused high PM_{10} levels. They are further corroborated by measurements done by KSPCB which also indicate high PM_{10} levels in the city, although there is variation in the locations done by KSPCB. The duration of exposure by commuters at these places is important to know the potential health impacts. However, the most affected people are those working in commercial establishments located on these roads.

The survey done exclusively for commercial establishments, shows that majority have attributed bad air quality to street sweeping followed by vehicular movement. Shops and function halls have expressed dissatisfaction at the quality of air in their surroundings, while hospitals and hotels have shown better satisfaction levels. This can be due to the lack of adequate covered area in shops and function halls as compared to the latter.

73.1% of the respondents reported the quality of air has been worse than before. However the entire shops category has expressed that the quality of air is worse when compared to other establishments.

Conclusion: Most citizens including commercial establishments have clearly expressed

that air quality in the city has deteriorated compared to what it was in 2005(ERC-1). To substantiate these perception levels among citizens, comparisons were made with measurable data collected in 2005 and 2011. It shows that there has been significant increase in particulate matter levels especially in the hotspot zones. But the SO₂ and NO₂ levels have remained within limits. Although the ambient air quality in the residential areas appears to be well within the standards, the perception among residents that the quality of air is not good enough seems to emanate from the feeling that air quality in the city as whole is not satisfactory. In spite of the increase in vehicles, the SO₂ and NO₂ levels have remained lower than prescribed limits because of better fuel quality with less sulphur content and also adoption of Euro 2 norms. But it is important to note that NO₂ levels have raised significantly compared to 2005 which is due to increase in diesel vehicles on road.

It is well known that development works can lead to higher particulate matter emissions. But the government must install pollution control devices in areas where PM₁₀ is very high at least to prevent those spending long hours in establishments located on these roads from being affected.. Further, citizens also need to be educated on what measures to take to protect themselves from exposure to such types of pollutants.

4. Vehicular Traffic



Bangalore is notorious for its traffic congestion and long hours of commuting within the city. Looking back, perhaps Bangalore was never designed to carry the kind of traffic load which it experiences today, thanks to the unforeseen and uncontrolled economic growth mainly contributed by the private sector, especially IT and ITES. In a recent publication, Bangalore has been rated as one of the top destinations for employment and has the lowest unemployment rate in South India. This implies more jobs are being created by the day and more people are coming into the

city for employment. Apart from in-migration, what adds to the commuting problems, is that more people now than before can afford to own private vehicles because of higher incomes.

It is estimated that one in every four persons in Bangalore owns a private vehicle based on total two wheeler and light motor vehicle population (City Traffic Police website as on 30-6-2011) with more than 70% owning two wheelers. This is a fairly high rate given that the density of population has increased substantially and so has the total urban area which is 800sqkm which has in turn increased travelling distance and traffic load. As per the CSD survey, only about 12-14% commute by cars while about 43% travel by bus and 32% by two wheelers. In spite of the fact that a substantial number travel by public transport (which adds to more than 50% if car pooling and hired vehicles are considered).

What accounts for traffic congestion in the city? This can be attributed to some of the factors other than merely the growing number of vehicles which is often said to be the cause. Such factors are - lack of proper lane discipline especially from two wheelers and autorickshaws whose population is one of the highest in India; erratic way of parking due to inadequate parking space thereby reducing the width of available space on the

road leading to slow moving traffic; too many intersecting junctions causing gridlocks and lack of awareness by citizens on efficient routes to be taken to reach a destination.

It is interesting to note that 58.5% have opined that they would not continue to use own vehicles if public transport were to be improved. This is a positive trend. Public transport authorities must take note and improve the services. Zonal analysis reveals that majority of people in west zone commute maximum by two wheelers and are not willing to switch over to public transport, while all others have shown a favorable response. This correlates to the survey result indicating 55% dissatisfaction in public transport from people in west zone. But in east zone, though 70% have expressed dissatisfaction at the present public transport system, 53% have agreed to use public transport if the services improve. A possible explanation for this trend is that majority of people residing in west zone travel long distances for their workplace and therefore prefer to depend on their own vehicles rather than public transport. In both zones, majority of the people have said that lack of public transport facility is the reason for using their own vehicles. In the south and added areas speed and convenience is rated as a major reason to use own vehicles. The survey also reveals that noise pollution from vehicles has become an irritant for many people across all zones in the BMP areas.

Table 8: Emission from vehicles

	Zones			BMP Area	Added area	Total
	East	West	South			
Tolerable	40.3%	22.7%	59.1%	41.3%	35.8%	38.3%
Bad	43.5%	40.3%	28.2%	37.3%	47.4%	42.8%
Very bad	16.2%	37.0%	12.7%	21.4%	16.8%	18.9%

The survey data reveals that a majority (60%) have rated that the emission from vehicles are not tolerable.

Conclusion: The government has made efforts to improve traffic conditions in the city. The bus transport system is said to be one of the best in the country which has encouraged citizens to commute by bus. But when CSD survey statistics for 2005 and 2011 are considered, there has been no improvement in the percentage of people travelling by bus, infact there is a slight decline. It was 45% in 2005 and 43.5% in 2011. On the other hand, those commuting by cars has almost doubled from 6.7% in 2005 to 12% in 2011. Although the type and condition of buses has remarkably improved, the frequency and connectivity could still be an issue, which is why many citizens have preferred to travel by other modes including autos and car pooling. It is yet to be seen whether the introduction of metro rail has motivated people to move towards public transport.

Noise Pollution

The respondents' perception on the noise levels mainly due to vehicular traffic has also been surveyed. The important parameters are

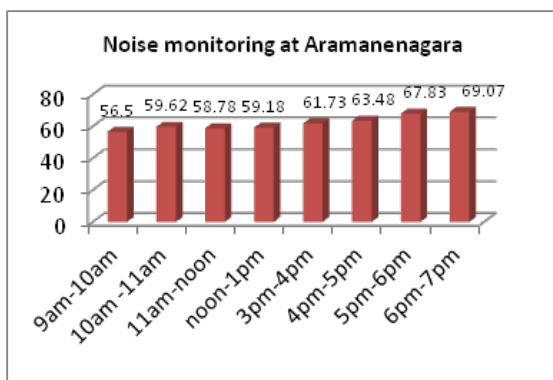
- Disturbance due to noise from vehicular traffic
- Current noise level compared to two years ago

Nearly 50% have reported disturbance due to vehicular traffic. 84% have reported noise to be beyond tolerable values. The current level of noise pollution compared to the situation two years ago is depicted in table below.

Table 9: Evaluation of noise pollution

	Zones					
	East	West	South	BMP Area	Added area	Total
Less than before	0.0%	0.0%	4.2%	1.6%	0.6%	1.1%
Same as before	26.9%	42.3%	32.1%	33.8%	15.8%	24.0%
More than before	73.1%	57.7%	63.7%	64.7%	83.6%	74.9%

A vast majority (nearly 75%) have reported that the current noise pollution in Bangalore is more than before. CSD has monitored noise levels at all the 8 zones covering 23 residential areas and 15 hotspots of Bangalore. The noise monitoring levels at Aramanegara (residential) is shown in the chart.

Chart 11:

The government has also undertaken a number of flyover constructions and road widening activities in the last couple of years. Did this really help? To a certain extent, but majority of the citizens continue to feel the effects of traffic congestion (55%). Urban experts have said that, new roads and lanes do provide additional mobility and transportation benefits, but increased road capacity provides less congestion relief. This is so because less congestion will attract drivers who previously used other routes and travelled at different times of the day.

One of the consequences of expanding urban area is that many residents and jobs have moved away from the core to the periphery. Simultaneously women workforce has substantially increased commuting patterns, especially when work places are located far away from their homes. It should also be mentioned that the number of drivers in household have increased coupled with easy finances to buy private vehicles, which is why the number of vehicles has grown so much. Therefore it is evident that traffic congestion is not merely a problem of vehicles or roads but is influenced by economic and social factors to a large extent. The citizen must accept his responsibility to reducing the traffic burden in the city, rather than only blaming the government.

5. Municipal Waste Disposal

CSD survey on waste collection and disposal from households reveals that while it is one of the issues that affects citizens across the city, there are zonal variations which need to be considered. East zone seems to have fared badly on all fronts. In all other zones the door to door collection is more than 75%, in east it is just 60%. Disposal of waste to road drains which is hardly 2% in west and south zones is alarmingly high at 15% in east and 7% in added areas. This could be one of the reasons why storm



water drains overflow during monsoon. Road side disposal is also high in east and added areas. Most of the people complained that due to irregular collection of garbage, they are forced to dispose it of in whatever place they find closest and convenient. It is interesting to note that the extent of door to door collection is nearly the same for slum and non-slum areas (71% and 76% respectively) and so is the case with disposal to road side drains (7.6% and 7.8%). This could mean that services within a particular area or zone are more or less uniformly provided without distinction between slum and non-slum areas and that people are forced to adopt alternative means of disposal irrespective of where they reside. The overall satisfaction levels of door to door collection is less than 50%. This is a cause for concern to the BBMP. The extent of dissatisfaction is highest in added areas (60%) followed by east 43%.

Table 10: Disposal methods of Municipal solid waste

	Zones			BMP Area	Added area	Total
	East	West	South			
Road side	22.0%	13.6%	8.2%	14.6%	14.8%	14.7%
Door to door collection	60.9%	82.9%	90.5%	77.9%	78.6%	78.3%
Vacant sites	5.1%	6.6%	3.9%	5.1%	8.0%	6.7%
Road side drains	15.1%	2.6%	1.3%	6.5%	7.1%	6.8%

The results regarding segregation of waste are slightly contradictory. While majority (>80%) of the people have responded that they don't segregate waste as dry and wet across all zones, people in west and south zones (>70%) have said they segregate recyclable waste. It may be a fact that people do segregate recyclable waste such as paper, plastic and bottles which is a common practice in all households; they may not segregate kitchen waste as dry and wet. Further the fact remains that one of the reasons for non-segregation by the households may be because there is no separate collection system for the dry and wet waste by the collecting mechanism. The survey explores that 12.2% of the economic class of people segregate the waste into wet and dry when compared to slum population of 22.8%.

It is interesting to note that none of the respondents have reported total satisfaction in the door-to-door collection. Only 15.7% have reported satisfaction with the door-to-door collection.

Table 11: Satisfaction level in door-to-door collection

	Zones			BMP Area	Added area	Total
	East	West	South			
Highly satisfied	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Satisfied	3.5%	48.4%	50.0%	28.5%	6.4%	15.7%
Neutral	40.4%	19.4%	27.8%	30.6%	13.6%	20.8%
Dissatisfied	43.9%	29.0%	16.7%	33.1%	60.0%	48.7%
Highly dissatisfied	12.3%	3.2%	5.6%	7.8%	20.0%	14.9%

27.7% and 14.3% of the general and slum population respectively have expressed satis-

faction regarding the door to door collection.

The survey reveals that 79.1% and 37.5% of the respondents respectively in the general and slum population reported regularity in door to door collection by BBMP.

Table 12: Satisfaction with the waste collection in commercial establishments

	Establishment Type					Total
	Func Halls	Hospital	Hotel	Shops	Total	
Highly satisfied	0.0%	29.6%	0.0%	0.0%	7.5%	0.0%
Satisfied	100.0%	70.4%	100.0%	100.0%	92.5%	15.7%
Neutral	0.0%	0.0%	0.0%	0.0%	0.0%	20.8%
Dissatisfied	0.0%	0.0%	0.0%	0.0%	0.0%	48.7%
Highly dissatisfied	0.0%	0.0%	0.0%	0.0%	0.0%	14.9%

The respondents have expressed greater satisfaction with regard to the waste collection.

Questions regarding the segregation and disposal of e-waste were asked separately to the respondents. Most of them were unaware of the need to segregate ewaste from the remaining waste. Only 28% said they segregate e-waste most of them from west and south zones where NGO activity on this issue is quite prominent. Disposal through buy back and organized collection centers is also very low (15%). It is however a positive indication that voluntary organizations are creating awareness about e-waste.

A closer examination of the statistics from the survey reveals the distinction in satisfaction levels between waste collection in general and door to door collection. In east and added areas this is most visible where just 3.5% have expressed satisfaction with door to door collection whereas 38% have said that waste collection is satisfactory. Similarly in added areas it is 4% and 46%. An informal discussion by the surveyors with the residents has revealed that BBMP collection in these areas is highly irregular, but there are private and local contractors who collect garbage only when the resident pays for it. So many people pay the collectors to get rid of their waste although the BBMP levies a solid waste cess on the people. This could be a reason for the difference in the satisfaction levels.

The results are completely converse when it comes to commercial establishments. All surveyed establishments have said that door to door collection of waste is 100%. This shows an improvement from 2005 data which was around 75%. The satisfaction levels with all establishments is 100% with hospitals expressing highly satisfied with collection systems. When it comes to segregation of waste commercial establishments seem to fare worse than households. Only in the case of hospitals they practice segregation to some extent(22%) because it is compulsory. This too is low considering that the law requires segregation of hazardous and bio-medical waste in commercial establishments.

Conclusion: Collection of waste from households is a plaguing issue for many areas in the city. The citizens do find ways to dispose of their garbage, but how healthy is it?

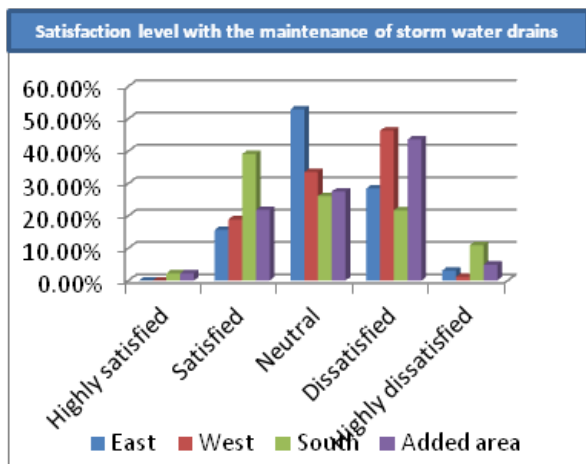
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If door to door collection works well in commercial establishments and some residential areas, why cant it be so for the rest of the city? The overall satisfaction levels in 2005 was around 88% which has reduced to 28.5% in 2011. What are the reasons for this drastic decline? The civic authorities have to further investigate to find answers to these questions. No doubt that segregation of waste has to be encouraged as it helps final disposal and makes it environmentally more sound. But residents have observed that even if they segregate the waste, the BBMP collectors again mix it up when loading into the trucks. Therefore the residents feel that it does not serve any purpose. NGOs in some parts especially south and west have been active in waste collection and segregation matters which are a positive sign. The MSW rules 2000 have made the civic authorities responsible for collection and management of waste. Proper planning and effective implementation are called for on the part of the authorities.

6. Drainage

The survey data reveals that hardly about 25% of the general population and just 2.9% of the slum population reported satisfaction level regarding the maintenance of storm water drains. However, 85.3% of the slum population is neutral on this issue. It is obvious that the maintenance of drains is far from satisfactory.

Chart 12



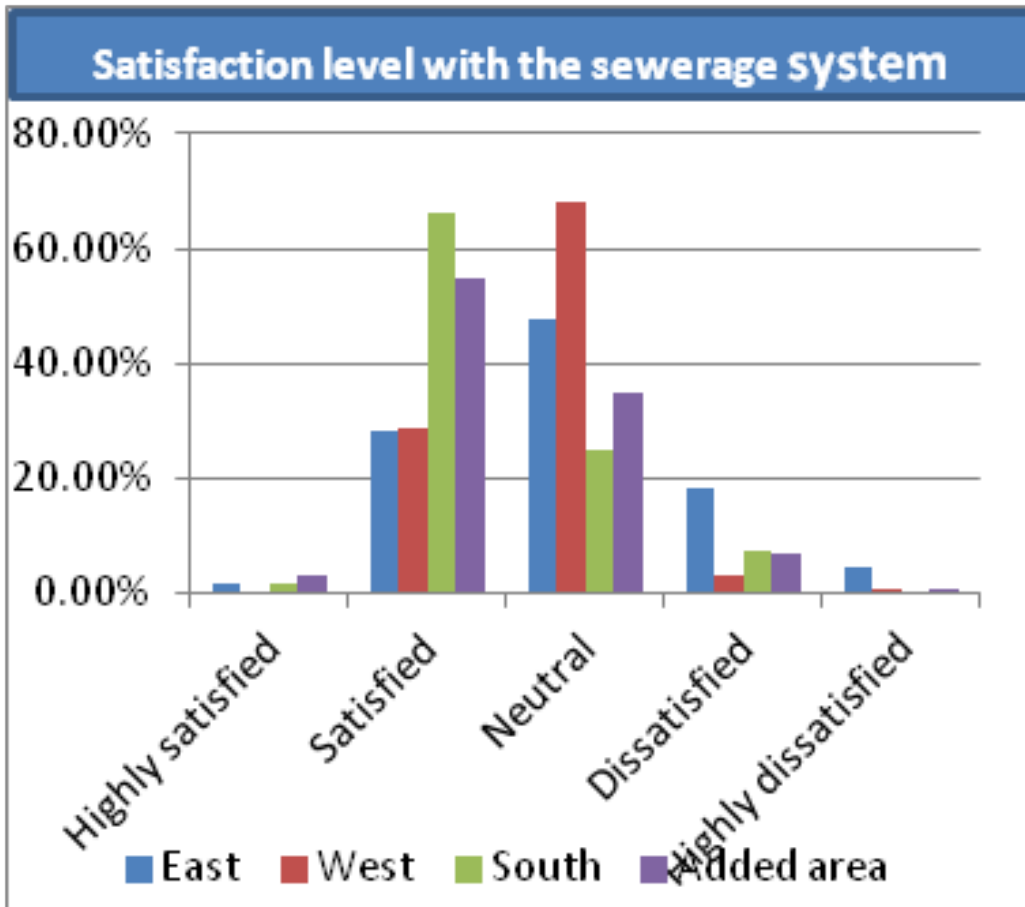
7. Waste water/sewage disposal

- Amongst the three BMP zones, South has a deficit of 20% sewer connections compared to hardly 3% in east and west. But satisfaction levels are highest in south with the functioning of sewerage system.
- Blockage of sewers has increased from 8% in 2005 to 22% in 2011.
- Slums are worst affected by blockages due to location, disposal of solid waste and uncovered manholes.
- Overall satisfaction levels remain low (<50%). The survey reveals that 40.5% and 27.5% of the general and slum respondents respectively have expressed satisfaction regarding the sewerage system.
- Citizens have attributed lack of response from civic authorities, blockages and improper maintenance and encroachment by commercial establishments on the drains as reasons for low satisfaction levels.

It must be mentioned that even in the BBMP area 3.4% in the east, 2.2% in the west, 20.2% in the south and 40.2% in the newly added areas still do not have sewerage connection.

8. Parks, playgrounds and tree cover

Chart 13:

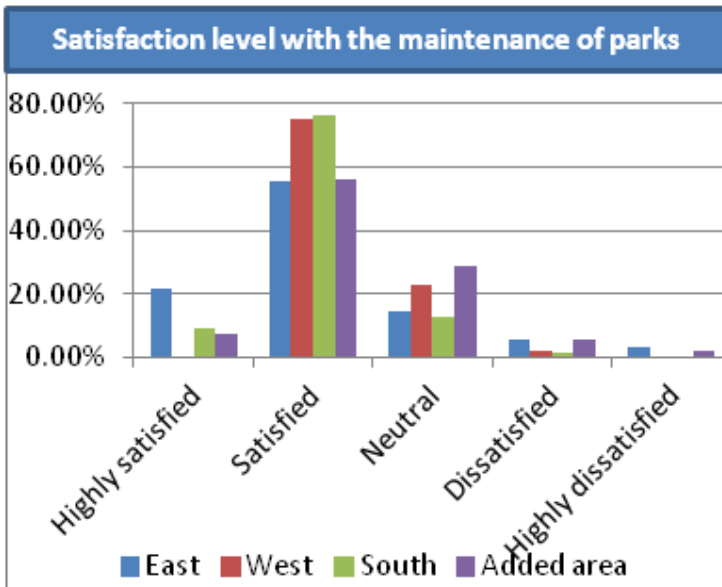


- Overall satisfaction level with regard to maintenance of parks in the city is fairly high. Credit must go to BBMP and BDA which maintain about 75% of the parks in Bangalore.
- It is disappointing to note that hardly 20% of the people visit parks regularly down from 30% in 2005. In the case of playgrounds it is worse, with only 6.3% using playground regularly as compared to 9% in 2005.

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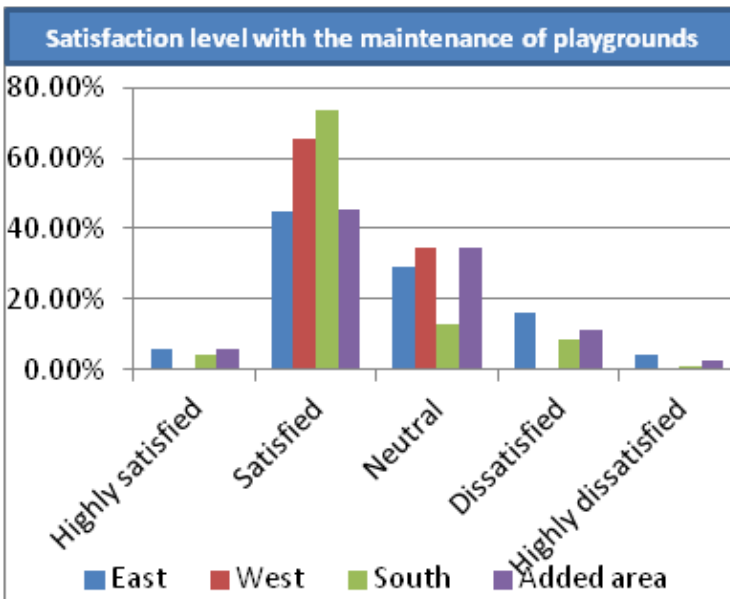
It is heartening to note that over 80% of the people including slum dwellers are satisfied about the maintenance of parks

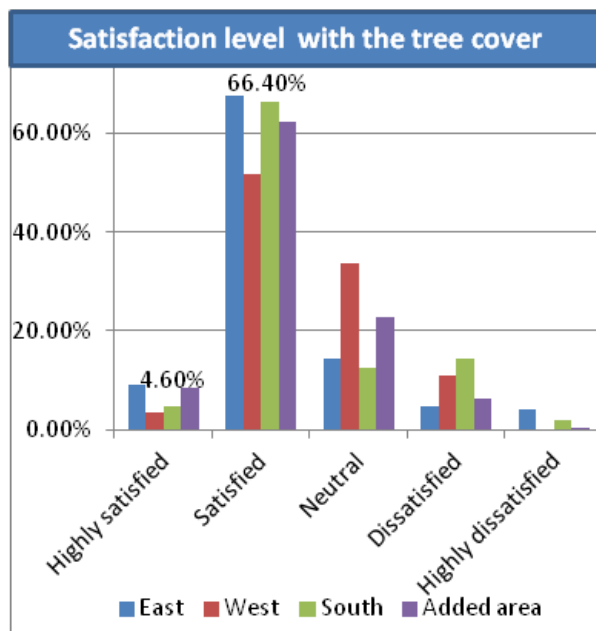
Chart 14:



In respect of playgrounds, about 65% and 97% of the general and slum respondents respectively have reported satisfaction.

Chart 15:



Tree cover**Chart 16**

- Majority of the people are happy with the extent of tree cover in their vicinity. Satisfaction levels for tree cover have significantly increased from 45% in 2005 to 69% in 2011.
- People in the west zone tend to perceive that trees could be the source of their allergic conditions, although the percentage of people suffering from allergic diseases in the west is lower than east and added areas.
- Amongst the commercial establishments, nearly 55% are satisfied with the tree cover. However, among the various types of establishments, hospitals have shown a great satisfaction level of 86%.

**9. Health impacts**

There is a close relationship between the environment and the health of the persons living in an area. There are specific ailments which can be attributed to air borne infection, water borne diseases, accumulation and non disposal of municipal waste in addition to stench and mal-odour.

Table 13: Air related diseases.

	Zones					Total
	East	West	South	BMP Area	Added area	

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Allergy (throat irritation, sneezing, skin rashes)	37.1%	34.5%	21.0%	30.6%	40.8%	36.1%
Asthma	18.1%	14.8%	6.6%	13.0%	14.5%	13.8%
Bronchitis	4.5%	3.1%	2.5%	3.4%	3.4%	3.4%
Nausea	2.8%	6.1%	0.4%	3.0%	4.4%	3.7%
None	47.0%	43.2%	74.5%	55.6%	42.4%	48.5%

More than one third of the people are suffering from allergies causing throat irritation, skin rashes and sneezing, although the incidence among slum dwellers is less. Asthma, believed to be a common ailment in Bangalore affects about 14% of the people. However a majority of the people do not suffer from any of these air related diseases. In the south zone, a vast majority (75%) are free from these ailments.

Table 14: Water borne diseases

	Zones			BMP Area	Added area	Total
	East	West	South			
Gastroenteritis	6.8%	9.2%	0.4%	5.2%	8.4%	6.9%
Dysentery	12.5%	7.0%	1.6%	7.0%	11.2%	9.2%
Diarrhea	6.2%	7.4%	5.8%	6.4%	8.5%	7.5%
Hepatitis	0.3%	3.9%	0.8%	1.6%	0.5%	1.0%
None	74.8%	72.5%	91.4%	80.0%	72.1%	75.8%

Vector borne diseases

Occurance of Vector borne diseases such as dengue, chickungunya and malaria has been reported by about 5% of the respondents. However, the occurrence rate in the added areas is comparatively more.

10. Community Participation

Strangely only 5.1% have reported that they are aware of the presence of Resident Welfare Associations working in their areas. However, these associations are active mostly in the areas of solid waste management.

Table 15: Frequency of inspection by the BBMP staff

	Zones			BMP Area	Added area	Total
	East	West	South			
Regularly	3.6%	0.0%	3.5%	2.2%	1.6%	1.9%
Occasionally	33.9%	30.2%	64.8%	40.8%	25.1%	32.2%
Not at all	62.5%	69.8%	31.7%	57.0%	73.3%	66.0%

Supervision over provision of civic services seems to be poor with 66% reporting no inspection at all by the corporation staff and 32% referring to occasional visits.

Table 16: Improvements carried out in the respective wards during the last two years.

	Zones			BMP Area	Added area	Total
	East	West	South			
Yes	26.3%	9.1%	45.7%	25.1%	21.2%	22.9%
No	73.7%	90.9%	54.3%	74.9%	78.8%	77.1%

It is significant to note that a vast majority (77%) have said that there have been no improvements in their wards during the last two years. Only 22% have reported improvements mostly concerning street lighting, display boards, renovated parks, common public taps and maintenance of roads.

Overall ranking on the environmental issues

A. Table 17: Households

Indicators	East	West	South	BBMP Area	Add-ed area	All zones
Quantity of water	2	3	3	2	1	1
Quality of water	1	2	4	1	2	2
Air quality	4	1	5	3	4	3
Traffic congestion	7	5	1	5	3	4
Pollution from vehicles(noise & smoke)	6	4	2	6	5	5
Waste collection	3	6	6	4	6	6
Lack of tree cover	5	8	8	7	8	7
Sewerage	10	9	7	9	7	8
Storm water / Side drains	9	7	10	8	9	9
Lack of open spaces (parks, play grounds etc)	8	11	11	10	10	10
Noise from industries and any other sources	11	10	12	11	11	11
Weeds / Dumping of waste in vacant sites	12	13	9	12	12	12
Industrial emissions or waste	13	12	13	13	13	13

B.Table 18: Commercial

Indicators/Rank	Function Halls	Hospitals	Hotels	Shops	All
Air quality	1	1	1	1	1
Pollution from vehicles(noise & smoke)	2	2	2	2	2
Traffic congestion	3	3	3	3	3
Quantity of Water	4	4	6	6	4
Quality of Water	5	5	5	5	5
Waste Collection	6	6	4	4	6
Noise from industries and any other sources	7	8	7	7	7
Storm water / Side drains	8	7	8	9	8
Lack of tree cover	9	9	9	8	9
Lack of open spaces (parks, play grounds etc.)	10	10	10	10	10
Sewerage	12	11	11	11	11
Industrial emissions or waste	11	12	12	12	12
Weeds / Dumping of waste in vacant sites	13	13	13	13	13

ERC 2005 AND ERC 2011 – A COMPARISON

A comparison of ERC 2005 and 2011 has been made to highlight the significant difference in perceptions by the citizens' on the identified environmental issues. This basically covers some of the broad parameters observed in both the ERCs in terms of percentile and the ranking.

Table 19: Quantity of Water

SL. No	Quantity of Water	Quantity of Water	
		ERC 2005	ERC 2011
1	Ranking	9th	1st
2	Sources of water supply		
	Household taps (BWSSB)	71%	88.5%
	Common public tap	3.7%	4.2%
	Groundwater by borewell	11.5%	20.9%

	Private tankers	3.2%	9.9%
3	Frequency of water supply		
	Alternate days	82.2%	65.8%
	Daily	8.5%	10.8%
4	Duration of water supply		
	< 3 hours	16%	31.6%
	4-6 hours	40%	54%
5	Implementation of RWH	0.7%	15.7%
6	Satisfaction levels	89.6%	44.7%

2. Table 20: Quality of Water

SL. No	Quality of Water	ERC 2005		ERC 2011	
1	Ranking	11th		2nd	
2	Water Quality test - Bacteriological				
	MPN/E.coli (total of 9 samples tested)	5 samples conforms to standards		3 samples conforms to standards	
3	Water filtration (aqua guards)	41%		57.8%	
4	Satisfaction levels	98%		53.9%	

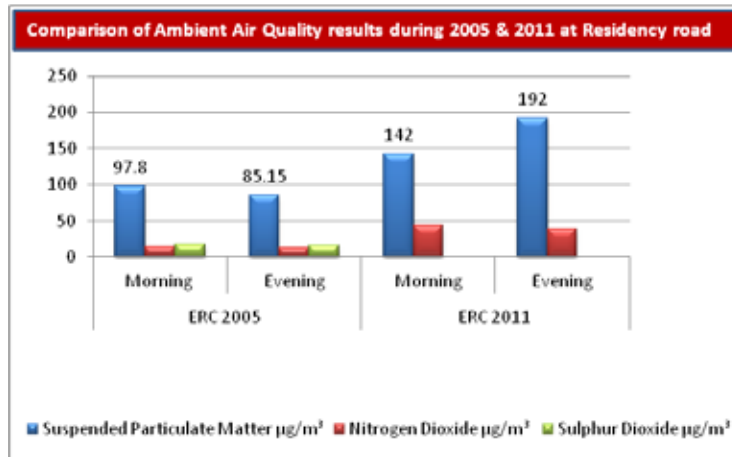
3. Table 21: Air Quality

SL. No	Air Quality	ERC 2005		ERC 2011	
1	Ranking	7th		3rd	
2	LPG as Fuel for cooking	93.1%		97.1%	
3	Fuel used for heating water				
	Electricity	40.2%		41.3%	
	LPG	18.7%		29.4%	
	kerosene	12.9%		13.5%	
	Wood	18.7%		5.2%	
4	Dust emanating from outside sources				
	Wind	94.6%		57.9%	
	Vehicular movement	93%		40%	

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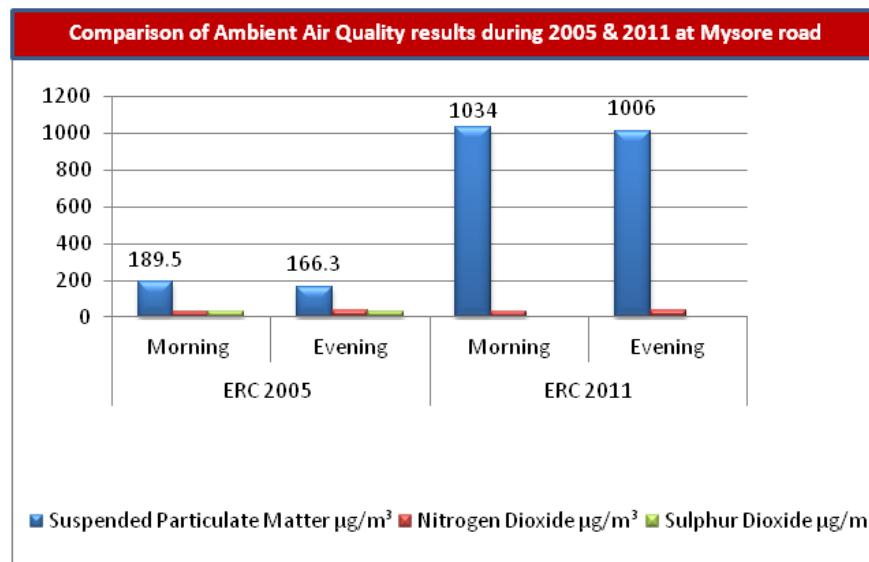
	Street sweeping	65.4%	27.2%
5	Tolerability levels	71.4%	50.4%

Chart 17:



The ambient air quality as monitored during ERC 2005 & 2011 in certain areas are shown below in the chart:

Chart 18:



The monitoring data obtained at Residency road show a two-fold rise in the SPM levels. However the Nitrogen dioxide levels have shot up when compared to 2005 data and the Sulphur dioxide levels are less than the detectable.

The data in the chart indicates that the Suspended Particulate Matter (SPM) levels have shown fivefold rise now when compared to the ERC 2005. This is due to the construction activities which is undergoing around this location. However the nitrogen dioxide

levels are well within the prescribed standards.

Chart 13:

4. Table 22: Traffic Congestion

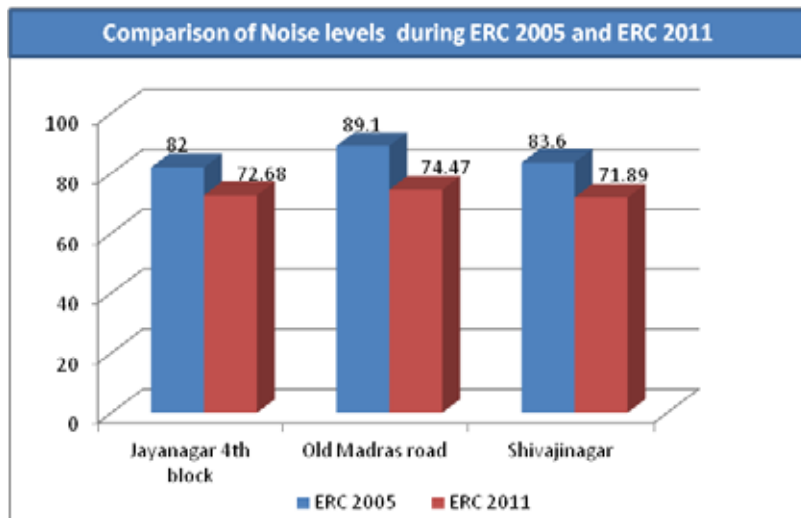
SL. No	Traffic Congestion	ERC 2005		ERC 2011	
1	Ranking	3rd		4th	
2	Mode of conveyance				
	Bus	45.5%		43%	
	2-wheeler	30.5%		33.6%	
	Car	6.7%		11.8%	
	Mix of car & 2-wheeler	1.8%		12.8%	
3	Traffic congestion in the vicinity	61.3%		53.1%	

There are some improvements in traffic congestion although the number of vehicles has risen continuously.

5. Table 23: Pollution from vehicles, commercial & industrial sources (noise, waste & smoke)

SL. No	Pollution from vehicles , commercial & industrial sources	ERC 2005		ERC 2011	
1	Ranking	1st		5th	
2	Noise generation from industrial source	43.2%		61.3%	
3	Waste generated from industrial source	4.9%		59.5%	
4	Air emissions	5.6%		30%	
5	Tolerability of noise	66.8%		28.2%	

Chart 19:



There is a steep increase in pollution levels.

6. Table 24: Waste collection

SL. No	Waste collection	ERC 2005	ERC 2011
1	Ranking	8th	6th
2	Disposal of household waste		
	Door to door collection	88%	77.9%
	Roadside	7.3%	14.6%
3	Segregation of household waste	2.6%	14.1%
4	Satisfaction with door to door collection	88%	28.5%

Satisfaction levels in respect of door to door collection have suffered a steep decline.

7. Table 25: Lack of tree cover

SL. No	Tree cover	ERC 2005	ERC 2011
1	Ranking	2nd	7th
2	Satisfaction levels with the tree cover	45%	66.9%

It shows a positive trend. A good majority of the people are satisfied with tree cover.

8. Table 26: Sewerage

SL. No	Sewerage	ERC 2005		ERC 2011	
1	Ranking	10th		8th	
2	Sewerage connections	97%		91.2%	
3	Incidence of blockages	8%		22.1%	
4	Presence of open big storm water drain	29%		26%	
5	Smell emanating from these open drains	20%		54.4%	
6	Satisfaction with the sewerage system	92.9%		41.6%	

A contrasting picture about the sewerage system with respect to satisfaction level is declining.

9. Table 27: Storm water/side drains

SL. No	Storm water drains	ERC 2005		ERC 2011	
1	Ranking	5th		9th	
2	Existence of side drains front of the house	84%		60.1%	
3	Drains covered	51.5%		43.5%	
4	Cleaning of drains done periodically	40%		28.2%	
5	Cases of rain water entering the house	3.6%		7.1%	
6	Rain water flooding the neighborhood	7.2%		15.4%	
6	Satisfaction with the maintenance of storm water drains	61.2%		22.9%	

The maintenance of storm water drains has clearly suffered with repeatedly malfunctioning during heavy monsoon resulting in severe flooding of the area including the storm water entering into the households.

10. Table 28: Lack of open spaces (parks, & playgrounds)

SL. No	Open spaces (parks & playgrounds)	ERC 2005		ERC 2011	
	Parks				
1	Ranking	4th		10th	
2	Distance to the nearest park				
	>100m	31.6%		66.1%	
	<100m	7.4%		33.9%	
3	Frequency of the visit to park				
	Regular	30%		19.9%	
	Occasional	23%		40%	

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4	Satisfaction with the maintenance of parks	97.5%	82.2%
	Playgrounds		
5	Distance to the nearest playground		
	>100m	85%	75.2%
	<100m	4.4%	24.8%
6	Frequency of using playgrounds		
	Regular	9%	8.3%
	Occasional	10%	32.5%

11. Table 29: Health Impacts

SL. No	Environment related health impacts		
	Air related disorders	ERC 2005	ERC 2011
1	Allergy	20.8%	30.6%
2	Asthma	7%	13%
3	Bronchitis	2.5%	3.4%

The incidence of air related disorders has gone up.

12. Table 30: Community Participation

SL. No	Community participation		
		ERC 2005	ERC 2011
1	Awareness by private groups/organization		
	Yes	5.1%	5.1%
	No	69.8%	44.5%
	Don't know	25.1%	50.5%
2	Frequency of visit by corporation staff		
	Regularly	3.3%	1.9%
	Occasionally	43.2%	32.2%
	Not at all	53.5%	66%

Awareness about residential organizations is rather low. The frequency of supervision by corporation staff has declined.



Chapter 4

Conclusions & Suggestions



CONCLUSIONS AND RECOMMENDATIONS

The ERC 2011 has been a great revelation of the citizens' perceptions on environment. By no means can the citizen be underrated for either the awareness levels or knowledge of environmental issues. This is amply demonstrated by the consistency in the answers provided to the questions on key issues. The following is a brief summary of the citizens' perceptions on these issues as well as the efforts of government agencies to address them. When asked about the quality of water as an issue in the first segment of the questionnaire, an overwhelming percentage underlined its importance. Subsequently, when asked to rate on scale of 1 to 10, activities that should be accorded high priority by government, over 80% rated this issue as high priority. Finally, in the overall ranking of environmental issues, quality of water was ranked second. It shows that water quality has emerged as the top issue that citizens perceive requiring immediate attention.

- 1. Water Quality** Dependence on private water suppliers and ground water has increased over the years due to the growing demand. Reports from Mines dept, BWSSB and CSD indicate that there are high levels of water contamination in many areas combined with excess chlorine in tap water which makes it an important issue. Little do citizens realize that water supplied through private tankers is also mostly drawn from borewells. Therefore ground water depletion and quality have become significant enough requiring legislations on ground water regulation which was passed recently by the Government of Karnataka. A lot depends on how effectively the law will be implemented.
- 2. Water Adequacy** A closely linked issue is that of adequate water supply to all people, which the citizens have also ranked as a top priority issue. The overall satisfaction level for quantity of water supplied is below 50% demanding immediate attention by the government. Residents in added areas and even in BMP zones are experiencing water shortages. Even where BWSSB is the major supplier, the frequency is remarkably low, with only about 10% of the population getting water all 7 days a week and most not having it for more than 3 days a week. Surprisingly, the commercial establishments do not consider water supply as a major issue and are satisfied with their demand being met. While commercial establishments are sinking huge bore wells and are willing to pay more for buying water, the ordinary citizen is deprived of adequate water supply. This explains the reason behind the contradictory satisfaction levels. It is worth noting that a sizeable number of households in the west and added areas yet to be covered by BWSSB connections. Exploring alternate sources of water supply to meet the future demands has become imperative. Rightly BWSSB is currently focusing its effort on making rain water harvesting compulsory in all new houses. This effort is also useful in recharging ground water levels provided it is done in a proper manner. There is a tendency amongst people to install the system only to satisfy the legal requirement, without understanding its necessity and utility value. The authorities have to regularly visit houses, inspect and educate the people. Only then RWH will be a meaningful exercise.
- 3. Air quality** and vehicular emissions are interrelated especially in metros like Bangalore. While a vast majority believe that motor vehicles are the cause for air pollution in their area. Measurements made by CSD show that vehicular emissions

in residential areas are within limits. In the case of commercial establishments, however most of them have rated air quality and vehicular emissions as a top priority environmental issue. The satisfaction levels in this segment are hardly 25%. This again is corroborated by measurements that show high levels of particulate matter and NO_x as well. In addition most of the establishments have attributed the dust from street sweeping as a major cause for pollution.



4. **Indoor Air Quality** Perhaps one issue that has not been considered seriously by the citizen is indoor air quality. Carbon monoxide(CO) emissions due to improper combustion of diesel and petrol from vehicles such as autos, tempos and two wheelers cause pollution. When CO gas enters inside cars it remains for a long time causing adverse health effects. Dust entering houses can also be dangerous as it could settle down on objects such as carpets, books, clothes etc and continuous dust settlements lead to dust mites which are known to cause severe allergies and bronchial infections. People living in slums are most vulnerable to air pollution as they are exposed to both indoor and outdoor sources for long durations. Government must provide periodical health check up to them to prevent diseases related to pollution, since many of them can't afford to go to private hospitals and they may not be aware of the impacts of air pollution.
5. **Waste collection** is another issue that bothers the citizens a lot. It is the only issue that has received the highest level of dissatisfaction in the survey (62%). Although the citizens have ranked it as the 6th most important environmental issue at the city level, they have strong reservations on the quality of service provided by the civ-

ic authorities regarding waste collection. Many residents, particularly in low income areas complain that they can't afford to pay the private collectors everyday to lift the garbage. Civic authorities have to enforce strict collection systems in all areas, as it is a legal obligation for them to do so.

6. There is a drastic shift in the perceptions of citizens when it comes to **ranking environmental issues in 2011 as compared to 2005**. Water, both quantity and quality were almost at the bottom in 2005, are now the number 1 and 2 issues for the citizens. Pollution from vehicles and lack of tree cover which were the top two issues in 2005 are now placed at 5 and 7. **What could be the possible reasons for the change in perceptions?** Could it be over emphasis on the development mantra on the cost of the environment?

The biggest negative effect has been the stress on our natural resources and that is clearly reflected in the citizens ranking water as the top priority. Ever expanding commercial complexes, multistoried flats and IT parks have created stress on the resources which can't cope with the demand. Both in terms of quantity and quality the resources are fast dwindling. The trends in satisfaction levels for most of the issues surveyed shows less than 50% of the people are satisfied with the quality of environment they are living be it water, waste disposal, sewerage, storm water drains, quality of air or traffic. On the other hand, the growth of the metropolitan area has been phenomenal with 98 new wards included as part of BBMP in the last five years. The area has expanded from 225 Sq.km to 800 Sq.km and the population has grown from 5.6 million in 2001 to 8.5 million in 2011, one of the fastest growth rates for an urban metro. The number of private vehicles has doubled. The consumption of water has increased. The built area has gone up for both domestic and commercial area by about 8%. The migrant population to Bangalore has also increased. Has government taken the required initiatives to handle this growth?

7. Various government agencies responsible for provision of services claim that measures have been taken to improve the services to the citizen. A study conducted by IISc (Indian Institute of Science) has highlighted the loss of city's green cover over the last 5 years from 2002-07 at about 25%. However the forest department statistics shows that 9 lakh trees have been planted since 2006. Strike out there has been increase 12%. The SO_x and NO_x levels have come down compared to 2005, inspite of the increase in the volume of vehicles indicating that better fuel efficient technology vehicles are in the market. The Traffic Police as per their statistics show increased number of fines and cases for traffic offences. B-TRAC 2010 is a first of its kind project launched by Traffic dept to address congestion and safety issues using latest technology. Conversion of a large number of autos from diesel to LPG in the last 3-4 years has substantially reduced CO emissions which are presently within limits.

BBMP has taken up road widening and construction of flyovers which they say has helped commuting to be faster and eased congestion. BWSSB has increased its network of connections from about 83% to 92% in the last five years. Storm water drains are now covered to an extent of 869 Sq.km which is not worthy. BWSSB is planning to put up separate trunk pipeline to carry more quantity of sewerage so that it does not block the storm water drains. CCTVs have been installed by BBMP at disposal sites for easier monitoring. BBMP has facilitated establishments of solid

waste processing units and set up dry waste collection centers. BMTC has launched eco-friendly buses that use in part bio-diesel to run their buses. It has deployed automatic washing system for buses which uses 100 Lts/bus as compared to 300 Lts/bus.



8. Going by the information gathered from the different agencies, one cannot deny their efforts in improving the services for a better environment. But there still persists a wide divergence between citizen perceptions and government action. Is the government not doing enough to meet the satisfaction levels of the common man? Would development itself remain meaningful if the citizen is dissatisfied with the quality of environment? Sustainable development has often been spoken of at international and national levels as a solution to many of the environmental and economic problems the society faces today. But the action has to take place at the local level. To implement sustainable development solutions, the two fundamental principles of 'equity' and 'common but differentiated responsibility' have to be adopted in our planning and policies.

The problems relating to urban environment has now become more localized. Hence zonal analysis of citizens' perceptions on environment will have to be considered along with the overall perceptions. Civic agencies may have to now focus greater attention on zonal issues before development of an integrated city plan. If one considers the large variations in the satisfaction levels between east and south zone on the issues of water, there appears to be the problem of equitable distribution of resources between various zones of the city. This explanation may apply to other resources as well and can be the cause for much of the dissatisfaction levels that persist in the different zones.

The principle of common but differentiated responsibility is based on the premise

that, while the responsibility to protect environment and conserve resources is common to all people but the extent to which the responsibility can be shared will differ between different sections of society. It is therefore important that any such issues on inequity should be addressed by placing greater responsibility on those sections of the society that are economically better off than the others. In short, it would mean that privileged sections must be willing to pay more for the resources and services they utilize and also move towards a sustainable consumption pattern which in turn will provide the less privileged sections with better access to the resources at reasonable cost. This can be achieved through appropriate policy interventions by the government and a more positivistic regulatory frame work.

Suggestions

Government must give due importance to environmental governance. ERC 2005 had suggested preparation of an Environmental Management Action Plan for Bangalore. So far, no such Plan has been prepared. As improving the environment of a city covers several aspects and involves several organizations as well as the people, a coordinated approach is imperative. The need for an integrated Action Plan with a time frame for implementation.

Amongst others, the Plan must focus on the following critical issues.

Water

- Step up Rain Water Harvesting implementation as it helps to augment water supply and recharge the natural aquifer which gradually improves the groundwater table.
- Stringent action to be taken against the untreated effluent discharges into the water bodies and prevent encroachment on lakes.
- Promote use of recycled water in all commercial and residential complexes.
- Reduce water losses including Unaccounted For Water (UFW) within a targeted time frame.

Air

- Implement decision to Phase out vehicles more than 15 years old.
- Increase penalty on the vehicles which fail to conform the emission standards.
- Plant native species of trees like Pongamia pinnata, Cassia Samaea, Azaridacta indica, Ficus spp., Gravelia robusta etc, which act as good air pollutant absorbers.
- KSPCB should increase the number of automated monitoring stations, especially covering all the hotspot areas of Bangalore to have a check on air and noise pollution on a regular basis.
- Civic authorities must consider night sweeping as a way to mitigate air pollution in commercial areas.

Waste

- Source segregation - the segregation of waste is to be made mandatory starting from the households and continued even during collection, transportation and final disposal by the concerned agencies.
- Decentralized waste treatment facilities – the sustainability of waste treatment options can be achieved with adequate Municipal and resident welfare group support, thereby avoiding carting of waste to far off dump sites. To name a few areas i.e., Dollars Colony, HSR layout in Bangalore already have a decentralized waste system in place.
- Waste to energy (WtE) plants need to be encouraged as the burden on landfill would be less.
- Creation of specific facilities for disposal of household e-Waste, and hazardous waste like expiry date medicines, detergents, phenyl containers and paints.

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