बहुजन हिताय बहुजन सुखाय

कोल्हापूर महानगरपालिका

स्थापना: १२-१०-१८५४ रूपांतर: १५-१२-१९७२

## Kolhapur Municipal Corporation

# ENVIRONMENTAL STATUS REPORT 2015-16

Final Report

# Environmental Status Report of Kolhapur City 2015-16

The Energy and Resources Institute

...towards global sustainable development

## For more information

T E R I

Western Regional Centre, Mumbai

318, Raheja Arcade

Sector-11, CBD-Belapur

Navi Mumbai- 400 614, India

**Tel:** +91 Mumbai (0)22 27580021 or 40241615

सत्यमेव जयते
**P. SIVA SANKAR** I.A.S.
Commissioner

**Kolhapur Municipal Corporation**
Post Box No. 33, Kolhapur - 416 002. (Maharashtra)

Ph.: (O) 0231 - 2546171
(Resi.) : 0231 - 2653171
Fax : 91 - 0231 - 2541830
E-mail : commissionerkmc@rediffmail.com
Web : www.kolhapurcorporation.gov.in

## Preface

The rapid urbanization and increasing demand for natural resources leads to exploitation and degradation of the environment. Thus in order to maintain the status of environment and to mitigate the pressures, detailed study with reference to different environmental components is very essential. Environmental Status report gives detail study of the city's environmental concerns, growth factors and its impacts, overall environmental pollution and degradation and possible mitigation measures.As per the Maharashtra Municipal Corporation Act, 1949, under section 67 A, it is mandatory for A class ULB's to document an annual ESR (Environmental Status Report). Towards this, the Kolhapur Municipal Corporation has been documenting the ESR for past few years now.

This year, after successful completion of tender formalities, the work was allotted to TERI (The Energy and Resource Institute) for preparing the report based on secondary information collected from different government offices, published reports, research studies and so on using D-P-S-I-R framework, endorsed by MPCB (Maharashtra Pollution Control Board) guidelines 2009. The report presents the detailed analysis of environmental and resource management issues, the response taken and enlists the recommendations to further manage the resources effectively. This report has identified some areas where KMC needs to take action especially for reducing the air pollution in terms of NOx and PM (Particulate Matter), water pollution in the *Nallahs*, conservation of decentralized resources like borewells, improve the water supply to the city, and so on.

I am sure this report will be of benefit not only to KMC but also help other stakeholders and citizens for taking decisions, allocating budgetary provisions and take necessary mitigation measures to help keep our environment pollution free.

P. Siva Sankar (I.A.S.)
Municipal Commissioner
Kolhapur Municipal Corporation

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# 1 Executive Summary

Kolhapur city is one of the historic and culturally significant cities of Maharashtra, India lying along the bank of the river Panchganga. As per Census report 2011, the population of Kolhapur municipal limits was about 5.5 Lakhs[1] and between 2001 and 2011 the population in the city increased by more than 13% (64 thousand). Today, Kolhapur ranks top as one of the key agricultural producers in Maharashtra and is known for its produce of sugar, chilli powder, tobacco, and jaggery[2].

Kolhapur is industrially quite developed with many industrial zones in and around the city. The MIDC areas of Shirol and Gokul Shirgaon also lie very close to the city. These MIDC areas are known to house around 300 foundries, which account to about 7–8% (6 Lakh tonnes) of India's total casting production. There are about 20 sugar factories in Kolhapur district out of which Chhatrapati Rajaram Sugar Factory and Kolhapur Sugar mill (Distillery) are well within the city limits of Kolhapur city. Apart from industries, there are various pilgrimage and tourist spots in and around the city like the famous and historic *Mahalaxmi* temple, Radhanagri wildlife Sanctuary, Panhala Hill station and so on making Kolhapur one of the most sought after tourist destinations of Maharashtra.

This not only provides ample of opportunities for employment but also boosts the economy of the region which is evident from the fact that the in the past five years, between 2009 and 2014, the GDDP (Gross District Domestic Product) and the NDDP (Net District Domestic Product) have registered growth by more than 75% to reach more than 54 thousand crores and 49 thousand crores respectively.

All the above factors, population and industrial growth, coupled together are highly resource and service demanding thus exerting pressure and creating impact on natural resources like water, land and air. This collectively has been termed as the 'Driving Forces' of the city. The pressure and impacts of these driving forces on the resources has been analysed and assessed in this report. The following sections discuss the status and the highlights of sections elaborated later in this report.

### 1.1.1 Air & Noise Pollution

In Kolhapur city, MPCB (Maharashtra Pollution Control Board) has identified three air monitoring locations namely at Dabholkar corner (Ruikar Trust), Mahadwar Road and Shivaji University Campus, under NAMP (National Air Monitoring Program). These sites were established in January 2005 and the daily operation, analysis and maintenance of these sites is managed by Shivaji University, Kolhapur. $SO_2$ (Sulphur Dioxide), NOx (Oxides of Nitrogen) $PM_{10}$ (Particulate Matter), are monitored twice a week throughout the year.

As for the air quality, the Kolhapur city is relatively safe from $SO_2$ pollution from the past 10 years as the concentrations of $SO_2$ has been less than the annual standard (50 $\mu g/m^3$) prescribed by CPCB (Central Pollution Control Board). However, it is the increasing concentrations of NOx and $PM_{10}$ which are a cause of concern in Kolhapur city.

The annual NOx concentrations have been increasing steadily over the past 8 years. In the year 2015–16 the annual NOx concentrations at Mahadwar Road (40 µg/m³), Ruikar Trust (51 µg/m³) and Shivaji University (23 µg/m³) have increased by 2.6, 2.8 and 5.5 times respectively as compared to concentrations recorded in 2009–10 at these locations. Similarly, the $PM_{10}$ concentrations in Kolahapur city has been relatively higher at two locations, Mahadwar road (84 µg/m³) and Ruikar trust (160 µg/m³), and violating the annual standards of (60 µg/m³) by almost 2 to 2.5 times respectively, set for $PM_{10}$ by CPCB. The area represented by the NAMP site at Shivaji University has been a border line category and recorded $PM_{10}$ concentrations between 60 to 63 µg/m³ for the past five years.

In terms of the AQI (Air Quality Index) the air quality in Kolhapur has been in between 'Moderate' and 'Satisfactory' category for majority of the time in the year 2015–16 (Figure No. 1). Hence based on the occurrence of various categories of AQI one may conclude that the air quality in Kolhapur may cause *'Breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adult'* or may cause *'Minor breathing discomfort to sensitive people'*. Almost 286 and 95 cases were being reported for bronchitis and asthma respectively in the past five years from Savitribai Phule hospital itself. In the year 2015–16, about 43 and 19 confirmed cases of bronchitis and asthma were recorded at this hospital alone.

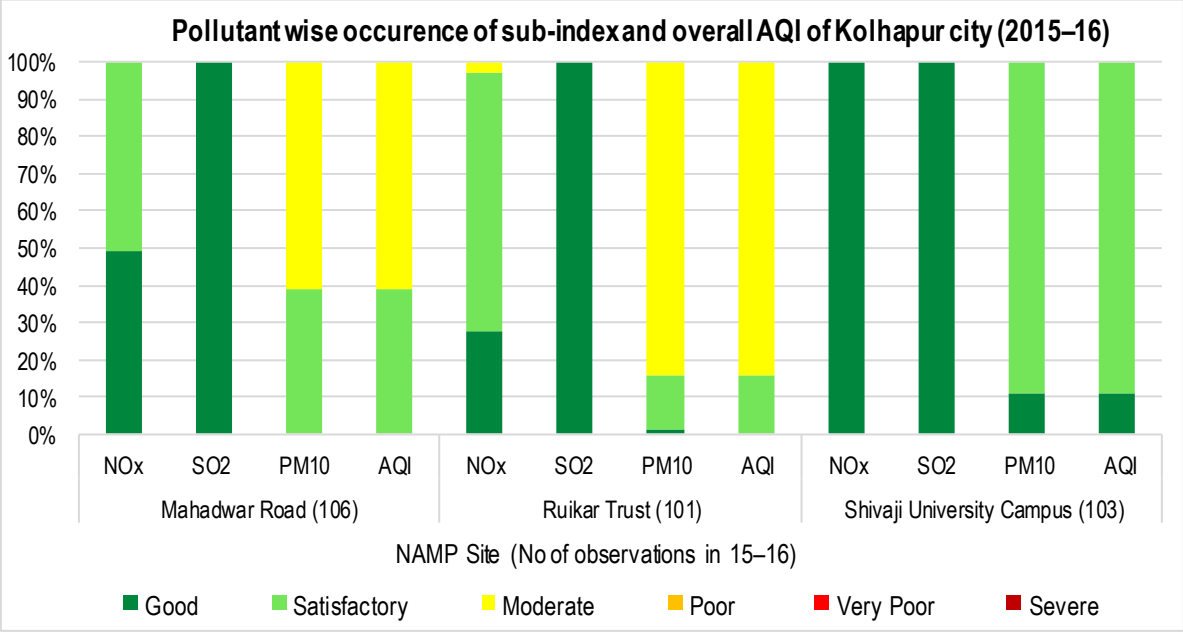



**Figure No. 1: Pollutant wise sub-index and overall AQI of Kolhapur city (2015–16)**
**Source: Maharashtra Pollution Control Board and AQI calculated by TERI**

The primary source of NOx and PM pollution may be attributed to vehicular emissions. The locations Ruikar trust and Mahadwar road are highly congested and traffic prone leading to high NOx concentrations. Also addition of new fleet of vehicles has been the highest in the year 2015–16 in which more than 18 thousand new vehicles were registered in Karvir Taluka taking the tally of total on road vehicles to more than 1.5 lakhs, which has doubled in just 5 years between 2009–10 and 2015–16. The overall consumption of Petrol and Diesel from the fueling station in the city has also increased by more than 18% in 2015–16 (30 thousand Kl) as compared

to 2014–15 (25 thousand Kl). Apart from vehicular emissions, the other sources of pollution identified in the city of Kolhapur include industrial activities in and around Kolhapur city, stone quarries, construction activates, road dust re-suspension are a few of the factors which induce air pollution for dust and PM in the Kolhapur city.

Various strategies for immediate reduction of air pollution in the city of Kolhapur includes the following:

- Developing a parking policy and dedicated parking zones. Multilevel parking places should be constructed especially in congested areas like near the Mahalaxmi Temple, Bindu chowk, Shivaji Market and so on. No vehicles should be allowed to be parked along the roadside in these areas.
- Parking areas to be made compulsory for all commercial and mixed buildings in Kolhapur by including it in the Bye laws of the city by the town planning department. The existing buildings should also create parking areas especially in the busy roads and lanes.
- Vigilance during construction activities and air pollution strategies during construction as suggested in the GRIHA (Green Rating for Integrated Habitat Assessment) - Rating System is highly recommended as immediate strategy to reduce air pollution in Kolhapur.
- Road sweeping and washing using treated waste water from the STP's for reducing re-suspension of the road side dust for supressing the dust particles which may arise due to vehicular movement.
- It is further suggested that that KMC should install 4 CAAQMS at strategic locations across the city for real time monitoring of air quality of the city.

In the year 2015, MPCB conducted noise monitoring during Diwali Festival at Bhavani Mandap, Bindu Chowk, Khas Baug Maidan, Mahalaxmi Mandir, Papachi tikati, Rajarampuri, Shivaji chowk and Tara Rani areas. The average noise decibel levels at these locations violated the night (55 dB(A)) and day (45 dB(A)) time standards. The average noise levels were recorded to be between 70 to 75 dB(A) during the day time almost 1.3 times the acceptable levels while the night time average levels were in the range of 56 to 66 dB(A) which violated the standard by 1.2 to 1.5 times.

Similarly in 2015, during Ganesh Utsav, MPCB monitored day time noise levels at Khas baug maidan, Mahalaxmi Mandir and Rajarampuri. It was observed that all the sites recorded average noise levels above the daytime standards. The average noise levels ranged between 70 to 76 dB(A) exceeding the standard by 1.3 times the permissible limit. Both the observations recorded for Noise indicate high noise pollution during the festivals.

## 1.1.2Water Resource

### 1.1.2.1 Surface Water

Panchganga River borders the city for about 18.31 km out of 44.62[3] km of the city's periphery. The river has a catchment area spread across 2538 km$^2$ and covers a distance of about 80 km from its origin at Prayag Sangam, at Chikhali village to its mouth at Narsobawadi where its drains in the Krishna river. MPCB has established two water monitoring stations under National Water Monitoring Programme (NWMP) on River Panchganga, one upstream and one down stream of Kolhapur city. Upon analyzing the data recorded at these stations, one may note that the WQI (Water Quality Index) of Panchganga River for last 5 years is recorded under *'Good to Excellent'* category at both the locations (**Table No. 1**).

**Table No. 1: WQI of Panchganga river in Kolhapur city (2011-2016)**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mar** | 81 | 86 | Dry | Dry | 78 | 83 | 78 | Dry | Dry | 81 |
| **Feb** | 79 | 85 | 57 | 63 | 58 | 78 | 82 | 64 | 62 | 55 |
| **Jan** | 69 | 77 | 75 | Dry | 7f2 | 64 | 77 | 71 | Dry | 75 |
| **Dec** | 75 | 79 | 84 | Dry | 77 | 75 | 83 | 79 | Dry | 72 |
| **Nov** | 82 | 81 | 72 | 62 | 67 | 82 | 75 | 65 | 65 | 69 |
| **Oct** | 84 | 85 | 34 | 64 | 81 | 62 | 85 | Dry | 64 | 78 |
| **Sep** | 86 | 84 | 84 | 67 | 75 | 84 | 85 | 85 | 61 | 77 |
| **Aug** | 80 | 84 | 84 | 65 | 81 | 76 | 85 | 72 | 64 | 79 |
| **Jul** | 64 | 83 | 77 | 65 | 77 | 64 | 72 | 67 | 64 | 77 |
| **Jun** | 80 | 81 | 88 | 66 | 80 | 77 | 87 | 71 | 64 | 82 |
| **May** | Dry | 79 | 83 | 64 | 72 | 87 | 73 | 82 | 66 | 74 |
| **Apr** | 80 | 77 | 83 | 44 | 81 | 84 | 74 | 77 | 41 | 80 |
| **FY** | **11-12** | **12-13** | **13-14** | **14-15** | **15-16** | **11-12** | **12-13** | **13-14** | **14-15** | **15-16** |
| **Station name** | Panchganga River at U/s of Kolhapur town near Balinga Pumping Station | | | | | Panchaganga river at D/s of Kolhapur town at Gandhi nagar near NH-4 bridge and MIDC intake well. | | | | |
| **Station code** | 1904 | | | | | 1905 | | | | |
| **Sub-Basin** | Krishna Upper | | | | | | | | | |
| **Basin** | Krishna | | | | | | | | | |

**Source: Water Quality Status of Maharashtra 2015–16**

Kolhapur city has 5 major nallahs – Dudhali, Jayanti, Bapat Camp, Line Bazar and Veet Bhati nallah. The total length of these nallahs is estimated to be about 94 km and all these drain into Panchganga River. There is no underground drainage facility in the city and drainage is mainly by surface drains. The large amount of sewage through nallahs -Jayanti nallah, Dudhali nallah, Bapat Camp nallah and Line Bazaar nallah (6 MLD) is directly discharged into Panchganga River which directly affects the water quality of the river.

There are major 6 lakes in Kolhapur city out of which Rankala Lake is of significant historic and recreation significance. Owing to pollution loads from release of sewage water and chemical detergents from washing and bathing the water at Rankala Lake was highly Eutrophic and weed infested in October 2008. However, KMC under under NLCP (National Lake Conservation Plan) received around 8.65 crores and utilised it for implementing various strategies for reducing pollution load in the lake. The initiatives undertaken by KMC included

[3] Calculated from Google Earth

- Diversion of drainage and waste released into the lake.
- Demarcation of lake boundaries, cleaning and removal of aquatic weeds, de –weeding and de-silting, treatment of lake body and lake peripherals etc.
- Timely removal of water hyacinth and silt.
- Separate arrangement for washing of clothes, animals have also been made by KMC for avoiding direct contamination of water and diversion of waste water to drainage system.

MPCB monitors water quality of Rankala Lake regularly and as for the monitoring done in 2015, all the parameters are observed to be within the permissible limit as per the standard prescribed by CPCB, indicating an improvement in the water quality of Rankala Lake owing to various initiatives undertaken by KMC

As a key response to avoid the water pollution, KMC has submitted a proposal for constructing the underground sewage scheme to cover entire city as well as for interception and diversion of sewage to STP (Sewage Treatment Plant) under AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme for laying additional drainage line of around 428 km, with an estimated budget of INR 257 crores. Once completed this shall help in processing 100% waste water generated in the city by 2020 which is expected to be around 101 MLD, thus reducing the release of waste water into the Panchganga River.

Since KMC is currently treating 56 MLD of waste water, it is expected that by 2020 KMC shall be in a position to process all its waste water. Thus it is highly recommended to develop policy framework for reusing treated water for secondary applications such as follows

- All construction activities, washing, curing, sanitation, flushing and secondary applications. A clause may be added in the building byelaws, DCR itself
- Irrigation applications in gardens owned by the corporation.
- Washing of roads and streets to suppress the road dust and its re-suspension in the city

KMC should set up an environment laboratory for monitoring water quality of the river along various check points especially upstream and downstream of all the *Nallah* release points. KMC should also monitor the water quality of all the lakes, water bodies and maintain data for the same.

### 1.1.2.2 Ground water

Overall, there are more than 800 borewells in Kolhapur city which are used to meet the water demands of the city. About 47 borewells are owned by the KMC and out of these, 4 borewells have been dug up in 2015–16.

The 3 stations of Central ground Water Board (CGWB) are considered as representation to understand the ground water status of the city. As it is observed, the lowest level of water i.e. depth of 6.675 m bgl was observed at the Washi monitoring station followed by station at Gokul shirgaon (1.17m) and Khupire (1.025m) in the year 2015. In order to understand the WQI, observation from 2 borewells, which are closest to the city have been recorded. In 2015- 16, the WQI of groundwater was recorded to be in '*Good to Excellent*' category for Hatkanangale site

and '*Very Poor*' category for Karvir site. The water quality has improved this year as against a severe deterioration in water quality which was observed in the year 2014- 15 at both the sites.

The increasing no. of borewells in the city is proving to be an important pressure on the water resource of the city as the water table is seen to be impacted. To mitigate this issue, KMC is incentivizing and promoting the concept of RWH (Rain Water Harvesting) and Recharge. It is mandatory, since 2005, for the properties having area equal /greater to 300 sq m for installing RWH structure.

## 1.1.3Water Management

### 1.1.3.1 Water Supply

KMC supplies about 120 to 130 MLD (Million Litres per Day) of water to Kolhapur city with an estimated average per-capita supply of about 135 LPCD (Litres per capita per day). This includes water for domestic, commercial, floating population, fire fighting, industrial and institutional usage and so on. The water is mainly supplied from the 4 jack wells installed by KMC, which have a combined capacity of 137 MLD capacity to lift water primarily sourced from rivers, Panchganga and Bhogawati, which are about 1 to 2 km from the city. There are about 44 bore wells from which KMC pumps out water for water supply through takers. There are 4 water treatment plants operated and maintained by KMC which help in purifying the water before supplying. It has a combined capacity of 137 MLD.

There are in all 28 storage reservoirs, 20 ESR's (Elevated Storage Reservoirs) and 8 GSR (Ground Water Reservoirs) with a total capacity of about 53 Million Litres which help in the storage of water. Out of the 1.4 Lakh households in Kolhapur city, around 89% (1.25 Lakhs) are connected with water supply lines, with a cumulative length of about 600 km. About 5% of the total connection holders are supplied water through direct pumping from the distribution system while more than 15 thousand households in Kolhapur city are still to be connected with water supply lines indicating a gap of around 11% in terms of coverage and demand for more water supply to meet the basic and baseline demand for water in the city. Kolhapur city reports NRW (Non-Revenue Water) of around 38% (45 – 50 MLD) as against the service level benchmark which permits a maximum of 20% of NRW.

### 1.1.3.2 Sewage Management

It is estimated that Kolhapur city generates about 83 MLD of waste water per day. Out of this, the domestic waste water accounts for 92% (76 MLD), followed by commercial establishments and sources 8% (7 MLD), while the industrial sources account for a negligible 0.1 MLD of waste water. As per Census report 2011, the coverage of latrines (individual households and community) covers around 99% of the population of Kolhapur city, indicating that the city is relatively free from open defecation.

The waste water is collected through drainage line of about 222 km across four zones Jayanti, Dudhali, Line Bazar and Bapat camp for sewage management. Around 45% of the households, translating to more than 64 thousand in Kolhapur city are not connected with the drainage line. Of this more than 30 thousand households from the Line bazar zone and Bapat camp zone itself which is yet to be connected with the drainage network leaving 100% households from this

areas without connection to drainage line. Around 43%[4] of the households in Kolhapur city have a septic tank facility in their households. However the treated waste water from the septic tanks is directly released to the road side gutter. This is true for around 90% of the septic tanks installed by the individual households. Kolhapur Municipal Corporation undertakes maintenance and repair work of the drainage network regularly. Drainage choke ups, removal of over flows and similar jobs are undertaken by the health department.

KMC has commissioned a 76 MLD capacity STP (Sewage Treatment Plant) as per funds received from NRCD (The National River Conservation Directorate) in the MoEFCC (Ministry of Environment, Forest and Climate Change). The current operational load on this plant is around 52 MLD. The water quality for the inlet and the outlet is monitored everyday by the laboratory established at the STP. The water quality parameters tested for the outlet water samples released post treatment are well within the standards prescribed by CPCB. Pilot plants of 10 $m^3$ capacity is based on DEWATS (Decentralized Waste Water Treatment System) has been installed and commissioned at the Isolation Hospital, Rajendranagar and Salokhe Park to promote decentralized waste water processing. Apart from the 76 MLD STP KMC, is in the process of constructing a 17 MLD capacity STP under the Maharashtra Suvarna Jayanti Nagarothan Maha Abhiyan and is expected to be commissioned by December 2016.

#### 1.1.3.3 Storm Water Management

Water logging during heavy spells of rain is a common phenomen in few areas of Kolhapur city especially the low lying areas and around 15 such areas (Section 6.3) have been identified by KMC. Kolhapur Municipal Corporation has appointed a private consultant to design a storm water management network based on sub-watersheds within the city of Kolhapur to address frequent localized flooding and water logging. As of March 2016, 83% of the work, i.e 9.5 km of the 12 km of the Nalla Channelisation work has been achieved. Apart from this the work for 34 culverts of 41 have been completed and 50% of the work for the road sides drain construction and repair work has been achieved.

### 1.1.4 Land resources

The Kolhapur city covers an area of 6682 hec under Municipal Corporation of which the maximum area lies under Agriculture (50%) followed by Built up area (28%), which is further classified into Residential, Commercial, Industrial and Transport sector. Barren land comprises about 15% area in KMC while area under green cover and water bodies is about 6% and 1% respectively.

As per the sanctioned DPR in the year 2000, the city recorded decrease in Agricultural and water bodies by 50% while increase in residential areas by double indicating many agricultural lands converted to non -Agricultural plots as compared to the year 1977. The activities like open dumping of solid waste, inert material from idols, encroachment results in poor agricultural activities, soil erosion and irregular sewage disposal affecting the land quality and human health.

There are 53 gardens spread across 30 hectors (0.4% of city area), with the maximum gardens in E ward (29). To maintain the green cover of the city, the municipal corporation regularly undertakes tree plantation drives and in the year 2015-16 KMC planted around 4845 trees. KMC has also established Tree Authority to regulate various activities pertaining to tree plantations, tree census, developing nurseries, organize exhibitions and extend support for tree plantation drives.

In terms of biodiversity, the Kolhapur city is blessed with about 125 species of avi fauna, 27 species of mammals, 22 species of reptiles, 30 species of fishes, 35 species of butterflies and 144 species of trees and shrubs, 30 species of pollinating insect, 22 species of Jassids, 36 species of odonates and so on were reported within and around the city. KMC has established a Biodiversity Monitoring Committee to help map the city's biodiversity and plan measures to conserve the local flora and fauna of the city. The committee shall also develop and maintain biodiversity registers by documenting the traditional indigenous knowledge about the wild edible plants, cultural diversity, species of local cattle, and so on.

### 1.1.5Solid Waste

It is estimated that the total quantity of MSW (Municipal Solid Waste) generated in Kolhapur city is about 185 MT (Metric Tons) per day which translates to more than 300 gm per capita/day. Out of the total generated, about 180 MT of MSW is collected daily in Kolhapur city through an effective system established by KMC. Of this, around 150 MT of waste is directly dumped at the open dumping spread across 8 acres site at Kasba Bawda which is within the city limits. About 10 MT of the waste collected from the markets is sent for bio-composting process via windrows technology at the Katyani area. 10-15 MT of waste collected from the hotels and restaurants via a dedicated collection trip is used for generating biogas by a food processing industry.

KMC has proposed a new waste to energy plant to be erected at the Kasba Bawda and has identified a contractor for same. The corporation has already undertaken the work of developing a scientific landfill site of about 1.5 hectares at Takala area which is an abandoned stone quarry site. The site has been layered with HDPE (High Density Poly-Ethylene) at the bottom to prevent leakage and seepage of the leachate. The site has further been developed by constructing concrete wall along the periphery of the site. The work for shifting of the waste will begin in July 2016 and is expected to end by December 2017. KMC has also acquired another abandoned stone quarry site spread across 7 hectare at Toap village, in Hatkangale taluka for developing a landfill site. It is located around 15 kms from the city. The site has a potential to cater to the scientific landfill requirements of Kolhapur city’s waste for about 25–30 years.

Kolhapur city generates about 0.7 tons/day of BMW (Bio-Medical Waste) from various hospitals, clinics and health care facilities. There are approximately 906 health care facilities, clinics blood banks, and hospitals in Kolhapur city which generate biomedical waste. In 2015–16, about 274 MT of biomedical waste was treated at the facility installed by a private agency appointed by MPCB. Out of the total BMW, 91% (250 MT) was disposed through incineration while 5% (13 MT) and 4% (10 MT) was disposed by chemical treatment and autoclaving/shredding respectively.

KMC, under the Swachh Bharat Abhiyaan, has proposed erecting two biogas plants of 5 ton capacity each at Bawada and Central Jail, Kalamba, to treat the biodegradable waste and generate power for meeting power requirements of local streetlights. The plant would be based on *Nisargruna Technology*.

## 1.1.6Health

Kolhapur city has good health facilities like private hospitals (9), Ayurvedic centers (4), Homeopathy Clinics (4), Private Nursing Homes (143) and Blood banks (8) and so on. In the year 2015–16 (**Figure No. 2**), a decrease in number of cases for water borne diseases like Gastroenteritis, Hepatitis B and Dysentery was recorded and the number for all the cases reduced by almost 50% as compared 2014-15. However cases of Typhoid have increased by almost 30 cases i.e from 238 in 2014–15 to 261 in 2015–16. In case of Malaria, the number of cases has registered a decline for last 5 years and mere 7 cases were registered in 2015–16 as compared to 16 cases in 2011–12. However, Dengue, cases have registered a drastic increase and almost 92 cases and two deaths were recorded in Kolhapur city. As for the cases of Tuberculosis (TB), around 467 cases of TB were recorded in the year 2015–16 and around 40 deaths owing to TB were recorded. Consistently from the past 5 years more than 450 cases of TB and around 35+ deaths.

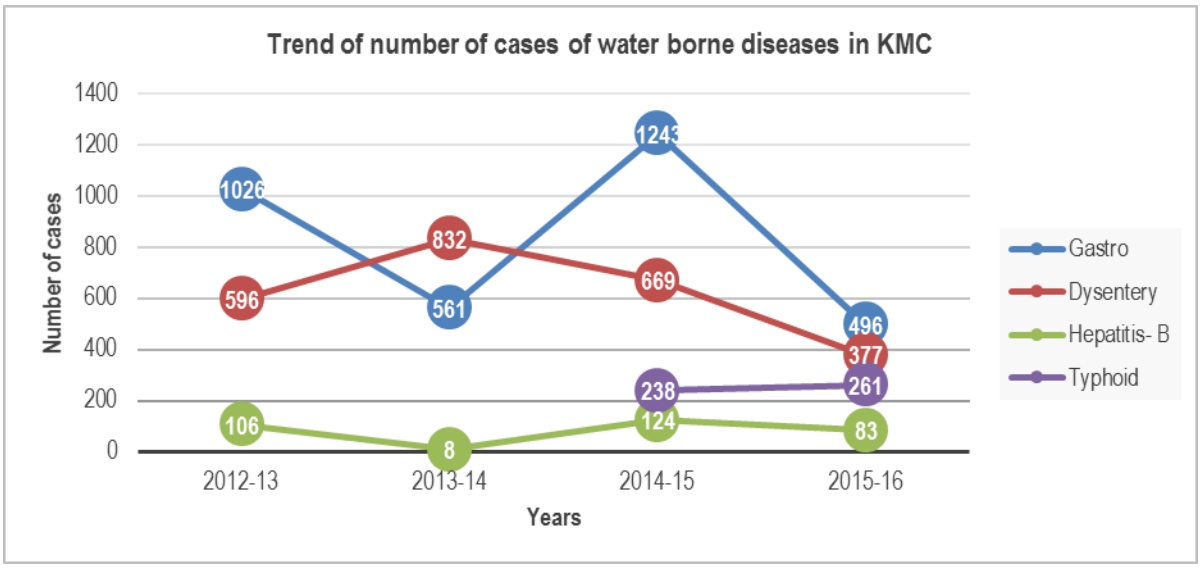



**Figure No. 2: Trend in cases of water borne diseases reported in KMC area**
**Source: Health Department, KMC**

As a mitigation measure, many awareness drive in order to prevent and cure the diseases are carried out. The KMC had organised special awareness programs during 24-27th March to commemorate it as TB week. Besides this, awareness drive highlighting the preventive measures against Dengue, Swine Flu and Malaria is also conducted every year.

# 2 City Profile

Kolhapur is one of the oldest and culturally significant cities of Maharashtra, India, lying along the bank of the river Panchganga. Its rich cultural heritage and history has given the city a grandeur, which is rare. It is famous for the Mahalaxmi temple situated here, along with a host of other natural and man-made tourist attractions. Kolhapur is also well known for its cuisine, especially the non-vegetarian fare, the famous Kolhapuri chappals (Footwear) and silver jewellery, sugarcane production industries and so on.

## 2.1 History of Kolhapur

The past rulers of Kolhapur were descendants of Chhatrapati Shivaji Maharaj, a great Maratha warrior, who successfully drove the Mughals out of western India. But after his death, due to the lack of a clear successor, there were two separate lines of descendants and internal rivalries soon leading to the decline of the Maratha from the state. Finally an agreement was reached where one line of descendants got Northern Maharashtra while the other got control over southern Maharashtra with Kolhapur as its capital[5]. The rulers of Kolhapur had to face powerful enemies in the south, like the Nizam of Hyderabad, and were also harassed by the Mughal rulers. Soon the ascension of Chhatrapati Shahu Maharaj in 1894 changed the fortunes of Kolhapur transforming it into a developed city, with educational institutions, outdoor sports, industries and so on. During the British reign, prior to Independence, the city was part of the Bombay Presidency and later became a part of the republic of India.

## 2.2 Agriculture, Industries, Commercial Activities

Today, Kolhapur is one of the top agricultural producers in Maharashtra. It produces and exports rice, sugar, chilli powder, tobacco, gur (jaggery)[6] on a large scale. The Kolhapur jaggery is very well known and the industry was first set up by Shahu Maharaj himself. Kolhapur is also well known for the famous Kolhapuri chappals which are appreciated all over the world, along with ornaments and jewellery made of silver.

Kolhapur is industrially quite developed with many industrial zones in and around the city which includes the MIDC at Shirol, Gokul Shirgaon, Kagal Hatkanangale and Ichalkaranji. These are famous not only for the sugar industry, foundries and textiles but also for non-material minerals, chemicals and drugs, oil engine, spare parts, aluminum vessels and so on[7].

[5] www.kolhapurtourism.org

[6] http://shodhganga.inflibnet.ac.in/bitstream/10603/4312/8/08_chapter%202.pdf

[7] http://shodhganga.inflibnet.ac.in/bitstream/10603/4312/8/08_chapter%202.pdf

## 2.3 Geography and Climate

Kolhapur city located 574 meters above mean sea level, is spread across an area of 66.82 km$^2$ and situated between 16°46′ and 16°39′ North and 74°11′ and 74°17′ East longitude[8]. The city ranges across the Deccan plateau in the rain shadow region of the Sahyadri mountain ranges which is present on the southern-most tip of the state of Maharashtra.

The climate of Kolhapur is tropical in nature and experiences three seasons, summer with hot weather (March to May), Monsoon (June to October) and winter with cold weather (November to February). There is a rapid rise in temperature in March, reaching the maximum of about 38°C in April and May which are the hottest months of the year in Kolhapur[9].

The average maximum and minimum temperature and rainfall over a period of thirty years (from 1961 to 1990) is given below in Table No. 2. The annual mean Maximum and Minimum temperature is found to be around 31°C and 19°C respectively. The average rainfall is around 1100 mm which is received from both the southwest monsoon winds and the north east monsoon winds. The rainfall recorded for current year 2015-16 in Kolhapur city is represented below in Table No. 3. Out of the normal rainfall (1043mm), the city has received only 46% (485mm) for 51 rainy days in the year 2015-16.

**Table No. 2: Monthly mean minimum and maximum temperature and rainfall in Kolhapur**

| Month | Mean temperature | | Extreme temperature | | Rainfall |
|---|---|---|---|---|---|
| | Max (°C) | Min (°C) | Max (°C) | Min (°C) | (mm) |
| January | 30.7 | 14.8 | 35.4 | 8.7 | 0.9 |
| February | 33.2 | 16.2 | 37.4 | 9.3 | 2.3 |
| March | 36 | 19.3 | 40.4 | 12.4 | 7.3 |
| April | 37.5 | 21.6 | 41.7 | 13.8 | 30.1 |
| May | 35.9 | 22.3 | 42.3 | 16.6 | 58 |
| June | 30.1 | 22 | 40 | 18.9 | 151.2 |
| July | 26.9 | 21.4 | 33.3 | 18.9 | 321.4 |
| August | 26.7 | 21.1 | 32.2 | 18.9 | 209.3 |
| September | 28.9 | 20.8 | 35 | 17.2 | 133 |
| October | 31.5 | 20.1 | 36.2 | 13.9 | 87.4 |
| November | 30.7 | 17.4 | 34.6 | 9.7 | 36.1 |
| December | 29.8 | 15.4 | 34.4 | 8.6 | 11.5 |
| **Annual** | **31.5** | **19.4** | **42.3** | **8.3** | **1048.5** |

**Data source: India Meteorological Department, Ministry of Earth Sciences.**

[8] Google Earth
[9] The Gazette, Government of Maharashtra

**Table No. 3: Rainfall recorded in Kolhapur city (2015-16)**

| Month | Normal Rain fall(mm) | Total Rainfall (mm) | %Rainfall | Rainy Days |
|---|---|---|---|---|
| Apr | 26.1 | 8.1 | 21.8 | 1 |
| May | 55 | 45.5 | 56.5 | 4 |
| Jun | 138.1 | 212.9 | 209.1 | 16 |
| Jul | 359.9 | 98 | 36.6 | 15 |
| Aug | 192.6 | 56 | 32.4 | 8 |
| Sep | 106.3 | 22.4 | 20.8 | 2 |
| Oct | 108.1 | 37.2 | 32.5 | 5 |
| Nov | 40.9 | 2 | 0 | |
| Dec | 7.2 | 0 | 0 | 0 |
| Jan | 3.1 | 0 | 0 | 0 |
| Feb | 0.4 | 0 | | |
| Mar | 5.7 | 2.5 | 43.9 | 0 |
| **Total** | **1043** | **485** | **46.44** | **51** |

**Data source: Rainfall Recording and Analysis, Department of Agriculture Maharashtra State**[10]

## 2.3 Connectivity

**By road**; Kolhapur is situated on the Pune – Bangalore National Highway No. 4 and located around 395 km to the South of Mumbai and 240 km from Pune. It is an eight to ten hour journey from Mumbai or Bangalore to Kolhapur by road. For intra city commute auto-rickshaws are the most common mode of transport apart from the city buses operated by KMT (Kolhapur Municipal Transport) run by the municipal corporation.

**Rail Connectivity**; Train journeys to Kolhapur from Mumbai or Bangalore take around ten to eleven hours. There are seventeen trains plying from Kolhapur and to Kolhapur railway station daily (with a few exceptions) to and from destinations such as Mumbai, Pune, Bangalore, Delhi, Tirupati, Ahmedabad, Nagpur, Hyderabad, and so on.

There exists an airport at Ujlaiwadi, which is around 9-10 kms from Kolhapur city. The air connectivity to Kolhapur began as early as 1939; however the commercial airport was completed only in 1997. The airport is currently closed and there are no commercial flights plying to Kolhapur Airport.

[10] http://maharain.gov.in/

# 3 Driving Forces

Kolhapur has been blessed with certain natural geographical benefits that have proved to be an advantage in developing the economy of the city. The city enjoys good rainfall and also has excellent irrigation facilities along with a good electric power supply, which has led to high agricultural yield. The constant supply of electricity has also ensured large-scale industrial development. The ever expanding industries in the city include the sugar industry, jaggery industry, textile industry, etc. along with agriculture, provides ample employment opportunities to not just the residents of Kolhapur but also several others who migrate to Kolhapur in search of employment. The large number of tourist spots in the city, making it one of the sought after tourist destinations of Maharashtra, is also an important source of livelihood for several of the residents. There is also a high in-migration of students from other parts of Maharashtra in pursuit of higher education, to renowned universities and colleges situated in Kolhapur such as (Chhatrapati) Shivaji University, D. Y. Patil college of Engineering and Technology, Kolhapur and so on.

The multipurpose hydro-electric power plant at Radhanagiri is greatly expected to enhance the economic prospects of the area, by fulfilling the energy requirements for the growing industrial sector and water requirements for agriculture[11]. The development of certain industries has also led to the development of a few subsidiary industries, such as the production of organic solvents from sugarcane molasses, a by-product of the sugar industry. The city is also blessed with certain traditional small scale industries such as manufacturing silver ornaments and the famous Kolhapuri chappals industry, a speciality of the region. The other major small scale industries are handloom weaving, oil crushing, brick and tile making, leather and tanning industries, etc. [12] The thriving small, medium and large-scale industries have attracted population migration to the city in recent times, acting as a major driving force.

Kolhapur city has seen exponential growth in population over the past few decades, causing a strain on the natural resources of the region, particularly, land and water. Along with rapid industrial development, tourism and population growth are also the key drivers which have led to an increase in pollution levels in the city.

[11] Kolhapur Gazeteer, Gazeteers Department
[12] www.kolhapuronline.in/city-guide/business-and-economy-of-kolhapur

## 3.1 Population Growth

The maximum decadal growth rate, was registered between the 1940's and 1970's when the population in the city registered growth ranging from 37-48%. Post that although the growth rate has been on a decline the absolute population of the city has been increasing. As observed in Figure No. 3, there has been a steady growth of population in Kolhapur city over the past century decade. As per Census report 2011, the population of Kolhapur municipal limits was about 5,49,283 (Five lakhs forty nine thousand two hundred and eighty three). In the last decade, between 2001 and 2011, the population in the city increased by almost 64 thousand translating to a decadal growth rate of 13.21%. The city has a sex ratio of 959 females per 1000 males. In the year 2015, the birth rate and crude death rate was recorded to be 18.67% and 10.37% respectively and both were the highest in the past 5 years (Table No. 4).

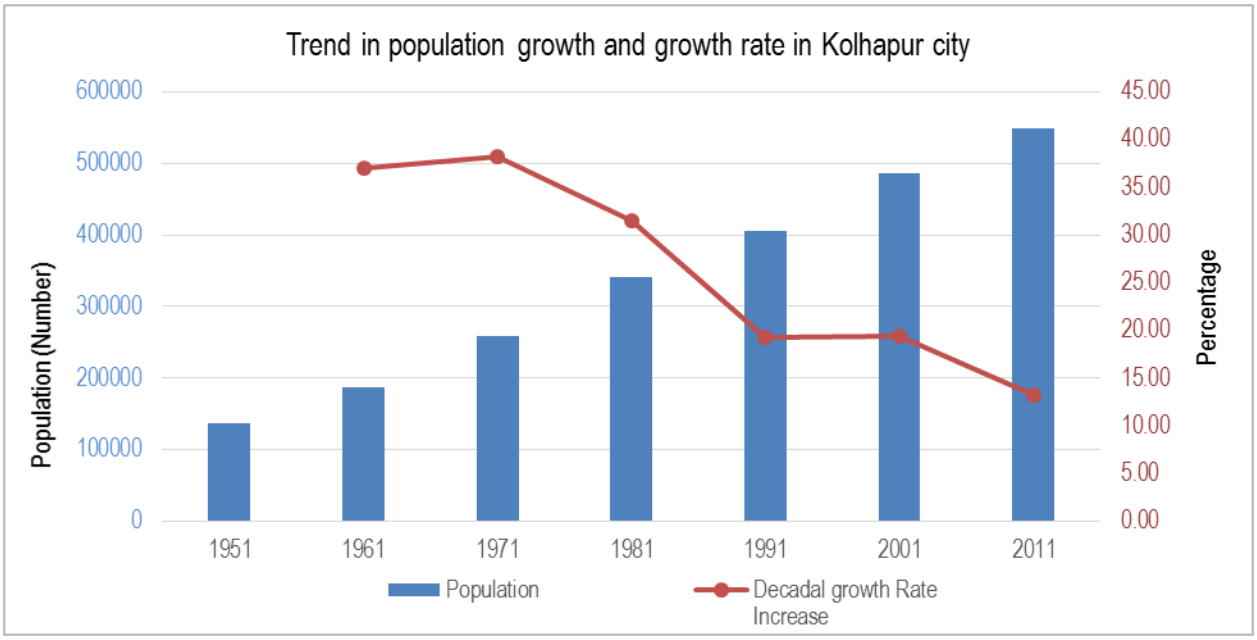



**Figure No. 3: Trend in population growth and growth rate in Kolhapur city**
**Data Source: Environmental Status Report of Kolhapur city, 2015-16**

**Table No. 4: Birth rate and death rate in Kolhapur city**

| Year | Birth rate | Crude Death rate |
|---|---|---|
| 2011 | 14.32 | 7.61 |
| 2012 | 15.60 | 8.17 |
| 2013 | 15.42 | 7.65 |
| 2014 | 13.82 | 7.44 |
| 2015 | 18.67 | 10.37 |

**Data Source: Health department, KMC**

### 3.1.1 Industrial and Commercial growth

Kolhapur region has been a hub for various industries and processing units especially for sugar industries, agro processing, textiles and so on. There are about 20 sugar factories in Kolhapur district out of which Chhatrapati Rajaram Sugar Factory and Kolhapur Sugar mill (Distillery) and well within the city limits of Kolhapur city. Apart from these the MIDC areas of Shirol and Gokul Shirgaon lie very close to the Kolhapur city.

There has been an increase in various establishments and commercial activities in and around Kolhapur city, especially Karvir Taluka. As per the data recorded by the DIC (District Industries Centre) Kolhapur, more than 3000 new establishments have been registered in terms of new registrations of industries and other establishments in the Taluka. As on October 2015, there are about 4959 industrial units in and around Kolhapur city.

The foundry industry in Kolhapur is one of the most important foundry clusters in India which started getting established in the 1960s. There are around 300 foundries in the Kolhapur foundry cluster and the total annual production is estimated at 600,000 tonnes, which represents about 7–8% of India's total casting production. According to estimates, the Kolhapur foundry cluster provides direct employment to over 40,000 people and indirect employment to nearly 100,000 people[13]

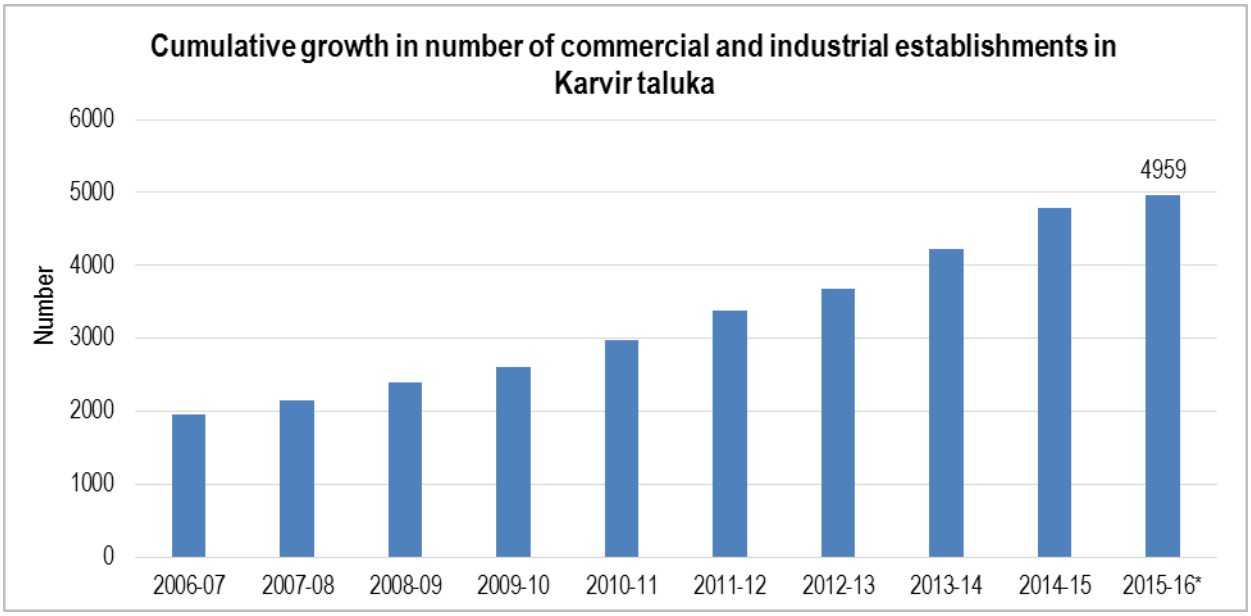



**Figure No. 4: Cumulative growth in number of establishments in Karvir taluka**
**Data Source: District Industries Centre, Kolhapur**
**includes updated data only till October 2015 as available with DIC, Kolhapur*

[13] sameeeksha.org/pdf/clusterprofile/Kolhapur_foundry_cluster.pdf. Compiled by TERI under the WB-GEF-SIDBI project "Financing Energy Efficiency at MSMEs".

## 3.1.2 Economic Growth

Owing to presence of major industrial belt as well as agricultural production, the economy of Kolhapur district has been increasing over the past few years. As seen in Figure No. 5, the GDDP (Gross District Domestic Product) as well as the NDDP (Net District Domestic Product) has been increasing steadily.

The GDDP in the year 2013-14 was estimated to be about INR 54.63 thousand crores while the NDDP in the same year was about 49.52 thousand crores. In the past five years between 2009 and 2014, the GDDP and the NDDP have registered growth by more than 75%. The higher GDDP is an indicator of increase in the PCNDDP (Per Capita Net District Domestic Product) and of the year 2013-14 it was estimated to be about INR 1,19, 783/- (One Lakh nineteen thousand seven hundred and eighty three only).

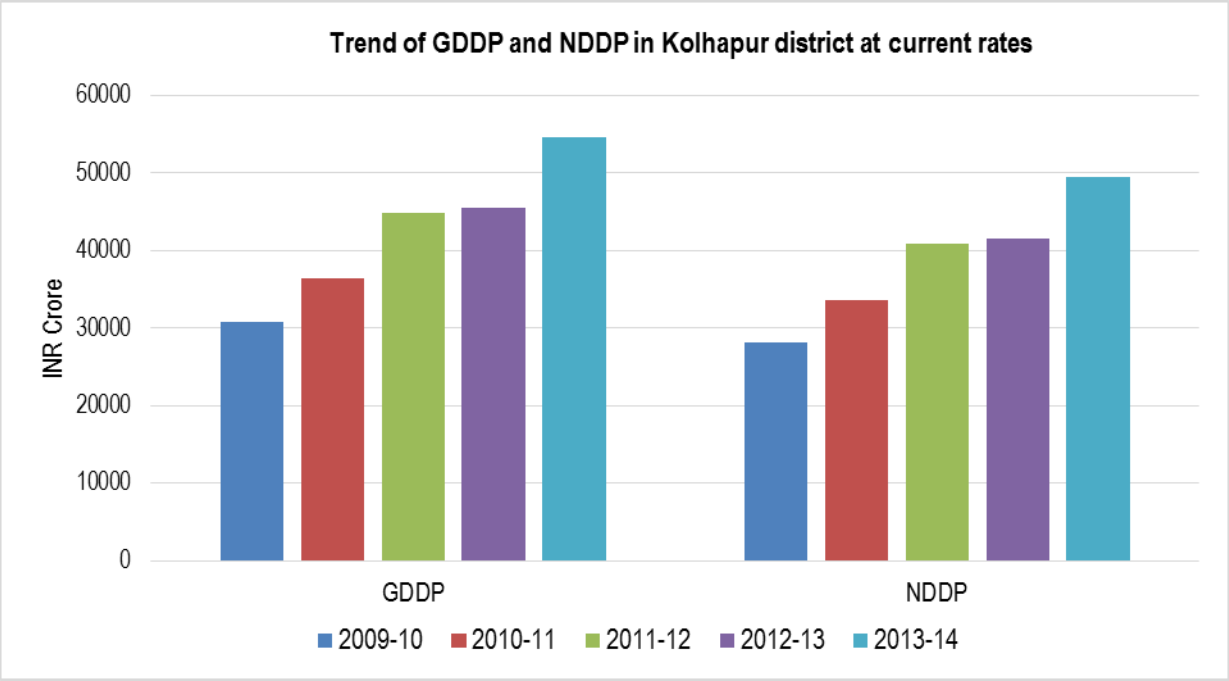



**Figure No. 5: Trend of GDDP and NDDP in Kolhapur district**
**Data Source: Economic Survey of Maharashtra 2010-11 to 2014-15*[14]**

[14] Due to unavailability of data as per the revised methodology, the estimates of District Domestic Product and subsequently Per Capita Net District Income have not been compiled for 2015-16.

### 3.1.3 Educational Hub

Due to the presence of Shivaji University in Kolhapur city there has been a lot of in-migration of students from the nearby districts to pursue higher education. The university was established in 1962 and then had about 34 affiliated colleges and about 14000 students with 5 Post-graduate Departments on the campus. As on 2015-16, the number of affiliated colleges has gone upto 280 while the annually admitted students is about 2.70 Lakhs for the past three years (Figure No. 6)

The university has 34 Postgraduate Departments on campus. The University imparts education in 10 major faculties of Arts, Social Science, Science, Commerce, Education, Fine Arts, Law, Medicine, Ayurvedic Medicine, Engineering and Technology.

Apart from options for higher education the city also has many schools offering primary, secondary and higher secondary education. As per data from Education department of KMC there are about 271 schools in Kolhapur city with about 61 Municipal schools, 133 private aided, 76 private unaided and one school of the Zilla parishad in Kolhapur city.

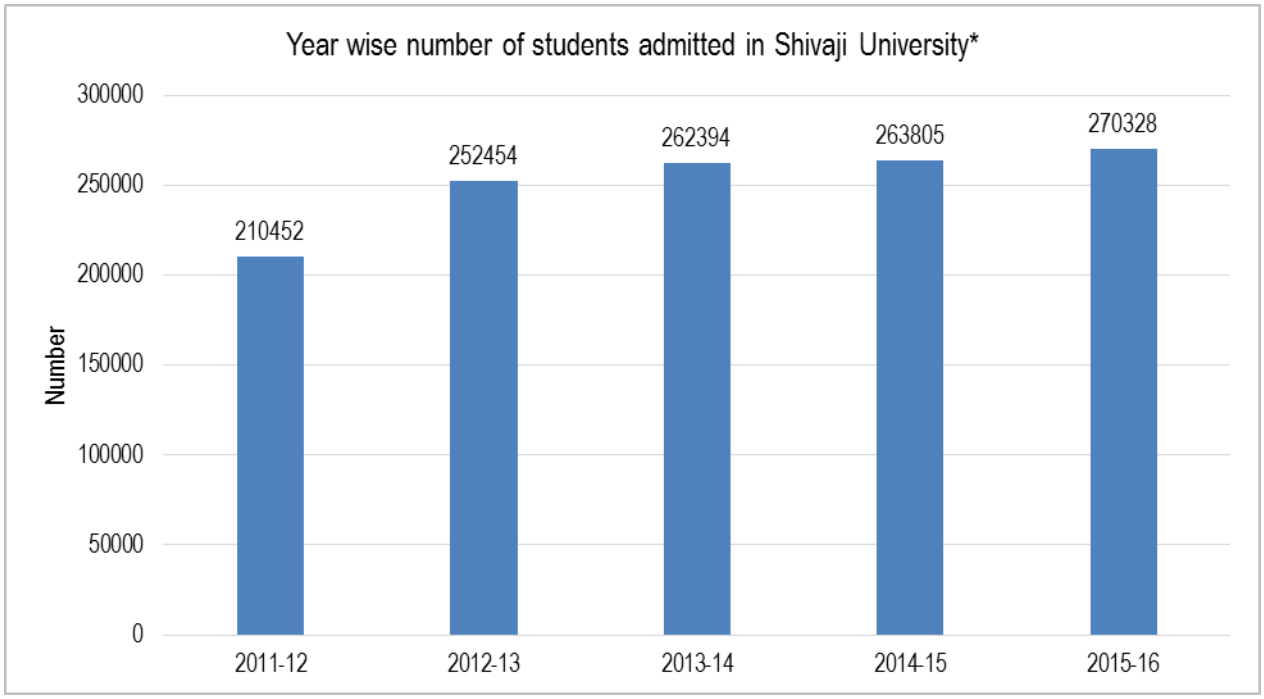



**Figure No. 6: Year wise number of students admitted in Shivaji University, Kolhapur**
**Data Source: Statistical Information 2015-2016, Shivaji University, Kolhapur[15]**
**includes data for colleges in the districts of Kolhapur, Satara and Sangli affiliated with Shivaji University*

## 3.2 Tourism & Pilgrimage

Kolhapur is an important tourist destination in Maharashtra as there are several temples of high religious importance, places of natural scenic beauty and culturally significant museums and other attractions. The city is visited by thousands of visitors every year.

[15] http://www.unishivaji.ac.in/uploads/suk/List/Statistical%20Information%202015-2016.pdf

The city is most famous for the Mahalaxmi temple situated here, which is a famous pilgrim destination and even has references in ancient religious texts. There are a host of other natural and man-made tourist attractions like the Panhala fort and hill station, Rankala Lake, Jotiba temple, Radhanagri Wildlife sanctuary (Dajipur) and so on.

## 3.2.1Mahalaxmi temple

The Mahalaxmi temple is one of the most renowned temples of Maharashtra, attracting scores of pilgrims on any given day. The temple is believed to be one of the '*shakthi peethas*' mentioned in the *Puranas* of Hinduism. It is also believed to be the abode of Goddess Mahalaxmi. Built in the 7th century by Chalukya rulers, the temple is an architectural wonder built out of stone. The idol itself is made out of gemstone. The temple is open on all seven days of the week between 4 am to 10.30 pm. It is around 2km away from Kolhapur railway station and is easily accessible with the help of local transport.

**Picture No. 1: The famous *Kalash domes* of Mahalaxmi temple dome**
**Photo credit: TERI**

## 3.2.2Panhala fort

The Panhala fort is one of the most beautiful and sought after tourist destinations of Maharashtra, 3177 feet above sea level. The Panhala fort and hill station have a number of attractions which include, the Ambharkhana built by the Marathas, the Sajja Kothi built by Muslim rulers in the 11th century, the Ambabai temple, Sambhaji temple, and so on. Also worth observing is the Nayakini Sajja, built by the Marathas to hide the Ravine or the moat next to the fort, a clever strategy by the Marathas as enemies would fall into the Ravine when they tried to climb over that particular corner. It is about 22 km to the northwest of Kolhapur on the

Kolhapur-Ratnagiri road and is easily accessible by road. One can use NH 204 from Kolhapur towards Ratnagiri and then take a ghat road towards Panhala.

### 3.2.3Jotiba temple

The Jotiba temple, situated in Wadi Ratnagiri and is dedicated to Lord Jotiba, who is believed to be the re-incarnation of Brahma, Vishnu, Maheshwara and Jamdagni is an important Hindu pilgrim center. According to mythology, this re-incarnation was created to kill the demon Rathnasur. Devotees and tourists throng to this temple premises for the large fair held yearly in the full moon days during the months of Vaishakh and Chaitra and this is the best time to visit this temple. The temple is situated around 25 km. from Kolhapur station and easily reachable using local transport such as autorickshaws and buses.

### 3.2.4Radhanagri Wildlife Sanctuary (Dajipur)

Radhanagri Wildlife Sanctuary, earlier known as Dajipur Wildlife Sanctuary, is the first notified wildlife sanctuary of Maharashtra located around 82 km from Kolhapur in Radhanagri Taluka[16]. The sanctuary is famous for Wild gaurs and was also known as the Bison sanctuary in the initial days. Dajipur has one of the thickest forests in the region and is home to a vast number of species of flora and fauna. The mammal fauna mainly consists of Indian leopard, sloth bears, deers, wild boars, and so on. Royal Bengal Tigers have also been reported in the sanctuary by the forest department. The large number of wild boar in the past led to large scale hunting of these animals, which has now been banned. The sanctuary is also designated as an Important Bird Area by BirdLife International and is home to the rare and globally threatened Nilgiri wood-pigeon (*Columba elphinstonii*)[17]. The scenic locale, along with its rich biodiversity makes it a must-see destination for nature lovers.

### 3.2.5Kidrapur

The ancient Kopeshwar temple situated at the banks of the river Krishna is a huge tourist attraction, both because of its religious significance and also for the artistic ancient sculptures. The temple was first built in the 7th century by the Chalukya kings but abandoned due to frequent invasions by the neighboring kings, but taken up once again in the 11th and 12th century. It was built using basalt stone and is dedicated to Lord Vishnu and Lord Shiva. The temple is adorned with intricate carvings and engravings depicting Gods, Goddesses and artists. Tourists throng the temple during Shravan and Shivratri. The temple is located in Kidrapur village which is around 22 km from Narsoba Wadi and 58 km from Kolhapur railway station.

[16] https://dreamvacationsindia.wordpress.com/2014/02/04/radhanagari-and-dajipur-wildlife-sanctuary-kolhapur-a-wildlife-hub/

[17] http://www.birdlife.org/datazone/geomap.php?r=i&bbox=-150%20-50%20150%2080

# 4 Air Quality

Today, Air pollution is one of the biggest problems faced by humans. The ever increasing dependence on fossil fuels to fulfil day to day energy requirements, along with rapid industrialization and population growth is causing our environment to degrade at a rate where the pollution in the air is taking a toll on the environment, humans as well as other organisms.

Air pollution is caused when harmful substances, both liquid and solid, such as particulate matter, ash, harmful chemicals, organic molecules, etc. gets added into the air beyond permissible limits; disturbing the natural composition of air. The most common causes of air pollution are the combustion of fossil fuels for transportation, energy production, industrial activities, mining activities, construction activities, burning of waste, and so on.

Air pollution is known to cause a number of health problems and the most common ailments which are believed to be caused by air pollutants are allergies, breathing problems, asthma, skin problems and so on. Certain pollutants are even known to be carcinogenic. Air pollutants are also responsible for acid rains wherein they mix with moisture carrying clouds making the precipitation acidic.

## 4.1 Status – Monitoring Network & Air Quality

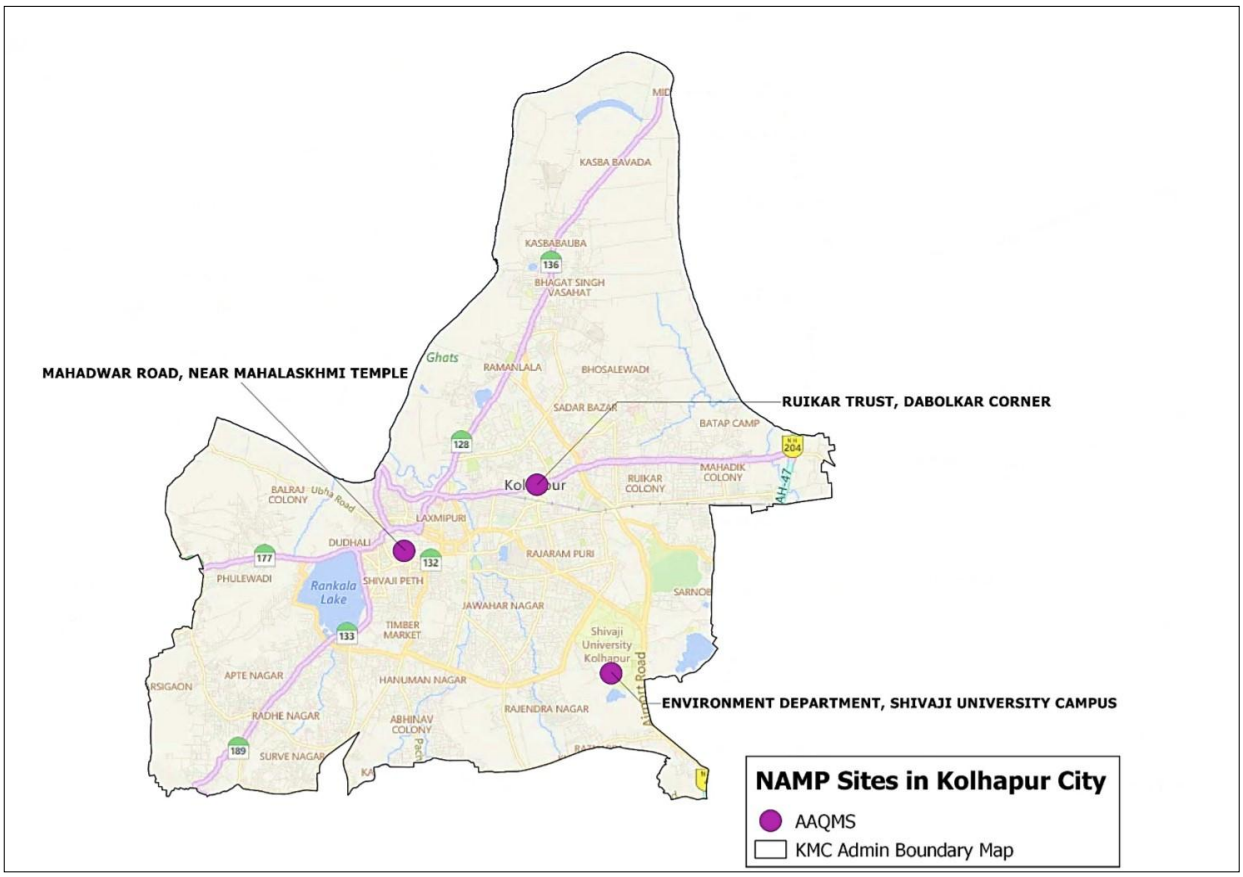
### 4.1.1 Air Quality Monitoring Network in Kolhapur City

In order to keep a check on the air quality of a region, MPCB (Maharashtra Pollution Control Board) has installed air quality monitoring stations at various locations across the state of Maharashtra. In Kolhapur city, MPCB has identified three monitoring sites, and allotted the regular monitoring and reporting task to Shivaji University, Kolhapur. The sites were installed in January 2005 and for the past 11 years the Environment department of Shivaji University co-ordinates this assignment under the NAMP (National Air Monitoring Program). As seen in Table No. 5, the air quality observation and readings are taken at these sites twice every week and more than 100 observation days have been recorded by each site in the year 2015–16.

**Table No. 5: Details of NAMP sites in Kolhapur city**

| Station code (NAMP) | Station Name | Station Location | Type | Monitoring Days | No of Observations days 15-16 |
|---|---|---|---|---|---|
| 508 | Shivaji University Campus | Shivaji University Campus, Vidyanagar, | Residential | Monday & Thursday | 103 |
| 509 | Ruikar Trust | Ruikar trust, Dhabhokar corner | Commercial | Tuesday & Friday | 101 |
| 510 | Mahadwar Road | Near Mahalaxmi temple | Residential | Wednesday & Saturday | 106 |

**Source: Maharashtra Pollution Control Board & Site Survey by TERI**




**Map No. 1: Network of NAMP sites in Kolhapur city**
**Source: Air quality Status report of Maharashtra 2014-15, Maharashtra Pollution Control Board**

## 4.1.2 Sulphur Dioxide

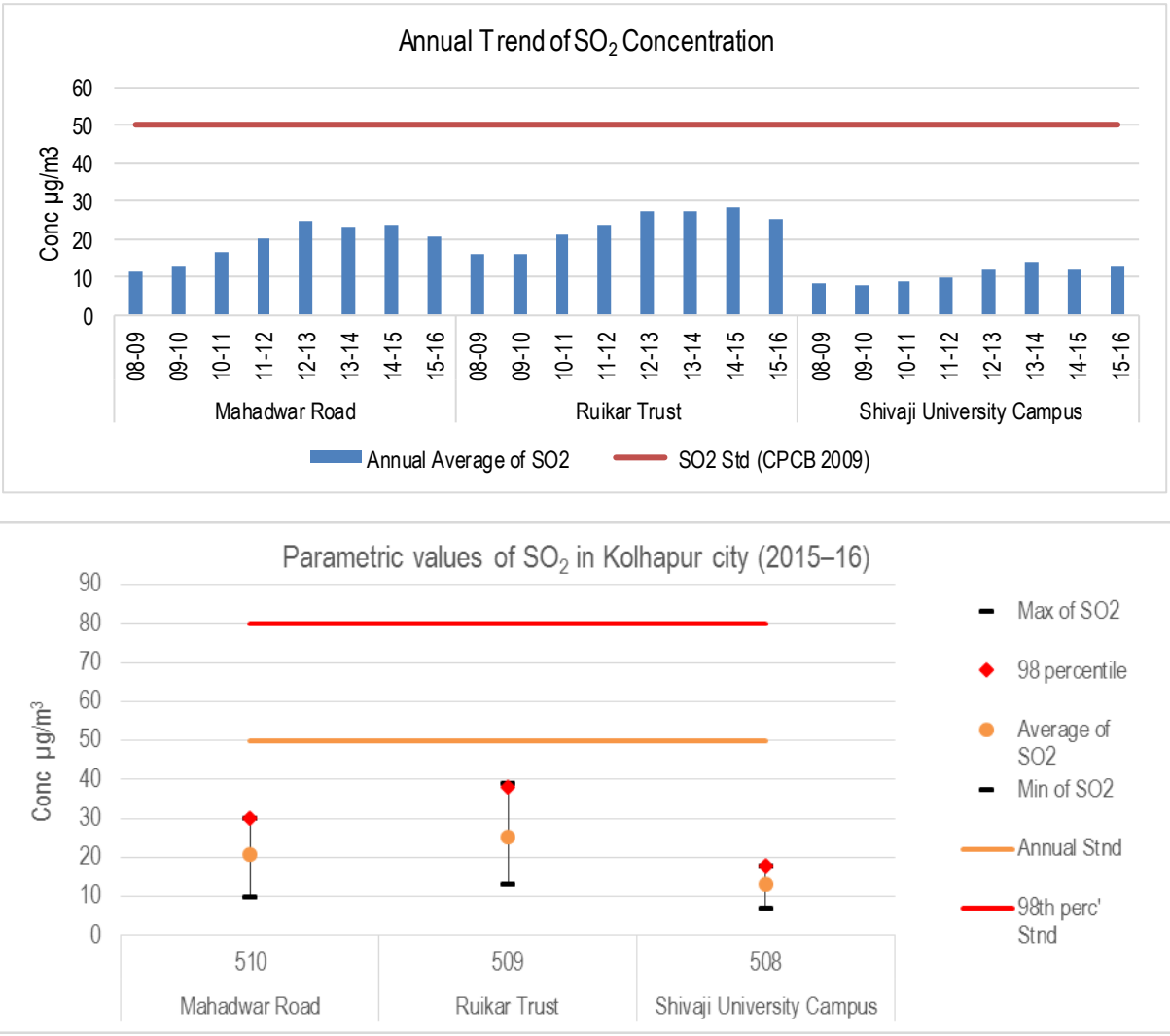



**Figure No. 7: Annual Trend and Parametric concentrations in 2015-16 of $SO_2$ in Kolhapur city**
**Data source: Maharashtra Pollution Control Board**

One may note from Figure No. 7, that the city of Kolhapur is relatively free from $SO_2$ pollution for all the years. As per the annual trend recorded at the 3 locations, it is interesting to note that although the annual concentrations have been almost half of the annual standard (50 µg/m³), there is an increase by almost 1.5 to 1.8 times the annual concentration for $SO_2$ pollution from 2008–09 to 2015–16 across the three sites.

In 2015–16, the daily maximum concentration of $SO_2$ was recorded at the Ruikar trust site (39 µg/m³) which was well within the daily standards of 80 µg/m³. The university area represented by the NAMP site at Shivaji University Campus (control site) and the residential area represented by NAMP site at Mahadwar road, recorded $SO_2$ concentrations in the range of 7–18 µg/m³ and 10–30 µg/m³ respectively in the year 2015–16.

The lower concentrations of $SO_2$ across Kolhapur city indicate that the city of Kolhapur was clean for $SO_2$ pollution in the year 2015–16

## 4.1.3Oxides of Nitrogen (NOx)

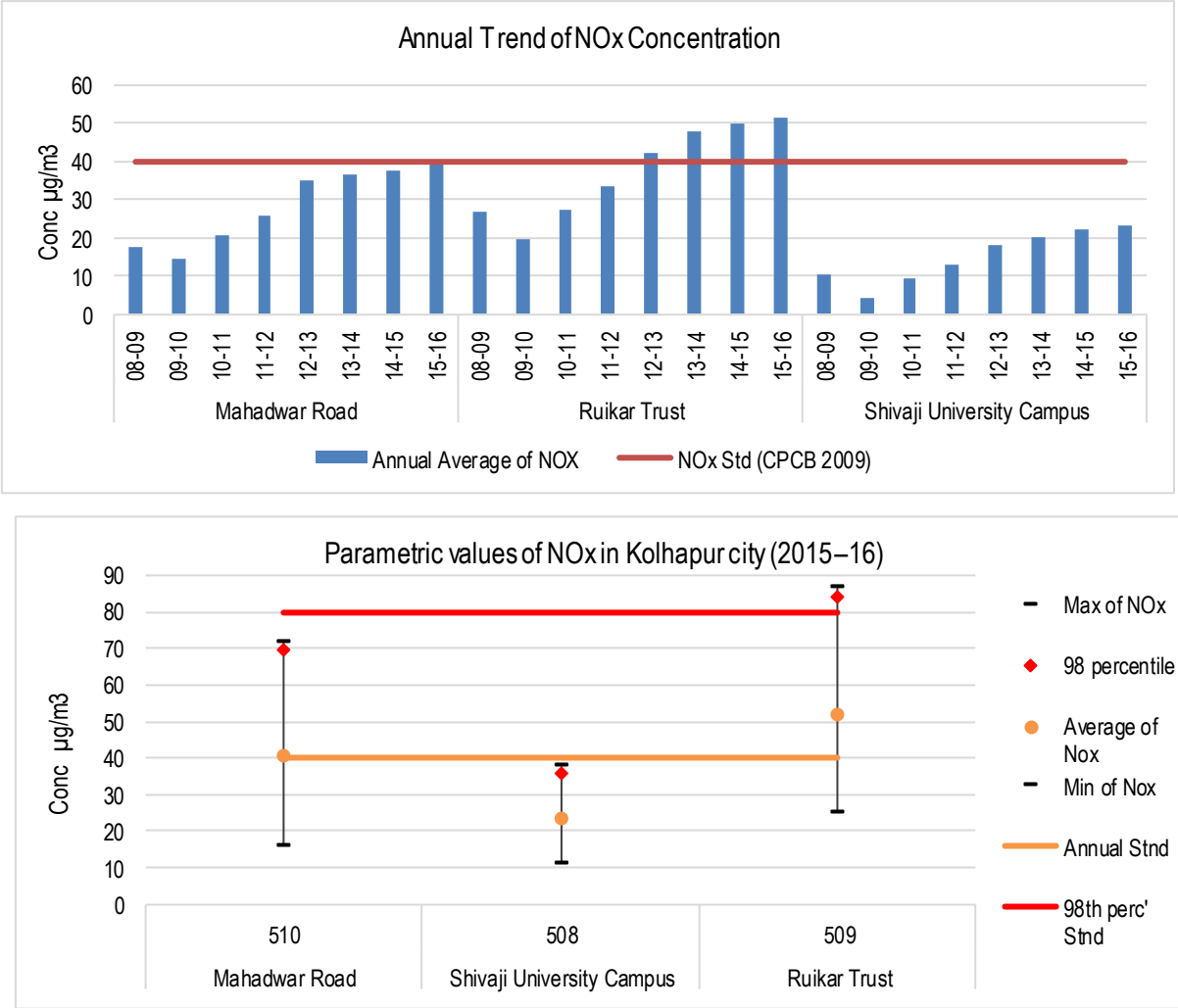



**Figure No. 8: Annual Trend and Parametric concentrations in 2015-16 of NOx in Kolhapur city**
**Data source: Maharashtra Pollution Control Board**

One may note from Figure No. 9, that the annual NOx concentrations in Kolhapur city have been increasing steadily over the past 8 years. The annual NOx concentrations recorded in 2015–16 at Mahadwar Road, Ruikar Trust and Shivaji University has increased by 2.6, 2.8 and 5.5 times as compared to 2009–10. One of the busiest and congested squares in Kolhapur, Dabhodkar corner (AAQMS at Ruikar Trust), has been exceeding the annual NOx standards (40 µg/ $m^3$) by up to 1.3 times, for the past 4 years while the area near the Mahalaxmi temple (Mahadwar road) has been a borderline case in the last year (40 µg/$m^3$) in 2015–16.

As for the daily concentrations in 2015–16, the area represented by Ruikar Trust site recorded the highest NOx concentrations of 84 µg/ $m^3$ exceeding the daily standard of 80 µg/ $m^3$ indicating certain days of high NOx concentrations. The Shivaji University site recorded annual average (23 µg/ $m^3$) and daily maximum (38 µg/$m^3$) concentration of NOx and both were below the standards.

The primary source of NOx pollution in any region is attributed to vehicular emissions. The locations Ruikar trust and Mahdawar road are highly congested and traffic prone leading to high NOx concentrations.

## 4.1.4Particulate Matter

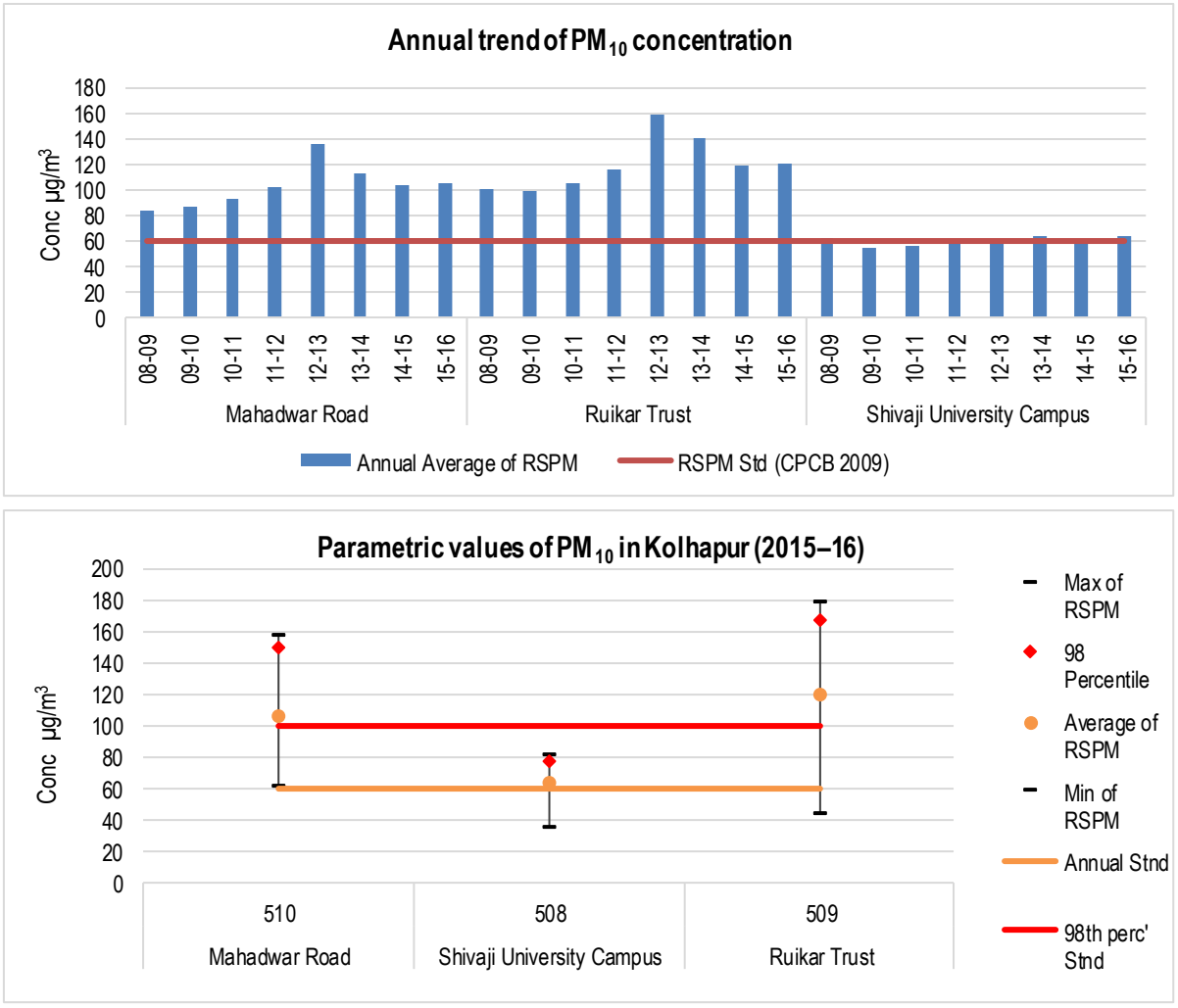



**Figure No. 9: Annual Trend and Parametric concentrations in 2015-16 of $PM_{10}$ in Kolhapur city**
**Data source: Maharashtra Pollution Control Board**

The $PM_{10}$ pollution in Kolhapur city has been relatively higher and both the sites, Mahadwar road and Ruikar trust, have recorded the annual concentrations between 84 and 160 µg/m³, violating the annual standards of (60 µg/m³) by almost 1.5 to 2.5 times, set for $PM_{10}$ by CPCB (Central Pollution Control Board). The area represented by the NAMP site at Shivaji University has been a border line category and recorded $PM_{10}$ concentrations between 60 to 63 µg/m³ for the past five years.

In the year 2015–16, all the three locations exceeded the annual standard and the Mahadwar and Ruikar sites recorded violation of daily standards (100 µg/m$^3$) for more than 50% of the observations and recorded annual concentrations almost double the standards.

The Mahadwar road site and the Ruikar trust site recorded the maximum daily concentration of 150 and 167 µg/m$^3$ respectively in the year 2015–16 violating the daily standard by 1.5 and 1.6 times. The Shivaji university site exceeded the annual standards for 2015–16 but did not violate the daily standards. The daily concentrations at this location were observed to be in a very narrow range (35 to 77 µg/m$^3$) and highly consistent $PM_{10}$ concentrations in the year 2015–16.

### 4.1.5 Air Quality Index 2015–16

To determine the overall air quality, it is suggested to calculate the AQI (Air Quality Index) in order to have a fair idea about the impact of the same on health and assess the vulnerability to susceptible persons. Hence, AQI forms a tool for effective communication on the status of the air quality to people. AQI transforms complex air quality data of various pollutants into a single index value, which is easy to understand. The categories of the AQI are usually expressed in terms of the air quality being 'Good', 'Satisfactory', 'Moderate', 'Poor', 'Very Poor' or 'Severe' based on the concentrations of various pollutants and their health impacts at various concentrations. The AQI for Kolhapur city has been calculated based on the calculation of AQI developed, specifically for India, by CPCB in consultation with IIT (Indian Institute of Technology) Kanpur in the year 2014[18]. Figure No. 10 presents the pollutant wise sub-index and overall AQI of Kolhapur city in the year 2015–16.

The air quality in Kolhapur has been between the categories, 'Moderate' and 'Satisfactory' for most of the time in the year 2015–16. It was about 10 to 12 days, out of 103 observation days, where the air quality was in the 'Good' category especially in the areas near Shivaji University which is relatively less polluted. As for the area near the temple the air quality was in the 'Satisfactory' category for around 38% (40 to 42 days) observation days while the remaining days, about 60 to 63 days the air quality here was of 'Moderate' quality. The Dhabokar corner (AAQMS at Ruikar Trust) which is one of the busiest squares in Kolhapur city recorded around 15% (15 to 16 days) of the observation days in the 'Satisfactory' category while the remaining days were in the 'Moderate' category. Hence based on the occurrence of various categories of AQI one may conclude that the air quality in Kolhapur may cause '*Breathing discomfort to people with lung disease such as asthma and discomfort to people with heart disease, children and older adults'* or may cause *'Minor breathing discomfort to sensitive people'*.

[18] CPCB 2014, *National Air Quality Index*, Central Pollution Control Board, Ministry of Environment & Climate Change, Government of India

One may observe from Figure No. 10, that in case of Kolhapur city it is the high concentration of $PM_{10}$ which determines the overall AQI of the city indicating that it is the high RSPM levels which are a cause of concern and needs immediate attention.

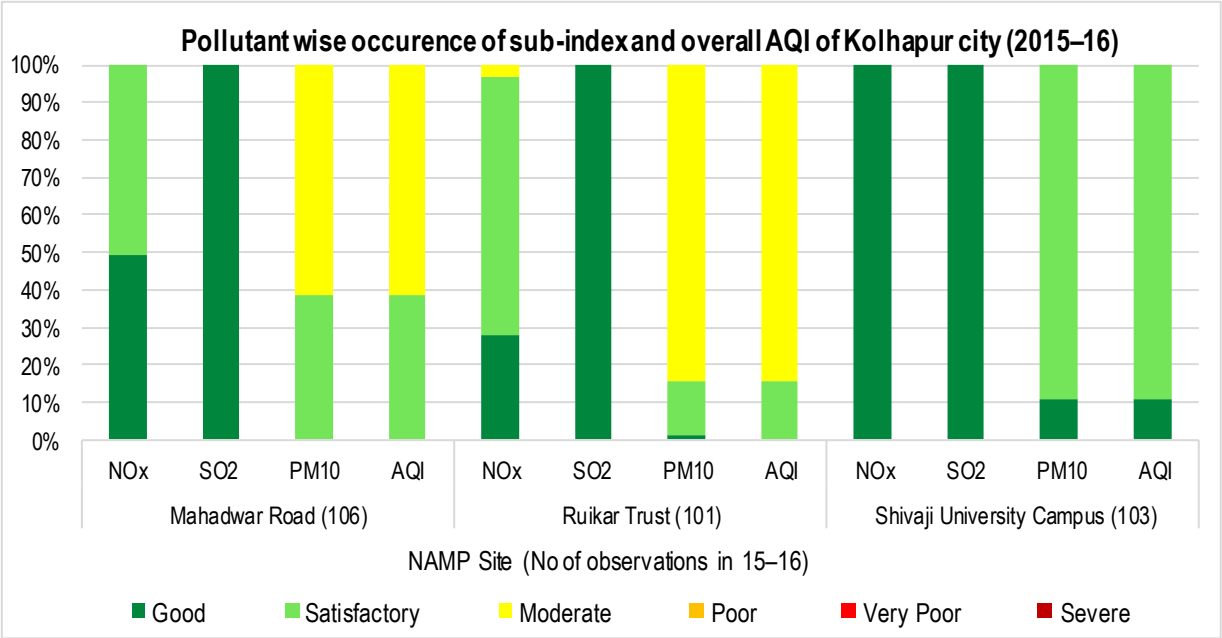



**Figure No. 10: Pollutant wise sub-index and overall AQI of Kolhapur city (2015–16)**
**Data source: Maharashtra Pollution Control Board and AQI calculated by TERI**

## 4.2 Noise Pollution

The increasing noise level in public places from various sources such as loud-speakers, fire crackers, generator sets, music system, vehicular horns and other mechanical devices have harmful effects on human health and psychological wellbeing of people. Hence it is necessary to regulate and control the noise producing sources by maintaining the levels within the standard limits of Noise Pollution (Regulation and Control) Rules, 2000. The rules were made under clause (ii) of sub section (2) of section 3, sub section (1) and clause (b) of subsection (2) of section 6 and section 25 of environment (Protection) Act 1986 (29 of 1986) with rule 5 of the Environment Protection Rules 1986[19].

### 4.2.1 Noise Pollution during Festivals

Noise levels in Kolhapur are monitored by the MPCB during the festivals of Diwali and Ganesh Utsav to keep a check on the exceeding noise decibel levels, which may be caused because of bursting of crackers, loud orchestras and use of loud speakers.

#### 4.2.1.1 Diwali Festival

During the Diwali festival, MPCB has been monitoring noise levels during the Day as well as the Night time for the past 6–7 years. MPCB has identified 8 locations spread across the city

[19] http://envfor.nic.in/legis/noise/noise.html

which represents the city. The locations identified by MPCB are Bhavani Mandap, Bindu Chowk, Khas Baug Maidan, Mahalaxmi Mandir, Papachi tikati, Rajarampuri, Shivaji chowk and Tara Rani.

In the year 2015, MPCB monitored the above locations on 11th, 12th and 13th November during the day as well as night (Figure No. 11). The average noise decibel levels at these locations violated the day (55 dB(A)) and night (45 dB(A)) time standards. The average noise levels were recorded to be between 70 to 75 dB(A) during the day time almost 1.3 times the acceptable levels while the night time average levels were in the range of 56 to 66 dB(A) which violated the standard by 1.2 to 1.5 times. The Papachi tikati area and Bindu chowk recorded the highest day and night time noise levels respectively of about 93 dB(A) at both the locations.

### 4.2.1.2 Ganesh Utsav

MPCB monitors the noise levels at three locations viz, Khas baug maidan, Mahalaxmi Mandir and Rajarampuri. As similar to the monitoring during Diwali festival MPCB has been monitoring the noise levels at these location for the past 6 to 7 years.

In the year 2015–16, all the sites were monitored during the day time and it was observed that all the sites recorded average noise levels above the daytime standards (Figure No. 11). The average noise levels ranged between 70 to 76 dB(A) exceeding the standard by 1.3 times the permissible limit. Khas Baug Maidan area recorded the highest average noise levels of 76 dB(A) as well as the highest maximum noise decibel levels of 101 dB(A) which is almost double the acceptable limits. The other location also recorded highest noise levels of about 97 and 98 dB (A) which is close to two times the limits.

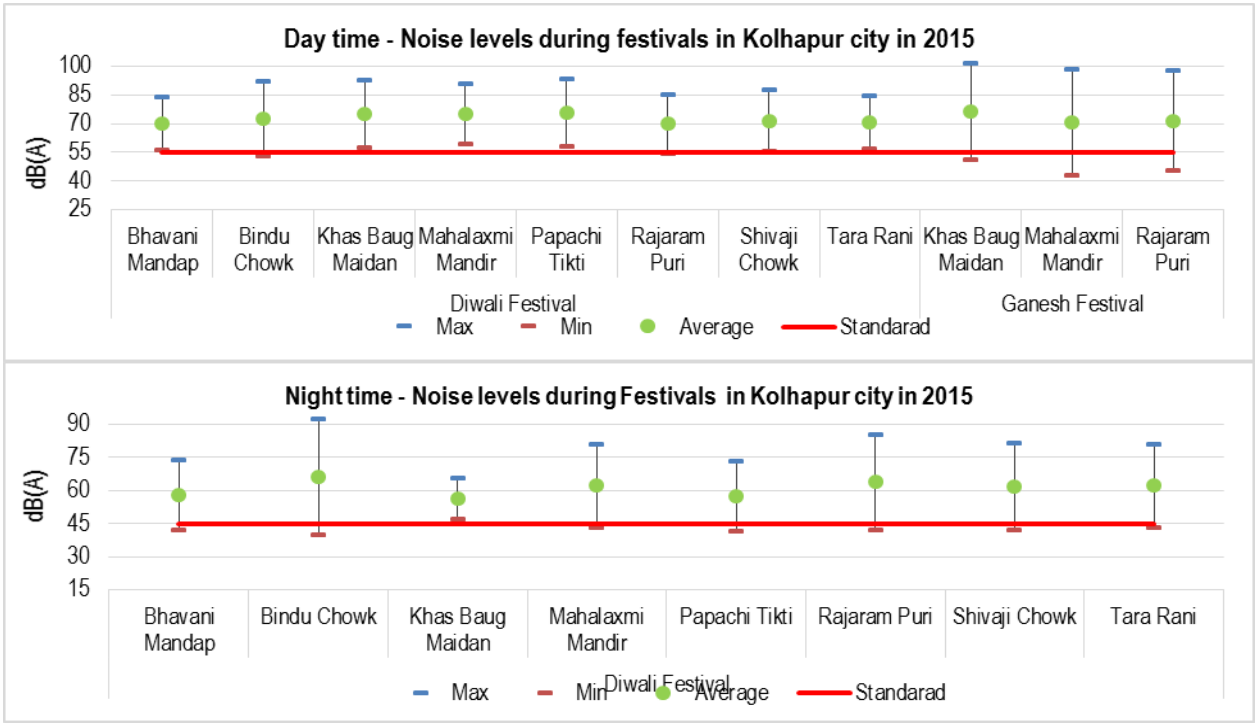



**Figure No. 11: Day & Night time noise levels during Diwali and Ganesh Utsav in Kolhapur (2015)**
**Data source: Maharashtra Pollution Control Board**

## 4.3 Pressures

Air quality is influenced by various activities and is rather a dynamic interaction between the emissions, pollution loads, wind current, temperature and so on. The major source of emissions which exert pressure on the air quality of Kolhapur city, like fuel combustion (transport and domestic), construction activities, mining/quarrying activities and so on have been discussed in this section.

### 4.3.1 Vehicular Growth

Vehicular growth is one of the most critical indicator of air pollution as it directly attributes to fuel consumption and combustion leading to emissions in the ambient air. As on March 31, 2016 it is estimated that there are more than 1.5 Lakh vehicles on road in Karvir taluka (Figure No. 12) and this number has increased from mere 67 thousand in the year 2010–11, indicating a growth by more than double the number of vehicles in past 5 to 6 years.

In the year 2015–16 alone, more than 18 thousand new vehicles got registered in the Karvir taluka, and this has been the highest number of new fleet added to the on road traffic in the past 5 years. This indicates that around 61 new vehicles were added every day[20] to the on road fleet traffic in Karvir taluka. As seen in Figure No. 13, majority of the share in new vehicles is of two wheelers which constitute about 81% of the new registrations followed by four wheelers 18%.

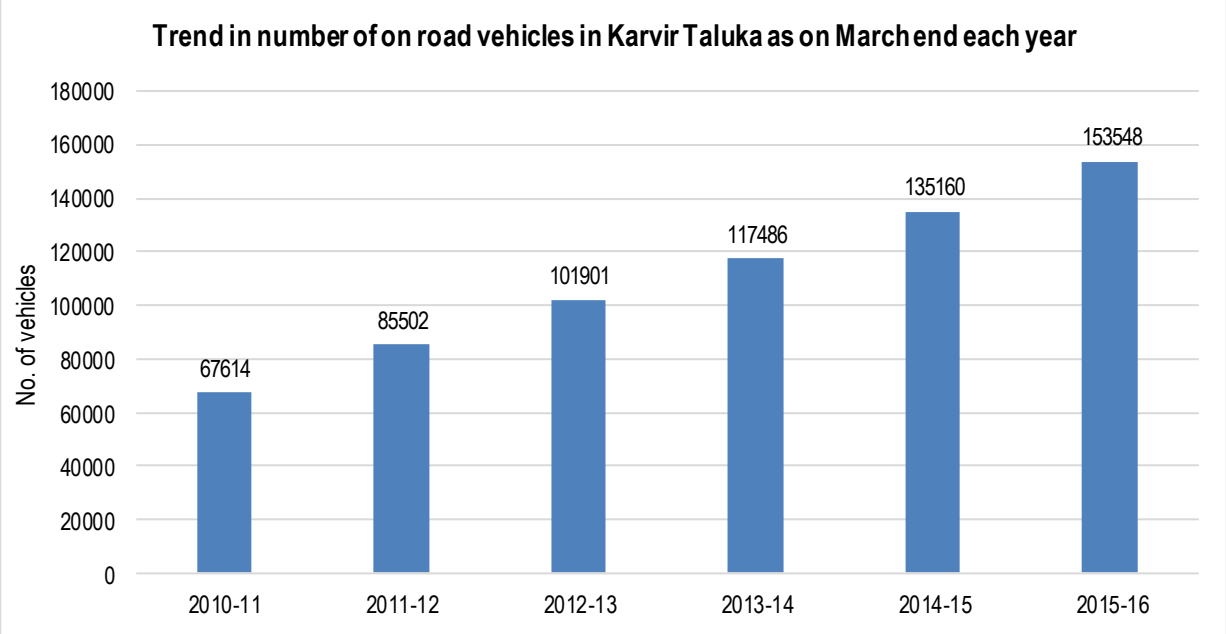



**Figure No. 12: Trend in number of on road vehicles in Karvir taluka as on March end each year**
**Data source: Regional Transport Office, Kolhapur**

[20] Considering 300 working days for RTO

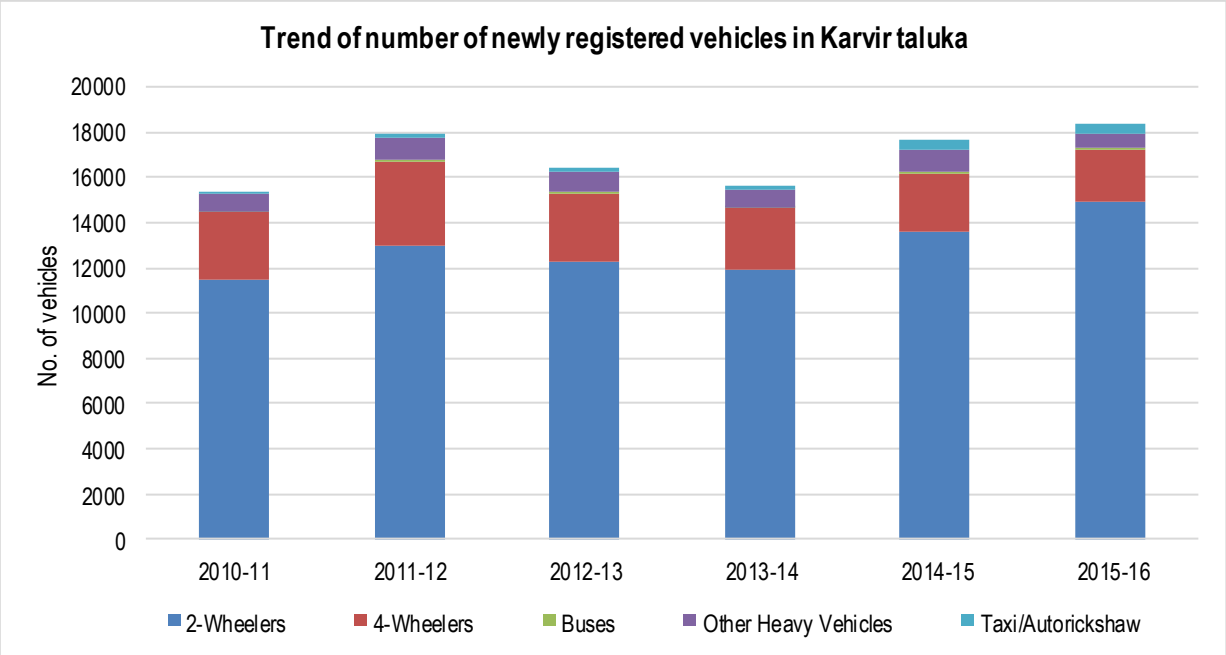



**Figure No. 13: Trend of number of newly registered vehicles in Karvir taluka**
**Data source: Regional Transport Office, Kolhapur**

## 4.3.2Fuel Combustion - Transport sector

The vehicular emissions are directly linked to the combustion of fuels like Petrol, diesel, Auto LPG (Liquefied Petroleum Gas), CNG (Compressed Natural Gas) and so on by the vehicles. As discussed in the previous section it is the two wheeler vehicle population which attribute for the major share, followed by four wheelers, in Kolhapur city and Karvir Taluka. Hence, consumption of Petrol (Motor Spirit) and Diesel (High Speed Diesel) form a key indicator for determining the emission load from vehicular emissions.

One may note from Figure No. 14 that in the year 2015–16, Kolhapur city consumed more than 30 thousand Kl of petrol and diesel from retails sales alone. There has been an increase in sale of petrol and diesel in Kolhapur city in 2015–16 (30 thousand Kl) as compared to 2014–15 (25 thousand Kl) by more than 18%. The consumption for both the fuel has increased proportionately. Out of the total sales, the share for petrol sales accounted for about 67% for both the years, which can be directly correlated to the high number of two wheeler population on road in Kolhapur city.

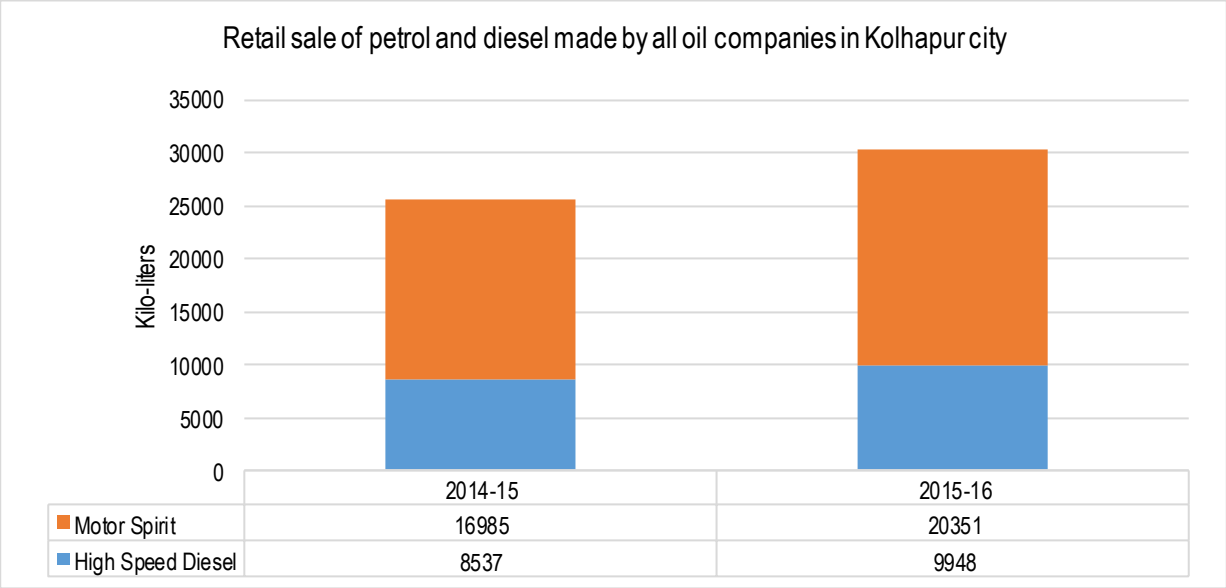



**Figure No. 14: Retail sale of petrol and diesel made by all oil companies in Kolhapur city**
**Data source: Area Sales Manager-Kolhapur Sales Area, Hindustan Petroleum Corporation Ltd.**

## 4.3.3Dependency for domestic Fuel usage

As per data published by Census of 2011 under the household assets and amenities, it is significant to note that almost 87% of the households in Kolhapur city are dependent on LPG (Liquefied Petroleum Gas) for meeting their cooking demands. This indicates a large dependency on LPG as a fuel within the city. Although LPG is considered to be a clean fuel since it does not emit any visible fumes, it emits NOx, CO (Carbon monoxide), organic compounds, and small amounts of $SO_2$ and PM[21].

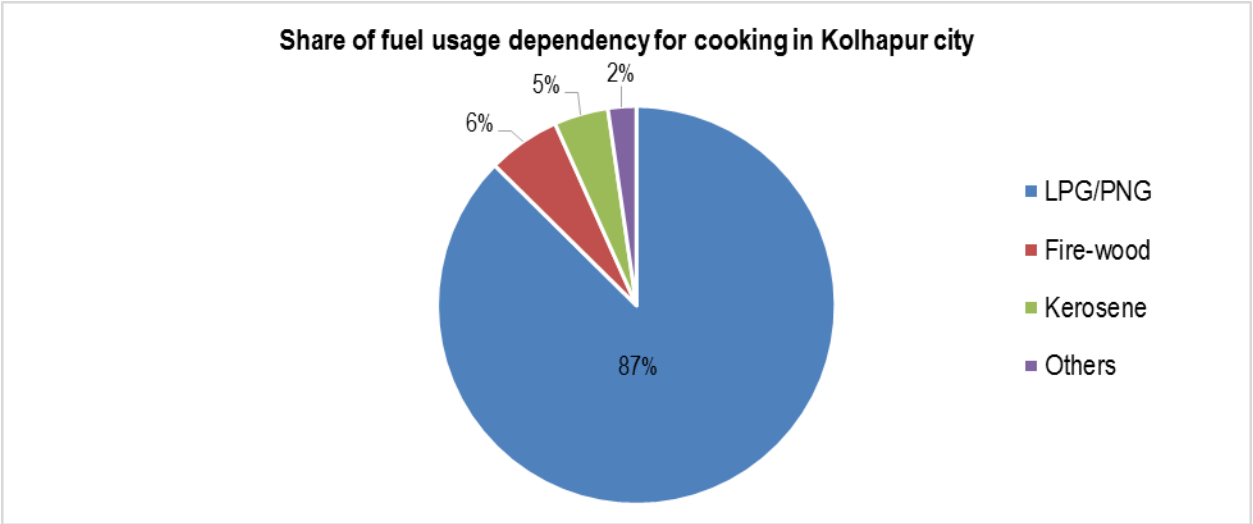



**Figure No. 15: Share of fuel usage dependency for cooking in Kolhapur city**
**Data source: Census of India, 2011**
*Note: Others includes Cow dung cake, Crop residue, Biogas, Coal, Charcoal, no cooking and any other*

[21] https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s05.pdf

## 4.3.4Industrial units in and around Kolhapur city

The city of Kolhapur is surrounded by many industrial areas. There are more than 8300 industrial units (Table No. 6) in the Kolhapur district and out of which about 1600 are categorised as Red or Orange type of industries, indicating that these are moderately or highly polluting industries. The MIDC's of Shirol, Gokul – Shirgaon and Five Star MIDC lie very close to the city. As per data recorded by MPCB Kolhapur, out of the 450 Foundries in the Kolhapur district, about 250 of them are in MIDC Shirol itself while around 15 foundry units are in Udayamnagar of Kolhapur city. The foundries are involved in metal casting and making of dyes are known to emit $SO_2$, NOx, VOC's, CO and PM emissions[22].

The major environmental issue with respect to foundries is the air pollution and unsatisfactory disposal of wastes causing water pollution. Particulate matter emitted from the furnaces in the foundries causes severe air pollution. Foundries are required to have pollution control systems in place to meet the required emission norms. However these systems have been known to be inefficient to sufficiently improve the ambient air quality.

**Table No. 6: Category wise number of Industries in Kolhapur district**

| Type | Red | Orange | Green | Total |
|---|---|---|---|---|
| Large | 102 | 19 | 6 | **127** |
| Medium | 18 | 9 | 11 | **38** |
| Small | 1042 | 537 | 6593 | **8172** |
| **Total** | **1047** | **565** | **6610** | **8337** |

**Data source: Maharashtra Pollution Control Board, Kolhapur**

## 4.3.5Burning of waste

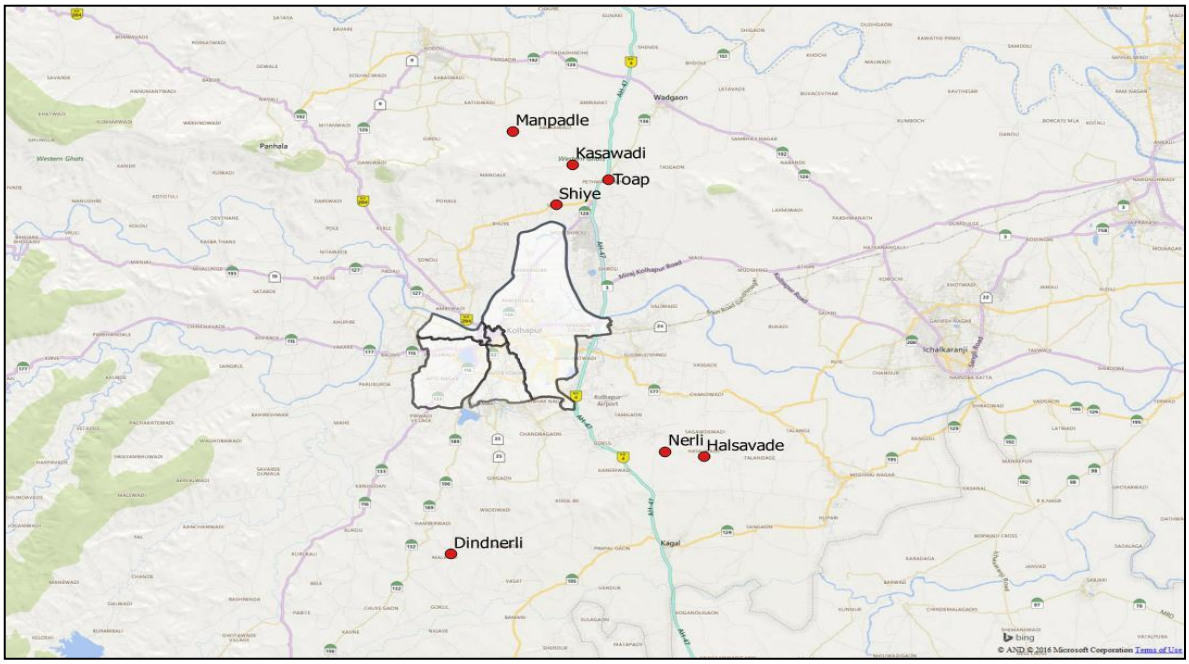
Burning of waste is one of the poorest forms of waste disposal as it is extremely harmful to the environment causing air pollution. When waste is burnt it releases huge amount of PM, soot, ash, sulphides, oxides and so on that pollute the air. Sometimes certain improperly or partially burnt wastes create by products which are extremely dangerous to both the environment and health. By products like soot can end up getting inhaled, mixed with water bodies, get deposited on soil, enter the food chain and further complicate and increase their toxic effects. Many of the components of the residue created by burning of wastes are carcinogenic in nature. Also, burning of substances like plastic, synthetic materials, etc. is even toxic to the environment and health of living organisms than burning wastes such as paper, cloth and organic wastes.

[22] http://www.ifc.org/wps/wcm/connect/4ccab880488554c3b3f4f36a6515bb18/Final+-+Foundries.pdf?MOD=AJPERES&id=1323162141647

## 4.3.6Stone Quarrying and crushing activities

Many of the mining and stone quarrying activities were active in and around Kolhapur city, however many of the quarries have been abandoned as of now. There are 7 active quarries which lie about 10 km from the city limits (Picture No. 3 & Table No. 7). The wind currents may blow in the suspended particulate matter impacting the air quality of the city.

**Picture No. 2: Satellite image of stone quarry activity at village Shiye, near Kolhapur city**
**Source: Google Satellite view, Imagery 2016; Retrived on July 19, 2016**




**Picture No. 3: Satellite image of stone quarries near Kolhapur city**
**Source: Google Satellite view, Imagery 2016, Retrived on August 12, 2016**

**Table No. 7: List of quarries around Kolhapur city**

| Sr No. | Stone Quarry | Distance from Kolhapur city boundary (km) |
|---|---|---|
| 1 | Dindnerli | 10.71 |
| 2 | Halsavade | 8.16 |
| 3 | Nerli | 6.02 |
| 4 | Shiye | 1.2 |
| 5 | Toap | 4.19 |
| 6 | Kasawadi | 4.08 |
| 7 | Manpadle | 7 |

**Data Source: Mining Officer, Collectorate of Kolhapur**

## 4.3.7Construction activities

Construction activities are one of the major sources of dust and particulate matter emissions. It consumes cement, sand, bricks and stones which are mixed, cut and shaped as per use, leading to a lot of emissions during the whole process. It also involves movement of transport vehicles leading to a lot of re-suspension of particulate matter.

There have been a lot of new building permissions approved by the town planning authority of Kolhapur city. As seen in Figure No. 16, more than 8100 permissions have been allotted in the past 5 years for construction activities. About 1500 applications have been approved in the last fiscal year. This indicates that a large amount of construction activities are active within the city.

Apart from this, around 29 km of new roads were also constructed by the KMC in the year 2015–16 (Table No. 8). Out of which around 86% (25 km) of the new roads were constructed using Tar/ Asphalt while about 2% (7 km) was constructed using cement. Both the activities are known to either emit fumes or dust particles.

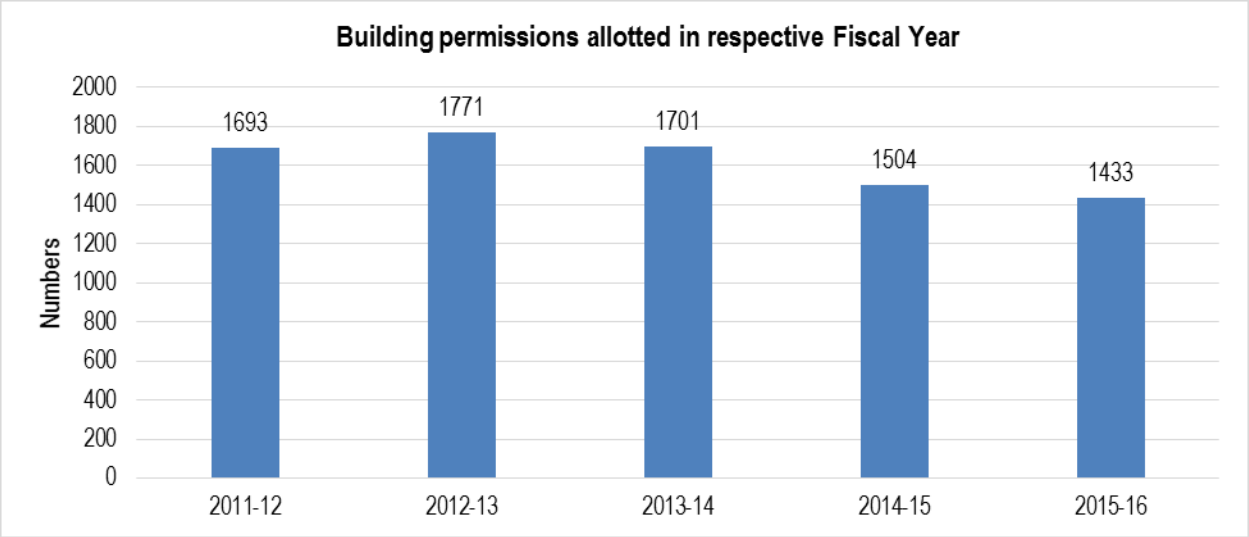



**Figure No. 16: Building permissions allotted in respective fiscal year**
**Data source: Town Planning department, KMC**

**Table No. 8: Road construction activities in 2015-16 in KMC**

| Type of roads | 2014-15 (km) | 2015-16 (km) | Difference (km) |
|---|---|---|---|
| Cement Concrete | 57.4 | 59.5 | 2.1 |
| Tar/Asphalt | 643.76 | 668.84 | 25.08 |
| Gravel roads | 69.04 | 69.9 | 0.86 |
| Others | 22.25 | 23.22 | 0.97 |
| **Total** | **792.45** | **821.46** | **29.01** |

**Source: City Engineering Department, KMC**

## 4.4 Impact

Air pollutants are known to have severe health impacts, especially amongst elderly people and young children. The severity of the health impacts depends upon the duration of exposure, as well as the kind and concentration of chemicals and particles exposed to. The short-term effects of air pollution on humans include irritation of eyes, nose and throat, and upper respiratory infections such as bronchitis while the other impacts of air pollution include headaches, nausea, and allergic reactions. Short-term air pollution could aggravates the medical conditions of individuals with asthma and emphysema. Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continued exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.

Below sections highlight the two specific conditions, nowadays, commonly caused by air pollution. The data represents the cases from only one government hospital of Kolhapur i.e. Savitribai Phule Corporation Hospital.

### 4.4.1 Cases of Bronchitis in Kolhapur city

Bronchitis is a condition in which the bronchial tubes (tubes carrying air to your lungs) become inflamed[23]. The common symptoms are cough, chest pain or discomfort, a low fever, and shortness of breath. It could be of two types short term i.e. Acute and long term i.e. Chronic. Smoking is the main culprit responsible for this condition. However, contact with dust, chemical fumes, and vapors, air pollution also increases your risk for the condition. It has been already proved that prevalence of chronic bronchitis appeared to be greater in areas with higher pollution[24].

[23] http://www.nhlbi.nih.gov/health/health-topics/topics/brnchi
[24] http://www.ncbi.nlm.nih.gov/pubmed/14241880

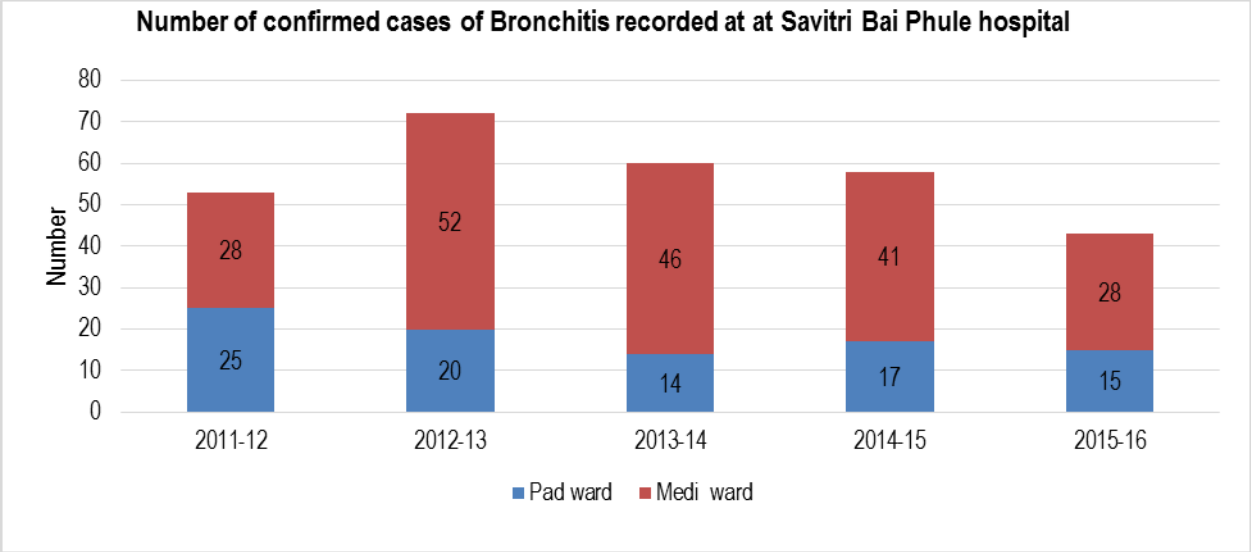



**Figure No. 17: Number of confirmed cases of Bronchitis recorded at Savitri Bai Phule hospital**
**Data source: Health Department, KMC**
**As shown in the**

Figure No. 17, the total number of cases are more or less constant in the past five years. But a decrease in cases has been observed as compared to last year for Pad (Pediatric) and Med (Medical) Ward. A decrease by almost half could be observed in the Medical Ward cases compared to last year.

## 4.4.2Cases of Asthma in Kolhapur city

Asthma is a condition in which your airways narrow and swell and produce extra mucus[25]. As shown in Figure No. 18, the cases in medical ward are constant and it has been proved that adults are more likely to worsen the breathing problems with a rise in winter air pollution[26], which is also evident from the figure as majority of the confirmed cases are from medical ward.

Almost 286 and 95 cases were being reported for bronchitis and asthma respectively in the past five years from a single hospital. The above figures indicate that there is an immediate need to control and decrease the prevalence of bronchitis as well as asthma.

[25] http://www.mayoclinic.org/diseases-conditions/asthma/basics/definition/con-20026992
[26] http://www.aafa.org/page/air-pollution-smog-asthma.aspx

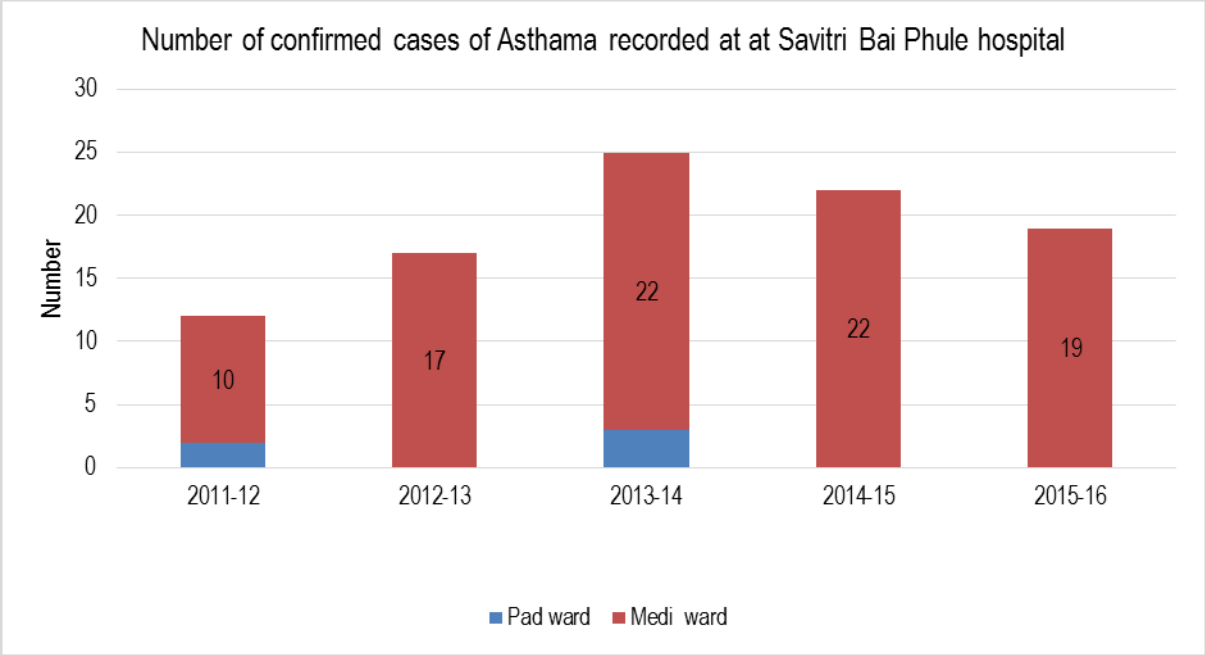



**Figure No. 18: Total number of confirmed Asthma cases from Pad (Pediatric) and Med (Medical) Ward in the past five years**
**Data source: Health Department, KMC**

## 4.5 Response

### 4.5.1 Traffic decongestion

Traffic congestion leads to a lot of combustion of fuel due to continuous idling of vehicles. This leads to unnecessary burning of fuel as well as leads to emissions which could have otherwise been avoided. To avoid such situations, many initiatives have been taken to decongest the traffic in Kolhapur city and a few major ones have been discussed below.

#### 4.5.1.1 One ways routes

In Kolhapur city, there are 25 major junctions which have been installed with traffic signals to control traffic in Kolhapur city however small lanes leading to major junctions lead to traffic congestion and a cascade effect for prolonged traffic jams. Hence such lanes are converted to one way lanes to help avoid congestion. Table No. 9, enlists the 21 lanes in Kolhapur city which have been converted to one way routes for decongestion.

**Table No. 9: List of one way lanes/roads in Kolhapur city**

| Sr No | From | To |
|---|---|---|
| 1 | S T Stand | Parikh Pul |
| 2 | Rajarampuri bus route | Bai cha putla |
| 3 | Bai Cha Putla | Janta Bazar Chowk |
| 4 | Bindu Chowk | Chhatrapati Shivaji Maharaj Putala |
| 5 | Malkar Tikati | Milan Hotel |
| 6 | Maharana Pratap Chowk | Mahanagarpalika (Municipal Corporation) |
| 7 | Lugadi Ol | Maharana Pratap Chowk |
| 8 | Kha So Putala | Durga hotel Chowk |
| 9 | Durga hotel Chowk | Azad Chowk |
| 10 | Azad Chowk | Tembe road |
| 11 | Tembe road | Kha So Putala |
| 12 | Bim Khambi Ganesh Mandir | Papachi tikati |
| 13 | Bim Khambi Ganesh Mandir | Mirajkar tikati |
| 14 | Khari Corner | Bim Khambi Ganesh Mandir |
| 15 | Papachi tikati | Mahanagarpalika (Municipal Corporation) |
| 16 | Chhatrapati Shivaji Maharaj Putala | Papachi tikati (Chappal Line) |
| 17 | Gujari | Mahadwar road |
| 18 | Mahanagarpalika (Municipal Corporation) | Samrat Chowk |
| 19 | Rankala tower | Rankala stand |
| 20 | Rankala stand | Tarabai road |
| 21 | Tarabai road | Rankala tower |

**Source: Traffic Police Office, Kolhapur**

### 4.5.1.2 Vehicular Parking initiatives

Traffic congestion is also caused due to erratic parking of vehicles along the roadside. These vehicles block the lanes and make them unusable, thus shrinking the overall useable space. The major roads and junctions prone to traffic congestions are Tararani road, CPR chowk, Shivaji Pul, Station road, Dabholkar chowk, Venus corner, Bindu chowk and so on. Owing to this specific parking and no parking locations have been identified and declared by the Traffic Police in Kolhapur. Odd and even parking scheme is been implemented between Bindu Chowk and Shivaji Chowk. In Shahpuri area, all lanes need to be converted to odd and even parking scheme and the proposal is pending with the Municipal Corporation.

As per information from Traffic police office of Kolhapur on an average 100 vehicles are fined for parking in no parking zones. In the calendar year 2015, around 13474 and in 2016 (until March) 4259, vehicles were fined on grounds for breaking the law set for no-parking zones.

During festivals and special occasions which invites a lot of foot fall at a particular location, the traffic police make special arrangements for parking of vehicles at various locations across the city. Some of the locations identified by Traffic police have been enlisted in Table No. 10 below. These locations are procured by the traffic police on making special requests to the respective owners for specific time duration to manage the traffic.

**Table No. 10: Locations identified for converting them to parking lots during high footfall days**

| Sr No | Location |
|---|---|
| 1 | Rajaram Chowk |
| 2 | Dr Zakir Hussain Urdu School, Laxmipuri |
| 3 | Bindu Chowk |
| 4 | Private High School |
| 5 | Gandhi Maidan |
| 6 | Khanvilkar Petrol pump |
| 7 | Siddharth Nagar |
| 8 | Panchganga Nadi Ghat |
| 9 | Mail Khadda |
| 10 | Dasra Chowk |

**Source: Traffic Police Office, Kolhapur**

#### 4.5.1.3 No entry for polluting vehicles

The Regional Transport Office has imposed a ban on the diesel operated six seater vehicles from entering the city limits. Around 72 vehicles were found breaching the law and were fined by the RTO for the same in 2015-16.

#### 4.5.1.4 Promotion of cleaner fuels for transportation

LPG (liquid Petroleum Gas) and CNG (Compresses Natural Gas) are relatively cleaner fuels and have been promoted in public vehicles on a large scale across the country. Although there are no CNG vehicles in Kolhapur city, there are about 4217 vehicles (2811 Light Motor Vehicles & 1406 Auto Rickshaws) which run on Petrol and LPG dual combination.

### 4.5.2Promotion of Public transport

KMC has taken a lot of initiatives to promote public transport within the city long back and established a Kolhapur Municipal Transport on April 1, 1962 to promote affordable transport facilities within the city. KMT not only facilitates intra city bus transport but also extends its services 15 to 20 km beyond the city limits to connect the peri-urban areas to the city.

In the year 2015–16, KMT had around 101 buses plying on 28 routes. These routes catered to more than 66 thousand passengers per day on an average and is estimated to cater to about 2.4 crore passengers in the same year.

However one may note from Table No. 11, that there has been a decreasing trend in the overall performance of the KMT. It may be attributed to growth in personalized vehicles thus discouraging the public transport. As compared to 2011–12, the number of passengers travelling

per day has decreased from 96 thousand to about 66 thousand in 2015–16 while the number of routes has reduced from 38 to 28 during the same duration. This can be translated to the fact that the average number of passengers per route has decreased from 2550 to about 2377 indicating that there has been a drastic decline in no of passengers on busy as well as non-busy routes.

**Table No. 11: Trend in annual statistics indicating performance of KMT**

| Sr. No. | Item | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 |
|---|---|---|---|---|---|---|
| 1 | No. of buses (Diesel) | 119 | 126 | 120 | 92 | 101 |
| 2 | No. of depots | 1 | 1 | 1 | 1 | 1 |
| 3 | No. of routes | 38 | 33 | 31 | 29 | 28 |
| 4 | No. of passengers travelling in a day | 96,889 | 99,974 | 97,732 | 70,520 | 66,561 |
| 5 | No. of passengers travelling in a Month | 2,906,670 | 2,999,220 | 2,931,960 | 2,115,600 | 1,996,830 |
| 6 | Distance travelled by buses per day (km) | 29,456 | 24,773 | 30,246 | 22,334 | 26,753 |
| 7 | Annual Diesel consumption (in Liters) | 2,498,396 | 2,327,902 | 2,175,674 | 2,306,383 | 2,261,285 |
| 8 | No. of employees | 1143 | 1059 | 991 | 1134 | 899 |

**Data source: KMT, Kolhapur**

## 4.6 Recommendations

From the status of the air quality one may conclude that the air in Kolhapur is polluted with NOx and PM pollutants. This indicates that the pollution is mainly because of the vehicular emissions. PM pollution is generally high in the state of Maharashtra and the condition is no different for Kolhapur city. Since PM pollution has various different sources there has to be a multi-pronged approach which should be incorporated by the corporation to reduce the same in the city. The following discusses the recommendations which may be adopted by the corporation on priority to reduce the air pollution levels.

### 4.6.1 Traffic Decongestion

#### 4.6.1.1 Parking policy and dedicated parking zones

It is been observed that there is no proper parking place in the city except for a few identified lanes by the RTO. However, people often park the vehicles along the road side thus reducing the actual usable road width.

Multilevel parking places should be constructed especially in congested areas like near the Mahalaxmi Temple, Bindu chowk, Shivaji Market and so on. Vehicles should not be allowed to be parked along the roadside in these areas.

Parking areas are to be made compulsory for all commercial and mixed buildings in Kolhapur. This can be included in the Bye laws of the city by the town planning department. The existing buildings should also create parking areas especially in the busy roads and lanes.

Heavy fine may be imposed by the traffic police for breach of this law and the existing parking rules may be imposed with strict vigilance.

#### 4.6.1.2 Traffic decongestion and management initiatives

- New one way lanes should be identified and declared especially for the ones which are highly congested and cannot carry two way traffic.
- Hawking zone may be declared and illegal hawkers may be diverted to dedicated zones and areas. It has been noted that hawkers encroach the lanes and thus congest the lanes.
- No entry for heavy vehicles in busy and congested areas may be declared in Kolhapur city.
- All the signals in Kolhapur city should be installed with timers to discourage idling of vehicles for longer durations.
- Phasing out of older and vintage vehicles can also help in improving in the air quality of Kolhapur. Since new engines are more efficient in burning of fuel and release less soot and smoke they must be promoted by phasing out the on road older vehicles.
- Public transport in Kolhapur city has been adversely affected due to increase and usage of personal vehicles. Public vehicle usage must be promoted in Kolhapur city by taking various initiatives.

### 4.6.2 Vigilance during construction activities

Construction activities give rise to various particulate matter. It is important to practice and implement various strategies during the same. The town planning authority can integrate the same at the policy level and the strategies could be inspired from the GRIHA (Green Rating for Integrated Habitat Assessment) - Rating System. The strategic could include the following good practices

- Provision of 3 meter high barricading around the construction area
- Wheel washing facility at the vehicular entrance of the site
- Covering of fine aggregate and excavated earth on site with plastic sheets/green shade fabric etc.
- Water sprinkling on fine aggregate (sand) and excavated earth. Periodic sprinkling of water at the site could help reduce dispersion of dust particles, cement, sand and other aerosols into the air. Treated water from the STP could be procured from for this activity.

### 4.6.3 Stone quarry activities

Stone quarry activities includes blasting, drilling, stone crushing as well as movement of Heavy Earth Mover Machines which causes air and noise pollution. MPCB has released '*Guidelines for*

*Environmentally Sound Operations for Stone Quarries'* in the December 2006[27]. Any Stone quarry activity in and around the Kolhapur city should be regulated and operated based on these guidelines.

Sprinkling of water using treated water from STP and Wheel washing facility for the vehicles entering and exiting the quarry premises should be made mandatory. This could effectively help serve two objectives, reuse of treated water as well as reduction in dispersion of PM and dust.

### 4.6.4Road sweeping and washing

Vehicular movement along the road leads to re-suspension of the road side dust. KMC already undertakes sweeping of the roads within the city. Taking the initiative one step further treated water from the STP could be used for washing of roads and supressing the dust particles which may arise due to vehicular movement.

### 4.6.5Commissioning new Monitoring sites

As per calculations presented in Table No. 12, Kolhapur Municipal Corporation should install at least 4 more regular AAQMS (Ambient Air Quality Monitoring Stations) in the city. Further as the city has a lot of vehicular density, it is highly recommended to also monitor CO (Carbon Monoxide) and Tropospheric ozone levels. Hence to fulfil all the criteria it is highly recommended that KMC should install 4 CAAQMS at strategic locations across the city. A separate study may be undertaken to identify the locations for installing these sites.

**Table No. 12: Existing and recommended number of ambient air monitoring stations in Kolhapur**

| Sr No | Heads | | Numbers | Source/Calculation |
|---|---|---|---|---|
| A | Kolhapur City Population | | 549,283 | Census of India 2011 |
| B | Existing Number of Stations | | 3 | Sites under NAMP |
| C | Minimum No. of AAQ Monitoring Stations for the Pollutant | SPM | 7 | = 4 + 0.6 per 1,00,000 population<br>= 4 + ((0.6 X 549283)/100000) |
| D | | $SO_2$ | 5 | = 2.5 + 0.5 per 1,00,000 population<br>= 2.5 + ((0.5 X 549283)/100000) |
| E | | $NO_2$ | 7 | = 4 + 0.6 per 1,00,000 population<br>= 4 + ((0.6 X 549283)/100000) |
| F | | CO | 2 | = 1 + 0.15 per 1,00,000 population<br>= 1 + ((0.15 X 549283)/100000) |
| G | Minimum AAQMS Required | | 7 | = Maximum amongst C to F |
| H | Additional number of stations desired | | 4 | = G – B |

**Source: Calculated by TERI as per IS: 5182 (Part 14), 2000, Methods for Measurement of Air Pollution, Part 14: Guidelines for Planning the Sampling of Atmosphere[28]**

[27] http://mpcb.gov.in/ereports/pdf/GUIDELINES%20FOR%20STONE%20QUARRYING.pdf
[28] https://law.resource.org/pub/in/bis/S02/is.5182.14.2000.pdf

# 5 Water Resources

Water is one of the essential natural resources for all living things on earth. As per the estimates by United Nations, the availability of fresh water on earth is about 3% out of which 75% is present at Polar Regions, in the form of ice, 22.6% in form of groundwater and remaining is in form of lakes and rivers[29]. These water resources are used for various applications like drinking, sanitation, agricultural and irrigation activities, transportation, recreational activities like boating and industrial purposes.The city of Kolhapur is blessed with rich water resources like rivers, lakes and healthy ground water table. The following section presents the status of surface and ground water in KMC, vis-a-vis the pressure and impact on these resources and the response taken by KMC in order to protect and conserve these resources.

## 5.1 Status – Surface Water

### 5.1.1River

Panchganga River lies along the Kolhapur city and borders about 18.31 km out of 44.62[30] km of the city's periphery. The five rivers - the Kasari, the Kumbhi, the Tulsi, the Bhogawati and the Dhamni convene at the Prayag Sangam to form Panchaganga River. The river covers a distance of about 80 km from its origin at Prayag Sangam, at Chikli village in Karvir Taluka to its mouth at Narsobawadi where its drains in the Krishna river thus forming a major tributary of the Krishna river. As per data records maintained by KMC, the river has a catchment area spread across 2538 $km^2$ and the city of Kolhapur depends on the river as a source of drinking water for the city. The river is surrounded by Ghat in northwest with many small and large size temples on the periphery.

**Picture No. 4: View of Panchganga River**
**Photo Credits: TERI**

[29] Ministry of Water Resources, River Development and Ganga Rejuvenation, 2014
[30] Calculated from Google Earth

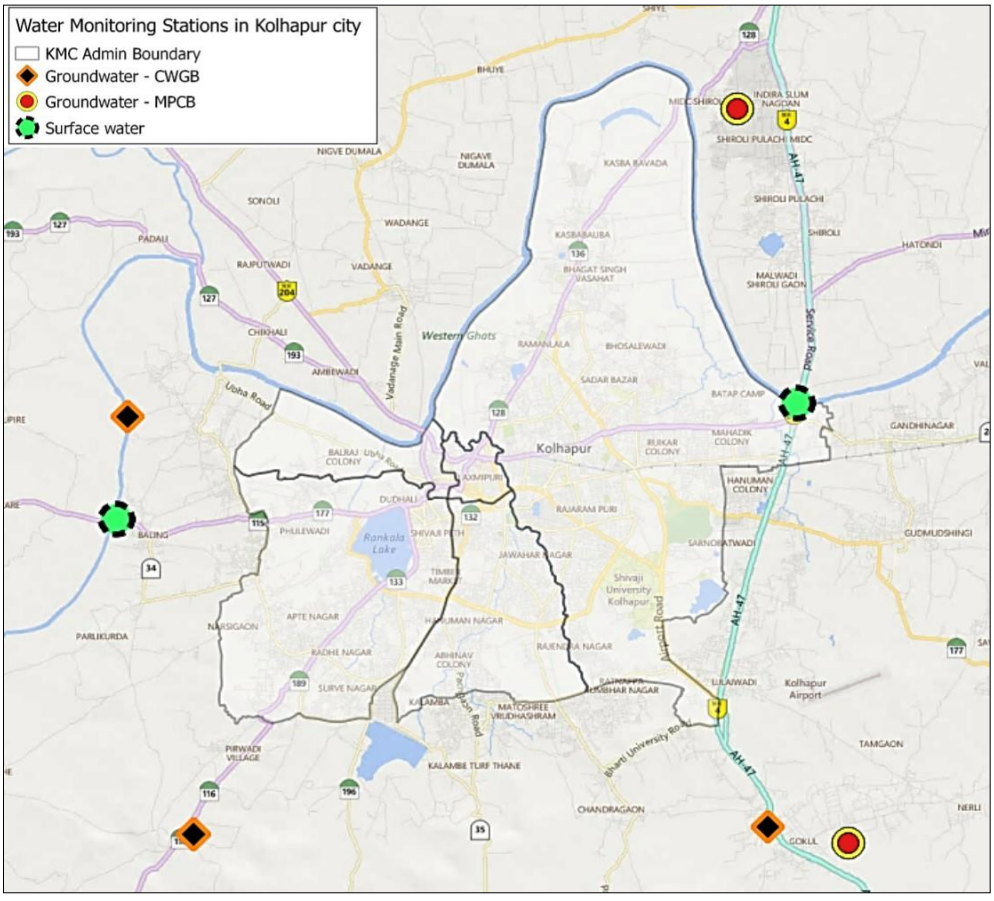
MPCB (Maharashtra Pollution Control Board) has established a network of monitoring stations on rivers across the state. There are two water monitoring stations established under National Water Monitoring Programme (NWMP), on River Panchganga. One lies upstream of Kolhapur city, near Balinga Pumping station in Karvir Taluka and the other is located downstream of Kolhapur city near MIDC area at Gandhi Nagar in Kolhapur.

The monitoring is carried out by MPCB every month for total 44 parameters which includes analysis of general parameters (like Turbidity, Hardness, COD), core parameters (like BOD, pH, Nitrate, Total Coliform, DO, temperature, conductivity) and trace metals (like Arsenic, lead, cadmium and so on). The location of the monitoring stations are represented in Table No. 13 and represented in Map No. 2.

**Table No. 13: Details of Water Quality Monitoring Stations in Kolhapur City**

| Basin | Sub-Basin | Station ID | Station Name |
|---|---|---|---|
| Krishna | Krishna Upper | 1904 | Panchganga River at U/s of Kolhapur town near Balinga Pumping Station |
| | | 1905 | Panchaganga river at D/s of Kolhapur town at Gandhi nagar near NH-4 bridge and MIDC intake well |

**Source: Maharashtra Pollution Control Board**




**Map No. 2: Water Monitoring stations in Kolhapur city**
**Source: Maharashtra Pollution Control Board; Central Ground Water Board**

In 1970, the National Sanitation Foundation, USA developed the Water Quality Index (NSFWQI), a standardized method for comparing the water quality of various water bodies. The water quality index represents a single number which expresses the overall water quality of that water body located in specific area or region considering criteria parameters. The WQI transforms complex water quality data into information that is understandable and usable by the public. It gives the general idea of water quality and possible problems with water in a particular area. The WQI based on National Sanitation Foundation (NSF) was calculated using the annual data recorded by WQMS of Kolhapur city using parameters like BOD, pH, DO and Faecal coliform. The WQI for surface water of Kolhapur city for last 5 years is represented in Table No. 14.

It is observed that the overall water quality of Panchganga River for last 5 years has been recorded under the category, 'Good' to 'Excellent' for both the water monitoring stations. The Monitoring station located near Balinga Pumping station, upstream of Kolhapur city recorded WQI in the category 'Good to Excellent' quality throughout the year till 2012–13. The deterioration in WQI was observed thereafter till the current year 2015–16 which recorded 5 observations under the 'Medium to Very Bad' category. The downstream station at Gandhi Nagar recorded WQI under the 'Good to Excellent' category throughout the year in 2012–13. In 2014-15, the 2 observations recorded at the same station 'Medium to Good' category while only one observation was noted in 'Bad' category. The 2015-16 showed almost all observations under the 'Good to Excellent' category.

**Table No. 14 : WQI of Panchganga River in Kolhapur city (2011-2016)**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mar** | 81 | 86 | Dry | Dry | 78 | 83 | 78 | Dry | Dry | 81 |
| **Feb** | 79 | 85 | 57 | 63 | 58 | 78 | 82 | 64 | 62 | 55 |
| **Jan** | 69 | 77 | 75 | Dry | 72 | 64 | 77 | 71 | Dry | 75 |
| **Dec** | 75 | 79 | 84 | Dry | 77 | 75 | 83 | 79 | Dry | 72 |
| **Nov** | 82 | 81 | 72 | 62 | 67 | 82 | 75 | 65 | 65 | 69 |
| **Oct** | 84 | 85 | 34 | 64 | 81 | 62 | 85 | Dry | 64 | 78 |
| **Sep** | 86 | 84 | 84 | 67 | 75 | 84 | 85 | 85 | 61 | 77 |
| **Aug** | 80 | 84 | 84 | 65 | 81 | 76 | 85 | 72 | 64 | 79 |
| **Jul** | 64 | 83 | 77 | 65 | 77 | 64 | 72 | 67 | 64 | 77 |
| **Jun** | 80 | 81 | 88 | 66 | 80 | 77 | 87 | 71 | 64 | 82 |
| **May** | Dry | 79 | 83 | 64 | 72 | 87 | 73 | 82 | 66 | 74 |
| **Apr** | 80 | 77 | 83 | 44 | 81 | 84 | 74 | 77 | 41 | 80 |
| **FY** | **11-12** | **12-13** | **13-14** | **14-15** | **15-16** | **11-12** | **12-13** | **13-14** | **14-15** | **15-16** |
| **Station name** | Panchganga River at U/s of Kolhapur town near Balinga Pumping Station | | | | | Panchaganga river at D/s of Kolhapur town at Gandhi nagar near NH-4 bridge and MIDC intake well. | | | | |
| **Station code** | 1904 | | | | | 1905 | | | | |
| **Sub-Basin** | Krishna Upper | | | | | | | | | |
| **Basin** | Krishna | | | | | | | | | |

Legend

| Good to Excellent | Medium to Good | Bad | Bad to Very Bad | Dry |
|---|---|---|---|---|

**Source: Water Quality Status of Maharashtra 2015–16**

#### 5.1.1.1 Court Case

1. Mr. Dattatray Mane had filed a P.I.L (183/2012) at the Hon. High Court, Mumbai regarding the water pollution of Panchganga River.
2. Under this PIL, a committee has been formed consisting of Divisional Commissioner, Pune; District Collector, Chief of Zilla Parishad and Officers of Ichalkaranji Municipal Council; local officers from Maharashtra Pollution Control Board and Mr. Uday Gaikwad, Environment expert. Necessary initiatives have been taken under the guidance of the committee.
3. 2 Sub committees have also been formed under the chairmanship of Divisional Commissioner, Pune for the purpose of monitoring and coordination of the mitigation activities of the Panchaganga pollution issue.
    a. Review Committee- Under the Chairmanship of District collector, Kolhapur
    b. Inspection Committee- Under the chairmanship of Sub divisional Officer, Karvir
4. KMC is adopting various measures to reduce the pollution of Panchganga River.

### 5.1.2Lakes

There are 6 major lakes (Table No. 15) in Kolhapur city which cover 3% of entire area of Kolhapur city. The city is dependent on these resources for various activities including water supply, fishing, irrigation, recreation and so on. Apart from these, Kolhapur city has other lakes like Lasktirth, New Palace Lake and 2 lakes at Shivaji University campus.

#### 5.1.2.1 Kalamba Lake

Kalamba lies on the outskirts of the Kolhapur city with area of 63.13 hectares. The Kalamba Lake was built on the stream coming from Katyayani hill situated on the southern side of city in 1873 to provide water to Kolhapur city. The water from lake is used for various purposes such as water supply to the city, fishing activities and irrigation activities. The upstream area of the lake is declared as non-development zone to prevent pollution and contamination of water body.

#### 5.1.2.2 Hanuman Lake

This lake was developed in the year 2002-03 and is surrounded by garden. The water from the lake is used for domestic purposes by the people in the vicinity.

#### 5.1.2.3 Raman Mala

The Raman Mala Lake is located in Kasaba Bavada area and the lake has been leased by KMC for 30 years to a private company (Dream Land) for development of a Water Park for recreational activities.

### 5.1.2.4 Rajaram Lake

The Rajaram Lake lies in the vicinity of the Shivaji University and was built in the year 1928. Water from this lake is used for fishing, irrigation and other domestic purposes.

### 5.1.2.5 Kotitirth Lake

This lake is located near Shahu Mill. The lake has a number of temples near the bank and is used for idol immersion as well as offering *Pooja*. Currently the water from the lake is also used for domestic purposes.

**Table No. 15: List of lakes in Kolhapur city**

| Sr No | Name of lake | Area (hectares) | Depth (Meters) |
|---|---|---|---|
| 1 | Rankala | 107 | 30 |
| 2 | Kalamaba | 63.13 | 14 |
| 3 | Kotitirth | 5.8 | 60 |
| 4 | Hanuman | 0.85 | 3 |
| 5 | Rajaram | 21.6 | 11 |
| 6 | Raman Mala | 1.85 | 4 |

**Source: Environmental Status Report 2014–15 of Kolhapur city, KMC**

### 5.1.2.6 Rankala Lake

Rankala Lake is situated in south west of the city and was developed during the reign of Chhatrapati Shahu Maharaja (1877–1883[31]). The lake has a temple of God Rank Bhairav at the center and a Rankala tower at the bank of lake.[32] To the south east of the lake lies the Padmaraje garden and to the north lies the Shalini Palace which is currently the only star rated Palace hotel in Maharashtra. The lake is blessed with water aquifers at the bottom which recharge the water body continuously. The lake is spread across a total area of 107 ha with fan shape catchment area of 700 ha and depth of 15m[33] and has a total capacity of lake is 4350.14 ML. Currently the Rankala Lake acts as source of water for irrigation and also recreational activities for tourists

#### *5.1.2.6.1 Water Quality Status*

Rankala is the biggest of all the lakes in Kolhapur city with a strong historical background. MPCB conducts monthly water quality tests of Rankala Lake and has been conducting the same from the past 3 to 4 years. Water samples are collected from Raj Ghat and the quality of water monitored in the year 2015 is presented in Table No. 16 which represents the water quality of Rankala Lake for 5 months in 2015. From Table No. 16; all the parameters are observed to be within the permissible limit as per the standard prescribed by CPCB, indicating the water quality to be good in the Rankala Lake. This may be attributed to the pro-active initiatives undertaken by the KMC discussed in the response section (5.4 ) below.

[31] Dr.D.H.Pawar,Physico-Chemical Status of the Water of Historical Lakes and Tanks in Kolhapur City, Pg no.2,2012
[32] http://www.kolhapurcorporation.gov.in/english/Tourist_Rankala_Lake.html
[33] http://www.moef.nic.in/sites/default/files/nlcp/Lakes/Rankala%20Lake.pdf

**Picture No. 5: View of the Rankala Lake**
**Photo Credit: TERI**

**Table No. 16: Water quality of Rankala Lake at Raj Ghat (2015)**

| | Standard | Month (2015) | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **Inland surface water** | **April** | **May** | **June** | **Aug** | **Sept** |
| pH | 5.5-9.0 | 7.4 | 8.0 | 8.2 | 7.6 | 7.8 |
| D.O | 5 mg/l | 2.9 | - | 5.0 | 4.8 | 0.38 |
| B.O.D. | 30 mg/l | 5.4 | 6.0 | 4.8 | 4.2 | 4 |
| C.O.D. | 250 mg/l | 24 | 48.0 | 32.0 | 32 | 24 |
| Suspended Solids | 100 | 12 | 16.0 | 10 | 22 | 12 |
| Oil And Grease | 10 | BDL | BDL | BDL | BDL | BDL |

**Data Source: Maharashtra Pollution Control Board, Kolhapur**
*BDL: Below Detection Limit*

#### *5.1.2.6.2 Court Case Status – Rankala Lake*

1. Mr. Sunil Kundalik Kembade, a citizen of Kolhapur, has filed a petition (No. 18/ 2015) with the Green Tribunal, Pune regarding the conservation aspect of Rankala Lake.
2. Green Tribunal had issued an order on December 12, 2015 regarding reviewing of the work from NLCP Phase II and developing of project report by the concerned organization.
3. Kolhapur Municipal Corporation (KMC) had appointed M. S. University, Baroda for developing the report. With respect to this, M. S. University, Baroda has presented the report to the tribunal on February 27, 2016. In the report, M. S. University, Baroda has recommended to conduct a detailed study and develop a DPR regarding the locations of STP and removal of silt/debris from Rankala Lake.
4. In the report submitted by M. S. University, Baroda from Kolhapur Municipal Corporation states that the work is in progress.

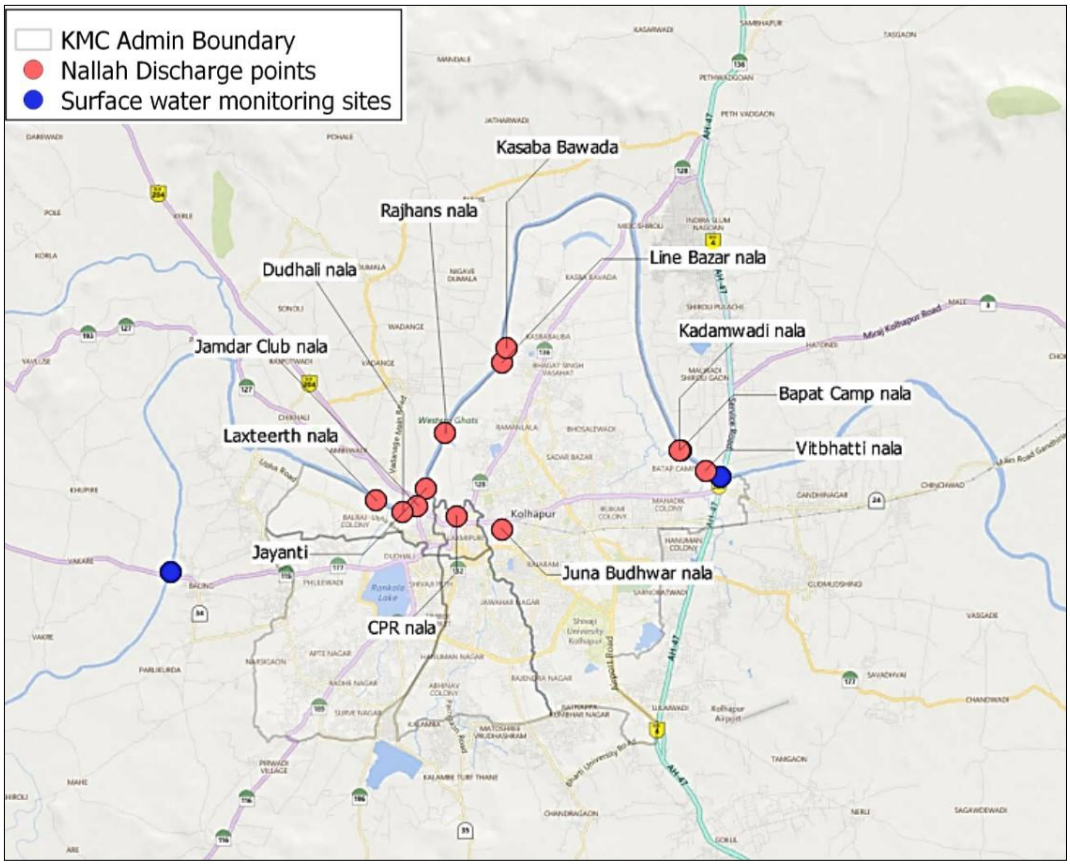
## 5.1.3Nallahs

Nallahs are the natural storm water drainage systems which carries the surface runoff during the monsoon season into rivers. Kolhapur city has 5 major nallahs – Dudhali, Jayanti, Bapat Camp, Line Bazar and Veet Bhati nallah. The total length of these nallahs is estimated to be about 94 km and all these drain into Panchganga River (Map No. 3). The list of nallahs and sub-nallahs with its catchment area is tabulated in Table No. 17 below. Currently due to urbanization there is a direct release of sewage and waste water into these nallahs which has been known to pollute the river.

**Table No. 17: List of Nallahs and sub nallahs in Kolhapur city**

| Sr no. | Main Nallah | Sub-Nallah | Catchment area (hec) |
|---|---|---|---|
| 1) | Dudhali | Phulewadi and Dudhali | 1447.87 |
| | | Laxtirth | 260.23 |
| | | Jamadar Club | 19.63 |
| 2) | Jayanti | Jayanti | 2446.62 |
| | | CPR | 20.21 |
| | | Juna Budhawar | 26.91 |
| 3) | Bapat Camp | Bapat camp | 982.83 |
| | | Kawala Naka | 592.83 |
| 4) | Line Bazar | Rajhauns | 106.82 |
| | | Raman Mala | 125.96 |
| | | Dream world | 107.66 |
| | | Laine Bazar | 196.01 |
| | | Kasaba Bawada | 131.09 |
| 5) | Veet Bhati | Veet Bhati | 217.33 |
| | **Total** | | **6682** |

**Source: Environment Report KMC, 2014-15**




**Map No. 3: Number of Nallahs discharge points in Kolhapur city**
**Source: Water Supply Department, KMC**

## 5.2 Pressure – Surface Water

### 5.2.1 Release of untreated sewage

There is no underground drainage in the city and drainage is mainly by surface drains. The large amount of sewage through nallahs -Jayanti nallah, Dudhali nallah, Bapat Camp nallah and Line Bazaar nallah (6 MLD) is directly discharged into Panchganga River. This subject has been further elaborated in section (6.2) of this report. About 75 to 80% is estimated to be domestic sewage whereas the remaining includes industrial (sugar, distilleries, textile) and non-point sources like agricultural runoff[34].

### 5.2.2 Leachate release/discharge

Open dumps and landfills are the most common ways of disposal of solid waste. During rainfall the water percolates through the landfill and the contaminants are leached from the solid waste which is known as leachate. This leachate contain high organic matter, heavy metals and toxic chemicals. This leachate accumulates at the bottom of the landfill, percolates through

[34] S. Kamble, *Water Pollution and Public Health Issues in Kolhapur City in Maharashtra*, 2014

the soil and reaches the groundwater. Such contamination of groundwater results in a substantial risk to local groundwater user and to the natural environment[35].

## 5.2.3Release of religious offerings

Rivers in India are worshipped as holy places by number of pilgrims. Due to certain rituals and practices the water of the river/lake indirectly gets polluted and contaminated. Religious activities during festivals produce solid waste in the form of *Nirmalaya* and idols. The idols when immersed in rivers results in the release of heavy metals like copper, zinc, lead, chromium and iron. Panchganga River and Lakes across the city are used as source for immersion of Ganesh idols in the city. A total of 20,271 *Ganesh* idols (Table No. 18) were recorded to have been immersed in the rivers/lakes in the year 2015-16. The offerings like flowers, cotton, eatables like *Prasad* further increase the suspended solids in water and also leads to eutrophication of water deteriorating the quality of water.

**Table No. 18: Idols immersed across various immersion locations and admin offices of KMC**

| Size of idol | Received at Location/Administrative office | Number of idols |
|---|---|---|
| Big (Sarvajanik) | Panchganga river-Shukarwar Peth | 485 |
| | Panchganga river-Rajaram Bandhara Kasaba Bawada | 129 |
| | Panchganga Bapat Campus | 30 |
| | Rankala Lake | 20 |
| | Kotitirta | 2 |
| | Rajaram Lake | 5 |
| Small | Gandhi Maidan | 3,460 |
| | Shivaji Market | 6,240 |
| | Rajarampuri | 2440 |
| | Kalvala Naka | 7,460 |
| **Total** | | **20,271** |

**Source: Environment Department, KMC**

## 5.2.4Runoff from agricultural fields

Agriculture is one of the major economic contributors of Kolhapur city. Kolhapur is located on the Deccan plateau which is rich in black soil and the availability of water suitable for agricultural activities.[36] The use of pesticides and fertilizers for agriculture acts as a non-point source of water pollution. Micro nutrients like NPK (Nitrogen –Phosphorus-Potassium) and micro nutrients like Zinc and iron are used as fertilizers for agriculture in Kolhapur city[37]. The Nitrogen and ammonia from these fertilizers are converted into nitrate and nitrite which tend to deplete the oxygen levels in water[38][39]. Also the large amount of phosphates acts as catalysts for the growth of algae in water bodies[40].

[35] S. K.Singh, *Groundwater Contamination due to Bhalaswa Landfill Site in New Delhi*, 2009
[36] City Development Plan 2031, Kolhapur ,Pg No.7
[37] http://agritech.tnau.ac.in/agriculture/sugarcrops_sugarcane.html#fert
[38] http://people.oregonstate.edu/~muirp/eutrophi.htm
[39] http://protectingwater.com/agriculture.html
[40] https://msu.edu/course/lbs/171l/Phosphate.html

It is commonly observed that the flood irrigation procedure is implemented in Kolhapur because of abundant availability of water in the region. This leads to increased surface run off which carries along with it, the pesticides and chemical fertilizers, draining the chemicals into the river body. As many of the agricultural fields lie along the river banks, (Picture No. 6) the threat arising from the surface runoff is high.

**Picture No. 6: Agricultural fields in the vicinity of Panchganga River**
**Photo Credit: TERI**

## 5.3 Impacts – Surface Water

### 5.3.1 Loss of aesthetic beauty

Dumping of garbage, plastics, religious offerings and release of sewage into water resources produces a visual impact as well as unpleasant odor to the water. It deteriorates the quality of water thus destroying its natural beauty.

### 5.3.2 Eutrophication

The industrial and agricultural runoff is mainly rich in nutrients like phosphates and nitrates. These nutrients stimulate the growth of algae when released into rivers and lakes, resulting into algal bloom. The algal bloom releases several toxins which further deteriorate the taste and odour of water. The overgrowth of algae also blocks sunlight obstructing the photosynthesis process of phytoplantons thus disrupting the ecosystem, depleting the oxygen content in water, and exerting a stress on the aquatic environment.

## 5.3.3Weed Infestation

Similarly, water enriched with nutrients like nitrogen, ammonia and phosphorus stimulate the growth of aquatic weeds. Aquatic weeds are unwanted plants which over grow making water bodies unfit. Some common aquatic weeds are *Eichhornia crassipes*, *Salvinia molesta, Nymphaea stellate, Hydrillla verticilla, Pistia stratiotes, Nitella spp* and so on[41]. The water hyacinth, *Eichhornia crassipes (Mart) Solens* is an invasive plant (native of Amazon Basin) invading many lakes, ponds and rivers. It is considered as the world's worst water weed which doubles its area within five days (Ranks in the top 100 list of the most dangerous invasive species of IUCN and the Top 20 list of Spain's GEIB (Biological Invasion Specialist Group[42])[43]. The weeds usually grow in river bodies which are enriched with plant nutrients like NPK [44] Rankala Lake was infested with water hyacinth in October 2008 (Picture No. 7).

## 5.3.4Loss of Biodiversity

The water pollutants released into water body like toxic chemicals and heavy metals produces abnormal conditions like changes in water temperatures, which can interfere with metabolic and productivity rate of the aquatic life causing disease, genetic mutations, birth defects behavioural changes, and death of aquatic life. Most of the toxins settle to the seafloor and then are taken in by organisms that live or feed on bottom sediments. These toxins get accumulated in the organism and are passed along the food chain causing Bio magnification.

**Picture No. 7: Weed Infestation at Rankala Lake in October 2008**
**Photo Credit: KMC**

[41] J.Varshney ,Current Status of Aquatic weeds and their Management in India
[42]E.Téllez ,The Water Hyacinth, Eichhornia crassipes: an invasive plant in the Guadiana River Basin (Spain)
[43]J.Mironga ,The effect of water Hyacinth, Eichhornia Crassipes, infestation on phytoplankton productivity in Lake Naivasha and the status of control,
[44] http://www.cabi.org/isc/datasheet/20544

## 5.4 Response – Surface Water

Considering the importance and significance of these water resources there have been various remedial measures undertaken by the corporation at various levels. The following section discusses the key initiatives undertaken by KMC.

### 5.4.1 Changes in Drainage system

Release of untreated sewage is one of the most critical reason attributed to pollution of Rankala Lake and Panchganga River. Over the past few years KMC has diverted all the Nallahs and drainage lines which were released into the river and lakes. This has significantly helped in reduction of the pollution levels. The proper and systematic drainage system is being constructed and diverted under the schemes like UIDSSMT, AMRUT and other government funds in order to reduce river pollution. The details are further elaborated in Section (6.2.3) of this report.

### 5.4.2 Initiatives under NLCP (National Lake Conservation Plan)

In October, 2006, MoEF sanctioned a project under NLCP (National Lake Conservation Program) for the restoration and conservation of Rankala Lake to the Kolhapur Municipal Corporation at an estimated cost of INR 8.65 crore. Some of the activities under the project for Phase-1 included the following:

- Demarcation of lake boundaries, cleaning and removal of aquatic weeds, de –weeding and de-silting (Picture No. 8), treatment of lake body and lake peripherals etc.
- Timely removal of water hyacinth and silt.
- Separate arrangement for washing of clothes, animals have also been made by KMC for avoiding direct contamination of water and diversion of waste water to drainage system.

**Picture No. 8: De-weeding operation (left) and De-silting (right) at Rankala Lake**

**Photo Credit: KMC**

## 5.4.3 Initiatives to prevent organic pollution

- Use of Poly aluminium chloride (PAC) and use of boats for aeration to reduce BOD levels.
- Coffer dam constructed at Padpath to control the growth of blue green algae
- Citizen Level Monitoring Committee (CLMC) is formed by KMC which comprises of environmental expertise who visit and recommend suggestions which are adopted by KMC to prevent pollution.

## 5.4.4 Immersion or Idols

- Separate arrangement for immersion of 21 feet Ganesh idols by KMC
- Donation of Ganesh idols for immersion and disposal at Takala quarry site. About 33,019 of idols were donated in 2015-16.
- 62% of Ganesh idols are sent to the Irani quarry site for reuse of inert materials.
- A total 140 MT of Nirmalaya waste was collected and sent to waste management for further process.

## 5.4.5 Awareness Drive

Public awareness and sensitization is one of the major key initiatives required for reducing the pollution of water bodies. Apart from making technical integrations in the system and structural changes, KMC also focuses on public awareness. KMC displays slogan boards (Picture No. 9) at different places for public awareness in order to control water pollution.


**Picture No. 9: Slogans Boards for public awareness set up by KMC**
**Photo Credit: KMC**

## 5.5 Status - Groundwater

Groundwater is the water found in the cracks and spaces in soil, sand and rock[45] and is one of the most dependable sources of water which is commonly extracted through dugwells, borewells and tubewells. As per the information available there are more than 800 borewells in Kolhapur city[46] and the ground water is used in the city to meet the water demands which also includes drinking. About 47 borewells are owned by the Kolhapur Municipal Corporation and out of these, 4 borewells have been dug up in 2015-16 and the average depth of each well is about 60 meters.

### 5.5.1 Groundwater table

The stations of CGWB (Central Ground Water Board) at Khupire, Washi and Gokul Shirgaon which lie about 2 km from the city have been considered as a representation of the ground water table in the city. The information for ground water table was analysed for a period of 6 years (2010 to 2015) and is represented in Figure No. 19 below.

In 2015, the lowest level of water i.e. depth of 6.675 m bgl was observed at the Washi monitoring station followed by station at Gokul shirgaon (1.17m) and Khupire (1.025m). Washi station has recorded the lowest water level pre monsoon compared to all the years. The other two areas Gokul Shirgaon and Khupire shows increase in water table from previous year 2014–15. The average depth of ground water table at Gokul Shirgoan for pre monsoon season ranges from 0.8 m to 2 m bgl for last few years. This area lies in MIDC zone and recorded increase in water table with 1.2 m bgl, half than 1.45 m bgl as recorded last year 2014. The Khupire area recorded groundwater levels of 1.0 meters bgl as compared to 1.4 meters bgl in the previous year 2014.

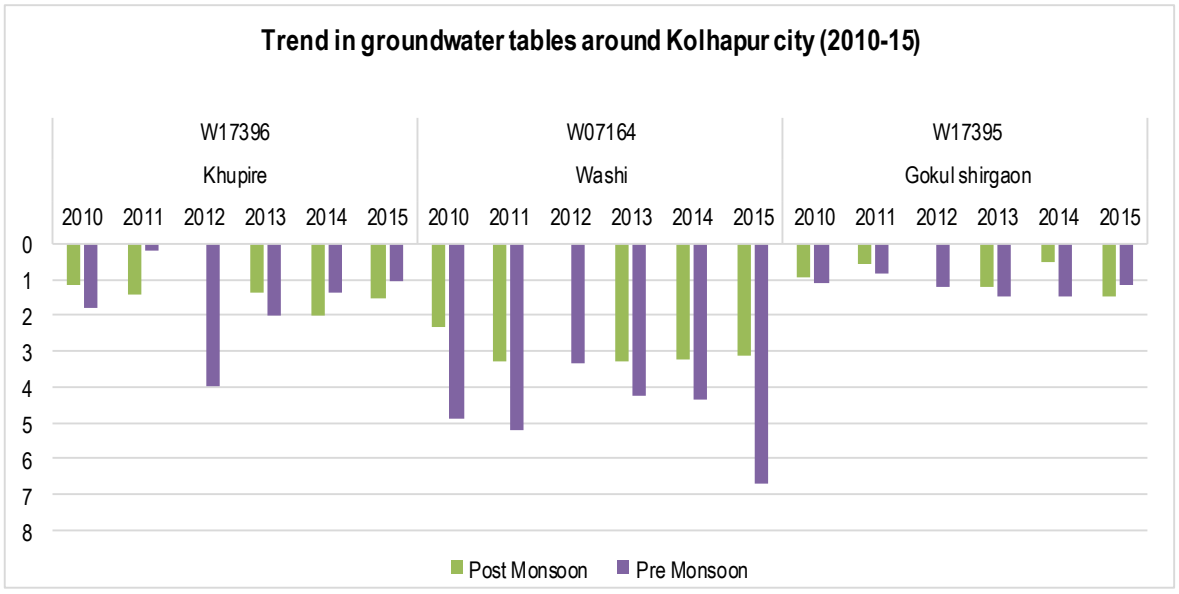



**Figure No. 19: Trend in groundwater levels around Kolhapur city (2010-15)**
**Source: Central Ground Water Board**

[45] http://www.groundwater.org/get-informed/basics/groundwater.html
[46] Environmental Status report 2014-15, KMC

## 5.5.2Groundwater Quality

Ground water quality of the borewell located at MIDC Shiroli and MIDC Gokul at Shirgoan are monitored by MPCB once in six months. Since these are the closest ground water samples being monitored near Kolhapur city they have been considered as representative for estimating the quality of ground water in Kolhapur city. Map No. 2 represents the spatial location and details of groundwater monitoring stations.

Parameters like pH, Total hardness, Calcium, Magnesium, Chloride, total dissolved solids, Fluoride, Manganese, Nitrate, Sulphates and so on are analysed for determining the quality of water. The observations recorded by MPCB at 2 borewells (Shirgoan and Gokul) are further calculated to determine the Water Quality Index. The WQI for groundwater is calculated using pH, Hardness, fluoride and nitrate as key parameters. The WQI for groundwater in Kolhapur city for the past 5 years is represented in Table No. 19.

The WQI of groundwater recorded the water quality to be in Good to Excellent category for Hatkanangale site and Very Poor category for Karvir site. A severe deterioration in water quality could be observed in the year 2014- 15 for both the sites. The water quality was in the "Very Poor" category for Hatkanangale site and was recorded under the category "Not suitable for drinking" in the Karvir area. So the water quality has relatively improved compared to last year. In the previous years, before 2014- 15, the average water quality was recorded under the "Good to Excellent" category for both the stations.

**Table No. 19: WQI of Groundwater for Kolhapur city (2011-2016)**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Oct** | 71 | 53 | 53 | NA | 72 | 97 | 33 | 40 | NA | 218 |
| **Apr** | 58 | 30 | 29 | 226 | **26** | 100 | 27 | 32 | 380 | 206 |
| **FY** | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 |
| **Taluka** | Hatkanangale | | | | | Karvir | | | | |
| **Station name** | Bore Well at MIDC Shiroli near M/s. Pratibha Enterprises | | | | | Bore Well at MIDC Gokul Shirgaon | | | | |
| **Station code** | 2829 | | | | | 2830 | | | | |

Legend

| Excellent | Good | Poor | Very Poor | Not suitable for drinking | Dry |
|---|---|---|---|---|---|

**Source: Water quality Status of Maharashtra 2015-16, Maharashtra Pollution Control board**

# 5.6 Pressure & Impact

## 5.6.1 Increasing Bore-wells

There are around 800 registered borewells within the Kolhapur city out of these the KMC had about total 47 borewells under their ownership through which it supplies water. Out of the 47 bore wells, 4 bore wells were newly established in the reporting year. The list of newly registered bore wells is tabulated in Table No. 20.

**Table No. 20: Registered bore wells in Kolhapur city in 2015-16**

| Year of establishment | Location of bore well | Diameter (inch) | Water discharge (ltr) |
|---|---|---|---|
| 25.08.2015 | Shahupuri- Santh Godobha Udhyan | 4 | 3000 |
| 25.09.2015 | Bhosalewadi-Saamtha High School | 6 | 2500 |
| 16.10.2015 | Bapat Campus | 6 | 2500 |
| 20.11.2015 | Yashwant Nagar Davari Vasant | 4 | 3000 |

**Source: Water Supply Department, KMC**

## 5.6.2 Reduction in groundwater tables

Excessive pumping can lead to groundwater depletion, where groundwater is extracted from an aquifer at a rate faster than it can be replenished. This results in lowering of the water table. Further, as the water table goes down, more energy is required to pump out the water, increasing the power costs[47][48]. Besides depletion of groundwater this may further lead to loss of vegetation and its associated habitat. One of the major effects of groundwater depletion is land subsidence. Also the loss of subsurface water can result in change of soil composition resulting in a change in land pattern[49].

One may note from Figure No. 19, that the ground water table at the Washi location has depleted more than 3 meters in the past three years from about 3.3 mbgl to 6.6 mbgl.

[47] http://www.groundwater.org/get-informed/groundwater/overuse.html
[48] http://groundwater.sdsu.edu/
[49] http://water.usgs.gov/edu/gwdepletion.html

## 5.7 Response – Groundwater

### 5.7.1 Incentivizing and promoting Rain Water Harvesting (RWH)

From the year 2005 onwards, the KMC has made it mandatory for the properties having area equal to/greater than 300 sq m for installing RWH structures. For the past years (2011 – 2016), more than 1700 properties have implemented the Rain water harvesting within their premises. The breakup of properties is represented in the Figure No. 20 where it is noted that Rain water harvesting is highest in the Residential sector (77%) followed by Mixed category (14%) and Remaining 8% in Commercial zone. 1% of rain water harvesting is practiced in the Others category which includes educational, hospitals and Religious places.

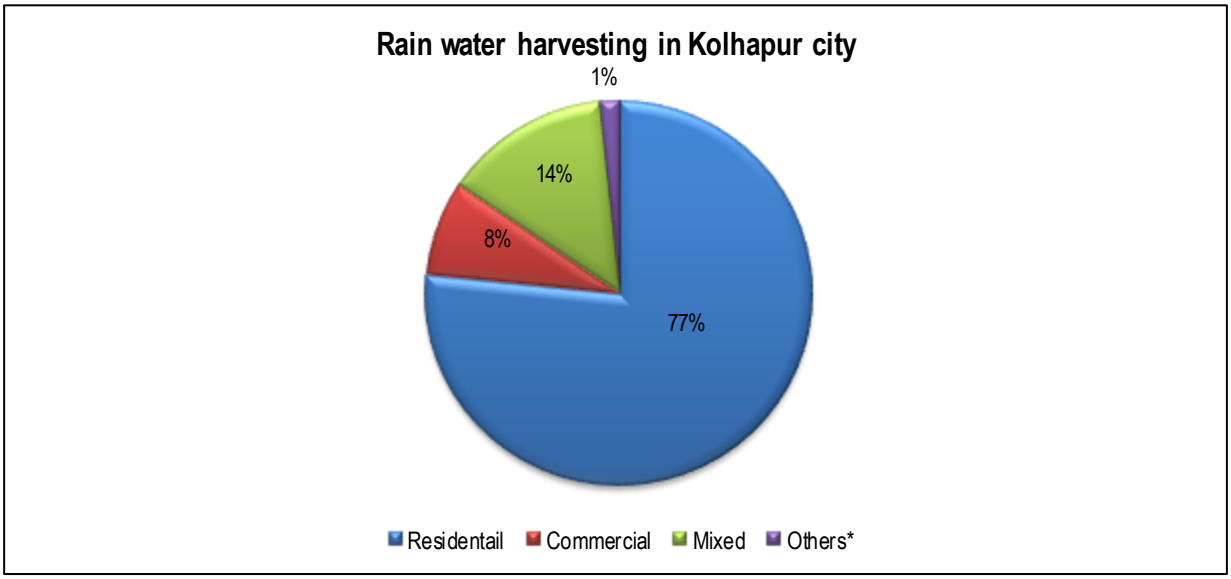



**Figure No. 20: Rain Water Harvesting in Kolhapur city**
**Others*-Institute, Industries, Hospitals, Education institute and Religious places**
**Source: Town Planning Department, KMC**

## 5.8 Recommendations

### 5.8.1 Monitoring infrastructure and analysis

As per recommended in the Section 66 of Maharashtra Municipal Corporation Act 1949, KMC should establish an environmental laboratory to conduct water quality monitoring of the water samples from the following:

- Weekly monitoring of Panchganga River
    - At two locations, one each at upstream and downstream of Kolhapur city
    - Around 15 locations covering upstream and downstream of all the Nallah release points on Panchganaga river
    - Upstream and downstream of all nallahs

- Monthly monitoring and analysis of water samples from all the lakes Kalamba, Hanuman, Raman Mala, Rajaram, Kotithirth and Rankala Lake.
- Monthly monitoring of ground water samples from various
- Weekly monitoring and quality analysis of the Leachate generate data the dumping site as well as at the proposed land fill site.

### 5.8.2 Policy framework for installing Bore wells

KMC should undertake a survey to develop a detailed inventory of the number of bore wells within the city. As for the new installations, it is recommended that new bores should be approved by the corporation with appropriate inventory. The applications should be linked to conditional approval, that all the bore wells should be augmented with a rain water recharging well structure.

The other detailed recommendations have been presented in the Water Management section 6.2.4

# 6 Water Management

## 6.1 Water Supply-Status

The Section 189, of Maharashtra Municipal Corporations Act 1949, states that it is incumbent of the Commissioner to ensure sufficient water for the residents' reasonable requirements[50], if the Commissioner has given public notice in a portion of the city that the Corporation has arranged to supply water to the area from public water works through private or public water connections (and where water benefit tax will be levied)[51]. Kolhapur Municipal Corporation has been obliged to supply water to the city and has been doing so since its formation.

### 6.1.1 Source – Quantitative and Qualitative

Kolhapur Municipal Corporation supplies about 120 to 130 MLD of water to Kolhapur city with an estimated average per-capita supply of about 135 LPCD (Litres per capita per day), including water for domestic, commercial, floating population, fire fighting, industrial and institutional usage and so on.

KMC has installed jack wells with total capacity of 137 MLD (Table No. 21) to lift water primarily sourced from the rivers, Panchganga and Bhogawati, which are about 1 to 2 km from the city. Raw water of about 129 MLD, 95% of surface water lifting is done from these rivers. Apart from this, water is also sourced from Kalamba Lake, which is used to draw up to 8 MLD water for Kolhapur city. Apart from these there are about 44 bore wells from which KMC undertakes water supply through takers. It is estimated that about 0.2 MLD of water is supplied through this source. KMC collects and sends water samples from all the WTP to the District Divisional Public Health Laboratory, Kolhapur for testing and analysis. The water received at the treatment plant is usually hazy and has an agreeable odour to it and the pH of this raw water is between pH 7 to 8 (Table No. 22).

**Table No. 21: Existing water sources and their capacities for Kolhapur city**

| Sr No | Name of Jackwell | Capacity (MLD) | Source |
|---|---|---|---|
| 1 | Shingnapur | 86 | Panchganga river |
| 2 | Balinga | 31 | Bhogawati |
| 3 | Nagdewadi | 12 | Bhogawati |
| 4 | Kalamba | 8 | Kalamba Lake |
| | **Total** | **137** | |

**Data source: City water supply and Drainage division, KMC**

[50] Section 189, Maharashtra Municipal Corporations Act 1949
[51] Section 130.1(b), Maharashtra Municipal Corporations 1949

**Table No. 22: Raw water quality of water samples as received at the WTPs in 2015–16**

| Sr.No | Test Parameters | Units | Water Treatment Plant | | | |
|---|---|---|---|---|---|---|
| | | | Puikhadi | Balinga | Bawda | Kalamba |
| 1 | Physical Appearance | | Sl. Hazy | Hazy | Sl. Hazy | Hazy |
| 2 | Odour | | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Turbidity | N.T.U | 2.92 – 34.3 | 2.81 - 18.17 | 0.48 - 10.05 | 1.71 - 18.29 |
| 4 | pH Value | | 7.1 -7.50 | 7.1 - 7.6 | 7.2 - 7.5 | 7.1 - 7.50 |
| 5 | Chlorides (as Cl) | mg/l | 14.0 -40.0 | 18.0 - 46.0 | 19.99 - 39.58 | 18.0 - 40.0 |
| 6 | Nitrates (as $NO_3$) | mg/l | 1.03 - 7.13 | 1.14 - 9.82 | 0.25 - 25.44 | 1.39 - 7.11 |
| 7 | Total Hardness ($CaCO_3$) | mg/l | 28.0-60.0 | 23.74 - 114.0 | 32.0 - 80.0 | 36.0 - 110.0 |
| 8 | Alkalinity ($CaCO_3$) | mg/l | 24.0 - 60.0 | 20.4 - 96.0 | 32.0 - 70.0 | 38.0 - 98.0 |
| 9 | Total Dissolved Solids | mg/l | 40.0 - 70.0 | 40.0 - 140 | 40.0 - 100.0 | 50.0 - 140.0 |
| 10 | Iron (as Fe) | mg/l | 0.01 - 0.06 | 0.01 - 0.03 | 0.02 - 0.05 | 0.02 - 0.08 |
| 11 | Fluoride (as F) | mg/l | Not Detected | 0.0 - 0.06 | 0.02 - 0.05 | 0.06 - 0.081 |

**Data source: the District Divisional Public Health Laboratory, Kolhapur**

## 6.1.2Water Treatment Plants – Quantitative and Qualitative

The raw water thus sourced from the jack wells is then transferred to the water treatment plants for treatment and purification before they are supplied to the city. There are four water treatment plants (Table No. 23) operated and maintained by KMC which have a combined capacity of 137 MLD.

**Table No. 23: Existing water sources and their capacities for Kolhapur city**

| Sr No | Name of Water Treatment Plant | Capacity (MLD) |
|---|---|---|
| 1 | Puikhadi | 50 |
| 2 | Balinga | 43 |
| 3 | Bawda | 36 |
| 4 | Kalamba | 8 |
| | **Total** | **137** |

**Data source: City water supply and Drainage division, KMC**

**Picture No. 10: The 36 MLD Water Treatment Plant at Kasba Bawda**
**Photo Credit: TERI**

## 6.1.3Water Distribution

Once the water gets treated at the treatment plants it is supplied to the city through the water supply network. The water supply distribution network is divided into 22 zones. There are in all 28 storage reservoirs, 20 ESRs (Elevated Storage Reservoirs) and 8 GSR (Ground Water Reservoirs) with a total capacity of about 53 Million Litres.

Table No. 24 enlists the capacities, ward and the name of the storage reservoirs in Kolhapur city. Out of the 140,748 households in Kolhapur city, around 89% (125,505) of the households are connected with water supply lines of about 600 km in length. About 5% of the total connection holders are supplied water through direct pumping from the distribution system, namely in the areas of Subhash Nagar, Javhar Nagar and Jiwba Nana Park area and the remaining connections are supplied water through the ESR's and GSR's. The 1.25 Lakh households are supplied water through 99,553 metered water connections. As seen in Table No. 25, around 97% of the consumers are of residential type while the commercial and industrial connections account for mere 2% and 1% respectively.

**Table No. 24: List of Elevated and Ground Storage Reservoirs and their capacities in Kolhapur**

| Sr. No. | Name | Ward | Type | Capacity (Lakh Litres) |
|---|---|---|---|---|
| 1 | Sakokhe Nagar | A | ESR | 22.5 |
| 2 | Kawala Naka | E | | 22.5 |
| 3 | Bawada Filetr House | E | | 22.5 |
| 4 | Tarabai Park | E | | 22.5 |
| 5 | Lukhey Bazar (Galli No.9) | E | | 22 |
| 6 | Market Yard (New) | E | | 20 |
| 7 | Bawada (New) | E | | 20 |
| 8 | Apte Nagar | A | | 18 |
| 9 | Kalamba Filter House | A | | 18 |
| 10 | Panicha Khajina | B | | 15 |
| 11 | Shenda Park | B | | 15 |
| 12 | Jarag Nagar | B | | 15 |
| 13 | Phulewadi | A | | 15 |
| 14 | Rajarampuri | E | | 13.5 |
| 15 | Koknemath | C | | 13.5 |
| 16 | Shahupuri (New) | E | | 10 |
| 17 | Vaibhav Tekadi | E | | 10 |
| 18 | Rajendra Nagar | E | | 9.5 |
| 19 | Padmavati | A | | 5 |
| 20 | Pukhadi Filter House | A | | 5 |
| 21 | Chambukhadi | A | GSR | 95 |
| 22 | Puikhadi | A | | 70 |
| 23 | Panicha Khajina | B | | 10 |
| 24 | Tembalai No. 3 | E | | 10 |
| 25 | Rajarampuri | E | | 9 |
| 26 | Tembalai No. 1 | E | | 9 |
| 27 | Tembalai No. 2 | E | | 9 |
| 28 | Shalini | B | | 2.5 |
| | **Total Capacity** | | | **529** |

**Data Source: City water supply and Drainage division, KMC**

**Table No. 25: Ward and type wise number of water supply connections in Kolhapur city**

| | Number of Connections | | | |
|---|---|---|---|---|
| **Ward** | **Residential** | **Commercial** | **Industrial** | **Total** |
| A | 28,588 | 215 | 288 | 29,091 |
| B | 19,040 | 262 | 205 | 19,507 |
| C | 4,369 | 205 | 134 | 4,708 |
| D | 5,735 | 56 | 35 | 5,826 |
| E | 34,522 | 826 | 520 | 35,868 |
| Govt. | 149 | 168 | 7 | 324 |
| Rural | 4,216 | 12 | 1 | 4,229 |
| **Total** | **96,619** | **1,744** | **1,190** | **99,553** |

**Data Source: City water supply and Drainage division, KMC**

## 6.1.4Pressure – Water Supply

Given the fact that water is the most essential element for life, there is always a dependency on this resource for the day to day activities. This exerts a severe pressure on water resources as the demand for water increases rapidly as there is increase in population and industrial activities in the city. This section discusses the pressure on water supply and distribution network in Kolhapur city.

### 6.1.4.1 Increase in demand for water and connections

More than 15 thousand households in Kolhapur city are still to be connected with water supply lines. This indicates that there is a gap of around 11% in terms of coverage and demand for more water supply to meet the basic and baseline demand for water in the city. To meet the growing demands, KMC has been installing new connections every year. One may observe from Figure No. 21, that there has been an ascending growth in terms of number of connections in Kolhapur city and the major numbers of connections (96%) are of 15 mm in the city. In the year 2015–16 more than 2 thousand new connections were installed by KMC.

As per estimations by KMC[52] it has been projected that by 2021, the water supply demand for Kolhapur city would be around 148 MLD indicating a growth of about 10–12 MLD in the next 5 years.

[52] AMRUT Slip, Water Supply, KMC, submitted in September 2015, City water supply and Drainage division, KMC

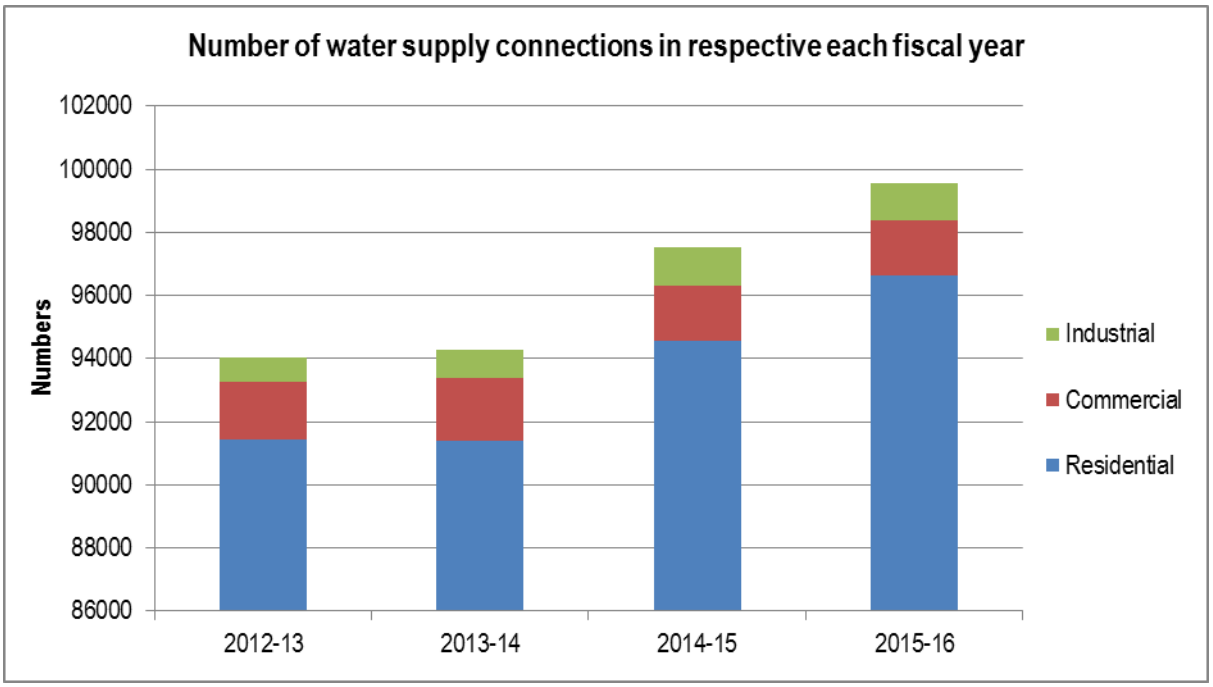



**Figure No. 21: Number of water supply connections in respective fiscal year**
**Data Source: City water supply and Drainage division, KMC**

### 6.1.4.2 NRW (Non-Revenue Water)

As per the service level benchmarks issued by Ministry of Urban Development, Government of India[53] the NRW highlights the extent of water produced which does not earn the utility any revenue. This is computed as the difference between the total water produced (ex-treatment plant) and the total water sold expressed as a percentage of the total water produced. This primarily includes the following;

a) Consumption which is authorised but not billed, such as public stand posts;

b) Losses owing to illegal water connections, water theft and metering inaccuracies; and

c) Losses which are leakages in the transmission and distribution networks

The service level benchmark permits a maximum of 20% of NRW however Kolhapur city reports NRW of around 38% indicating that around 45 – 50 MLD of water is NRW for KMC. Extrapolating the average loss per day, it is estimated that in the year 2015–16 around 16–18 thousand million liters of water treated and supplied by KMC was NRW.

[53] http://www.wsp.org/sites/wsp.org/files/publications/service_benchmarking_india.pdf

### 6.1.4.3 Below Average rainfall

Kolhapur city has recorded rainfall below annual average rainfall (1000 mm) for the last five years (Figure No. 22). The decline in rainfall was recorded from the year 2008 which recorded 898 mm rainfall. A minimum rainfall of 390mm was recorded last year.

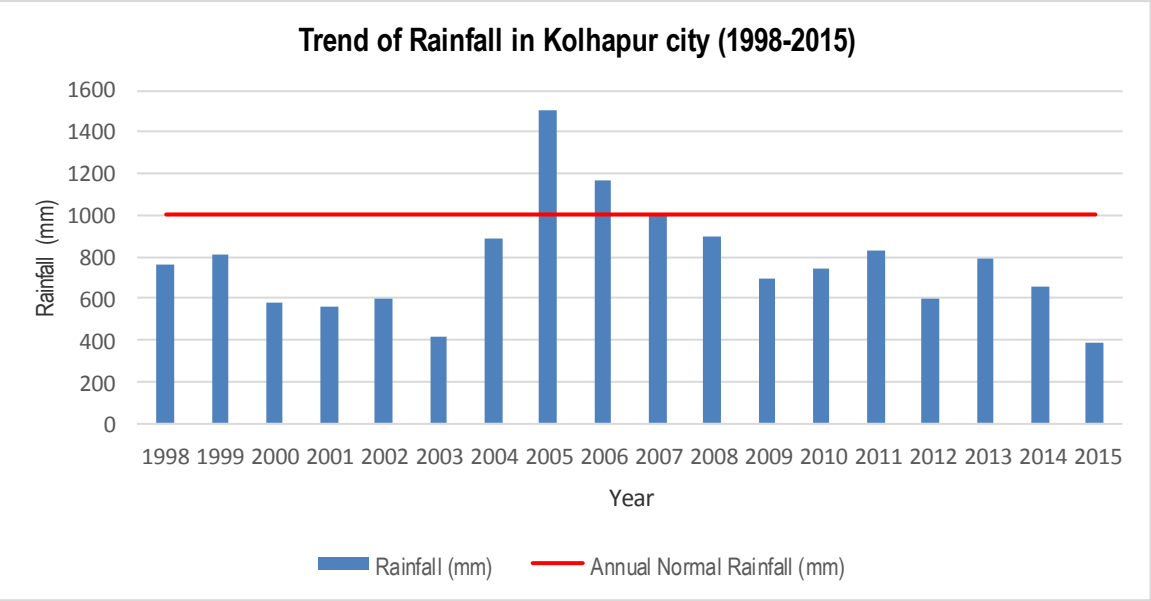



**Figure No. 22: Trend of Rainfall in Kolhapur city (1988-2015)**
**Source Rainfall Recording and Analysis, Department of Agriculture Maharashtra State, Government of India.**[54]

## 6.1.5Response

### 6.1.5.1 Augmentation of water supply scheme

In order to provide potable water supply to Kolhapur city, the Municipal Corporation has initiated a project titled 'Augmentation of Water Supply system for Kolhapur City from Kalammawadi Dam as source' under UIDSSMT (The Urban Infrastructure Scheme for Small and Medium Towns) scheme launched by the Government of India (GoI). The corporation received approval for INR 425.41 crores under the scheme in December 2013[55].

The Kalammawadi dam is located 50 km away from the Kolhapur city and constructed on river Dudhaganga, a river near Kalmmawadi village in Radhanagari Taluka of Kolhapur district. The Dam has a gross storage capacity of 719.12 MLD. and dead storage of 40.01 MLD. Total 2.38 TMC is reserved for Kolhapur City[56]. The scope of work under UIDSSMT scheme is drafted below in Table No. 26

[54] http://maharain.gov.in/
[55] http://www.kolhapurcorporation.gov.in/pdf/IBKS/finalweb.pdf
[56] http://forestsclearance.nic.in/writereaddata/Addinfo/0_0_101115122912191Necessityofprojectonlineforest.pdf

**Table No. 26: Scope of work under U.I.D.S.S.M.T Scheme.**

| Sr No. | Work |
|---|---|
| 1 | Head Works (dams, infiltration galleries, trench galleries, bank pitching, intake works, connecting pipe, Jack well and pump house and approach bridges, etc) |
| 2 | Recirculation sump & pump house |
| 3 | Construction of Pipelines-<br>• From Kalammawadi Dam to Puikhadi (1800*52.9km)<br>• From Puikhadi WTP to Kalamba WTP- (800mm*9km)<br>• From Puikhedi to Phule wadi for Bawada (600 mm * 4.5 km).<br>• From Puikhadi WTP. To Chabukhadi MBR(1000mm*2.5km)<br>• Raw Water Pumping Main-From Jack well to BPT (1800mm *100meter)<br>• Break Pressure Tank (15,00000 ltrs) |
| 4 | Water Treatment plant at Puikhadi 80 MLD |
| 5 | SCADA system at Head works, BPT, Br. Point at Puikhedi, WTP @ Puikhedi, Bawada |
| 6 | Miscellaneous works- approach Road at head works, Chainlink fencing & gate, Staff quarter at Head Works & WTP |

**Data Source: Tender Document-Water Supply Scheme for Kolhapur under UIDSSMT**[57]

***Work status for year 2015-16***[58]***:***

- Construction of Jackwell Pumphouse, BPT have been started after C.E.S approval of Government.
- Construction of Pipeline from Kalammawadi Dam to Puikhadi (1800*52.9km)
- Approval for 37.5 km length (29 km Public construction and 8.5 km from Karvir taluka) is granted out of which 11.3 km work has been done and remaining is under construction.
- Out of 11.70 km within the Irrigation Department Limits, 1.6 km under sanctuary and 1.7 km under Zilla Parishad has not been approved still.
- Work of construction of other pipelines within city limits is elaborated in Table No. 27 below.

**Table No. 27: Work done for construction of pipelines (2015-16)**

| Sr No. | Diameter of Pipe(mm) | Total Length Pipe (km) | | % Work done |
|---|---|---|---|---|
| | | Proposed | Work completed | |
| 1 | 600 | 4.5 | 2.75 | 61 |
| 2 | 800 | 9 | 4.55 | 51 |
| 3 | 1000 | 2.5 | 1.63 | 65 |
| Total | | 16 | 8.93 | **56** |

**Source: City water supply and Drainage division, KMC**

[57] http://engineeringprojects.com/Tender/UploadFiles/2105_004-Tech.-Specs-Electro-Mech-work.pdf
[58] Water Supply Department,KMC

#### 6.1.5.2 Proposal under AMRUT for augmenting the distribution network

It is estimated by KMC that out of 750 km of street length around 600 km of street have water distribution pipelines while about 150 km of street length are without water distribution pipelines. This indicates a gap in the existing infrastructure and KMC has already made plans for augmenting the water supply network as well as repairing and replacing the old pipes. Towards this, under the AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme. KMC has submitted a proposal with an estimated cost of INR 160 crores for the following tasks.

1. Plan and design a distribution network to cover the remaining area,
2. Replacing of old pipelines
3. Increasing the storage capacity in the city
4. To improve billing and recovery system

#### 6.1.5.3 Control on NRW

KMC has been addressing the issue of NRW since the past few years. KMC has successfully reduced the NRW from 45.80% to 38% through various initiatives like replacing the pipelines which were prone to heavy leakages and closing a few public stand-posts. Now, KMC aspires to reduce the NRW to 20% by making the distribution system more efficient and undertaking a more efficient billing and collection system. The initiatives undertaken by KMC are as follows;

1. Purchase and installing of tamper proof air valves
2. Conduct a comprehensive water audit and it has been sent for technical sanction to MJP (Maharashtra Jeevan Pradhikaran)
3. Spot billing systems for public stand posts
4. Recovery of dues from customers by undertaking special drives

## 6.2 Sewage- Collection and Disposal

### 6.2.1Status

#### 6.2.1.1 Generation and Network

It is estimated that Kolhapur city generates about 83 ML (Million Liters) of domestic waste water per day. Out of this, the domestic waste water accounts for 92% (76 MLD), followed by commercial establishments and sources 8% (7 MLD), while the Industrial sources account for a negligible 0.1 MLD of waste water.

As per a survey made in 2015 by the health department, it is estimated that there are 1.11 lakh households in Kolhapur city and around 87% of these households have a personal toilet facility. The remaining population depends upon the public toilets and urinals installed by the corporation (Table No. 28), for daily sanitation. As compared to the 2011 census report, the coverage has increased in absolute number as well as coverage efficiency. It is estimated that the coverage of latrines (individual households and community) is around 99% of the population of Kolhapur city, indicating that the city is relatively free from open defecation.

**Table No. 28: Coverage of toilets and Number of Public toilets in Kolhapur city**

| Year/ Source | No of HH | HH with toilets | | Public toilets | | | Urinals | |
|---|---|---|---|---|---|---|---|---|
| | | Number | % | Units | Seats for Males | Seats for Females | M | F |
| 2011/ Census report | 120,678 | 95,660 | 79 | 318 | 1598 | 1521 | 541 | 22 |
| 2015/ Survey by Health Department | 128,211 | 111,466 | 87 | 324 | 1658 | 1581 | 541 | 34 |

**Data Source: Health Department, KMC**

The waste water is collected through a drainage line of about 222 km across four zones Jayanti, Dudhali, Line Bazar and Bapat camp for sewage management. Out of this, about 150 km pipeline was laid in 1974 and is often referred to as the old drainage network, while additional 72 km of drainage network was augmented between 2011–2014 under UIDSSMT, (Urban infrastructure Development Scheme for Small & Medium Towns), scheme of the Ministry of Urban Development, Government of India.

Table No. 29, below, elaborates the zone wise number of households and the corresponding number of households connected with sewage network. It is estimated that around 55% of the households are covered with sewerage network. Although Jayanthi zone and Dudhali zone have a fair share of network coverage of about 79% and 55% respectively, the households in Line Bazar and Bapat camp zone need to be soon connected to sewage network. As per census report 2011, around 43% of the then households had septic tank facility in their households. This indicates that a large share of the households still depend on the septic tank disposal system. These septic tanks are opened and cleaned once in two years and the sludge is collected through suction tankers and disposed on the sludge drying beds near the STP (Sewage Treatment Plant).

**Table No. 29: Zone wise coverage of households with sewage network**

| Zone No | Total Number of Households (Number) | Households connected with Sewerage Network (Number) | Coverage of Sewerage Network (%) |
|---|---|---|---|
| Jayanti | 66,152 | 52,550 | 79.44 |
| Dudhali | 43,632 | 24,130 | 55.30 |
| Line Bazar | 11,259 | - | 0.00 |
| Bapat Camp | 19,705 | - | 0.00 |
| **Total** | **140,748** | **76,680** | **54.48** |

**Data Source: AMRUT scheme slip, City water supply and Drainage division, KMC**

### 6.2.1.2 Sewage Treatment Plant

Kolhapur Municipal Corporation has commissioned a 76 MLD capacity STP (Sewage Treatment Plant) (Picture No. 11) as per funds received from The National River Conservation Directorate (NRCD) in the MoEFCC (Ministry of Environment, Forests and Climate Change). The Ministry is implementing the Centrally Sponsored Schemes of NRCP (National River Conservation Plan) and NPCA (National Plan for Conservation of Aquatic Eco-systems) for conservation of rivers, lakes and wetlands in the country. This STP is operational since April 2015 and is based on the SBR (Sequence Batch reactor) technology.

The SCADA (Supervisory Control and Data Acquisition) system for the STP was started in May 2015 and since then daily load has been calculated and recorded by Kolhapur Municipal Corporation. The current operational load on the plant is estimated to be around 52 MLD. As seen in the year 2015–16, during the months of May to August there was a dip in the load and operation since the system was under the final stages of commissioning. Post the month of September, the STP has recorded average daily load above 50 MLD. Given the fact that the STP has been designed to treat 76 MLD of waste water and the existing load is mere 52 MLD this indicates that the STP currently runs at an efficiency of about 68%.

**Picture No. 11: One of the basin at the 76 MLD capacity Sewage Treatment Plant at Kasba Bawda**
**Photo credits: TERI**

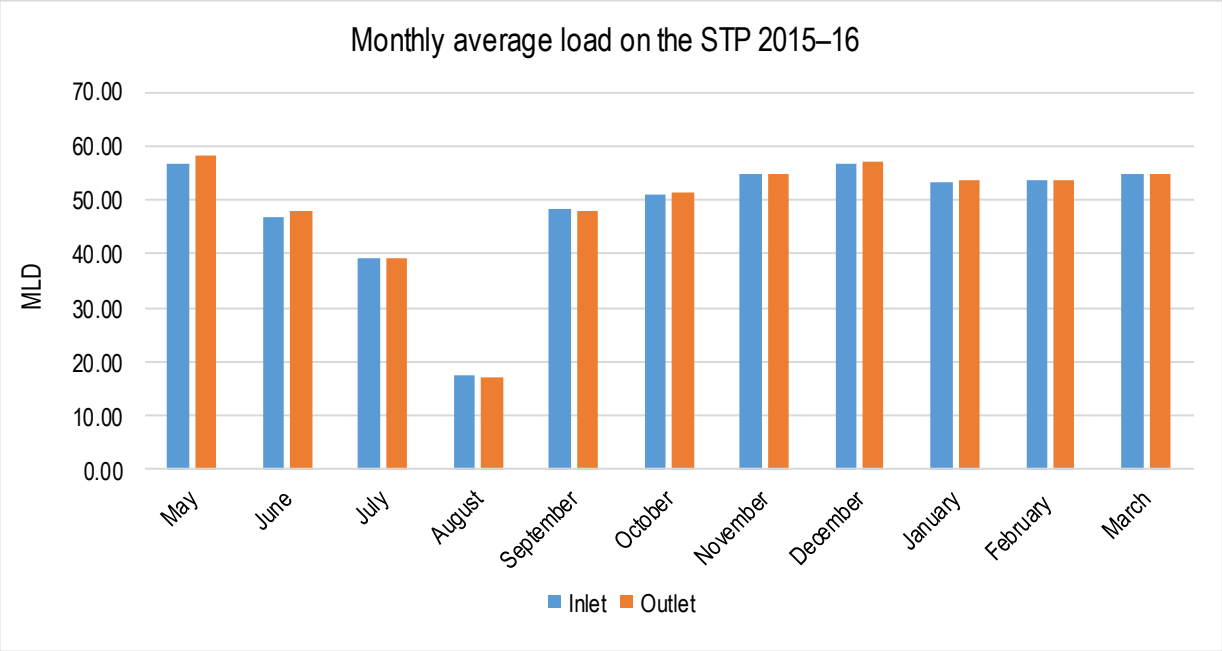



**Figure No. 23: Monthly average load on the 76 MLD STP 2015-16**
**Data source: SCADA system of the STP, Water Supply and Drainage Division, KMC**

The water quality for the inlet and the outlet is monitored everyday by the laboratory established at the STP. The daily monitored parameters include pH, DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), Phosphorus, oil and grease, Alkalinity, Total Hardness and conductivity. An inventory of the information is maintained at the laboratory.

Random samples are collected per month and tested by MPCB (Maharashtra Pollution Control Board), at their regional laboratory at Chiplun. These samples are tested for pH, DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), SS (Suspended Solids), Chloride, Sulphate, Phosphate, TDS (Total Dissolved Solids), oil and grease, TRC (Total Residual Chlorine) and so on.

Sampling by two agencies helps in keeping a third party check in place and thus increasing the reliability of the information.


**Figure No. 24: Monthly performance and trend of the outlet water quality at 76 MLD STP Kasba Bawda**
**Data source: Kasba Bawda STP, Water Supply and Drainage Division, KMC**

One may observe from Figure No. 24, that the water quality parameters tested for the outlet water samples released post treatment are well within the standards prescribed by CPCB (Central Pollution Control Board). The parameters are comparable to the standards prescribed for natural inland waters indicating that the water is of very good quality post treatment.

The outlet samples were found to be well within the standard limit as well as the desired range for the parameters of BOD and pH. Even the maximum BOD level (20 mg/litre), detected in the month of June was found to be less than the set limit of 30 mg/litre. Similarly the pH values were in the prescribed limits of 5.5 to 9.0. As for the DO (Dissolved Oxygen) levels it was in the month of October and November when it did not match the minimum desired limit of 5mg/litre, while for the other months the DO was well above the minimum desired limits. As for the COD values all the samples were recorded to be well within the standard limits of 250 mg/litre.

The only cause of concern is the exceeding limits of oil and grease from the outlet samples. As the values were found to be as high as 182 mg/litre (June 2015) which is almost 18 times higher against the standard of 10 mg/litre prescribed by CPCB. Even the minimum value recorded for oil and grease was about 58 mg/litre which is almost six times higher than the standard. Table No. 30 presents month wise maximum concentrations of various water quality parameters.

**Table No. 30: Month wise maximum concentrations of water quality parameters at STP**

| Month | BOD (mg/l) | | COD (mg/l) | | DO (mg/l) | | Oil & Grease (mg/l) | | pH | |
|---|---|---|---|---|---|---|---|---|---|---|
| | In | Out | In | Out | In | Out | In | Out | In | Out |
| *Standards* | *30* | | *250* | | *5* | | *10* | | *5.5–9.0* | |
| June | 186 | 20 | 280 | 120 | 1.68 | 8.01 | 148 | 139 | 8.7 | 7.8 |
| July | 238 | 10.13 | 318 | 101 | 2.21 | 6.94 | 189 | 182 | 7.2 | 6.9 |
| August | 220 | 9.89 | 238 | 102 | 2.18 | 6.52 | 121 | 112 | 7.4 | 8.4 |
| September | 212 | 10.15 | 183 | 72 | 1.69 | 6.48 | 118 | 108 | 7.77 | 7.58 |
| October | 163 | 10.05 | 159 | 76 | 1.72 | 4.62 | 113 | 102 | 7.9 | 7.8 |
| November | 118 | 9.72 | 160 | 72 | 1.18 | 4.47 | 96 | 90 | 7.9 | 7.9 |
| December | 82 | 10.12 | 130 | 76 | 1.15 | 5.92 | 120 | 95 | 7.9 | 7.9 |
| January | 82 | 9.3 | 115 | 67 | 1.14 | 4.9 | 108 | 95 | 7.9 | 7.9 |
| February | 74 | 9.8 | 103 | 94 | 1.17 | 5.92 | 89 | 80 | 7.8 | 7.4 |
| March | 74 | 8.8 | 97 | 49 | 2.11 | 5.52 | 82 | 73 | 7.8 | 7.5 |

**Data source: Kasba Bawda STP, Water Supply and Drainage Division, KMC**

## 6.2.2Pressure

### 6.2.2.1 Gaps in coverage

Around 45% of the households, translating to more than 64 thousand (Table No. 31) in Kolhapur city are not connected with the drainage line. Of this more than 30 thousand households from the Line bazar zone and Bapat camp zone itself which is yet to be connected with the drainage network leaving 100% households from these areas without a connection to drainage lines. While around 33 thousand households from the Dudhali and Jayanti zone are yet to be connected to the sewerage network.

In the Dudhali zone, sewer lines have been laid in areas such as Tapovan, Timber market, Solokhenagar and so on however the households are not connected to the sewer lines. In some areas the toilets are connected to the sewer line but the water from the bathrooms and kitchens are not connected to the sewer line.

**Table No. 31: Zone wise non-connected households to sewerage network in Kolhapur city**

| Zone No | HH in the Zone (number) | HH yet to be connected with Sewerage network (number) | HH yet to be connected with Sewerage network (%) |
|---|---|---|---|
| Jayanti | 66,152 | 13,602 | 20.56 |
| Dudhali | 43,632 | 19,502 | 44.70 |
| Line Bazar | 11,259 | 11,259 | 100.00 |
| Bapat Camp | 19,705 | 19,705 | 100.00 |
| **Total** | **140,748** | **64,068** | **45.52** |

**Data source: AMRUT scheme slip, City water supply and Drainage division, KMC**

### 6.2.2.2 Un-regulated over flows and release of sewage

The treated waste water from the septic tanks is directly released to the road side gutter. This is true for around 90% of the septic tanks installed by the individual households. These over flow, then get connected to the Nallahs and then join the river, thus polluting the river. It is also observed that many households along the Nallahs directly release the waste water into the open drains.

## 6.2.3Response

### 6.2.3.1 Maintenance of drainage network

Kolhapur Municipal Corporation undertakes maintenance and repair work of the drainage network regularly. Drainage choke ups, removal of over flows and similar jobs are undertaken by the health department, KMC under the supervision of Chief Sanitary Inspector, Divisional Sanitary inspectors and ward sanitary inspectors.

Until now, the work was been done manually by the laborers using rodding machines. However Kolhapur Municipal Corporation has recently purchased a new truck mounted jet machine for this task.


**Picture No. 12: Truck mounted Jet Machine used by KMC**
**Photo credits: Kolhapur Municipal Corporation**

### 6.2.3.2 Augmenting the drainage network to cover entire city

Kolhapur Municipal Corporation has submitted a proposal for constructing the underground sewage scheme to cover entire city as well as for interception and diversion of sewage to STP under AMRUT (Atal Mission for Rejuvenation and Urban Transformation) scheme launched by Ministry of Urban Development, Government of India.

Keeping a vision for the year 2020, it is estimated that around 1.4 Lakh households would generate about 101 MLD of waste water. Further, additional drainage line of around 428 km, almost double than the existing line (222 km), would be required to cover the entire city. The budget estimated for the proposal is around 257 crores.

### 6.2.3.3 New sewage treatment plants

Apart from the 76 MLD STP which has been made operational last year KMC, is in the process of constructing a 17 MLD capacity STP under the under Maharashtra Suvarna Jayanti Nagarothan Maha Abhiyan. The STP is under construction and more than 40% of the work has been completed. The STP is proposed to be commissioned by December 2016. Under the AMRUT scheme funds have been requested, to set up an additional 8.5 MLD STP to cater to the projected demand of 101 MLD by 2020.

### 6.2.3.4 Up gradation of Jayanti pumping station

Until July 2013, the Jayanthi Nallah Pumping station was equipped with around 850 HP capacity (150 HP X 3 and 200 HP X 2) pumps to pump water from the nallahs. However during monsoon and heavy precipitation days it led to severe flooding in the viscinity. To tackle this issue and further supply more waste water to the recently constructed STP (76 MLD at Kasba) the pumping capacity has been increased. A total capacity of 900HP (450 HP X 2) has been installed to augment and upgrade the pumping station. Apart from the active pumps 2 stand by pumps, (450 HP capacity each), have been erected at the location. It is further proposed to add two additional pumps of similar capacity in reserve. Upon implementation, the Jayanthi Nallah Pumping station will have a total capacity of 2700HP for pumping waste water.

**Picture No. 13: Jayanti Nallah pumping station**
**Photo Credit: TERI**

### 6.2.3.5 Application of wastewater byelaws

To reduce the river pollution due to the sewage/sullage ingresses through remaining KMC has drafted its own wastewater byelaws. The regulatory implementation of wastewater byelaws is applied along with the Building Development Control Rules. As per the bye laws it is mandatory to install an individual STP, treat waste water and practice reuse of recycled water in following cases:

- Layouts more than 4000 $m^2$ (1 acre) area
- Apartments having more than 20 tenements
- Hospitals having more than 40 beds
- Daily water usage more than 10000 lit
- Commercial area more than 1500 $m^2$

### 6.2.3.6 Decentralized processing

Decentralized waste water processing has been demonstrated at the Isolation Hospital, Rajendranagar and Salokhe Park. Pilot plants of 10 $m^3$ capacity is based on DEWATS (Decentralized Waste Water Treatment System) have been installed. DEWATS is a wastewater treatment system that is reliable and low-cost in operation. It can treat organic wastewater from both domestic and industrial source with flows from 1 to 1000 $m^3$ per day. The DEWATS system is an effective and efficient wastewater treatment solution that minimizes water and soil pollution in housing complex/settlements. DEWATS technology is based on the principle of low cost and low-maintenance since most important parts are locally available and work without technical energy inputs. Standard applications are based on four basic treatments using sedimentation and flocculation, and anaerobic and aerobic treatment using different filter and ponds.

**Picture No. 14: Photograph of DEWATS system installed at Isolation Hospital**
**Photo credits: Kolhapur Municipal Corporation**

### 6.2.3.7 Reuse of treated water

As of now, the treated waste water is sporadically reused by the agricultural fields in the vicinity of the STP. The owners get their own pumps and pump out water as per their requirement. Since it is managed at a very small scale keeping tab of the actual consumption is practically difficult.

Water for irrigation in the corporation owned gardens is supplied by using this treated water. In the past one year since the plant has been made operational, approximately 20 thousand liters/day of water is being reused for this application.

**Picture No. 15: Tanker being refilled with treated water for secondary applications at Bawda STP**
**Photo credit: KMC**

## 6.2.4Recommendations

### 6.2.4.1 Survey and restructuring of septic tanks

As per the Indian Standard Code of '*Practice for Installation of Septic Tanks Part I Design Criteria and Construction*' (IS:2470 (Part 1)-1985 Reaffirmed 1996)[59] point 3.1.3 "Under no circumstances should effluent from a septic tank be allowed into an open channel drain or body of water without adequate treatment". It is highly recommended that the septic tanks made by the individual household owners should be redesigned and a soak pit be installed before the water gets released to open drains/Nallahs.

Strict audits and vigilance is highly recommended for new constructions where sewer line connection is not available and town planning authorities may impose strict adherence to this clause before issuing the occupational certificate.

[59] Web link to IS:2470 (Part 1)-1985 Reaffirmed 1996

#### 6.2.4.2 Land acquisition for erecting pumping station

The Bapat camp and line bazar zone need to be connected to the STP on priority as more than 30 thousand households are left un-connected to the sewer line. It is highly recommended to acquire land for erecting the pumping station and the sump well for immediate connection of households in this zone to the STP.

#### 6.2.4.3 Policy and information on reuse of treated water

A policy level intervention for reuse of waste water is strongly recommended. Reuse of waste water should be made compulsory for the following;

- All construction activities, washing, curing, sanitation, flushing and secondary applications. A clause may be added in the building byelaws, DCR itself
- Irrigation applications in gardens owned by the corporation.
- Washing of roads and streets to suppress the road dust and its re-suspension in the city

#### 6.2.4.4 Appropriate monitoring and data management

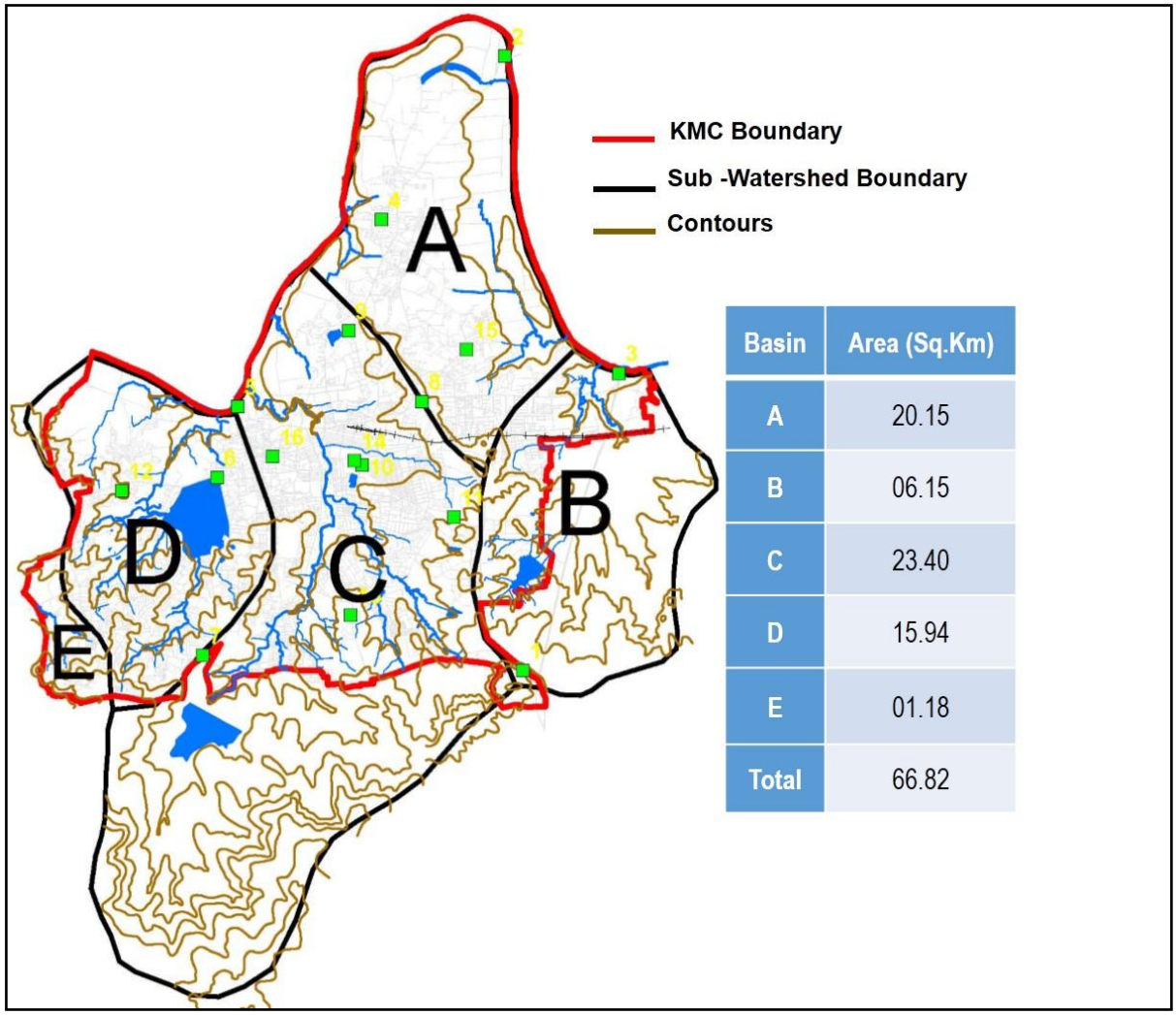
Appropriate monitoring of sewage inlet and outlet samples based on standard procedures and getting the laboratory ISO certified is highly recommended. Maintenance of data needs to be made in soft copies and spread sheets through proper data entry procedures. Installation of flow meter is recommended to monitor the consumption of water by the tankers from the STP.

## 6.3 Storm Water Management

### 6.3.1Status – Natural drains

The natural drainage system of Kolhapur consists of rivers and natural nallahs. The major natural drains of Kolhapur city are Jayanti nallah, Gomati nallah, Dudhali nallah, Line bazaar nallah and Bapat camp nallah. All these natural nallahs carry storm runoff along with sewage and discharge into river Panchaganga.

As per the contour map of Kolhapur city, it could be divided into 5 sub-watersheds, as seen in Map No. 4, The C sub watershed is the biggest of the five and is spread across 23.40 $km^2$ closely followed by A sub-watershed which is about 20.15 $km^2$. E is the smallest of all and is mere 1.18 $km^2$. The total length of the nallahs carrying drainage from these sub-water sheds is estimated to be about 94 km.




| Basin | Area (Sq.Km) |
|---|---|
| A | 20.15 |
| B | 06.15 |
| C | 23.40 |
| D | 15.94 |
| E | 01.18 |
| Total | 66.82 |

**Map No. 4: Sub water shed map of Kolhapur city**
**Source: Storm Water Management System in Kolhapur City, Phase-II, PriMove Consultants**

## 6.3.2Pressure & Impact

### 6.3.2.1 Increase in paved surfaces

However owing to urbanization and increase in built up areas there has been alterations for accommodating building and transportation network. It is estimated that 'Paved' areas result in as much as 3 times the surface runoff causing nearly 90% of precipitation as runoff. Many a times this built up areas are not aligned with the natural contour and the sub-watershed, it forces the natural drain to change its course thus getting accumulated in low lying areas (Table No. 32) at many times.

### 6.3.2.2 Release of liquid and solid waste in Nallahs

The Nallahs are generally treated as disposal sites for the release of wastes (liquid & solid). Release of untreated sewage, into the Nallahs causes severe pollution in the river as the Nallahs drain into the river. This has been further discussed in section (5.2) of this report.

The lack of maintenance and dumping of garbage leads to clogging and blockage of the drains. This has led to a reduction in the carrying capacity of natural drains, roadside open drains and culverts causing water logging issue during rainy season.

#### 6.3.2.3 Lack of proper Storm water drain system

It has been observed that the coverage of storm water drainage in the city is not adequate. Most of the roadside drains are not of adequate design and do not have the proper inlet arrangements to catch the storm runoff and carry it to the disposal point. The length of existing open pucca and kutcha drains is 267.54 km and closed drains 16.61 km as per the City Development Plan of KMC.

**Table No. 32: List of water logging prone areas in Kolhapur city**

| Sub-Watershed | Water logging prone areas in Kolhapur city |
|---|---|
| B | Bapat Camp, Lonar Vasahat |
| C | Siddharth Nagar |
| C | Sutar Wada,Chitradurghmath |
| C | Dalal Market, Laxmipuri |
| C | Kumbhar Lane,Shahupuri |
| C | Mandlik Vasahat |
| C | Nashate Complex |
| C | Jamadar Club |
| C | Ramananda Nagar |
| C | Basant Bahar Talkies |
| C | Venous Talkies |
| C | New Palace Area |
| D | Shingnapur Naka, Gawatmandai |
| D | Shankaracharya Math |
| D | Dudhali Pavilion |

**Source: Storm Water Management System in Kolhapur City, Phase-II, PriMove Consultants**

## 6.3.3Response

Kolhapur Municipal Corporation has acknowledged the fact of having a proper storm water network in the city and appointed PriMove Infrastructure Development Consultants Pvt. Ltd to design a storm water management network based on sub-watersheds within the city of Kolhapur to address frequent localized flooding. Post the blue print of the network and the actual implementation on site the current status of the project stands as enlisted in Table No. 33. The steps involved in designing the storm water drain for the city involved the following: Preparation of the base map, Identify sub-watersheds, Prediction of rainfall intensity, Define flow patterns within a sub watershed – Identify Roads and nallahs that will drain the watershed, Topographic Survey, Estimation of Runoff and Design of Network

**Table No. 33: Status of Storm Water Management System for Kolhapur City as on March 2016**

| Sr. No. | Sub work | Target | Achievement | % Achievement |
|---|---|---|---|---|
| 1 | Nalla Channelisation and Development Work *(km)* | 11.90 | 9.50 | 83 |
| 2 | Culvert *(NOs)* | 41 | 34 | 83 |
| 3 | Roadside Drains *(km)* | 67.07 | 33.703 | 50 |

**Source: Storm Water Management System in Kolhapur City, Phase-II, PriMove Consultants**

# Land Resource

## 6.4 Status

### 6.4.1 Land Use

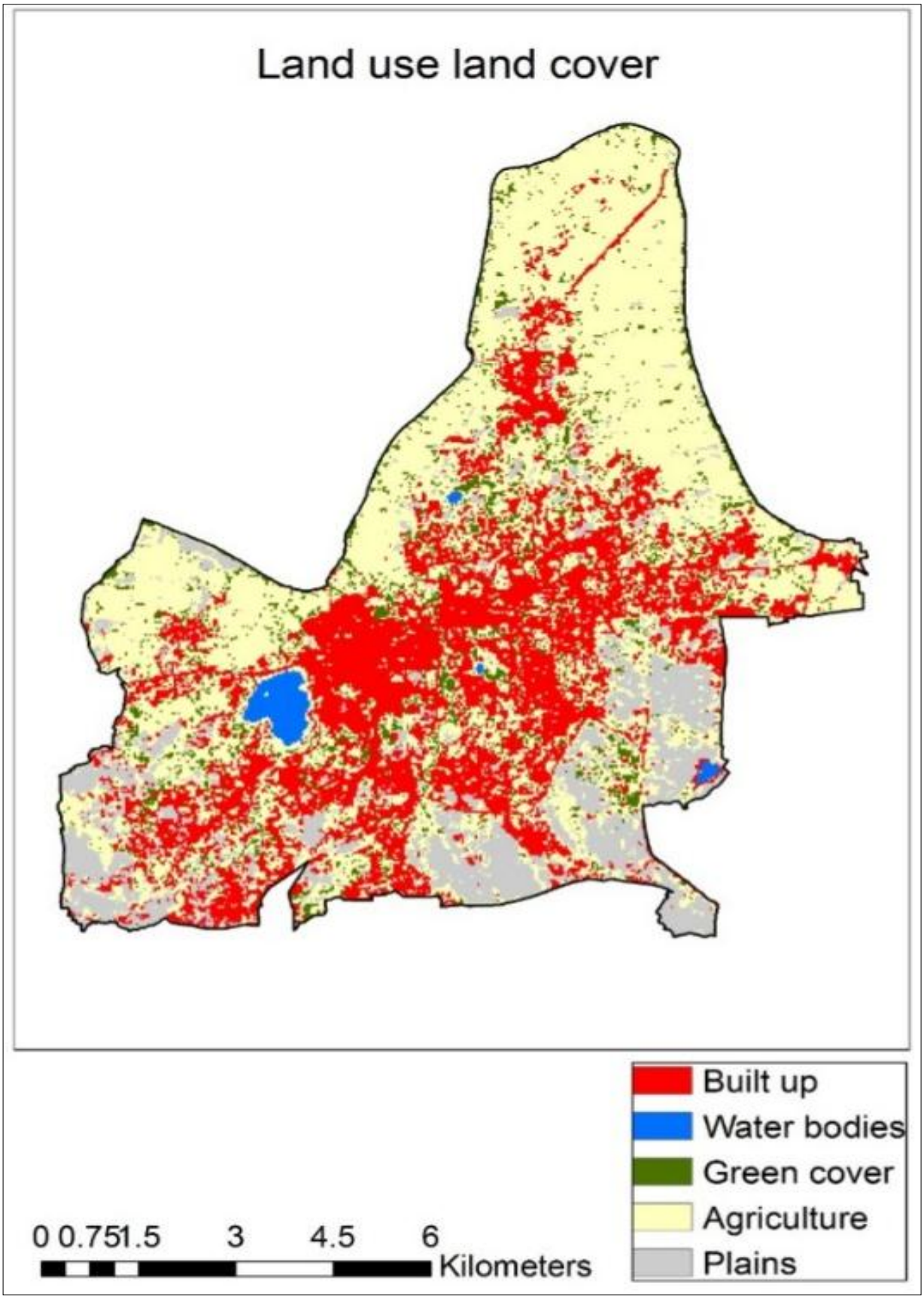
For this report TERI has generated a Landuse land cover data through satellite images for estimating the existing status of the Land use pattern of Kolhapur. The base shape file of Kolhapur city was procured from Surve Infotech Pvt Limited which was used to derive satellite imagery with help Landsat satellite 8 OLI (Landsat 8 Operational Land Imager) and TIRS (Thermal Infrared Sensor). The data for March 18th, 2016 was acquired with supervised classification method/semi-automatic classification. The supervised classification is an image processing technique that allows the identification of materials in an image, according to their spectral signatures. Depending on the sensor resolutions, the number and kind of land cover classes have been identified in the image significantly. The software used in the classification process is ERDAS Imagine 2010 and ArcGIS for creating vector database and maps. This map classifies the LULC (Land Use Land Cover) considering the area of 6922 hectares of Kolhapur city as per the availability of shape file.

As per the Map No. 5, the land use pattern of the city consists of built up area, water bodies, green cover, Agriculture and Plain (Barren lands). Total 6682 ha. of area of Kolhapur city is under Municipal Corporation. However due to availability of shape file, total 6922 hectare of the city is considered (Table No. 34). As recorded, the major area (50%) is under Agriculture sector followed by Built up category by 28%. 15 % constitutes barrens lands while 6% is green cover. About 28% of area in Kolhapur is under Built up categories which comprises of Residential, Commercial, Industrial, transport sectors. About 1% of total area of Kolhapur city is covered with water bodies as discussed in the Water resource chapter.

**Table No. 34: Break up of Land Cover in Kolhapur city**

| Classes | Area (Hectare ) | Area ($km^2$) | % Share of Land |
|---|---|---|---|
| Built up | 1964 | 19.64 | 28 |
| Water bodies | 75 | 0.75 | 1 |
| Green cover | 420 | 4.20 | 6 |
| Agriculture | 3430 | 34.30 | 50 |
| Plains | 1033 | 10.33 | 15 |
| **Total** | **6922** | **69.22** | **100** |

**Source: Base Shape file from Surve Infotech Pvt Limited, LandSat and TRIS**




**Map No. 5: Land Use Land cover of Kolhapur city March 2016**
**Source: Base Shape file from Surve Infotech Pvt Limited, LandSat and TRIS**

## 6.4.2Developed Land use

The Kolhapur city's DP (Development Plan) was sanctioned in 1977 which was modified during the year 1987 – 1989 and 2000. As per the updated DP, Kolhapur city covers an area of about 6682 hectare (66.82km$^2$). This area contains buildings, infrastructure, gardens, open spaces, play grounds and so on. Table No. 35 represents the Land use pattern of the city as per the Sanctioned DPR in year 2000.

The existing land use statistics, latest revised in 2000, indicate that more than 68% of the land is proposed under development while 32% of the land is reserved for commercial purpose and the rest for utilities and water bodies. As per the Census data 2011, Kolhapur city is classified under large cities as per the policy framework of UDRPI (Urban and regional development plans formulation and implementation) guidelines. The guidelines of which were published in 1995 under the 77TH Constitution Amendment Act, 1992 following the recommendations of National Workshop on Master Plan Approach. This policy framework classifies the city as per population for effective use of land resource[60].

But due to the increase in population and change in land pattern, the new amendment URDPFI guidelines, 2014 were published. It is notable from Table No. 35, that the land use of the city has been defined as per the URDPFI standards, except for Public/Semi-public land use which was recorded to be 16% as per the Sanctioned plan in 1997. Public/Semi Public includes post office, police post, telephone, crematories and so on[61].

There is a long overdue in the extension and expansion of the city limit. It is proposed that the city will soon include 17 villages lying on the periphery of the city, increasing the total city area upto 18,926 hectare almost 3 times the existing city coverage.

**Table No. 35: Share of Existing Land use as per town planning department**

| Land Use | Share as per sanctioned revised DP (2000) | UDRPFI Standard (%) - 2014 |
|---|---|---|
| Residential | 36 | 36-39 |
| Commercial | 3 | 5-6 |
| Industrial | 2 | 7-8 |
| Public/Semi Public | 16 | 10-12 |
| Recreational | 4 | 14-16 |
| Road and Transport | 8 | 12-14 |
| Agriculture, Water bodies and special areas* and others | 33 | |

**Source: City Development Plan of Kolhapur City, 2006 & (URDPFI) guidelines Volume 1, 2014[62].**
*Note: includes about 120 hectares (1.78%) under defense areas. Defense area has been included under special others as per UDFPRI's classification*

## 6.4.3.Tree census

The work for study of tree census within the Kolhapur city is allotted partially to two agencies- The Surve Infotech Pvt Ltd, Kolhapur and Terracon Ecotech Pvt Ltd, Mumbai. Around 5 lakh trees are estimated within the Kolhapur city.

[60] https://www.scribd.com/doc/62477051/UDPFI-Guidelines-Vol-I-Urban-Development-Plan-Formulation-Implementation-Guidelines
[61] URDPFI Guidelines WL-2014
[62] http://moud.gov.in/sites/upload_files/moud/files/URDPFI%20Guidelines%20Vol%20I.pdf

## 6.4.4Gardens

Kolhapur city has 53 gardens which cover an area of 0.4 % (30 hectare) of total area of Kolhapur city. The highest number of gardens is in Ward E (29) Followed by ward A (10) while ward C has only 2 gardens. The total number of gardens in each ward are represented in Figure No. 25 which depicts that Ward E has the highest area for gardens about 14 hectare followed by Ward A which has 11 hectares. Ward C and D have only about 1 hectare of garden, whereas ward B has 4 hectare of land under garden category.

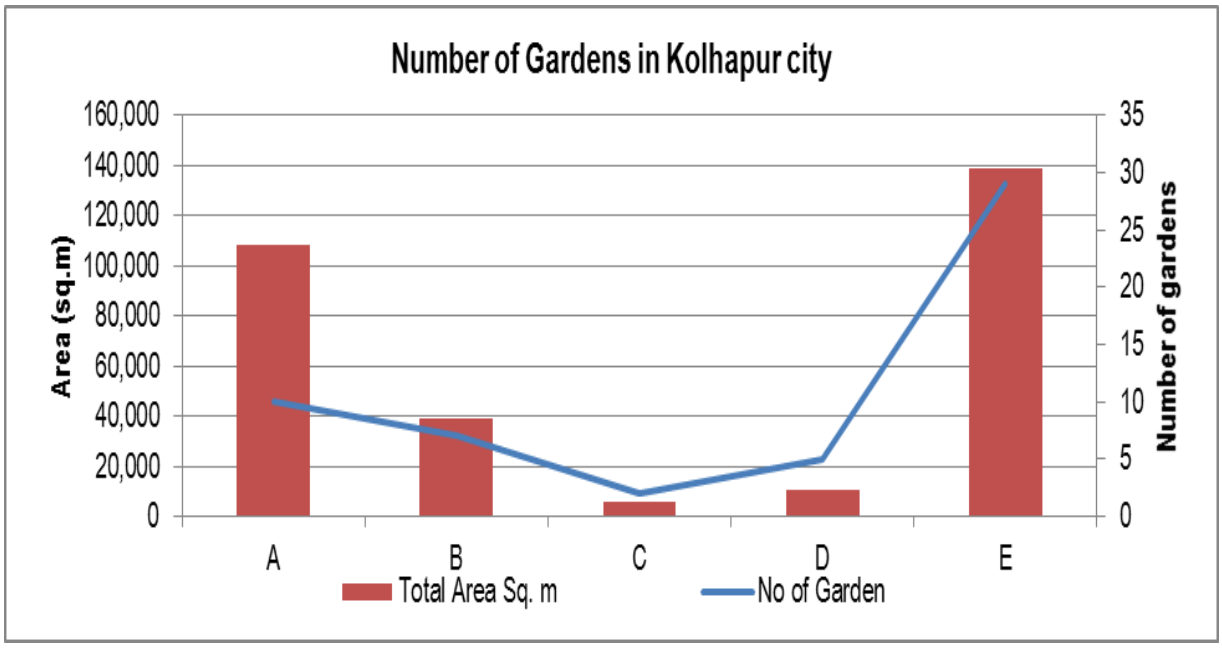



**Figure No. 25: Number of gardens in Kolhapur city**
**Source: Garden Department, KMC**

## 6.4.5Biodiversity

Nestled in the Western Ghats, a biodiversity hotspot, Kolhapur is blessed with diverse biodiversity due to the presence of several habitats in and around the city. Around 125 species of avi fauna, 27 species of mammals, 22 species of reptiles, 30 species of fishes, 35 species of butterflies and 144 species of trees and shrubs were reported within and around the city[63]. A total of 30 species of pollinating insects belonging to the five orders viz. Hymenoptera, Lepidoptera, Diptera, Coleoptera and Thysanoptera have been reported from the Kolhapur region[64]. Sathe et al (2014) have identified 22 species of Jassids belonging to the genera Deltocephalus, Empoasca, Nilaparvata, Nephotettix, Recilia, Cofta and Typhlocyba from the agriculture areas present around the city[65]. 36 species of odonates have been reported from the paddy ecosystem present in the Kolhapur district belonging to the genera, Crocothemes, Pantala, Anax, Neurothemis, Ichneura etc. by Sathe and Shinde

[63] N.Desai,Urban Wilderness in and Around Kolhapur Municipal Corporation Limits,2016
[64] http://biolifejournal.com/33.1%20sathe%20576-582.pdf
[65] http://ijset.net/journal/338.pdf

(2014)[66]. Insect species such as Orthopteroids, Scarab beetles, mosquitos and so on have also been studied in the Kolhapur region[67][68].

**Picture No. 16: Common pea fowl spotted near New Palace, Kolhapur**
**Photo Credit: TERI**

## 6.5 Pressure

### 6.5.1 Land use change

The land use of the city has changed over a period of time and the otherwise undeveloped areas categorised in the DP have been transformed to built up areas. From Figure No. 28

, it is conspicuous that the land categorised under Agriculture and water bodies has decreased drastically by almost 50% between 1989 and 2000, in just 11 years, while during the same time the land categorised under residential area has increased by more than 2 times, indicating a conversion of agricultural plots to NA (Non Agricultural) plots.

Apart from these, there has been an increase in terms of infrastructure for roads and transport which increased by 3% between 1989 and 2000. The other sectors have also recorded an increase which is attributed to the growth of the city

[66] http://www.worldwidejournals.com/indian-journal-of-applied-research-(IJAR)/file.php?val=September_2014_1409575130__2.pdf
[67] https://www.researchgate.net/publication/255699938_Biodiversity_of_Orthopteroid_Insects_of_Kolhapur_District_Maharashtra
[68] http://mosquito-taxonomic-inventory.info/node/12477

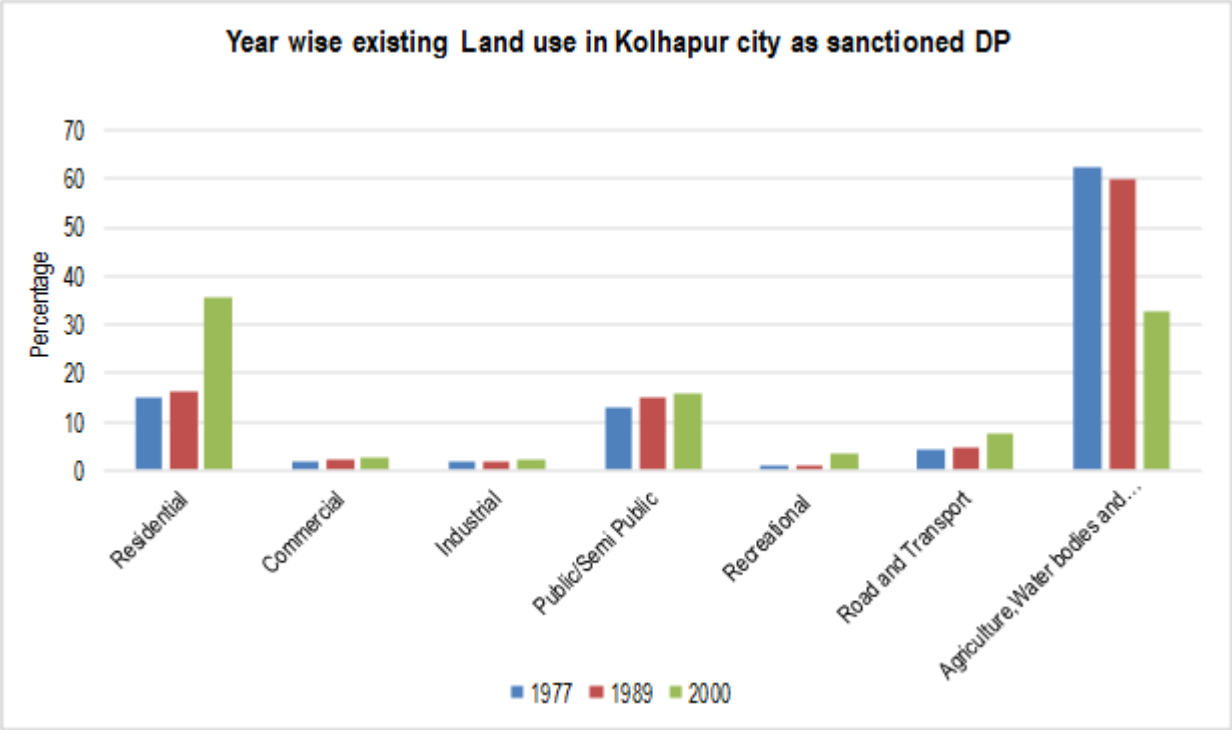



**Figure No. 26: Year wise existing Land use in Kolhapur city as sanctioned DP**
**Source: Environmental Status report 2008-09 of Kolhapur city, Kolhapur Municipal Corporation**

## 6.5.2Tree Cutting

Owing to various threats posed by unstable trees, KMC regularly undertakes trimming and translocation of trees within the city limits. Thus to avert any calamities and inconvenience to human life about 191 trees were cut down in Kolhapur city in the year 2015-16.

## 6.5.3Stone Quarries

Currently there are no active quarries located within the Kolhapur city. All the quarries in the city are used for dumping the solid wastes and for idol immersions. The closest active stone quarry in the village Shiye is located about half a km from the city. Continuous dumping of solid waste and inert material from idol can cause changes in the land pattern thus degrading it. The effects of these dumping are drafted in Water Section (5.3).

## 6.5.4Encroachment

The increasing number of hawkers in the city is a major issue. There are a total of 8600 - 12000 hawkers within Kolhapur city[69]. Tembalabai hill, Shivaji University and Bramhapuri are the major hills within Kolhapur city. But due to encroachment, many hills are getting converted into residential zones. There are a total of 18 illegal slums in Kolhapur city[70] .

The increase in human settlements not only changes the land use pattern but also affects the fragile hill eco-system. It also results in land pollution due to improper solid waste disposal, poor agricultural activities, soil erosion and irregular sewage disposal further affects the health of the citizens.

[69] Environmental Status report 2014-15,KMC
[70] Environmental Status Report 2014-15,KMC

## 6.5.5Dumping of solid waste and Landfill site

The open dumping of solid wastes and landfill sites exerts pressure on land resulting in a change in the land quality and pattern. These sections are further elaborated in Section (7.1.3) Response.

## 6.5.6Tree Authority

The Kolhapur Municipal Corporation has formed the Tree authority in order to conserve and maintain the tree cover within the city. The roles and responsibilities of the committee are drafted below:

**Roles and responsibilities of the Tree Committee**
Tree committee shall be responsible for the things mentioned below, regardless of whatever is mentioned in the related acts or any other prevailing laws, while following state government directions:

1. Conservation and Preservation of trees present on the land in the jurisdiction of the committee.
2. (Once before 1996 and once after every 5 years thereafter), conducting census of trees present on the land in the jurisdiction of the committee.
3. Indicating the number and species of trees present and which could be planted on the respective area.
4. Developing and maintaining the plant nurseries in order to supply seeds, saplings and trees to the persons who are either eager to plant new trees or plant trees as a replacement for cut (or unwillingly uprooted) trees.
5. Replantation of trees where transfer of tree is required either to build new roads or to widen existing roads or protect from threat to property and humans.
6. Organizing flowers, fruits, vegetables, trees and sapling exhibitions (minimum once a year) and extending help to private and public organizations to organize such exhibitions and generating awareness about the significance of plants in the life of common people.
7. Providing help and technical support to anyone who needs help and suggestion regarding planting, protecting and conserving trees.

### 6.5.7Tree plantations undertaken by KMC

Realising the need to increase the green cover of the city, KMC is regularly undertaking tree plantations throughout the city. In 2015- 16, KMC has planted a total of 4845 trees at around 178 sites in the city (Table No. 36). Tree species such as *Ficus sps*, *Delonix regia*, Silver Oak (*Grevillea robusta*), Mahogany (*Swietenia mahagoni*), *Cassia sps*, *Spathodea sps*, Morpankhi (*Platycladus orientalis*), Chafa (*Plumeria sps*) and so on.

**Table No. 36: Tree plantations undertaken in KMC**
**Source: Garden Department, KMC**

| Sr. No | Division | Total sites under plantation | Total plantation |
|---|---|---|---|
| 1 | Siddhala Area | 74 | 1266 |
| 2 | Shahu Garden | 11 | 126 |
| 3 | Rajaram Hall | 26 | 1677 |
| 4 | Mahavir Garden | 67 | 1776 |
| **Total** | | **178** | **4845** |

### 6.5.8Formation of Biodiversity Monitoring Committee

With the key objective of conserving the biodiversity and preserving the traditional knowledge of Kolhapur, KMC has formulated a Biodiversity Monitoring Committee which would help map the city's biodiversity and plan measures to conserve the local flora and fauna of the city. The committee shall also develop and maintain biodiversity registers by documenting the traditional indigenous knowledge about the wild edible plants, cultural diversity, species of local cattle, and so on.

## 6.6 Recommendations

### 6.6.1Study on Land use and change using remote sensing

It is recommended that Kolhapur city should undertake Remote sensing Technique to study the trend of Land Use and land cover change of the city. Land classification- Built area, Transport, Agriculture, Water bodies, Barren land and Green cover should be done in order to study the difference in land pattern over the period of time.

### 6.6.2Strict Vigilance and action against Encroachment

Hawkers:

- KMC should draft new policy for Hawkers. based on Street Vendor Act, 2014[71]
- Hawkers Zone, No Hawkers Zone should be declared within the city.
- Ensure that the licensed hawkers operate their stalls in accordance with the conditions of their licences.
- Stringent enforcement action against unlicensed hawkers selling prohibited/restricted food

[71] http://www.indiacode.nic.in/acts2014/7%20of%202014.pdf

- Monitoring at regular intervals at hawker black-spots.

Encroachment:

- Monitoring survey for checking the documents of the owner to be carried at intervals.
- Proper waste and sewage treatment to licensed houses.
- Recommend alternate places for housing with proper license to people.
- Sign Boards on restriction for encroachment on hills.

### 6.6.3Conservation of Urban Biodiversity

KMC should develop a conservation management road map for the conservation of the natural habitats which supports the biodiversity of the city. Initiatives such as identifying City biodiversity Index, restoration of degraded habitats such as hills and wetlands, plantation of indigenous trees and so on should be undertaken by the corporation.

# 7 Solid Waste Management

Solid wastes are the unwanted solid materials that get generated from residential, domestic, commercial and industrial processes[72]. Solid wastes include organic material, paper, glass, metal and also inflammable, hazardous or toxic materials. Inefficient disposal of solid wastes causes pollution such as land, water, thermal and air pollution. The solid organic wastes cause gaseous emissions (especially methane gas) contributing to global warming. It is also further known to cause fluctuations in the temperature of the surrounding areas. Plastic, a major component of solid wastes, is a toxic polluter, when burnt for disposal and takes thousands of years to get biodegraded.

Owing to the environmental hazards, the issue of solid waste management has become one of the prime focus areas of any city. Its collection and disposal have to be as scientific as possible to minimise the environmental impacts. Solid waste management is the procedure that includes all the activities and processes from the initial collection of wastes to the final disposal. It also includes the treatment and recycling of the wastes wherever necessary, along with monitoring and regulation of the entire procedure. Owing to changing lifestyles, industrial processes and medical treatment facilities; the solid waste generated has been classified into MSW (Municipal Solid Waste), Hazardous waste (usually industrial sources) and BMW (Bio-Medical Waste). Kolhapur city generates MSW as well as BMW. The following section discusses the status of generation and disposal of these wastes by KMC. As per information with KMC, the city does not generate hazardous waste and if any hazardous waste is generated by industries within the city then it is disposed and treated by the industry owners themselves.

## 7.1 Municipal Solid Waste

As per MoEFCC, Municipal solid waste is defined as *'Commercial and residential wastes generated in a Municipal or notified areas in either solid or semi-solid forms, excluding industrial hazardous wastes but including treated bio-medical wastes'.*

In order to maintain standards in managing various different types of solid waste, various guidelines have been released by Government of India. In the year 1999, MoEF had released the Municipal Solid Waste (Management and Handling) Rules, 2000[73] which was a guiding tool for all urban local bodies for managing their MSW. As an amendment to the guidelines, Solid Waste Management Rules, 2016 (8th April 2016) were published under the notification of the Government of India in the MoEF& CC on the basis of sections 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986).

### 7.1.1 Generation

The primary sources of solid waste in Kolhapur city are the local households, markets, commercial establishments, hotels, restaurants and hospitals. It is estimated that the total quantity of MSW (Municipal Solid Waste) generated in Kolhapur city is about 185 MT (Metric Tons) per day which translates to more than 300 gm per capita/day which is lower than the national average of 370 gm/capita/day[74]. Out of the total waste generated in the city KMC collects about 180 MT through an appropriate mechanism and infrastructure.

[72] www.cyen.org/innovaeditor/assets/Solid%20waste%20management.pdf
[73] http://www.moef.nic.in/sites/default/files/SWM%202016_0.pdf
[74] http://swmindia.blogspot.in/2012/01/municipal-solid-waste-msw-generation-in.html

As seen in Figure No. 27, about 77% (140 MT) of the total MSW generated in Kolhapur city is contributed by the residential sector. While the restaurants, hotels and market source contribute to about 8% (15 MT) each to the total generation. The markets and educational institutes generate about 5% (10 MT) and 2% (3 MT) respectively.

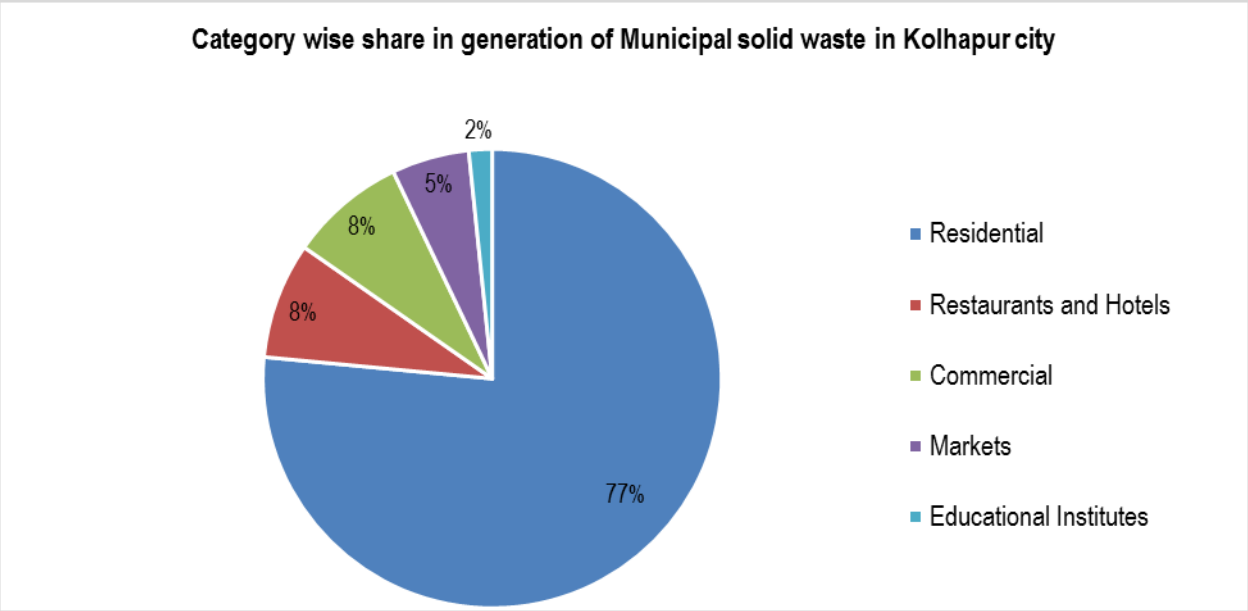



**Figure No. 27: Category wise share in generation of Municipal solid waste in Kolhapur city**
**Source: Solid Waste Management Division, Health Department, KMC**

## 7.1.2Collection & Management

About 180 MT of MSW is collected daily in Kolhapur city through an effective system established by KMC. About 1,578 workers are engaged by KMC for waste collection through sweeping of roads and door to door collection. KMC has provided about 900 dustbins of 3.5 $m^3$ capacity across the city.

As on 2015–16, KMC has 10 refuse compactors and each of them makes about three to four trips per day on dedicated routes for collection of MSW from the 3.5 $m^3$ dustbins across the city. Apart from this, KMC is equipped with 150 cycle rickshaws which are allocated with the task of door to door collection of waste especially in the congested and high density areas. As for the collection of rejects, inert waste, silt, muck, clean up from drains, local shifting and transfer, KMC is equipped with about 3 Hyva dumpers of 10 ton capacity each, and 8 (2 owned by the department and 6 provided by KMC) dumpers of 5 ton capacity each. KMC has separate collection system and dedicated trips for collecting waste from hotels and markets (fish and vegetable markets). Table No. 37 below summaries the list of major equipment's owned and utilized by the solid waste department in Kolhapur.

**Table No. 37: List of Major Equipment's owned by Solid Waste Management Department, KMC**

| Sr No | Type of Equipment | No's |
|---|---|---|
| 1 | Refuse Compactors | 10 |
| 2 | Steel Containers (2.5 ton capacity each) | 300 |
| 3 | Cycle Rickshaws | 150 |
| 4 | Dumpers – Hyva (10 MT Capacity) | 3 |
| 5 | Dumpers – Department owned (5 MT Capacity) | 2 |
| 6 | Dumpers – KMC owned (5 MT Capacity) | 6 |

**Source: Solid Waste Management Division, Health Department, KMC**


**Picture No. 17: Door to Door Collection of MSW and transitory collection in garbage bins**
**Photo Credits: KMC**

## 7.1.3MSW – Disposal Segregation and Processing

The MSW thus collected from the city is subjected to various disposal techniques as may be suitable to that waste.

Out of the 180 MT of MSW collected from the city, around 150 MT of waste is directly dumped at the open dumping spread across 8 acres site at Kasba Bawda which is within the city limits. About 10 MT of the waste collected from the markets is sent for bio-composting process via windrows technology at the Katyani area.

10-15 MT of waste collected from the hotels and restaurants via a dedicated collection trip is used for generating biogas by a food processing industry. The waste collected by KMC is bought to Kasba Bawda site and there on it is collected by the industry owner at his own cost and expenses. The location of the industry is about 20 km from the city. Apart from the

above, about 10 MT of inert waste which is collected, is currently being used for land reclamation and levelling activities.

The segregation of waste has been in place with a three pronged approach viz. segregation at source, segregation at dump site and segregation with help from rag pickers. Around 750 women rag pickers associated with NGO 'Ekati' have been involved to pick up to collect plastic & other non-biodegradable material at the dump site.

As for the Leachate generated at the processing site it is primarily collected in leachate collection tank. The collected leachate is recirculated on the existing accumulated MSW by using electric pump. This has been undertaken a pro-active and temporary measure to reduce the pollution of river which may have been caused due to release of the leachate into the river.

**Picture No. 18: The open dumping site at Kasba Bawda**
**Photo credit: TERI**

## 7.1.4Response & Future plans

### 7.1.4.1 Gaps in collection infrastructure

The existing infrastructure for collection of waste hinders the efficient working for solid waste collection. The number of vehicles for collection and disposal of solid waste areas are less than the required. Presented below in Table No. 38 is the list of proposed vehicles and collection equipment's which have been proposed by KMC under the Swachh Bharat Abhiyaan:

**Table No. 38: Proposed vehicles for MSW collection and disposal**

| Sr. No. | Type of Vehicle | Existing No | Actually required and Proposed |
|---|---|---|---|
| 1. | Truck-Tipper | 3 | 5 |
| 2. | Tractor-Trailer | 1 | 1 |
| 3. | Refuse-collector | 10 | 12 |
| 4. | Dumper-placers | 1 | 2 |
| 5. | Animal Cart | 1 | 1 |
| 6. | Tricycle | 310 | 400 |

**Source: Solid Waste Management Department, KMC**

### 7.1.4.2 Waste to Energy Plant

Initially in the year 2000, KMC had signed contract of 30 years with Zoom Bio fertilizer Pvt and since 2003-04 it used to segregate biodegradable solid waste for making bio fertilizers. But as the company went into liquidation, this project was closed in July 2011[75]. After which, KMC has appointed M/s. Rochem Separation Pvt. Ltd, Mumbai as new concessioner for the processing of MSW by advanced technology at the Kasaba Bawada site.

Establishment of a Waste to Energy plant has been proposed at the Kasba Bawda site based on the mass combustion technology. In the meantime, KMC has received the permissions from MPCB and Collector office Kolhapur to shift the existing waste at the Takala landfill site. The work for shifting of the waste will begin in July 2016 and is expected to end by December 2017.

### 7.1.4.3 Development of scientific Landfill sites

To overcome the practice of open dumping which has been in practice in Kolhapur city since a very long time establishing of scientific landfill sites has been proposed. The abandoned stone quarries at Takala and Toap have been identified by the corporation for converting them into scientific landfill sites. The following section discusses the updates and brief on the same.

#### *7.1.4.3.1 Takala Landfill site*

The Takala quarry site is currently owned by the Municipal Corporation and is spread across 3.5 hectares. Out of the total land area, the landfill site is proposed across 1.5 hectares while the remaining site has been reserved for developing an amusement park. KMC has received all the statutory permissions for developing the scientific landfill site.

The installation of the site has been completed and is layered with HDPE (High Density Poly Ethylene) at the bottom to prevent leakage and seepage of the leachate. The site has further been developed by constructing concrete wall along the periphery of the site.

[75] Environmental Status Report 2014-15,KMC

This location will be utilised as a transitory facility for shifting the existing waste from Kasba Bawda dump site. Post the transfer the site would be closed by capping, levelling and developing it further.

**Picture No. 19: The Takala Land fill site layered with HDPE and concrete wall along the periphery**
**Photo credits: TERI**

#### *7.1.4.3.2 Toap Landfill site*

KMC has identified an abandoned quarry spread across 7 hectare at Toap village, in Hatkangale taluka for developing a landfill site. It is located around 15 kms from the city. The site was approved and handed over to the corporation by the Additional Collector, Kolhapur in 2007, however the site was not used owing to stay of the Hon'ble District Court. Later the case was transferred to Hon'ble NGT (National Green Tribunal), Pune which has now given permission for development of landfill site. The site has a potential to cater to the scientific landfill requirements of Kolhapur city's waste for about 25-30 years.

### 7.1.4.4 Bio- Methanation Plant

Under the Swachh Bharat Abhiyaan, KMC has decided to construct two Biogas plants of 5 ton capacity each to treat the biodegradable waste and generate power for meeting power requirements of local streetlights .The plant would be based on Nisargruna Technology (BARC) of 5 Ton capacity at Bawada and Central Jail, Kalamba.

**Picture No. 20: Picture depicting a prototype of Bio –Methanation plant**
**Photo credit: KMC**

### 7.1.4.5 1.1.1.1 Awareness and Cleanliness drive

KMC has been proactively undertaking various awareness drives to sensitize the citizens on good practices of managing the solid waste. In the year 2015–16, KMC in collaboration with various partners organised 6 awareness drives in Kolhapur city under SBA (Swachh Bharat Abhiyaan). Presented below in Table No. 39 and Picture No. 21 are the details and pictures of the awareness drives organised by KMC in the reporting year.

**Picture No. 21: Photographs of awareness drives conducted by KMC under SBA in 2015–16**
**Photo credit: KMC**

**Table No. 39: List of awareness drives undertaken by KMC under SBA in Kolhapur city**

| Program | Date | Organization |
|---|---|---|
| Swachh Bharat Abhiyan Jangaruti | 5th June 2015 | KMC and Ekati Santha |
| Swachh Bharat Abhiyan Janjagruti Nirmalya Collection | 27th Sep 2015 | KMC and Ekati Santha |
| Swachh Bharat Abhiyan Janjagruti /Swachata | 2nd Oct 2015 | KMC |
| Swachh Bharat Abhiyan Janjagruti/Swachata (Railway Station) | 2nd Oct 2015 | KMC |
| Swachh Bharat Abhiyan Swachata | 9th Oct 2015 | KMC & Gokhale College |
| Swachh Bharat Abhiyan Janjagruti Rally | 12th Oct 2015 | KMC and Ekati Santha |

**Source: Solid Waste Management Department, KMC**

## 7.2 Biomedical waste

According to Biomedical Waste (Management and Handling) Rules, 1998 of India "*Any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological*' is classified as Bio-Medical waste. As per estimates by WHO (World Health Organization) around 15%–35% of the hospital waste are infectious waste and hence discarding this waste with appropriate treatment is of utmost importance.

Kolhapur city generates about 0.7 tons/day of BMW (Bio-Medical Waste) from various hospitals, clinics and health care facilities. There are approximately 906 health care facilities, clinics blood banks, hospitals and so on in Kolhapur city generate biomedical waste. NIN (Nature in Need) CBMWTSDF (Common Biomedical Waste Treatment Storage and Disposal Facility) has been appointed by MPCB to collect and dispose the BMW from Kolhapur city.

In the year 2015, about 82% of healthcare facilities (819), clinics, hospitals and so on were empaneled with NIN CBMWTSDF to dispose off their BMW with the agency (Figure No. 28). The number of health care centres joined with this facility has increased from around 700 in 2012 to about 819 in 2015 however about 100 centres are yet to join the facility and are expected to join the same by end of 2016.

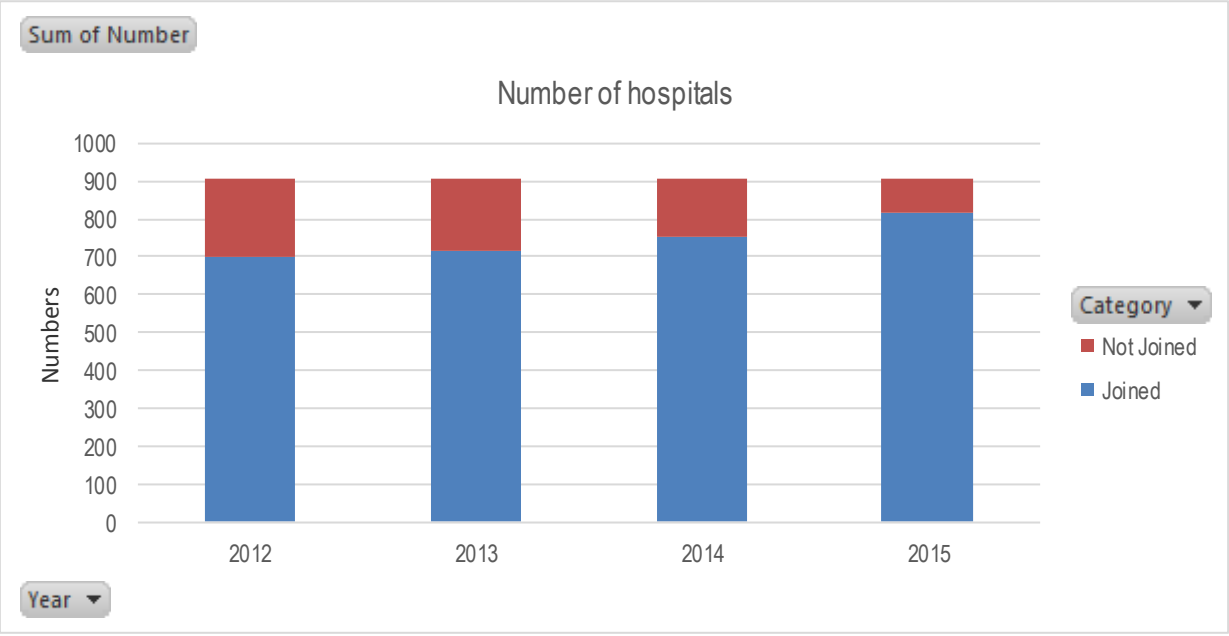



**Figure No. 28: Number of Institutes producing Bio-Medical waste**
**Data source: Nature in Need CBMWTSDF, Kolhapur**

The biomedical waste treatment facility has been established near the 76 MLD STP (Sewage Treatment Plant) at Kasba Bawda in Kolhapur city itself. From Figure No. 29, it is observed that over the past 5 years the total biomedical waste collected and treated in Kolhapur city has increased by more than 1.5 times from 184 MT in 2012–13 to about 274 MT in the year 2015–16. More than 90% of the biomedical waste is disposed of through incineration technique while chemical treatment and disinfection is used to dispose of glass wares which

have a share of 5%. The remaining waste (4%) which comprise mainly of plastic is shredded off and autoclaved and then recycled.

In 2015–16, about 274 MT of biomedical waste was treated at this facility of which 91% (250 MT) was disposed through incineration while 5% (13 MT) and 4% (10 MT) was disposed by chemical treatment and autoclaving/shredding respectively.

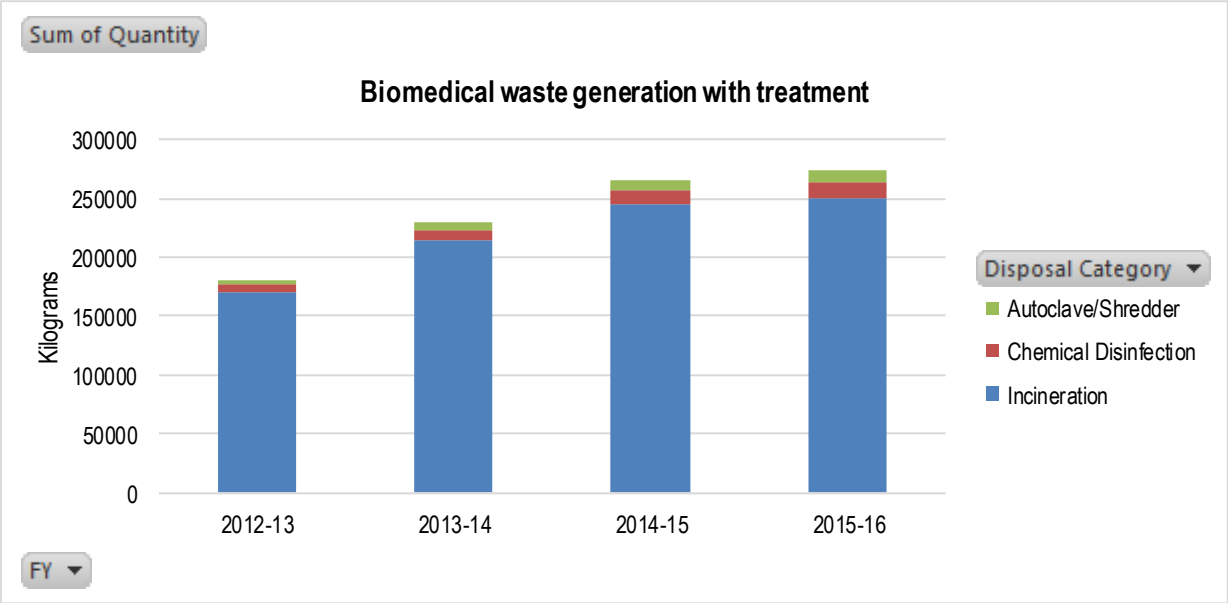



**Figure No. 29: Biomedical Waste Generation (2012-16) with Treatment**
**Source: Nature in Need CBMWTSDF, Kolhapur**

## 7.3 Recommendations

### 7.3.1.1 Study on Composition of waste

Ward wise classification of waste under Biodegradable and non-biodegradable of waste should be done within the city. Biodegradable waste should be classified further for Paper Waste, Rags and so on and Non-Biodegradable to be classified for Glass, Plastic, Metals, Inert material and so on

# 8 Health

## 8.1 Environment and Health

The environment which we interact with daily is a major determinant of our health and well-being. Physical, chemical and micro -biological factors in the environment have repercussions on our health, both physical and mental. However, the interface between the two is so complex that it is difficult to assess and attribute the same to any one particular reason. Environment can have both a positive as well as a negative influence on our health for e.g. positive influences such as green belts and entertainment areas have the capability to boost our health and energy whereas on the other hand, negative factors such as ambient air pollution, poor water quality, insufficient sanitation, noise and so on are having a reverse impacts on our health. It is necessary to identify these negative impacts. As per WHO, there are five major quantifiable environmental exposures which together account for nearly 10% of deaths and disease burden globally[76] which are:

1. Unsafe water, sanitation and hygiene
2. Indoor smoke from solid fuels
3. Urban outdoor air pollution
4. Lead exposure and
5. Global climate change

As per another research by WHO, environmental factors are responsible for spreading more than 80% of the diseases. Diseases with the largest absolute burden from environmental exposure included diarrhoea, lower respiratory infections, Dengue and Malaria. The status of health of 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. Table No. 40 below presents the tally of the various health facilities present in KMC. While the following section discusses the status of various diseases recorded in KMC in the year 2015-16 and the important response taken in KMC area.

**Table No. 40: List of health care facilities in KMC**

| Heads | 2015-16 |
|---|---|
| No. of Private Hospitals | 9 |
| Ayurvedic Clinics | 4 |
| Homeopathy Clinics | 4 |
| Pediatricians | 28 |
| Gynecologists | 86 |
| Private Nursing Homes | 143 |
| Blood Banks | 8 |

**Source: Health Department, KMC**

[76] http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf?ua=1&ua=1

## 8.2 Water Borne Diseases

Water borne diseases are caused by variety of pathogenic microorganisms, biotoxins and other toxic contaminants which are directly or indirectly transmitted through contaminated water. These could also spread through flies or filth but water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases. Outbreaks of waterborne diseases often occur after a severe precipitation event such as heavy rainfall, floods etc.

As seen in Figure No. 30, there is a very uncertain pattern for all the diseases. From 2012–13 to 2013–14, there is a significant drop in cases of Gastro and Hepatitis, however a steep increase by double is noticed in the following year i.e. 2014–15. But this year (2015- 16), a decrease of 60% and 33% decline has been registered in the cases of Gastroenteritis and Hepatitis B respectively from the previous year. The cases of Dysentery are on a decrease since the last three years, whereas typhoid cases were reported to have increased by approx. 9% from 2014-15 to 2015-16.

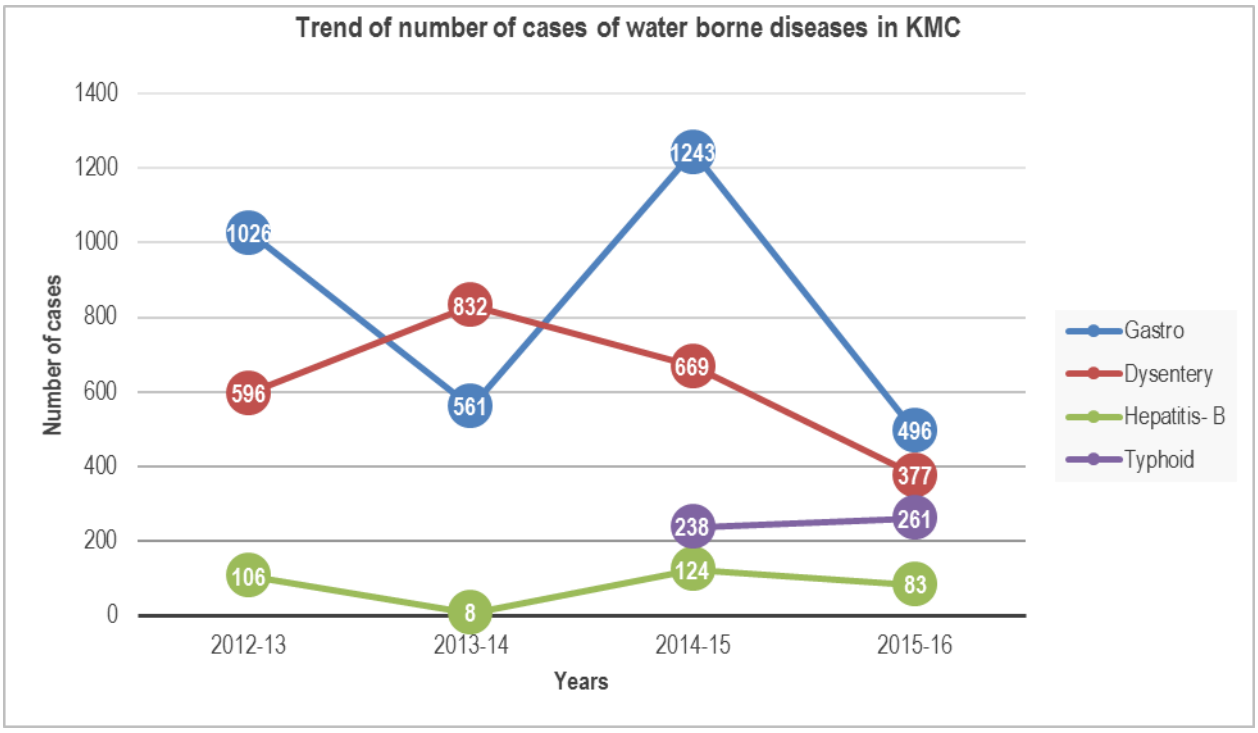



**Figure No. 30: Trend in cases of water borne diseases reported in KMC area**
**Source: Health Department, KMC**

## 8.3 Vector Borne Diseases

Organisms that transmit pathogens and parasites from one infected person (or animal) to another, causing serious diseases in human populations are known as vectors and they are known to transmit infections. These diseases are commonly found in the regions where access to safe drinking-water and sanitation systems is a challenge. According to WHO, vector-borne diseases account for 17% of the estimated global burden of all infectious diseases, with dengue and malaria at the top of the list.

### 8.3.1Malaria

Malaria, a parasitic infectious disease, is transmitted by mosquitoes which breed in fresh or occasionally brackish water. The species of *Plasmodium*, a causal parasite of malaria resides in the body of *Anopheles* mosquito, which acts as a vector in transmission of the malarial infection. Figure No. 31 enlists total number of malaria cases reported by KMC's health department in the last 5 years. As seen in the table, the total number of malaria cases reported in KMC are continuously decreasing, which could be a result of proper and timely health facilities available at hospitals and medical practitioners in and around KMC.

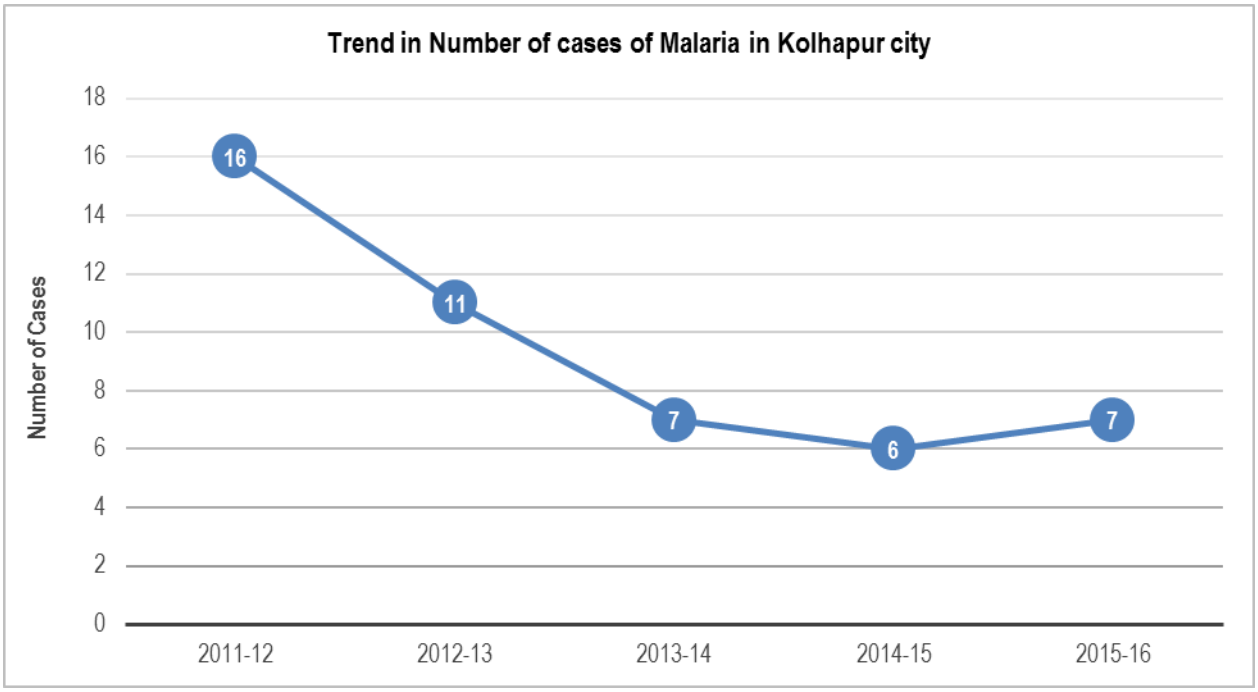



**Figure No. 31: Total number of malaria cases reported in past five years**
**Data source: Health Department, KMC**

## 8.3.2Dengue

Dengue fever, also known as break bone fever, is a tropical disease caused by the dengue virus. The *Aedes* sp. of mosquito acts as the vector for transmission of dengue infection. It is one of the deadliest vector borne diseases and owing to its severity, Government of Maharashtra has classified dengue as a 'notified disease'. Now, officials are authorized to enter residential premises to check for larvae breeding of the dengue causing *Aedes aegypti* mosquito[77].

Symptoms of Dengue include fever, headache, muscle and joint pains, and a characteristic skin rash that is similar to measles. The mosquitoes responsible to carry the dengue viruses are most active from dawn to dusk, but they can also bite at night. Dengue and dengue hemorrhagic fevers could be prevented by following good practices like wearing protective clothing, managing water containers and avoiding accumulation and stagnation of freshwater in and around houses, use of mosquito repellents and so on.

As shown in the Figure No. 32, the number of cases for Dengue fever has a decreasing trend with an exception to the year 2013-14 in the past five years. However a steep increase is noticed in the last year 2015–16 and almost 92 cases with 2 deaths were recorded, an increase of 80% as compared to the previous year. The number of cases in 2015–16 is more than the total number of cases recorded in the previous four years.

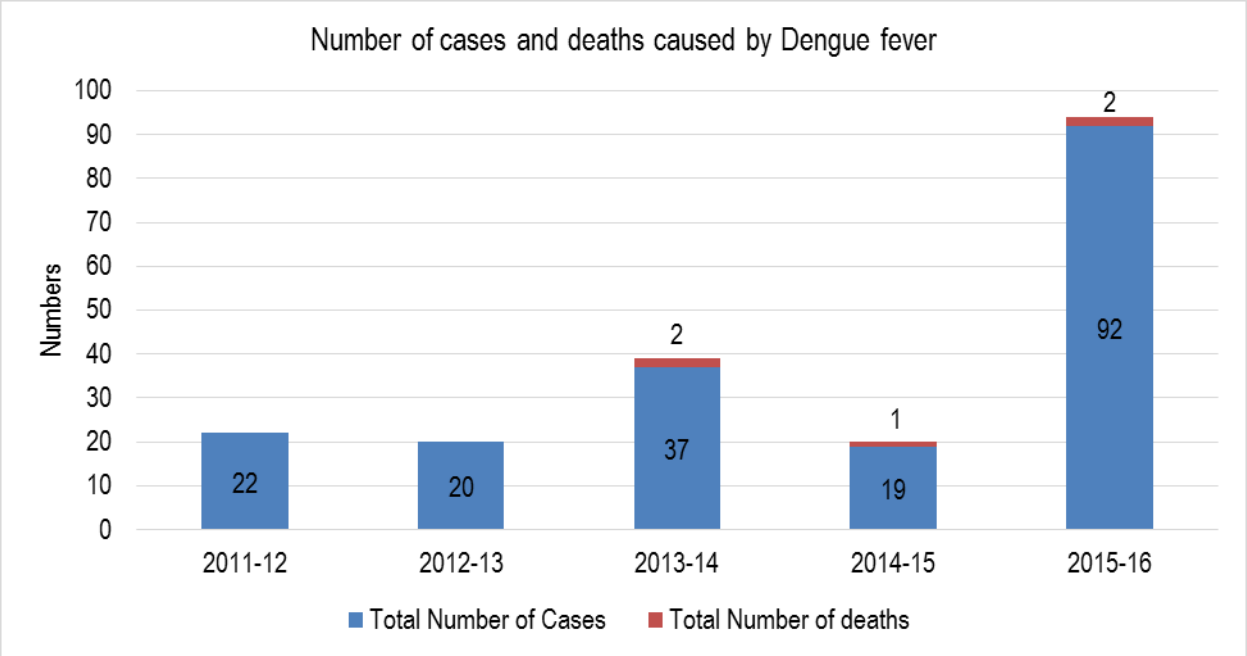



**Figure No. 32: Total number of cases and deaths reported by Dengue in the past 5 years**
**Data source: Health Department, KMC**

[77] http://indianexpress.com/article/india/india-news-india/dengue-maharashtra-governmentt-classifies-dengue-as-notified-disease-2912763/

## 8.4 Air Borne Disease – Tuberculosis

Airborne diseases are caused by pathogens and transmitted through the medium of air. TB is a deadly disease which occurring in every part of the world with more than 9 million new cases every year. Unfortunately, India is amongst the five countries which account for almost 54% of all new cases in the world[78]. As per Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, TB (Tuberculosis) is considered as the prototypic disease of airborne transmission, however its transmission could be prevented through adequate ventilation and limited contact with patients.

TB causing bacteria spread from person to person in tiny microscopic droplets when a TB patient coughs, sneezes, speaks, sings, or laughs. TB is caused by bacteria (*Mycobacterium tuberculosis*) that affects the lungs as well as other internal body parts also. Around 467 cases of TB were recorded in the year 2015–16 and around 40 deaths owing to TB were recorded. Consistently from the past 5 years more than 450 cases of TB and around 35+ deaths. The total number of cases and deaths reported in the region are more or less constant from the past few years (Figure No. 33) indicating consistent prevalence and incidence of TB cases in Kolhapur.

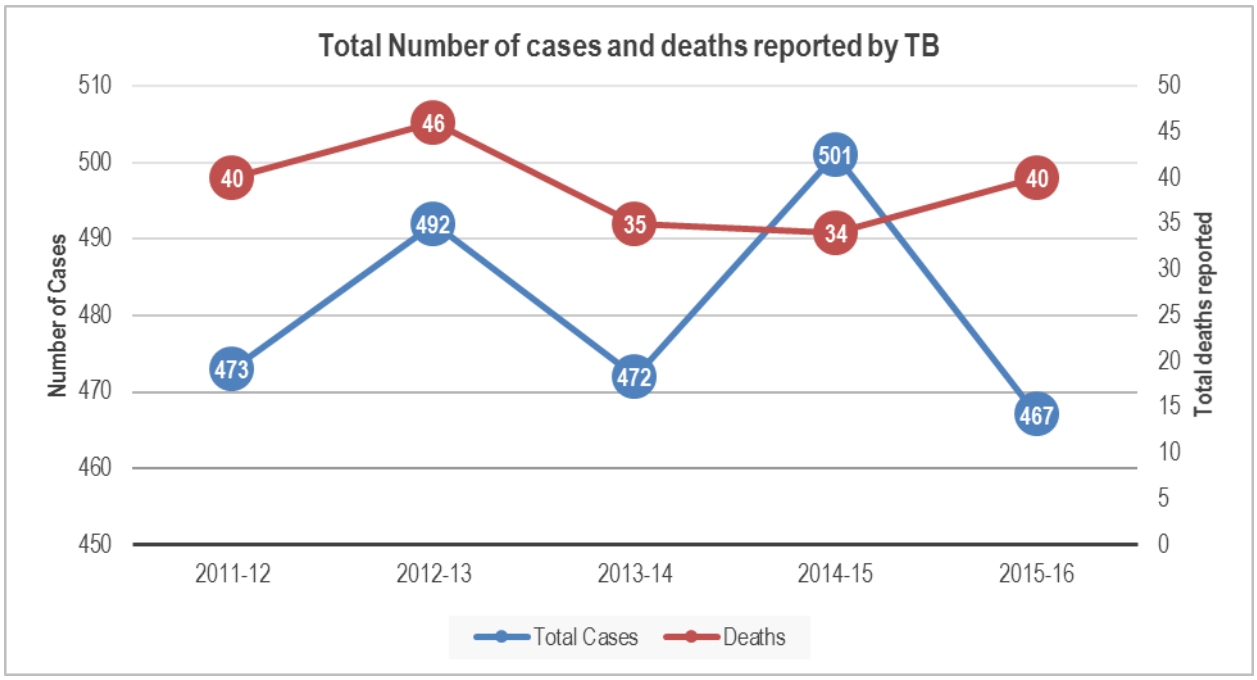
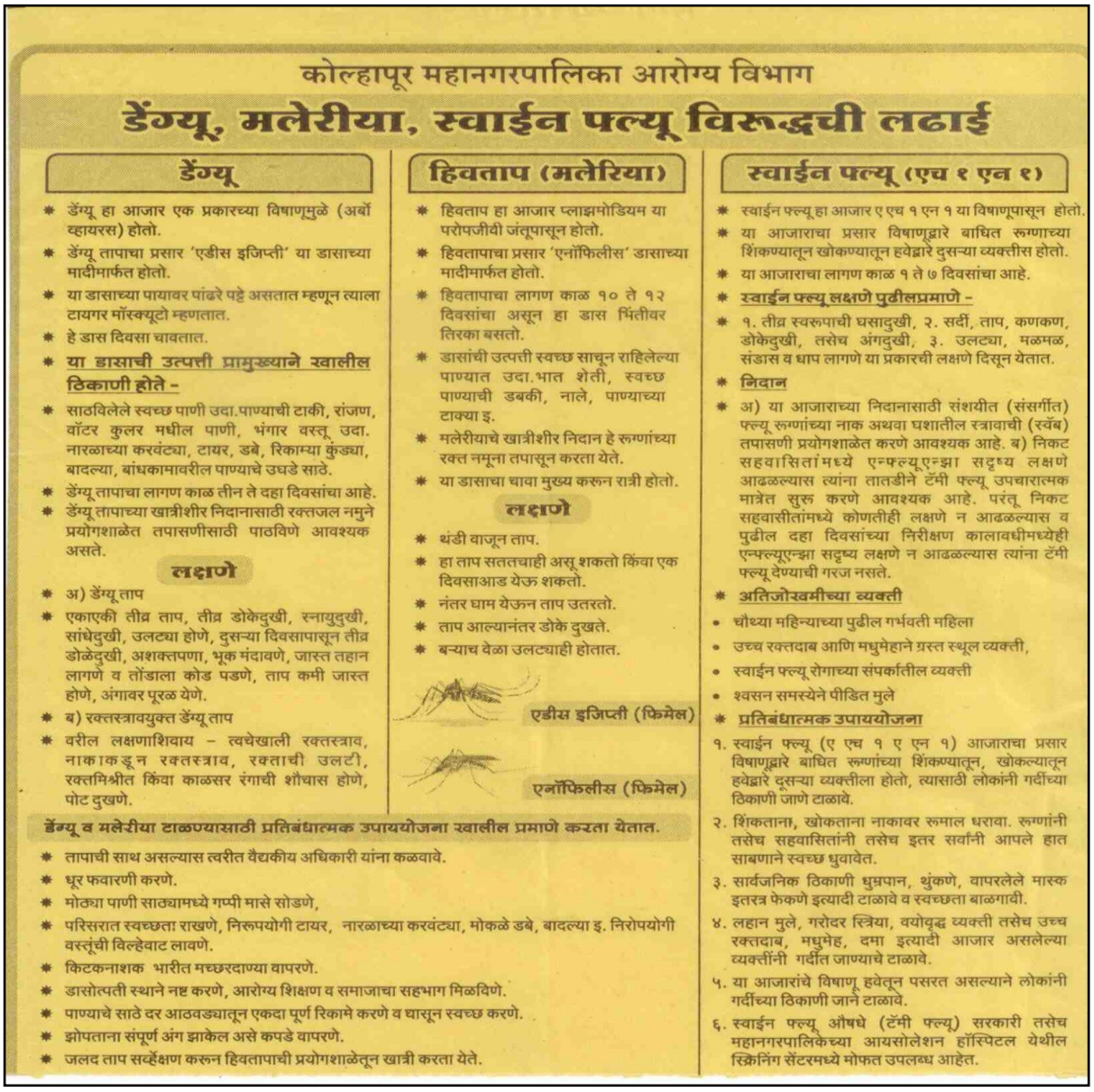



**Figure No. 33: Total number of cases and deaths reported due to TB in the past five years**
**Source: Health Department, KMC**

[78] World Health Statistics, 2016; World Health Organization

## 8.5 Response and Achievements

All the diseases described above are preventable as well as curable. However, these are largely ignored and as a result they continue to cause significant mortality and morbidity in the developing world. To avoid the grave situation arising because of these diseases, creating awareness about it and its effects to millions of people in the world is critically important. Giving importance to this fact, KMC had distributed more than 3 thousand pamphlets through a network of 11 PHC's (Primary Health Centres) on the preventive measures, symptoms and curative measures about Dengue, Malaria and Swine flu.



कोल्हापूर महानगरपालिका आरोग्य विभाग

**डेंग्यू, मलेरीया, स्वाईन फ्ल्यू विरूद्धची लढाई**

**डेंग्यू**

* डेंग्यू हा आजार एक प्रकारच्या विषाणूमुळे (अर्बो व्हायरस) होतो.
* डेंग्यू तापाचा प्रसार 'एडीस इजिप्ती' या डासाच्या मादीमार्फत होतो.
* या डासाच्या पायावर पांढरे पट्टे असतात म्हणून त्याला टायगर मॉस्क्यूटो म्हणतात.
* हे डास दिवसा चावतात.
* **या डासाची उत्पत्ती प्रामुख्याने खालील ठिकाणी होते –**
* साठविलेले स्वच्छ पाणी उदा.पाण्याची टाकी, रांजण, वॉटर कुलर मधील पाणी, भंगार वस्तू उदा. नारळाच्या करवंट्या, टायर, डबे, रिकाम्या कुंड्या, बादल्या, बांधकामावरील पाण्याचे उघडे साठे.
* डेंग्यू तापाचा लागण काळ तीन ते दहा दिवसांचा आहे.
* डेंग्यू तापाच्या खात्रीशीर निदानासाठी रक्तजल नमुने प्रयोगशाळेत तपासणीसाठी पाठविणे आवश्यक असते.

**लक्षणे**

* अ) डेंग्यू ताप
* एकाएकी तीव्र ताप, तीव्र डोकेदुखी, स्नायुदुखी, सांधेदुखी, उलट्या होणे, दुसऱ्या दिवसापासून तीव्र डोळेदुखी, अशक्तपणा, भूक मंदावणे, जास्त तहान लागणे व तोंडाला कोड पडणे, ताप कमी जास्त होणे, अंगावर पूरळ येणे.
* ब) रक्तस्त्रावयुक्त डेंग्यू ताप
* वरील लक्षणाशिवाय – त्वचेखाली रक्तस्त्राव, नाकाकडून रक्तस्त्राव, रक्ताची उलटी, रक्तमिश्रीत किंवा काळसर रंगाची शौचास होणे, पोट दुखणे.

**हिवताप (मलेरिया)**

* हिवताप हा आजार प्लाझमोडियम या परोपजीवी जंतूपासून होतो.
* हिवतापाचा प्रसार 'एनॉफिलीस' डासाच्या मादीमार्फत होतो.
* हिवतापाचा लागण काळ १० ते १२ दिवसांचा असून हा डास भिंतीवर तिरका बसतो.
* डासांची उत्पत्ती स्वच्छ साचून राहिलेल्या पाण्यात उदा.भात शेती, स्वच्छ पाण्याची डबकी, नाले, पाण्याच्या टाक्या इ.
* मलेरीयाचे खात्रीशीर निदान हे रुग्णांच्या रक्त नमूना तपासून करता येते.
* या डासाचा चावा मुख्य करून रात्री होतो.

**लक्षणे**

* थंडी वाजून ताप.
* हा ताप सततचाही असू शकतो किंवा एक दिवसाआड येऊ शकतो.
* नंतर घाम येऊन ताप उतरतो.
* ताप आल्यानंतर डोके दुखते.
* बऱ्याच वेळा उलट्याही होतात.

एडीस इजिप्ती (फिमेल)

एनॉफिलीस (फिमेल)

**स्वाईन फ्ल्यू (एच १ एन १)**

* स्वाईन फ्ल्यू हा आजार ए एच १ एन १ या विषाणूपासून होतो.
* या आजाराचा प्रसार विषाणूद्वारे बाधित रुग्णाच्या शिंकण्यातून खोकण्यातून हवेद्वारे दुसऱ्या व्यक्तीस होतो.
* या आजाराचा लागण काळ १ ते ७ दिवसांचा आहे.
* **स्वाईन फ्ल्यू लक्षणे पुढीलप्रमाणे –**
* १. तीव्र स्वरूपाची घसादुखी, २. सर्दी, ताप, कणकण, डोकेदुखी, तसेच अंगदुखी, ३. उलट्या, मळमळ, संडास व धाप लागणे या प्रकारची लक्षणे दिसून येतात.
* **निदान**
* अ) या आजाराच्या निदानासाठी संशयीत (संसर्गीत) फ्ल्यू रुग्णांच्या नाक अथवा घशातील स्त्रावाची (स्वॅब) तपासणी प्रयोगशाळेत करणे आवश्यक आहे. ब) निकट सहवासितांमध्ये एन्फ्ल्यूएन्झा सदृष्य लक्षणे आढळल्यास त्यांना तातडीने टॅमी फ्ल्यू उपचारात्मक मात्रेत सुरू करणे आवश्यक आहे. परंतू निकट सहवासीतांमध्ये कोणतीही लक्षणे न आढळल्यास व पुढील दहा दिवसांच्या निरीक्षण कालावधीमध्येही एन्फ्ल्यूएन्झा सदृष्य लक्षणे न आढळल्यास त्यांना टॅमी फ्ल्यू देण्याची गरज नसते.
* **अतिजोखमीच्या व्यक्ती**
  - चौथ्या महिन्याच्या पुढील गर्भवती महिला
  - उच्च रक्तदाब आणि मधुमेहाने ग्रस्त स्थूल व्यक्ती,
  - स्वाईन फ्ल्यू रोगाच्या संपर्कातील व्यक्ती
  - श्वसन समस्येने पीडित मुले
* **प्रतिबंधात्मक उपाययोजना**

१. स्वाईन फ्ल्यू (ए एच १ ए एन १) आजाराचा प्रसार विषाणूद्वारे बाधित रुग्णांच्या शिंकण्यातून, खोकल्यातून हवेद्वारे दूसऱ्या व्यक्तीला होतो, त्यासाठी लोकांनी गर्दीच्या ठिकाणी जाणे टाळावे.

२. शिंकताना, खोकताना नाकावर रूमाल धरावा. रुग्णांनी तसेच सहवासितांनी तसेच इतर सर्वांनी आपले हात साबणाने स्वच्छ धुवावेत.

३. सार्वजनिक ठिकाणी धुम्रपान, थुंकणे, वापरलेले मास्क इतरत्र फेकणे इत्यादी टाळावे व स्वच्छता बाळगावी.

४. लहान मुले, गरोदर स्त्रिया, वयोवृद्ध व्यक्ती तसेच उच्च रक्तदाब, मधुमेह, दमा इत्यादी आजार असलेल्या व्यक्तींनी गर्दीत जाण्याचे टाळावे.

५. या आजारांचे विषाणू हवेतून पसरत असल्याने लोकांनी गर्दीच्या ठिकाणी जाने टाळावे.

६. स्वाईन फ्ल्यू औषधे (टॅमी फ्ल्यू) सरकारी तसेच महानगरपालिकेच्या आयसोलेशन हॉस्पिटल येथील स्क्रिनिंग सेंटरमध्ये मोफत उपलब्ध आहेत.

**डेंग्यू व मलेरीया टाळण्यासाठी प्रतिबंधात्मक उपाययोजना खालील प्रमाणे करता येतात.**

* तापाची साथ असल्यास त्वरीत वैद्यकीय अधिकारी यांना कळवावे.
* धूर फवारणी करणे.
* मोठ्या पाणी साठ्यामध्ये गप्पी मासे सोडणे,
* परिसरात स्वच्छता राखणे, निरूपयोगी टायर, नारळाच्या करवंट्या, मोकळे डबे, बादल्या इ. निरोपयोगी वस्तूंची विल्हेवाट लावणे.
* किटकनाशक भारीत मच्छरदाण्या वापरणे.
* डासोत्पत्ती स्थाने नष्ट करणे, आरोग्य शिक्षण व समाजाचा सहभाग मिळविणे.
* पाण्याचे साठे दर आठवड्यातून एकदा पूर्ण रिकामे करणे व घासून स्वच्छ करणे.
* झोपताना संपूर्ण अंग झाकेल असे कपडे वापरणे.
* जलद ताप सर्व्हेक्षण करून हिवतापाची प्रयोगशाळेतून खात्री करता येते.

**Picture No. 22: Pamphlets for sensitization on Dengue and Malaria distributed by KMC**
**Source: Health Department, KMC**

Apart from the above, KMC had also started a campaign for creating awareness on tuberculosis. A full "TB week" was celebrated from March 24-27, 2016, by the corporation targeting different stake-holders through different measures. KMC received an award from

the state TB office for *"Best IEC (Information Education and Communication) practices"* for their innovative measures of creating awareness about the TB which included the following:

1. KMC has created a TB literate ward at Siddharth Nagar, in which education related to TB causes, symptoms and preventive measures was imparted to the citizens. The results were very promising as all the citizens actively participated in it.
2. KMC also carried out awareness drives in KMT buses with the help of 15 MSW (Masters of Social Works) students and also set-up RNTCP (Revised National Tuberculosis Control Program) stalls.
3. A TB rally and community meetings are also being organized timely and at different places for the citizens.

## 8.6 Recommendations

As per WHO, following proposed approaches should be focused to reduce the burden of the diseases:

**1. Diagnosis and case management**

An efficient and early diagnosis, capacity building of the health workers, awareness generation of the local citizens are some of the measures which the corporation should take on priority.

**2. Integrated surveillance and outbreak preparedness**

**Surveillance** is critical for dengue prevention and control programme as it provides the information necessary for risk assessment and programme guidance. The following points should be followed strictly for a successful surveillance and preparedness:

i. Hospitals and health check-up centers have to be updated with latest technologies and equipment for early detection and interventions;

ii. Data recording and management for the assessment of its social and economic impacts on affected communities;

iii. Proper monitoring of the trends and distribution of the infection geographically and periodically, risk factors and other water, sanitation and hygiene-related diseases

**Outbreak preparedness** has to be technical as well as operational all the time as an effective response always depends on an operative and well-planned contingency plan. The plan should cover, its aims and objectives, emergency contact agencies, contact of implementing agencies and so on.

The 8 priority areas for planning dengue emergency response, adapted from Rigau-Pérez and Clark[79] (2005), are to:

i. Establish a multispectral dengue action committee
ii. Formalize an emergency action plan
iii. Enhance disease surveillance, vector surveillance and control
iv. Perform diagnostic laboratory testing
v. Protect special populations and reduce the impact of environmental determinants
vi. Ensure appropriate patient care
vii. Engage the community and relevant professional groups about dengue control as well as their participation in dengue prevention and control
viii. Manage the proper awareness campaigns and advertisements.

**3. <u>Sustainable vector control</u>**

Preventive and effective vector control interventions aim to reduce dengue transmission, thereby decreasing the incidence of the infection and preventing outbreaks of the disease. These are necessary to achieve reduction of morbidity attributable to dengue. The following measures could be adopted:

i. As dengue mosquito breed in fresh water sources, periodic cleaning of the community water tanks, lakes, fresh water reservoirs and so on
ii. Removal of containers, pots that are favorable sites for the breeding of mosquitoes and development of the aquatic stages
iii. Insecticides spraying and residual surface treatments
iv. Guppy fish are proven enemies of dengue mosquitoes, they usually eat larvae and don't allow mosquitoes to grow and breed. They are a cheap and effective tool. A study claims that guppies do not harm water quality and can survive on microscopic organic material in the absence of mosquito larvae[80]

[79] http://apps.who.int/iris/bitstream/10665/75303/1/9789241504034_eng.pdf
[80] http://vaccinenewsdaily.com/stories/510535225-guppy-fish-could-be-used-to-fight-dengue-fever

The Energy and Resources Institute
www. teriin.org