पनवेल महानगरपालिका

स्थापना - २०१६

ENVIRONMENTAL STATUS REPORT 2020-21

PANVEL MUNICIPAL CORPORATION, PANVEL

पनवेल महानगरपालिका

स्थापना - २०१६

Environmental Status Report 2020-21

PANVEL MUNICIPAL CORPORATION, PANVEL

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Mumbai School of Economics and Public Policy

University of Mumbai, Mumbai

Prepared by

Mumbai School of Economics and Public Policy

University of Mumbai, Mumbai

Submitted to

Panvel Municipal Corporation, Panvel

For more information

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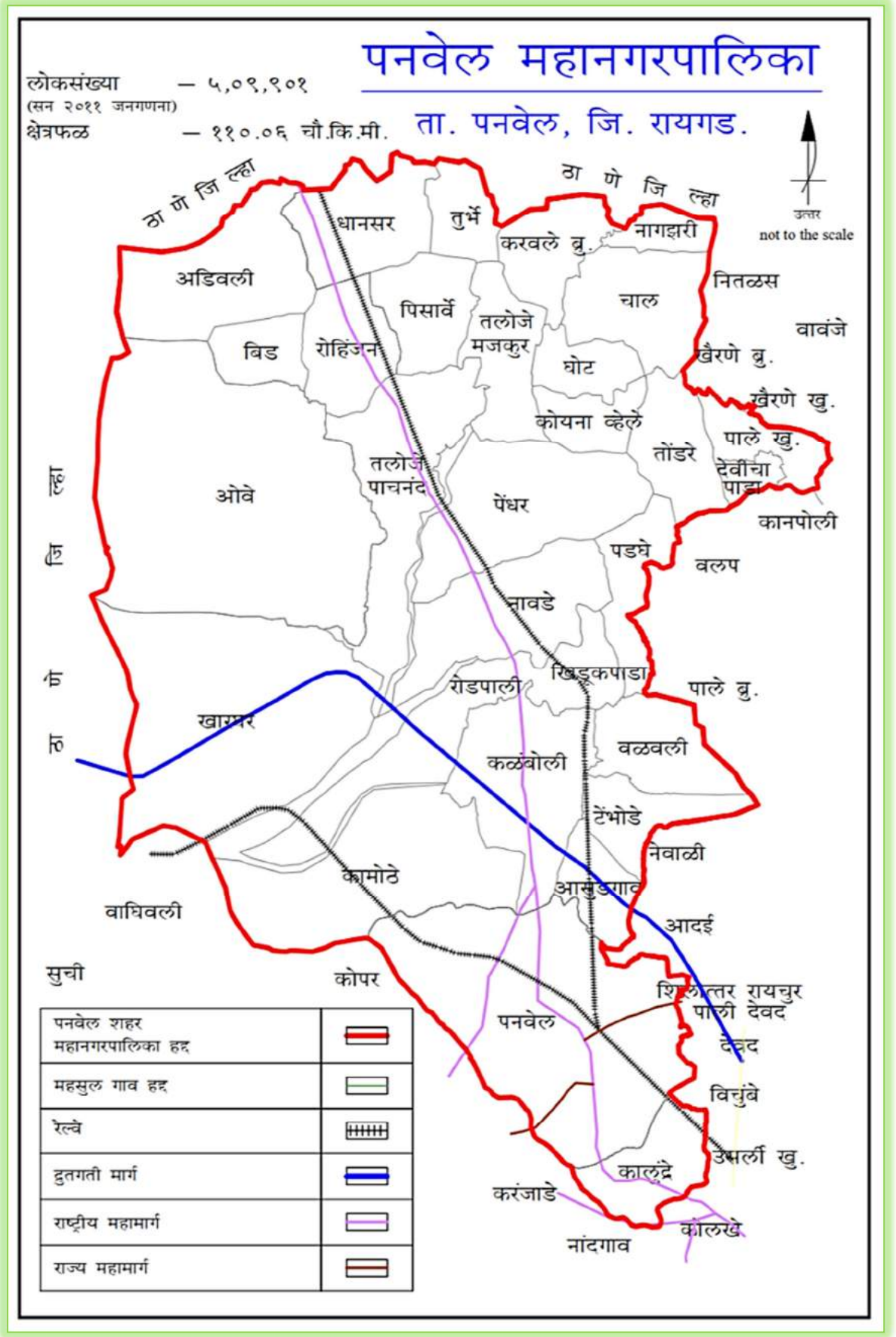
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राष्ट्रीय महामार्ग
राज्य महामार्ग

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Foreword

I am delighted to present the Environmental Status Report, 2020-21 for the Panvel Municipal Corporation. Panvel City has emerged as the most preferred residential location in MMR. The PMC takes the responsibility to keep the City clean and maintain its beauty while conserving and preserving the environment.

The PMC is the hot spot in terms of the environment since many industrial units are in the vicinity. We are collectively engaged in Environmental protection and conservation. The PMC secured 20th All India Rank in Swachha Survekshan-2020. The significant improvement in our ranking has raised the bars of expectations from the households in the City. The team of MSE-PP, University of Mumbai, drafted the Environmental Status Report for 2018-19 and 2019-20, with suggestions and policy recommendations. The report helped us in shaping the future policies for sustainable Panvel City. The team has presented the Environmental Status Report 2020-21 with a technically sound and rigorous methodology.

I am sure that the Environmental Status Report would help PMC make our City clean, beautiful, and healthy and help improve residents' quality of life.

Dr. Kavita Choutmol

Mayor

Panvel Municipal Corporation, Panvel

Foreword

The Corporation is newly constituted and has administrative and financial constraints; given the conditions, the PMC has initiated steps to make Panvel City clean and environmentally sustainable. The sincere attempts brought in the 20th ranking in Swachh Survekshan 2020 made a proud moment for the PMC. The environmental Status Report is a complete report of initiatives taken by the various departments of PMC under the kind guidance of the Mayor and administration of the Commissioner of PMC. The report will further strengthen our efforts to make city pride.

Jagdish Gaikwad

Deputy Mayor

Panvel Municipal Corporation, Panvel

Foreword

The importance of the environment for households in a city is the top priority of local governments. The Environmental Status Report records all the dimensions of environmental variables that influence the lives of the community.

In a very short period, the secured place in the top 20 cities in India in Swachh Survekshan 2020 due to its best practices in solid waste management and received ODF++ Certification. Our endeavours to collect and dispose of solid waste, maintain the roads, manage the drainage and sewerage system, increase the tree cover by planting plants every year, maintain the beautification of chowks and plan the City as per increasing population to make the city environment efficient and balanced have generated positive outcomes.

The Mumbai School of Economics and Public Policy (MSE-PP) collected data and information from various institutions including the PMC. For the third time in the history of PMC, an Environmental Survey of 800 households was conducted by MSE-PP to shape the Environmental Status Report presented herewith. We wish to formulate policies to safeguard the environment in the City based on suggestions made in the report.

Ganesh Deshmukh
Commissioner,
Panvel Municipal Corporation, Panvel

Foreword

The progress of the PMC in sustaining the environment in the City is well documented in the Environmental Status Report, 2020-21. Despite the adverse situations that occurred due to the Covid-19 pandemic, we have fulfilled our obligations restlessly. I was impressed with the work carried by MSE-PP on the Environmental Status Report-2018-19 and 2019-20. The present report is an outcome of policy prescriptions executed efficiently and positive changes fulfilling suggestions made by corporators, representatives of residents, experts and expectations of residents in Panvel.

Environmental Status Report, 2020-21 presented by PMC will guide to make Panvel clean, a beautiful, eco-friendly, environmentally sustainable and ideal city in the vicinity.

Paresh Thakur
Leader of House,
Panvel Municipal Corporation, Panvel

Foreword

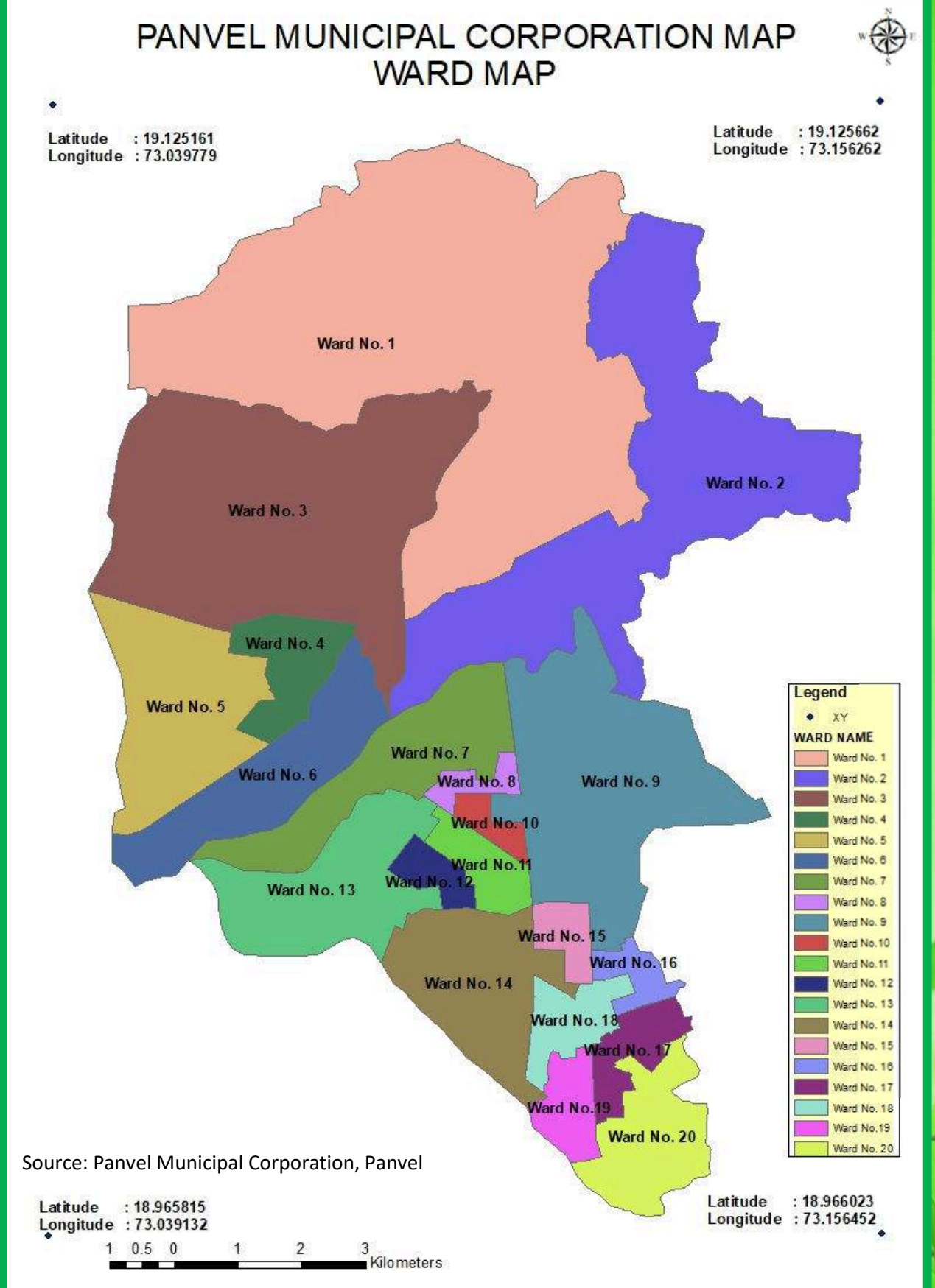
The PMC has brought a significant change in the City in recent years. The Environmental Status Report, 2020-21 is an outcome of initiatives taken by PMC in making our City environmentally friendly. Sustainable urban development is essentially achieved by all local urban bodies, knowing our responsibility for the policies and strategies directed by Honourable Mayer and the Commissioner. The report will guide us as policy prescription to make City further clean and beautiful. I am happy that the officials at Environment Division have come up with a scientific document that will help PMC to make the City proud.

Pritam Mhatre

Leader of Opposition

Anvel Municipal Corpration, Panvel

PANVEL MUNICIPAL CORPORATION MAP
WARD MAP



Source: Panvel Municipal Corporation, Panvel

Environmental Status Report, 2020-21

Prepared under the able guidance of

Hon. Shri. Ganesh Deshmukh

Commissioner

Hon. Shri. Jagdish Gaikwad

Deputy Mayor

Hon. Dr. Kavita Choutmol

Mayor

Hon. Shri. Paresh Thakur

Leader of House

Hon. Shri. Santosh Shetty

Chairman, Standing Committee

Hon. Shri. Pritam Mhatre

Leader of Opposition

Hon. Mrs. Monika Mahanwar

Chairman, Women and Child Welfare

All Corporators and Officers

Panvel Municipal Corporation, Panvel

CERTIFICATIONS AND RECOGNITIONS TO PMC

There have been continuous efforts to make the city clean, beautiful and progressive and environment friendly with proper plan and implementation to the fullest extent. As a result, PMC has ODF++ Certification under Swachha Survemshan in August 2019. The PMC secured 20th Rank in All India Ranking in Swachh Survekshan for the year 2020.

Ministry of Housing and Urban Affairs
Government of India

150 YEARS OF CELEBRATING THE MAHATMA

स्वच्छ भारत

एक कदम स्वच्छता की ओर

SWACHHATA CERTIFICATE

This is to certify that

Panvel (M Cl)

Urban Local Body, Raigad District in the state of Maharashtra has been declared as

OPEN DEFECATION FREE ++

as on 26-Aug-19

A city is declared ODF++ if, at any point of the day, not a single person is found defecating and/or urinating in the open, all community and public toilets are functional and well maintained, AND faecal sludge/septage and sewage is safely managed and treated, with no discharging and/or dumping of untreated faecal sludge/septage and sewage in drains, water bodies or open areas.

V. K. Jindal

Vinod Kumar Jindal
Joint Secretary & Mission Director
Swachh Bharat Mission (Urban)

Dr. Ravi P. Singh
Secretary General
Quality Council of India

This certificate will be valid for a period of six months

ACKNOWLEDGEMENT

The MSE-PP owes to the cooperation and supports extended by officials of the Panvel Municipal Corporation, Panvel in the preparation of the report titled “Environmental Status Report for 2019-20” for Panvel Municipal Corporation, Panvel. At the outset, the MSE-PP would like to express its appreciation for the cooperation and engagement extended by Dr. Kavita Choutmol, *Mayer*, Panvel Municipal Corporation, Shri. Sudhakar Deshmukh, *Former Commissioner*, Panvel Municipal Corporation, Panvel and Shri. Ganesh Deshmukh, *Commissioner*, Panvel Municipal Corporation, Panvel. The MSE-PP would especially like to acknowledge the constant support received from Shri. Vitthal Dake, *Dy. Commissioner* and Shri. Dhairyasheel Jadhav, *Former Assistant Commissioner*, Panvel Municipal Corporation, Panvel as well as valuable guidance of the fellow committee members of PMC-ESR, while formulating the ESR.

The MSE-PP acknowledges the valuable inputs from the senior experts from the planning division of PMC, heads of various departments at PMC. The MSE-PP’s team expresses its gratitude to Shri. Sachin Adkar, Sub Regional Officer, Raigad I, Maharashtra Pollution Control Board (MPCB), Belapur, Navi Mumbai for extending full support and for sharing information and data for the study.

The MSE-PP remains appreciative of the help extended by Shri. Dudhe, Dy. Commissioner of Police, Subdivision I, Panvel and also Additional Executive Engineers, MAHADISCOM of Kharghar, Bhingari, Kalamboli, Panvel City subdivisions for data support. The help extended by Station Manager, Panvel Railway Station, Panvel is highly appreciated. We also express our gratitude to Shri. Arvind Mhatre, Corporator, PMC and Environmentalist and Shri. S. V. Ranade an Environmentalist and associated NGOs that have significant work for the environment in Panvel City.

Prof. Neeraj Hatekar

Project Coordinator, Former Professor

Mumbai School of Economics and Public Policy (MSE-PP), University of Mumbai

and Executive Director, Department of Tribal, Government of Maharashtra

ABOUT PANVEL MUNICIPAL CORPORATION

Panvel has been counted as one of the major cities in North Konkan for about seventy-eight hundred years. The Panvel municipal council was established on 1st September 1852, as the first municipal council in the country by the Indian British Government. Panvel has been known as a trading centre since ancient times. Its realization comes from the adjacent port of Panvel Bay. Panvel is in the Raigad district of Maharashtra state and it is known as Konkan Convener situated at the headquarters of Pune-Mumbai. Panvel is also a taluka and it borders the Thane district. Panvel City, coordinates at 18°59'40"N and 73°06'50"E, is located 60 km away in the suburbs of Mumbai, the capital of the state of Maharashtra. The city council area comprises historic temples, mosques, churches and lakes and all the religious people live in the city. Water supply to Panvel city is made from the Dehrang dam owned by PMC. Also, in the present case, the development of Panvel city is taking place at a rapid pace and CIDCO has developed New Panvel adjoining the old Panvel. Also, due to Konkan Railway passing through Panvel and the upcoming Navi Mumbai International Airport near Panvel City, Shivadi-Nhava Sea Link Bridge and SEZ projects, which are 25 to 30 km away from Panvel, are increasing the flow of citizens in this city.

Panvel Municipal Corporation is established on 1st October 2016 as the 27th Municipal Corporation in Maharashtra. The PMC includes areas of Panvel Municipal Council, Taloja MIDC and Panvel taluka's 29 revenue villages. It spreads over 110.6 square kilometres, as per the 2011 census, it has a population of 5.09 lakh. It includes areas of gram panchayats, CIDCO, MIDC, MMRDA, Panvel Municipal Council and Raigad District Panchayat.

Panvel has a mixed population consisting of Agri samaaj, Muslims and the Koli community. Panvel is a medium-sized city but densely populated as it strategically lays between Mumbai and Pune. The city is the headquarters of the Panvel sub-division of Raigad district, which is the largest in the district as per the number of villages (564).

Panvel lies approximately 40 kilometres east of Greater Mumbai right outside the Mumbai Metropolitan Region. It is surrounded by the mountains of Matheran to the east and south-east and outer regions of Panvel i.e. villages of Dundhare, Maldunge are separated from the suburbs of Badlapur and Ambernath by hilly ranges of the Western Ghats.

The climate here is tropical. Most months of the year are marked by significant rainfall. The short dry season has little impact. The average annual temperature in Panvel is 27.0 °C. In a year, the average rainfall is 3267 mm. The driest month is January, with 0 mm of rain. The greatest amount of precipitation occurs in July, with an average of 1276 mm. May is the warmest month of the year. The temperature in May averages 30.3 °C. The lowest average temperatures in the year occur in January when it is around 23.4 °C. There is a difference of 1276 mm of precipitation between the driest and wettest months. The variation in temperatures throughout the year is 6.9 °C (climate-data.org).

Panvel is surrounded by some major Maharashtra Industrial Development Corporation (MIDC) managed regions like Patalganga, Taloja, Nagothane, Roha, Khopoli, Bhiwandi. Some of the Indian industry majors like Larsen & Toubro Limited, Reliance, Hindustan Organic Chemicals Ltd., ONGC, IPCL are based around Panvel providing mass employment. The JNPT port is also located near Panvel. New SEZ declared by the government are coming around Panvel.

Panvel is an important junction point as many major highways meet and pass through the city. The Mumbai-Pune Expressway, Sion-Panvel Expressway, NH 4B and NH 66 start from here while NH 4 passes through Panvel. Roads of New Panvel are maintained by CIDCO while those in Panvel by PMC. New Panvel, being developed by CIDCO, has well planned and wide lane major roads and even the arterial roads are of two lanes.

Panvel railway station is one of the most important junctions on the Konkan Railway. Harbour line from Mumbai CST, the central line from Diva / Karjat, the western freight corridor from JNPT and the Konkan railway line from Mangalore meet at Panvel. Panvel railway station comes under the Mumbai division of central railway. Panvel is the terminating station of Mumbai railway's harbour line.

There are two main bus stands in Panvel - ST stand on the National Highway and NMMT stand near Railway Station. The ST buses are available from Panvel to Karjat, Alibaug, Pen, Roha, Khopoli, Thane, Bhiwandi, Kalyan, Dombivali, Badlapur, Dadar, Uran as well as beyond the city. NMMT buses are available from Panvel to Thane, Vashi, Dadar and inner areas of Panvel city. NMMT AC Volvo buses are also available from Panvel to Dadar. Panvel is the second busiest bus station in the state after Latur. It is the major bus station for the state as it is a junction for Konkan and Pune routes buses. There is a heavy rush on Ganpati Festival, Diwali Festival and May vacations.

The Navi Mumbai International Airport or "NMIA", which is to come up around the Panvel-Kopra area, would be built through public-private partnership (PPP) — with the private sector partner getting 74% equity and Airports Authority of India (AAI) & Maharashtra government, through CIDCO, holding 13% each. The International Civil Aviation Organisation (ICAO) has already given techno-feasibility clearance to the airport and the central cabinet has cleared it. The project is at the global tendering stage. "NMIA" is going to help the locals a lot, with job opportunities.

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ABBREVIATIONS

AIILSG	All India Institute of Local Self-Government
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AMC	Ambarnath Municipal Council
AOI	Area of Interest
AQI	Air Quality Index
CAGR	Compound Annual Growth Rate
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
DO	Dissolved Oxygen
DPSIR	Driver-Pressure-Status-Impact-Response Framework
EPI	Environmental Performance Index
ESR	Environmental Status Report
FCC	Fast Colour Composite
FSI	Forest Survey of India
GIS	Geographic Information System
IR	Infra Red
IHHL	Independent Household Latrine
IT	Information Technology
LPG	Liquefied Petroleum Gas
LULC	Land Use and Land Cover
MIDC	Maharashtra Industrial Development Corporation
MJP	Maharashtra Jeevan Pradhikaran
MLD	Million Liters Per Day
MMR	Mumbai Metropolitan Region
MPCB	Maharashtra Pollution Control Board
MU	Million Units
NAAQS	National Ambient Air Quality Standard
NAQMP	National Air Quality Monitoring Programme

NAMP	National Air Monitoring Program
NGO	Non-Government Organisation
NGT	National Green Tribunal
NO2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
OLI	Operational Land Imager
PDS	Public Distribution System
PM10	Particulate Matter below 10 micrometers diameter
PM2.5	Particulate Matter below 2.5 micrometers diameter
PUC	Pollution Under Control
RS	Remote Sensing
RSPM	Respirable Suspended Particulate Matter
RTO	Regional Transport Office
SHG	Self Help Group
SO2	Sulphur Dioxide
SO2	Oxides of Sulphur
SPM	Suspended Particulate Matter
STP	Sludge Treatment Pool
UDCPR	Urban Development Control and Promotion Regulations
ULB	Urban Local Body
UNCED	United Nations Conference on Environment and Development
USGS	United States Geographical Survey
UV	Ultra Violet
WQI	Water Quality Index
WHO	World Health Organization

EXECUTIVE SUMMARY

The Government of Maharashtra directed and made it mandatory for all Municipal Corporations to prepare an Environmental Status Report (ESR) every year as a result of the 74th Amendment in the Indian Constitution. The ESR indicates the status of the environment and its management in the City and identifies areas where further interventions for improvement are required. Hence ESR is an important document in decision making for sustainable urban development. The Govt. of Maharashtra provided a broad methodology to prepare ESR based on Drivers-Pressure-State-Impact-Response (DPSIR) framework, as per the guidelines given by Govt. of Maharashtra vide Government Resolution No. ESR-2010/pr.kr.40/2010/ta.ka.1 dated 4th June 2010, a good analytical base to identify issues and frame sound policies for an environment-friendly sustainable City.

The Environmental Status Report (ESR), 2020-21, on similar lines as The Environmental Status Report (ESR), 2018-19 and 20219-20, aims to fulfil the objectives stated through the guidelines given by Govt. of Maharashtra in 2010 for the preparation of ESR. The report follows the DPSIR framework to identify environmental issues and provides policies for making Panvel city an environment-friendly sustainable City.

Initially, to analyze the present status of various environmental components, the required secondary data was collected from various sources like Panvel Municipal Corporation (PMC), MPCB, MJP, MIDC, MAHADISCOM, Indian Railways, MSRTC and Panvel Police. To fill the data gaps, it was decided to conduct an environmental survey of the City to understand the City's environmental issues. The environmental survey was conducted for a randomly selected sample of 800 households in 20 wards in the City for 2020-21 as it was also carried in 2018-19 and 2019-20. The survey aimed to know the environmental issues and efforts taken by PMC to mitigate the problems and understand the reasonable expectations of households in developing the City sustainable and environment friendly. Some data variables are used in the present report taken from the environmental survey 2018-19 since the variables are static in nature and not dynamic. Wherever required a comparative analysis is carried based on the data from all three the surveys.

The drivers like Population, the standard of living, occupational structure of households, urbanization and industrialization and social factors like health and levels of education are primary drivers of the environment in urban regions that are analyzed to understand the reasons for environmental deterioration due to increasing urbanization and localization of industries within and around the City. The City observed considerable differences in population density across the wards in the City and needs to be addressed through a sustainable urban development plan. The income inequality in the City is very high, which also causes the inequal distribution of assets and amenities, indicates that a few contribute largely to the degradation of the environment in the City.

Human interventions in the environment such as Land use, Resource extraction, External inputs (fertilizers, chemicals and irrigation), Emissions (pollutants and waste), Modification and movement of organisms are important pressures to the environment that is generated in urban regions. Due to high migration, affordable housing, efficient railway connectivity, and large industrial activities, the increasing population are the main drivers for pressures on the environment as a public good in Panvel City. The changing landscape is one of the most important features of Panvel City in recent years. There is a significant change in land use and land cover in the City. There is rising demand for housing in Panvel City, causing pressure on the available land in the City. The changes in land use and the land cover reveal that there has been rapid urbanization in the City. The land use in Ward No. 1, 2, 3 and 20 is unplanned, requiring the immediate attention of urban planning. Perhaps slums are primarily unplanned and hence the issues like low level of tree cover, high density of population, narrow roads and unusual water supply system (pipeline through drainage line - as there is no enough space to put in separate water pipeline) impact people in slums badly.

It is observed that drinking water quality is not good in the months of July and August. There is air pollution in and around the industrial area. The households believe that the industrial residual pollutes water bodies.

The report discusses Natural Capital, such as atmosphere, land, water and biodiversity, environmental impacts and changes such as climate change and depletion of stratospheric ozone layer, biodiversity changes and pollution, degradation and depletion of air, water, minerals, and land. The environmental status report discusses the depletion of resources like water and biodiversity due to increasing population, urbanization and various industrial activities.

The efforts made by PMC regarding solid waste management, public and community toilets and sewerage management, and attempts to provide clean and safe water supply by MJP have resulted in relatively low morbidity levels in the City.

Further, the study analyses the status of air and noise (during Ganesh Festival and Diwali) with the help of data provided by MPCB. For noise pollution, it is attempted to collect sample sound levels for Navaratri Festival and for non-festival days like weekdays and weekends to find the sound levels in the City at selected locations. The water bodies like Kasadi and Taloja River are highly polluted because of industrial residual let out in water flows that affect the health of residents nearby. The report also uncovers the reasons for air pollution, though moderate levels of air pollution (revealed by Air Quality Index computed with the help of methodology prescribed by CPCB) on most of the days in the year 2020-21, that are mainly sourced from vehicles and industries in the City. The Environmental Status Report, 2018-19 suggested for CAAQM to monitor continuous air pollution. The PMC took it very seriously to implement the suggestion,

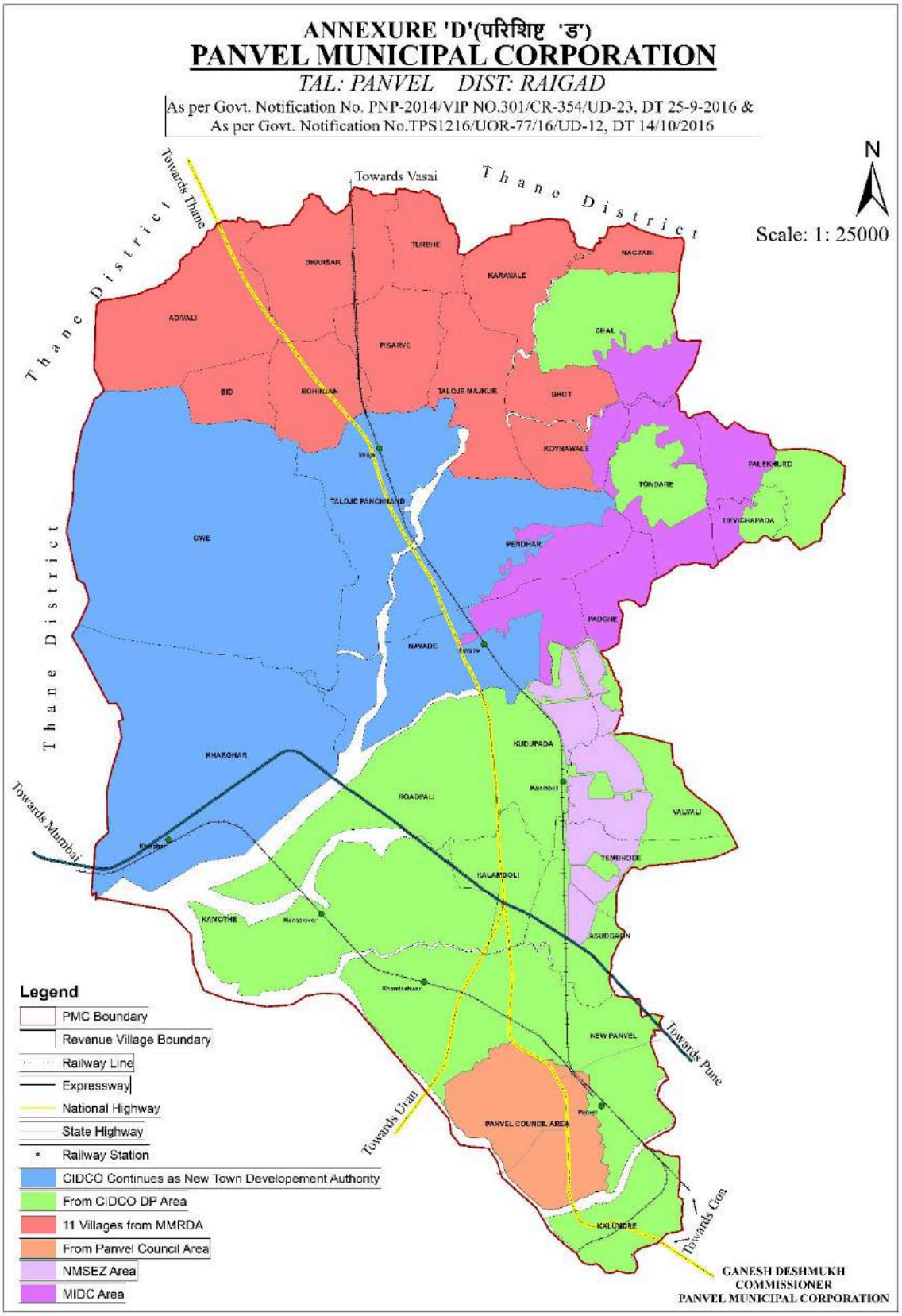
for which it has applied for CAAQM and CPCB has granted CAAQM in Panvel City.

The scientific analysis based on satellite images from NASA discovers land use and land cover in the City and enables us to understand the land cover classification and percentage distribution of land use, such analysis is carried for 2016, 2018, 2019, 2020 and 2021. The analysis be used for City Development Plan. Further, the analysis of the status of and changes in biodiversity help us to understand the impact of urbanization on the environment. It discloses the need for increased tree cover for better levels of oxygen in the City. The report also brings out the attempts made by PMC to increase the tree cover through tree plantation programmes for many years.

The improved rank in Swachh Survekshan 2020 from the all India ranking 86 to 20 in 2020 (4599.74 marks out of 6000) is evident for sincere efforts made by PMC in making the City clean, beautiful and environmentally friendly. It secured 5th Rank in Maharashtra in the cities having 1 to 10 Lakh population. The PMC received ODF++ certification in August 2019. The residents in Panvel appreciated the PMC for its efforts relating to solid waste management, sewerage system, cleaning of City regularly and improved road quality except for a few areas in the City.

The report at the end evaluates the initiatives taken by PMC on the suggestions and policy recommendations reported in the Environmental Status Report, 2018-19. The PMC has decided to initiate Biogas Plant to make as many resources to generate electricity and install solar-based LED streetlights in the City. Positive steps are taken to improve the quality of gardens and tree cover in the City. The initiatives are taken related to the following aspects: segregation of solid waste in organic and organic solid waste, to strengthen rainwater harvesting, to increase the supply of water and improve the quality of water, to widen the roads wherever possible, to promote solar energy, implement the ban on usage of plastic bags, strengthen the dissemination of information to reduce the use of plastic in general, to form an environment regulation body at PMC, to initiate to install environment monitoring station at PMC and to institute the 'Environment Club', to appoint 20 'Paryavaran Doot' on an experimental basis for the active participation of volunteer residents in all wards and to enhance the involvement of NGOs including SHGs in conserving the environment in the City. After the Maharashtra government issued a notification in 2018 regarding the ban on plastics, the PMC acted against the plastic producers, sellers and consumers; it banned and seized a large quantity of plastics and collected a fine of Rs 39.71 lakh till February 2020.

The focused efforts to make the Panvel City environmentally sustainable are evidential and also are acclaimed by the State and Central Government Authorities.


ANNEXURE 'D'(परिशिष्ट 'ड')
PANVEL MUNICIPAL CORPORATION
TAL: PANVEL DIST: RAIGAD
As per Govt. Notification No. PNP-2014/VIP NO.301/CR-354/UD-23, DT 25-9-2016 &
As per Govt. Notification No.TPS1216/UOR-77/16/UD-12, DT 14/10/2016
N
Scale: 1: 25000
Towards Vasai
Towards Thane
Thane District
Towards Mumbai
Towards Pune
Towards Uran
Towards Goa
DHANSAR
TURBHE
KARAVALE
NAGZARI
ADIVALI
PISARVE
CHAL
BID
ROHINJAN
TALOJE MAJKUR
GHOT
KOYNAWALE
PALEKHURD
TONDARE
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PENDHAR
PADGHE
NAVADE
KHARGHAR
KUDUPADA
ROADPALI
VALVALI
TEMBHODE
KALAMBOLI
KAMOTHE
KHANDESHWAR
NEW PANVEL
PANVEL COUNCIL AREA
KHUNDRE
Legend
PMC Boundary
Revenue Village Boundary
Railway Line
Expressway
National Highway
State Highway
Railway Station
CIDCO Continues as New Town Developement Authority
From CIDCO DP Area
11 Villages from MMRDA
From Panvel Council Area
NMSEZ Area
MIDC Area
GANESH DESHMUKH
COMMISSIONER
PANVEL MUNICIPAL CORPORATION

1 INTRODUCTION

The Panvel Municipal Corporation prepared its Environmental Status Report for 2018-19 and 2019-20; the Environmental Status Report 2018-19 is submitted to the Govt. of Maharashtra. The present document is the Environmental Status Report for 2020-21 for the Panvel Municipal Corporation, Panvel. The Environmental Status Report (ESR) is a document that highlights the conditions of the biophysical environment of a geographic area that may be a territorial administrative limit of a country, state, district or municipal body. The Maharashtra Municipal Corporations Act, Section 67 (A), makes it mandatory for all the Urban Local Bodies (ULBs) in Maharashtra to submit an annual ESR to the state government. Further Government of Maharashtra directed all the Urban Local Bodies (ULBs) to prepare the report in a very scientific and systematic form. That is known as the DPSIR approach.

The Driving Force-Pressure-State-Impact-Response (DPSIR) approach is an offshoot of the PSR framework. The DPSIR framework concentrates on reporting the dynamic ecosystem relationships reflecting both cause and effects and is thus able to reflect the complexity of environmental dynamics to some extent. The analytical framework of the ESR should assist in drawing meaningful inferences and guide responses to environment protection and improvement in the city. The framework can transcend the impacts of the driving forces and pressures on the state of the environment and provide a logical decision-making structure for responses to planners and policy makers.

The stepwise approach in the DPSIR framework allows this to a certain extent, but additional analytical interventions are found necessary to translate the ‘D-P-S-I’ into the ‘R’. (Driving Forces-Pressures-State-Impact to Response). Indicators can provide crucial guidance for decision-making in a variety of ways. They can translate knowledge on physical and social science into manageable units of information to facilitate the decision-making process. Indicators also can help to measure and calibrate progress towards sustainable development goals.

Chart 1 DPSIR Framework

Source: Prepared by the Authors as per the guidelines by MPCB

Further, it provides a systematic, comprehensive and integrated coverage across sectors. Such a framework also facilitates the development and evaluation of policy responses to environmental problems. The DPSIR Approach attempts to answer five crucial questions essential to understand the environmental complexities and develop responses to address these concerns.

The present report is an attempt to bring out the status of the environment in the city, drivers that cause the environment depletion, the areas of environment in which the pressures are observed, the impact of various environmental parameters on human life and biophysical aspects in the environment and efforts made by Panvel Municipal Corporation to deal with multiple environmental issues during 2020-21. The year 2020-21 is significantly different from any of the normal years due to the Covid-19 lead pandemic and lockdown across the country. The pandemic has put the ULBs in a very challenging situation, along with the civic responsibilities the ULBs had to make the health provisions to fight the pandemic. Due to lockdown, all economic activities were at a halt for many months that generated some positive impact on environmental variables. A special attempt is made in the report to cover the Covid-19 led situation in the city and the measures taken by the local government are discussed in detail.

2. DRIVERS (D) THAT INFLUENCE ENVIRONMENT

The DPSIR framework recommends a study of drivers that influence the environment as follows. Drivers (D) include Human Development in the context of:

1. Demographics
2. Economic processes (Consumption, Production, Markets and Trade)
3. Scientific and technological innovation
4. Distribution Pattern Processes
5. Cultural, Social, Political and Institutional Processes

Hence, the population, standard of living, occupational structure of households, rate of urbanization, industrialization, and prevailing social factors like literacy rate and levels of education, health standards, biodiversity, and availability of open space are the main drivers of the environment in urban regions.

2.1 Demographics

Increasing population has been a centre point of discussion globally and is one of the determining factors that impact the environment. Maharashtra's industrial dispersal policy to reduce the population pressure of Mumbai city promoted industrialization to form Thane-Belapur industrial belt and Taloja MIDC. The resultant impact was urbanization in and around these industrial areas. Further, the development of JNPT to reduce the pressure of Mumbai Port Trust and handle large cargo triggered population growth in the region. CIDCO initiated urban development in and around Panvel City to meet the increasing demand for housing.

Agglomeration of economic activities triggered enormous employment opportunities in local and neighbouring industrial areas leading to exponential population growth in Panvel City. The increasing population impacts environment in two forms, it leads to increased utilization and consumption of natural resources such as land, food, water, air and other socio-economic resources like health and education and waste creation as a result of consumption such as air and water pollutants, solid waste and greenhouse gases. Hence the population is one of the important drivers that influence the environment in that region.

2.1.1 Population

The size of the population is one of the main factors that impact the environment by generating pressure on environmental resources available in a region. Natural resources like land and water are scarce and they are to be used efficiently and sustainably. And these resources get exhausted as a large and large population make use of them. Hence there is some threshold level of population that can sustain the use of environmental resources. Thomas Malthus cited it as the Carrying Capacity of a region. An area's carrying capacity can be defined as the maximum number of people that the environment of that area can support through optimum utilization of the available resources (ILPWRM, 2012). Perhaps this carrying capacity is crossed in many regions globally, increasing the pressure on the environment and caused environmental degradation. Crutzen (2016) introduced a concept of Anthropocene Epoch which describes human influence on the environment. Hence one has to contextualize the population and its impact on the environment.

Table 1 Ward-wise Total and Percentage Population in Panvel City

Ward No	Population	Percentage to Total Population	Ward No	Population	Percentage to Total population
1	26237	5.1	**11**	**18523**	**3.6**
2	25847	5.1	**12**	26154	5.1
3	24064	4.7	**13**	24989	4.9
4	28415	5.6	**14**	28308	5.6
5	**28530**	5.6	**15**	27526	5.4
6	23667	4.6	**16**	28239	5.5
7	23995	4.7	**17**	28510	5.6
8	23727	4.7	**18**	24380	4.8
9	28102	5.5	**19**	25483	5.0
10	23805	4.7	**20**	21400	4.2
Total Population & Percentage				**509901**	**100**

Source: Census of India, 2011

Panvel City has a total population of 509901 as per the Census of India (2011). The PMC is administratively divided into 20 wards.

Table 2 Ward-wise Classification of Concentration of Population in Panvel City

Sr. No.	Size Class of Population	Class-group (% Concentration)	Wards	Level of Concentration
1	Up to 20,000	Up to 4	11	Low
2	20001 – 26000	4.1 to 5	3,6,7,8,10,13,18,19,20	Moderate
3	26001-29000	More than 5.0	1,2,4,5,9,12,14,15,16,17	High

Source: Authors Estimations based on Census of India, 2011

It is observed that the total population relatively low concentration of population to the total population of PMC is observed in ward number 11, less than 20,000. In contrast, a moderate level of concentration is observed in 9 wards with a population above 20000 to 26000. There is a high concentration in 10 wards with a population size ranging between 26000 and below 30000. Except ward number 11, overall, the population is evenly distributed in all the wards of PMC, probably exhibiting the outcome of planned development in the city, which is a most appreciable situation. Such a situation is generally noticed where the levels of socio-economic conditions are more evenly balanced. It is a welcome situation and is a sign of development.

It has a total SC population of 37883 and that of ST is 12727. It is important to note that all the wards in the PMC have some population concentration belonging to SC and ST, which is an admirable situation as observed as follows.

Table 3 Ward-wise Proportion of SC and ST Population to Total Population of SC and ST

Ward No.	SC Population	Percentage to Total SC Population	ST Population	Percentage to Total ST Population
1	1320	3.5	711	5.6
2	1378	3.6	759	6.0
3	851	2.2	1115	**8.8**
4	1888	5.0	270	2.1
5	1547	4.1	829	6.5
6	2315	6.1	435	3.4
7	1329	3.5	478	3.8
8	930	2.5	370	2.8
9	1611	4.3	1162	9.0
10	1040	2.7	420	3.3
11	1976	5.2	390	3.1
12	3729	**9.8**	736	5.8
13	3331	8.8	569	4.5
14	1163	3.1	782	6.1
15	2827	7.5	544	4.3
16	2546	6.7	498	3.9
17	3169	8.4	596	4.7
18	1868	4.9	350	2.8
19	1555	4.1	992	7.8
20	1510	4.0	721	5.7
Total	**37883**	**100**	**12727**	100

Source: Census of India, 2011

Table 4 Classification of ward-wise Concentration of SC and ST Population

Sr. No.	Class Group	SC	ST	Level of Relative Concentration
1	Up to 4 %	1,2,3,7,8,10,14, 20	4,6,7,8,10,11,16,18,	Low
2	4.1 to 6	4,5, 9,11,18,19	1,2,12,13,15,17,20	Moderate
3	6.1 to 8	6,15, 16,	5,14,19	High
4	More than 8	12, 13,17	3,9,	Very high

Source: Authors Estimations based on Census of India, 2011

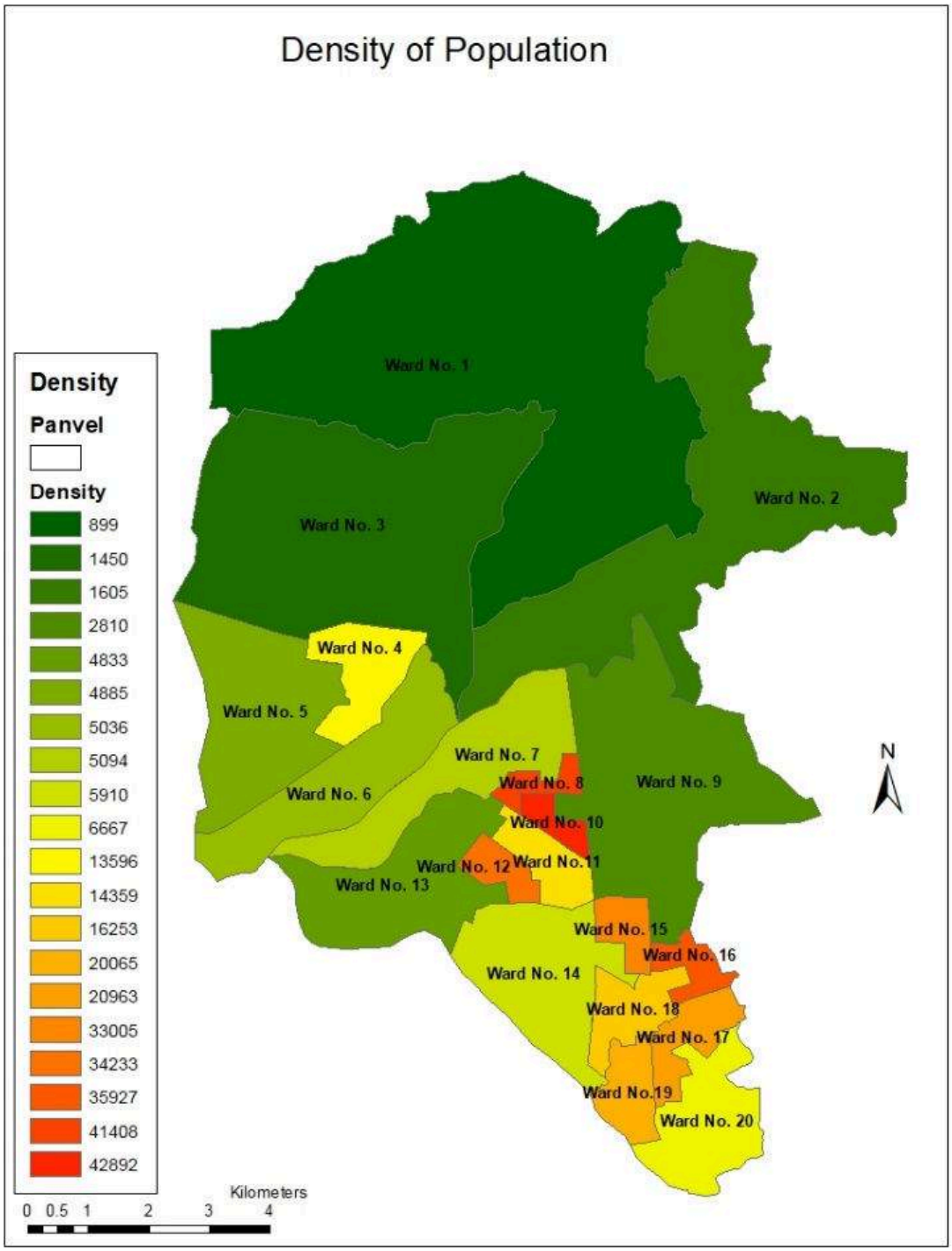
However, within the wards relatively more significant concentration of SC population is found in ward number 12 and that of the Scheduled Tribe population is found in ward number 3. When grouped into class-group, it is noticed that eight wards each have concentration up to 4 per cent of the SC and ST population. Overall, the SC and ST proportion in each class group is more or less evenly concentrated among the number of wards in PMC.

2.1.2 Population Density

One of the critical indices of population concentration is the density of population. It is defined as the number of persons living per square kilometre area (Census of India). The density of the population is one of the indicators that influence the quality of the environment. If the administration cannot provide basic civic amenities and infrastructure to its population, it adversely affects the means of survival; it is said to be overpopulated. The population density adversely affects the environmental quality in the long run (Rahman, 2017).

According to Hunter (2000), population dynamics have important environmental implications, and population size is one variable among all other variables. And population flows and population densities also pose challenging environmental problems. The increasing population brings changes in land use and pressure the demand for water and other civic amenities and when they become scarce in supply, it contributes to environmental degradation.

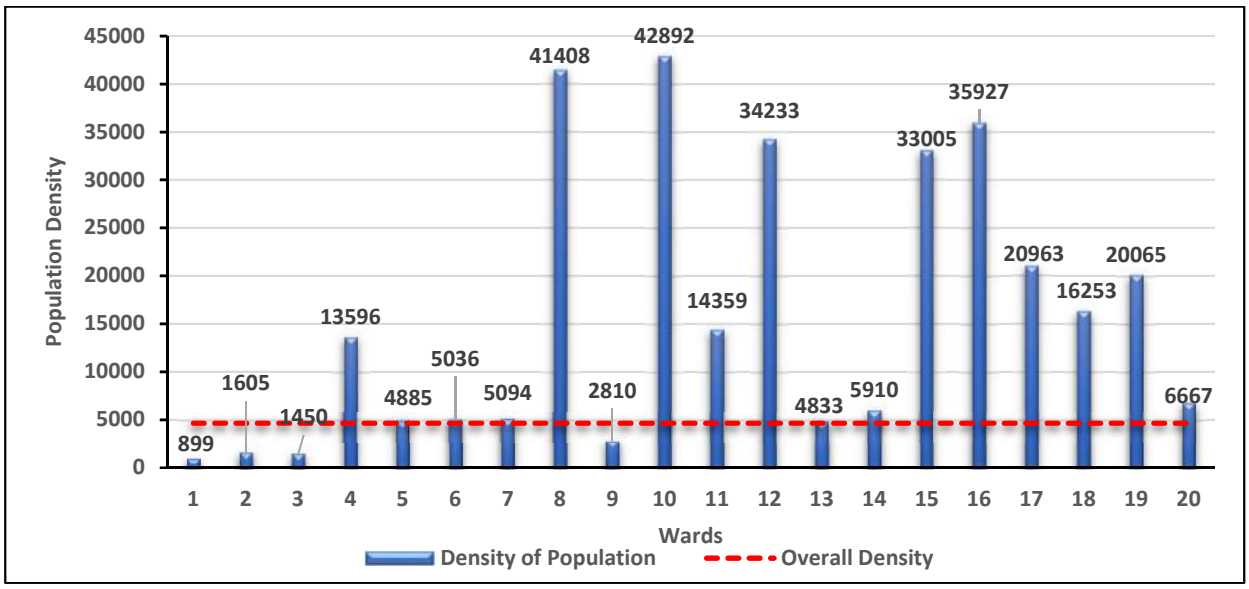
Map 1 Ward-wise Density of Population in Panvel City



Source: Census of India (2011) and Panvel Municipal Corporation, Panvel

It is generally observed that the highly-dense urban areas show a decline in environmental quality (Camagni, Gibelli and Rigamonti 2002). Hence population density is one of the essential variables in understanding environmental quality in urban areas.

Figure 1 Ward wise Population Density in Panvel City



Source: Authors Computations

We have measured population densities for all the 20 wards in Panvel City. The ward wise data on population is from the Census of India (2011) and area in square km is measured from the maps provided by Panvel Municipal Corporation.

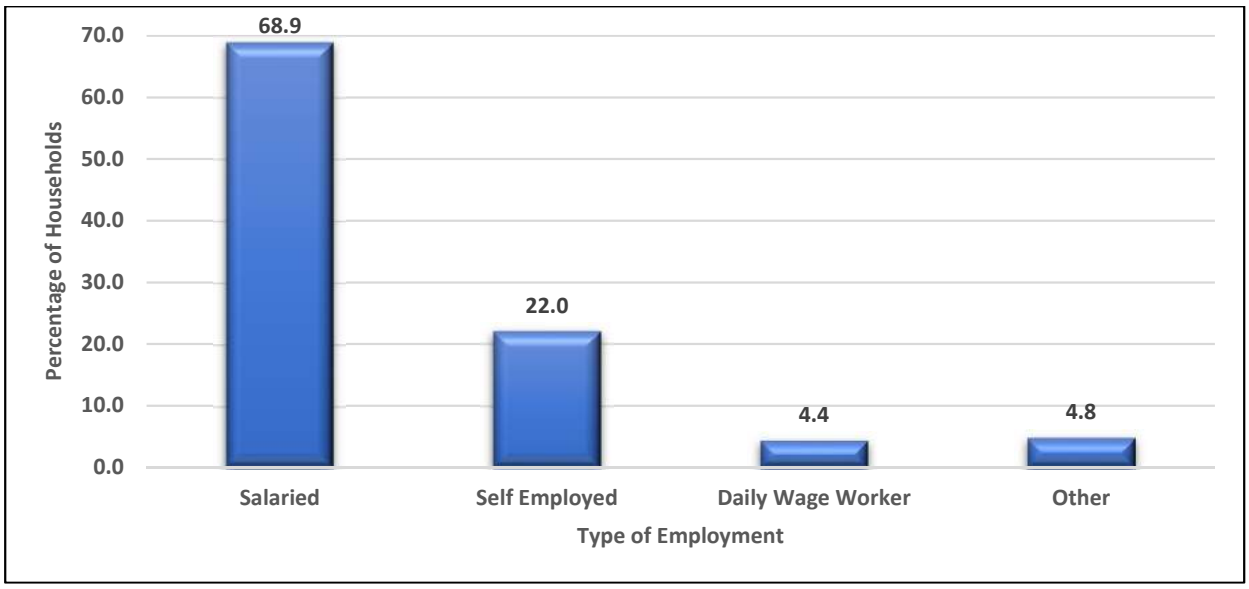
Panvel City has an overall density of **4636** persons per square kilometre. Ward No. 10 has the highest density (42892) and the Ward No. 1 has the least density of population (899) among all the wards in the city. The wards with very low density are mainly villages (Ward No. 1, 2, 3 and 9) that are unplanned spreads and a mix of industrial areas. Ward No. 8, 10, 12, 15 and 16 are among the top five highly dense wards in Panvel City, of which Ward No. 8 and 10 are in Kalamboli and Ward No. 15, 16 and some parts of Ward No.17 are known as New Panvel developed by CIDCO.

It is observed that there are some wards with a very high density of population, and a few have a lower density of population. Panvel City is expected to be one of the Smart Cities in India. Therefore, the density of the population forms one of the important components to be taken into consideration while preparing the Urban Development Plan.

2.2 Economic Processes

Panvel City is located in Mumbai city's vicinity at 35 km, which is the state's capital and national financial capital. And it is also close to MIDC (Trance Thane Creek) TTC and has Taloja MIDC situated within its region. MIDC Taloja Industrial area is one of the reserved Chemical Industrial Areas developed by Maharashtra Industrial Development Corporation (MIDC). The Industrial area is situated adjacent to Navi-Mumbai and Panvel. It is one of the fully developed Industrial Area having Industries involved in various Industrial activities. The dominating Industrial activities are Chemical, Food and Fish Processing, Dairy Products & Cold stores and Engineering. Panvel is also close to Jawahar Nehru Port Trust (JNPT) that generates heavy traffic in and around the city. The city of Panvel has housed the human resources required for industrial purpose and logistic purpose for these industrial zones. It is observed that Semi-Skilled & Unskilled human resources are readily available in the Taloja and Kalamboli part of Panvel City. The Managerial and Senior managerial people travel from Panvel and Kharghar.

Figure 2 Distribution of Households by Type of Employment



Source: Environmental Survey 2020-21 for Panvel Municipal Corporation

The survey conducted shows that 68.9 per cent of the workforce is employed in industry and other fixed paid job categories. And 22 per cent of the workforce is self-employed. A very small

workforce is engaged on a daily wage basis. It is observed that the Corona pandemic has affected the livelihoods of the people in the city in the year 2020-21.

2.3 Scientific and Technological Innovation

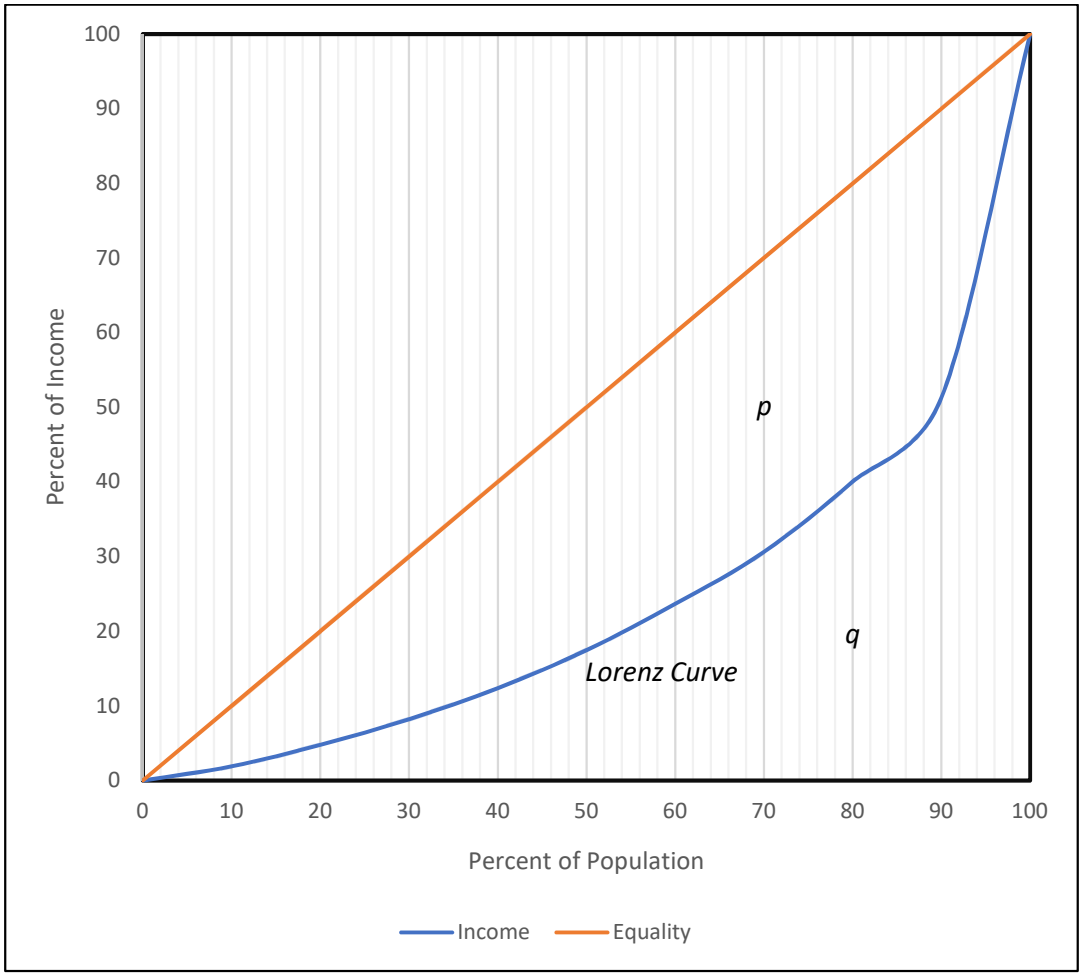
The scientific and technological innovations are carried by National and International Institutions that are specifically established for the purpose and R&D departments of the industries. There are no National or International Institutions that carry scientific and technological innovations in Panvel City. Perhaps a few industries have R&D departments that carry out some research activities and do not reveal their research activities. And such information is not available in the public domain, hence unable to analyze the impact of scientific and technological innovations on the environment in Panvel City.

2.4 Income Distribution

In recent years the discussion about the spatiality of income inequality and its effect on the environment is at the centre of development economics. Many studies have shown that income distribution has a direct and indirect impact on environmental quality. Grossman and Kruger (1991) have talked about per capita GDP and levels of pollution; the study indicates that countries with higher levels of per capita income show higher levels of waste creation and pollution. Boyce (1994) stated that higher levels of inequality of income lead to an increase in environmental degradation. Jun et al. (2011) show that income inequality tends to have more adverse effects on the environment. Environmental degradation appears to be a side effect of economic inequality, and analyses show a negative correlation between income inequality and environmental sustainability. Higher the income inequality, the worse is the environmental indicators such as waste production, meat and water consumption, biodiversity loss and environmental composite indices (e.g. ecological footprint) (Lewandowsky and Haupt, 2012).

The above discussion shows that a society that has high income inequality has greater chances of environmental degradation. Hence to analyze the relationship between income inequality and environmental degradation, we have computed income inequality with the GINI coefficient and estimated Lorenz Curve for Panvel City from the primary data collected for 800 households for the environmental survey of 2018-19.

Figure 3 Lorenz Curve for Panvel City



Source: Environmental Status Report 2018-19 for Panvel Municipal Corporation

The GINI coefficient is a standard measure to compute income inequality with the help of the Lorenz Curve. The formula that is being used here to calculate income inequality is as follows.

$$G = \frac{p}{p+q}$$

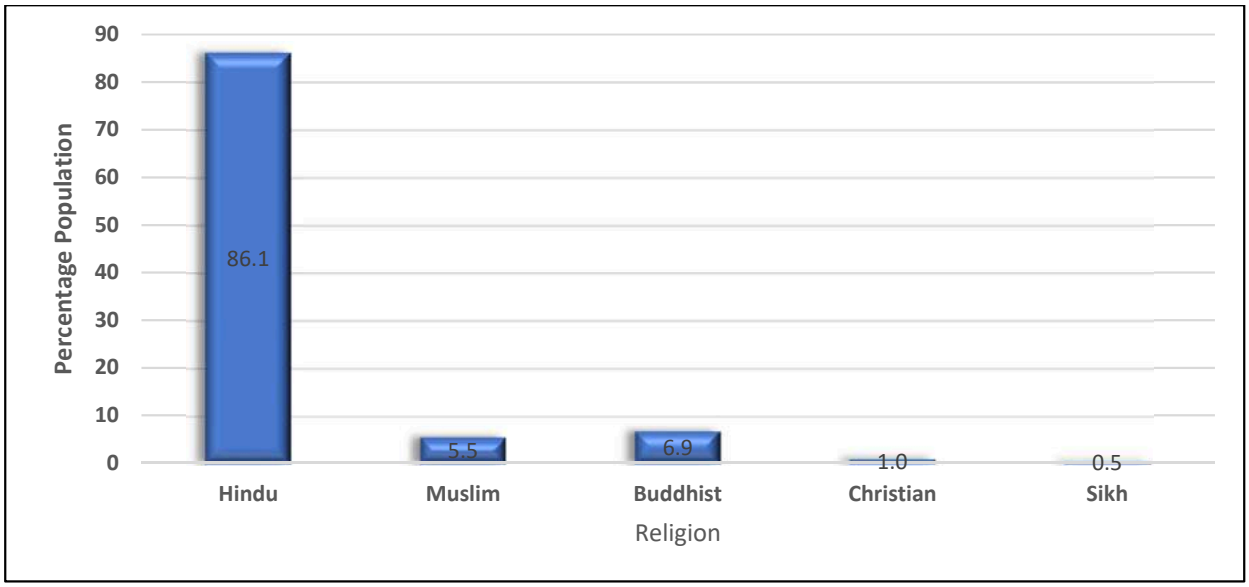
With the help of a tool in excel, we have computed the income inequality. According to the Environmental Status Report 2018-19, the GINI coefficient for Panvel is $G = 0.519342$ which indicates that 51.93 per cent of income is distributed unequally. The Lorenz curve shows that 90 per cent of the population has 51 per cent of income and the rest 10 per cent rich class of the population has 49 per cent of income. Hence income distributed among the population is skewed towards the richer population. It also indicates that 10 per cent of the population has more access

to resources and contributes more to pollution. And 90 per cent of the population has fewer resources that contribute to relatively lower levels of pollution.

2.5 Cultural, Social, Political and Institutional Processes

Cultural and social factors also influence the environment in society. The culture that includes beliefs, habits, customs, and traditions is part of the lives of people residing in a region. Cultural factors largely depend upon religion and ethnicity.

Figure 4 Religion of Households in Panvel



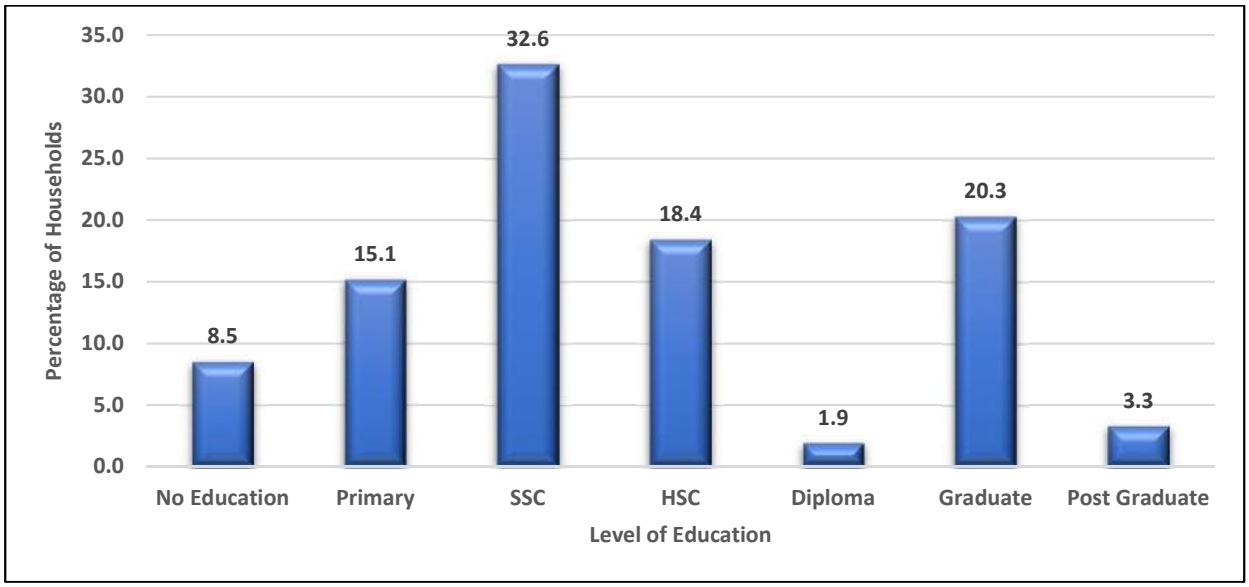
Source: Environmental Survey 2020-21 for Panvel Municipal Corporation

Panvel City, though, originally belong to Marathi Speaking population. In recent years migration to this region has happened very dynamically. Primarily the people residing in Panvel are Hindu by religion. The people having Muslim, Buddhist, Christian and Sikh religions are also found in the City.

The culture also includes the festivals celebrated by the community. Holi, Ganeshotsav, Navratrotsav and Diwali are the main festivals celebrated by the people in Panvel City. In recent years new year celebration has become a common event of celebration. A large population with social gatherings also celebrates Chatrapati Shivaji Maharaj Jayanti and Dr. Babasaheb Ambedkar Jayanti.

Levels of education is also an essential factor that influences the environment in a region. Education increases awareness about the environment and helps in conserving ecology. The head of a family's education level significantly impacts the level of information a family has. Hence, we can consider the level of education of the head of a family as a proxy for society's knowledge level.

Figure 5 Level of Education of Head of the Family



Source: Environmental Survey 2020-21 for Panvel Municipal Corporation

It is observed that 81.5 per cent of the head of the families are literate. Twenty-five per cent of the head of the families are highly qualified and 76.4 per cent of the head of the families have minimum secondary school level education.

The national and state-level political parties have active participation in local government, including social mobilization.

The above discussion implies that the city has diverse populations in terms of income, caste, and education levels, which are the main drivers of the environment.

3. PRESSURES (P)

Anthropogenic activities of production, consumption and distribution create emissions and waste, extract and degrade the environment. Regions that can manage the pressure on the environment and even successfully reduce the stress so that it does not affect environmental quality are more likely to remain sustainable in the long run.

Human intervention has an immense adverse impact on the environment. The economic activities rendered by humans have implications for land use, air and water pollution. Human intervention in the environment has been evident through climate change in recent years across the globe. The increasing urbanization has an impact on land use that implies deforestation. Industrial activities and increasing transport facilities are continuously contributing to air pollution. Industrial water waste has been polluting water bodies around the industrial agglomeration. The solid waste generated is also a major concern in urban regions in recent years. Hence human intervention has short run as well as long-run implications for the environment.

DPSIR framework enlists Human Interventions in Environment as follows.

1. Land use
2. Resource extraction
3. External inputs (fertilizers, chemicals, irrigation)
4. Emissions (pollutants and waste)
5. Modification and movement of organisms

3.1 Land Use

The land is the source of most extractable resources and produces renewable resources and commodities, including livestock, vegetables, fruit, grain, and timber. The land supports residential, industrial, commercial, transportation, and other uses. Land, and the ecosystems it is part of, provide services such as trapping chemicals as they move through the soil, storing and breaking down chemicals and wastes, and filtering and storing water (USEPA).

While human activities on land (including food and fibre production, land development, manufacturing, and resource extraction) provide multiple economic, social, and environmental

benefits to communities, they can also involve the creation, use, or release of chemicals and pollutants that can affect the environment and human health (USEPA).

Land Use refers to the human use of land. Land use represents land use for economic activities such as agriculture, residential, industrial and mining, and recreational activities. Land-use changes constantly occur and at many scales and can have specific and cumulative effects on air and water quality, watershed function, generation of waste, extent and quality of wildlife habitat, climate, and human health (USEPA).

The changes in land use create impervious surfaces by constructing roads, parking lots and other such structures. As cities grow and more development occurs, the natural landscape is replaced by roads, buildings, housing developments and parking lots (USGS). Impervious surfaces can affect local streams, both in water quality and streamflow and flooding characteristics.

A significant portion of rainfall in forested watersheds is absorbed into soils (infiltration), is stored as groundwater, and is slowly discharged to streams through seeps and springs. Flooding is less significant in these conditions because some of the runoff during a storm is absorbed into the ground, thus lessening the amount of runoff into a stream during the storm. As watersheds are urbanized, much of the vegetation is replaced by impervious surfaces, reducing the area where infiltration to groundwater can occur. Therefore, more stormwater runoff occurs - runoff that must be collected by extensive drainage systems that combine curbs, storm sewers, and ditches to carry stormwater runoff directly to streams. More simply, in a developed watershed, much more water arrives into a stream much more quickly, resulting in an increased likelihood of more frequent and more severe flooding (USGS).

The above discussion confirms that land-use changes in urban regions have adverse effects on the environment. Urban areas have been one of the focal themes throughout human history. They are the direct representation of societal change, be it political, economic, social, etc. Urbanization and urban sprawl occurring at an unparalleled scale worldwide, be it developing or the developed world as we know, have significantly modified the environment physically and cultural forms. The phenomena being inevitable have changed and expanded cities and towns' boundaries, merging the city’s periphery towards their hinterland areas, resulting in the spatial expansion of cities beyond their territorial limits to have room for ever-growing urban migration.

As a result, it becomes imperative to analyze and understand the urban change in the geographical landscape.

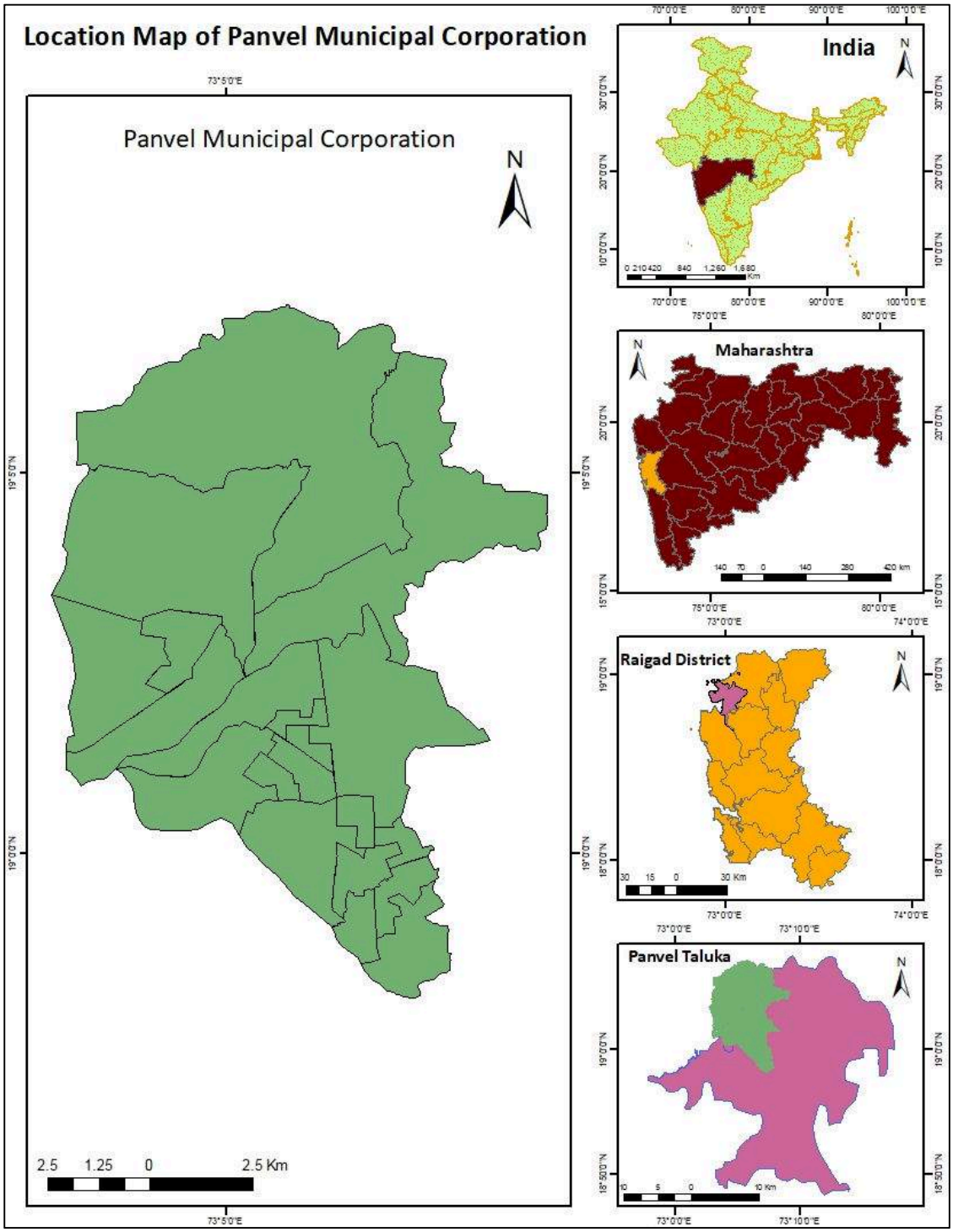
At the global level, LULC studies have attracted the minds of urban planners using modern geospatial techniques. The reason behind this is evident and pressing due to the issues relating to rising pollution (be it water, air and noise) levels, scarcity of available land, and other resources. Land cover and land use studies help understand the interaction between the physical (natural) environment and man's cultural environment, thereby providing a picture of the 'output environment'. Remote sensing and GIS technologies are cost and time effective, but the results thus obtained can offer a future model prediction for better and sustainable use of resources.

As per the United Nations reports, approximately 55 per cent of the global population resides in urban areas and is projected to increase by 68 per cent by 2050. This trend of urbanization is accounted mainly for the movement of the people from the rural areas. North America alone accounts for the highest level of urbanization, whilst the continent of Asia (which comprises our study area), accounts for just 50 per cent of the population living in urban areas. As in India's case, there has been a substantial increase in urbanization, from just 11.4 per cent in the 1901 census to 31.16 per cent in 2011 (i.e. about a three-fold increase). The Panvel Municipal Corporation is part of the biggest urban agglomeration in the country, i.e. The Mumbai Metropolitan Region. The city's functional economy has transformed from agriculture, industry to services, trade, and commerce, providing a firm economic base for the study area. This has, in turn, accelerated the population growth, which is 509901 as per the record of the 2011 census. Along with the industrial development in the region, structural transformation is also a reason for migration in the city, which significantly impacted land use and land cover.

3.1.1 Study Area

Panvel Municipal Corporation is within the administrative boundaries of Panvel Tehsil of Raigad District. It is bordered by offshoots of Sahyadri Ranges in the east, Dombivali and Thane in the north, Uran and JNPT port in the South, and Navi Mumbai in the West. The Panvel Municipal Corporation has demarcated its administrative boundaries by approximately 110.06 square kilometres.

Map 2 Location Map of the Panvel Municipal Corporation Area



Source: Estimated by Authors based on data provided by Panvel Municipal Corporation

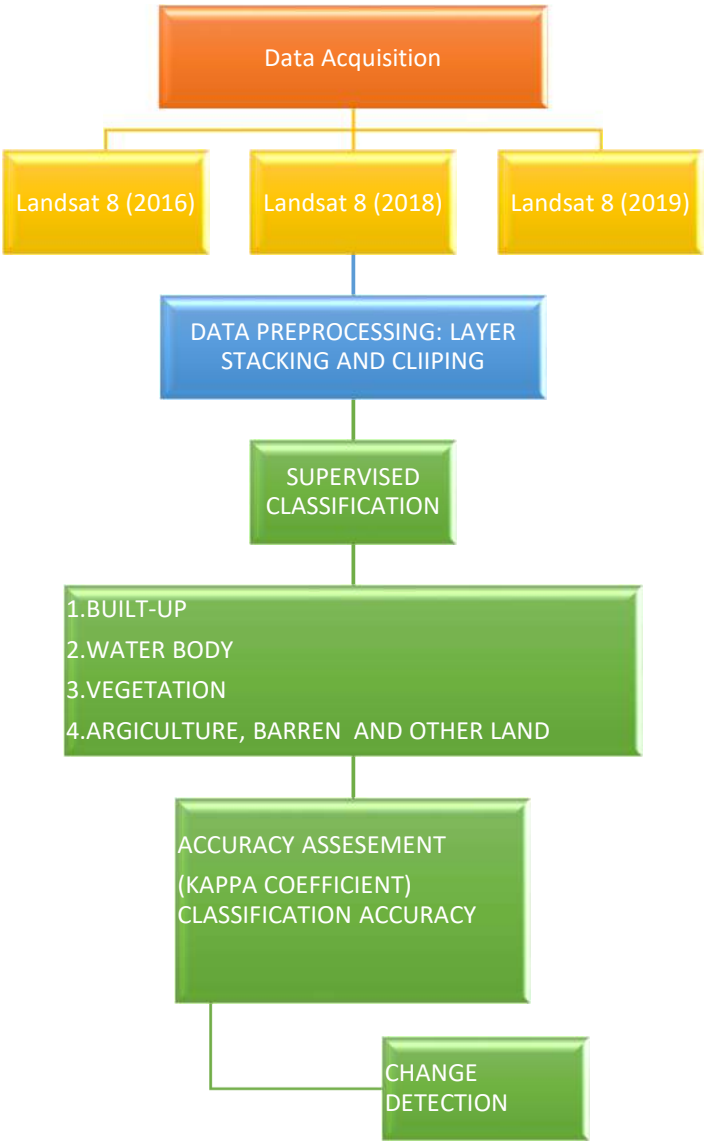
3.1.2 Methodology

Present work is carried out in the following stages,

1. Creation of GIS layers: digitization of built-up area, drainage network, and rural-urban boundaries using Landsat-8 data of the study area.

2. Geo-correction of remote sensing data and collection of training data.

Chart 2 Methodology for LULC



Application of image processing techniques (standard image processing techniques like: image extraction, rectification, restoration, and classification).

The image obtained from Landsat-8 in three bands, namely: Band 3 (green), Band 4 (red), and Band 5 (near infra-red), were used to create FCC (false colour composite). Training polygons were chosen from the composite image and corresponding attribute data was generated and based on

these signatures, corresponding to various land features, image classification is done using simple overlay analysis.

From the original classification of land use, the images are classified into four broader categories: built-up, water bodies, vegetation, agriculture, and barren lands.

3.1.3 Data Sources

The following five datasets are used in the study:

Table 5 Image Information for LULC

Satellite	Sensor	Acquisition date	Path/Row	Spatial Resolution	No. of Spectral Bands
LANDSAT 8	OLI/TIRS	30-09-2016	Path-147, Row-47	30m	11 Bands
LANDSAT 8	OLI/TIRS	29-02-2018	Path-147, Row-47	30m	11 Bands
LANDSAT 8	OLI/TIRS	05-02-2019	Path-147, Row-47	30m	11 Bands
LANDSAT 8	OLI/TIRS	17-02-2020	Path-147, Row-47	30m	11 Bands
LANDSAT 8	OLI/TIRS	10-02-2021	Path-147, Row-47	30m	11 Bands

Source: USGC, 2021

The datasets are georeferenced in a common coordinate system and used in GIS overlay analysis. Steps were as following:

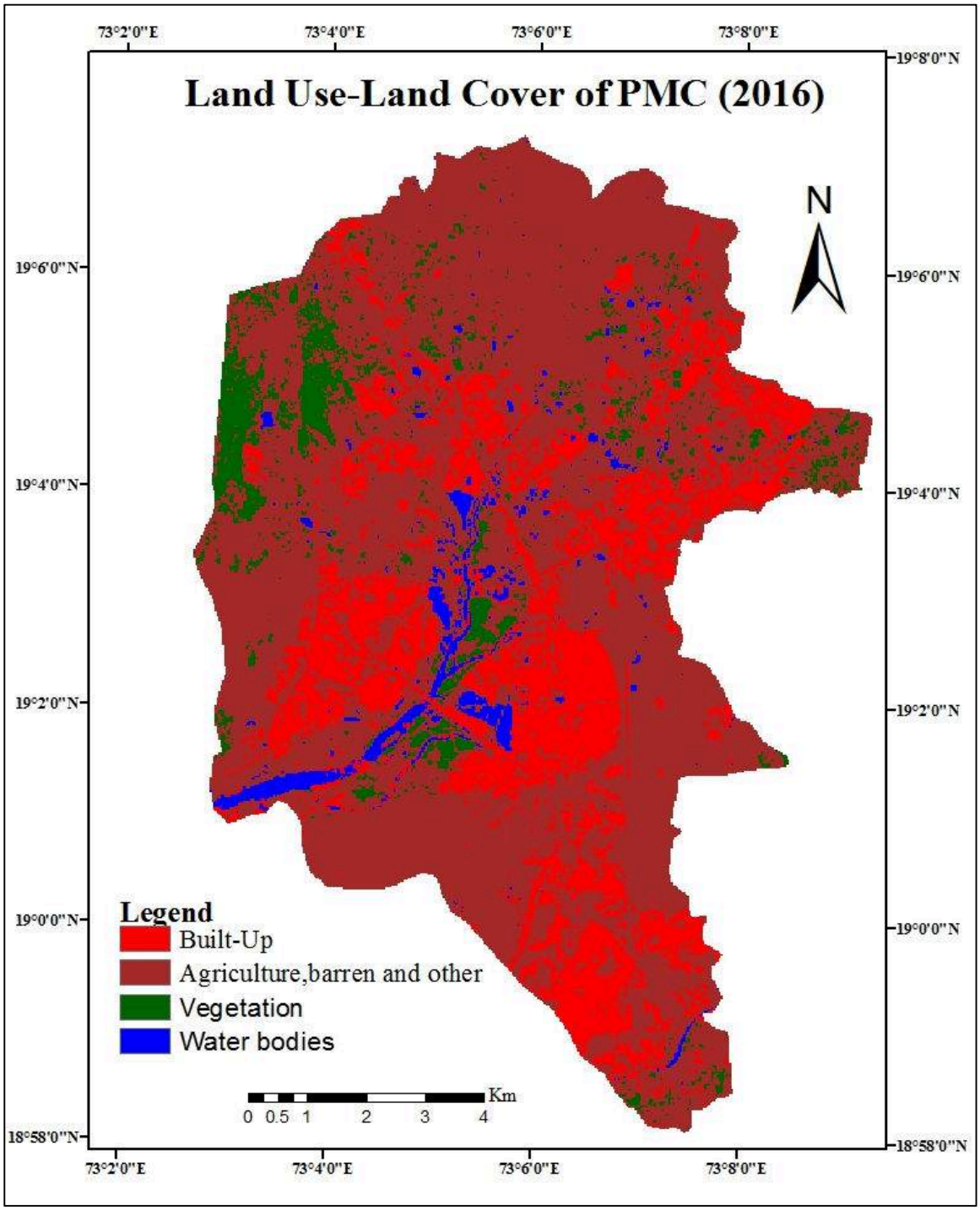
Data preparation and land cover and land use mapping. Firstly, Panvel Municipal area shape file is geo-referenced, and the satellite images are projected into the UTM WGS84 projection.

Classification of object classes is done using supervised classification for four categories, namely:

1. Built-up
2. Water body
3. Vegetation
4. Agriculture and Barren and open land

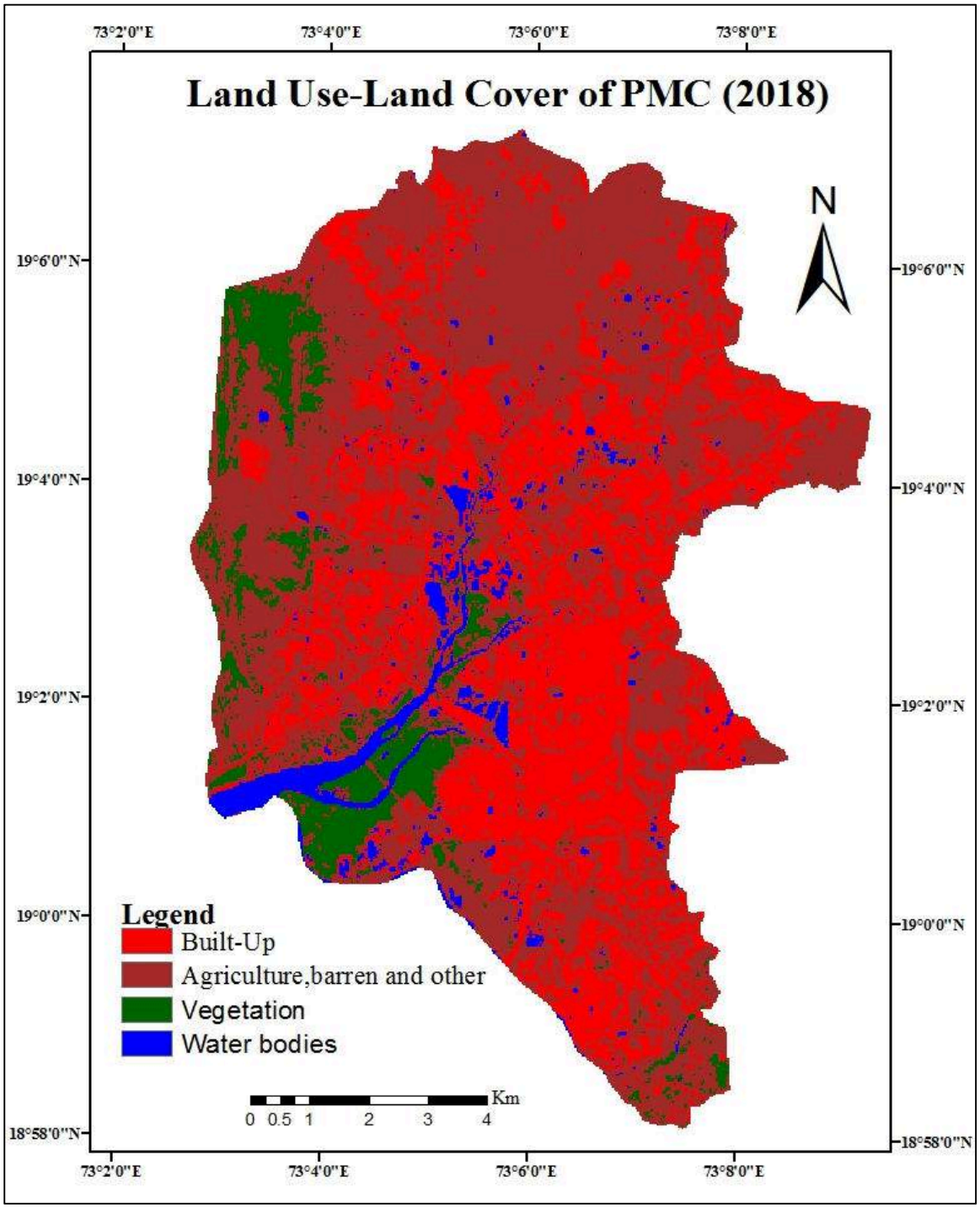
The accuracy assessment is done to derive classification accuracy with Kappa Coefficient; change detection of classified land use is derived for five years (i.e. 2016, 2018, 2019, 2020 and 2021). For the above classification, licensed software is used. ERDAS IMAGINE 2010 is used for image processing, while ARCGIS 10.2 is used for map preparation and layout.

Map 3 Land Cover-Land Use Map of Panvel Municipal Corporation (2016)



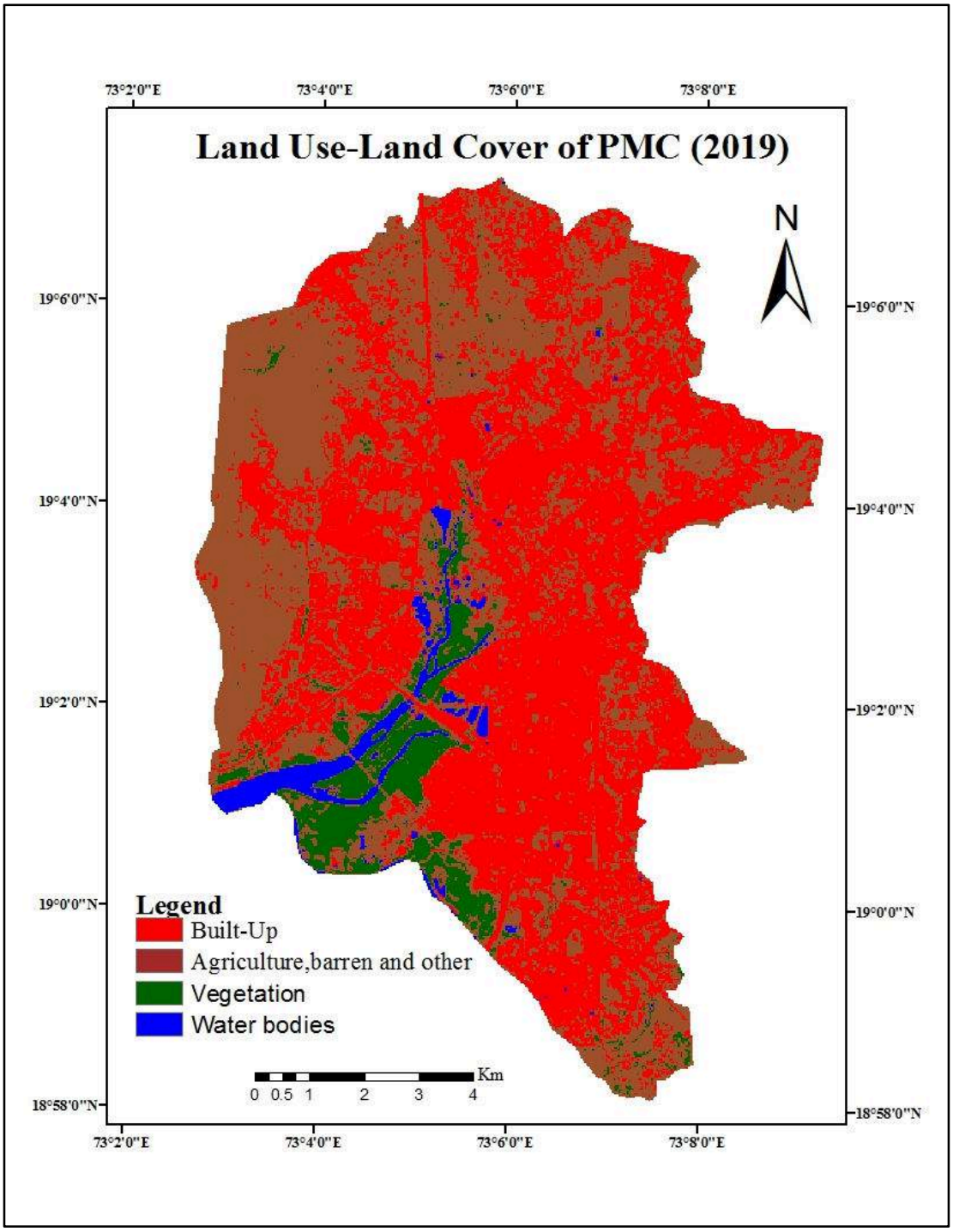
Source: Authors Estimation

Map 4 Land Cover-Land Use Map of Panvel Municipal Corporation (2018)



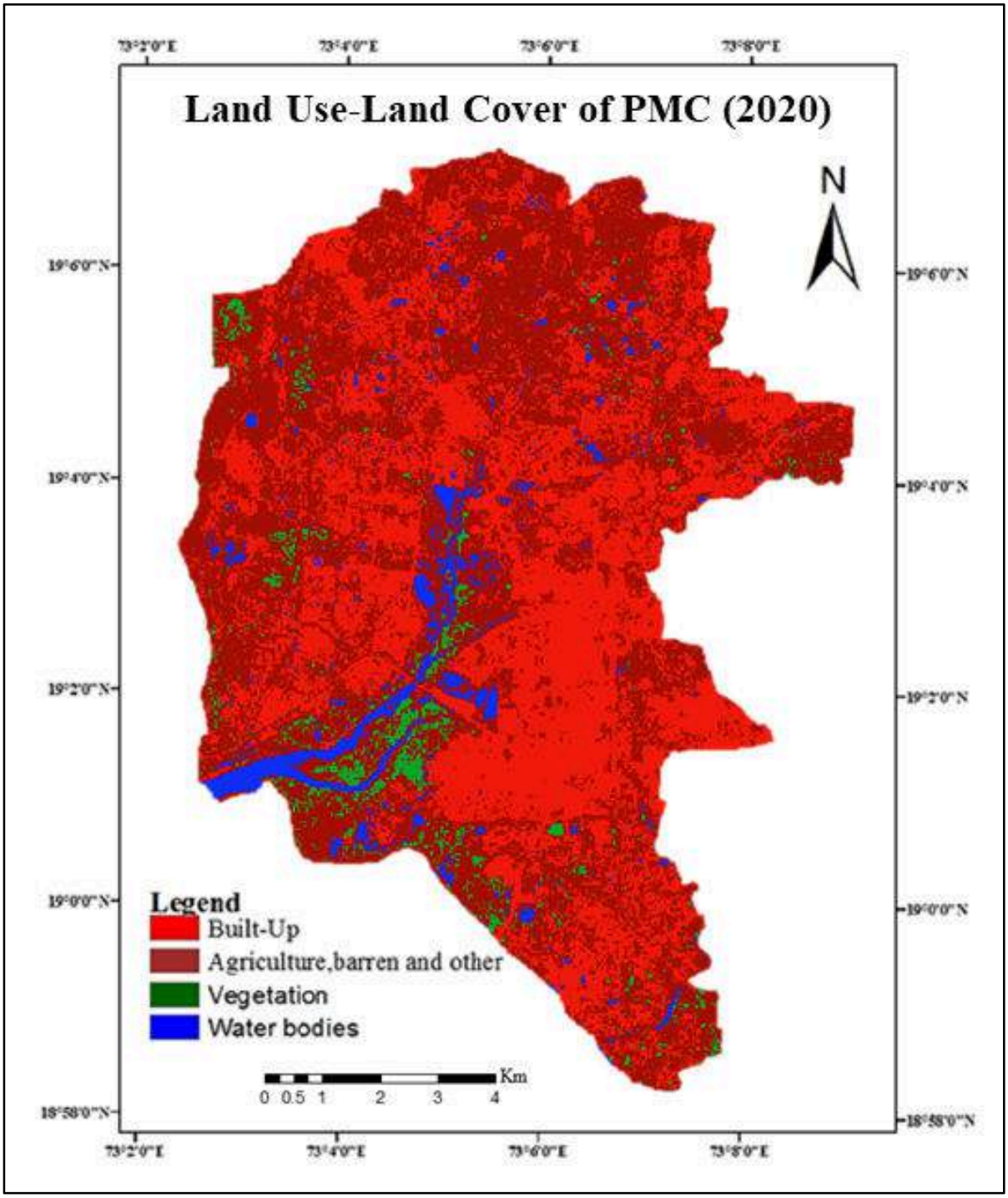
Source: Authors Estimation

Map 5 Land Cover-Land Use Map of Panvel Municipal Corporation (2019)



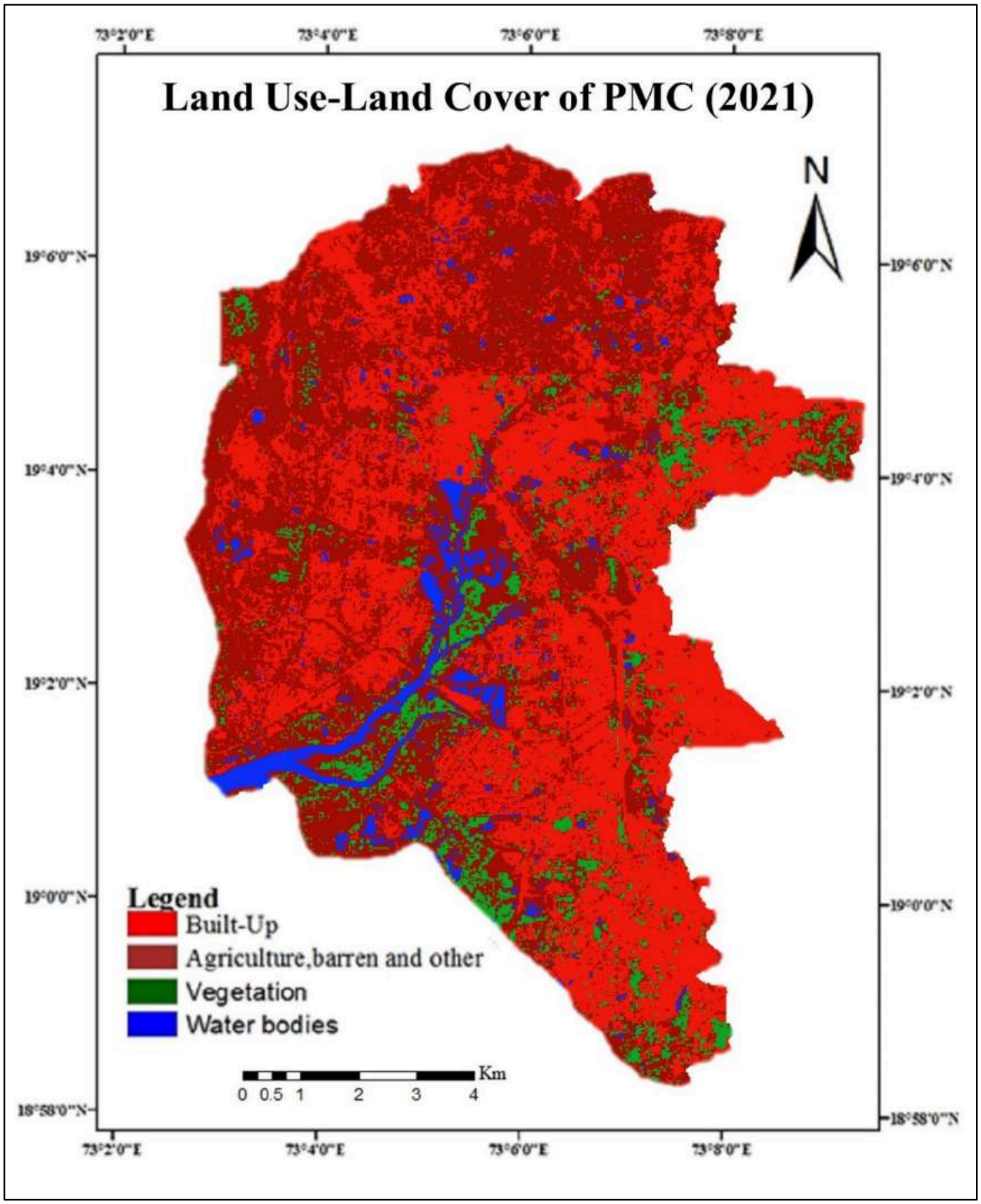
Source: Authors Estimation

Map 6 Land Cover-Land Use Map of Panvel Municipal Corporation (2020)



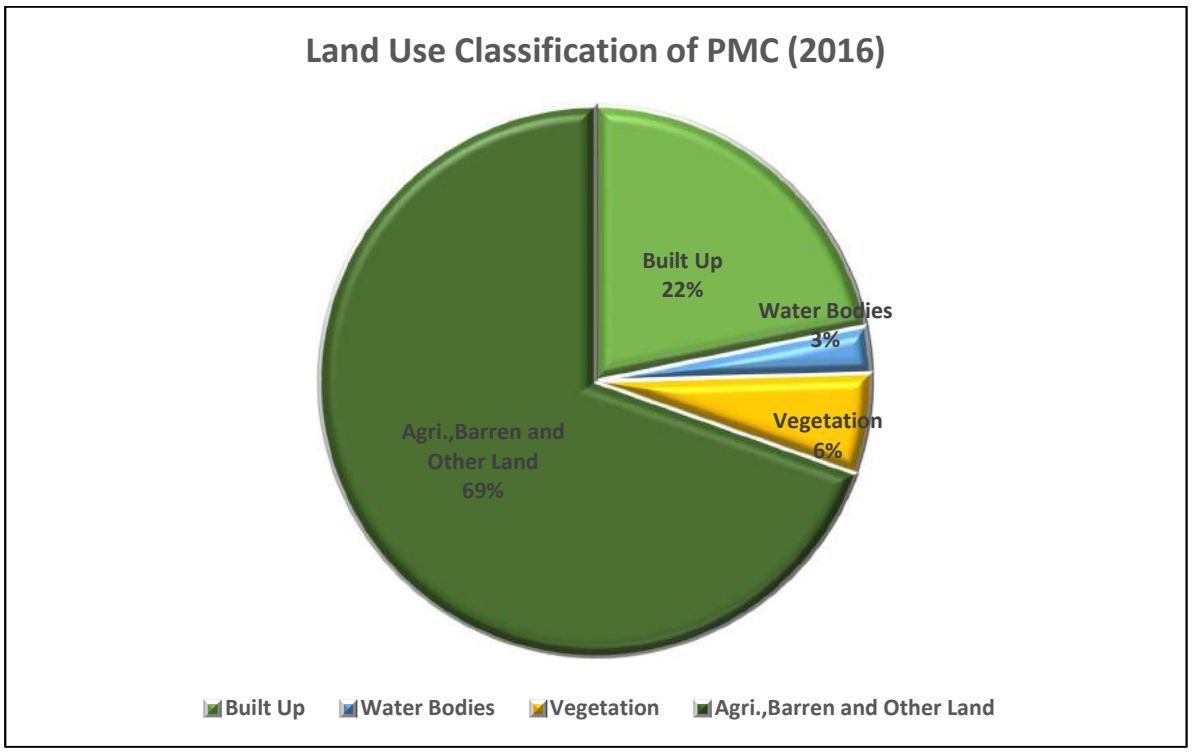
Source: Authors Estimation

Map 7 Land Cover-Land Use Map of Panvel Municipal Corporation (2021)

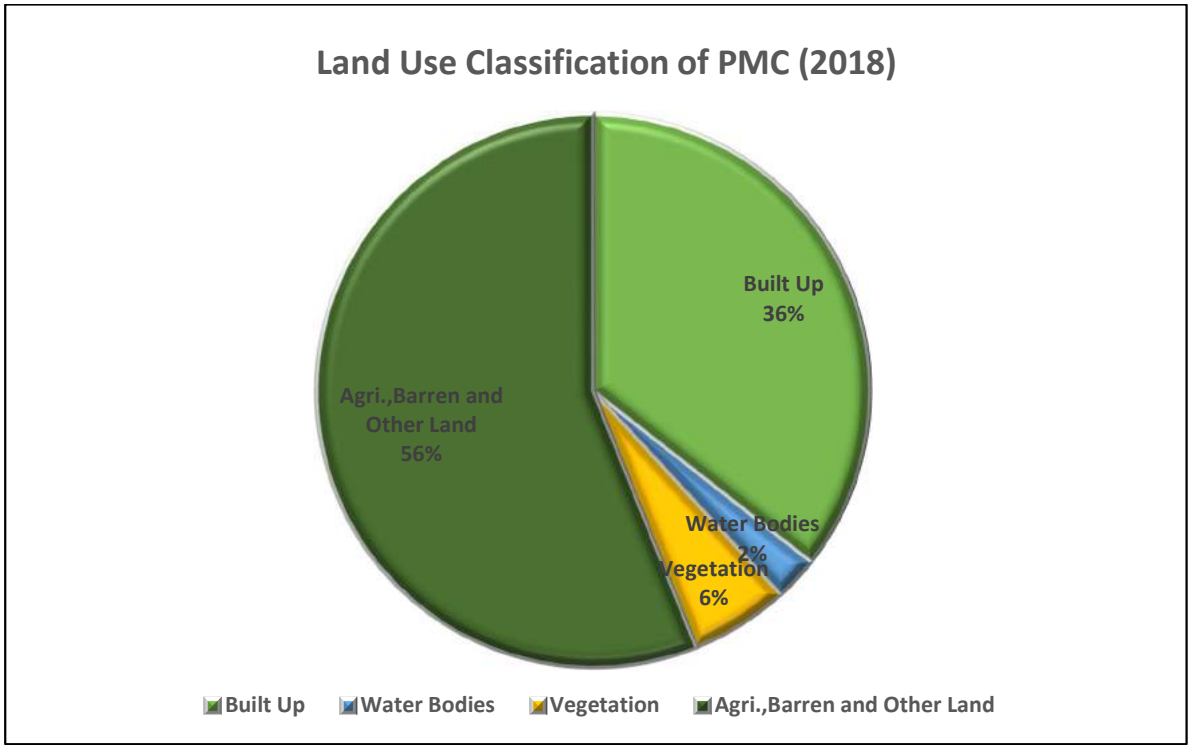


Source: Authors Estimation

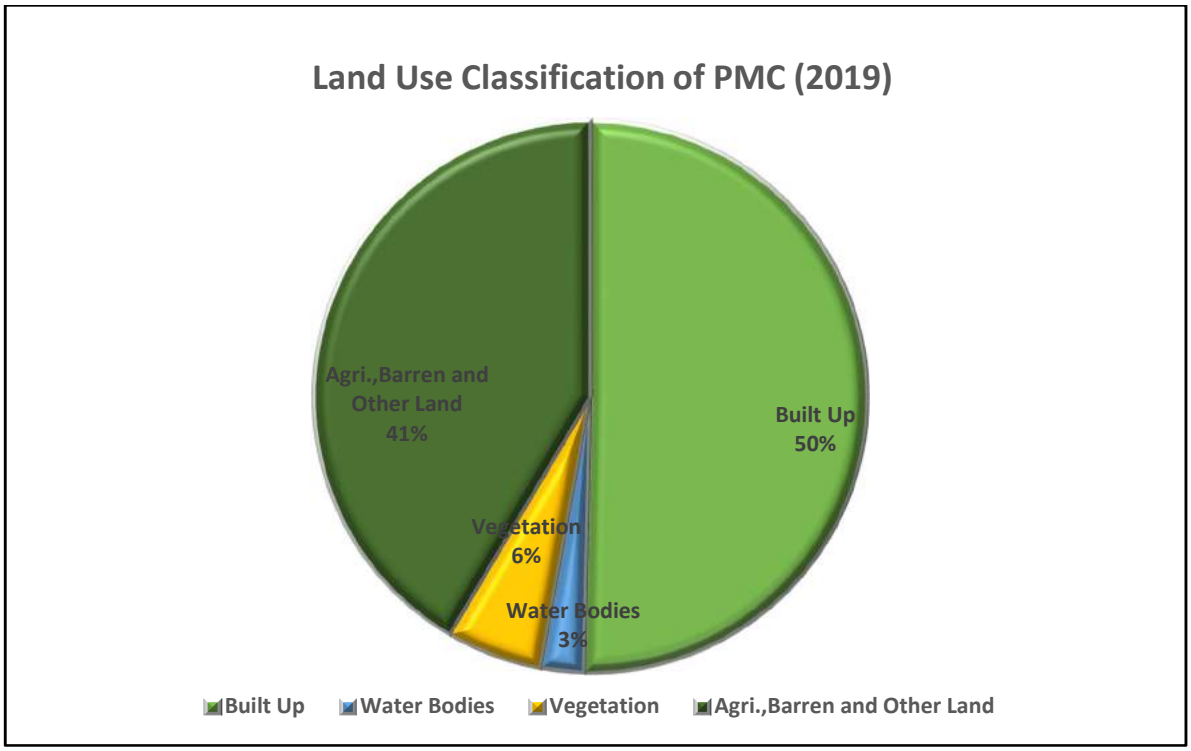
Chart 3 Comparison of Land Use Classification of Panvel Municipal Corporation (2016-21)



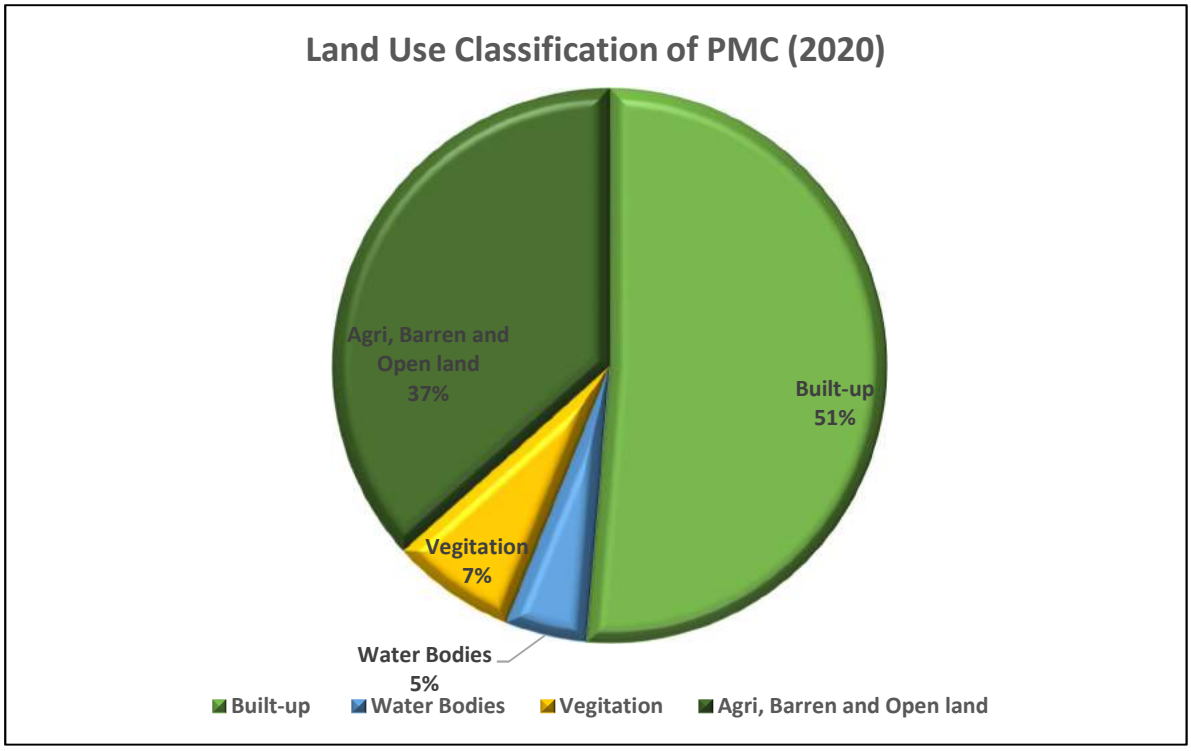
Source: Authors Estimation



Source: Authors Estimation



Source: Authors Estimation



Source: Authors Estimation

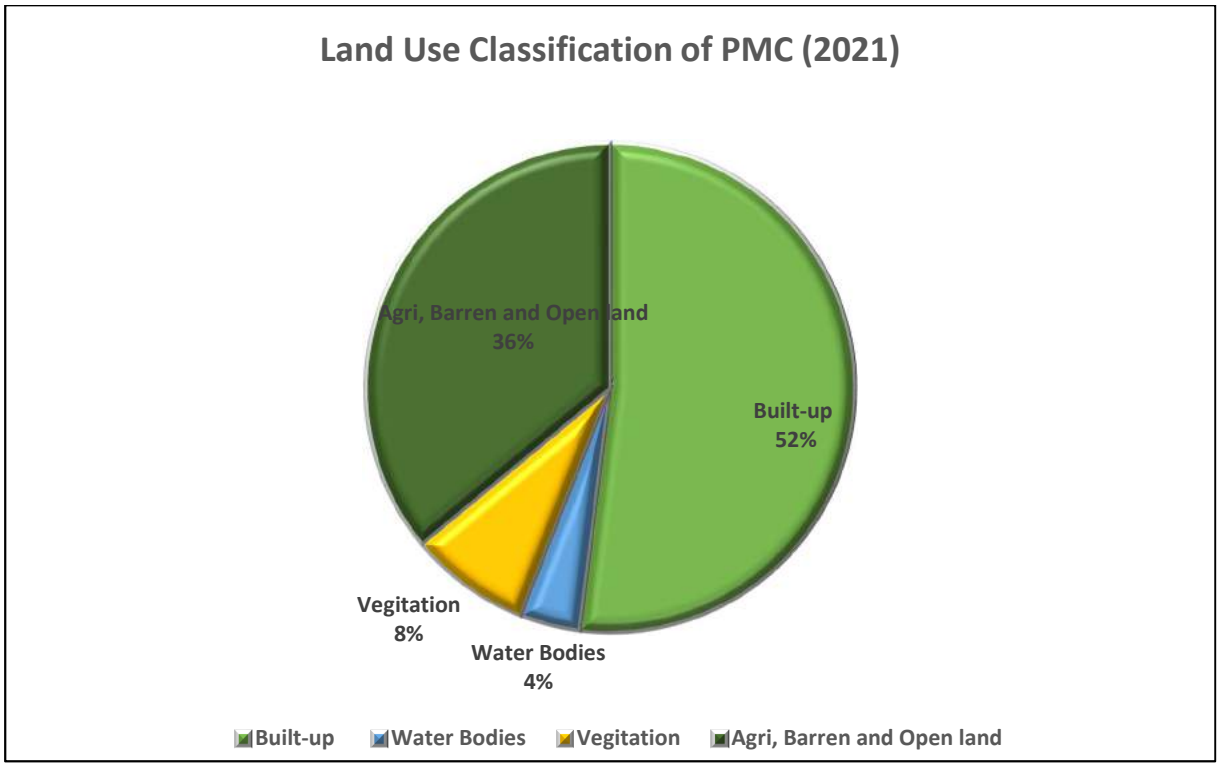
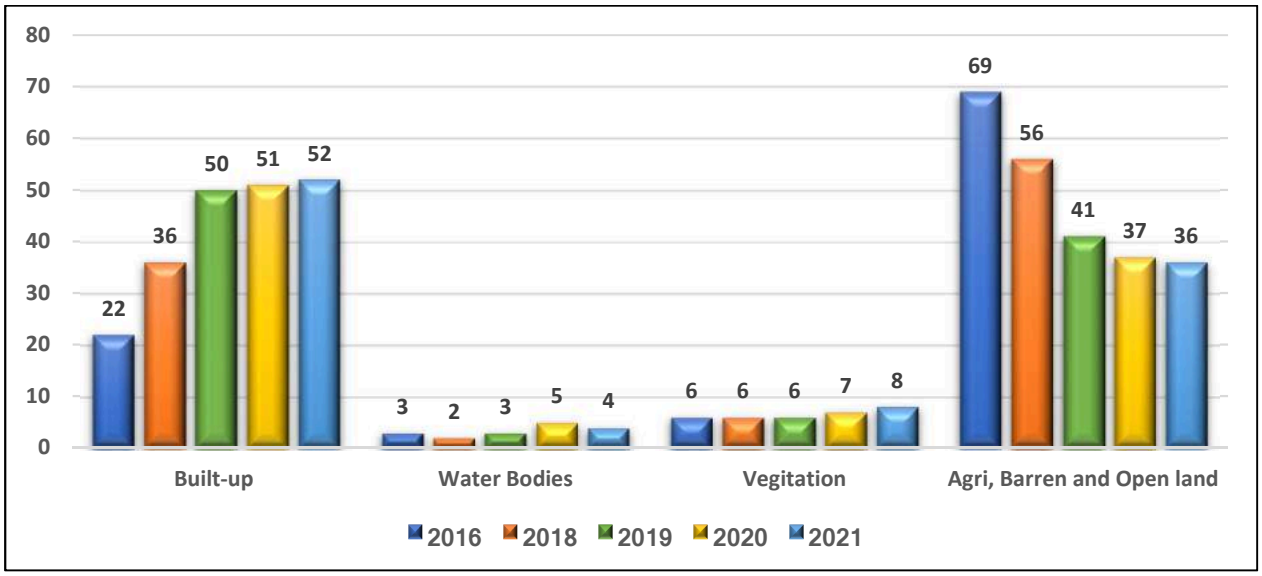


Figure 6 Class wise break up of land use classification for Panvel Municipal Corporation



Source: Author's Estimation

3.1.4 Accuracy Assessment of Land-Use Land Cover Classes of Study Area:

The user's accuracy, producer's accuracy, Kappa coefficient, and overall accuracy is derived for 2016, 2018, 2019, 2020 and 2021 for Panvel Municipal area as per LULC classes. Findings of accuracy assessment are as follows,

Table 6 Accuracy Assessment of Land Use Classification (2016)

Classes	Reference Total	Classified Total	Number Correct	Producer Accuracy (per cent)	Users Accuracy (per cent)	Kappa
Built-Up	31	34	31	100	91.18	
Water bodies	10	10	7	100	70	
Vegetation	7	14	10	100	71.42	
Agriculture, Barren and Other Land	89	96	89	100	92.91	
Overall Accuracy					89.80	0.843

Source: Author's Estimation

Table 7 Accuracy Assessment of Land Use Classification (2018)

Classes	Reference Total	Classified Total	Number Correct	Producer Accuracy (per cent)	Users Accuracy (per cent)	Kappa
Built-Up	38	50	38	100	76	
Water bodies	10	10	09	100	90	
Vegetation	12	14	12	100	85.71	
Agriculture, Barren and Other Land	64	78	64	100	82.05	
Overall Accuracy					87.5	0.81

Source: Author's Estimation

Table 8 Accuracy Assessment of Land Use Classification (2019)

Classes	Reference Total	Classified Total	Number Correct	Producer Accuracy (per cent)	Users Accuracy (per cent)	Kappa
Built-Up	58	71	57	100	80.28	
Water bodies	10	10	09	100	90	
Vegetation	13	14	1	100	78.57	
Agriculture, Barren and Other Land	53	60	52	100	86.67	
Overall Accuracy					89.2	0.85

Source: Author's Estimation

Table 9 Accuracy Assessment of Land Use Classification (2020)

Classes	Reference Total	Classified Total	Number Correct	Producer Accuracy (per cent)	Users Accuracy (per cent)	Kappa
Built-Up	23	25	23	100	92.0	
Water bodies	8	12	8	100	66.66	
Vegetation	18	20	17	100	85.00	
Agriculture, Barren and Other Land	31	35	29	100	82.85	
Overall Accuracy					81.63	0.81

Source: Author's Estimation

Table 10 Accuracy Assessment of Land Use Classification (2021)

Classes	Reference Total	Classified Total	Number Correct	Producer Accuracy (per cent)	Users Accuracy (per cent)	Kappa
Built-Up	27	32	27	100	84.37	
Water bodies	10	12	10	100	83.33	
Vegetation	23	25	22	100	88.00	
Agriculture, Barren and Other Land	18	23	18	100	78.26	
Overall Accuracy					83.49	0.80

Source: Author's Estimation

3.1.5 Results and Discussion

The present study takes into consideration Landsat-8 satellite imagery to understand possible land cover changes. Panvel Municipal Area is going through rapid urbanization in the last decade due to several development projects like New Mumbai International Airport, Multi-corridor project and Belapur-Taloja Metro. Supervised classification of Landsat-8 of PMC area for 2016-2018, 2018-2019, 2019-2020 and 2020-21. Subsequent change detection provides results and observations as follows,

1. In Panvel Municipal Area, there is high densification found along the major arterial roads adjoining the highways, especially Mumbai-Pune Expressway, National Highway Number 4A from JNPT to Kalamboli and Kalamboli to Kalyan Shilphata Road.

2. There is two-fold growth (increase) in the built-up area during 2016-2021. The announcement of development projects by CIDCO, MMRDA and the Government of Maharashtra in the PMC area has various effects on the high growth of the construction sector.

3. Decrease in vegetation, agriculture, barren and other land is primarily attributed to the increase in built-up in the said period (2016-2021). The water body's area remains the same during this period.

4. Comparison of land use classification in the said period indicates the high conversion of agriculture and barren land into built-up.

5. Around 31 square kilometre areas from agriculture, barren and other land were converted into built-up areas in the respective years.

6. In 2018-21 years, similar trends in the conversion of agriculture and barren land into built-up continues. Despite this fact, a decrease in vegetation and other forest areas becomes an issue of concern for further development.

3.2 Resource Extraction

There are few villages included in the Panvel City area that have some agricultural activities. Mainly rice is the crop produced by farmers in this area. Due to increasing urbanization, the land under cultivation has been started shifting land use towards housing infrastructure. There are few water bodies in Panvel City like Ballaeshwar Lake, Dewale Lake, Panvel Market Lake, Israel Lake, Khandeshwar Lake, Shiv Mandir Pond in Kamothe, Roadpali Lake and Holding Pond and rivers like Taloje, Kasadi and Kalundre (Gadhi) are the main water flow in the City. And Taloje Creek is also a big water body, including wetland around the creek. There are few fishing activities in the Kalundre river. But the water bodies of Taloje and Kasadi are highly polluted due to industrial wastewater and hence no fishing activities are observed in these rivers. The groundwater extracted by individuals is mainly used for domestic use, construction, and industrial purposes except for drinking purposes.

Through GIS, it is observed that there has been a stone mining site near Valavali Village in Panvel City. Except for the Valavali stone mining site, no other stone extraction is observed in the City. Perhaps there have been a few stone mining sites nearby areas around Panvel City. Though they are not part of PMC territory, the environmental effects are bound to occur.

3.3 External Inputs (Fertilizers, Chemicals and Irrigation)

Land use for agriculture has been observed a significant decline recently in the municipal region. Raigad District is known for its organic farming, and such activities are also observed in the villages in the municipal territory. The main crop is rice in the area and there are no irrigation facilities found in the region. There has been some vegetable cultivation on the Kalundre river banks, where fertilisers and pesticides are common, but the land under such cultivation is minimal in size.

3.4 Emissions (Pollutants and Waste)

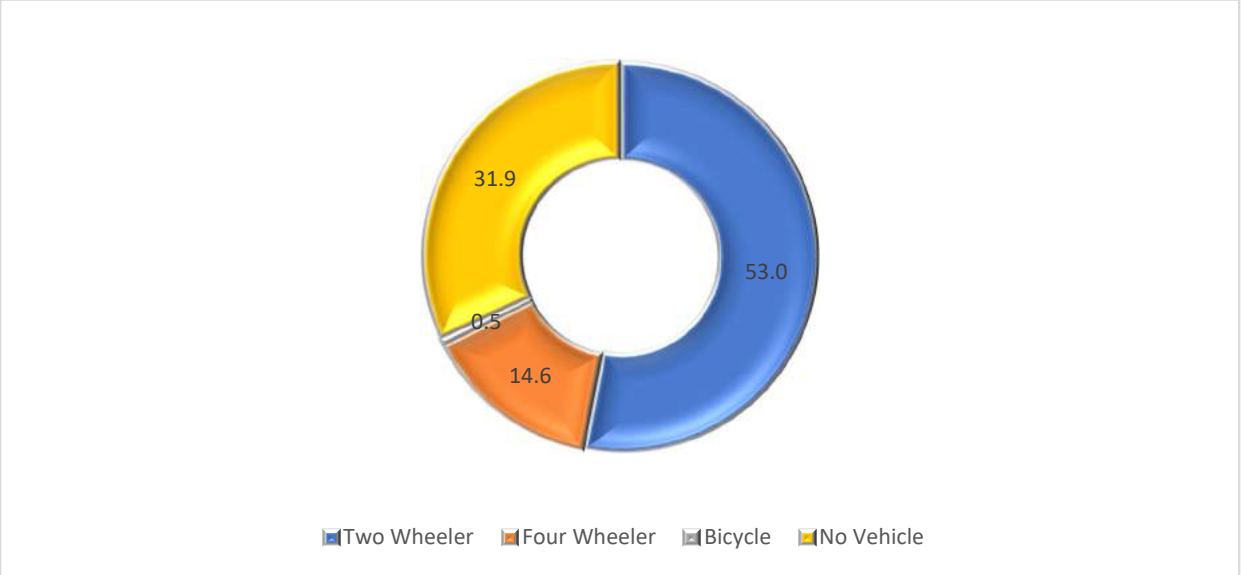
The primary sources of pollutants and waste are industrial residual and waste, urban solid waste, and transportation emissions. Industrial activities are essential for any society's economic growth and development that primarily bring employment to the workforce. There are forward and backward linkages of employment in industrial development. The industrial residual generates pollutants that pollute the water bodies and air if untreated before being discharged into the environment.

The Commission for Environmental Cooperation (2008) reports that Industrial pollution and waste encompass the full range of unwanted substances and losses generated by industrial activities, including emissions to air or surface waters and the substances sent to sewage treatment plants, deposited in landfills, released or applied to the land, treated, injected underground, controlled through storage, recycled or burned for energy recovery. Industrial production contributes to goods, services and jobs, but it is also a major source of pollution and waste. This pollution and waste can be classified into six categories: toxic chemicals, criteria air contaminants, greenhouse gases, hazardous wastes, non-hazardous wastes and radioactive wastes. The toxic chemical substances are hazardous to human health and the environment. The Criteria Air Contaminants include nitrogen oxides, sulfur oxides, carbon monoxide, particulate

matter and volatile organic compounds associated with environmental effects such as smog, acid rain and regional haze, and health effects such as respiratory illness. The Greenhouse Gases include carbon dioxide (CO2), methane, and nitrous oxide linked to global climate change. Hazardous wastes are industrial waste streams that may contain more than a single chemical or substance. They are typically defined by characteristics such as ignitability, reactivity, corrosivity and toxicity. And Non-hazardous industrial wastes include coal ash, foundry sands, cement kiln dust, mining and mineral processing wastes, oil and gas production wastes, and other wastes that lack hazardous waste characteristics. Taloja MIDC, Kalamboli Industrial Area and Jawahar Co-operative Industrial Estate, Kamothe are the major industrial areas in Panvel City. Taloja MIDC has many chemical factories and the Kalamboli Industrial area has units that produce and process steel and metals. There have been instances when the residents near Kasadi and Taloje river banks have complained that nearby industries contaminate the river water. And it is also observed that the residents have experienced polluted air due to residuals from these industrial units. Our environmental survey confirmed the observations. We asked the households in Panvel City whether they experienced any industrial air pollution in recent times. Fifty-four per cent of the total households revealed that industrial pollution is moderate to a very high level in the city. The wards closer to the industrial areas have strongly indicated that the industrial pollution is high to very high in their proximity; such wards include Ward No. 1, 2, 3, 13, 14 and 15. And Ward No. 6, 10, 11, 19 and 20 expressed that air pollution by the industrial units is not a significant issue.

People travel every day for various purposes such as work, schools, hospitals, shopping, and recreation. The residents use multiple modes of transportation for such purposes. Road transport is a major source of air pollution that harms human health and the environment. Vehicles emit a range of pollutants, including nitrogen oxides (NOx) and particulate matter (PM). NOx comprises a mixture of nitric oxide (NO) and nitrogen dioxide (NO2). In the air, NO is rapidly converted to NO2, which will also react in the air to form nitrate particles and ozone (O3). NO2 is a toxic gas harmful to health. NOx emissions also contribute to acidification and eutrophication, causing severe damage to ecosystems. Road transport accounts for a third of NOx emissions and is the dominant source in urban, heavily trafficked areas (Transport & Environment).

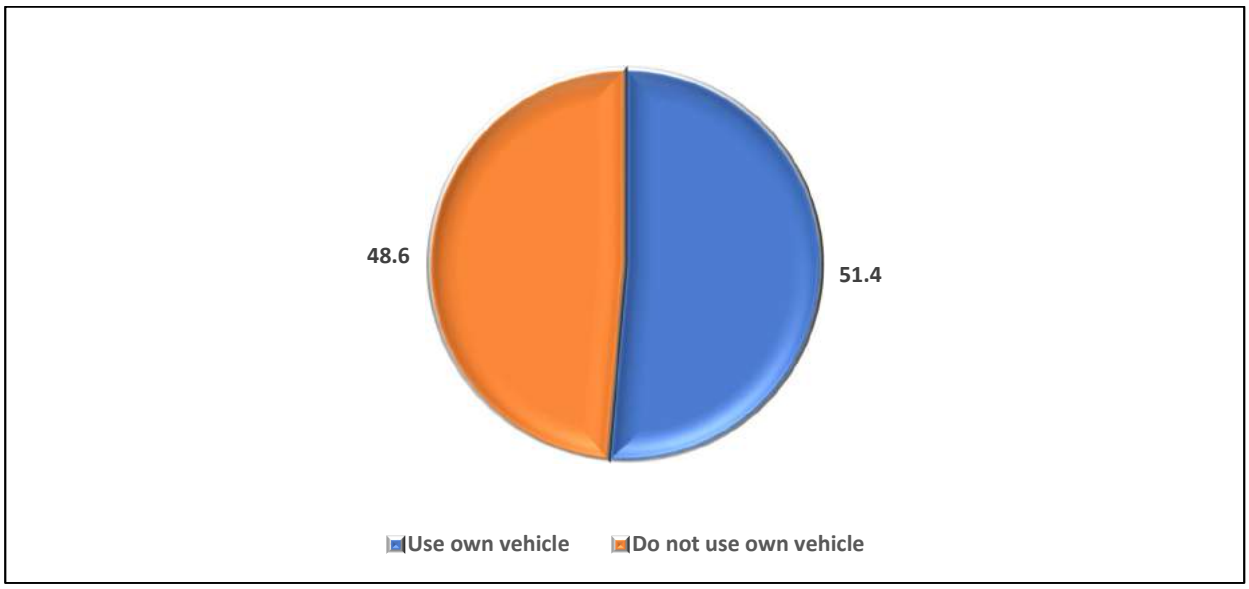
Chart 4 Vehicle Ownership of Households



Source: Environmental Survey, 2020-21

It is found that 68.1 per cent of households use their own vehicles for transportation in the city. Two-wheeler is owned by 53 per cent of households and 14.6 per cent of households owning four-wheeler vehicle.

Chart 5 Percentage of Households Using own vehicle for transportation to go to work



Source: Environmental Survey, 2020-21

It is found that 48.6 per cent of total households use their vehicle for transportation to go to work. It is also observed that 75.4 per cent of the households who own the vehicles use their vehicle for transportation to go to work. 74.3 per cent of two-wheeler owners use two-wheelers to go to work and 79.5 per cent of four-wheeler owners travel by four-wheelers to work. Among the people with no vehicle owned, 48.5 per cent people use auto-rickshaw for transport. Besides owned vehicles, people use auto-rickshaws, ST/Municipal Buses, Company Buses, and local trains to travel to reach work.

Maharashtra State Transport Corporation (MSRTC) has a central bus stand with 74 buses housed. MSRTC provides local and regional transportation facilities. MSRTC buses run on 73 routes every day. Every day 24577 passengers use public transport supplied by MSRTC.

Table 11 Provision of Public Transportation by MSRTC

State Transport Facilities	No.
Total No. of Buses	74
Total Trips	645
No of Routes	73
Per day total travelled km	18879
Per day total passengers travelled	24577

Source: Maharashtra State Road Transport Corporation, Panvel Division, Panvel

The railway is one of the greener modes of transport (EC). Rail is the most energy-efficient mode of passenger transport. If more people were to travel by train and more freight transported by rail, then the CO2 emissions from the transport sector would be significantly reduced. While trains are more energy-efficient than automobiles, they affect the environment, including producing nitrogen dioxide, carbon dioxide, and particulate matter that contribute to air pollution and adverse health effects. The construction and use of railroads can also contribute to the fragmentation of ecosystems. Travelling by rail is a prevalent form of passenger transport in India (ELC).

Panvel City is part of MMR, where people commute to Mumbai and Mumbai Suburbs frequently. It is found that 27.2 per cent of households in Panvel City travel by local trains to go to work. Panvel hosts a railway station on Harbour Line and Central Line of the Mumbai Suburban Railway network. Panvel Station initially started as Panvel-Diva Line for rail freight transport in 1962, connecting Diva Railway Station. Regular Passenger Service began in 1964 for commuting to Khopoli. Panvel also serves as a connecting line to Karjat, mainly set up for cargo services. The Mankhurd-Belapur-Panvel Railway Corridor Line was initiated as a single line up to Khandeshwar in 1995 and later expanded to Panvel in 1998. In 2000, the line was expanded as a double line connecting Chatrapati Shivaji Terminus, Mumbai to Panvel.

Table 12 Railway Transportation in Panvel

Information on Railway Transportation	Inbound+Outbound	Total
Passenger Trains	3+3	6
MEMU Trains	8+8	16
EMU Local Trains		345
Mail Express	54+54	108
Goods Trains	30+30	60
Daily Average number of Passengers		120000

Source: Station Manager, Central Railways, Panvel Station

The Central Railways started shuttle services between Diva and Panvel in 2015 extended to Vasai/Virar connecting Bhiwandi. Recently few passenger trains and express train services have been started on Karjat-Panvel Line also. Panvel connects Konkan Railway through the Roha railway station since 1993, which networks Maharashtra, Goa, Karnataka and Kerala. Hence

Panvel Railway Station is one of the most connecting stations in MMR. There are 345 local passenger services every day from Panvel Railway Station on Harbour and Central Lines. One hundred eight trains connect Western, Central, Southern and Northern parts of India. Panvel Station connects the primary industrial belt in the region and serves JNPT with 60 goods carrying trains every day. Panvel Railway Station serves an average of 120000 passengers in a day.

3.5 Modification and Movement of Organisms

Human Intervention through modification and movement of organisms includes biophysical environments, ecosystems, biodiversity and natural resources (Hawksworth and Bull, 2008). Modifying the environment as per the needs of society causes severe damages to the environment. Human activities like overconsumption, overexploitation, pollution and deforestation cause damage to the environment (EPA). The total area under the Panvel Municipal region is legally under its jurisdiction since October 2016. Before that, the villages were part of corresponding Gram Panchayats and hence land under these Gram panchayats was controlled by them and the CIDCO had control over the area developed by the CIDCO. The CIDCO, in sectors 34 and 36 in Kamothe, Sectors 8, 10, 16, 17, 25 and 28 in Kharghar and Sections 20 and 23 in Taloje, have reclaimed wetland in Taloje Creek. These developments have altered these areas' landscapes but may lead to environmental degradation and cause damages to biodiversity in the proximity. Through Google Historical Imagery, there have been stone mining near Owe Dam from 2004 to 2010, located in West of Panvel and near Valavali and Nevali villages from 2008 to 2015 in the East Panvel. The modifications and alteration in the Panvel area must have caused damages to biodiversity in the region.

4 STATE AND TRENDS (S) IN ENVIRONMENTAL ASPECTS

The state and trends in environmental aspects reflect the observable changes in the environment due to pressures exerted. A region shall be considered more sustainable if its initial endowment is good and the ecosystem is preserved, allowing it to regenerate and replenish. DPSIR Framework necessitates a discussion on Natural Capital such as atmosphere, land, water and biodiversity, environmental impacts, climate change and depletion of the stratospheric ozone layer, biodiversity changes and pollution, degradation, and depletion of air, water, minerals and land.

4.1 Natural Capital: Atmosphere, Land, Water and Biodiversity

Its absolute location in the world determines the climate of any region that too much extent influences its temperature and pressure conditions about the distance from the sun over the year, its relative location specified by its surroundings, i.e. maritime or continental, its Physiography and land-cover, and its land-use determined human activities. The cumulative effect of all these factors determines the climate of a region.

4.1.1 Temperature and Rainfall

The temperature and rainfall data are available from the Indian Meteorological Department (IMD), Pune, under the Ministry of Earth Sciences, Government of India. Besides the data on temperature by IMD, one can estimate Land Surface Temperature (LST) using satellite images made available by USGS and Bhuvan.

Table 11 depicts the average high and low temperatures in degrees Celsius and average rainfall in millimetres for Panvel for 2020-21.

High Temperature: It can be well understood from the information that; this place recorded the maximum average high temperature as 35.29^{0}C in the month of March 2021 and the minimum average high temperature as 29.77^{0}C in the month of August 2020 for the given year.

Low Temperature: The maximum average low temperature recorded for the month of May 2020 is 27.35^{0}C, which is the warmest month of the year and the minimum average low temperature for the month of January 2021, which is also the coldest month of the entire year in the northern hemisphere is recorded as 19.16^{0}C.

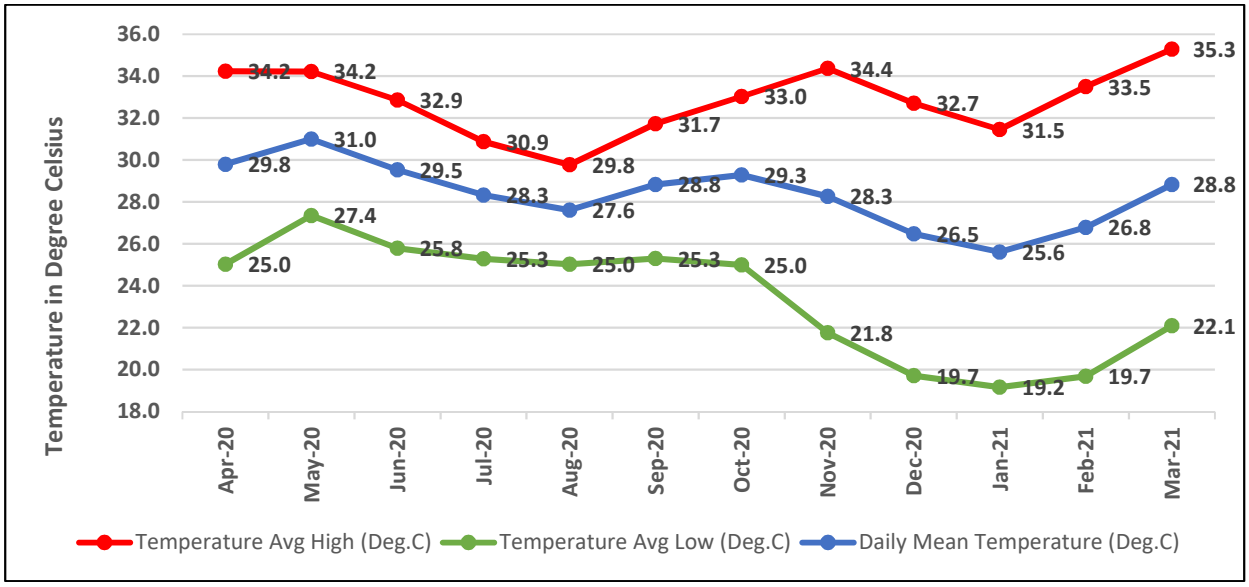
Table 13 Weather data of Panvel Municipal Corporation (2021)

Month	Temperature Avg High (Deg.C)	Temperature Avg Low (Deg.C)	Daily Mean Temperature (Deg.C)	Avg Rainfall (mm)
Apr-20	34.23	25.03	29.80	0
May-20	34.23	**27.35**	**31.00**	0
Jun-20	32.87	25.80	29.53	237.00
Jul-20	30.87	25.29	28.32	880.92
Aug-20	**29.77**	25.03	27.61	**1441.60**
Sep-20	31.73	25.30	28.83	716.50
Oct-20	33.03	25.00	29.29	234.90
Nov-20	34.37	21.77	28.27	22.14
Dec-20	32.71	19.71	26.48	0
Jan-21	31.45	**19.16**	**25.61**	0
Feb-21	33.50	19.68	26.79	0
Mar-21	**35.29**	22.10	28.84	0
Yearly	32.84	23.44	28.37	3510.92

Source: Accuweather and Panvel Tehsil, Panvel

Daily Mean Temperature: As far as the Daily Mean Temperature for the warmest month, i.e. May 2020, is concerned, it was recorded as 31^{0}C and for the coldest month, it was 25.61^{0}C in January 2020. This shows that neither is a considerable difference between the maximum average high and low temperatures nor the diurnal ranges of temperature. This can be attributed to the nearness to the sea, which moderates the city's climate.

Figure 7 Monthly Average Temperature in Panvel City (2020-21)



Source: Accuweather

4.1.2 Land Surface Temperature

Land surface temperature (LST) is defined by the International LST and Emissivity Working Group as a measure of how hot or cold the surface of the Earth would feel to the touch. It is an important parameter related to surface energy and water balance at local and global scales (Li and Duan, 2018). It is of fundamental importance to many aspects of the geosciences, for example, net radiation budget at the Earth surface, monitoring the state of crops and vegetation, as well as an important indicator of both the greenhouse effect and the physics of land-surface processes at local through global scales (Yu, Liu and Yu, 2018).

We have measured LST for Panvel City for April 2018, April 2019 and April 2020. Medium Spatial Resolution Data from U.S. Geological Survey is known as LANDSAT. LANDSAT 8 comes with Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). OLI has a resolution of 30 meters for 11 spectral bands that comes with LANDSAT 8. The collection category of LANDSAT 8 data is Tier 1 (T1), which contains the highest quality Level-1 Precision Terrain (L1TP) data considered suitable for time-series analysis. The LANDSAT data is available at the USGS website through the GloVis.

The details of the LANDSAT data sets acquired for the study are as follows.

Period	LANDSAT 8 Scene ID	Acquired date
April 2018	LC81480472018097LGN00	11th April 2020
April 2019	LC81480472019100LGN00	13th April 2021
April 2020	LC81480472020103LGN00	11th April 2021
April 2021	LC81480472021089LGN00	12th September 2021

The study area covers a total of 110.6 square kilometers.

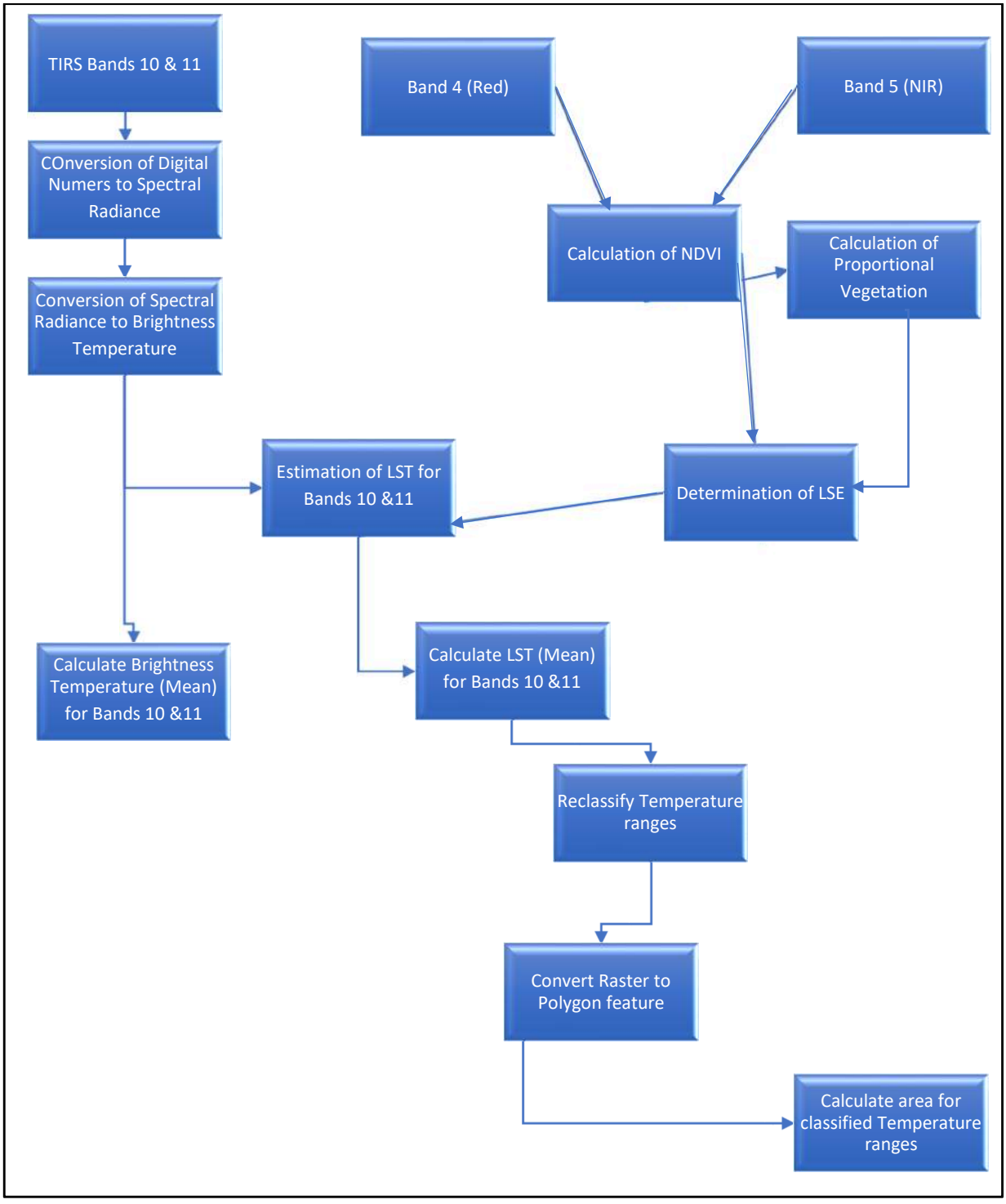
The sensors aboard each of the Landsat satellites were designed to acquire data in different ranges of frequencies along the electromagnetic spectrum. The Landsat 8 acquires 11 bands from two separate sensors: Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). The Bands, Wavelength and Resolution of LANDSAT images are as follows.

Table 14 The Band Designations for Landsat 8

Bands	Wavelength	Resolution
	(micrometers)	(meters)
Band 1 - Coastal aerosol	0.43-0.45	30
Band 2 – Blue	0.45-0.51	30
Band 3 – Green	0.53-0.59	30
Band 4 – Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 – Panchromatic	0.50-0.68	15
Band 9 – Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100

Source: USGS

Chart 6 Flowchart for the Estimation of Land Surface Temperature



Following Meta Data Values are used for calculation.

1. Radiance Add Band 10 = 0.10000
2. Radiance Add Band 11 = 0.10000
3. Radiance Mult Band 10 = 0.0003342

4. Radiance Mult Band 11 = 0.0003342
5. K1 Constant Band 10 = 774.8853
6. K2 Constant Band 10 = 1321.0789
7. K1 Constant Band 11 = 480.8883
8. K2 Constant Band 11 = 1201.1442

Process to Estimate Land Surface Temperature

Top of Atmosphere (TOA) Radiance: Using the radiance rescaling factor, Thermal Infra-Red Digital Numbers are converted to TOA spectral radiance.

$$L\lambda = ML \times Qcal + AL$$

Where

$L\lambda = \text{TOA spectral radiance i. e.} \left(\frac{Watts}{m^2 \times sr \times \mu m}\right)$

$ML = \text{Radiance Multiplicative Band (No.)}$

$Qcal = \text{Quantized and calibrated standard product pixel values (DN)}$

$AL = \text{Radiance Add Band (No.)}$

Top of Atmosphere (TOA) Brightness Temperature (BT): Spectral radiance data is converted to top of atmosphere brightness temperature using the thermal constant values in Meta data file.

$$BT = \frac{K2}{\ln\left(\frac{K1}{L\lambda} + 1\right)} - 272.15$$

Where

$BT = \text{ Top of Atmosphere (TOA) Brightness Temperature}$

$L\lambda = \text{TOA spectral radiance i. e.} \left(\frac{Watts}{m^2 \times sr \times \mu m}\right)$

$K1 = \text{K1 Constant Band (No.)}$

$K2 = \text{K2 Constant Band (No.)}$

Normalized Differential Vegetation Index (NDVI): The Normalized Differential Vegetation Index (NDVI) is a standardized vegetation index calculated using Near Infra-red (Band 4) and Red (Band 5) bands.

$$NDVI = (NIR - RED)/(NIR + RED)$$

Where

$RED =$ DN values from the RED band

$NIR =$ DN values from Near − Infra band

Land Surface Emissivity (LSE): Land surface emissivity (LSE) is the average emissivity of an element of the surface of the Earth calculated from NDVI values.

$$E = (0.004 \times PV) + 0.986$$

$$PV = ((NDVI - NDVI\ min)/(NDVI\ max + NDVI\ min))^2$$

Where

$E =$ Land Surface Emissivity

$PV =$ Proportion of Vegitation

$NDVI =$ DN values from NDVI Image

$NDVI\ min =$ Minimum DN values from NDVI Image

$NDVI\ max =$ Maximum DN values from NDVI Image

Land Surface Temperature (LST):

The Land Surface Temperature (LST) is the radiative temperature which is calculated using Top of Atmosphere Brightness Temperature *(BT)*, Wavelength of emitted radiance (W), Land Surface Emissivity *(E)*.

$$LST = \left(\frac{BT}{1}\right) + W \times \left(\frac{BT}{14380}\right) \times \ln(E)$$

Where

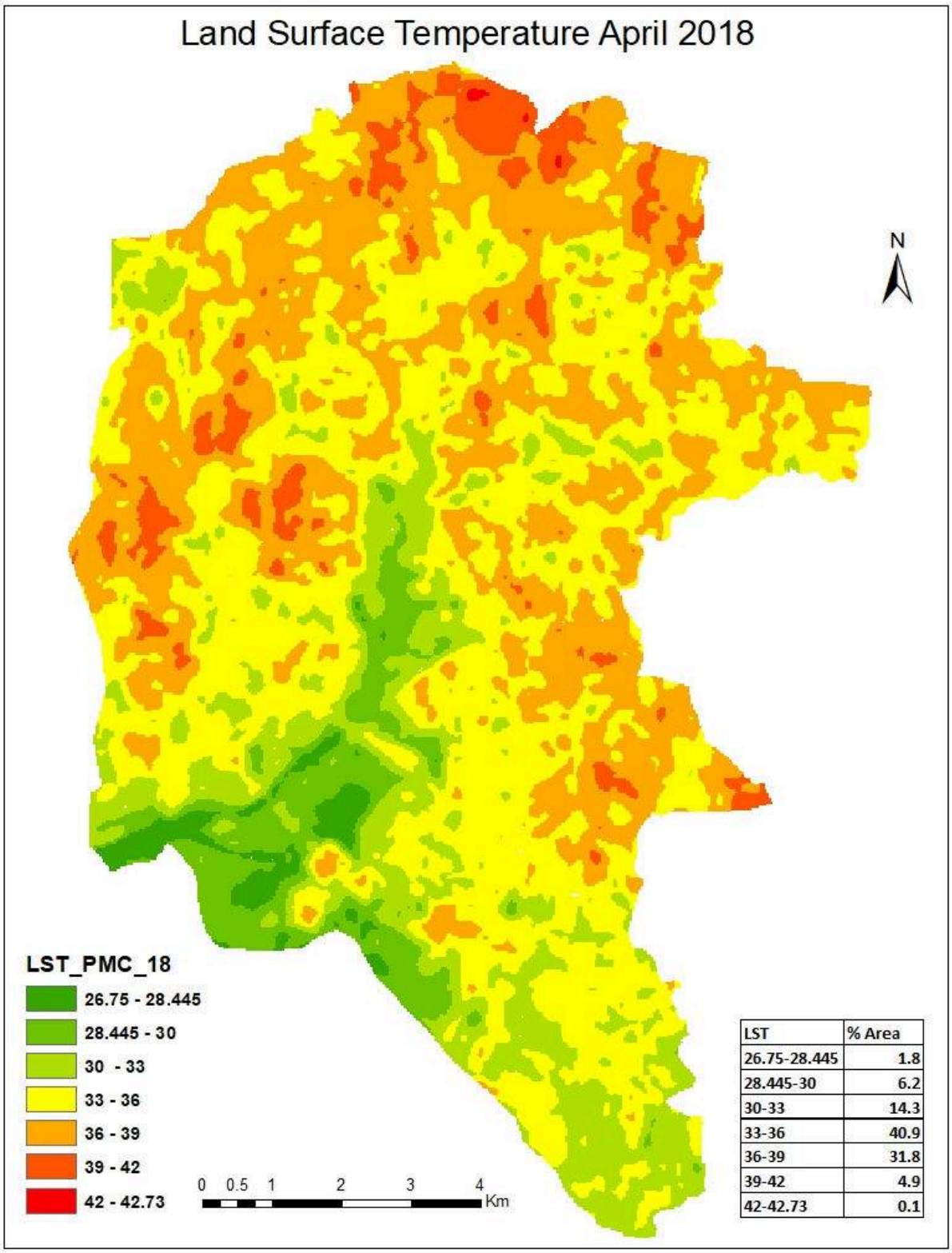
$LST =$ Land Surface Temperature

$BT =$ Top of Atmosphere (TOA) Brightness Temperature

$E =$ Land Surface Emissivity

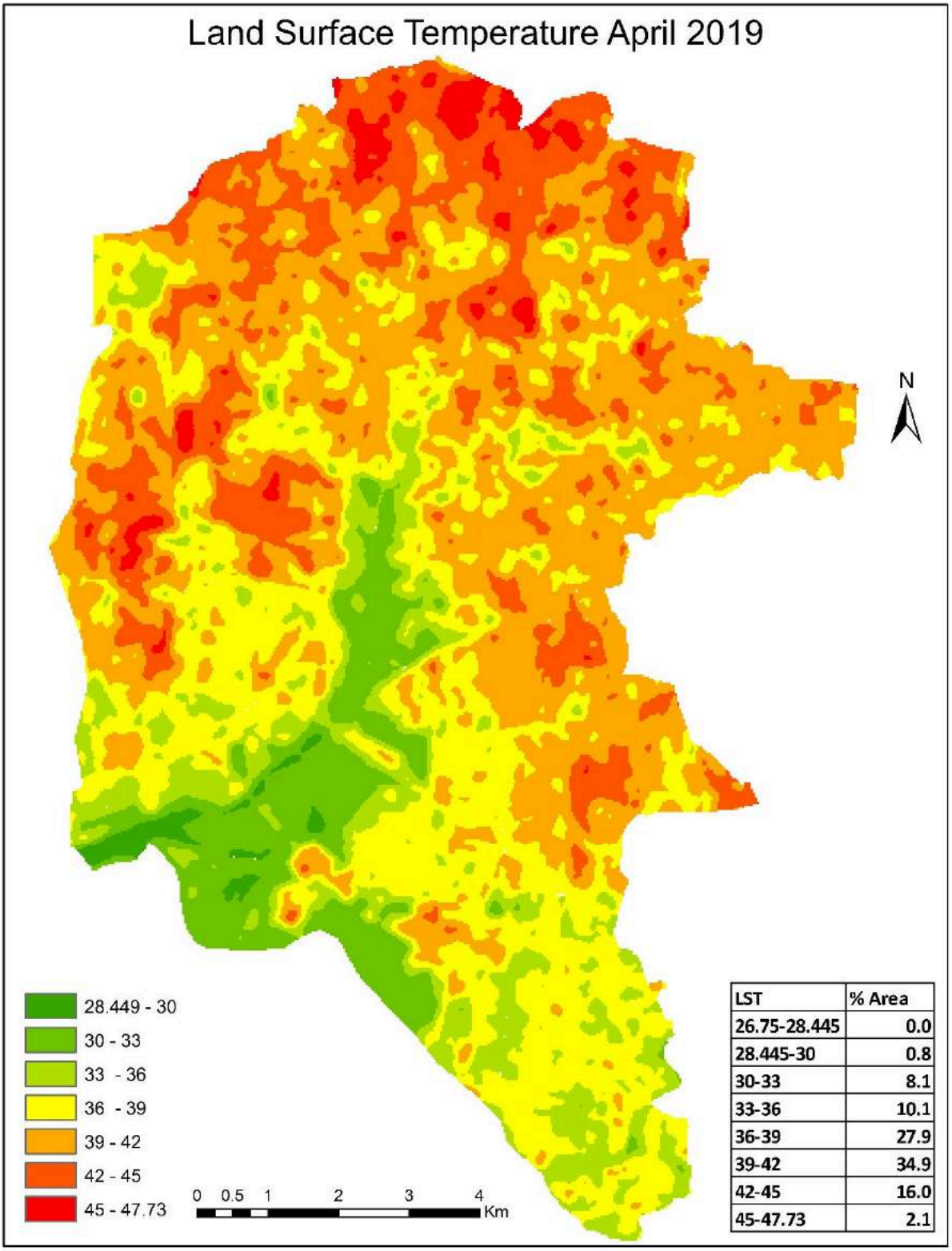
Applying the above procedure, we have estimated LST for April 2018 and April 2019 and constructed the following maps.

Map 8 Land Surface Temperature in Panvel City for April 2018



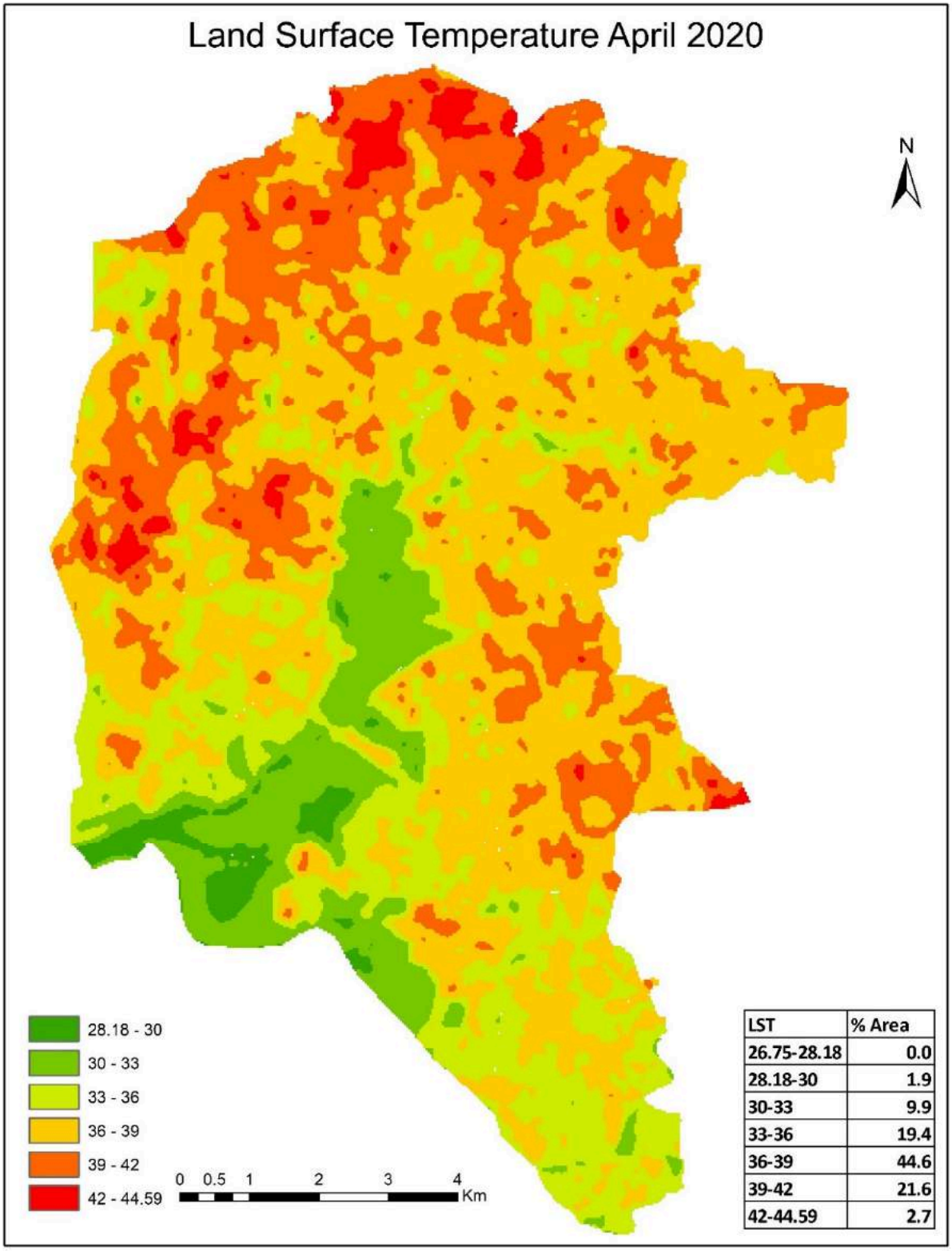
Source: Estimated by Authors

Map 9 Land Surface Temperature in Panvel City for April 2019



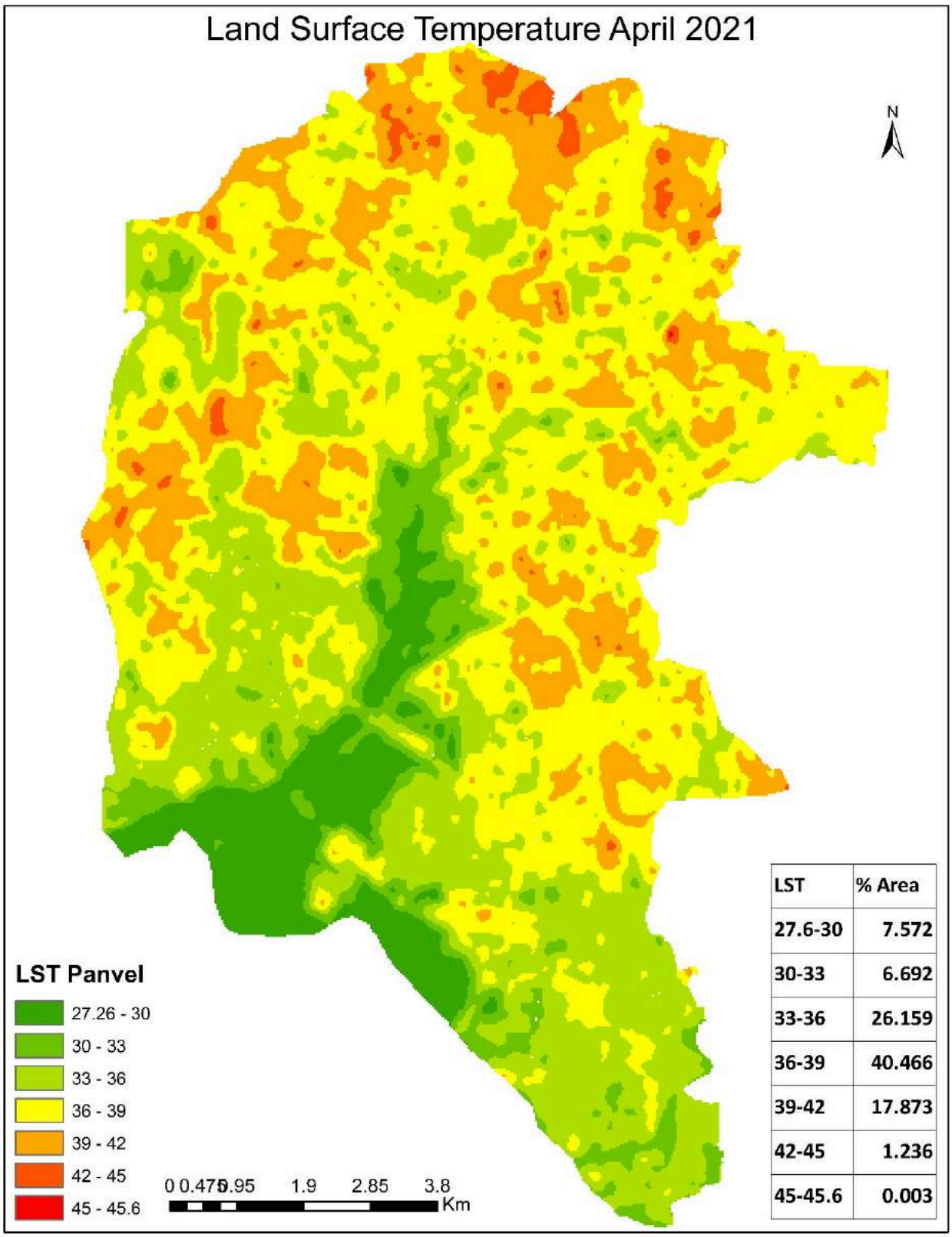
Source: Estimated by Authors

Map 10 Land Surface Temperature in Panvel City for April 2020



Source: Estimated by Authors

Map 11 Land Surface Temperature in Panvel City for April 2021



Source: Estimated by Authors

Table 15 The Band Designations for Landsat 8

Land Surface Temperature Rage	% Area			
	Apr-18	Apr-19	Apr-20	Apr-21
26.75-28.445	1.8	0.0	0	0
28.445-30	6.2	0.8	1.9[$]	7.57[&]
30-33	14.3	8.1	9.9	6.7
33-36	**40.9**	10.1	19.4	26.2
36-39	31.8	27.9	**44.6**	**40.5**
39-42	4.9	**34.9**	21.6	17.9
42-45	0.1[*]	16.0	2.7	1.2
45-47.73	0.0	2.1	0.0	0.003[#]
Total	100.0	100.0	100.0	100.0
Average Land Surface Temperature	34.9	38.8	37.0	36.3

[*]42-42.73, [$]28.18-30, [&]27.6-30 and [#]45-45.6

Source: Estimated by Authors

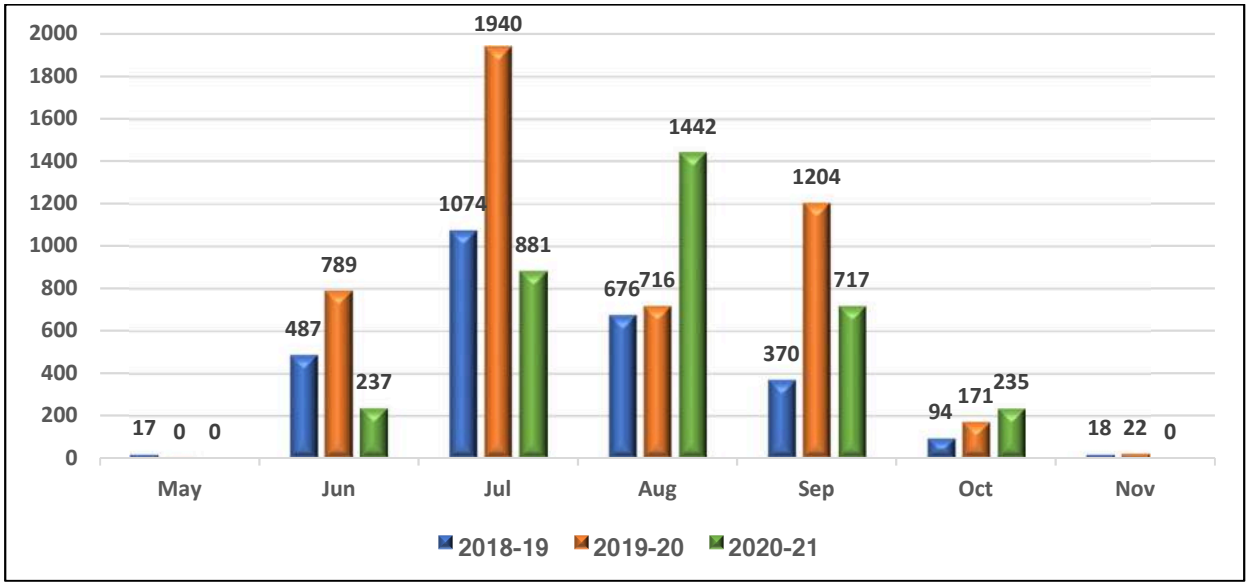
The above maps and table show that from 2018 to 2021 in the month of April, the minimum land surface temperature in the City was in the range of 26.75 to 30 degrees that was found in the area ranging 0.8 per cent to 7.57 per cent of the total area. And the maximum land surface temperature ranged from 42 to 47.73 degrees. The maximum temperature of 42-45 degrees was found in 0.1 per cent of the area in the City in 2018. In 2019 the maximum temperature was in the range of 45 to 47.73 degrees which was found in 2.1 per cent of the area. The maximum temperature in the range of 45-45.6 degrees was located on 0.003 per cent of the area in April 2021. In April 2018, 72.7 per cent of the area in the City had a temperature in the range of 33 to 39 degrees. In April 2019, 38 per cent of the area had a temperature of 33 to 39 degrees, and 50.9 per cent of the area had a temperature of 39 to 45 degrees. In April 2020, 85.6 per cent area had a temperature in the range of 33 to 42 degrees. In April 2021, 84.6 per cent area had a temperature in the range of 33 to 42 degrees and only 1.203 per cent area experienced a temperature greater than 42 degrees. It is observed that the land surface temperature is significantly decreased, the effect may be associated with the increased tree cover and fallen

economic activity and consequent pollution during the Covid pandemic period in the city. There has been a significant change in the land use and land cover in the City in recent years. Along with global warming, local land use and land cover change and changes in the land use and land cover around the Municipal Areas also contributed to the rise in the land surface temperature in the City.

4.1.3 Rainfall

The Panvel Municipal Corporation is in the North Konkan Region and receives rainfall from the monsoon winds. Maximum rainfall amount (95%) is received from south-west monsoon winds blowing from the Arabian Sea during the months of June to September and then some rain amount from North-East winds during retreating monsoon in the months of October to November. Figure 2 reveals that the average rainfall recorded in Panvel is at its peak, i.e. 1073.9 mm as the wettest month of the year, i.e. July and minimum in the month of March, i.e. 0.3 mm, to record nil rainfall as this is the beginning of summer season when there is a rise in temperatures as given in Figure 2**.**

Figure 8 Average Rainfall in Panvel City (mm)



Source: Panvel Tehsil, Panvel

March, April and May are the months with high temperatures and high evaporation rates, giving rise to the formation of moisture-laden clouds on the Arabian Sea driven by southwest monsoon

winds towards the Konkan coast get uplifted by obstruction of Western Ghats. As a result, there is a heavy downpour of rainwater that witnesses the month of July with a maximum number of rainy days, i.e. 27.3, followed by August with 25.4 rainy days. In 2018-19, the highest rainfall was observed in July (1073.9 mm). In 2019-20, the highest rainfall was observed in July (1939.32 mm), almost twice the previous year. 2019-20 was uncommon in precipitation as the month of September has observed four times more rainfall (1204 mm) compared to its last year. In the year 2020-21, July 2020 experienced a significant decrease in rainfall compared to its previous year and the highest rainfall (1442 mm) in a month is observed in the month of August 2020 which is almost twice of its previous year in the same month. It is observed that there is a structural change in the rainfall in the city.

4.2 Environmental Impacts and Change:

Climate change is expected to have unprecedented implications on where people can settle, grow food, build cities, and rely on functioning ecosystems for the services they provide. In many places, temperature changes and sea-level rise are putting ecosystems under stress and affecting human well-being (UN).

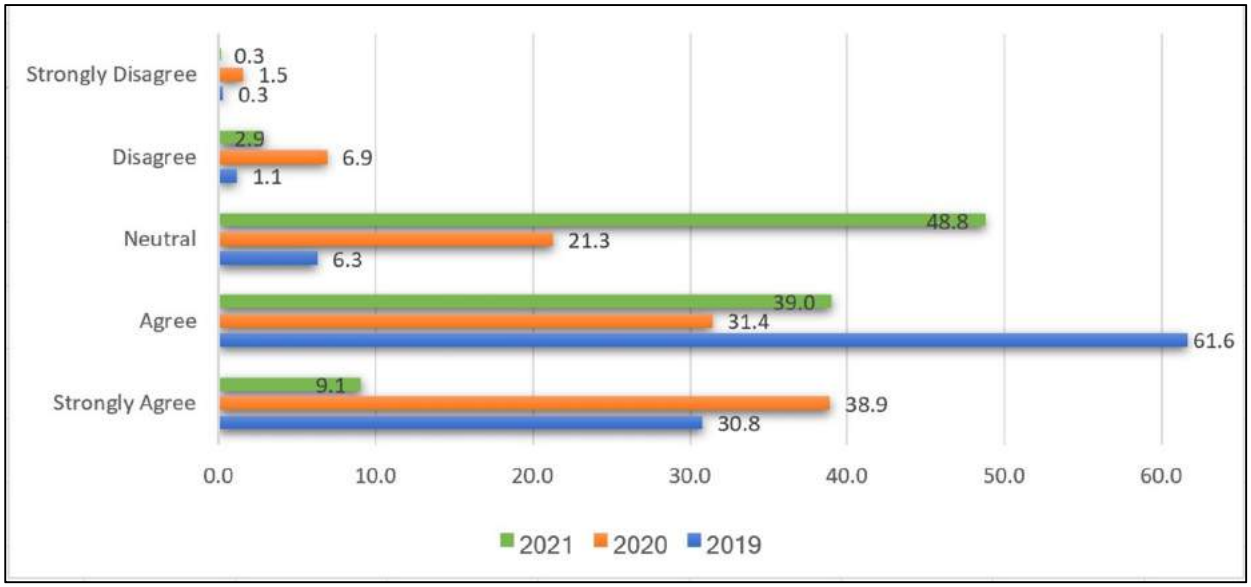
Potential risks to human health from climate change would arise from increased exposure to thermal extremes (cardiovascular and respiratory mortality) and increases in weather disasters (including deaths and injuries associated with floods). Other risks may arise because of the changing dynamics of disease vectors (such as malaria and dengue fever), the seasonality and incidence of various food-related and waterborne infections, the yields of crops, the range of plant and livestock, pests and pathogens, the salination of coastal lands and freshwater supplies resulting from rising sea-levels, the climatically related production of photochemical air pollutants, and the risk of conflict over depleted natural resources. Effects of climate change on human health can be mediated through complex physical, ecological, and social factors. These effects will undoubtedly have a more significant impact on societies or individuals with scarce resources, where technologies are lacking, and where infrastructure and institutions (such as the health sector) are least able to adapt. For this reason, a better understanding of the role of socio-economic and technological factors in shaping and mitigating these impacts is essential. Because of this complexity, current estimates of climate change's potential health impacts are based on

models with considerable uncertainty. Besides, the spores, pollens, allergens produced by cats and dogs and dust mites may pose health risks to human beings.

Hence, we, in our survey, included queries related to climate changes in Panvel City. And we found that people in Panvel are well-informed about climate changes that are taking place in the recent period.

We asked people whether there has been a significant increase in temperature in the city. They have given the following responses.

Figure 9 People's Response to query, whether the temperature in recent years is increased significantly?

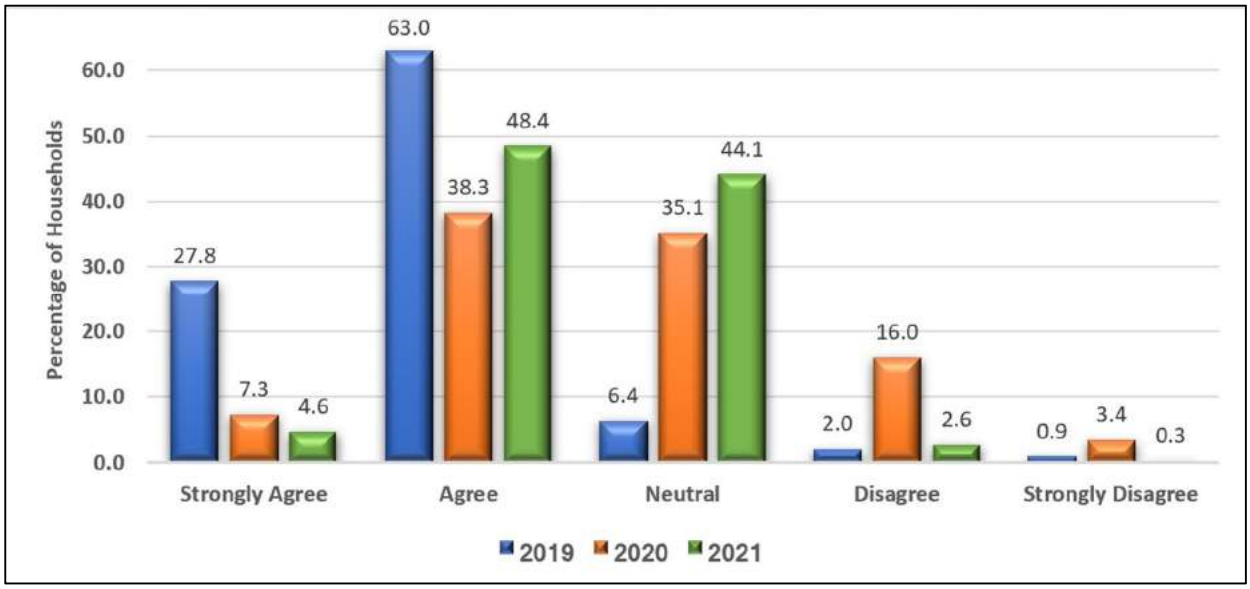


Source: Environmental Survey for Panvel, 2018-19, 2019-20 and 2021

It is observed that 92.4 (2018-19), 70.3 (2019-20) and 48.1 (2020-21) per cent of people in Panvel agreed that there had been a significant rise in temperature in recent years. The increased temperature caused an increase in Air Conditioners' use even in October and February to June. Increased temperature in the city also has caused a rise in electricity use to make the temperature cool.

We asked people whether rainfall in Panvel City in recent years has decreased significantly. They have given the following responses.

Figure 10 People's Response to query- whether rainfall in recent years has decreased significantly?



Source: Environmental Survey for Panvel, 2018-19, 2019-20 and 2020-21

It is observed that 90.8 (2018-19), 45.6 (2019-20) and 53 (2020-21) per cent of people agreed that there had been significant decline in rainfall in recent years in Panvel City. Though rainfall in the city does not imply concerns about agricultural imbalance, the rainfall in the region has implications for drinking water availability. In discussion with people, it is also found that variation in rainfall has increased compared to the last few years. Due to huge rainfall during July and August, water logging problems are observed in some of the areas in Panvel City.

The above discussion implies that there has been a change in climate in Panvel City in recent years.

4.3 Biodiversity Change

Biological diversity means the variability among living organisms from all sources, including inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes they are a part; this includes diversity within species, between species, and ecosystems. (Convention on Biodiversity, 1992)

The above definition is important because it draws our attention towards various dimensions of biodiversity and explicitly recognizes that every biota is characterized by its unique features like taxonomic, genetic diversity, and ecological. In this way, it helps us to look at various dimensions of biodiversity, giving rise to a new concept of multidimensional assessment of biodiversity. The idea of multivariate evaluation provides information about biodiversity and offers some insights into the relationship between changes in biodiversity and its resultant on the differences found

in ecosystem services. This throws a light on the ecosystem, which includes all the ecosystem that can be managed and unmanaged. The category of unmanaged ecosystems consists of parks, wildlands, or nature preserves, which is incorrect because these ecosystems are managed naturally. But Earth Biologists define managed ecosystems as the Earth's terrestrial area that can be cultivated and form its biodiversity. This kind of definition pays off the critical role of biodiversity and making it irrelevant.

Importance of biodiversity

"At least 40 per cent of the world's economy and 80 per cent of the poor's needs are derived from biological resources. Besides, the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive responses to such new challenges as climate change." (Convention on Biodiversity)

Biodiversity plays an essential role in boosting the productivity of the ecosystem, no matter what the size of the species is. It possesses the same importance as the other large one. For example, several plant species found in the environment mean a large variety of crops to found. This results in a more significant amount of species diversity to ensure the natural sustainability of all life forms living on Earth. Besides, healthy biodiversity also provides several

ecosystems natural services like water resources protection, breakdown and pollution absorption, recovery and maintenance of unpredictable events and ecosystems.

Moreover, it also provides some social benefits like cultural values, tourism and research scope, education, and recreation monitoring features of nature. There are many services that we get it for free by nature. Hence, paying for these services can be quite expensive; taking care of the resource and preventing them from getting extinct is a must.

The Millennium Ecosystem Assessment in 2005 was the first global effort to examine links between human well-being and biodiversity. The assessment found benefits to societies from biodiversity in material welfare, the security of communities, resilience of local economies, relations among groups in cities, and human health. It also emphasized the term 'ecosystem services' under four broad categories (Morton and Hill, 2014):

- provisioning services—the production of food, fiber, and water
- regulating services—the control of climate and diseases
- supporting services—nutrient cycling and crop pollination
- social services—such as spiritual and recreational benefits.

4.3.1 Ecological stability

Biodiversity is the term that is used to describe all kinds of biological diversity for a variety of different scales. Each array of species performs a function within an ecosystem. Some of the roles are they capture and store energy, produce organic material, decompose organic material, help water cycle process and nutrients throughout the ecosystem, control erosion or pests, fix atmospheric gases and regulating the natural climate. Moreover, ecosystems provide support to the production of new species and natural services without which humans could not survive. These services include soil fertility, plant pollinators, predators, waste decomposition, air & water purification, moderation of the climate, control on natural calamities, and other environmental disasters.

The recent research reports show that the more diverse an ecosystem becomes, the better it will withstand environmental stress and result in more productivity. This, in turn, will help reduce the loss of species and maintain the ability of the system to recover instead of damage due to species extinction. Many complex mechanisms are underlying these ecological effects, but the current concern is maintaining the stability between the native species and human-managed ecosystems given in the myriad of global changes. Stability is principally defined as a stable system with a low variability despite environmental changes, often termed as the system's resistance. But strength is somewhat a different aspect. It indicates the ability of an ecosystem to return to its original state after a disturbance or perturbation.

Theoretical models suggest that there could be multiple relationships between diversity and stability, depending on how we define stability (Ives and Carpenter, 2007). Stability is represented at the ecosystem level-for example, a rancher might be interested in the ability of a grassland ecosystem to maintain primary production for cattle forage across several years that may vary in their average temperature and precipitation. Biologically diverse communities are also more likely to contain species that confer resilience to that ecosystem because as a community accumulates species, there is a higher chance that anyone has traits that enable them to adapt to a changing environment. Such species could buffer the system against the loss of other species. Scientists have proposed the insurance hypothesis to explain this phenomenon (Yachi and Loreau, 1999).

In contrast, if stability is defined at the species level, then more diverse assemblages can have lower species-level stability. This is because there is a limit to the number of individuals that can be packed into a community, such that as the number of species in the city goes up, the average population sizes of the species in the community goes down. (Nature Education, 2011)

4.3.2 Economic benefits to humans

For living beings, biodiversity becomes a significant and first resource of their daily life. Agriculture, forestry and fisheries products, stable natural hydrological cycles, fertile soils, a stable climate, and numerous other vital ecosystem services depend upon the conservation of biological diversity. Such preservation of crop diversity is called agrobiodiversity. Food production relies on agrobiodiversity for a variety of food plants, pest control, nutrient provision, genetic diversity, and disease prevention. These include both medicinal plants and manufactured pharmaceuticals that rely on natural and human-managed biodiversity. Most people see biodiversity as a reservoir of resources to be drawn upon for the manufacture of food, pharmaceutical, and cosmetic products. Hence, resource shortages may be related to the erosion of biodiversity.

In comparison, the decreased biodiversity can lead to increased transmission of diseases to humans and increased healthcare costs. Thus, to maintain the level of tourists that come to see, biodiversity does the multi-billion-dollar fishing and hunting industry work. Some of the critical economic commodities that biodiversity supplies to humankind are:

- Food: Crops, livestock, forestry, and fish. Genetic diversity in food systems provides the foundation of crop development and food security and promotes resistance to environmental stresses. Therefore, loss of agricultural biodiversity can threaten the livelihood sustainability of our future security of food and nutrition. (COHAB)

- Medication: Wild plant species have been used for medicinal purposes since the beginning of recorded history. According to the National Cancer Institute of the USA, over 70 % of the promising anti-cancer drugs come from plants in the tropical rainforests. The animal may also play a role, in particular for research. It is estimated that from 2,50,000 known plant species, only 5,000 have been researched and are known for the possible use of medical applications. (COHAB)

- Industry: Fibers for clothing, wood for shelter, and warmth. Biodiversity may be a source of energy (such as biomass). Other industrial products are oils, lubricants, perfumes, fragrances, dyes, paper, waxes, rubber, latexes, resins, poisons, and cork can all be derived from various plant species. Supplies of animal origin are wool, silk, fur, leather, lubricants, waxes. Animals may also be used as a mode of transportation. (COHAB)

- Tourism & Recreation: Biodiversity is a source of economic wealth for many areas, such as many parks and forests, where wild nature and animals are a source of beauty and joy for many people. Ecotourism is a growing outdoor recreational activity. (COHAB)

4.3.3 Ethical Reasons

Biodiversity is the most precious gift of nature humankind blessed. As all the organisms in an ecosystem are interlinked and interdependent, the value of biodiversity in the life of all the organisms, including humans is enormous (Mondal). The role of biodiversity is to mirror our relationships with the other living species, an ethical view with rights, duties, and education. If humans consider species have a right to exist, they cannot cause their extinction voluntarily. Besides, biodiversity is also part of many cultures' spiritual heritage.

4.3.4 Urban Biodiversity

Urban biodiversity refers to the variety and variability among living organisms found in a city and the ecological systems they occur. Overall, urban biodiversity responds to a combination of

biogeographic and anthropogenic factors, with a strong influence of the latter. In a rapidly urbanizing world under the pressing threat of climate change, there is a growing interest in understanding how cities benefit from local biodiversity and how these benefits can be under threat due to climate change (Puppim de Oliveira, Doll, Moreno-Peñaranda and Balaban, 2014)

How urban biodiversity is helpful for human beings. Human survival is dependent on biodiversity, that is, the diverse range of organisms inhabiting the planet. This is because they affect ecosystem processes and functions, and therefore, ecosystem services. The drivers and feedback mechanisms between biodiversity and ecosystem services are involved, non-linear, and synergistic, but species diversity can affect ecosystem processes and services. Ecosystem services are the benefits that humans derive, either directly or indirectly, from the functions of ecosystems (Zari, 2015)

4.3.5 The Impact of Cities on Biodiversity

This is another factor that helps in determining the effects of the developed towns on biodiversity. Urban areas have profoundly transformed their landscape and rapid human-caused changes. Human health can be improved by municipal ecosystem services such as reducing air pollution, exposure to natural environments, psychological benefits of exposure to urban green space, increase in greater biodiversity, etc. Although there may be human health benefits from exposure to any urban green spaces, the ability of the public to perceive any benefit from species richness suggests that the protection or creation of biologically diverse urban environments is essential. When planning urban green space for human health benefits, access becomes critical. There is a need to consider how people

will travel to the site. Walking access is ideal, although the provision of green spaces within walking distance would require many small green spaces throughout the city instead of a smaller number of large areas. Beyond the immediate benefits to human health, broader conservation goals can be served by creating or encouraging high-quality interactions between people and the natural world. Improving social well-being might be a by-product of successful conservation in urban areas, but this effect can, in turn, catalyze people to be more supportive of other efforts at biodiversity conservation. The critical anthropogenic drivers of biodiversity change are:

- Land-use and land coverage
- Climate change
- Nitrogen deposition and acid rain
- Introduction of biotic species in the ecosystems

4.3.6 The Impact of Biodiversity on People in Cities

Just as cities affect biodiversity, in the same way, biodiversity also impacts people in numerous ways. Biodiversity affects people in terms of climate change, resilience, and quality of the services provided by the ecosystem to the people for free. This can be explained as follows:

In the global efforts to conserve biodiversity, cities become a crucial player. Suppose the goal of urban design and urban planners is to create cities to support the well-being of the people. In that case, the support and regeneration of urban biodiversity must be kept in mind by policymakers to develop a highly sustainable and potentially regenerative metropolitan area. Thus, to progress with the above agenda, urban design concepts and methods enable cities to produce an ecosystem service that provides a higher volume and scope for sustainable development. For this, an ecosystem analysis method can be used to measure the impact and policy well-being of biodiversity.

4.3.7 Biodiversity in Panvel City

Panvel is a locality of the Konkan Division of Raigad District in the state of Maharashtra. The region is situated on the banks of the Gadhi River (Kalundre river) with coordinates 18.98°N 73.1°E and MSL 28 m. The place is by far the largest and most popular city in the Raigad district. It is the node of Navi Mumbai as it in the center. Environmentalists and some local citizens pointed out that the Gadhi river is in a sorry state due to sewage pipes getting dumped in the river. Local citizens of Panvel have urged the authorities to clean the river, but the situation of the river is the same and has been closed for solving traffic congestion space.

Panvel is located between Karjat Taluka of the metropolitan city, Navi Mumbai & Uran Taluka. Being the center of the node makes the city as edible vegetation at the outskirts. The whole area of Panvel comprises a small patch of forest, open grass, scrub, agriculture and plantations, freshwater wetlands, urban parks, gardens, or avenues. The adjoining river opens into a creek known as Panvel Creek. Panvel soil is rich in minerals, but the human-dominated localities in Panvel range from rural agro landscapes to core urban zones. In addition to this, the area has substantial numbers of estuarine habitats that harbour many mangrove species. Thus, Panvel comprises many habitats from highly human-dominated spaces to native, linked together in a dynamic matrix of heterogenic complexity. Besides this, the average annual temperature at Panvel is 27°C, and the average precipitation is 3267 mm. The average humidity level is 62 per cent.

We have observed animals, birds and trees in Panvel City to find out the ecosystem in the city. There have been different types of trees and plants in the city that constitute tree cover. We found animals and birds in the city that are also located in the region in the proximity.

Animals and Birds in Panvel City

The animals in Panvel City include a wide range of amphibians, reptiles, mammals, butterflies and birds. The increasing urbanization and changes in land use and land cover suggest that their existence is in danger.

Table 16 Birds in Panvel City

Sr.No.	Common Name	*Scientific name*	Sr.No.	Common Name	*Scientific name*
1	Purple Heron	*Ardea purpurea*	**100**	Indian Cuckoo	*Cuculus micropterus*
2	Little Grebe	*Tachybaptus ruficollis*	**101**	Common Barn-Owl	*Tyto alba*
3	Little Cormorant	*Phalacrocorax niger*	**102**	Spotted Owlet	*Athene brama*
4	Eastern Cattle Egret	*Bubulcus coromandus*	**103**	Indian Eagle-Owl	*Bubo bengalensis*
5	Intermediate Egret	*Egretta intermedia*	**104**	Indian Little Nightjar	*Caprimulgus asiaticus*
6	Great Egret	*Egretta alba*	**105**	Indian Jungle Nightjar	*Caprimulgus indicus*
7	Little Egret	*Egretta garzetta*	**106**	Little or House Swift	*Apus affinis*
8	Grey Heron	*Ardea cinerea*	**107**	Asian Palm Swift	*Cypsiurus balasiensis*
9	Indian Pond Heron	*Ardeola grayii*	**108**	Lesser Pied Kingfisher	*Ceryle rudis*
10	Western Reef Egret	*Egretta gularis*	**109**	White-breasted Kingfisher	*Halcyon smyrnensis*
11	Black-crowned Night-heron	*Nycticorax nycticorax*	**110**	Common Kingfisher	*Alcedo atthis*
12	Striated Heron	*Butorides striatus*	**111**	Blue-cheeked Bee-eater	*Merops persicus*
13	Black Bittern	*Dupetor flavicollis*	**112**	Green Bee-eater	*Merops orientalis*
14	Chestnut Bittern	*Ixobrychus cinnamomeus*	**113**	Blue-tailed Bee-eater	*Merops philippinus*
15	Painted Stork	*Mycteria leucocephala*	**114**	Indian Roller	*Coracias benghalensis*
16	Asian Openbill	*Anastomus oscitans*	**115**	Common Hoopoe	*Upupa epops*
17	Woolly-necked Stork	*Ciconia episcopus*	**116**	Indian Grey Hornbill	*Ocyceros birostris*

18	Oriental White Ibis	*Threskiornis melanocephalus*	**117**	Coppersmith Barbet	*Megalaima haemacephala*
19	Eurasian Spoonbill	*Platalea leucorodia*	**118**	Brown-headed Barbet	*Megalaima zeylonica*
20	Glossy Ibis	*Plegadis falcinellus*	**119**	Indian Pitta	*Pitta brachyura*
21	Indian Black Ibis	*Pseudibis papillosa*	**120**	Eurasian Wryneck	*Jynx torquilla*
22	Ruddy Shelduck	*Tadorna ferruginea*	**121**	Black-rumped woodpecker	*Dinopium benghalense*
23	Northern Pintail	*Anas acuta*	**122**	Yellow-crowned Woodpecker	*Dendrocopos mahrattensis*
24	Greylag Goose	*Anser anser*	**123**	Ashy-crowned Sparrowlark	*Eremopterix griseus*
25	Common Teal	*Anas crecca*	**124**	Rufous-tailed Lark	*Ammomanes phoenicura*
26	Spot-billed Duck	*Anas poecilorhyncha*	**125**	Malabar Lark	*Galerida malabarica*
27	Garganey	*Anas querquedula*	**126**	Citrine Wagtail	*Motacilla citreola*
28	Gadwall	*Anas Strepera*	**127**	Yellow Wagtail	*Motacilla fla*
29	Eurasian Wigeon	*Anas Penelope*	**128**	Grey Wagtail	*Motacilla cinerea*
30	Northern Shoveller	*Anas clypeata*	**129**	White Wagtail	*Motacilla alba*
31	Comb Duck	*Sarkidiornis melanotos*	**130**	Large Pied Wagtail	*Motacilla maderaspatensis*
32	Lesser Whistling-duck	*Dendrocygna javanica*	**131**	Tree Pipit	*Anthus trivialis*
33	Black-shouldered Kite	*Elanus caeruleus*	**132**	Paddyfield Pipit	*Anthus rufulus*
34	Black Kite	*Milvus migrans*	**133**	Wire-tailed Swallow	*Hirundo smithii*
35	Brahminy Kite	*Haliastur indus*	**134**	Barn Swallow	*Hirundo rustica*
36	Black-eared Kite	*Milvus milvus lineatus*	**135**	Common Woodshrike	*Tephrodornis pondicerianus*
37	Shikra	*Accipiter badius*	**136**	Ashy Woodswallow	*Artamus fuscus*
38	White-eyed Buzzard	*Butastur teesa*	**137**	Large Cuckooshrike	*Coracina macei*
39	Oriental Honeybuzzard	*Pernis ptylorhynchus*	**138**	Orange Minivet	*Pericrocotus flammeus*
40	Common Buzzard	*Buteo buteo*	**139**	Small Minivet	*Pericrocotus cinnamomeus*
41	Montagu's Harrier	*Circus pygargus*	**140**	Common Iora	*Aegithina tiphia*
42	Palid Harrier	*Circus macrourus*	**141**	Gold-fronted Chloropsis	*Chloropsis aurifrons*
43	Western Marsh Harrier	*Circus aeruginosus*	**142**	Red-vented Bulbul	*Pycnonotus cafer*
44	Crested Serpent-eagle	*Spilornis cheela*	**143**	Red-whiskered Bulbul	*Pycnonotus jocosus*

45	Short-toed Snake-eagle	*Circaetus gallicus*	**144**	White-eared Bulbul	*Pycnonotus leucotis*
46	Booted Eagle	*Hieraaetus pennatus*	**145**	Long-tailed Shrike	*Lanius schach*
47	Black Eagle	*Ictinaetus malayensis*	**146**	Southern Grey Shrike	*Lanius meridionalis*
48	Greater Spotted Eagle	*Aquila clanga*	**147**	Orange-headed Thrush	*Zoothera citrina*
49	Indian Spotted Eagle	*Aquila pomarina*	**148**	Jungle Babbler	*Turdoides striatus*
50	Common Kestrel	*Falco tinnunculus*	**149**	Yellow-eyed Babbler	*Chrysomma sinense*
51	Peregrine Falcon (Shaheen)	*Falco peregrinus perigrenator*	**150**	Puff-throated Babbler	*Pellorneum ruficeps*
52	Jungle Bush-quail	*Perdicula asiatica*	**151**	Oriental Magpie-robin	*Copsychus saularis*
53	Indian Peafowl	*Pavo cristatus*	**152**	Common Stonechat	*Saxicola torquatus*
54	Grey Francolin	*Francolinus pondicerianus*	**153**	Pied Bushchat	*Saxicola caprata*
55	Painted Francolin	*Francolinus pictus*	**154**	Isabelline Wheatear	*Oenanthe isabellina*
56	Barred Buttonquail	*Turnix suscitator*	**155**	Indian Robin	*Saxicoloides fulicatus*
57	White-breasted Waterhen	*Amaurornis phoenicurus*	**156**	White-rumped Shama	*Copsychus saularis*
58	Grey-headed Swamphen	*Porphyrio porphyrio*	**157**	Zitting Cisticola	*Cisticola juncidis*
59	Common Moorhen	*Gallinula chloropus*	**158**	Plain Prinia	*Prinia inornata*
60	Eurasian Coot	*Fulica atra*	**159**	Ashy Prinia	*Prinia socialis*
61	Slaty-breasted Rail	*Gallirallus striatus*	**160**	Grey-breasted Prinia	*Prinia hodgsonii*
62	Ruddy-breasted Crake	*Porzana fusca*	**161**	Clamorous Reed-warbler or Indian Great Reed-warbler	*Acrocephalus [stentoreus] bruniscens*
63	Brown Crake	*Porzana akool*	**162**	Common Tailorbird	*Orthotomus sutorius*
64	Bronze-winged Jacana	*Metopidius indicus*	**163**	Lesser Whitethroat	*Sylvia curruca*
65	Pheasant-tailed jacana	*Hydrophasianus chirurgus*	**164**	Red-breasted Flycatcher	*Ficedula parva*
66	Red-wattled Lapwing	*Vanellus Indicus*	**165**	Asian Brown Flycatcher	*Muscicapa dauurica*
67	Little Ringed Plover	*Charadrius dubius*	**166**	White-browed Fantail-flycatcher	*Rhipidura albicollis*
68	Watercock	*Gallicrex cinereal*	**167**	Indian Paradise Flycatcher	*Terpsiphone paradise*

69	Common Snipe	*Gallinago gallinago*	**168**	Tickell's Blue Flycatcher	*Cyornis tickelliae*
70	Greater Painted Snipe	*Rostratula benghalensis*	**169**	Black-naped Monarch	*Hypothymis azurea*
71	Common Redshank	*Tringa totanus*	**170**	Great Tit	*Parus major*
72	Wood Sandpiper	*Tringa glareola*	**171**	Thick-billed Flowerpecker	*Dicaeum agile*
73	Common Sandpiper	*Tringa hypoleucos*	**172**	Purple Sunbird	*Cinnyris asiatica*
74	Common Greenshank	*Tringa nebularia*	**173**	Purple-rumped Sunbird	*Leptocoma zeylonica*
75	Green Sandpiper	*Tringa ochropus*	**174**	Vigors' Sunbird	*Aethopyga vigorsii*
76	Marsh Sandpiper	*Tringa stagnatilis*	**175**	Indian Silverbill	*Euodice malabarica*
77	Black-tailed Godwit	*Limosa limosa*	**176**	Red Avadavat	*Amandava amandava*
78	Temminck's Stint	*Calidris temminckii*	**177**	Black-headed Munia	*Lonchura Malacca*
79	Little Stint	*Calidris minuta*	**178**	Scaly-breasted Munia	*Lonchura punctulata*
80	Black-winged Stilt	*Himantopus himantopus*	**179**	White-rumped Munia	*Lonchura striata*
81	Gull-billed Tern	*Gelochelidon nilotica*	**180**	Tricoloured Munia	*Lonchura malacca*
82	Caspian Tern	*Sterna caspia*	**181**	Common Rosefinch	*Carpodacus erythrinus*
83	Whiskered Tern	*Chlidonias hybridus*	**182**	House Sparrow	*Passer domesticus*
84	River Tern	*Sterna aurantia*	**183**	Baya Weaver	*Ploceus philippinus*
85	Brown-headed Gull	*Larus brunnicephalus*	**184**	Black-breasted Weaver	*Ploceus benghalensis*
86	Black-headed Gull	*Larus ridibundus*	**185**	Yellow-throated Sparrow	*Petronia xanthocollis*
87	Heuglin's Gull	*Larus heuglini*	**186**	Rosy Starling	*Sturnus roseus*
88	Rock Pigeon	*Columba livia*	**187**	Brahminy Starling	*Temenuchus pagodarum*
89	Yellow-footed Green-pigeon	*Treron phoenicoptera*	**188**	Chestnut-tailed Starling	*Temenuchus malabarica*
90	Laughing Dove	*Streptopelia senegalensis*	**189**	Asian Pied Starling	*Gracupica contra*
91	Eurasian Collared Dove	*Streptopelia decaocto*	**190**	Common Myna	*Acridotheres tristis*
92	Spotted Dove	*Streptopelia chinensis*	**191**	Jungle Myna	*Acridotheres fuscus*
93	Alexandrine Parakeet	*Psittacula krameria*	**192**	Eurasian Golden Oriole	*Oriolus oriolus*
94	Rose-ringed Parakeet	*Psittacula krameri*	**193**	Black-hooded Oriole	*Oriolus xanthornus*
95	Plum-headed Parakeet	*Psittacula cyanocephala*	**194**	Black Drongo	*Dicrurus macrocercus*

96	Asian Koel	*Eudynamys scolopaceus*	**195**	Ashy Drongo	*Dicrurus leucophaeus*
97	Greater Coucal	*Centropus sinensis*	**196**	House Crow	*Corvus splendens*
98	Common Hawk Cuckoo	*Hierococcyx varius*	**197**	Jungle Crow	*Corvus macrorhynchos*
99	Jacobin Cuckoo	*Clamator jacobinus*			

Source: www.indiabiodiversity.org

Table 17 Plants in Panvel City

Sr. No.	Common Name	*Scientific Name*	Sr. No.	Common Name	*Scientific Name*
1	Gunj	*Abrus precatorius*	**66**	Fire bush	*Hamelia patens*
2	Australian acacia	*Acacia auriculiformis*	**67**	Sontakka	*Hedychium coronarium*
3	Khair	*Acacia catechu*	**68**	Anantmol	*Hemidesmus indicus*
4	Babul	*Acacia nilotica*	**69**	Jaswand	*Hibiscus rosa-sinensis*
5	Cat Tail	*Acalypha hispida*	**70**	Chilbil/Vavla	*Holoptelea integrifolia*
6	Harit-manjari	*Acalypha indica*	**71**	Beach Spider Lily	*Hymenocallis littoralis*
7	Agada	*Achyranthes aspera*	**72**	Adulsa / Vasaka	*Justicia adhatoda*
8	Ratan Gunj	*Adenanthera pavonina*	**73**	Sausage Tree	*Kigelia Africana*
9	Adulsa	*Adhatoda vasica*	**74**	Jarul	*Lagerstroemia speciose*
10	Gorakh Chinch/Baobab	*Adonsonia digitate*	**75**	Common Lantana	*Lantana camara*
11	Bael	*Aegle marmelos*	**76**	Heena/Mehndi	*Lawsonia inermis*
12	Goat Weed	*Ageratum conyzoides*	**77**	Subabhul	*Leucaena leucocephala*
13	Shirish	*Albizia lebbeck*	**78**	Kavath	*Limonia acidissima*
14	Saptaparni /Devil Tree	*Alstonia scholaris*	**79**	Pan Lavang	*Ludwigia octovalvis*
15	Kaju	*Anacardiium occidentale*	**80**	Mahua	*Madhuca indica*
16	Sitaphal	*Annona squamosa*	**81**	Chikoo	*Manikara zapota*
17	Supari	*Areca catechu*	**82**	Pudina	*Mentha viridis*
18	Jackfruit	*Artocarpus heterophylla*	**83**	Karanj	*Millettia pinnata /Pongamia pinnata*
19	Shatavari	*Asparagus racemose*	**84**	Bakul	*Mimoseps elengi*

20	Bilimbi	*Averrhoa bilimbi*	**85**	Kadamb	*Mitragyana parviflora*
21	Kadu Neem	*Azadirachta indica*	**86**	Noni	*Morinda citrifolia*
22	Bamboo	*Bambusa arundinaceae*	**87**	Mulberry	*Morus alba*
23	Butterfly Flower	*Bauhinia monandra*	**88**	Khaj Khujali	*Mucuna pruriens*
24	Apta	*Bauhinia racemose*	**89**	Kaddipatta	*Murraya koenigii*
25	Bogainviliea	*Bogainvillea spectabilis*	**90**	Mussaenda	*Mussaenda erythrophylla*
26	Kante Savar	*Bombax ceiba*	**91**	Kanher	*Nerium indicum*
27	Tad	*Borassua flbellifer*	**92**	Parijat	*Nyctanthes arbor-tristis*
28	Palash	*Butea monosperma*	**93**	Tulsi	*Ocimum sanctum*
29	Bottle Brush	*Callistemon lanceolatus*	**94**	Kevda	*Pandanus odorattismus*
30	Rui	*Calotropis gigantea*	**95**	Copper pod, Rusty shield bearer	*Peltophorum pterocarpum*
31	Indian Shot	*Canna indica*	**96**	Avala	*Phyllanthes embelica*
32	Karvand	*Carissa carandas*	**97**	Rai Avla	*Phyllanthus acidus*
33	Fish Tail Palm	*Caryota urens*	**98**	Jungli jalebi	*Pithacellobium dulce*
34	Candle Cassia	*Cassia alata*	**99**	Champa tree	*Plumera rubra*
35	Amaltas	*Cassia fistula*	**100**	Frangipani /Champa	*Plumeria*
36	Takla	*Cassia tora*	**101**	Pandhara Champa	*Plumeria pudica*
37	Sadaphuli	*Catharanthus roseus*	**102**	Asopalav	*Polyalthia longifolia*
38	White Silk Cotton, Kapok	*Ceiba pentandra*	**103**	Madhumalati	*Quisqualis indica*
39	Brahmi	*Centella asiatica*	**104**	Traveller's Palm	*Ravenala madagascariensis*
40	Tendli	*Coccinia grandis*	**105**	Castor	*Ricinus communis*
41	Coconut	*Cocos nucifera*	**106**	Royal Palm	*Roystonea regia*
42	Pan Ova	*Coleus aromaticus*	**107**	Rain Tree	*Samanea saman*
43	Bhokar	*Cordia dichotoma*	**108**	Sita Ashok	*Saraca asoca*
44	Kailaspati	*Couraupita guienensis*	**109**	Kusum	*Scheichera oleosa*
45	Khulkhula	*Crotalaria retusa*	**110**	Mahabala	*Sida cordifolia*
46	Kali Musali	*Curculigo orchioides*	**111**	Pichkari	*Spathodea campanulate*

47	Amarvel/Dodder	*Cuscuta reflexa*	**112**	True Mahogani	*Swietenia mahagoni*
48	Umbrella Plant	*Cyperus alternifolius*	**113**	White jamun	*Syzigium jambos*
49	Shisham / Indian rosewood	*Dalbergia sissoo*	**114**	Jamboo	*Syzygium cumini*
50	Datura	*Datura inoxia*	**115**	Tagar	*Tabernaemontana coronaria*
51	Gulmohar	*Delonix regia*	**116**	Marigold	*Tagetes patula*
52	Shend vel	*Dioscoria pentaphylla*	**117**	Imli	*Tamarindus indica*
53	Draceana	*Draceana sp.*	**118**	Sag / Teak	*Tectona grandis*
54	Maka / Bhringaraj	*Eclipta prostrata*	**119**	Arjun	*Terminalia arjun*
55	Pangara /Indian Coral Tree	*Erythrina variegate /Erythrina indica*	**120**	Deshi Badam	*Terminalia catappa*
56	Christamas Plant	*Euphorbia pulcherrima*	**121**	Bhendi	*Thespesia populnea*
57	Wad, Banyan	*Ficus bengalensis*	**122**	Thuja/Morpankh	*Thuja orientalis*
58	Pukar	*Ficus Benjamin*	**123**	Gulvel	*Tinosperma cordifolia*
59	India rubber Tree	*Ficus elastica*	**124**	Nirgudi	*Vitex negundo*
60	Kala Umbar	*Ficus hispida*	**125**	Ashwagandha	*Withania somnifera*
61	Gular	*Ficus racemose*	**126**	Tamda Kuda	*Writia tomentosa*
62	Peepal	*Ficus religiosa*	**127**	Bor	*Ziziphus mauritiana*
63	Undirmar	*Gliricidia sepium*	**128**	Amba	*Mangifera Indica*
64	Kal-lavi	*Gloriosa superba*	**129**	Bitti	*Cascabela thevetia*
65	Dhaman	*Grevia tiliaefolia*			

Source: www.indiabiodiversity.org

Table 18 Butterflies in Panvel City

Sr. No	Common Name	*Scientific Name*
1	Gram Blue	*Euchrysops cnejus*
2	Tiny Grass Blue	*Zizula hylax*
3	Grass Jewel	*Chilades trochylus*
4	Red Pierrot	*Talicada nyseus*
5	Common Cerulean	*Jamides celeno*
6	Forget-me-not	*Catochrysops Strabo*
7	Dark Grass Blue	*Zizeeria karsandra*

8	Common Lineblue	*Prosotas nora*
9	Tailless Lineblue	*Prosotas dubiosa*
10	Pointed Cilliate Blue	*Anthene lycaenina*
11	Slate Flash	*Rapala manea*
12	Common Silverline	*Spindasis vulcanus*
13	Peacock Royal	*Tajuria cippus*
14	Apefly	*Spalgis epius*
15	Common Small Flat	*Sarangesa dasahara*
16	Grass Demon	*Udaspes folus*
17	Rice Swift	*Borbo cinnara*
18	Blank Swift	*Caltoris kumara*
19	Spotted Small Flat	*Sarangesa purendra*
20	Brown Awl	*Badamia exclamationis*
21	Common Baron	*Euthalia aconthea*
22	Gaudy Baron	*Euthalia lubentina*
23	Baronet	*Symphaedra nais*
24	Common Crow	*Euploea core*
25	Plain Tiger	*Danaus chrysippus*
26	Striped Tiger	*Danaus chrysippus*
27	Blue Tiger	*Tirumala limniace*
28	Glassy Tiger	*Parantica aglea*
29	Great Eggfly	*Hypolimnas bolina*
30	Danid Eggfly	*Hypolimnas misippus*
31	Blue Oakleaf	*Kallima horsfieldi*
32	Common Eveningbrown	*Kallima horsfieldi*
33	Common Bushbrown	*Mycalesis perseus*
34	Chocolate Pansy	*Junonia iphita*
35	Peacock Pasy	*Junonia almanac*
36	Blue Pansy	*Junonia orithya*
37	Commander	*Moduza Procris*
38	Tawny Rajah	*Charaxes Bernardus*
39	Black Rajah	*Charaxes solon*
40	Common Nawab	*Polyura athamas*
41	Common Sailor	*Neptis hylas*
42	Short-banded Sailor	*Neptis hylas*
43	Tawny Coster	*Acraea terpsicore*

44	Common Leopard	*Phalanta phalantha*
45	Lemon Pansy	*Junonia lemonias*
46	Common Jezebel	*Delias eucharis*
47	Indian Wanderer	*Pareronia hippie*
48	Common Mormon	*Papilio polytes*
49	Blue Mormon	*Papilio polymnestor*
50	Common Rose	*Pachliopta aristolochiae*
51	Crimson Rose	*Pachliopta hector*
52	Lime Swallowtail	*Papilio demoleus*
53	Spot Swordtail	*Graphium nomius*
54	Tailed Jay	*Graphium agamemnon*
55	Common Jay	*Graphium doson*
56	Common Bluebottle	*Graphium Sarpedon*
57	Psyche	*Leptosia nina*
58	Common Grass Yellow	*Eurema hecabe*
59	Small Saloman Arab	*Colotis amata*
60	Common Emigrant	*Catopsilia Pomona*
61	Mottled Emigrant	*Catopsilia pyranthe*
62	Common Gull	*Cepora Nerissa*
63	Suffused Double-banded Judy	*Abisara bifasciata*

Source: www.indiabiodiversity.org

Table 19 Snakes in Panvel City

Sr.No	Common Name	*Scientific Name*
1	Indian Spectacled Cobra	*Naja naja*
2	Russell's Viper	*Daboia russelii*
3	Saw-scaled Viper	*Echis crinatus*
4	Common Krait	*Bungarus caeruleus*
5	Checkered Keelback	*Xenochrophis piscator*
6	Buff-striped Keelback	*Amphiesma stolatum*
7	Rat Snake	*Ptyas mucosa*
8	Common Wolf Snake	*Lycodon aulicus*
9	Travancore Wolf Snake	*Lycodon travancoricus*
10	Common Vine Snake	*Ahaetulla nasuta*
11	Common Cat Snake	*Boiga trigonata*
12	Indian Rock Python	*Python molurus*
13	Common Sand Boa	*Eryx conicus*
14	Red Sand Boa	*Eryx jhonii*

15	Montane Trinket	*Coelognathus helena*
16	Green Keelback	*Macropisthodon pumbicolor*
17	Slender Coral Snake	*Calliophis melanurus*
18	Bamboo Pit Viper	*Trimeresurus gramineus*
19	Gunther's Racer	*Platyceps gracilis*

Source: www.indiabiodiversity.org

Table 20 Amphibians in Panvel City

Sr. No,	Common Name	*Scientific Name*
1	Common Indian Toad	*Duttaphrynus melanostictus*
2	Common Tree Frog	*Polypedates maculatus*
3	Fungoid Frog	*Hydrophylax bahuvistara*
4	Bush frog sps.	*Raorchestes sps.*
5	Indian Bullfrog	*Hoplobatrachus tigerinus*
6	Cricket frog	*Minervarya sps.*
7	Common Skittering Frog	*Euphlyctis cyanophlyctis*

Source: www.indiabiodiversity.org

4.4. Pollution, Degradation and/or Depletion of Air, Water, Minerals and Land

Human activities are causing the depletion of resources such as air, water and land. Aspirations of a higher standard of living require to achieve higher economic growth, which cannot be achieved without environmental degradation. There is a trade-off between economic growth and environmental degradation. Environmental degradation has become a “common concern” for humankind over the past few decades. Environmental degradation is the exhaustion of the world's natural resources such as land, air, water and soil (El-Haggar, 2010). Perhaps Grossman and Krueger (1991) argued that with the rise in per capita income, environmental degradation increases up to a level and later increases per capita income, leading to an improved environment, which is popularly known as Environmental Kuznets Curve. If no attempts to improve the environment are initiated, we may have any per capita income level, which will cause irreversible environmental degradation.

With the increasing environmental degradation, human health also gets affected by pollution. Human health is affected by various forms of pollution such as air, water and noise sourced from multiple economic activities such as power generation, transport, industrial activities, construction, agriculture and residential use of resources. The World Health Organisation (2012) estimated that 23 per cent (12.6 million people) of all deaths in the world were due to

environmental causes. UN Environment advocates that pollution constitutes a significant impediment to achieving health, well-being, prosperity and the sustainable development goal of "leaving no one behind". Hence pollution of any form impedes achieving sustainable development. The national goals are directing local governments to take initiatives to improve the environmental quality in urban regions. The following discussion spreads over to understand the levels of pollution such as air, water and noise pollution in Panvel City.

4.4.1 Air Pollution

Air pollution refers to the contamination of the air. Further pollution can be explained as a physical, biological or chemical alteration to the air in the atmosphere. Air pollution not only affects the health of human but also the animals and plants in urban space. There are two types of air pollution, indoor and outdoor air pollution in urban regions. Perhaps there are many reasons for air pollution: transportation, agriculture, industrial residual, mining, and indoor air pollution from fuel for cooking. WHO (2016) claims that around 9 lakh deaths were caused due to air pollution in India.

Krishna (2012) gives a list of pollutants that contribute largely to the deteriorating environment and clean air includes Sulphur Dioxide (SO2), Oxides of Nitrogen (as NO2), PM2.5, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/PM10). The term particulate matter (PM) is commonly used to represent the solid phase suspended matter in the atmosphere.

Particulate matter is the sum of all solid and liquid particles suspended in air, the contents of which may be organic and inorganic substances such as dust, pollen, smoke and liquid droplets. Mass and composition in urban environments tend to be divided into two principal groups: coarse particles and fine particles. The barrier between these two fractions of particles usually lies between 1 µm and 2.5 µm. However, the limit between coarse and fine particles is sometimes fixed by convention at 2.5 µm in aerodynamic diameter ($PM_{2.5}$) for measurement purposes. The smaller particles contain the secondarily formed aerosols (gas-to-particle conversion), combustion particles and re-condensed organic and metal vapours. The larger particles usually contain earth crust materials and fugitive dust from roads and industries. The fine fraction contains most of the acidity (hydrogen ion) and mutagenic activity of particulate matter, although in fog, some coarse acid droplets are also present (WHO, 2003).

The size of suspended particles in the atmosphere varies over four orders of magnitude, from a few nanometres to tens of micrometres. The largest particles, called the coarse fraction (or mode), are mechanically produced by the break-up of larger solid particles. These particles can include wind-blown dust from agricultural processes, uncovered soil, unpaved roads or mining operations. Traffic produces road dust and air turbulence that can stir up road dust. Near coasts, evaporation of sea spray can produce large particles. Pollen grains, mold spores, and plant and insect parts are all in this larger size range. The amount of energy required to break these particles into smaller sizes increases as the size decreases, which effectively establishes a lower limit to produce these coarse particles of approximately 1 µm. Smaller particles, called the fine fraction or mode, are largely formed from gases. The smallest particles, less than 0.1 µm, are formed by nucleation, condensation of low-vapour-pressure substances formed by high-temperature vaporization or by chemical reactions in the atmosphere to form new particles (nuclei). Four major classes of sources with equilibrium pressures low enough to form nuclei mode particles can yield particulate matter: heavy metals (vaporized during combustion), elemental carbon (from short C molecules generated by combustion), organic carbon and sulphates and nitrates. Particles in this nucleation range or mode grow by coagulation, that is, the combination of two or more particles to form a larger particle, or by condensation, that is, condensation of gas or vapour molecules on the surface of existing particles. Coagulation is most efficient for a large number of particles, and condensation is most efficient for large surface areas. Therefore, both coagulation and condensation efficiency decrease as particle size increases, which effectively produces an upper limit such that particles do not grow by these processes beyond approximately 1 µm. Thus, particles tend to “accumulate” between 0.1 and 1 µm, the so-called accumulation range (WHO, 2003).

Sub micrometre-sized particles can be produced by the condensation of metals or organic compounds that are vaporized in high-temperature combustion processes. They can also be produced by condensation of gases that have been converted in atmospheric reactions to low vapour-pressure substances. For example, sulphur dioxide is oxidized in the atmosphere to form sulphuric acid (H_2SO_4), which can be neutralized by NH_3 to form ammonium sulfate. Nitrogen dioxide (NO_2) is oxidized to nitric acid (HNO_3), which in turn can react with ammonia (NH_3) to form ammonium nitrate (NH_4NO_3). The particles produced by the intermediate reactions of gases in the atmosphere are called secondary particles. Secondary sulphate and nitrate particles are usually the dominant components of fine particles. Combustion of fossil fuels such as coal, oil

and petrol can produce coarse particles from the release of non-combustible materials, i.e. fly ash, fine particles from the condensation of materials vaporized during combustion, and secondary particles through the atmospheric reactions of sulphur oxides and nitrogen oxides initially released as gases (WHO, 2003).

Putaud et al. (2003) describe that sulphate and organic matter are the two main contributors to the annual average PM_{10} and $PM_{2.5}$ mass concentrations, except at curbside sites where mineral dust (including trace elements) is also the main contributor to PM_{10}. On days when $PM_{10} > 50$ $\mu g/m^3$, nitrate also becomes the main contributor to PM_{10} and $PM_{2.5}$. Black carbon contributes 5–10% to $PM_{2.5}$ and somewhat less to PM_{10} at all sites, including the natural background sites. Its contribution increases to 15–20% at some of the curbside sites.

The Govt. of India prescribed National Ambient Air Quality in 2009 to curb air pollution. CPCB and MPCB have a network of stations to monitor air quality in the state of Maharashtra. MPCB monitors the air quality in Panvel City at three monitoring stations installed at Panvel Water Supply, opposite Central Bus Stand, Panvel, MIDC Common Facility Building, Taloja and Nimisha Hospital Sector 12, Kharghar. The air monitoring stations at Panvel and Kharghar monitors air quality in residential areas and the Taloja station monitors air quality in the industrial area. MPCB regularly monitors Sulphur Dioxide (SO2), Oxides of Nitrogen (as NO2), Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/PM10) with a frequency of two days a week. The air quality monitoring is undertaken continuously for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter).

CPCB prescribes the Air Quality Index (AQI) to understand the concentration of pollutants in a region. An AQI is useful for: (i) the general public to know the air quality in a simplified way, (ii) a politician to invoke quick actions, (iii) a decision-maker to know the trend of events and to chalk out corrective pollution control strategies, (iv) a government official to study the impact of regulatory actions, and (v) a scientist who engages in scientific research using air quality data (CPCB).

Central Pollution Control Board (CPCB) and the Ministry of Environment and Forests (MoEF) have initiated this project on National Air Quality Index to strengthen the air quality information dissemination system for larger public awareness and their participation in air quality management. An expert committee was constituted with members drawn from academia, medical fraternity, research institutes, MoEF, advocacy groups, SPCBs and CPCB. The committee

was mandated to deliberate, discuss and devise consensus on the AQI system that is appropriate for Indian conditions. The technical study was assigned to IIT Kanpur on a grant-in-aid basis. The report stated that the AQI developed in the study is based on human exposure and health effects and may not be strictly applicable to ecologically sensitive areas (CPCB).

Primarily two steps are involved in formulating an AQI: (i) formation of sub-indices (for each pollutant) and (ii) aggregation of sub-indices to get an overall AQI.

Sub-indices (Step 1):

The general equation for the sub-index (I_i) for a given pollutant concentration (C_P); as based on 'linear segmented principle' is calculated as:

$$I_i = \left(\frac{I_{HI} - I_{LO}}{B_{HI} - B_{LO}}\right) \times (C_P - B_{LO}) + I_{LO}$$

where,

B_{HI} = Breakpoint concentration greater or equal to given concentration.

B_{LO} =Breakpoint concentration smaller or equal to given concentration.

I_{HI} =AQI value corresponding to B_{HI}

I_{LO} = AQI value corresponding to B_{LO}

C_P = Pollutant concentration

Aggregation of Sub-indices (Step 2):

For the AQI, a maximum operator system is selected:

$$AQI = Max(I_1, I_2, I_3, \dots, I_n)$$

There are two reasons for adopting a maximum operator function: 1) Free from eclipsing and ambiguity (Ott 1978) and 2) Health effects of the combination of pollutants (synergistic effects) are not known and thus, a health-based index cannot be combined or weighted.

The AQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as follows:

Table 21 AQI Category, Pollutants and Health Breakpoints

AQI Category (Range)	PM_{10} (24hr)	$PM_{2.5}$ (24hr)	NO_2 (24hr)	O_3 (8hr)	CO (8hr)	SO_2 (24hr)	NH_3 (24hr)	Pb (24hr)
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5-1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

**One hourly monitoring (for mathematical calculations only)*

Source: CPCB, Ministry for Environment, Forests & Climate Change, Govt. of India

The health impacts that are associated with AQI are discussed in the following table.

Table 22 Health Statements for AQI categories

Good (0-50)	Minimal Impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101-200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease.
Very poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

Source: CPCB, Ministry for Environment, Forests & Climate Change, Govt. of India

We received observations for Panvel City, Kharghar Taloja monitoring for 2018-19 and 2019-20. MPCB computed Air Quality Index (AQI) as per the given methodology by CPCB for all stations for all observations, which is provided for all three monitoring stations. For Panvel City, the AQI is found for almost the same days in 2018-19 and 2019-20 in every month. But at Taloja and Khaghar air quality monitoring stations, the sample days in each months are found to be more or less different in 2019-20 compare to 2018-19. We found that the data, though not comparable for any of the AQI monitoring stations, broadly provides the AQI for sample days each month.

Table 23 Air Quality Index for Residential Areas in Panvel City for 2018-19

No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3	µg/m3	
Standards		80	80	100	---	
April 2018						
1	04-04-2018	24	62	73	131	78
2	07-04-2018	24	71	77	146	89
3	11-04-2018	25	61	89	169	89
4	14-04-2018	23	56	100	185	
5	18-04-2018	22	57	75	140	75
6	21-04-2018	23	64	83	155	83
7	25-04-2018	27	62	108	206	105
8	28-04-2018	25	66	82	155	83
May 2018						
9	02-05-2018	22	44	80	151	80
10	05-05-2018	17	50	81	151	81
11	09-05-2018	22	44	100	188	
12	12-05-2018	17	56	64	116	70
13	16-05-2018	24	49	96	178	96
14	19-05-2018	20	50	104	197	103
15	23-05-2018	24	55	81	152	81
16	26-05-2018	20	60	88	144	88
17	30-05-2018	21	56	104	197	103
June 2018						
18	02-06-2018	19	57	77	142	77
19	05-06-2018	17	50	84	160	84
20	09-06-2018	20	52	85	160	85
21	13-06-2018	19	53	107	203	105
22	16-06-2018	17	49	83	153	83
23	20-06-2018	19	62	58	105	78
24	23-06-2018	23	52	66	122	66
25	27-06-2018	16	60	79	147	79
26	30-06-2018	17	58	93	176	93
July 2018						
27	04-07-2018	14	44	46	80	55

28	07-07-2018	16	44	83	155	83
29	11-07-2018	16	51	44	77	64
30	14-07-2018	12	48	46	83	60
31	18-07-2018	12	57	43	77	71
32	21-07-2018	16	42	41	72	53
33	25-07-2018	16	51	50	89	64
34	28-07-2018	18	60	55	100	75
August 2018						
35	01-08-2018	18	36	37	66	45
36	04-08-2018	17	39	38	63	49
37	08-08-2018	16	37	36	63	46
38	11-08-2018	16	36	44	77	45
39	18-08-2018	13	36	45	78	45
40	22-08-2018	15	41	39	70	51
41	25-08-2018	14	39	43	78	49
42	29-08-2018	15	42	31	56	53
September 2018						
43	01-09-2018	24	45	44	80	56
44	05-09-2018	22	47	39	71	59
45	08-09-2018	23	46	30	52	58
46	12-09-2018	21	50	61	111	63
47	15-09-2018	24	47	47	118	59
48	19-09-2018	21	47	47	85	59
49	22-09-2018	22	47	37	64	59
50	26-09-2018	23	46	38	67	58
51	29-09-2018	23	45	47	85	56
October 2018						
52	03-10-2018	19	42	65	119	65
53	06-10-2018	22	44	69	126	69
54	10-10-2018	20	46	56	99	58
55	13-10-2018	22	43	59	109	59
56	17-10-2018	17	45	68	122	68
57	20-10-2018	19	45	63	114	63
58	24-10-2018	20	55	55	96	69
59	27-10-2018	21	45	51	84	56
60	31-10-2018	22	51	70	128	70
November 2018						
61	03-11-2018	14	40	61	112	61
62	07-11-2018	18	49	68	124	68
63	10-11-2018	17	43	55	105	55
64	14-11-2018	19	45	46	86	56
65	17-11-2018	19	40	50	90	
66	21-11-2018	17	40	43	77	
67	24-11-2018	20	46	50	93	58
68	28-11-2018	17	41	54	98	54
December 2018						
69	01-12-2018	18	44	52	92	55

70	05-12-2018	19	42	52	96	53
71	08-12-2018	18	43	68	125	68
72	12-12-2018	17	39	53	93	53
73	15-12-2018	24	47	47	118	59
74	19-12-2018	16	38	61	111	61
75	22-12-2018	18	43	61	109	61
76	26-12-2018	19	41	63	117	63
77	29-12-2018	16	42	50	89	53
January 2019						
78	02-01-2019	17	55	69	129	69
79	05-01-2019	19	51	66	118	66
80	09-01-2019	18	55	55	95	69
81	12-01-2019	16	56	54	101	70
82	16-01-2019	24	47	47	118	59
83	19-01-2019	19	56	53	96	70
84	23-01-2019	18	57	48	87	71
85	30-01-2019	18	56	74	74	74
February 2019						
86	02-02-2019	17	46	38	69	58
87	06-02-2019	16	44	44	83	55
88	09-02-2019	19	49	47	81	61
89	13-02-2019	18	45	45	79	56
90	16-02-2019	24	47	47	118	59
91	20-02-2019	15	44	47	87	55
92	23-02-2019	18	44	44	77	55
93	27-02-2019	17	46	49	77	58
March 2019						
94	02-03-2019	22	52	59	106	65
95	06-03-2019	18	46	43	79	58
96	09-03-2019	21	59	41	75	74
97	13-03-2019	23	53	55	97	66
98	16-03-2019	24	47	47	118	59
99	20-03-2019	21	64	47	86	80
100	23-03-2019	20	53	61	111	66
101	27-03-2019	22	57	59	108	71
102	30-03-2019	21	47	40	74	59

Source: MPCB, 2018-19

Table 24 Air Quality Index for Residential Areas in Panvel City for 2019-20

No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3	µg/m3	
Standards		**80**	**80**	**100**	**---**	
April 2019						
1	03-04-2019	18	59	40	70	74
2	06-04-2019	21	62	60	101	78
3	10-04-2019	22	67	64	115	84

4	13-04-2019	20	57	53	94	71
5	17-04-2019	24	47	47	118	59
6	20-04-2019	20	64	64	115	80
7	24-04-2019	20	64	49	90	80
8	27-04-2019	19	68	70	125	85
June 2019						
9	01-06-2019	19	55	54	99	69
10	05-06-2019	18	51	63	116	64
11	08-06-2019	18	53	47	84	66
12	12-06-2019	19	53	58	105	66
13	15-06-2019	17	50	47	84	63
14	19-06-2019	20	63	52	93	79
15	22-06-2019	23	54	53	95	68
16	26-06-2019	19	62	50	88	78
17	29-06-2019	17	47	56	101	59
July 2019						
18	03-07-2019	14	49	60	107	61
19	06-07-2019	15	49	55	95	61
20	10-07-2019	16	53	50	86	66
21	13-07-2019	15	52	54	96	65
22	17-07-2019	15	56	59	104	70
23	20-07-2019	14	46	50	88	58
24	24-07-2019	15	51	59	105	64
25	27-07-2019	20	57	54	95	71
26	31-07-2019	14	52	63	114	65
August 2019						
27	03-08-2019	14	43	53	95	54
28	07-08-2019	16	42	66	119	66
29	10-08-2019	15	41	57	103	57
30	14-08-2019	14	42	62	111	62
31	17-08-2019	15	56	52	96	70
32	21-08-2019	15	41	57	100	57
33	24-08-2019	13	42	63	114	63
34	28-08-2019	14	57	54	94	71
35	31-08-2019	14	42	65	118	65
September 2019						
36	04-09-2019	15	41	56	99	56
37	07-09-2019	18	47	50	87	59
38	11-09-2019	18	49	51	87	61
39	14-09-2019	16	42	47	82	53
40	18-09-2019	24	47	47	85	59
41	21-09-2019	19	49	49	86	61
42	25-09-2019	18	46	48	70	58
43	28-09-2019	21	50	56	98	63
October 2019						
44	02-10-2019	18	43	54	95	54
45	05-10-2019	12	46	48	84	58

46	09-10-2019	17	45	59	104	59
47	12-10-2019	17	42	61	111	61
48	16-10-2019	15	47	63	114	63
49	19-10-2019	18	51	63	112	64
50	23-10-2019	17	46	63	108	63
51	26-10-2019	15	47	64	113	64
52	30-10-2019	20	49	59	103	61
December 2019						
53	04-12-2019	15	42	44	77	53
54	07-12-2019	14	41	45	73	51
55	11-12-2019	14	42	43	70	53
56	14-12-2019	13	40	46	80	
57	18-12-2019	15	38	50	85	
58	21-12-2019	12	38	44	74	48
59	25-12-2019	14	39	45	78	49
60	28-12-2019	15	42	43	74	53
February 2020						
61	01-02-2020	18	36	46	79	46
62	05-02-2020	17	40	48	83	
63	08-02-2020	13	35	48	82	48
64	12-02-2020	14	36	45	77	45
65	15-02-2020	13	47	47	76	59
66	19-02-2020	13	40	48	81	
67	22-02-2020	13	43	49	84	54
68	26-02-2020	16	41	49	80	51
69	29-02-2020	14	46	47	79	58
March 2020						
70	04-03-2020	12	45	48	84	56
71	07-03-2020	13	40	48	84	
72	11-03-2020	14	42	45	79	53
73	14-03-2020	13	47	43	74	59
74	18-03-2020	13	47	47	71	59
75	21-03-2020	14	38	45	77	48

Source: MPCB, 2019-20

Table 25 Air Quality Index for Residential Areas in Panvel City for 2020-21

Sr.No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3		
Standards		**80**	**80**	**100**		
May-20						
1	20-05-2020	7	15	32	55	32
2	23-05-2020	6	15	34	55	34
3	27-05-2020	6	15	33	53	33
4	30-05-2020	7	17	32	53	32
Jun-20						

5	06-06-2020	11	35	41	84	44
6	10-06-2020	11	45	42	79	56
7	13-06-2020	12	43	42	74	54
8	17-06-2020	13	47	42	71	59
9	20-06-2020	11	38	45	77	48
10	24-06-2020	14	45	43	73	56
11	27-06-2020	15	42	43	72	53
Jul-20						
12	01-07-2020	11	40	42	68	50
13	04-07-2020	11	34	42	58	43
14	08-07-2020	12	37	42	64	46
15	11-07-2020	12	36	41	66	45
16	15-07-2020	13	47	43	67	59
17	18-07-2020	11	38	41	64	48
18	22-07-2020	14	45	40	67	56
19	25-07-2020	12	42	42	66	53
20	29-07-2020	11	32	42	64	42
Aug-20						
21	01-08-2020	12	34	40	61	43
22	08-08-2020	11	41	40	58	51
23	12-08-2020	14	40	40	57	50
24	19-08-2020	15	37	39	65	46
25	22-08-2020	12	39	40	67	49
26	26-08-2020	13	39	39	66	49
Sep-20						
27	02-09-2020	13	39	45	64	49
28	05-09-2020	12	35	42	69	44
29	09-09-2020	13	35	45	64	45
30	12-09-2020	12	36	42	64	45
31	16-09-2020	13	47	44	64	59
32	19-09-2020	12	37	44	66	46
33	26-09-2020	13	38	40	68	48
34	30-09-2020	12	46	44	60	58
Oct-20						
35	03-10-2020	13	43	49	64	54
36	07-10-2020	13	35	53	65	53
37	10-10-2020	12	35	52	63	52
38	14-10-2020	14	42	55	67	55
39	17-10-2020	15	47	55	65	59
40	21-10-2020	14	45	55	72	56

41	24-10-2020	14	46	53	72	58
42	28-10-2020	15	44	57	70	57
43	31-10-2020	13	49	51	68	61
Nov-20						
44	04-11-2020	15	35	45	71	45
45	07-11-2020	13	35	46	78	46
46	11-11-2020	16	39	46	77	49
47	14-11-2020	14	40	48	77	50
48	18-11-2020	18	41	49	81	51
49	21-11-2020	19	40	44	73	50
50	25-11-2020	19	43	46	72	54
51	28-11-2020	14	44	46	73	55
Dec-20						
52	02-12-2020	14	45	50	78	56
53	05-12-2020	15	46	45	75	58
54	09-12-2020	14	45	48	75	56
55	12-12-2020	14	42	54	85	54
56	16-12-2020	15	47	56	85	59
57	19-12-2020	14	44	57	86	57
58	23-12-2020	13	46	57	81	58
59	26-12-2020	15	45	51	77	56
60	30-12-2020	14	44	58	83	58
Jan-21						
61	02-01-2021	16	47	56	80	59
62	06-01-2021	18	48	5	85	60
63	09-01-2021	17	45	57	84	57
64	13-01-2021	16	54	51	76	68
65	16-01-2021	18	49	59	81	61
66	20-01-2021	17	50	59	86	63
67	23-01-2021	18	46	54	83	58
68	27-01-2021	19	53	57	86	66
69	30-01-2021	18	47	54	81	59
Feb-21						
70	03-02-2021	14	35	54	79	54
71	06-02-2021	15	35	60	85	60
72	10-02-2021	17	36	56	84	56
73	13-02-2021	16	45	62	86	62
74	17-02-2021	18	34	55	79	55
75	20-02-2021	17	35	53	78	53
76	24-02-2021	16	38	59	88	59

77	27-02-2021	15	35	56	86	56
Mar-21						
78	03-03-2021	17	44	49	76	55
79	06-03-2021	16	42	52	83	53
80	10-03-2021	15	40	52	83	52
81	13-03-2021	15	44	56	80	56
82	17-03-2021	14	47	51	81	59
83	21-03-2021	16	41	57	88	57
84	24-03-2021	13	47	52	81	59
85	27-03-2021	15	40	45	76	50
86	31-03-2021	16	42	57	76	57

Source: MPCB, 2020-21

It is observed that AQI for only four days among all observation crossed the threshold prescribed by CPCB. AQIs that crossed the threshold are observed in April 2018 (103), May 2018 (103 and 103) and June 2018 (105). The highest AQI (105) is observed in the month of April and June 2018. All four observation that crossed the threshold lie in the moderately polluted (101 to 200) category. Perhaps, during 2019-20 the highest AQI was found to be 85 in the month of April 2019. The AQI across all the days during 2019-20 is found to be lower than that of 2018-19. We did not get AQI data for the month of May and November 2019 and January 2020 from MPCB. Very low AQIs are observed across all the days during April 2020 to March 2021, since a stringent lockdown was executed in the city as per the orders of the State Government and consequently, all the economic activities were operational at minimal levels except the emergency services and also the vehicles rarely were on the roads during the lockdowns in the main city. We did not get AQI data for the month of April 2020 from MPCB. The higher AQI than 100 indicates that the air quality may cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults in the Panvel City area near Central Bus Stand.

Table 26 Air Quality Index for Residential Areas in Kharghar for 2018-19

Sr. No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m³	µg/m³	µg/m³	µg/m³	
Standards		80	80	100	---	
April 2018						
1	03-04-2018	23	59	82	156	82
2	06-04-2018	23	66	78	142	83
3	10-04-2018	23	57	74	139	74
4	13-04-2018	24	66	125	238	117
5	17-04-2018	22	59	82	153	82
6	20-04-2018	21	65	109	204	106
7	24-04-2018	25	67	59	106	84
8	27-04-2018	24	62	56	105	78
May 2018						
9	01-05-2018	23	45	72	135	72
10	04-05-2018	17	48	68	127	68
11	08-05-2018	20	46	94	176	94
12	11-05-2018	19	56	86	161	86
13	15-05-2018	17	55	97	183	97
14	18-05-2018	23	53	100	188	100
15	22-05-2018	22	51	92	175	92
16	25-05-2018	17	61	71	132	76
17	29-05-2018	15	58	72	135	73
June 2018						
18	01-06-2018	19	36	71	133	71
19	05-06-2018	20	44	57	104	57
20	08-06-2018	17	38	72	136	72
21	12-06-2018	22	42	75	140	75
22	15-06-2018	19	36	81	154	81
23	26-06-2018	18	46	48	89	58
24	29-06-2018	21	34	55	100	55
July 2018						
25	03-07-2018	16	41	59	107	59
26	06-07-2018	19	43	61	114	61
27	10-07-2018	12	39	37	64	49
28	13-07-2018	14	41	50	93	51
29	17-07-2018	13	38	49	90	49
30	20-07-2018	14	44	48	86	55
31	24-07-2018	16	37	44	80	46
32	27-07-2018	14	44	42	75	55
33	31-07-2018	16	38	50	92	50
August 2018						
34	03-08-2018	17	38	34	60	48
35	07-08-2018	20	38	38	67	48
36	10-08-2018	18	39	43	77	49
37	14-08-2018	17	37	45	83	46

38	17-08-2018	14	39	42	76	**49**
39	21-08-2018	14	44	34	62	**55**
40	24-08-2018	16	37	42	72	**46**
41	28-08-2018	18	40	38	67	**38**
42	31-08-2018	17	39	43	74	**49**
September 2018						
43	04-09-2018	21	39	59	107	**59**
44	07-09-2018	21	40	58	104	**58**
45	11-09-2018	21	41	53	98	**53**
46	14-09-2018	21	43	56	98	**56**
47	18-09-2018	20	41	51	94	**51**
48	21-09-2018	14	44	61	113	**61**
49	25-09-2018	16	37	50	91	**50**
50	28-09-2018	20	44	52	98	**55**
October 2018						
51	02-10-2018	21	36	49	89	**49**
52	05-10-2018	22	36	71	130	**71**
53	09-10-2018	21	38	60	110	**60**
54	12-10-2018	19	41	61	113	**61**
55	16-10-2018	21	41	62	112	**62**
56	19-10-2018	14	44	53	95	**55**
57	23-10-2018	16	38	55	102	**55**
58	26-10-2018	22	39	44	93	**49**
59	30-10-2018	22	47	55	98	**59**
November 2018						
60	02-11-2018	18	42	56	100	**56**
61	06-11-2018	16	38	61	112	**61**
62	09-11-2018	19	46	66	118	**66**
63	13-11-2018	18	45	55	100	**56**
64	16-11-2018	19	41	56	105	**56**
65	20-11-2018	14	44	57	100	**57**
66	23-11-2018	16	37	51	91	**51**
67	27-11-2018	17	42	66	116	**66**
68	30-11-2018	17	43	58	106	**58**
December 2018						
69	04-12-2018	13	53	56	100	**66**
70	07-12-2018	15	15	56	100	**56**
71	11-12-2018	13	46	54	99	**58**
72	14-12-2018	14	45	77	143	**77**
73	18-12-2018	17	43	67	121	**67**
74	21-12-2018	14	44	66	122	**66**
75	25-12-2018	16	37	53	92	**53**
76	28-12-2018	15	46	41	72	**58**
January 2019						
77	01-01-2019	18	50	47	84	**63**
78	04-01-2019	16	56	57	99	**70**
79	08-01-2019	17	48	52	87	**60**

80	11-01-2019	19	50	63	114	**63**
81	15-01-2019	16	52	55	102	**65**
82	18-01-2019	14	44	47	68	**55**
83	22-01-2019	16	37	55	121	**55**
84	25-01-2019	17	57	52	92	**71**
85	29-01-2019	19	56	50	88	**70**
February 2019						
86	01-02-2019	18	49	32	57	**61**
87	05-02-2019	17	47	62	113	**62**
88	08-02-2019	18	53	53	94	**66**
89	12-02-2019	15	52	50	87	**65**
90	15-02-2019	14	46	55	94	**58**
91	19-02-2019	14	44	52	91	**55**
92	22-02-2019	16	37	47	85	**47**
93	26-02-2019	18	51	50	87	**64**
March 2019						
94	01-03-2019	17	46	54	99	**58**
95	05-03-2019	25	58	48	86	**73**
96	08-03-2019	23	55	49	87	**69**
97	12-03-2019	21	56	46	78	**70**
98	15-03-2019	22	57	56	102	**71**
99	19-03-2019	14	44	58	105	**58**
100	22-03-2019	16	37	53	93	**53**
101	26-03-2019	22	56	59	105	**70**
102	29-03-2019	22	60	54	95	**75**

Source: MPCB, 2018-19

Table 27 Air Quality Index for Residential Areas in Kharghar for 2019-20

Sr. No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3	µg/m3	
Standards		**80**	**80**	**100**	**---**	
April 2019						
1	02-04-2019	22	67	60	118	**84**
2	05-04-2019	24	66	49	85	**83**
3	09-04-2019	21	63	59	94	**79**
4	12-04-2019	21	59	59	108	**74**
5	16-04-2019	20	64	61	105	**80**
6	19-04-2019	14	44	59	96	**59**
7	23-04-2019	16	37	45	72	**46**
8	26-04-2019	20	72	74	144	**90**
9	30-04-2019	22	60	55	104	**75**
June 2019						
10	04-06-2019	20	39	39	69	**49**
11	07-06-2019	21	44	59	107	**59**
12	11-06-2019	18	39	47	84	**49**
13	14-06-2019	16	39	33	59	**49**

14	18-06-2019	18	46	42	75	58
15	21-06-2019	19	44	54	96	55
16	25-06-2019	16	37	60	109	60
17	28-06-2019	17	37	53	95	53
July 2019						
18	02-07-2019	14	46	52	95	58
19	05-07-2019	17	44	44	83	55
20	09-07-2019	13	41	46	79	51
21	12-07-2019	18	40	51	88	51
22	16-07-2019	14	51	51	90	64
23	19-07-2019	13	44	51	90	55
24	23-07-2019	16	37	49	87	49
25	26-07-2019	19	44	51	91	55
26	30-07-2019	15	43	55	96	55
August 2019						
27	02-08-2019	15	41	52	95	52
28	06-08-2019	13	41	44	83	51
29	09-08-2019	14	41	46	79	51
30	13-08-2019	15	42	51	112	53
31	16-08-2019	15	42	51	90	53
32	20-08-2019	13	44	51	114	55
33	23-08-2019	16	37	48	83	48
34	27-08-2019	14	45	51	94	56
35	30-08-2019	15	43	55	105	55
September 2019						
36	03-09-2019	15	33	57	102	57
37	06-09-2019	15	34	58	101	58
38	10-09-2019	19	37	38	85	46
39	13-09-2019	16	42	60	108	60
40	17-09-2019	18	47	64	115	64
41	20-09-2019	14	44	48	83	55
42	24-09-2019	16	37	60	102	60
43	27-09-2019	20	47	49	108	59
October 2019						
44	01-10-2019	18	34	57	102	57
45	04-10-2019	16	37	58	101	58
46	08-10-2019	19	39	38	85	49
47	11-10-2019	16	41	60	108	60
48	15-10-2019	18	47	64	115	64
49	18-10-2019	14	44	48	83	55
50	22-10-2019	18	37	60	94	60
51	25-10-2019	20	42	49	108	53
52	29-10-2019	20	68	53	99	85
December 2019						
53	03-12-2019	13	39	57	102	57
54	06-12-2019	13	43	58	101	58
55	10-12-2019	14	37	38	85	46

56	13-12-2019	13	42	60	108	60
57	17-12-2019	13	37	49	85	49
58	20-12-2019	14	44	44	76	55
59	24-12-2019	18	47	47	78	59
60	27-12-2019	13	43	49	108	54
61	31-12-2019	20	42	58	74	58
January 2019						
62	03-01-2020	16	59	63	101	74
63	07-01-2020	17	65	64	105	81
64	10-01-2020	21	60	64	112	75
65	14-01-2020	15	56	58	101	70
66	17-01-2020	15	56	60	105	70
67	21-01-2020	15	55	60	104	69
68	24-01-2020	15	54	61	108	68
69	28-01-2020	14	53	61	109	66
February 2019						
70	04-02-2020	14	33	50	82	
71	07-02-2020	15	30	58	83	58
72	11-02-2020	13	35	38	93	44
73	14-02-2020	17	34	47	78	47
74	18-02-2020	19	38	50	86	
75	21-02-2020	14	33	45	78	45
76	25-02-2020	16	41	44	75	51
77	28-02-2020	14	35	49	86	49
March 2019						
78	03-03-2020	14	44	50	82	55
79	06-03-2020	15	37	58	83	58
80	10-03-2020	14	42	38	93	53
81	13-03-2020	15	46	47	78	58
82	17-03-2020	15	42	50	86	53
83	20-03-2020	14	33	45	78	45

Source: MPCB, 2019-20

Table 28 Air Quality Index for Residential Areas in Kharghar for 2020-21

Sr.No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m$_3$	µg/m$_3$	µg/m$_3$	µg/m$_3$	
Standards		**80**	**80**	**100**	**---**	
May 2020						
1	19-05-2020	7	16	35	57	35
2	22-05-2020	8	17	33	54	33
3	26-05-2020	6	17	33	55	33
4	29-05-2020	7	17	32	52	32
June 2020						
5	02-06-2020	10	38	40	67	48
6	05-06-2020	11	39	41	68	49
7	09-06-2020	12	42	42	69	53

8	12-06-2020	11	46	44	78	58
9	23-06-2020	12	44	41	72	55
10	26-06-2020	12	46	43	73	58
11	30-06-2020	11	47	40	67	59
July 2020						
12	03-07-2020	12	34	40	67	43
13	07-07-2020	12	41	41	68	51
14	10-07-2020	BDL - 1	38	42	69	48
15	14-07-2020	10	46	43	65	58
16	17-07-2020	11	33	41	63	41
17	21-07-2020	12	46	45	66	58
18	24-07-2020	12	44	42	65	55
19	28-07-2020	12	46	42	62	58
20	31-07-2020	11	47	40	65	59
August 2020						
21	04-08-2020	12	38	40	67	48
22	07-08-2020	12	37	43	71	46
23	11-08-2020	11	39	46	79	49
24	14-08-2020	12	36	42	70	45
25	18-08-2020	11	41	42	72	51
26	21-08-2020	13	44	41	68	55
27	25-08-2020	16	37	42	69	46
28	28-08-2020	11	42	44	68	53
September 2020						
29	01-09-2020	13	37	45	73	46
30	04-09-2020	12	34	41	70	43
31	08-09-2020	13	38	42	71	48
32	11-09-2020	11	37	47	78	47
33	15-09-2020	12	35	41	65	44
34	18-09-2020	14	33	39	67	41
35	22-09-2020	16	38	38	65	48
36	25-09-2020	12	36	43	65	45
37	29-09-2020	13	39	44	68	49
October 2020						
38	02-10-2020	14	35	57	63	57
39	06-10-2020	13	35	58	65	58
40	13-10-2020	14	39	60	65	60
41	16-10-2020	13	44	64	71	64
42	20-10-2020	14	44	51	71	55
43	23-10-2020	18	56	52	69	70
44	27-10-2020	15	48	49	67	60
45	30-10-2020	20	65	53	64	81
November 2020						
46	03-11-2020	14	36	57	63	57
47	06-11-2020	17	36	58	65	58
48	10-11-2020	14	42	43	67	53
49	13-11-2020	13	45	44	78	56

50	17-11-2020	17	44	46	71	55
51	20-11-2020	14	44	45	71	55
52	24-11-2020	18	46	50	79	58
53	27-11-2020	12	45	49	84	56
December 2020						
54	01-12-2020	15	43	57	61	57
55	04-12-2020	15	43	58	65	58
56	08-12-2020	15	46	38	65	58
57	11-12-2020	16	45	49	65	56
58	15-12-2020	18	45	59	71	59
59	18-12-2020	16	44	60	84	60
60	22-12-2020	14	56	63	61	70
61	25-12-2020	14	51	49	87	64
62	29-12-2020	14	45	60	87	60
January 2021						
63	01-01-2021	16	50	49	73	63
64	05-01-2021	17	52	49	76	65
65	08-01-2021	17	50	58	82	63
66	12-01-2021	16	46	54	78	58
67	15-01-2021	17	50	61	85	63
68	19-01-2021	16	49	54	80	61
69	22-01-2021	18	48	57	84	60
70	29-01-2021	16	48	60	89	60
February 2021						
71	02-02-2021	15	40	56	85	56
72	05-02-2021	15	37	61	84	61
73	09-02-2021	16	41	54	77	54
74	12-02-2021	15	40	62	86	62
75	16-02-2021	18	50	60	84	63
76	19-02-2021	16	38	63	91	63
77	23-02-2021	16	42	62	85	62
78	26-02-2021	16	35	58	85	58
March 2021						
79	02-03-2021	16	49	50	75	61
80	05-03-2021	17	48	52	81	60
81	09-03-2021	17	45	56	86	56
82	12-03-2021	18	51	46	76	64
83	16-03-2021	17	53	54	77	66
84	19-03-2021	19	49	55	78	61
85	23-03-2021	16	52	53	86	65
86	26-03-2021	15	47	55	75	59
87	30-03-2021	16	45	56	81	56

Source: MPCB, 2020-21

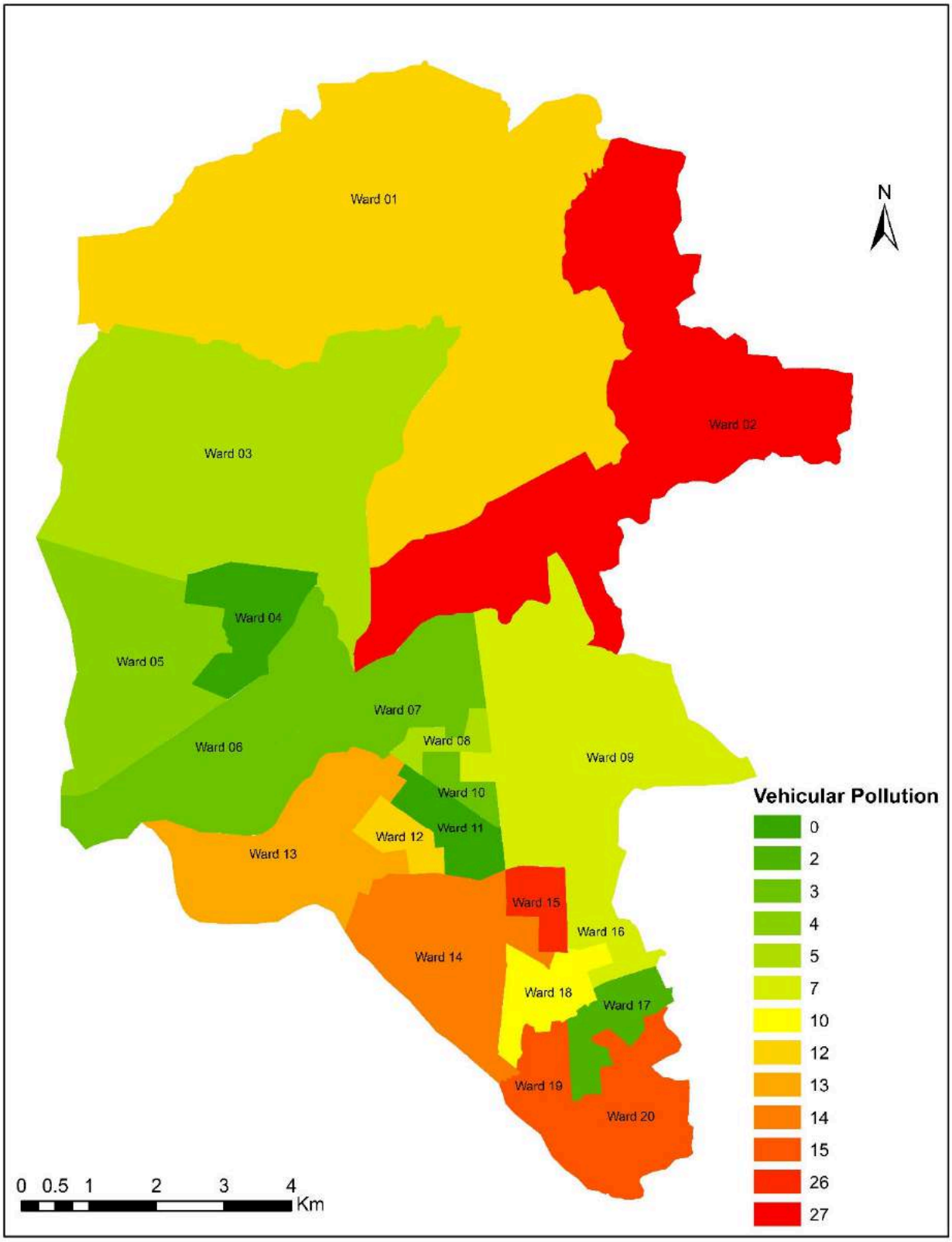
AQI observed for only two days among all observations crossed the threshold prescribed by CPCB at Kharghar air quality monitoring station during 2018-19. AQIs that crossed the threshold are observed in April 2018 (117 and 105). The highest AQI (117) is observed in the month of April 2018. The observations that crossed the threshold lie in the moderately polluted (101 to 200) category.

It is observed that in none of the days in 2019-20, the AQI crossed the threshold prescribed by CPCB. The highest AQI was found 90 and a few days, it crossed 80 in April 2019. The year 2020-21 is unique in the context of AQI for the Kharghar region of the city, across all the days during the year of the Covid-19 pandemic the AQI is the lowest among the three years and none of the days it crossed the threshold. Kharghar in general experiences the air pollution due to the industrial residual from Thane-Belapur Industrial Belt and Taloja MIDC.

The AQI of more than 100 indicates that the air quality may cause breathing discomfort to people with lung disease such as asthma and discomfort to people with heart disease, children and older adults in Kharghar residential area.

Generally, it is observed that residential areas have air pollution from transportation. The vehicles used by the residents for commuting within the city for various reasons contribute to air pollution. We explored residents' perception about vehicular pollution in the city and found that the responses varied in different wards in the city. A large percentage of residents staying in Ward 2 which is very close to Taloja Industrial Area and Kalamboli Industrial Area, where a large number of heavy vehicles serve the transportation for industrial purpose and 15, 19 and 20 Wards in old Panvel City either have very high commute of vehicles and are closer to Mumbai-Pune Express Highway, felt vehicular air pollution is in the range of high to very high.

Map 12 Percentage Households claiming high to very high Vehicular Pollution in Panvel City



Source: Environmental Survey, 2020-21

Table 29 Air Quality Index for Industrial Area in Taloja for 2018-19

Sr.No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m³	µg/m³	µg/m³	µg/m³	
Standards		80	80	100	---	
April 2018						
1	02-04-2018	24	56	73	131	73
2	05-04-2018	25	57	63	116	71
3	09-04-2018	26	68	91	168	91
4	12-04-2018	27	60	120	232	113
5	16-04-2018	23	61	106	135	104
6	19-04-2018	27	62	86	161	86
7	23-04-2018	36	66	89	166	89
8	26-04-2018	26	65	83	154	83
9	30-04-2018	24	59	87	163	87
May 2018						
10	03-05-2018	21	59	99	183	99
11	07-05-2018	22	49	80	151	80
12	10-05-2018	26	55	84	158	84
13	14-05-2018	21	49	89	169	89
14	17-05-2018	24	57	90	167	90
15	21-05-2018	24	49	78	146	78
16	24-05-2018	27	54	71	133	71
17	28-05-2018	21	53	80	150	80
18	31-05-2018	24	42	86	161	86
June 2018						
19	04-06-2018	16	55	57	104	69
20	07-06-2018	15	46	97	183	97
21	11-06-2018	21	53	97	183	97
22	14-06-2018	14	59	64	118	74
23	18-06-2018	20	49	60	108	61
24	21-06-2018	17	56	66	120	70
25	25-06-2018	18	54	55	101	68
26	28-06-2018	19	53	69	128	69
July 2018						
27	02-07-2018	15	33	57	104	57
28	05-07-2018	15	43	55	100	55
29	09-07-2018	14	42	33	58	53
30	12-07-2018	13	40	36	65	50
31	19-07-2018	15	49	40	68	61
32	23-07-2018	12	44	45	80	55
33	26-07-2018	17	41	69	85	69
34	30-07-2018	17	49	34	58	61
August 2018						

35	02-08-2018	17	34	30	54	**43**
36	06-08-2018	18	32	54	98	**54**
37	09-08-2018	16	34	34	60	**43**
38	13-08-2018	16	33	40	70	**41**
39	16-08-2018	18	34	37	66	**43**
40	20-08-2018	16	40	37	60	**50**
41	23-08-2018	16	36	36	64	**45**
42	27-08-2018	15	34	69	68	**69**
43	30-08-2018	13	35	45	78	**45**
September 2018						
44	03-09-2018	23	42	45	79	**53**
45	06-09-2018	21	43	37	65	**54**
46	10-09-2018	21	43	37	64	**54**
47	13-09-2018	20	41	48	87	**51**
48	17-09-2018	18	34	37	66	**43**
49	20-09-2018	20	43	39	64	**54**
50	24-09-2018	21	43	53	97	**54**
51	27-09-2018	22	41	69	84	**69**
October 2018						
52	01-10-2018	18	40	56	102	**56**
53	04-10-2018	20	40	53	95	**53**
54	08-10-2018	22	41	50	97	**51**
55	11-10-2018	19	40	48	87	**50**
56	15-10-2018	19	43	37	66	**54**
57	18-10-2018	21	41	42	68	**51**
58	22-10-2018	22	41	52	95	**52**
59	25-10-2018	21	39	69	93	**69**
60	29-10-2018	20	42	44	76	**53**
November 2018						
61	01-11-2018	16	40	59	103	**59**
62	05-11-2018	17	45	67	121	**67**
63	08-11-2018	16	41	66	116	**66**
64	12-11-2018	20	44	42	77	**55**
65	15-11-2018	18	34	37	66	**43**
66	19-11-2018	16	39	50	92	**50**
67	22-11-2018	17	44	58	103	**58**
68	26-11-2018	16	38	69	79	**69**
69	29-11-2018	17	42	57	104	**57**
December 2018						
70	03-12-2018	15	42	63	113	**63**
71	06-12-2018	15	45	66	119	**66**
72	10-12-2018	12	38	69	126	**69**
73	13-12-2018	15	41	60	109	**60**
74	17-12-2018	18	34	37	66	**43**

75	20-12-2018	19	46	51	93	**58**
76	24-12-2018	17	44	58	105	**58**
77	27-12-2018	17	45	69	105	**69**
78	31-12-2018	13	13	44	79	**44**
January 2019						
79	03-01-2019	14	59	59	107	**74**
80	07-01-2019	17	52	48	87	**65**
81	10-01-2019	18	52	52	99	**65**
82	14-01-2019	17	51	54	94	**64**
83	17-01-2019	18	34	37	66	**43**
84	21-01-2019	17	55	43	68	**69**
85	24-01-2019	17	58	54	98	**73**
86	28-01-2019	20	50	69	82	**69**
87	31-01-2019	16	52	44	90	**65**
February 2019						
88	04-02-2019	14	51	50	88	**64**
89	07-02-2019	15	52	45	81	**65**
90	11-02-2019	17	51	39	74	**64**
91	14-02-2019	18	46	45	77	**58**
92	18-02-2019	18	34	37	66	**43**
93	21-02-2019	16	51	44	74	**64**
94	25-02-2019	14	50	56	101	**63**
95	28-02-2019	17	52	69	93	**69**
March 2019						
96	04-03-2019	22	57	55	100	**71**
97	07-03-2019	23	60	63	116	**75**
98	11-03-2019	20	46	47	85	**58**
99	12-03-2019	20	43	59	118	**59**
100	14-03-2019	21	41	47	83	**51**
101	18-03-2019	18	34	37	66	**43**
102	25-03-2019	25	43	52	93	**54**
103	27-03-2019	20	41	69	73	**69**

Source: MPCB, 2018-19

Table 30 Air Quality Index for Industrial Area in Taloja for 2019-20

Sr. No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3	µg/m3	
Standards		80	80	100	---	
April 2019						
1	01-04-2019	23	60	42	76	**75**
2	04-04-2019	22	56	49	86	**70**
3	08-04-2019	19	75	65	117	**94**
4	11-04-2019	23	50	50	89	**63**

5	15-04-2019	18	34	37	66	43
6	18-04-2019	21	64	45	82	80
7	22-04-2019	19	52	68	126	68
8	25-04-2019	20	68	69	100	85
9	29-04-2019	21	51	58	111	64
June 2019						
10	03-06-2019	17	52	52	93	65
11	06-06-2019	18	45	41	72	56
12	10-06-2019	19	43	60	111	60
13	13-06-2019	16	54	42	72	68
14	17-06-2019	15	46	55	99	58
15	20-06-2019	16	45	54	93	56
16	24-06-2019	19	53	54	98	66
17	27-06-2019	17	40	56	102	56
July 2019						
18	01-07-2019	14	35	64	115	64
19	04-07-2019	16	45	51	91	56
20	08-07-2019	14	42	52	92	53
21	11-07-2019	16	45	57	100	57
22	15-07-2019	15	50	37	88	63
23	18-07-2019	16	48	58	99	60
24	22-07-2019	16	45	61	104	61
25	25-07-2019	18	51	64	64	64
26	29-07-2019	16	43	66	66	66
August 2019						
27	01-08-2019	19	36	61	110	61
28	05-08-2019	15	30	64	115	64
29	08-08-2019	16	32	47	84	47
30	12-08-2019	15	34	62	112	62
31	19-08-2019	15	39	63	114	63
32	22-08-2019	16	37	54	91	54
33	26-08-2019	13	35	57	102	57
34	29-08-2019	15	38	62	112	62
September 2019						
35	02-09-2019	15	37	60	107	60
36	05-09-2019	18	41	57	100	57
37	09-09-2019	15	42	62	110	62
38	12-09-2019	17	45	59	105	59
39	16-09-2019	18	34	37	66	43
40	19-09-2019	17	44	50	83	55
41	23-09-2019	17	43	67	120	67
42	26-09-2019	19	38	69	87	69
43	30-09-2019	16	38	60	123	60
October 2019						
44	03-10-2019	14	41	60	108	60
45	07-10-2019	17	42	62	111	62
46	10-10-2019	19	42	63	114	63

47	14-10-2019	15	41	65	118	65
48	17-10-2019	18	47	37	66	59
49	21-10-2019	18	44	50	83	55
50	24-10-2019	17	45	67	117	67
51	28-10-2019	19	38	69	106	69
52	31-10-2019	18	42	67	121	67
December 2019						
53	02-12-2019	14	51	64	116	64
54	05-12-2019	13	44	63	112	63
55	09-12-2019	17	50	65	112	65
56	12-12-2019	16	46	65	118	65
57	16-12-2019	18	47	64	117	64
58	19-12-2019	14	49	64	116	64
59	23-12-2019	15	46	63	114	63
60	26-12-2019	14	50	69	116	69
61	30-12-2019	12	45	60	111	60
January 2020						
62	02-01-2020	16	58	65	116	73
63	06-01-2020	16	57	64	114	71
64	09-01-2020	14	53	63	115	66
65	13-01-2020	16	60	59	104	75
66	16-01-2020	18	44	63	111	63
67	20-01-2020	17	58	58	103	73
68	23-01-2020	15	58	63	110	73
69	27-01-2020	17	57	69	108	71
70	30-01-2020	14	53	60	111	66
February 2020						
71	03-02-2020	15	41	67	120	67
72	06-02-2020	14	41	68	123	68
73	10-02-2020	16	36	66	117	66
74	13-02-2020	17	43	65	116	65
75	17-02-2020	18	40	63	111	63
76	20-02-2020	14	42	63	120	63
77	24-02-2020	14	42	63	110	63
78	27-02-2020	17	44	69	108	69
March 2020						
79	02-03-2020	14	53	62	113	66
80	05-03-2020	13	55	66	112	69
81	09-03-2020	14	48	57	102	60
82	12-03-2020	13	49	66	118	66
83	16-03-2020	18	40	63	111	63
84	19-03-2020	13	52	62	109	65

Source: MPCB, 2019-20

Table 31 Air Quality Index for Industrial Area in Taloja for 2020-21

Sr.No.	Date	SO2	NOx	RSPM	SPM	AQI
		µg/m3	µg/m3	µg/m3	µg/m3	
Standards		80	80	100	---	
May 2020						
1	18-05-2020	11	32	39	63	40
2	21-05-2020	10	32	37	63	40
3	25-05-2020	9	33	45	71	45
4	28-05-2020	9	30	45	73	45
June 2020						
5	01-06-2020	11	38	48	83	48
6	08-06-2020	12	45	44	75	56
7	11-06-2020	11	51	43	72	64
8	15-06-2020	18	40	43	43	50
9	18-06-2020	12	48	46	46	60
10	22-06-2020	11	48	44	43	60
11	25-06-2020	12	45	45	45	56
12	29-06-2020	12	52	46	46	65
July 2020						
13	02-07-2020	12	42	43	76	53
14	06-07-2020	12	43	41	70	54
15	09-07-2020	13	44	41	72	55
16	13-07-2020	12	43	40	71	54
17	16-07-2020	14	40	43	76	50
18	20-07-2020	12	47	42	77	59
19	23-07-2020	11	45	44	75	56
20	27-07-2020	12	44	43	75	55
21	30-07-2020	12	43	42	72	54
August 2020						
22	03-08-2020	13	36	44	73	45
23	06-08-2020	12	38	43	68	48
24	10-08-2020	13	43	44	75	54
25	13-08-2020	13	43	43	75	54
26	17-08-2020	15	39	44	71	49
27	20-08-2020	13	44	43	73	55
28	24-08-2020	12	41	43	72	51
29	27-08-2020	13	42	41	69	53
30	31-08-2020	12	43	43	70	54
September 2020						
31	03-09-2020	12	38	52	77	52

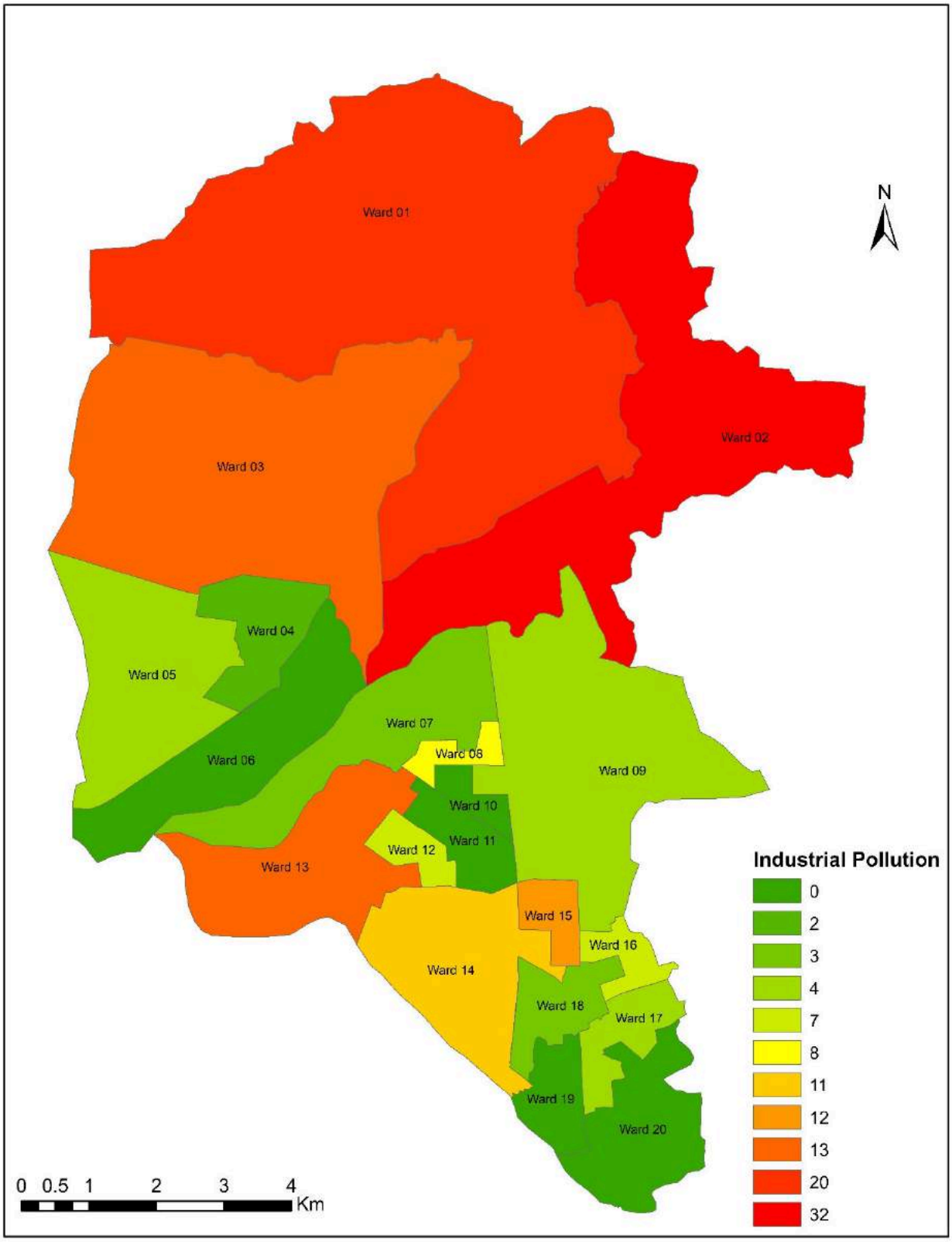
32	07-09-2020	13	41	52	76	52
33	10-09-2020	13	39	52	76	52
34	14-09-2020	13	43	54	78	54
35	17-09-2020	18	40	48	72	50
36	21-09-2020	14	42	48	73	53
37	24-09-2020	13	42	50	76	53
38	28-09-2020	14	40	48	75	50
November 2020						
39	02-11-2020	14	45	69	90	69
40	05-11-2020	15	45	73	98	73
41	09-11-2020	15	44	76	98	76
42	12-11-2020	19	47	69	94	69
43	16-11-2020	18	47	70	98	70
44	19-11-2020	19	50	78	103	78
45	23-11-2020	15	47	72	98	72
46	26-11-2020	14	47	62	99	62
47	30-11-2020	18	48	63	97	63
December 2020						
48	03-12-2020	15	54	61	92	68
49	07-12-2020	14	46	64	92	64
50	10-12-2020	13	49	65	93	65
51	14-12-2020	15	51	67	103	67
52	17-12-2020	16	52	66	119	66
53	21-12-2020	15	55	63	110	69
54	24-12-2020	15	53	73	120	73
55	28-12-2020	15	46	74	120	74
56	31-12-2020	14	53	67	118	67
January 2021						
57	04-01-2021	20	56	64	90	70
58	07-01-2021	17	58	67	93	73
59	11-01-2021	18	56	73	101	73
60	14-01-2021	17	55	79	104	79
61	18-01-2021	20	62	76	101	78
62	21-01-2021	18	57	75	105	75
63	25-01-2021	19	61	79	108	79
64	28-01-2021	20	58	83	116	83
February 2021						
65	01-02-2021	19	44	66	95	66
66	04-02-2021	17	45	75	101	75
67	08-02-2021	19	44	71	97	71

68	11-02-2021	16	46	67	95	67
69	15-02-2021	17	43	75	104	75
70	18-02-2021	18	45	64	94	64
71	22-02-2021	17	47	68	92	68
72	25-02-2021	18	45	64	98	64
March 2021						
73	01-03-2021	21	57	59	92	71
74	04-03-2021	20	51	60	92	64
75	08-03-2021	20	54	64	103	68
76	11-03-2021	17	56	57	94	70
77	15-03-2021	21	59	65	107	74
78	18-03-2021	23	52	72	103	72
79	22-03-2021	19	54	68	97	68
80	25-03-2021	23	50	72	101	72
81	29-03-2021	17	49	75	104	75

Source: MPCB, 2020-21

It is observed that AQI for only two days among all observation crossed the threshold prescribed by CPCB. AQIs that crossed the threshold are observed in April 2018 (113 and 104). The highest AQI (113) is observed in the month of April 2018. Both of observations that crossed threshold lie in moderately polluted (101 to 200) category. During 2019-20, AQI on none of the days crossed the threshold. The highest AQI (90) was found in the month of April 2019. The Covid-19 Pandemic year 2020-21 has eased the lives of the people in and around the Taloja MIDC area, on none of the days AQI crossed the threshold set by the CPCB. The highest AQI was observed in one of the days in January 2021, as an average January 2021 recorded relatively greater AQI compared with other months in the year. Though the AQI for Taloja MIDC have been largely below the threshold, the people in and around the industrial catchment have raised concerns about a relatively unbearable smell during late nights. The higher AQI than 100 indicates that the air quality may cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults in Taloja Industrial area.

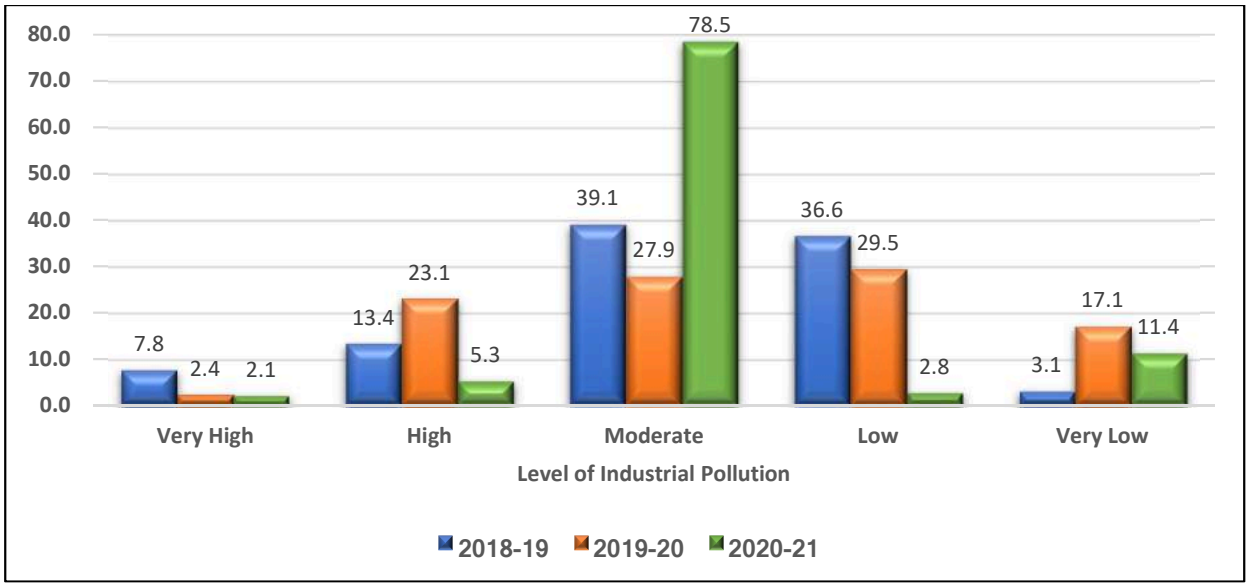
Map 13 Percentage Households claiming High to Very High Industrial Pollution



Source: Environmental Survey, 2020-21

We also tried to explore residents' perception about industrial pollution in the city, indicating that there is significantly high to very high air pollution in Ward 1 and 2, 3 which are very close to Taloja and Kalamboli Industrial Area. This year the people in Ward 13 also shown concern about the industrial pollution. The households in Ward 8, 14 and 15 have expressed moderate to high industrial pollution.

Figure 11 Household perception about Industrial Air Pollution



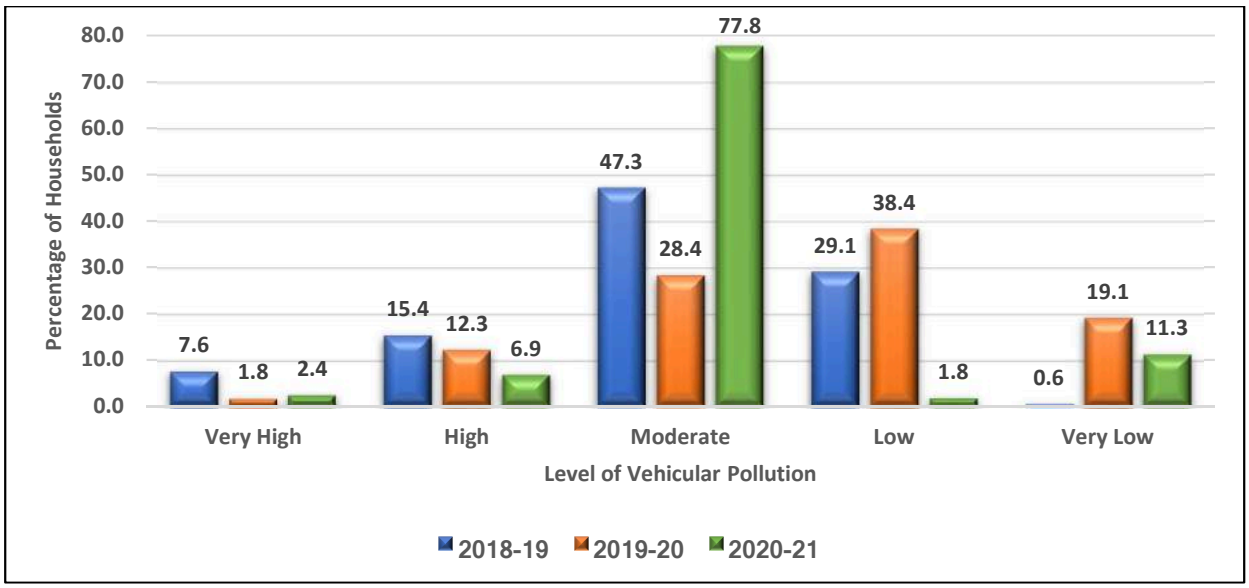
Source: Environmental Survey 2018-19, 2019-20 and 2020-21 for Panvel City

We asked the households in Panvel City whether they experienced any industrial air pollution in recent times. During 2018-19, 60 per cent households revealed that industrial pollution is at moderate to a very high level in the city. Perhaps, 52.4 per cent of the total households, in 2019-20, revealed that industrial pollution is at moderate to a very high level in the city.

In 2020-21, 85.9 per cent households stated that they experience a moderate to very high industrial pollution, among them only 7.4 per cent households recorded a high to very high industrial pollution during the year, the observation is mainly due to the lockdown during the year. The wards closer to the industrial areas have strongly revealed that the industrial pollution is high to very high in their proximity; wards include Ward No. 1, 2, 3, and 8. And Ward No. 6, 10, 11, 18, 19 and 20 expressed that the air pollution by the industrial units is not a significant issue to them.

Vehicular Air Pollution: We do not get any data to confirm the exposure of vehicular air pollution from any of the Air Monitoring Institution. Hence, we got responses from our environmental surveys about vehicular pollution from the households residing in the City.

Figure 12 Household Perception about Vehicular Air Pollution



Source: Environmental Survey 2018-19, 2018-19 and 2020-21 for Panvel City

Panvel is preferred in MMR for residential purposes; people travel for work purpose, attend schools and visit hospitals and shopping for purpose within Panvel City and to neighbouring cities that include Navi Mumbai, Mumbai and Thane.

The perception of households about vehicular pollution is observed through conducted Environmental Survey. During 2018-19,70 per cent of household believed that there is a moderate to a very high level of vehicular pollution in the city. Only 42.5 per cent of the households stated that there is a moderate to a very high level of vehicular pollution in the city during 2019-20. The year 2020-21, being a year of pandemic, has shown deceleration in vehicular pollution. Only 9.3 per cent of the households stated that there have been a high to very high vehicular pollution in the city during the year.

4.4.2 Noise Pollution

Noise is defined as an unwanted sound. Noise observed in urban areas is called Community Noise, according to WHO. It is also known as environmental noise, domestic noise or residential noise.

It is the noise emitted from all sources except noise at the industrial workplace (WHO). The urban areas may get affected by various sources of noise that include road, rail and air traffic, construction, public works and neighbourhood. The main sources of indoor noise are home equipment and appliances and neighbours.

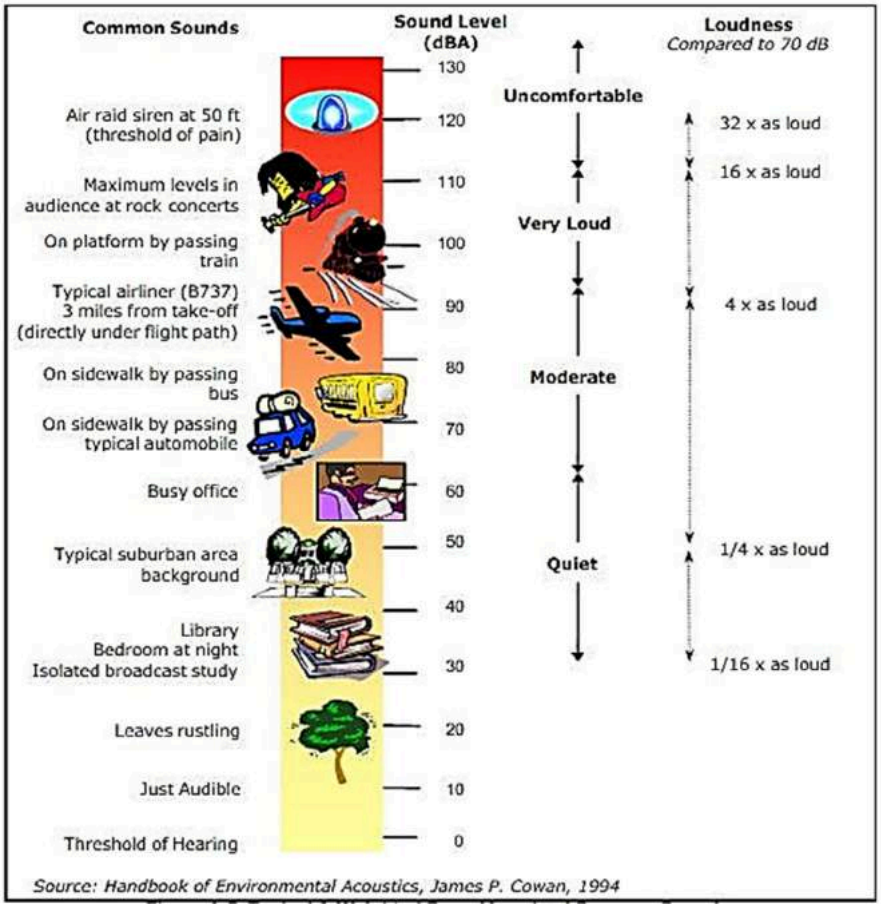
Sound is such a common part of everyday life that we rarely appreciate all of its functions. It provides enjoyable experiences such as listening to music or to the singing of birds. A sound source radiates power and this result in sound pressure. Sound power is the cause. Sound pressure is the effect. What we hear is sound pressure, but it is caused by the sound power emitted from the source. The sound pressure that we hear, or measure with a microphone, depends on the distance from the source and acoustic environment (or sound field) in which sound waves are present. This is in turn, depends on the size of the room and the sound absorption of the surfaces. The sound may be defined as any pressure variation (in air, water or another medium) that the human ear can detect. If variation in atmospheric pressure occurs more rapidly, i.e. at least 20 times a second, it can be heard and called sound. Sound travels as small waves of pressure through the air at a speed of about 740 miles per hour and what we hear are sound waves provided by vibrations of air molecules (CPCB).

Noise is usually defined as an unwanted sound pollutant that produces undesirable physiological and psychological effects in an individual by interfering with social activities like work, rest, recreation and sleep. A sound might be unwanted because it is: Loud, Unpleasant or annoying and Intrusive or distracting. Noise perception is subjective. Factors such as the magnitude, characteristics, duration, and time of occurrence may affect one's subjective impression of the noise. The Noise is also considered a mixture of many different sound frequencies at high decibel levels (CPCB).

Noise pollution refers to sounds in the environment caused by humans and threatens the health or welfare of human or animal inhabitants. The most common source of noise pollution, which affects the most people on the planet, is motor vehicles. The aircrafts and industrial machineries are also significant sources of noise pollution. Additional noise pollution is contributed by office machines, sirens, power tools, and other equipment. The response of the ear to sound is very

dependent on the frequency content of the sound. The ear has a peak response around 2.5 – 3 kHz and has a relatively low response at low frequencies (CPCB).

Sound is usually made up of a wide range of different frequencies. The spread of sound energy across the audible frequency "spectrum" (about 20Hz – 20kHz) is one factor that helps to make it identifiable to the human ear. The human ear is a very sensitive system with an extensive dynamic range. Sound levels are measured using the decibel (dB) scale (MPCB) to accommodate this very large range.



Sound Level Meter is an instrument designed to respond in approximately the same way as the human ear and give objective, reproducible sound pressure measurements. The sound level meter consists of a microphone, a processing unit and a read-out unit. The microphone converts the sound signal to an equivalent electrical signal. There are many types of the microphone like condenser microphone, electrets condenser, dynamic microphone, carbon microphone, piezoelectric microphone, fibre optic microphone, which is used for various purposes. The most

suitable type of microphone for sound level meters is the condenser microphone, which combines precision with stability and reliability. The electrical signal produced by the microphone is quite small, so it is amplified by a preamplifier before being processed (CPCB).

A sound level meter theoretically has a flat response; in other words, it responds exactly the same at different frequencies. Unlike a sound level meter, the human ear responds differently at different frequencies, so a weighting, or filter, can be used so that the meter responds more like the human ear. The most commonly used weighting is the 'A' weighting and readings usually measured in dBA. The "sound pressure level" (SPL) is twenty times the logarithm to the base 10 of the ratio of the effective pressure (p) of a sound to the reference pressure (Pr) of 20 µPa. Thus the sound pressure level in dB = 20 log1O P/Pr (MPCB).

The Central Pollution Control Board (CPCB) developed National Ambient Noise Monitoring Network Programme as an initiative of National Environment Policy (NEP)-2006, which includes the installation of Noise Monitoring Stations all over India which in turn will provide necessary information for decision-makers. The National Ambient Noise Monitoring Network comprises 70 Noise Monitoring Stations spread over 07 metropolitan cities, including Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Lucknow, and Mumbai (10 stations in each city). Panvel City does not have a Noise Monitoring Station installed by neither CPCB nor MPCB.

The Noise Pollution can be observed and analysed for Festival Days and Non-Festival Days. During Festivals and celebrations like Ganeshotsav, Navaratri, Deewali and New Year Night may have significant noise pollution in almost all the cities in Maharashtra, Panvel City is no exception. And the Non-Festival Noise levels are also important to be analysed to see the impact of noise levels on a day to day life of residents in the city. Hence we have analysed noise pollution for Festival Days and Non-Festival Days.

4.4.2.1 Noise Pollution During Festivals:

As stated above, there are many occasions like festivals and celebrations of various days of importance when the noise levels may exceed the ambient noise levels set by CPCB for day and night time in a city. There are several festivals such as Ganeshotsav, Navratri and Deewali and celebrations of days like Republic Day, Independence Day, New Year Eve, Chatrapati Shivaji

Maharaj Jayanti and Dr. Babasaheb Ambedkar Jayanti. We have analysed the noise pollution during Ganesh and Navaratri Festival in the present study.

The Ganeshostav is one of the most celebrated festivals in India. People wait for this festival eagerly. It is celebrated in various states of the country; however, it is celebrated in a grand way in Maharashtra. It is the most important festival of Hindus which devotees celebrate every year with great preparations and enthusiasm for ten days.

Maharashtra Pollution Control Board has been carrying out the study of the ambient noise levels in the state of Maharashtra during the period of the Ganesh Festival for more than 10 years as a continuous process. Noise monitoring was carried out at 132 locations from 27 Municipal Corporation of Maharashtra for five days during Ganesh Festival, i.e. on 13th, 14th, 17th, 19th and 23rd September 2018 from 6 PM to 12 AM in residential, commercial and silence zone.

Three locations in Panvel City were selected where noise monitoring was carried by MPCB on the above dates in the month of September 2018. Hourly Noise Levels on 13th, 14th, 17th, 19th and 23rd September 2018 during Ganesh Festival at three locations in Panvel is given below.

For 2019, MPCB carried noise monitoring of 132 locations from 27 Municipal Corporation of Maharashtra for five days during the Ganesh Festival, i.e. on 2nd, 3rd, 6th, 8th and 12th September 2019 from 6 PM to 12 AM in residential, commercial and silence zone.

Three locations in Panvel City were selected where noise monitoring was carried by MPCB on the above dates in the month of September 2018. Hourly Noise Levels on 2nd, 3rd, 6th, 8th and 12th September 2019 during Ganesh Festival at three locations in Panvel is given below.

Most environmental sounds are made up of a complex mix of many different frequencies. Frequency refers to the number of vibrations per second of the air in which the sound is propagating and it is measured in Hertz (Hz). The audible frequency range is normally considered to be 20–20 000 Hz for younger listeners with unimpaired hearing. However, our hearing systems are not equally sensitive to all sound frequencies, and to compensate for this various types of filters or frequency weighting have been used to determine the relative strengths of frequency components making up a particular environmental noise. The A-weighting is most commonly

used and weights lower frequencies as less important than mid- and higher-frequencies. It is intended to approximate the frequency response of our hearing system.

The effect of a combination of noise events is related to the combined sound energy of those events (the equal energy principle). The sum of the total energy over some time period gives a level equivalent to the average sound energy over that period. Thus, LA_{eq}, *T* is the energy average equivalent level of the A-weighted sound over a period *T*. $LA_{eq,\ T}$ should be used to measure continuing sounds, such as road traffic noise or types of more-or-less continuous industrial noises. However, when there are distinct events to the noise, as with aircraft or railway noise, measures of individual events such as the maximum noise level (LA_{max}), or the weighted sound exposure level (SEL), should also be obtained in addition to $LA_{eq,\ T}$. Time-varying environmental sound levels have also been described in terms of percentile levels.

Currently, the recommended practice is to assume that the equal energy principle is approximately valid for most types of noise and that a simple $LA_{eq,\ T}$ measure will indicate the expected effects of the noise reasonably well. When the noise consists of a small number of discrete events, the A-weighted maximum level (LA_{max}) is a better indicator of the disturbance to sleep and other activities. However, in most cases, the A-weighted sound exposure level (SEL) provides a more consistent measure of single-noise events because it is based on integration over the entire noise event. In combining day and night $LA_{eq,\ T}$ values, night-time weightings are often added. Night-time weightings are intended to reflect the expected increased sensitivity to annoyance at night, but they do not protect people from sleep disturbance.

There are no clear reasons for using other measures; it is recommended that $LA_{eq,\ T}$ be used to evaluate more-or-less continuous environmental noises. Where the noise is principally composed of a small number of discrete events, the additional use of LA_{max} or SEL is recommended. There are definite limitations to these simple measures, but there are also many practical advantages, including the economy and the benefits of a standardized approach.

The equivalent steady sound level of a noise energy-averaged over time was calculated represented as $L_{eq,T}$ based on which MPCB measures the impact of noise created during the festival for Panvel City. The formula for calculating $L_{eq,T}$ is as given below:

$$L_{eq,T} = 10\ln\left(\frac{1}{n\sum_{i=1}^{n} 10^{L_i/10}}\right)$$

Where, L_i = levels observed at n equally spaced times during interval T.

Table 32 L_{eq} Night Time for Panvel City during Ganeshotsav in September 2018 and 2019

2918-19				2019-20			
Location	**Utsav Chowk, Kharghar**	**Panvel Municipal Corporation Building, Old Panvel**	**Khanda Colony, New Panvel**	**Location**	**Utsav Chowk, Kharghar**	**Panvel Municipal Corporation Building, Old Panvel**	**Khanda Colony, New Panvel**
13th Sept. 2018	76.4	78.6	87.4	**02nd Sept. 2019**	72.2	69.3	69.1
14th Sept. 2018	89.1	89.8	104.7	**03rd Sept. 2019**	73.4	73.6	70.6
17th Sept. 2018	76.2	83.1	70.2	**06th Sept. 2019**	77.7	82.7	81.5
19th Sept. 2018	68.9	68.7	76.1	**08th Sept. 2019**	79.4	74.2	74.0
23rd Sept. 2018	85.8	84.1	71.8	**12th Sept. 2019**	74.7	73.7	75.1

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2018 and 2019

When we compare these three locations, Khanda Colony recorded the highest noise level on 13th, 14th and 19th September 2018 with 87.4 dB(A), 104.7 dB(A) and 76.1 dB(A), respectively. Old Panvel and Utsav Chowk had the highest noise level on 17th and 23rd September 2018 with 83.1 dB(A) and 85.8 dB(A).

Utsav Chowk, Kharghar, Old Panvel and Khanda Colony had the highest noise level of 89.1 dB(A), 89.8 dB(A) and 104.7 dB(A), respectively, on 14th September 2018 compared to all other days during Ganesh Festival.

According to MPCB Report, at all 3 locations of Panvel, on the first two days, higher noise levels were observed than in the previous year. On 19th September 2018, Old Panvel, Panvel Corporation Building had a higher noise level and on 23rd September 2018, Utsav Chowk and Old Panvel, Panvel Corporation Building had higher noise levels than previous year Ganesh Festival.

When we compared these three locations in 2019, we found that Khanda Colony recorded the highest noise level on only 12th September 2019 with 75.1 dB(A). Old Panvel recorded the highest noise level on 3rd and 6th September 2019 with 73.6 dB(A) and 82.7 dB(A), respectively. And Utsav Chowk had the highest noise level on 2nd and 8th September 2019 with 72.2 dB(A) and 79.4 dB(A).

Utsav Chowk, Kharghar had the highest noise level of 79.4 dB(A) on 8th September 2019, whereas Old Panvel and Khanda Colony had the highest noise level of 82.7 dB(A) and 81.5 dB(A), respectively, on 6th September 2019 compared to all other days during Ganesh Festival.

Table 33 Hourly L_{eq} Noise Levels during Ganeshotsav on 2nd September 2019

Location Name	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11 PM-12AM	Max	Min	L_{eq} 6PM-12AM
Utsav Chowk, Kharghar	74.3	75.1	72.9	70.5	68.4	65.3	75.1	65.3	72.2
Panvel Municipal Corporation Building, Old Panvel	71.5	72.7	69.2	67.3	65.1	62.8	72.7	62.8	69.3
Khanda Colony, New Panvel	70.8	71.6	70.5	68.1	65.2	61.0	71.6	61.0	69.1

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2019

According to MPCB Report, at all 3 locations of Panvel, on the first two days in 2019, lower noise levels were observed than in 2018. The fall in noise pollution is significantly high on the 2nd day in 2019 of the Ganeshotsav compared to in 2018. On the 6th day, more or less noise levels were the same in 2018 and 2019 at Utsav Chowk and Old Panvel, Panvel Corporation Building, but the noise levels were significantly high in 2019 compared to 2018 at Khanda Colony. There is a significant fall in noise levels on the day of Visarjan in 2019 compared to 2018 at all locations except Khanda Colony.

On 2nd September 2019, which was the first day of the Ganeshotsav, we found the highest hourly noise levels were found during 7 to 8 PM at all locations.

Table 34 Hourly L_{eq} Noise Levels during Ganeshotsav on 3rd September 2019

Location Name	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11 PM-12AM	Max	Min	L_{eq} 6PM-12AM
Utsav Chowk, Kharghar	70.6	65.4	73.7	66.4	74.8	77.6	77.6	65.4	73.4
Panvel Municipal Corporation Building, Old Panvel	70.9	73.4	73.8	73.0	73.0	75.9	75.9	70.9	73.6
Khanda Colony, New Panvel	69.4	66.5	71.4	70.7	71.8	71.6	71.8	66.5	70.6

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2019

On the second day of the Ganeshotsav (3rd September 2019), the noise levels were relatively high from 11 PM to 12 AM at Utsav Chowk (77.6 dB(A)) and Old Panvel, Panvel Corporation Building (75.9 dB(A)) and noise levels were also relatively high during 10 to 11 PM at Khanda Colony (71.8 dB(A)).

Table 35 Hourly L_{eq} Noise Levels during Ganeshotsav on 6th September 2019

Location Name	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11 PM-12AM	Max	Min	L_{eq} 6PM-12AM
Utsav Chowk, Kharghar	75.2	76.8	71.9	76.5	79.7	80.6	80.6	71.9	77.7
Panvel Municipal Corporation Building, Old Panvel	83.0	82.8	83.1	83.6	82.6	80.1	83.6	80.1	82.7
Khanda Colony, New Panvel	81.9	79.6	81.1	81.8	81.2	82.8	82.8	79.6	81.5

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2019

On 6th September 2019, the noise levels were relatively high from 11 PM to 12 AM at Utsav Chowk (80.6 dB(A)) and Khanda Colony (82.8 dB(A)), and noise levels were also relatively high from 10 to 11 PM in Old Panvel (83.6 dB(A)).

Table 36 Hourly L_{eq} Noise Levels during Ganeshotsav on 8th September 2019

Location Name	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11 PM-12AM	Max	Min	L_{eq} 6PM-12AM
Utsav Chowk, Kharghar	67.0	75.0	74.0	86.0	77.0	69.0	86.0	67.0	79.4
Panvel Municipal Corporation Building, Old Panvel	76.0	74.0	73.0	73.0	76.0	71.0	76.0	71.0	74.2
Khanda Colony, New Panvel	74.0	76.0	72.0	76.0	72.0	71.0	76.0	71.0	74.0

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2019

The noise levels were relatively high from 9 to 10 PM at Utsav Chowk (86 dB(A)) and Khanda Colony (76 dB(A)) and noise levels were also relatively high from 10 to 11 PM in Old Panvel (76 dB(A)) on 8th September 2019.

Table 37 Hourly L_{eq} Noise Levels during Ganeshotsav on 12th September 2019

Location Name	6-7 PM	7-8 PM	8-9 PM	9-10 PM	10-11 PM	11 PM-12AM	Max	Min	L_{eq} 6PM-12AM
Utsav Chowk, Kharghar	66.2	68.8	80.5	72.0	72.6	72.1	80.5	66.2	74.7
Panvel Municipal Corporation Building, Old Panvel	74.3	68.9	74.8	69.7	77.4	70.5	77.4	68.9	73.7
Khanda Colony, New Panvel	73.5	72.5	72.5	75.8	79.8	52.3	79.8	52.3	75.1

Source: MPCB, Noise Monitoring Report During Ganesh Festival 2019

On the day of Visarjan (12th September 2019), the noise levels were relatively high from 9 to 10 PM at Old Panvel, Panvel Corporation Building (77.4 dB(A)) and Khanda Colony (79.8 dB(A)) and noise levels were also relatively high during 8 to 9 PM in Utsav Chowk (80.5 dB(A)).

The data on noise pollution during Ganesh Festival for the year 2020-21 is not made available by the MPCB, perhaps due to Covid-19 guidelines, the public celebration of the festival was not allowed in the city, and the households were also asked to celebrate it at home. Hence the entire ten days of the Ganesh Festival of 2020, there was no noise pollution.

Recently Navaratra Festival has become very popular in Panvel City. It is one of the most favoured festivals among youth in recent times in Panvel City. Garbha and Dandiya are performed by the participants every day from 8.00 to 10.00 PM for nine days.

We monitored noise levels at three locations each day for two days (12th October and 16th October 2018) during the Navaratra Festival. We used Sound Level Meters to continuously observe noise levels from 8.00 to 10.00 PM on selected days at three locations in Panvel City. We followed the same methodology as adopted by MPCB to capture the noise levels during Ganesh Festival. As well, we explored Min and Max noise levels for the given times at these locations.

We computed hourly L_{eq} and Min and Max for three locations each day for two selected dates during Navratra Festival summarized in the following tables separately for 8.00 to 9.00 PM, 9.00 to 10.00 PM and 8.00 to 10.00 PM. The Standards of Noise Levels under EPA (1986) and Noise Pollution (Regulation & Control) Rules, 2000 define day time as 6.00 AM to 10.00 PM.

On 12th October 2018, we recorded observations at Kalamboli, Utsav Chowk, Kharghar and Khanda Colony, New Panvel. And on 16th October 2018, these were recorded at Kalamboli, Utsav Chowk, Kharghar and Kamothe.

Table 38 L_{eq} Noise Levels for Navratra Festival 2018 and 2019 (Time 8.00 to 9.00 PM)

Location	12th October 2018			16th October 2018			4th October 2019			6th October 2019		
	Min	L_{eq}	Max	Min	L_{eq}	Max	Min	L_{eq}	Max	Min	L_{eq}	Max
Kalamboli	71.5	82	102.7	71.5	82	102.7	66.7	88.2	115.5	63.5	83.8	91
Utsav Chowk	58.4	98.8	113.5	65.7	82	93.9	64.9	85.3	98.4	64.9	87.9	98.4
Khanda Colony	62.2	**104.8**	120.9	-	-	-	82	**93.2**	102.9	67.1	**92.8**	105.4
Kamothe	-	-	-	53.8	**89.4**	99.2						

Source: Samples collected by Environmental Status Report Committee at MSE-PP

For the year 2019, we monitored noise level at three locations each day for two days (4th and 6th October 2019) during the Navaratra Festival. We followed the same methodology as we applied in 2018 to collect the noise samples during the festival in 2019. We recorded observations at Kalamboli, Utsav Chowk, Kharghar and Khanda Colony, New Panvel on 4th and 6th October 2019.

From 8.00 to 9.00 PM, the highest noise levels were found on 12th and 16th October 2018 at Khanda Colony, New Panvel (104.8 dB(A)) and Kamothe (89.4 dB(A)), respectively. L_{eq} at Kalamboli on both days was around 82.0 dB(A). The noise levels at Utsav Chowk, Kharghar, on 12th October 2018 were more (98.8 dB(A)) compare to the other day.

For the Navaratra Festival in 2019, from 8.00 PM to 9.00 PM, the highest noise levels were found on 4th and 6th October 2019 at Khanda Colony, New Panvel 93.2 dB(A) and 92.8 dB(A), respectively. L_{eq} was 88.2 dB(A) on 4th October 2019 and 83.8 dB(A) on 6th October 2019 at Kalamboli. The noise levels at Utsav Chowk, Kharghar, on 6th October 2019 were more (87.9 dB(A)) than the other day.

There are marginal changes in the noise levels on both days at Kalamboli and Utsav Chowk in 2019 compared to 2018 in the initial hour. In 2019, there is a substantial fall in the noise levels at Khanda Colony compare to 2018.

Table 39 L_{eq} Noise Levels for Navratra Festival 2018 and 2019 (Time 9.00 to 10.00 PM)

Location	12th October 2018			16th October 2018			4th October 2019			6th October 2019		
	Min	L_{eq}	Max	Min	L_{eq}	Max	Min	L_{eq}	Max	Min	L_{eq}	Max
Kalamboli	70.5	86.0	95.6	71.3	86.0	98.6	67.2	86.8	97.4	68.3	85.4	92.7
Utsav Chowk, Kharghar	71.2	118.2	117.1	70.0	85.6	98.4	72.7	87.7	101.5	72.7	92.3	101.5
Khanda Colony, New Panvel	71.5	108.4	118.3	-	-	-	69.9	90.9	100.3	79.8	92.0	105.1
Kamothe	-	-	-	54.8	90.0	101.9						

Source: Samples collected by Environmental Status Report Committee at MSE-PP

From 9.00 to 10.00 PM, the highest noise levels were found on 12th and 16th October 2018 at Utsav Chowk, Kharghar (118.2 dB(A)) and Kamothe (90.0 dB(A)), respectively. L_{eq} at Kalamboli

on both days was around 86.0 dB(A) during the later hour. The noise levels at Utsav Chowk, Kharghar on 12th October 2018 were more (118.2 dB(A)) than the other day from 9.00 PM to 10.00 PM.

For the Navaratra Festival in 2019, from 9.00 PM to 10.00 PM, the highest noise levels were found on 4th at Khanda Colony (90.9 dB(A)) followed by Kalamboli (86.8 dB(A)). The noise levels were highest at Utsav Chowk (92.3 dB(A)) on 6th October 2019 compare to the other two locations. L_{eq} at Kalamboli on both days was around 85.4 to 86.8 dB(A) during the later hour. The noise levels at Utsav Chowk, Kharghar on 6th October 2019 were more (92.3 dB(A)) than the other day from 9.00 PM to 10.00 PM.

There is no significant change in the noise levels at Kalamboli in 2019 compared to 2018 in the later hour. In 2019, there is a substantial fall in the noise levels at Utsav Chowk and Khanda Colony compare to 2018.

Table 40 L_{eq} Noise Levels for Navratra Festival 2018 and 2019 (Time 8.00 to 10.00 PM)

	12th October 2018			16th October 2018			4th October 2019			6th October 2019		
Location	**Min**	**L_{eq}**	**Max**	**Min**	**L_{eq}**	**Max**	**Min**	**L_{eq}**	**Max**	**Min**	**L_{eq}**	**Max**
Kalamboli	71.5	84.5	102.7	71.5	84.5	102.7	66.7	87.3	115.5	63.5	84.7	92.7
Utsav Chowk, Kharghar	71.2	**120.0**	117.1	70.0	84.1	98.4	64.9	86.9	101.5	64.9	90.6	101.5
Khanda Colony, New Panvel	71.5	107.3	120.9	-	-	-	69.9	**92.2**	102.9	67.1	**92.4**	105.4
Kamothe	-	-	-	54.8	**91.2**	101.9						

Source: Samples collected by Environmental Status Report Committee at MSE-PP

We have also analysed the observations for 8.00 to 10.00 PM for the selected locations and selected days. From 8.00 to 10.00 PM, the highest noise levels were found on 12th and 16th October 2018 at Utsav Chowk, Kharghar (120.0 dB(A)) and Kamothe (91.2 dB(A)), respectively. L_{eq} at Kalamboli on both days was around 84.5 dB(A) during entire two hours.

The noise levels at Utsav Chowk, Kharghar on 12th October 2018 were more (120.0 dB(A)) than the other day from 8.00 to 10.00 PM. The Minimum Level of Noise at all locations were in the

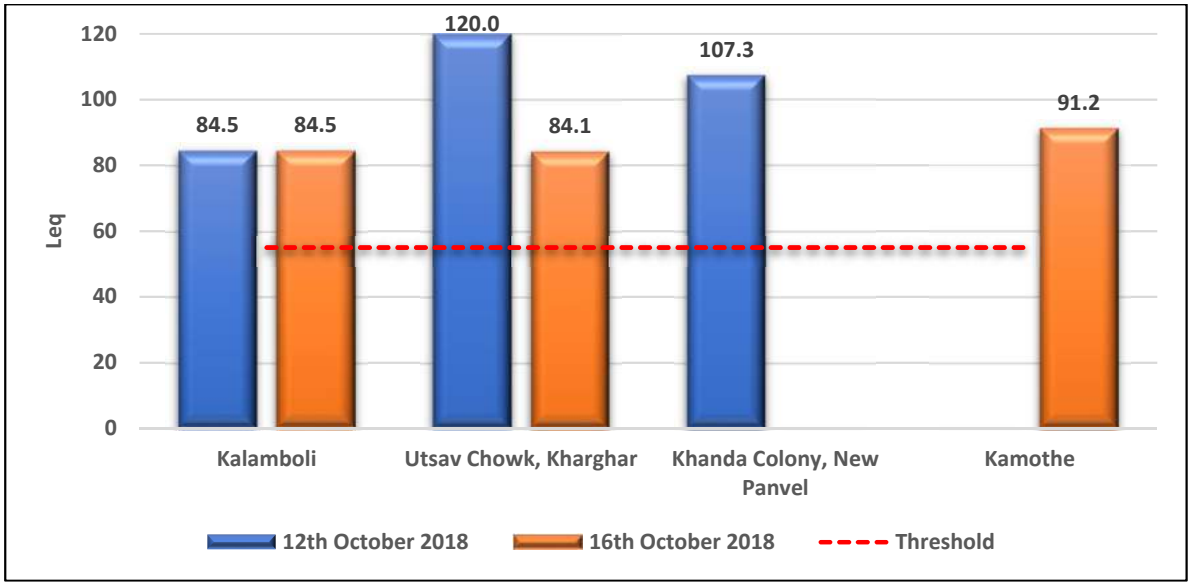
range of 71.2 to 71.5 dB(A) on 12th October 2018 and on 16th October 2018, respectively; the same was found to be 54.8 dB(A) at Kamothe and 70.0 dB(A) and 71.5 dB(A) at Kharghar and Kalamboli, respectively. The Maximum Level of Noise at all locations were in the range of 98.4 to 120.9 dB(A) on these two days.

During the Navaratra Festival in 2019, from 8.00 to 10.00 PM, the highest noise levels were found on 4th and 6th October 2019 at Khanda Colony (92.2 dB(A)) and Kamothe (92.4 dB(A)), respectively. L_{eq} at Kalamboli on both days was around 84.7 to 87.3 dB(A) during the entire two hours.

The noise levels at Utsav Chowk, Kharghar on 6th October 2019 were more (90.6 dB(A)) than the other day from 8.00 to 10.00 PM. The Minimum Level of Noise at all locations was in the range of 63.5 to 69.9 dB(A) on these two days. At all locations, the Maximum Level of Noise was in the range of 92.7 to 115.5 dB(A) on these two days.

There is no significant change in the noise levels in the entire two-hour duration at Kalamboli in 2019 compared to 2018 in the later hour. In 2019, there is a substantial fall in the noise levels in the entire two-hour duration at Utsav Chowk and Khanda Colony compared to 2018.

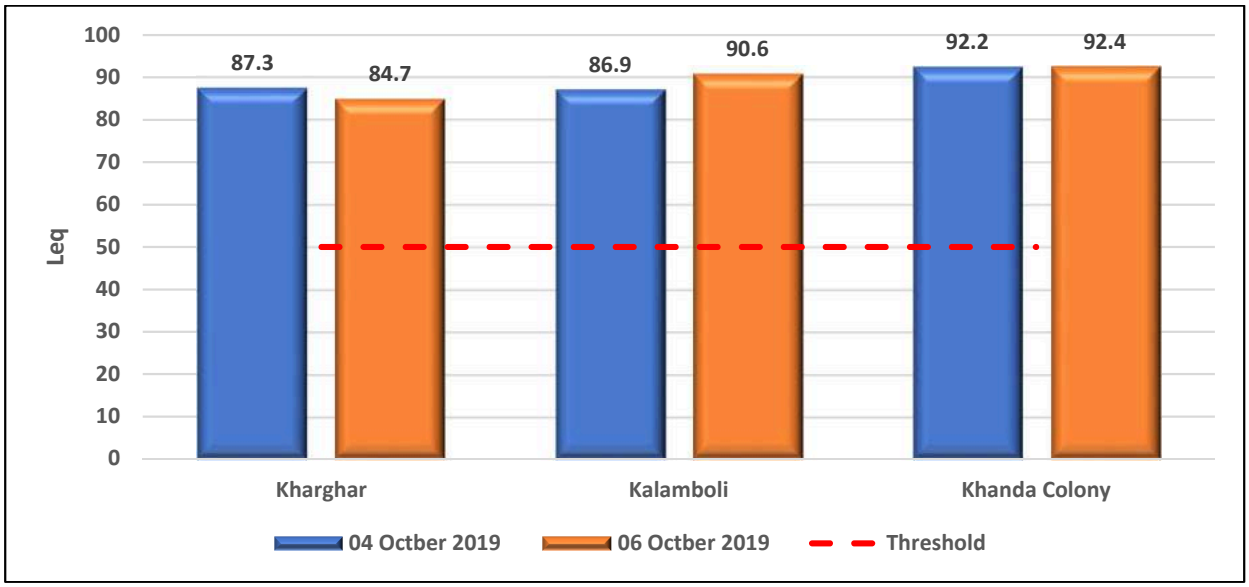
Figure 13 Comparison of threshold and Observed L_{eq} during Navaratra Festival (2018)



Source: Samples collected by Environmental Status Report Committee at MSE-PP

The above chart reveals that all the locations of the celebration of Navaratra Festival during October 2018 violated the threshold noise level standards set by the Govt. of India. The noise level norms got violated on the selected days at all the chosen locations in Panvel City.

Figure 14 Comparison of threshold and Observed L_{eq} during Navaratra Festival (2019)



Source: Samples collected by Environmental Status Report Committee at MSE-PP

2019 was no different from 2018 about the noise levels during the celebration of the Navaratra Festival in Panvel that violated the threshold noise level standards set by the Govt. of India. The noise level norms got violated on the selected days at all the chosen locations in Panvel City.

Due to Covid-19 guidelines, the Navaratra Festival celebrations were not allowed in the city, hence there was no noise pollution during the Navaratra Festival 2020-21.

The MPCB collects and measures noise levels for day time (6AM to 10PM) and night time (10 PM to 6AM) during Diwali Festival every year. During Diwali Festival the MPCB collected and measured the noise levels for day and night time in Panvel City at three locations (Shivaji Chowk, Khanda Colony, and Utsav Chowk, Kharghar) on 26th, 27th and 29th October 2019.

Table 41 Noise Levels during Diwali Festival Day/Night Time (2019)

Location	Date	Day Time (6AM-10PM) values in dB(A)					
		L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}
Shivaji Chowk	26.10.2019	73.9	67.2	80.8	77.1	71.5	68.8
Khanda Colony	26.10.2019	73.9	66.7	79.3	76.7	72.9	68.8
Utsav Chowk, Kharghar	26.10.2019	**76.0**	63.3	**81.4**	79.1	74.5	70.0
	Date	**Night Time (10PM-6AM) values in dB(A)**					
Shivaji Chowk	26.10.2019	59.2	54.7	63.1	61.6	57.9	55.1
Khanda Colony	26.10.2019	**64.7**	58.7	68.7	68.4	63.1	59.4
Utsav Chowk, Kharghar	26.10.2019	62.9	53.2	**69.8**	64.8	58.8	54.7
	Date	**Day Time (6AM-10PM) values in dB(A)**					
Shivaji Chowk	27.10.2019	**69.8**	63.0	**75.3**	73.8	67.7	63.9
Khanda Colony	27.10.2019	64.5	52.9	69.0	67.3	62.4	59.9
Utsav Chowk, Kharghar	27.10.2019	64.3	55.7	68.6	66.3	64.5	56.1
	Date	**Night Time (10PM-6AM) values in dB(A)**					
Shivaji Chowk	27.10.2019	59.0	52.3	62.1	61.5	58.7	54.0
Khanda Colony	27.10.2019	58.8	53.2	61.2	61.1	58.5	54.0
Utsav Chowk, Kharghar	27.10.2019	**59.1**	52.6	**63.3**	62.2	58.1	52.7
	Date	**Day Time (6AM-10PM) values in dB(A)**					
Shivaji Chowk	29.10.2019	**69.6**	58.9	**73.0**	72.3	69.6	62.8
Khanda Colony	29.10.2019	69.3	62.3	72.3	71.4	69.3	65.2
Utsav Chowk, Kharghar	29.10.2019	68.5	57.2	72.3	71.3	67.5	57.9
	Date	**Night Time (10PM-6AM) values in dB(A)**					
Shivaji Chowk	29.10.2019	58.3	52.3	62.3	60.9	57.6	52.3
Khanda Colony	29.10.2019	57.0	50.3	63.1	60.3	53.6	51.0
Utsav Chowk, Kharghar	29.10.2019	**58.9**	51.3	**65.1**	61	56.6	51.3

Source: MPCB, Noise Monitoring Report During Diwali Festival 2019

The noise levels from 6 AM to 10 PM, known as the Day-Time, were found violating the threshold levels. On 26th October, the L_{eq} was found to be highest at Utsav Chowk (76 dB(A)) from 6 AM to 10 PM and at Khanda Colony (64.7 dB(A)) from 10 PM to 6 AM compared to the other two locations. The highest L_{eq} was observed at Shivaji Chowk (69.8 dB(A)) from 6 AM to 10 PM and Utsav Chowk (59.1 dB(A)) during the Night-Time on 27th October 2019. The highest L_{eq} was observed at Shivaji Chowk (69.6 dB(A)) during day time and Utsav Chowk (58.9 dB(A)) during the Night-Time on the 29th October 2019.

The higher L_{max} is very dangerous for human ears, it may be more harmful during night time compare to day. On 26th October, the L_{max} was found to be highest (81.4 dB(A)) from 6 AM to 10

PM (69.8 dB(A)) from 10 PM to 6 AM at Utsav Chowk compared to the other two locations. The highest L_{max} was observed at Shivaji Chowk (75.3 dB(A)) from 6 AM to 10 PM and Utsav Chowk (63.3 dB(A)) during the Night-Time on 27th October 2019. The highest L_{max} was observed at Shivaji Chowk (73.0 dB(A)) during day time and Utsav Chowk (65.1 dB(A)) during the Night-Time on the 29th October 2019.

Table 42 Noise Levels during Diwali Festival for last 2 years

Date	Day/Night Time	Measure	Location		
			Shivaji Chowk	Khanda Colony	Kharghar Utsav Chowk
01-Nov-18	Day Time	L_{eq}	70.1	68.4	70.4
		L_{min}	61.3	60.3	61.3
		L_{max}	78.0	74.0	78.0
26-Oct-19		L_{eq}	73.9	73.9	**76.0**
		L_{min}	67.2	66.7	63.3
		L_{max}	80.8	79.3	**81.4**
01-Nov-18	Night Time	L_{eq}	57.1	59.3	55.5
		L_{min}	45.5	49.1	45.5
		L_{max}	64.2	65.3	61.6
26-Oct-19		L_{eq}	59.2	**64.7**	62.9
		L_{min}	54.7	58.7	53.2
		L_{max}	63.1	68.7	**69.8**
07-Nov-18	Day Time	L_{eq}	**74.0**	70.8	73.3
		L_{min}	65.4	60.2	61.5
		L_{max}	77.7	80.8	**82.8**
27-Oct-19		L_{eq}	69.8	64.5	64.3
		L_{min}	63.0	52.9	55.7
		L_{max}	75.3	69.0	68.6
07-Nov-18	Night Time	L_{eq}	58.5	58.0	**61.0**
		L_{min}	52.2	51.7	52.2
		L_{max}	66.1	65.0	**68.2**
27-Oct-19		L_{eq}	59.0	58.8	59.1
		L_{min}	52.3	53.2	52.6
		L_{max}	62.1	61.2	63.3
09-Nov-18	Day Time	L_{eq}	68.5	**74.8**	70.6
		L_{min}	59.1	64.3	52.1
		L_{max}	73.3	**78.8**	75.9
29-Oct-19		L_{eq}	69.6	69.3	68.5
		L_{min}	58.9	62.3	57.2
		L_{max}	73.0	72.3	72.3
09-Nov-18	Night Time	L_{eq}	58.6	**60.2**	58.2
		L_{min}	51.2	50.2	52.6
		L_{max}	62.6	**65.6**	60.3
29-Oct-19		L_{eq}	58.3	57.0	58.9
		L_{min}	52.3	50.3	51.3
		L_{max}	62.3	63.1	65.1

Source: MPCB, Noise Monitoring Report During Diwali Festival 2018, 2019

There are three days when people burn the crackers during Diwali, including Narak Chaturdashi, Laxmi Pujan and Bhau Beej. Both L_{eq} and L_{max} were high in 2019 at Utsav Chowk Kharghar in 2019 compared to 2018 at any locations on the first day of Diwali. On Laxmi Pujan, the L_{eq} and L_{max} were more or less the same in 2019 compared to 2018. The highest L_{eq} of 74.8 dB(A) and L_{max} of 78.8 dB(A) were found in the Day Time in 2018 compared to 2019 at Khanda Colony.

Table 43 Hourly Noise Levels during Diwali Festival (2019)

Hour	Shivaji Chowk			Khanda Colony			Utsav Chowk, Kharghar		
	26-10-2019	27-10-2019	29-10-2019	26-10-2019	27-10-2019	29-10-2019	26-10-2019	27-10-2019	29-10-2019
06:00-07:00	67.2	63	58.9	66.7	61.9	67.8	63.3	56.1	63.5
07:00-08:00	68.9	64.6	69.3	69.3	60.3	69.3	70.1	56.1	65.7
08:00-09:00	69.5	66.2	62.3	72.5	52.9	66.9	73.1	59.8	58.6
09:00-10:00	68.7	67	69	73.7	59.4	70.2	74.4	62.4	60.2
10:00-11:00	80.8	63.2	72.3	69.3	61.4	71.2	74.6	63.9	57.2
11:00-12:00	73.1	67.9	65.3	71	61.7	65.2	75.9	65	71.2
12:00-13:00	69.9	73.1	69.9	71.6	64.1	62.3	72.3	65.3	71.3
13:00-14:00	70.7	75.3	63.3	73.2	67.3	65.1	79.9	64.6	62.5
14:00-15:00	75.9	68.7	66.3	73.4	67.3	69.3	81.4	65.7	69.3
15:00-16:00	78.3	71	68.3	68.3	62.5	71.3	72.3	64.3	69.3
16:00-17:00	69.5	69.3	72.3	72.3	66.5	72.3	76.3	64	72.3
17:00-18:00	71.8	66.3	71.3	74.7	60.9	69.3	78.3	66.2	71.3
18:00-19:00	71.7	68.7	70	74.3	66.7	65.3	69.9	55.7	70.5
19:00-20:00	71.3	74.5	73	75.8	69	69.3	76.9	66.4	65.7
20:00-21:00	74.2	65.2	71.3	77.5	65.3	70.3	78	64.6	57.2
21:00-22:00	72.3	67.4	69.9	79.3	62.3	71.5	71.7	68.6	71.3
22:00-23:00	63.1	60.8	60.3	68.7	59.2	63.1	69.8	63.3	65.1
23:00-00:00	60.2	58.7	52.3	68.2	55.1	55.3	62.7	57.6	59.3
00:00-01:00	57.4	54.7	58.4	64.8	54.3	52.3	57.8	52.6	51.3
01:00-02:00	56.2	52.3	62.3	63.7	61.2	50.3	56.1	58.6	56.3
02:00-03:00	55.2	58.7	54.3	59.8	60.8	51.3	53.2	59.6	51.3
03:00-04:00	54.7	54.8	59.3	58.7	57.8	53.3	55.4	55.2	53.3
04:00-05:00	58.4	61.3	56.9	59.7	53.2	59.1	59.8	52.8	58.8
05:00-06:00	60.9	62.1	52.3	62.4	61.1	53.8	62.5	61.7	56.8

Source: MPCB, Noise Monitoring Report During Diwali Festival 2019

It is observed that Utsav Chowk, Kharghar had more noisy hours followed by Khanda Colony during the 2019 Diwali Festival. It is also observed that 26th October had relatively more noisy hours than the other two days. Khanda Colony had relatively more noisy hours in Night-Time.

The detailed data on Diwali Festival of 2020-21 is not made available by the MPCB, but overall city level noise monitoring was conducted by the MPCB due Covid-19 guidelines of the government.

Table 44 Noise Level Monitoring Before Diwali for the year 2019 and 2020

Dates	11-Nov-20	26-Oct-19	11-Nov-20	26-Oct-19
Time Slots	Day Time (6 am to 10 pm)		Night Time (10 pm to 6 am)	
Standards	65 dBA (C)		55 dBA (C)	
	Leq dBA	Leq dBA	Leq dBA	Leq dBA
Panvel City	69.8	74.6	57.5	62.3

Source: MPCB, Noise Monitoring Report During Diwali Festival 2019 and 2020

The noise pollution during Diwali Festival in 2020-21 had a great impact of Covid-19 guidelines. During the first day of the Diwali Celebrations relatively lower noise pollution was recorded in the city in 2020 compared to the same day of the Diwali celebration of 2019.

Table 45 Noise Level Monitoring During Diwali for the year 2019 and 2020

Dates	14-Nov-20	27-Oct-19	14-Nov-20	27-Oct-19
Time Slots	Day Time (6 am to 10 pm)		Night Time (10 pm to 6 am)	
Standards	65 dBA (C)		55 dBA (C)	
	Leq dBA	Leq dBA	Leq dBA	Leq dBA
Panvel City	73.7	66.2	61.2	59

Source: MPCB, Noise Monitoring Report During Diwali Festival 2019 and 2020

On the day of Narak Chaturdashi and Laxmi Pujan during 2020 Diwali Festival, relatively greater noise pollution was recorded compared to that of the same days of 2019, which is very surprising, though it is not significantly high compared to the threshold.

Table 46 Noise Level Monitoring on Bhaubij (Diwali) for the year 2019 and 2020

Dates	16-Nov-20	29-Oct-19	16-Nov-20	29-Oct-19
Time Slots	Day Time (6 am to 10 pm)		Night Time (10 pm to 6 am)	
Standards	65 dBA (C)		55 dBA (C)	
	Leq dBA	Leq dBA	Leq dBA	Leq dBA
Panvel City	71.8	69.1	61.4	58.1

Source: MPCB, Noise Monitoring Report During Diwali Festival 2019 and 2020

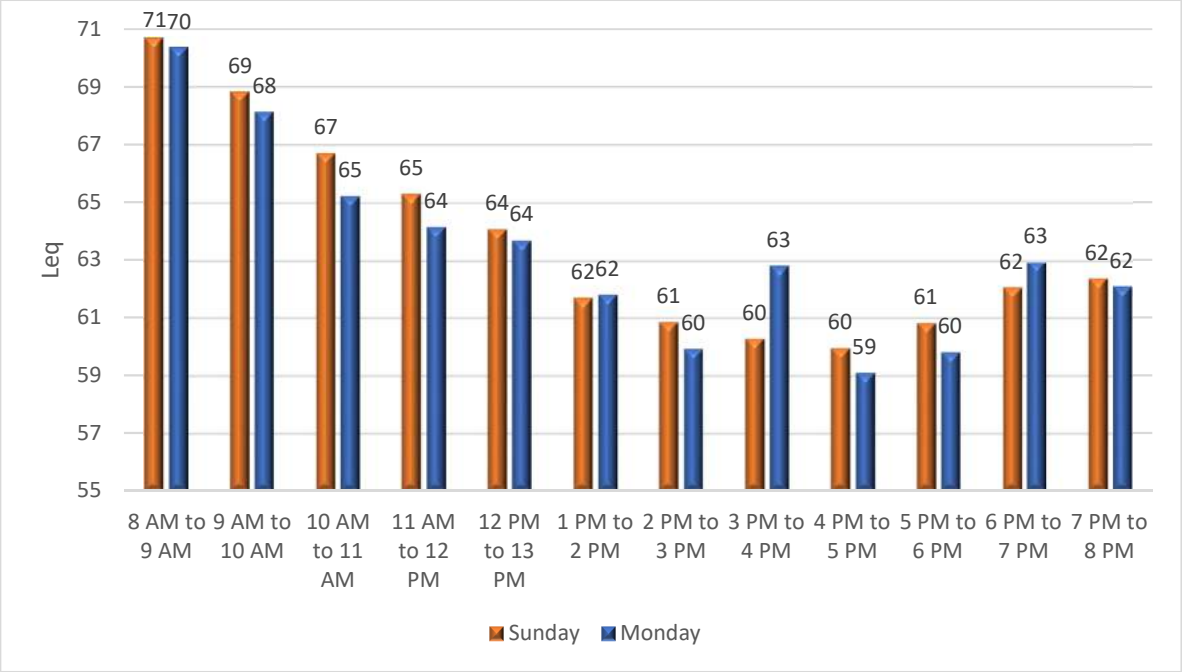
On the day of Bhaubij Celebrations during Diwali 2020, marginally greater noise pollution was observed compared to the same days of Diwali 2019.

4.4.2.2 Noise Pollution during Non-Festival Days

The data from MPCB covers noise pollution in Ganesh Festival and our samples in Navaratri Festival helps in analysis of noise levels during Festivals. However, there is also a need to observe the levels of noise on non-festival days, for which we have carried noise analysis for Panvel City by selecting one weekday and one weekend. We selected three locations in the city for sample noise levels viz. one from a residential area in Kamothe, one near to highway at Kalamboli Circle and one with heavy traffic at Central Bus Stand, Panvel. We have done a sample collection of noise with the help of A Type Sound Level Meters.

The hourly L_{eq} is computed for both days from 8 AM to 8 PM at selected locations on Sunday as a weekend and Monday as a Weekday. Our classification of 12 hours from 8 AM to 8 PM, to capture hourly L_{eq} and observe high noise level hours and low noise level hours, is part of day time (6 AM to 10 PM) as defined by CPCB.

Figure 15 Noise Levels (Hourly L_{eq}) at Sector 16, Kamothe on Weekday and Weekend



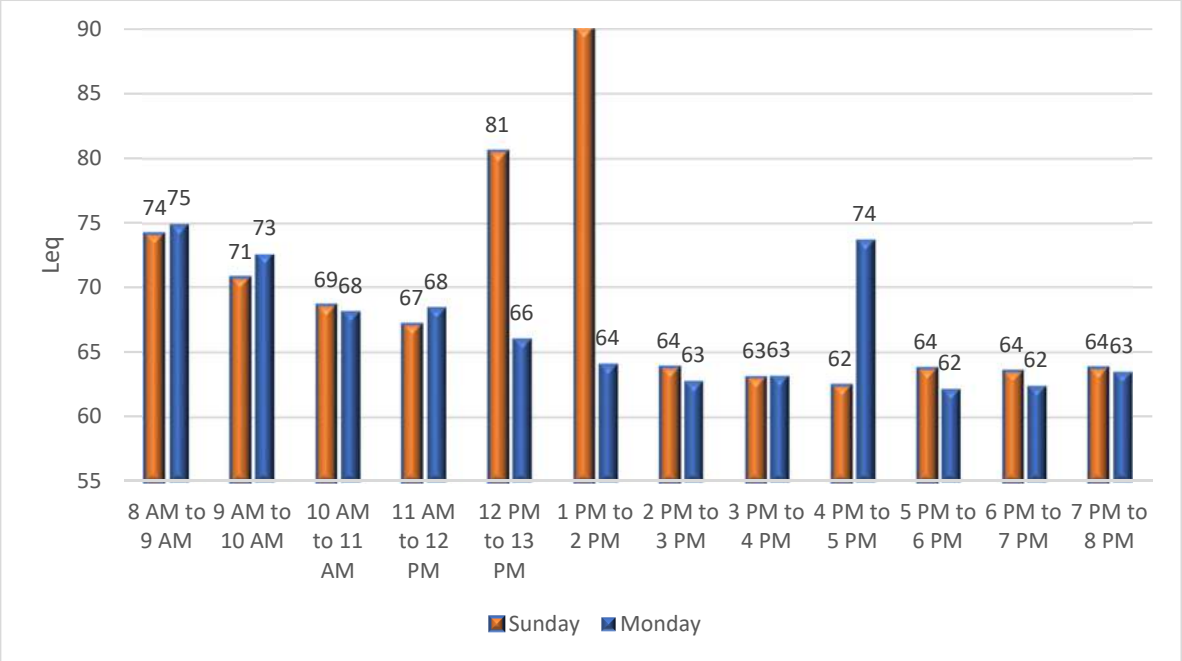
Source: Author's Estimations

The Standards of Noise Levels under EPA (1986) and Noise Pollution (Regulation & Control) Rules, 2000 prescribed threshold levels of hourly L_{eq} for Day Time is 50 dB(A) for silence zones, 55 dB(A) for residential areas, 65 for commercial areas and 75 for commercial areas. We have compared our hourly L_{eq} with that of respective threshold levels of noise. The results are as follows.

It is observed that Sector 16, Kamothe, is a residential area in the city and has significantly greater noise pollution during all hours classified (8 AM to 8 PM) compared to threshold noise levels. It is also observed that the noise levels are significantly high during the morning, 8 AM to 10 AM. And noise levels from 4 PM to 6 PM are close to the threshold but greater than the threshold.

It is observed that Kalamboli Circle, which is on Mumbai-Pune Highway, had significantly greater noise pollution during all hours classified (8 AM to 8 PM) compare to threshold noise levels on both days. It is also observed that the noise levels were significantly high during the morning from 12 PM to 2 PM on Sunday. 8 AM to 10 AM also observed high levels of noise compared to the rest of the hours except 12 PM to 2 PM. And noise levels from 3 PM to 5 PM on Sunday and 5 PM to 7 PM on Monday were close to the threshold but greater than the threshold.

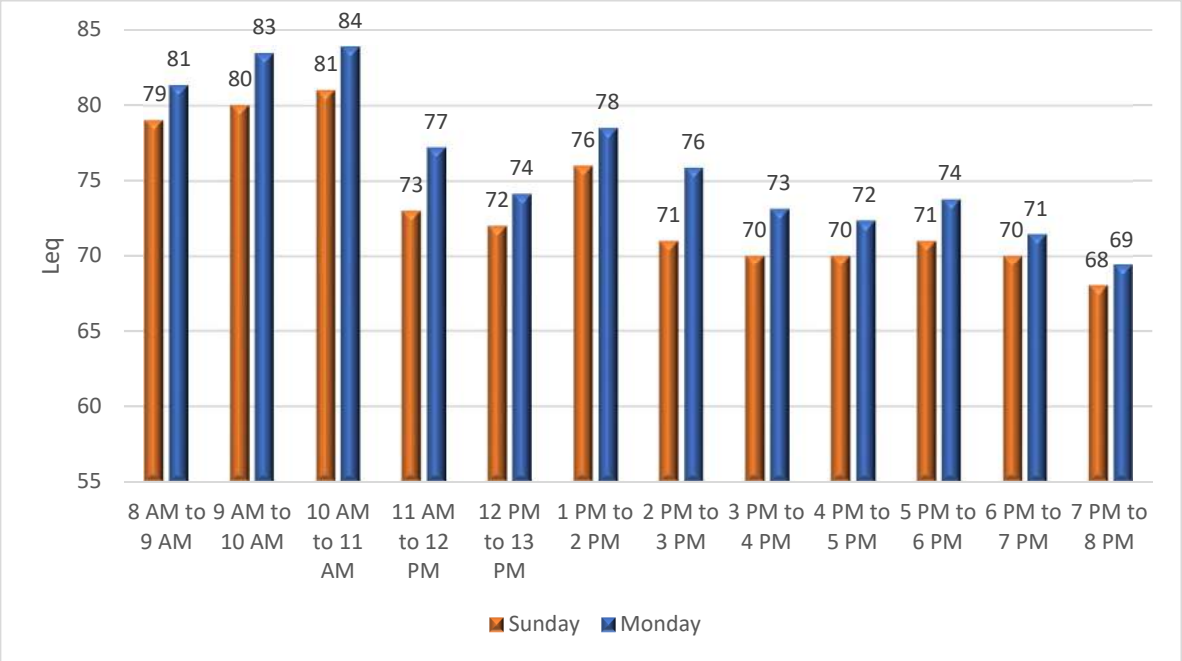
Figure 16 Noise Levels (Hourly L_{eq}) at Kalamboli Circle on Weekday and Weekend



Source: Author's Estimations

The Bus Stand, Panvel, is almost Commercial Area, had significantly greater noise pollution during all hours classified (8 AM to 8 PM) compare to threshold noise levels (65).

Figure 17 Noise Levels (Hourly L_{eq}) at Bus Stand, Panvel on Weekday and Weekend



Source: Author's Estimations

The noise levels were significantly high from 8 AM to 11 AM on Monday. 1 PM to 2 PM also observed high noise levels compared to the rest of the hours except 8 AM to 11 AM. And noise levels from 7 PM to 8 PM were least in the entire day but greater than the threshold.

Due to Covid-19 guidelines noise samples were not collected for the non-festival days in the city during 2020-21.

4.2.3 Water Pollution:

The UN Environment states that once water is contaminated, it is difficult, costly, and often impossible to remove the pollutants. Still today, 80 per cent of global wastewater goes untreated, containing everything from human waste to highly toxic industrial discharges. The nature and amount of pollutants in freshwater determine water suitability for many human uses such as drinking, bathing, and agriculture. In addition, pollution of freshwater ecosystems can impact fish and other wildlife's habitat and quality of life.

Pollution in freshwater ecosystems can include pathogens (mainly from human and animal waste), organic matter (including plant nutrients from agricultural run-off such as nitrogen or phosphorus), chemical pollution and salinity (from irrigation, domestic wastewater and run-off of mines into rivers). (UN).

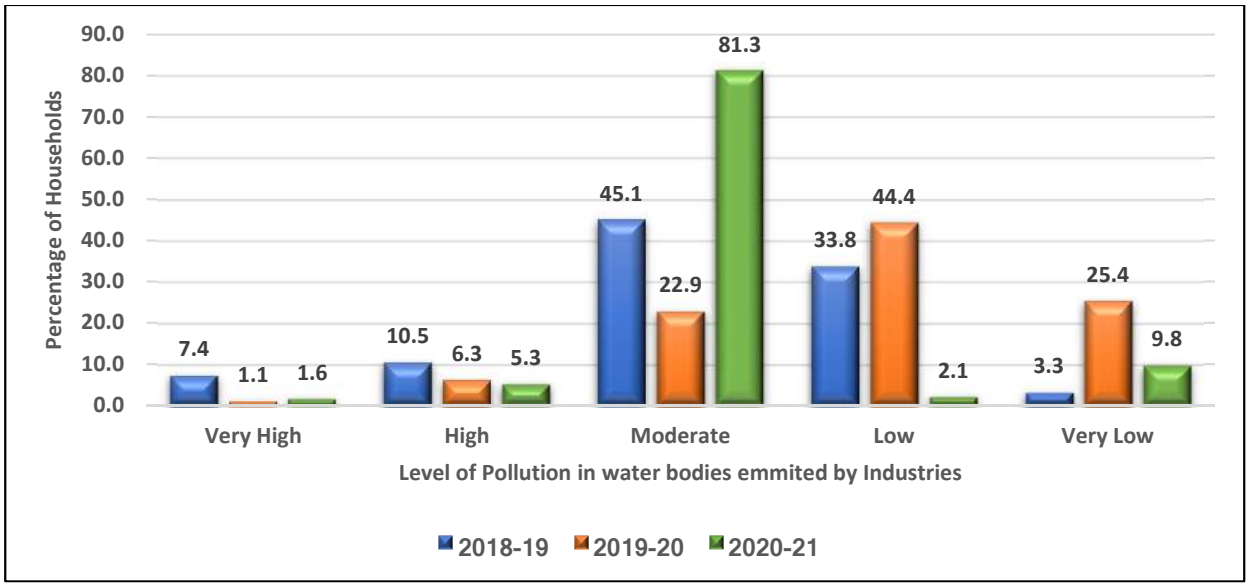
Water quality problems persist in developed and developing countries alike and include the loss of pristine-quality water bodies, impacts associated with changes in hydromorphology, the rise in emerging pollutants and the spread of invasive species (UN, 2018). Poor water quality directly impacts people who rely on these sources as their main supply by further limiting their access to water (i.e. water availability) and increasing water-related health risks (not to mention their overall quality of life) (UNWWDR, 2019).

Several water-related diseases, including cholera and schistosomiasis, remain widespread across many developing countries, where only a very small fraction (in some cases less than 5%) of domestic and urban wastewater is treated before its release into the environment (WWAP, 2017).

Taloja MIDC, Kalamboli Industrial Area and Jawahar Co-operative Industrial Estate, Kamothe are the major industrial areas in Panvel. Taloja MIDC has many chemical factories and the Kalamboli Industrial area has units that produce and process steel and metals. There have been instances

when the residents near Kasadi and Taloje river banks have complained that nearby industries contaminate the river water. And it is also observed that the residents have experienced polluted air due to residuals from these industrial units. Our environmental survey confirmed the observations.

Figure 18 Household Perception about Water Pollution by Industrial Units



Source: Environmental Survey 2018-19, 2019-20 and 2020-21 for Panvel City

We also have explored the perception of households about pollution in water bodies contributed by industrial units in the City. Ninety-two per cent of households believe that Industrial Units pollute water bodies in the range of a moderate to very high and only 6.9 per cent believed that there is a high to very high water pollution in Panvel City by releasing industrial wastewater in water bodies, mainly Taloje and Kasadi rivers. The households from Ward No. 1 and 2 have expressed serious concerns about pollution in water bodies by industrial units in Taloja MIDC.

Though largely water is supplied through the tap, every month, Panvel Municipal Corporation sends water samples to Public Health Laboratory, Alibag, for testing the water quality to check whether the water supplied in the City is safe. The details of the test carried on drinking water is as follows.

The water quality was not good in the month of June, July, August and September 2018. The water quality was worst in the month of July 2018 and 2019. In the rest of the months, water quality is good in Panvel City. The percentage of invalid samples in 2018-19 was 7.42 and in 2019-

20, it was 7.2. The percentage of invalid samples in 2020-21 was only 4.9 per cent. The months of June, July and August together had 68, 60.6 and 8.94 per cent of invalid samples in 2018, 2019 and 2020, respectively.

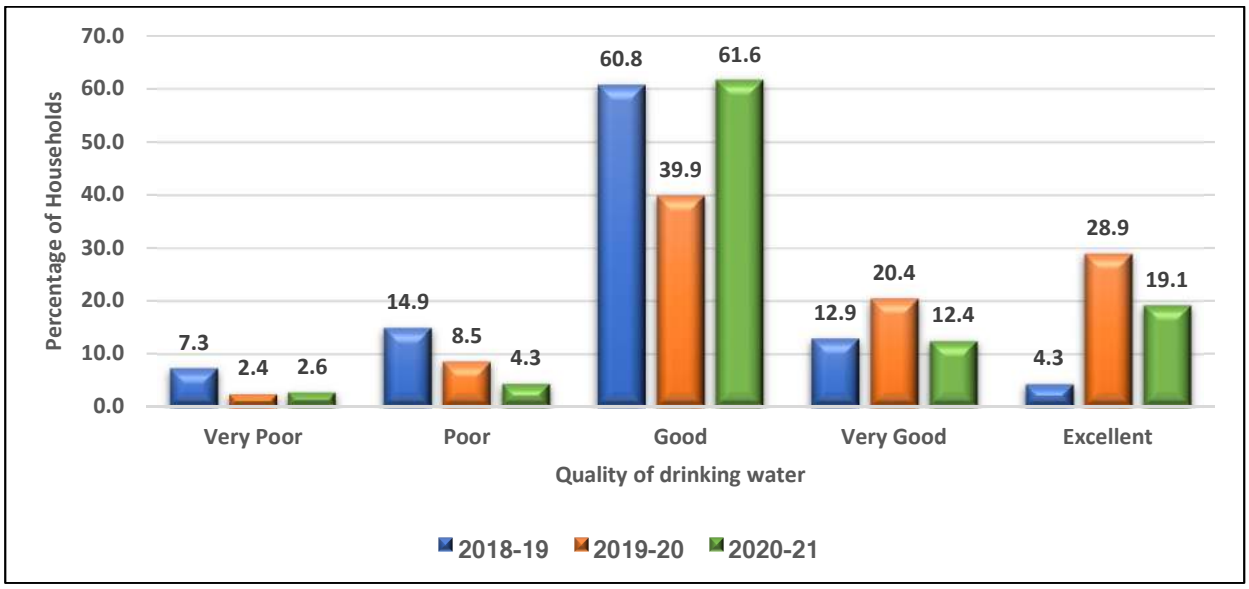
Table 47 Report of Quality of Drinking Water in Panvel City

Month	Samples Sent			Valid Samples			Invalid Samples			Percentage of Invalid Samples		
	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21	2018-19	2019-20	2020-21
Apr	120	124	80	114	116	74	6	8	6	5	6.5	7.5
May	120	120	120	120	106	99	0	14	**21**	0	11.7	**17.5**
Jun	120	120	123	108	100	112	12	20	11	10	16.7	8.94
Jul	120	120	123	87	94	123	**33**	**26**	0	**27.5**	**21.7**	0
Aug	120	120	80	92	103	80	28	17	0	23.3	14.2	0
Sep	120	120	120	108	119	115	12	1	5	10	0.8	4.16
Oct	120	120	102	119	117	96	1	3	6	0.8	2.5	5.88
Nov	121	121	140	121	117	136	0	3	4	0	2.5	2.85
Dec	120	120	140	110	114	137	10	6	3	8.3	5	2.14
Jan	120	121	128	120	118	123	0	3	5	0	2.5	3.9
Feb	120	121	121	118	121	117	2	0	4	1.7	0	3.3
Mar	120	121	121	117	118	117	3	3	4	2.5	2.5	3.3
Total	1441	1448	1398	1334	1343	1329	107	104	69	7.4	7.2	4.9

Source: Water Supply Department, Panvel Municipal Corporation, Panvel

It is observed that 88 per cent of households revealed that Drinking Water Quality is good to excellent. Twenty-nine villages get water supply from MIDC located around Taloja MIDC and others from MJP and Panvel Municipal Corporation except for residents in CIDCO developed areas.

Figure 19 Percentage of Households revealing Quality of Water



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

Only 6.9 per cent of the households stated that the water quality in the City in 2020-21 is poor to very poor. It indicates that largely water quality is good to excellent. There has been improvement in the quality of the water, revealed by the households in 2020-21 compared with the earlier years. Though water quality is good, households use various methods to purify water as a precautionary measure to save themselves from water-borne diseases.

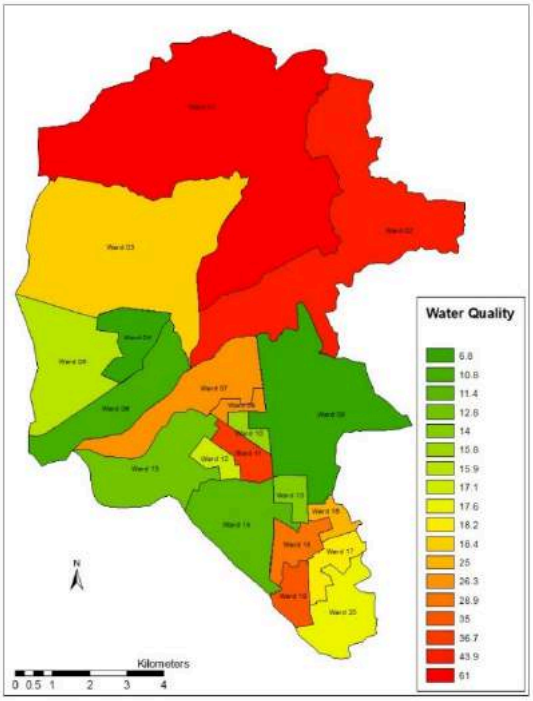
Hence it would be important to know in which areas of Panvel City water quality is revealed to be poor to very poor. It is observed that in Ward No. 1 and 2 that constitutes mainly villages to which MIDC supplies water, 61 percent and 43.9 percent of households respectively expressed that the water quality is poor to very poor in 2018-19. The water quality in Ward No. 11 and 19 has been revealed as poor to very poor by significant percentage of households.

There is improvement in the water quality in the City, as the maximum percentage of households revealing the quality of water to be poor to very poor found to be 44 in Ward 1 in 2019-20.

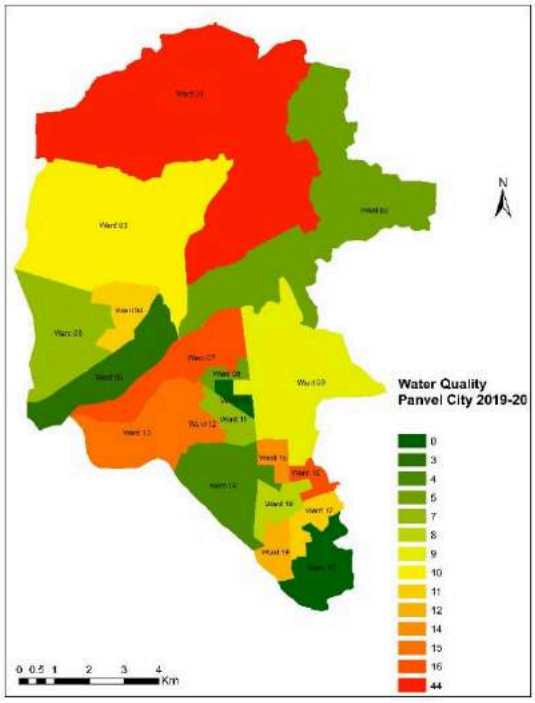
The households revealed that there have been significant improvements in the quality of drinking water during 2020-21, except wards 1, 2 and 3. The households in Kalamboli (Ward 8) have shown concerns over the quality of drinking water.

Map 14 Ward-wise Percentage Households claiming Poor to Very Poor Quality of Water

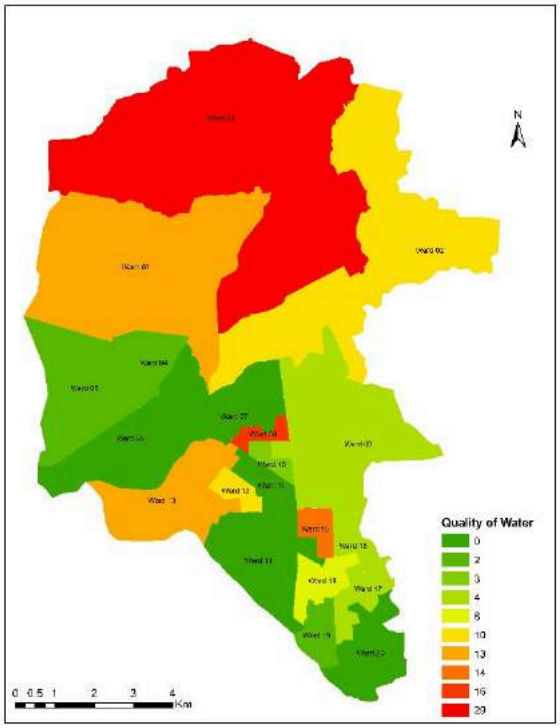
2018-19



2019-20



2020-21



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

5 IMPACTS-FACTORS DETERMINING HUMAN WELL-BEING

There are environmental, demographic, social and material factors determining human well-being. The environmental factors include ecological services, cultural services, regulating services and supporting services provided by local governments, non-ecosystem natural resources and stress, diseases and hazards. And demographic, social and material factors include security, basic material needs, good health and good social relations, which may result in human development or poverty, inequity and human vulnerability.

5.1 Environmental Factors Determining Human Well-Being

Ecological services such as provisioning services (consumptive use), cultural services (non-consumptive use), regulating services and supporting services (indirect use), Non-ecosystem natural resources, i.e. hydrocarbons, minerals and renewable energy, Stress, inter alia diseases, pests, radiation and hazards determine human well-being.

5.1.1 Ecological services

Ecological services such as provisioning services (consumptive use), cultural services (non-consumptive use), regulating services and supporting services (indirect use) are important in understanding the impact on human well-being.

The provisioning services are the products obtained from ecosystems such as food, freshwater, wood, fibre, genetic resources and medicines. Soil biodiversity is a major factor in soil formation, which supports a range of provisioning services such as food, fibre and fuel provision and is fundamental to soil fertility, a highly important ecosystem service.

The Panvel City has very limited agricultural activities that too for subsistence level through which only rice is produced. There are few water bodies in Panvel City like Ballaeshwar Lake, Dewale Lake, Panvel Market Lake, Israel Lake, Khandeshwar Lake, Shiv Mandir Pond in Kamothe, Roadpali Lake and Holding Pond and rivers like Taloje, Kasadi and Kalundre are the main water flow in the City. And Panvel Creek is also a big water body, including wetland around the creek. There are few fishing activities in the Kalundre river. But the water bodies of Taloje and Kasadi are highly

polluted due to industrial wastewater and hence no fishing activities are observed in these rivers. The groundwater extracted by individuals is mainly used for domestic use, construction, and industrial purposes except for drinking purposes.

The quality of drinking water is a powerful environmental determinant of health. Assurance of drinking water safety is a foundation for the prevention and control of waterborne diseases. Water is supplied by Maharashtra Jeevan Pradhikaran (MJP), MIDC and Panvel Municipal Corporation in Panvel City. With the inception of Panvel Municipal Corporation, 29 villages from Raigarh Zilla Parishad and CIDCO developed nodes were transferred to Panvel Municipal Corporation. In these areas, independent water supply systems were available.

Under the ownership of PMC, Deharanga Dam is constructed in the year 1964 considering the future water demand. The Deharanga can store 3.57 MLM of water, However, with increasing population and considering the area under PMC the water demand is more than supply. As a result, PMC needs to buy water from Maharashtra Jeevan Pradhikaran (MJP), Maharashtra Industrial Development Corporation (MIDC) and Navi Mumbai Municipal Corporation (NMMP). The Old Panvel receives water from MJP and MIDC, which is less than the requirement. To meet the requirement, the excess water is been extracted from Dehrang Dam. Therefore, to manage the water reserve at Dehrang dam till June, the water supply at the old Panvel has to be cut down for one day per week.

It can be seen from the chart, there is a total of six sources through which PMC is able to manage the water supply. It recorded the total water deficit is 28 ML per day. The PMC area (including Municipal Area and 29 villages) recorded an 8 ML per day water deficit. The water sources are not connected therefore water cannot transfer to other sources in the crisis. The Panvel Municipal Corporation has total 15591 tap connections in its region.

The details of the water supply in the City are as follows.

Table 48 Water Supply in the Panvel City

Sr. No.	Area	Current Demand	Current Supply	Source	Water Deficit
1	Municipal Area	30 ML	30 ML	Deharanga Dam-16ML MJP-10ML MIDC-4 ML	0
2	29 Villages	20 ML	12 ML	MIDC – 9 ML (Palatganga and Baravi) CIDCO – 3ML (Hetavane and Patalganga)	5
3	CIDCO Area New Panvel (East and West)	42 ML	33 ML	MJP-33 ML (Patalganga)	9
4	Kalamboli	30 ML	30ML	MJP – 30 ML (Patalganga)	0
5	Kamothe	40ML	35ML	NMMP – 35 ML (Morabe)	5
6	Navade	1ML	1ML	MIDC – 1 ML – (Baravi)	0
7	Kharghar	72 ML	67ML	CIDCO-57 ML (Hetvane) NMMP-10ML (Morabe)	5
8	Taloja	8ML	7ML	MIDC – 07 ML (Baravi)	1
9	Kalundre	1ML	1ML	MIDC – 071 ML (Baravi)	0
	TOTAL	**244**	**216**		**28ML**

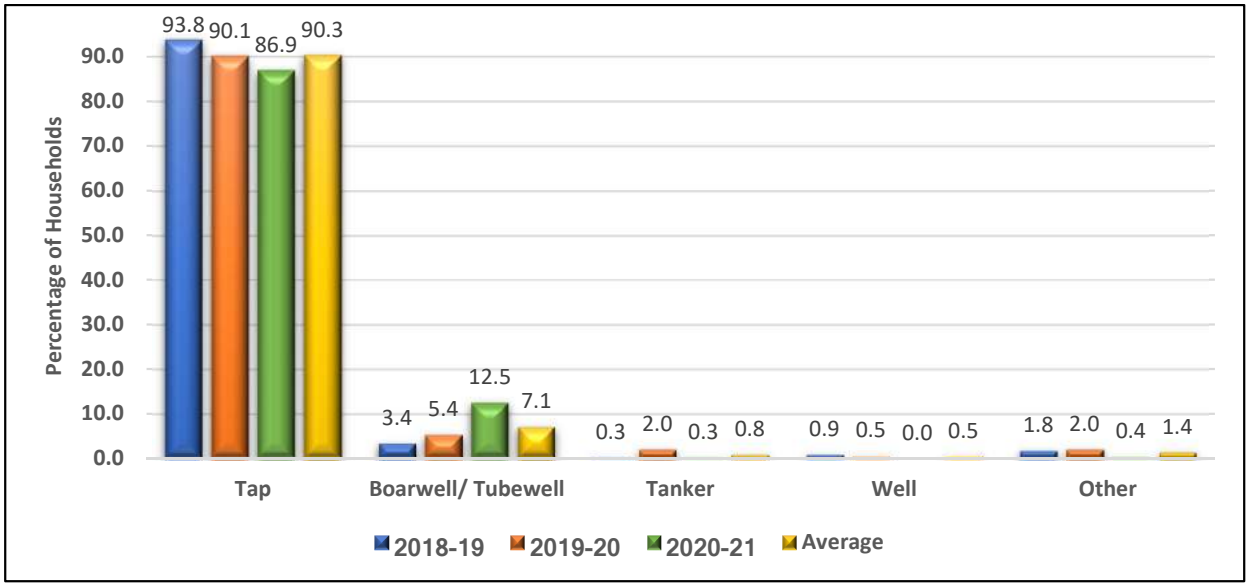
ML: Million Liters

Source: Water Supply Department, Panvel Municipal Corporation, Panvel, 2020-21

In general, the water supply in Panvel City is regular. The water gets over in Dehrang Dam in Summer, which causes a reduction in water supply from MJP and MIDC. There is an alternate day water supply in Municipal Council Area and villages get a shortage of water. Hence Municipal Corporation provides water with the help of tankers in Panvel City. An average of 50 to 60 tankers per day water is supplied in addition to tapped water in Panvel City in Summer.

Our Environmental Surveys also explored the provision of water in Panvel City.

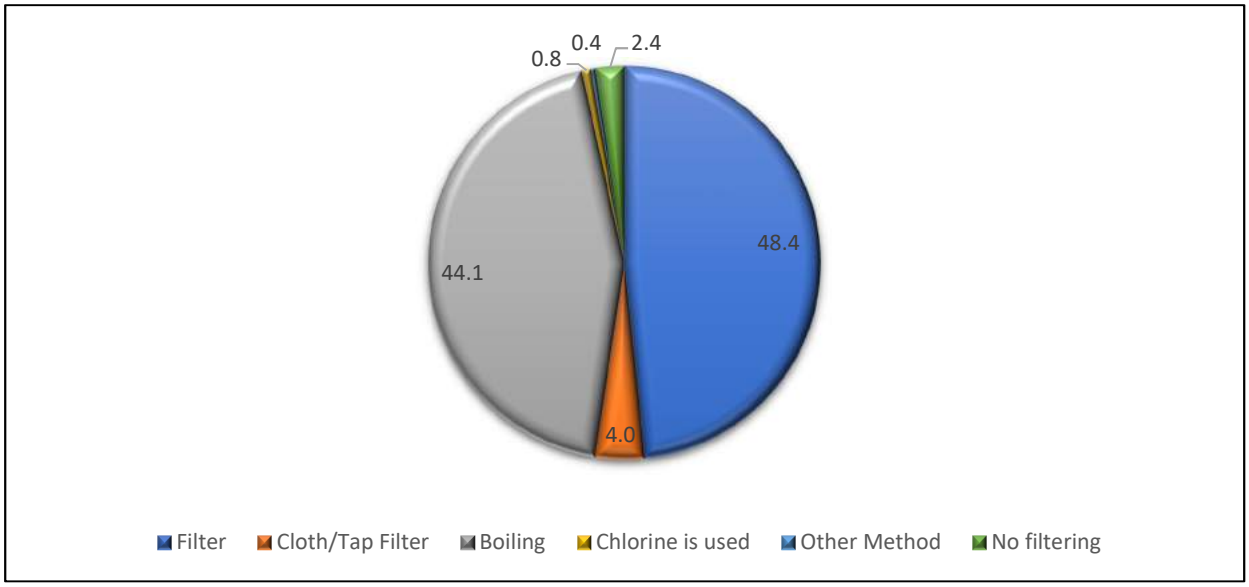
Figure 20 Source of Drinking Water in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

Our survey confirms that 87 to 93.8 per cent of total households in the city get tapped water for drinking. The WHO and UN Environment define tap water as a source of safe and quality drinking water. But we have observed that a significant proportion of residents use water filters to improve water quality and make water safe for consumption.

Chart 7 Methods of Filtering Water adopted by Households in Panvel City (2020-21)



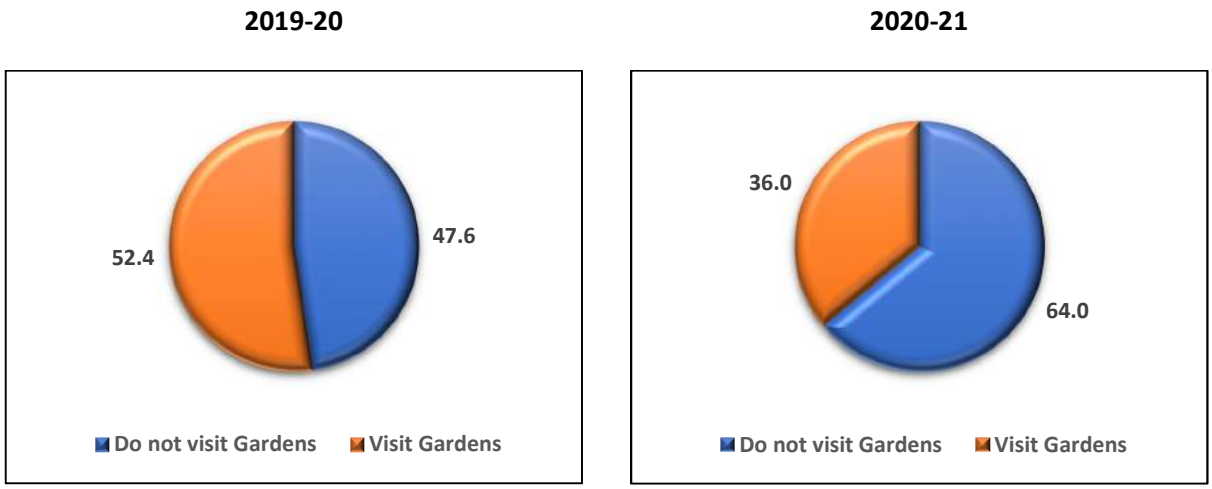
Source: Environmental Survey, 2020-21

Though only 6.9 per cent of the households stated that the water quality is poor to very poor, 97.6 per cent of households use one or the other method for filtering and cleaning water to make it safe for drinking. 48.4 per cent of households have proper filters for cleaning water and making it safe for drinking. Only 2.4 per cent of households do not filter water before drinking.

The cultural services include non-material benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values. Narali Pornima is a festival celebrated by some people like Koli and Agri, originally belonging to Konkan Region in Panvel City, by offering Coconut to the sea. Hindu women perform Vat Savitri Pujan by tying thread to Banyan Tree (Vatvruksh) to prolong husbands' lives. Plants of Banana Tree, Leaves of Mango Tree, leaves of various trees and various fruits are used in offerings to God by Hindu devotees while performing various Poojas and celebrating various festivals across the year. Through which people explore spiritual enrichment, intellectual development and aesthetic values.

Panvel City does not have many tourist spots except gardens, playgrounds and a few lakes and ponds. There is ISKON Temple in Kharghar, where devotees across Panvel and Navi Mumbai visit frequently. Kharghar has a Central Park developed by CIDCO, where the Amphitheatre, Musical Instrumental Park, Hasta Mudra Park and Indian Classical Music Park are very popular, and people visit this park very frequently. Near Central Park, there is Kharghar Golf Club. From the main road, a branch road is made around the 300 m periphery of the golf club and it terminates at the base of Kharghar hills. This small road is known as a driving range. From here, there are pedestrian ways to climb on the hills and enjoy the beauty of the landscapes around. Trekking is a popular activity here. During the rainy season, many people from Kharghar and nearby areas visit here to enjoy the waterfalls and water in a river nearby.

Chart 8 Percentage of Residents Visit Gardens

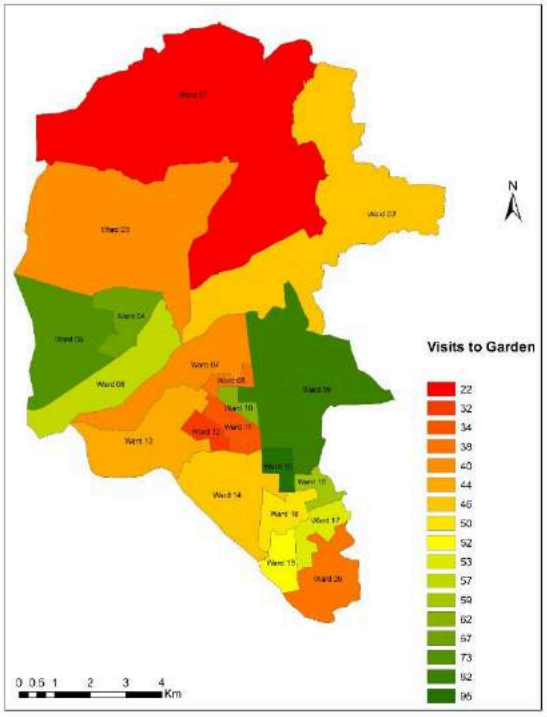


Source: Environmental Survey, 2019-20 and 2020-21.

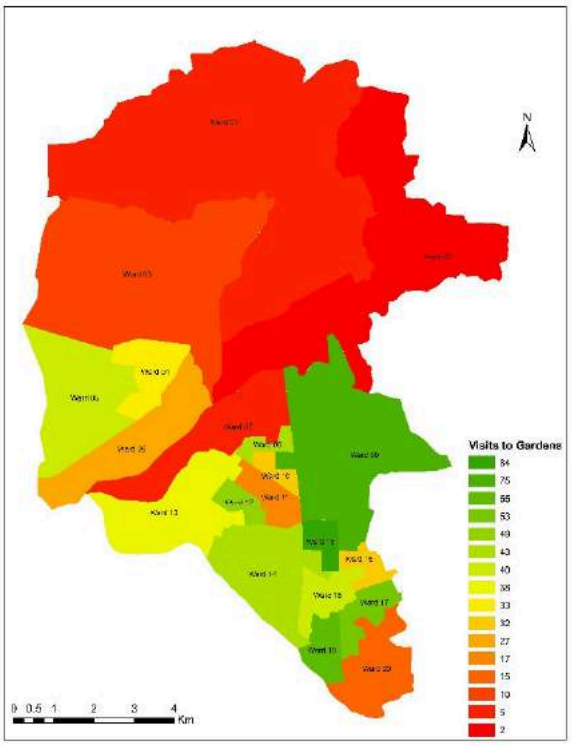
Some bird lovers enjoy watching birds every year as lakhs of migratory birds visit Navi Mumbai, Panvel, and Uran. We explored the resident's visits to the gardens through the environmental survey. It is observed that 50 to 72 per cent of residents visit parks one or the other day in Panvel City, perhaps during Covid-19 (2020-21) the households reduced their visits to the gardens. In the year 2020-21, 36 per cent households stated that they visit the gardens.

Map 15 Ward-wise Percentage Residents Visiting Gardens in Panvel City

2019-20



2020-21



Source: Environmental Survey, 2019-20 and 2020-21.

2.4 per cent residents belonging to Ward No. 2 visited gardens which lowest among all wards. Ward 1, 2, 3, 7 and 20 are the wards in which the households revealed that they do not have gardens nearby hence very rarely visit the gardens. The wards in Kharghar and New Panvel have planned residential areas by CIDCO with reserved plots for parks and playgrounds where relatively more residents visit gardens than other wards. The residents belonging to CIDCO and Panvel Municipal Council Area tend to visit gardens as enough gardens are available nearby their residential locations, but in 29 villages where it is observed that people do not visit gardens frequently due to the non-availability of parks near their residential areas.

Regulating services are defined as the benefits obtained from regulating ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination or pest control. Climate regulation is one of the most important ecosystem services

both globally and in developing countries like India. The climate regulating the function of peatlands depends on land use and intensification (such as drainage and conversion to agriculture). It is likely to profoundly impact the soil capacity to store carbon and carbon emissions (significant quantities of carbon are being emitted from drained peatlands).

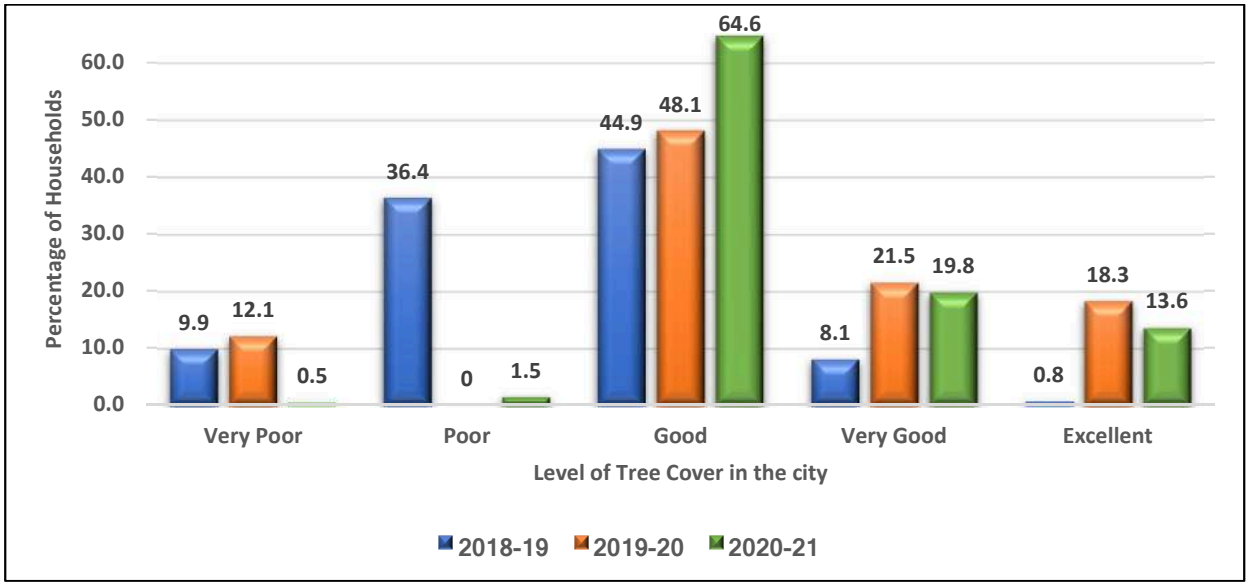
Carbon is an element commonly found on earth in various forms. It is an essential element of all forms of life. The bodies of living organisms contain a sustainable portion of carbon. Carbon is also found in large quantities in non-living things like oil, natural gas, coal, rocks and air. Globally carbon is held in various stocks as oceans, fossil fuel deposits, terrestrial system and the atmosphere. In the terrestrial system, carbon is stored in rocks, sediments, swamps, wetlands, forests, forest soil, grassland and agriculture. About two-thirds of global terrestrial carbon is contained in forests and forest soils. In addition, there are some non-natural human-created carbon stocks as wood products and waste dumps.

The exchange of carbon among its various forms from the atmosphere, oceans and land is called the carbon cycle. The most significant form of carbon exchange is by the plants. Plants draw in carbon dioxide (CO_2) from the atmosphere through photosynthesis and turn it into biomass (wood, leaves and fruits). A part of CO_2 taken by plants is returned to the atmosphere through respiration. Thus, the carbon cycle is renewed and continue interminably.

Human-induced disturbance to the carbon cycle has been both direct and indirect. Direct effects include the carbon cycle through fossil fuel combustion and land-use change, leading to modification of the vegetation structure and distribution. Indirect human impacts on the carbon cycle include changes in other global biogeochemical cycles, alteration of the atmospheric composition through the additions of pollutants as CO_2 and changes in biodiversity of landscape and species.

We have tried to estimate whether tree cover is sufficient in the city since higher tree cover enables an efficient carbon cycle. When we asked the households to rank the tree cover in Panvel city, we received the following observations.

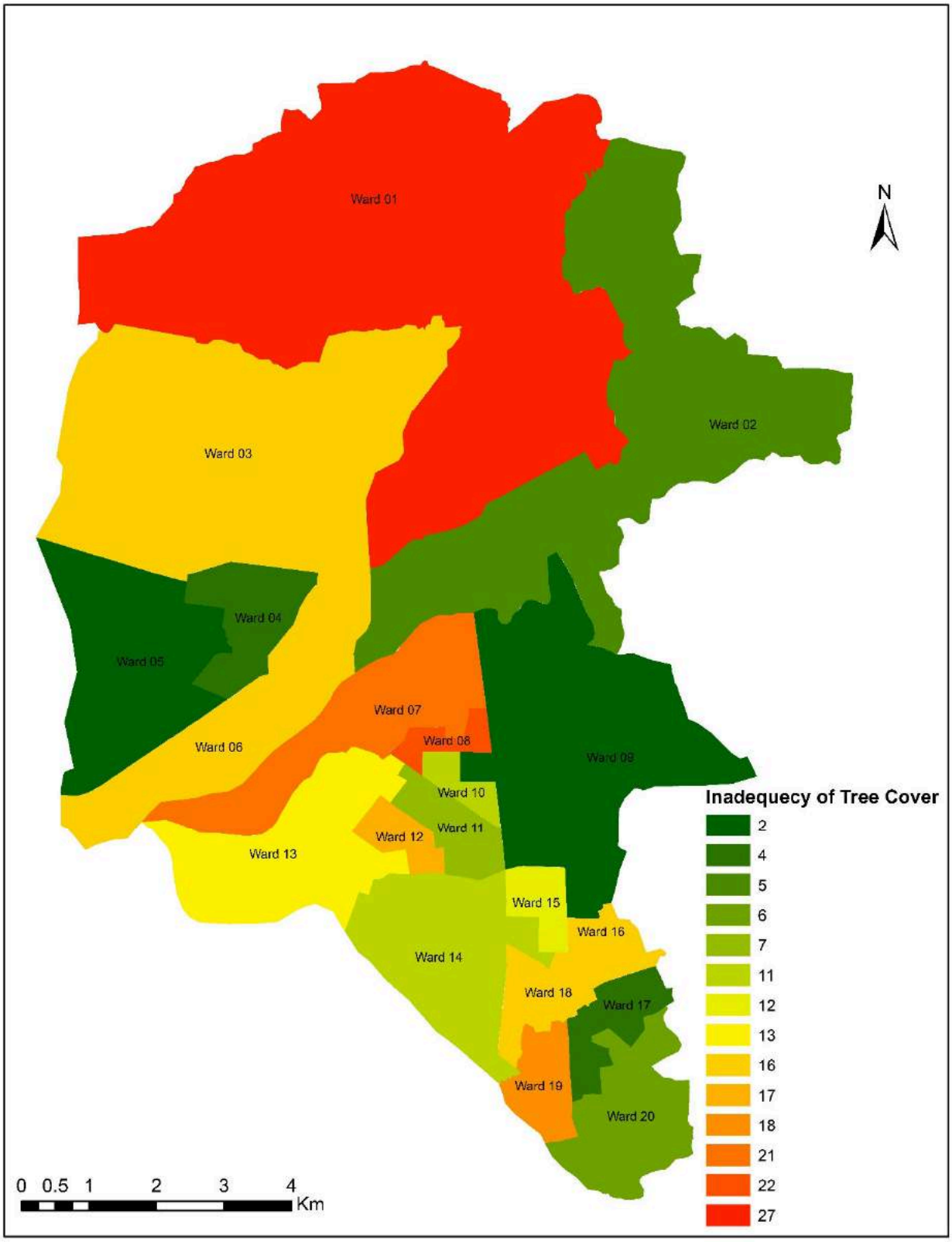
Figure 21 Response of Households about Tree Cover in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

The responses were recorded on a five-point ranking from very poor to excellent. 12.1 per cent of households in 2019-20 stated that the tree cover in Panvel City is poor to very poor, whereas in 2020-21, only 2 per cent households revealed that the tree cover is in the range of poor to very poor. The change in the response related to the tree cover is very surprising, indicating the tree cover improvement in just two years. And 33.4 per cent of households (2020-21) said that the tree cover is very good to excellent. It suggests that the tree cover is significantly improved. There must be damage to the carbon cycle due to deforestation due to rapid urbanisation in the city area. It becomes necessary to observe the ward-wise distribution of responses related to tree cover in Panvel City.

Map 16 Ward-wise Inadequacy of Tree Cover in Panvel City



Source: Environmental Survey, 2020-21

A high proportion of households in Ward No. 1, 7, 8, 19 and 12, followed by 3, 6, 16 and 18, stated that the tree cover is not adequate and needs to be increased (2020-21). The households from almost all the wards revealed that the tree cover in the city is not sufficient and immediate steps be taken to improve the tree cover. As a whole only 13.3 per cent of the households (2020-21) stated that the tree cover is excellent. Though there is an improvement, PMC has decided to increase the tree cover significantly.

Mangrove ecosystem establishes and grows at the interface of soil and water bodies like sea, creeks, estuaries, bays and lagoons. They are commonly found in inter-tidal areas – an area between the high tide and the low tide. The mangrove ecosystem is believed to have evolved around 114 million years back in tropical and subtropical regions (Godrej).

The Godrej Study (2017) found that each year, 50,000 tonnes of carbon dioxide (CO2) is being added and stored at the protected reserved forest in Vikhroli. Mangroves are salt-tolerant plants that protect the coastline from inundation. Mangrove species capture CO2 from the atmosphere and store them as carbon. According to climate scientists, this process is called carbon sequestration, and it helps control global warming by reducing CO2 levels in the atmosphere. Similarly, Panvel Creek has a huge cover of mangroves that capture CO2 from the atmosphere and store them as carbon.

Pests and diseases are regulated in ecosystems through the actions of predators and parasites as well as by the defence mechanisms of their prey. Insectivorous birds provide such a regulating service in farms that use most of their land for agriculture. Nyffeler, Şekercioğlu and Whelan (2018) stated that insectivorous birds capture billions of potentially harmful herbivorous insects and other arthropods to fulfil the nutrition need of the birds. They further estimated that annually insectivorous birds in urban areas consume biomass of 84 to 289 kg per ha. In Panvel City, we found many species of birds that are insectivorous and are regulating the ecosystem.

Providing living spaces for plants or animals and maintaining a diversity of plants and animals are ‘supporting services' and the basis of all ecosystems and their services (UN). Ecosystems provide

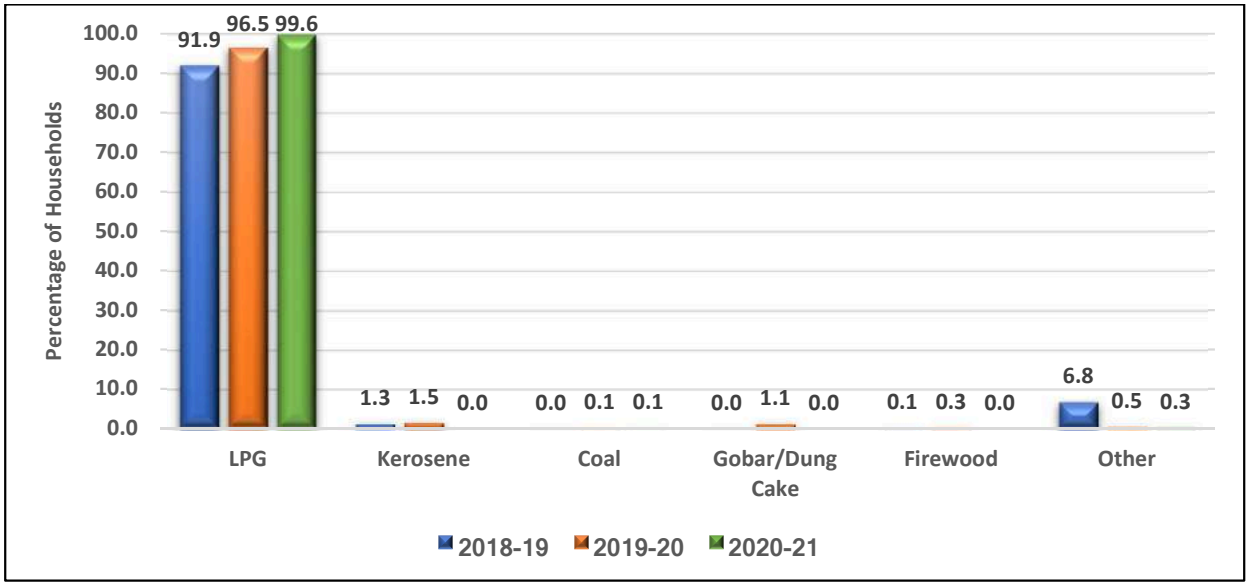
living spaces for plants and animals; they also maintain a diversity of complex processes that underpin the other ecosystem services. Some habitats have an exceptionally high number of species, making them more genetically diverse than others, known as biodiversity hotspots. We have already discussed the biodiversity in Panvel City in 3rd chapter of the report.

5.1.2 Non-Ecosystem Natural Resources

Non-ecosystem natural resources such as hydrocarbons, minerals and renewable energy equally perform an impact on human well-being. As discussed by Owen (1971) and Reimers (1990), there are a number of natural resources. We do not have much information about all such resources for Panvel City.

The fuel for cooking is a natural resource that people use to prepare food. Natural resources like LPG, Kerosene, firewoods and solar energy are used for cooking food in general.

Figure 22 Source of Fuel for Cooking Food in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

It is observed that 99.6 per cent of households (2020-21) in the city use LPG as a fuel source for cooking food, which reduces indoor pollution and does not affect the healthy environment in the house. The use of electricity through induction cooker is increasing in trend as an emergency source of fuel for cooking.

Table 49 Electricity Connections in Panvel City

Purpose	Substation				Total 2018-19	Total 2019-20	Total 2020-21
	Kalamboli	Kharghar	Bhingari	Panvel City			
Household	89912	67421	68965	77020	303318	311406	343618
Business	14250	5893	5557	10786	36486	41391	47409
Industrial	640	924	2515	71	4150	3392	3713
Agriculture	-	-	-	46	46	601	617
Solar	16	51	15	53	135	728	138
Other						1848	3523
Total					344135	359366	399018

Source: MAHADISCOM

The use of electricity supplied by MAHADISCOM is common for lighting purpose. We found that 100 per cent of households have electricity connection in the city. There are no attempts to produce energy in Panvel City except a few attempts to produce Solar Energy. There were only 135 households in 2018-19 making use of solar energy that have increased by more than five-fold (728) in 2019-20, but during Covid-19 (2020-21) there has been a decline in the Solar consumers. Though it is not substantial compared to conventional energy sources, we observe the attempts to opt for renewable energy sources like solar energy sources are appreciable.

Electricity is produced making use of fossil fuel like coal, oil or gas. Fossil fuel power plants burn carbon fuels such as coal, oil or gas to generate steam that drives large turbines that produce electricity. However, burning carbon fuels produces large amounts of carbon dioxide, which causes climate change. They can also produce other pollutants, such as sulphurous oxides, which cause acid rain (WNA).

When an individual consumes one unit of electricity, it causes some amount of CO_2 emitted at the time of electricity production. Though electricity primarily is not produced locally, the people

in ULBs consume electricity. They contribute to CO2 emission at production stage and contribute to climate change unfavourably. And hence we analysed household use of electricity in the city and estimated contributed CO_2 emission due to electricity consumption.

We have collected data for average monthly electricity consumption for 800 households and know the respective family size. From which we computed per person electricity consumption. We also know the total population of Panvel City. According to National Electricity Plan 2018, CO_2 emission from burning coal for power generation is 0.99 Kg/Kwh. With the help of available information, we could estimate per person per day the CO_2 emission that a person contributes in Panvel by consuming electricity. We also estimated the total yearly emission contributed by the total population in the city.

Table 50 Electricity use and CO2 Emission

Sr. No.	Electricity use and CO_2 Emission	2019-20	2020-21
1	Per capita yearly electricity consumption	696.8 Kwh	629.3 Kwh
2	Per capita yearly CO_2 Emission	689.8 KgCO_2	623 KgCO_2
3	Per Day Per Person CO_2 Emission	1.9 KgCO_2	1.7 KgCO_2
4	The total CO_2 Emission contribution by Panvel CIty	351721 TonneCO_2	317661 TonneCO_2

Source: Author's estimation based on data from Environmental Survey 2019-20 and 2020-21

We found that the per capita yearly electricity consumption is 696.8 Kwh in 2019-20 which declined to 629.3 Kwh in 2020-21. Hence one person, yearly, is responsible for 689.8 KgCO_2. Per day Per Person, CO_2 emission is estimated to be 1.9 KgCO_2 that got reduced to 1.7 KgCO_2 in 2020-21. Total CO_2 emission contributed by the total population in Panvel in year 2019-20, as per the population by Census of India, 2011 was 351721 TonneCO_2 that decreased to 317661 TonneCO_2 in 2020-21 which amounts to 9.68 per cent decline in CO_2 Emission in one year.

5.1.3 Stress, Inter alia Diseases, Pests, Radiation and Hazards

The population stresses the land use in Old Panvel and New Panvel. Hence, population density in these areas is very high and has generated stress on environmental goods like land, air, and water. The emergence of slums in urban areas is due to non-affordability due to the high demand for housing. We have observed that slums in Panvel City are of increasing nature. The details of which are as follows.

Table 51 Slums in Panvel City (2019-20)

	2019-20		2020-21	
Nature of Slums	No of Slums	Population	No of Slums	Population
Notified	*4*	*1084*	*4*	*1082*
Non-Notified	*57*	*7802*	*56*	*7784*
Total	*61*	*8886*	*60*	*8866*

Source: Panvel Municipal Corporation, Panvel

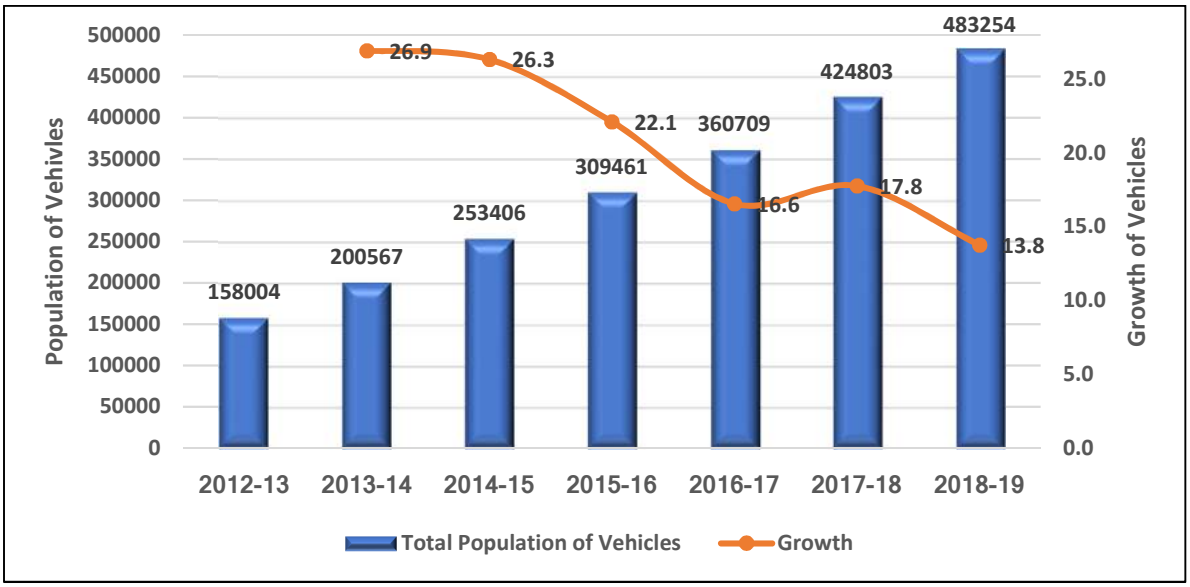
Twenty-six slums in PMC belong to the earlier municipal council area, whereas 35 are on the CIDCO land under PMC. The four slums viz. Valmiki Nagar, Mahakali Nagar, Kachchi Mohalla and Patel Mohalla and notified slums. These are notified under Pradhan Mantri Awas Yojana – Urban (PMAY-U) on 2nd January 2020. The detailed proposal is sent to the Government. The total population residing in slums accounts for 8866.

As stated earlier, there is water stress (shortage) observed in Panvel City during summer. The water supply in Panvel heavily depends on the availability of water in Deharang Dam on Gadhi (Kalundre River). The increasing population in Panvel City has impacted the water supply in the city. People in the city show their concern about the regular water supply. People do not make use of groundwater for drinking purpose due to heavy minerals that cause health issues.

Water safety and quality are fundamental to human development and well-being. Providing access to safe water is one of the most effective instruments in promoting health and reducing poverty (WHO). We also found patients with skin diseases that are mainly caused due to

consumption of contaminated water and direct contact with river or seawater. There were 9.8 per cent of families in which we found patients with skin diseases in 2019-20 that declined to 1.6 per cent in 2020-21.

Figure 23 Population of Vehicles in the City

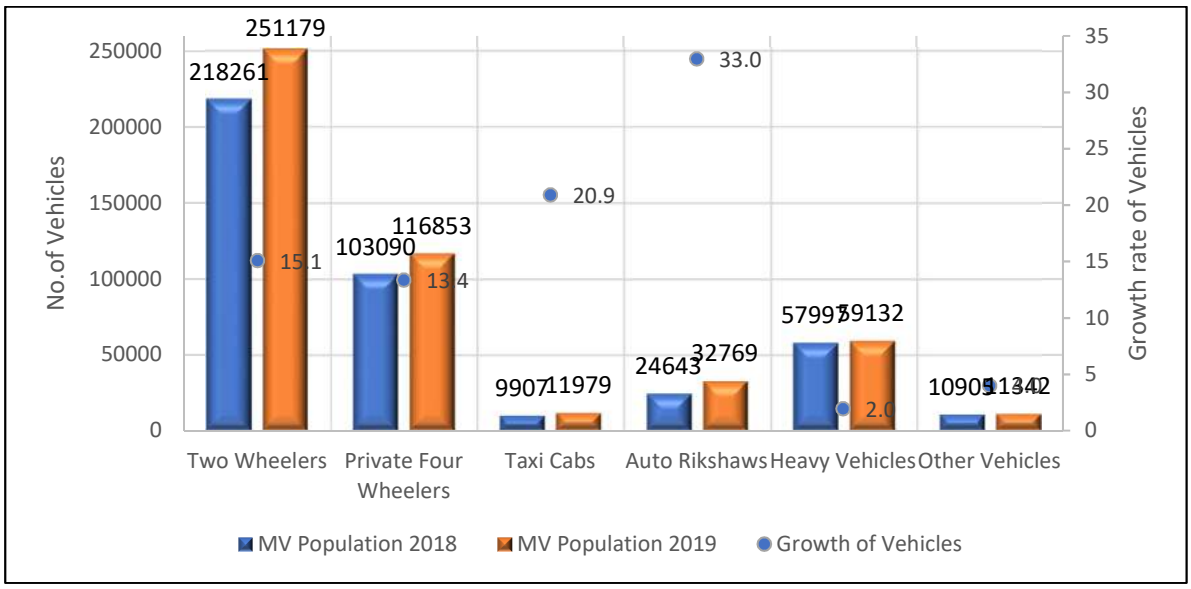


Source: Regional Transport Office, Panvel

There has been a consistent rise in the population of vehicles in the city. The density of the roads is more or less the same in the city and also there are concerns over the width of the roads in the city. The parking in the main city areas is also a matter of concern. In the given scenario, the rising population of vehicles will harm the environment by raising vehicular pollution. One good thing is found that there has been a significant rise in the demand for CNG vehicles.

The stress is also observed in the levels of oxygen in the air in the city. In 2019-20, in 10.8 per cent of families, we found Asthma patients, which is very serious and indicate that the air pollution is significant enough to impact the health of the individuals in the city. With the help of medical practitioners, a detailed database is required to get real status of asthmatic patients in the city. Besides Industrial Pollution, air pollution is contributed by transport sector also. The stress is also found on the roads in the city. We found that the vehicle carrying capacity is reached at optimum.

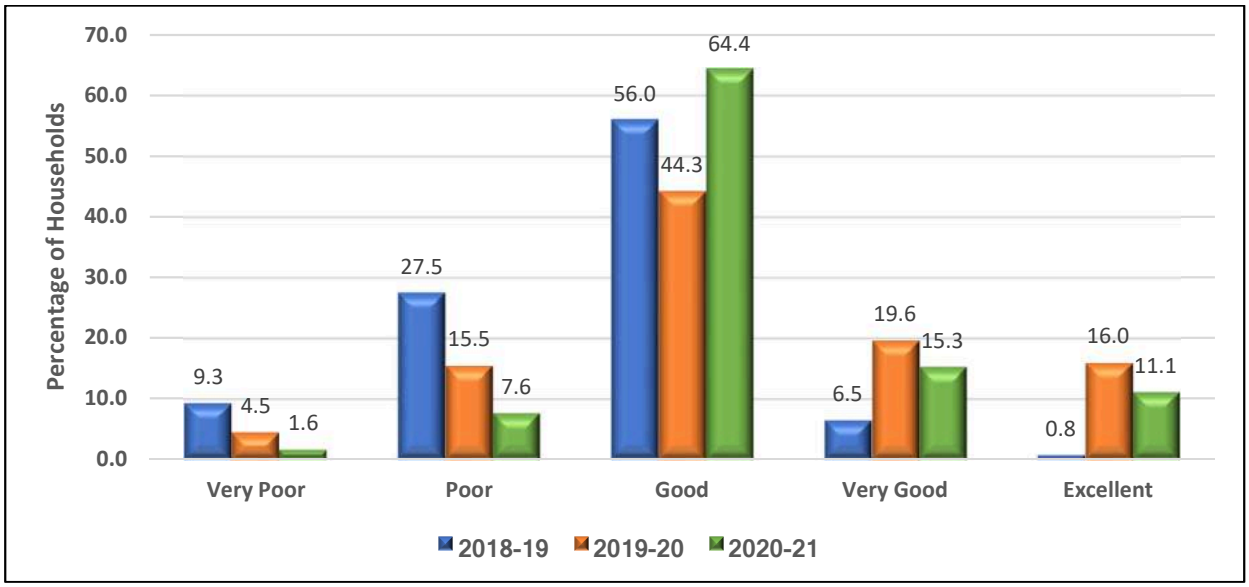
Figure 24 Population of Vehicles by types in the City



Source: Regional Transport Office, Panvel

We explored expected width of the roads in city, whether the existing width of the roads is sufficient, or residents feel that the road width is not enough and needs to be increased.

Figure 25 Perception about Width of Roads in Panvel City.



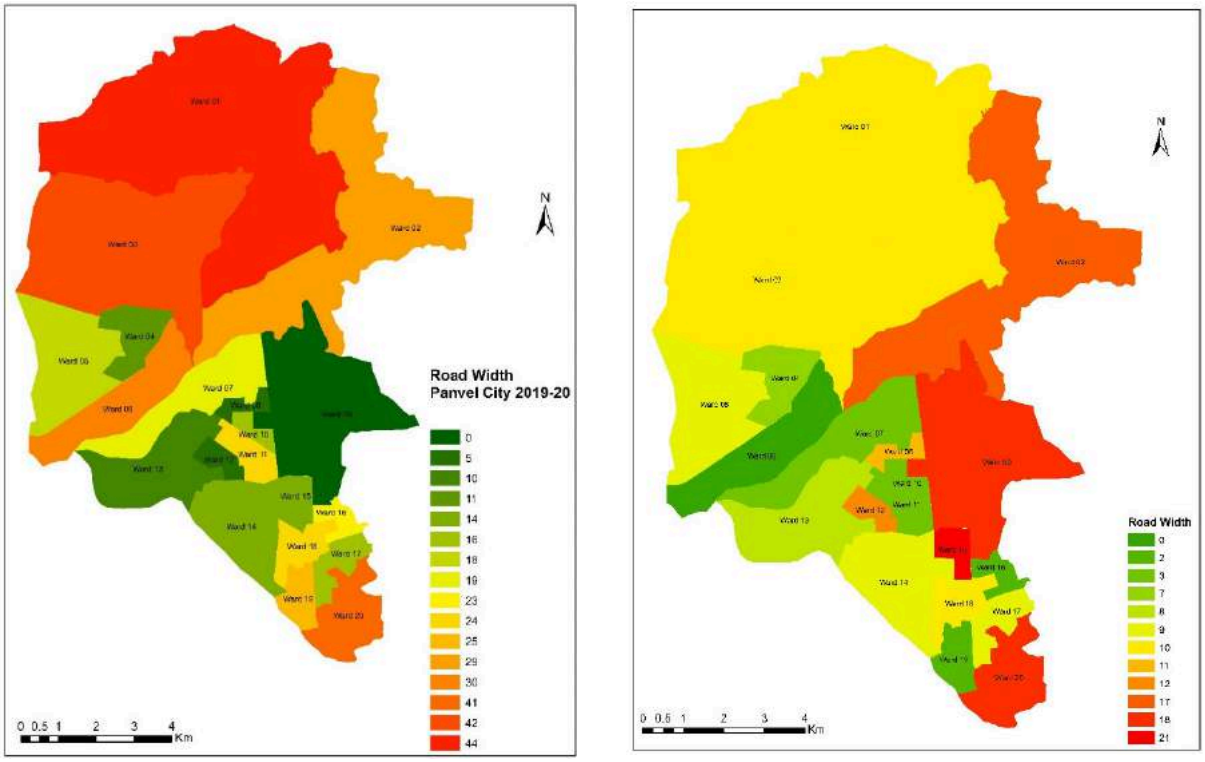
Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

In 2018-19, 36.8 per cent of households revealed that the existing width of the roads in the city is poor to very poor. The change in the responses indicates an improvement in the width of the roads in the city. In 2019-20, 20 per cent of households stated that the width of the roads in the

city is poor to very poor. In 2020-21, 9.2 per cent of households stated that the width of the roads in the city is poor to very poor, which indicates improvement in the width of the roads in the city. There is a five times increase in the responses stating the width of the roads between very good to excellent during 2018-19 to 2019-20. We also tried to know which wards have low width of roads and do not meet the citizens' expectations.

Map 17 Ward-wise Percentage Households stating Width of Roads is Poor to Very Poor

2019-20 2020-21



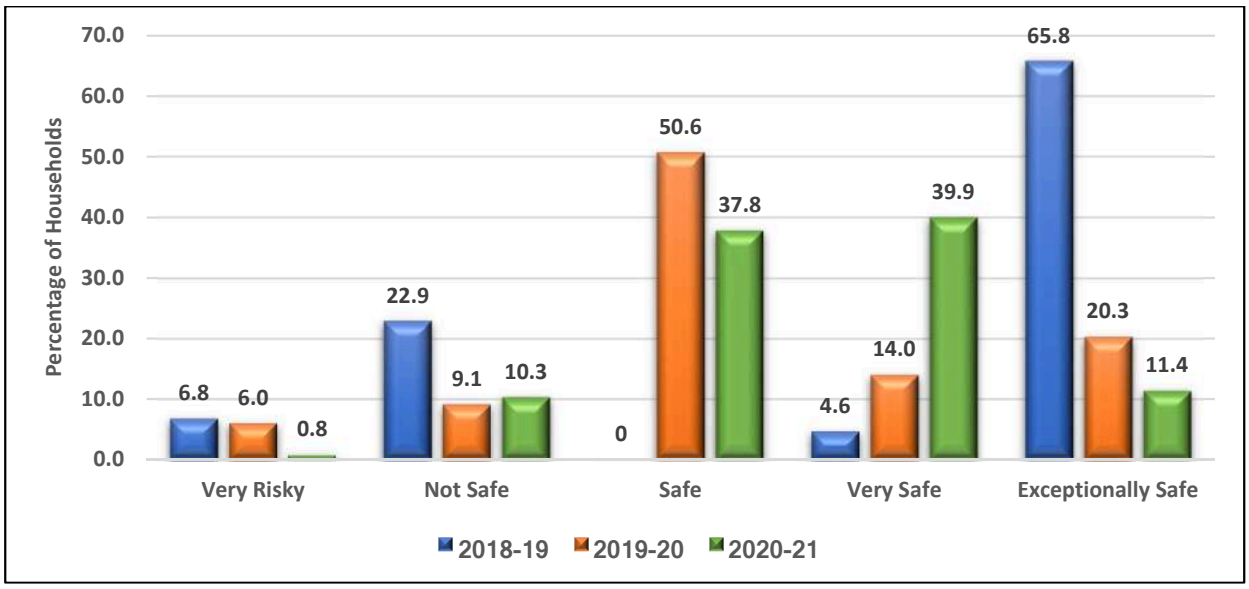
Source: Environmental Survey, 2019-20 and 2020-21

The above chart expresses concern about road width in the city; a large proportion of households in Ward No.1, 2, 3, 19 and 20 stated that the width of roads is poor to very poor in 2019-20. And the households in Ward No. 2, 9, 15 and 20 have shown concerns related to width of the roads in the city. The villages are worst affected due to the road width, the villages like Pendhar and Padaghe need immediate attention. Narrower roads not only increase the probability of accidents but also lead to congestion and increased vehicular pollution.

Road infrastructure is strongly linked to fatal and serious injury causation in road collisions. Road traffic injuries cause considerable economic losses to individuals, their families, and nations.

These losses arise from the cost of treatment and lost productivity for those killed or disabled by their injuries and for family members who need to take time off work or school to care for the injured (WHO, 2018). To understand the efficiency of roads, we also asked the households whether roads accident-free (Safety of Roads) in the city. The following result is received.

Figure 26 Safety of Road in Panvel City

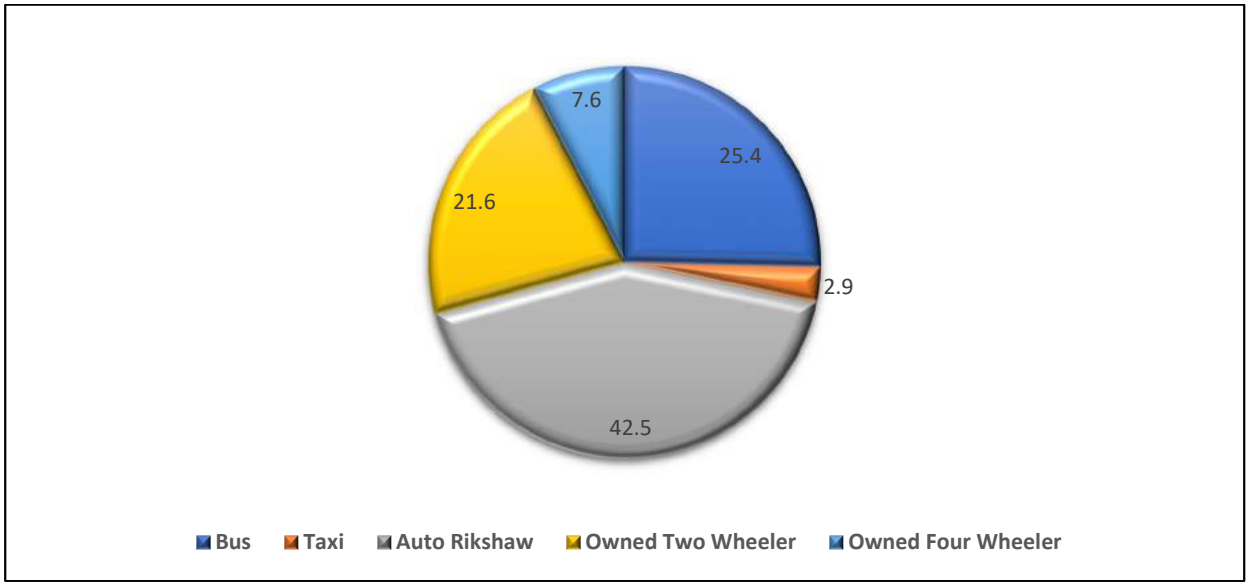


Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

We observed that around 29.7 per cent of households in 2018-19 believed that road in the city are not safe and increase the probability of accidents, perhaps the percentage of such households fell to 15.1 in 2019-20 and 11.1 per cent in 2020-21 which indicate the improvement in the traffic system and road maintenance and management.

According to WHO, there is a direct relationship between population and the number of vehicles. The population in Panvel city has increased significantly in recent years. During 2018-19, the percentage growth of vehicles in the city was around 13.75 per cent. Two-wheelers and private four-wheelers increased at a rate of 15.1 and 13.4 per cent, respectively. The Panvel Municipal Corporation does not have its own public transport facility which forces people to use private vehicles owned by them. And residents rely mainly on private transportation rather than public in the city.

Chart 9 Mode of Transport used by Residents for Local Transportation in Panvel



Source: Environmental Survey, 2020-21.

We found that 25.4 per cent of the households use city buses and 29.2 percent of households use their owned vehicles for local transportation in Panvel. A significant proportion of residents (42.5 per cent) make use of auto rickshaws for local travel.

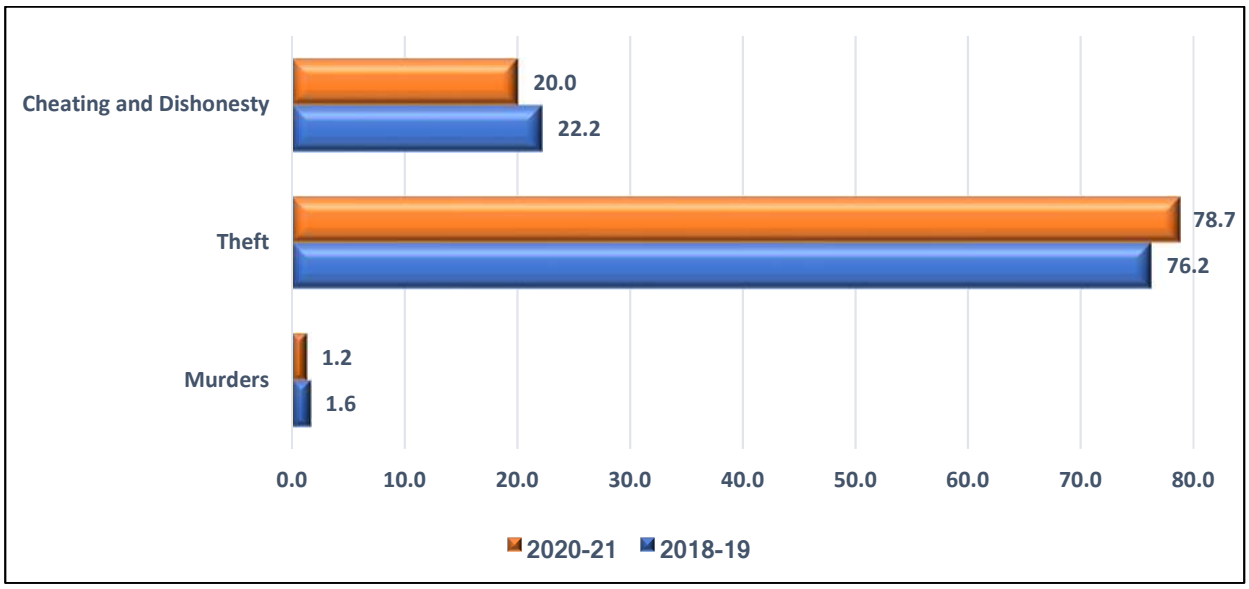
5.2 Demographic, Social and Material Factors Determining Human Well-Being

Change in human well-being broadly defined as human freedoms of choice and actions, to achieve, inter alia:

5.2.1 Security

Human freedom and choice are highly depending upon how safe the society is they reside in. The crime rates in the city can know the safety in a society. Relatively Panvel City is the safest city among the cities in the Mumbai region. The nature and extent of crime in city can be observed from the following table.

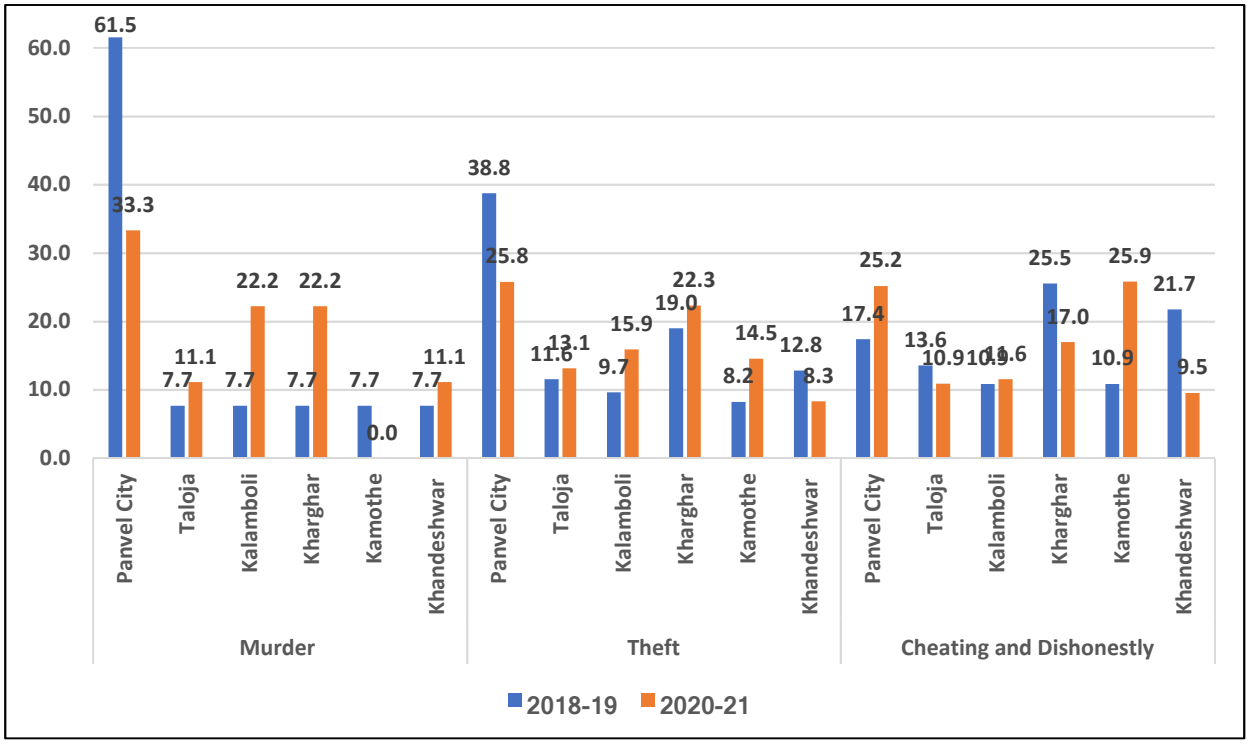
Figure 27 Total Crimes in Panvel City



Source: Deputy Commissioner of Police, Panvel (2018-19 and 2020-21)

It is found that 76.2 (2018-19) and 78.7 (2020-21) per cent of the total cases registered in Panvel City were of theft of goods and articles. 22.2 per cent of the cases were registered for cheating and dishonesty crime in 2018-19 that declined to 20 per cent in 2020-21. Only 1.6 per cent of total crimes are registered for murder crime in 2018-19 that recorded 1.2 per cent in 2020-21.

Figure 28 Police Station wise Crimes in Panvel City



Source: Deputy Commissioner of Police, Panvel (2018-19 and 2020-21)

It is observed that the murders (61.5 per cent of total murders in the city in 2018-19 that went down to 33.3 per cent in 2020-21) and thefts (38.8 per cent to total theft cases in the city that went down to 25.8 per cent in 2020-21) are relatively more in the area under Panvel City Police Station. Perhaps the Kharghar area has relatively more cheating and dishonesty cases compare to other areas in the city in 2018-19 whereas in 2020-21 Kamothe experienced greater per cent of cheating and dishonesty cases in 2020-21.

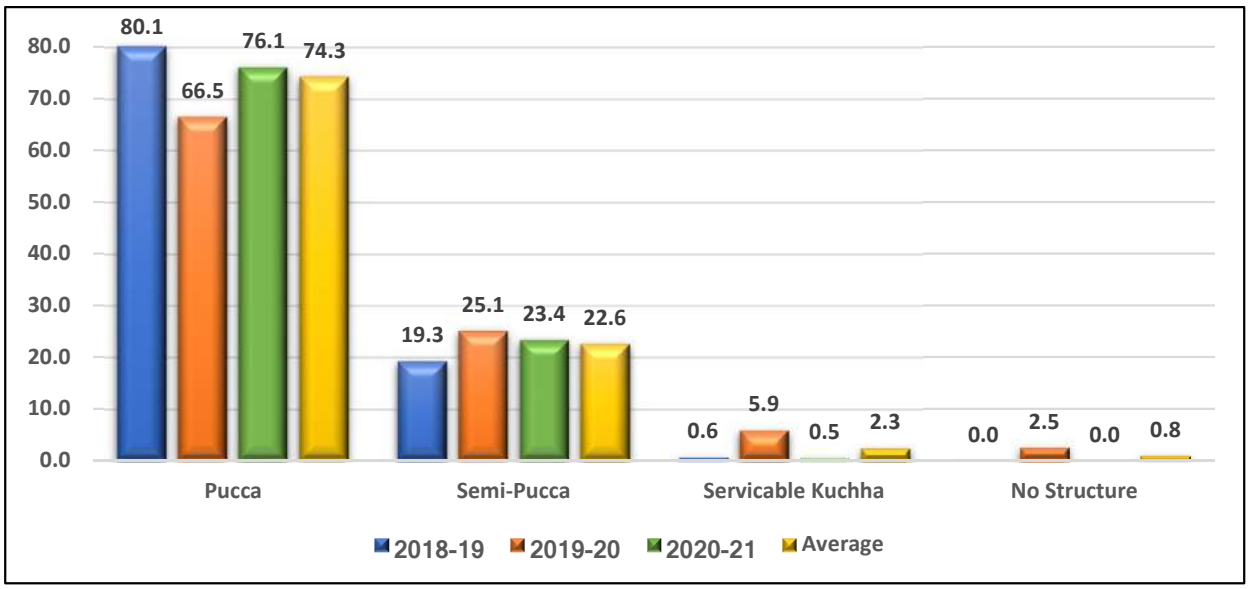
Though there have been criminal cases found in Panvel, people prefer to choose Panvel as one of the best cities in the Mumbai region.

5.2.2 Basic Material Needs

Traditionally, we believe humankind has three basic needs: food (including water), housing, and clothing. Modern development thinkers believe that the traditionally defined basic needs be extended to education, healthcare, sanitation and the internet. Besides above, the Census of India also gives importance to household amenities that include sanitation and hygiene, access to electricity, safe drinking water and availability of toilets.

According to the Census of India, individuals must have a pucca house. There is no Census data available on housing for Panvel Municipal Corporation. Hence, we explored the nature of housing in Panvel through an environmental survey, 2018-19, 2019-20 and 2020-21.

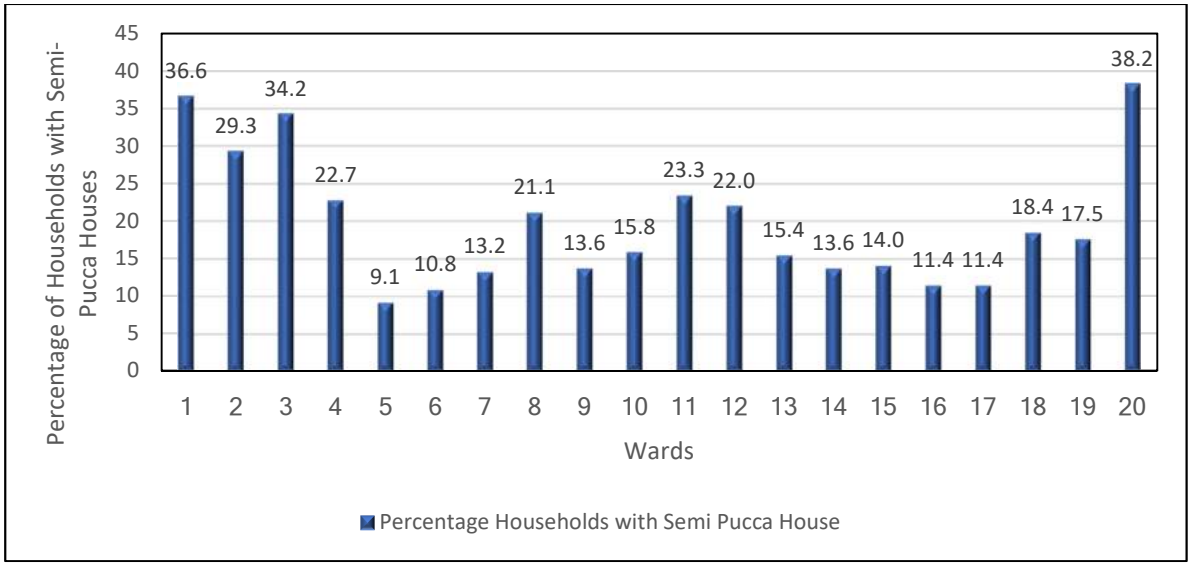
Figure 29 Type of Housing in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

According to the environmental survey, there is 74.3 per cent of households having a pucca house. 22.6 residents have semi-pucca house to stay. There are 29 villages in Panvel City, where along with the pucca house, we observed semi-pucca houses.

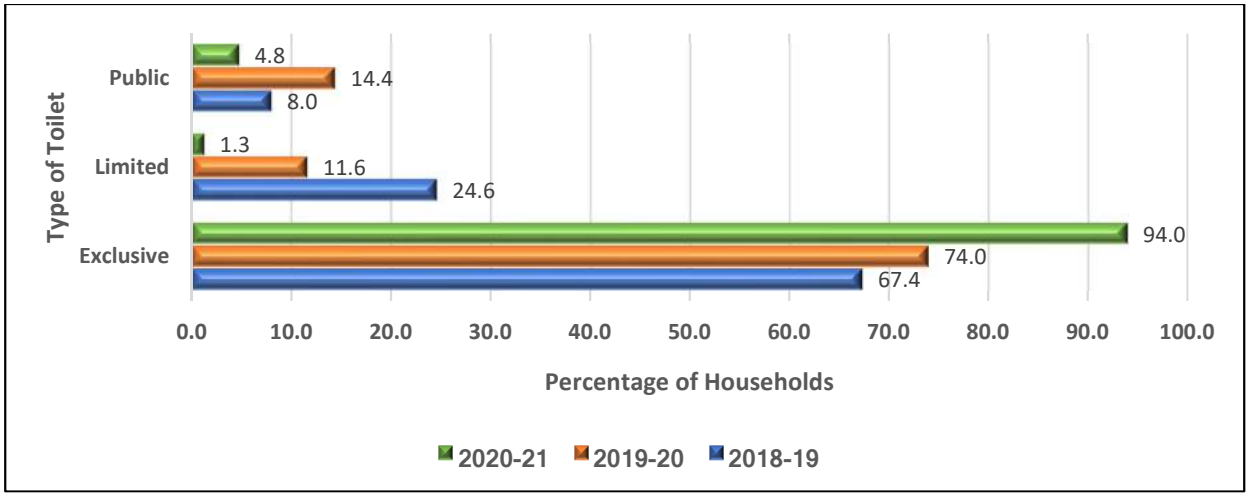
Figure 30 Ward-wise Percentage Households with Semi Pucca Houses



Source: Environmental Survey, 2018-19.

Those who have Semi-Pucca houses in Panvel City predominantly reside in 29 villages that are included in Panvel City with its inception. Ward No. 1, 2, 3 and 20 are where a significant proportion of households live in Semi-Pucca houses. Ward No. 1, 2, 3 and 20 have 36.6, 29.3, 34.2 and 38.2 per cent households, respectively, with semi-pucca houses. Chota Khanda and Motha Khanda, which is very close to the central city, also has semi-pucca houses.

Figure 31 Availability of Toilets in Panvel



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

Availability of Toilets is one of the most important household needs in urban areas. Panvel is one of the open defecation free (ODF++) cities in India. Household's access to toilets in the city can be explored as follows.

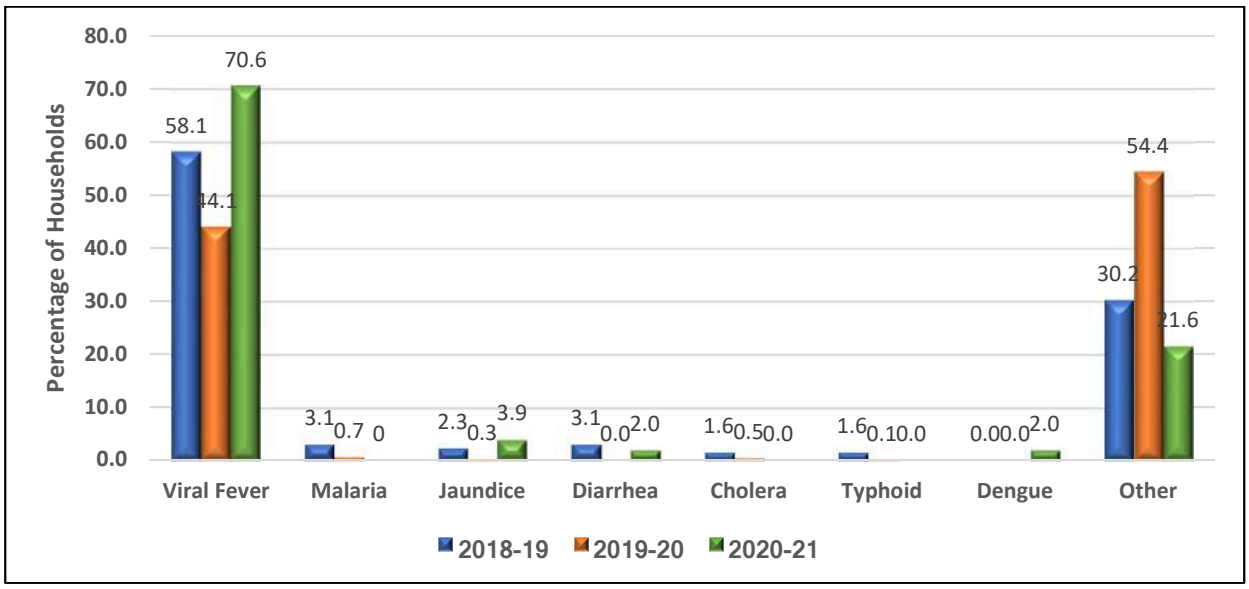
It is observed that 67.4 per cent of households had availability of toilets within their premise in 2018-19, which increased to 74 per cent in 2019-20 and further increased to 94 per cent in 2020-21. Six per cent of households use common toilets exclusively for members of society or chawls or public toilets provided by Municipal Corporation.

5.2.3 Good Health

The increasing population also have pressure on the provision of healthcare in the city. Conventionally it is believed that better health brings more productivity and sustainable development. Health outcomes show how healthy a society is. The life expectancy of people residing in Panvel City is 75 years of age. The maternal mortality rate is a low as 0.77 per 1000 pregnancies in the city. Perhaps the infant mortality rate is quite high, which observed to be 25.4 per 1000 births. There is only one rural hospital in village areas in the city with 30 beds and three doctors. There are some private hospitals in the city. The birth rate and death rate are found to be respectively 17 and 7.8 per 1000 midyear population and the child mortality rate is almost negligible, around 0.83 per 1000 midyear population.

We also explored morbidity in the city to capture exposure of illness and the reasons for disease. We found the morbidity rate for the population residing in Panvel City around 16.1 per cent. According to WHO, there is a wide range of diseases which may include: those due to ingestion of water contaminated by micro-organisms and chemicals such as diarrhoea, arsenicosis or fluorosis; diseases like schistosomiasis, which have part of their lifecycle in water; diseases like soil-transmitted helminthiasis resulting from poor sanitation and hygiene; diseases like malaria or dengue with water-related vectors; and others such as legionellosis carried by aerosols containing certain micro-organisms; furthermore, access to water and sanitation is key for preventing sepsis, especially in newborn children, and for preventing healthcare-associated infections. The diseases can be classified into two categories- water-borne diseases and airborne diseases. Cholera outbreaks can occur where water supplies, sanitation, food safety and hygiene practices are inadequate (WHO). Overcrowded communities with poor sanitation and unsafe drinking-water supplies are most frequently affected.

Figure 32 Nature of Diseases during explored Morbidity in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

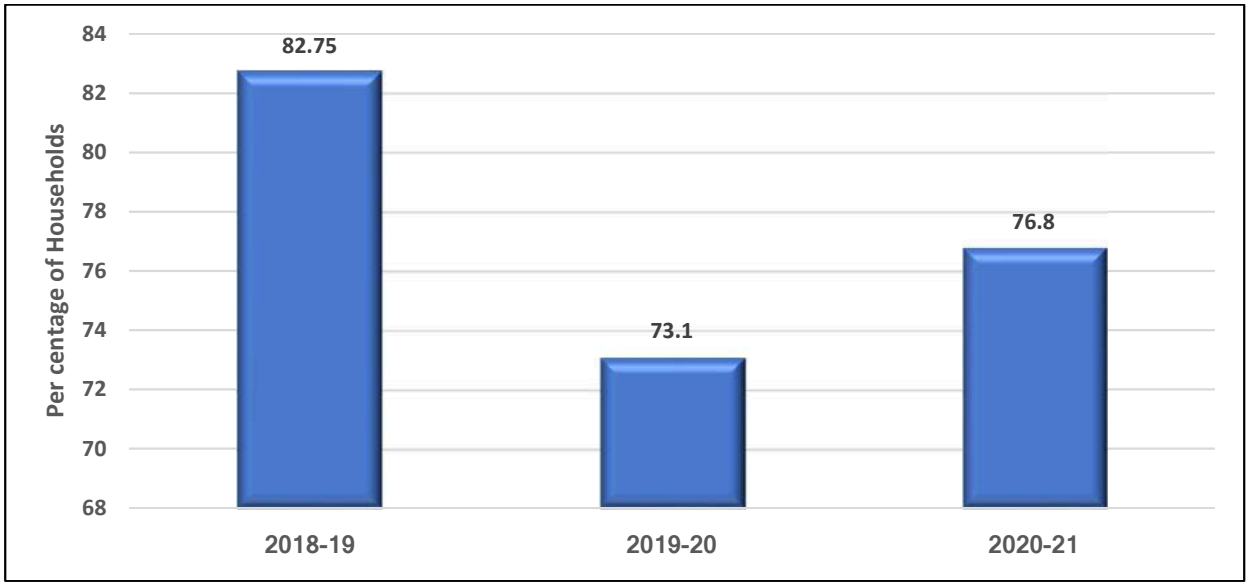
We observed that 70.6 percent of the total patients found in survey had Viral Fever that causes due to climate change. And we found a very small proportion of patients had water borne diseases like Malaria, Jaundice, Diarrhea, Cholera and Typhoid in the city.

5.2.4 Good Social Relations

According to August and Rook (2013), social relationships refer to the connections between people who have recurring interactions that the participants perceive to have personal meaning. This definition includes relationships between family members, friends, neighbours, co-workers, and other associates but excludes social contacts and interactions that are fleeting, incidental, or perceived to have limited significance (e.g., time-limited interactions with service providers or retail employees). A number of festivals are celebrated by the residents, which bring the community together to form a solid n=bond among the society members in the city. There are a number of Non-Government Organisations that organise various activities to improve social relationships.

The use of social media is one of the modes of social relationships. Kietzmann et al. (2011) enlist various benefits of social media in social relationships. We make use of social media as a proxy to measure social relations.

Figure 33 Internet and Social Media exposure to households in Panvel City



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21.

We observed that 76.8 percent of household make use of internet and they also use social media for communication with their friends and the other society members.

6 RESPONSE (R) TO ENVIRONMENTAL CHALLENGES

Response (R) to environmental challenges includes formal and informal adaption to, and migration of, environmental change (including restoration) by altering human activity and development patterns within and between the Drivers, Pressures and Impacts through inter alia: science and technology, policy, law and institutions. There are a number of areas related to the environment in which ULBs have a more significant role to perform to conserve and protect the environment and improve the quality of life of residents. The interventions by ULBS make not only the city clean and beautiful but also sustainable. Such interventions include solid waste management, sewerage management, provision of safe drinking water, regulating and increasing tree cover, disaster management, making the plastic free city, provision of roads and maintenance of roads and making city congestion-free, provisioning of gardens and playgrounds and regulating pollution in the city.

6.1 Solid Waste Management

Solid waste management (SWM) is an integral part of an environmental management system (Das et al., 2019). The Ministry of Housing and Urban Affairs is very serious about solid waste management in cities in India. One of the Swachh Bharat Mission (Urban) objectives is to make cities garbage-free and certify the cities under a 7-star rating programme. Panvel Municipal Corporation received a 2 Star Rating for 2018-19, which indicates the scope of improvement in solid waste management.

There are short-lived climate pollutants (SLCPs) such as methane and black carbon emitted from solid waste generated in urban areas. If solid waste management fails to dispose of solid waste within hours, the pollutants may destroy the environment in the proximity. Hence local urban bodies have to be efficient manage the solid waste generated in the city. Waste management can be considered a strategic supply chain problem as it involves the waste generation, collection, separation, transportation, treatment, distribution, and disposal (Mohammadi et al., 2019).

The total waste generated in Panvel City is 450 tons per day (TDP), out of which 270 TDP is wet waste and dry waste is 172.8 TDP, domestic biomedical waste is 7.2 TDP and Construction & Demolition waste constitute 20 TDP. Panvel Municipal Corporation segregates waste at source only; 100 per cent of waste is segregated at source. There are 58 Bell Vehicles (Ghanta Gaddis) to

collect and transport solid waste; these Bell Vehicles go door to door to collect solid waste. And there are 25 Compactors for the transport of solid waste to the processing facility at Taloja. All the vehicles are monitored with the help of GPS technology.

The processing of solid waste is also an important task in solid waste management. Out of 450 TDP, almost 425 TDP is processed in CIDCO Solid Waste Management Plant, Taloja. Segregated inorganic waste is processed at a materials recovery facility (MRF), a place where solid wastes are delivered to be separated, processed, and stored for later use as raw materials for remanufacturing and reprocessing refuse-derived fuel (RDF) is produced. The organic waste is also processed from which compost fertilizer is produced and is sold as a brand 'Bhumiputra'. The Panvel Municipal Corporation has its landfill site at which old solid waste is processed. 1.78 TDP of household hazardous waste and Bio-Medical waste is transported to Mumbai West Management Company run By RAMK at Taloja and the company process it with the help of an incineration facility and then a secure landfill is carried out.

The residents and students in schools and colleges are trained to segregate organic and inorganic waste and process organic waste to compost fertilizer. Therefore, they are motivated to process the organic waste in compost fertilizer under Swachha Bharat Mission; consequently, 24 organizations (13 Cooperative Housing Societies and 11 educational institutes) process their organic waste and produce organic compost fertilizer.

The banners and hoardings and paintings on walls displaying the importance of organic and inorganic waste segregation are installed at various locations in the city to make citizens aware.

The PMC also has installed 50 Compost Fertilizer Trunks (Khat Kundya) at various residential locations in Panvel City, which are maintained and monitored by private contractors. The organic

waste is processed in these Compost Fertilizer Trunks and the produced fertilizer is used from plants in the area. In addition, seven hundred eighty litter beans have organic and inorganic compartments installed in residential and commercial areas in the city.

A survey of waste collectors in Panvel City was carried out with the help of Stree Mukti Sanghatana (Women's Liberation Organization); all such waste collectors are registered with PMC and are integrated with the solid waste management department of PMC. There are 135 waste collectors (Swachhagrahi), out of which 118 are women and 17 men. They are trained to collect inorganic waste and are allotted wards in which they need to collect inorganic waste. The PMC, through this measure, could generate a few person-days employment for needy people.

The Construction and Demolition Waste (C&D Waste) is also a matter of concern in Panvel City. A Private Contractor is employed to collect C&D waste from all areas in the city and roads and level and dispose of it. The residents are also given public instructions about C&D waste management.

6.1.1 Plastic Free City Intervention

The Maharashtra Non-Biodegradable Garbage (Control) Act, 2006, was passed by Maharashtra state to curb the use of plastic and non-biodegradable garbage that provides Maharashtra Plastic Carry Bags (Manufacture and Usage) Rules, 2006. It was observed that despite having imposed a ban on the use of plastic of specified feature, people didn't stop using such plastic in urban regions in Maharashtra. Therefore, the Maharashtra State issued a notification named Maharashtra Plastic and Thermocol Products (Manufacture, Usage, Sale, Transport, Handling and Storage) Notification, 2018. Therefore, the Clause (1) & (2) of Section 4 of the Maharashtra Non-Biodegradable Garbage (Control) Act, 2006, the Government of Maharashtra authorizes the

regulations for the manufacture, usage, sale, storage, transport of the products made from plastic & thermocol which generates non-biodegradable waste.

There were concerns about usage and disposal of plastic are diverse and include accumulation of waste in landfills, water bodies and in natural habitats, physical problems for wild animals resulting from ingestion or entanglement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans are increasing. It was observed that non-biodegradable plastic waste handling of municipal solid waste becomes difficult and incurs more financial burden and also due to burning such waste in the open environment causes various diseases in humans and animals. It is observed that non-biodegradable garbage is responsible for clogging drains and nallas, causing flood in urban settlement leading to loss of lives and damage to properties and infrastructure. Plastic waste and microplastic cause danger to marine and freshwater biodiversity and also hamper ecosystem services due to the spreading of such waste in and around ecosystems, on tourists places, beaches and on agriculture and forest areas. The non-biodegradable plastic waste and microplastic are having negative impacts on fish diversity and fisheries activity. The non-biodegradable waste is posing problems in the effective implementation of the Clean India Mission. Detailed stakeholders consultations and deliberations with the field level officials were undertaken, and public notices were also published in leading newspapers. Despite the ban on plastic bags of less than 50 microns through Maharashtra Plastic Carry Bags (Manufacture and Usage) Rules, 2006, there was an increase in the non-biodegradable plastic garbage waste causing damage to the environment and health.

The 2018 notification was influential in the implementation of the said Act stringently in the areas of local urban bodies where a significant amount of plastic waste is generated. In spite of the ban on the use of plastic, people continued to make use of plastic. The plastic waste generated in Panvel City during 2018-19 was 5503 Tons. The plastic waste is processed at the Taloja facility. 66.3 per cent of plastic was channelized for recycling and reuse and 33.7 per cent was sent for landfilling in 2018-19.

Table 52 Plastic Collected and Processed during 2018-19 and 2019-20

Particulars	2018-19	2019-20
Plastic waste generated	5503	4700
Plastic waste collected	5503	4700
Plastic waste channelized for recycling	3650	4320
Plastic waste channelized for use	3650	4320
RDF(Refuse Derived Fuel)	3650	4320
Plastic Waste sent to Landfilling facility	1850	380

TPA is Tons per annum

Source: MPCB, ULBs Annual reports for 2018-19 and 2019-20

The Panvel Municipal Corporation took it very seriously to make the city plastic-free in 2018. A special task force performed the responsibility to inspect, confiscate, and penalize the manufacturers and suppliers of plastic banned from being used. As a result, the total plastic was generated and collected in the city dropped to 4700 tons in 2019-20. There is a reduction in plastic waste generated by 14.6 per cent compared to its previous year. The collected plastic was processed and channelized for recycling and reuse accounts for 91.9 per cent, which indicates that the plastic waste generated in the city was largely recyclable and only 8 per cent of the plastic was sent for landfilling.

Table 53 Penitentiary Proceedings and Spot fine for Production, Supply and Use of Plastic

Year	Confiscated Plastic Weight (in Kg)	Fine (in Rs.)
2017-18	200.0	54500
2018-19	2021.6	248700
2019-20*	5751.1	3668000
Total	**7972.7**	**3971200**

Till February 2020.

Source: Panvel Municipal Corporation

The PMC succeeded in curbing the non-biodegradable plastic significantly. In the effort, the PMC could earn a significant amount of fine by penalizing the manufacturers, suppliers and end-users. The PMC confiscated 7.97 tons of plastic and collected a fine of Rs. 39.71 Lakhs till February 2020. The efforts made by the PMC are commendable in banning the use of plastic. The year 2019-20 is more successful in implementing the plastic ban in which the PMC confiscated 5.7 Tons of Plastic that accounts for 72 per cent of the total confiscated plastic. And it earned Rs. 36.68 Lakhs from fine that accounts for 92 per cent of the total fine collected for manufacturing, supplying

and using banned plastic in 2019-20 . The data for the year 2020-21 is not available with MPCB, hence no analysis is made for the same.

6.1.2 Training, Information and Communication Services

Following are the best practices about training, information and communication are followed by PMC.

1. The PMC, in cooperation with Infinity Foundation and INIFD, organized Minithon 2020-Run for Pollution Free City to promote Swachha and Pollution Free City Campaign.
2. An organization from Pune trains all the cleaning workers at the Solid Waste Department.
3. All trained cleaning workers make residents aware of how effectively waste be segregated.
4. Swachh August Kranti Campaign was conducted during 1st to 31st August 2020.
5. Cleanliness is Service Campaign was organized during 15th September to 2nd October 2020.
6. Two Week Swachhata Campaign was carried during 1st to 15th September 2020.
7. Single Use Plastic Free Panvel City Campaign was very successful during the year. And Panvel Municipal Corporation office premises is made free from Single Use Plastic.
8. Swachhata Competition was conducted to promote the message of Swachhata.
9. Ingnored Garbage Removal Campaign was also carried to clean the city.
10. Zero Garbage Campaign was very successfully conducted in the city.
11. Plastic Free Wards Campaign received a great success in the year.
12. The residents are appealed through News Papers to segregate organic and inorganic waste while handing them to cleaning workers or Bell Vehicle.
13. The residents in slums are trained to segregate waste into organic and inorganic with the help of Self-Help Groups (SHGs).
14. The citizens are appealed to download Swachhata App to register complaints about cleanliness and solid waste anomalies. Twenty per cent of households in the city have installed the App and they are efficiently using this App.
15. The Municipal Corporation organized 250 Public Awareness programs related Swachh Panvel City.

The above discussion gives an elaborate picture of the efforts of PMC related to Solid Waste Management. It is certainly necessary to assess solid waste management carried out by PMC. For which we asked households a question about how they rank solid waste management in Panvel City. The following chart shows the results.

Figure 34 Ranking for Solid Waste Management given by Households in Panvel City.

Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

The residents are largely observed to be happy with solid waste management carried out by PMC. 81.3 per cent households recorded that the solid waste management in the city is good to excellent in 2018-19, which stood at 93.7 in 2019-20 and went up to 94.2 per cent in 2020-21. 18.7 per cent of households stated that the solid waste management in the city is between poor to very poor, out of which only 2.6 per cent of households said it was very poor in 2018-19. In 2019-20, only 6.3 per cent of households ranked solid waste management from poor to very poor, and 1.5 per cent feel that it is very poor. The efforts made by the PMC are commendable such that only 0.9 per cent of the households stated that the solid waste management was very poor in 2020-21. There is a phenomenal change in the ranking expressed by the households during the last three years due to continuous efforts taken by the PMC by taking the active participation of the people in the city. The change in the response of the households shows the success of PMC in solid waste management.

6.2 Sewerage System and Sewage Treatment

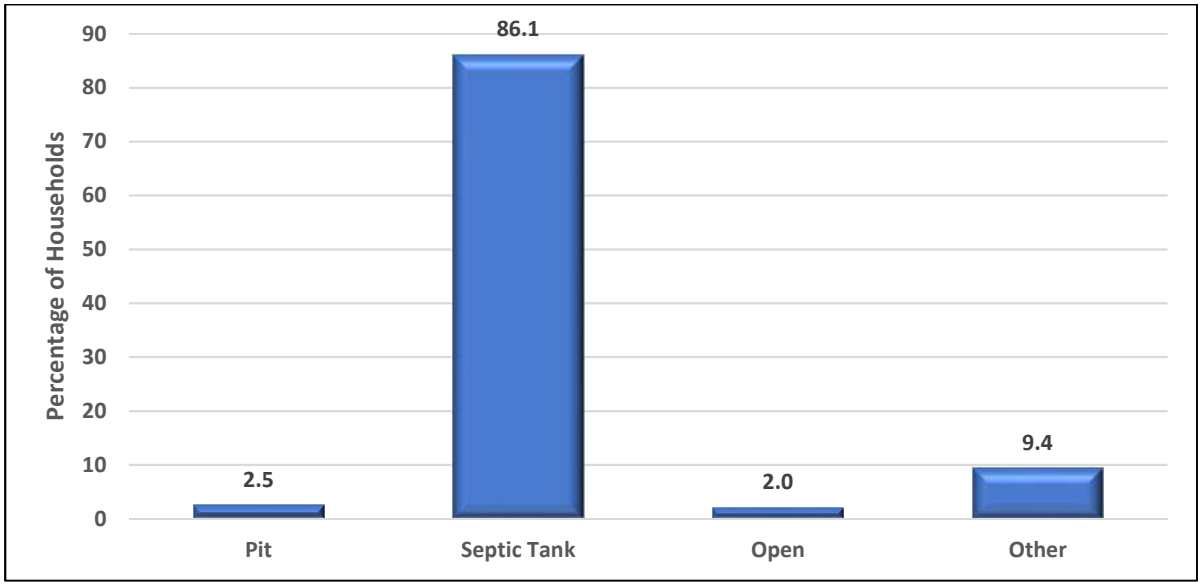
Sewerage systems are sewer networks for collecting wastewater, conveying it via pipes, conduits, and ancillary works from its origin to treatment before discharge back into the environment

(Read, 1997). And discharges into a sanitary sewerage system consist of domestic wastewater (sewage), industrial discharge, inflow, and infiltration (Peirce et al., 1998). Therefore, there are two types of sewage residual generated in urban areas, including industrial sewage and residential sewage. The Panvel City consists of the areas earlier governed by CIDCO, Raigarh Zilla Parishad, MIDC and Panvel Municipal Council and hence different levels of development of sewerage systems exist in the city.

We have explored what systems are existing in the residential areas through the environmental survey. Households adopt different systems to discharge sewerage, including Pit (Soak Pit), Septic Tank, and Open Sewerage system. A Soak Pit is a covered, porous-walled chamber that allows water to soak into the ground slowly. Pre-settled effluent from the septic tank is discharged to the underground chamber from where it infiltrates the surrounding soil (Paul, CivilDigital, 2014).

CIDCO, under its administration, has properly covered sewerage pipelines for its planned area. The Panvel Municipal Corporation has 17.16 km of the area covered and 15.41 km uncovered sewerage pipeline. The 29 villages under PMC do have a proper sewerage system in place.

Figure 35 Availability of Sewerage System in the City



Source: Environmental Survey, 2019-20

It is observed that 86.1 per cent of households in the city have septic tanks to manage the sewerage. In comparison, 2.5 per cent of households have soak pit to manage sewerage.

Wastewater treatment plants are one of the most influential and complicated infrastructures in the Municipal environment. Important because waste and wastewater are two components of daily life significantly contributing to pollution (Anton et al., 2014).

The Common Effluent Treatment Plant and Sewage Treatment Plants are necessary to process sewage and residual wastewater and treat up to a certain level of water quality before reusing or discharging in water bodies. There are 6 Sewage Treatment Plants (STPs) in Panvel City and all the individual, public and common toilets are connected through sewerage pipeline to these STPs.

Taloja MIDC has CEPT named Taloja CEPT Cooperative Society Ltd located in Taloja. Taloja CETP Co-operative Society Ltd. has a cluster of 1036 Member Industries. These units are mainly involved in manufacturing viz. chemicals, Bulk drugs, drug Intermediates, Fertilizers, Glass, Petrochemicals, Pigments, Dyes and Intermediates, Specialty chemicals, Engineering and Textile, Food and Fish processing. The product range results in a set of individual effluents, which have to be provided for a combined treatment. Under the guidelines from the Ministry of Environment & Forests, New Delhi, the Common Effluent Treatment Plant facility for industries in the Taloja MIDC area was proposed in 1994. The CETP initially was conceptualized for Small Scale Industries considering their space, financial and technical constraints of effluent treatment. Later on, the large and medium scale industries were made part of CETP due to common effluent collection and disposal line and considering their treated effluent as a dilutant of effluent to make the treatment scheme feasible.

The CETP of 10 MLD capacity was constructed and brought into operation in December 1999. Over time CETP modifications were carried out. The equalization volume was increased by converting the disposal sump into an equalization tank and the inefficient surface aerators in the aeration tank were replaced with Diffused Aeration System costing about Rs. 1.31 Crore. The Decanter Centrifuge costing Rs. 24.18 lacs was installed. The CETP capacity thus was increased to 12.5 MLD. Meanwhile, new units in the industrial area and existing companies expanding their production capacities started and considerably increased the effluent quantity. Therefore, Taloja CETP Society decided to go for the expansion of CETP by another 10 MLD. The additional 10 MLD Expansion Project thus has been commissioned in February 2008 and is into operation. Thus, the capacity of Taloja CETP became 22.5 MLD.

The effluent generated by the industries is collected through gravity lines in two Collection Sumps, one near Ghot Village and the other at CETP. From the Collection Sump near Ghot village, effluent is pumped to the Collection Sumps at CETP. The Equalization Tank is used to dampen the variations in the quality and flow rate. To keep the effluent suspended solids away from settling and ensure proper mixing Floating Aerators have been installed in old plants and diffused coarse aeration is there in the expansion plant. The pH correction is carried out with lime if required.

The effluent is pumped to a flash mixer wherein PAC is dosed with rapid mixing and led to Clariflocculator to flocculate and settle suspended solids and remove a certain portion of suspended organic matter. The Suspended Solids settle down in Primary Clarifloculator, leaving the clear supernatant overflow from the weir top and it is the primary treated effluent, which goes to Aeration Tank for secondary biological treatment. The settled sludge is scrapped with a scrapper mechanism and pumped to the sludge sump, further thickened in a thickener and dewatered with Centrifuge Decanter. The centrate of the Centrifuge Decanter is taken to Equalization Tank for further treatment. In Aeration Tank, the Biomass has been developed, which is the culture of aerobic microorganism. Diffused Aeration System supplies the oxygen required for microorganism. The bacteria consume the organic matters present in the effluent as their food source, producing the new bacterial cells and Carbon Dioxide and water as by-products. The overflow of Aeration Tank goes to Secondary Clarifier where Biomass (MLSS) settles down leaving clear supernatant at the top which is treated water. The treated water is discharged in the Waghivali Creek by pumping through HDPE closed pipeline. The settled sludge is partially recycled back to Aeration Tank for maintaining the MLSS concentration in it and partially wasted in sludge sump and is dewatered and dried with sludge generated in primary treatment. The dried sludge is sent to Mumbai Waste Management Ltd. for further disposal by secured landfilling as per the consent conditions.

Though the waste residual from industries is treated by CEPT, it is observed that many industries in Taloja discharge residual water in Kasadi River. It is also observed that severe pollutants are discharged at Waghivali Creek by CEPT that are hazardous for residents' health and biodiversity in the region. The sludge is also a matter of grave concern; the lead and many chemical components in sludge generate harmful effects on the ecosystem, including vegetation, aqua system and wildlife in the vicinity.

Mr Arvind Mhatre, a Corporator and Environmental Activist filed a petition with the National Green Tribunal (NGT) claiming that the CETP and a few industries in Taloja are polluting the Kasadi and Taloja River by discharging industrial effluents. Due to the continuous legal battle by Mr Arvind Mhatre, a Corporator and Environmental Activist, the National Green Tribunal has ordered the closure of 350 industries in Taloja MIDC. The MPCB has issued the closure of all such industries and closed 18 industries with immediate effect. And MPCB is taking action to close the rest of these industries.

In the process Central Pollution Control Board (CPCB) and Maharashtra Pollution Control Board (MPCB) prepared a report dated 2nd January 2018 that was considered by the NGT on 4th April 2018. The report found that CETP was functioning and was managed by Taloja CETP Co-operative Society Limited since 2013. CETP was not properly maintained. This was resulting in untreated industrial effluents being discharged in the water body causing damage to the eco-system and the health of the inhabitants as the said water was being used for drinking purpose also. The NGT directed Taloja CETP Co-operative Society Limited to stop of polluting discharge. Since the CETP was not functioning, the MPCB was directed to shut down the polluting industries. 18 industries were shut down and the others were issued the show cause notice by MPCB during May 2018.

In July 2018, the NGT noted that there was huge accumulation of sludge. The CETP was required to be repaired on account of several defects. 92 industries to which show cause notice was issued were also closed. The society was required to deposit the amount of Rs. 5 Crores as earlier directed in April 2018 in view of discharge of polluting effluents for the last five years. It was noted that the industries operating in the area had turnover of Rs. 6,000 Crore annually and could provide for resources to check pollution.

The July 2018 Report by CPCB and MPCB concludes that

> *Due to closure directions and show cause directions from MPCB to member units 195 out of total effluent generating industrial units in the MIDC are discharging effluent to CETP. Thus, CETP is receiving controlled flow and concentration load in terms of COD and BOD. In spite of that CETP is not able to meet the norms. In full capacity the situation may be much worse. It can be inferred that the inlet condition is temporarily controlled due to closure directions of units. The inlet concentration though well within the design parameters of CETP except pH (acidic range) and Ammonical Nitrogen. The overall reduction of about 22% in the concentration of COD, from inlet to final outlet, indicates poor performance of CETP. The CETP has not yet started implementing*

most of the recommendations made by the joint team of Central Pollution Control Board and MPCB during earlier visit. The only work of de-sludging from the collection tank near distribution chamber has been initiated. The de-sludging activity, handling storage of sludge was not found satisfactory. No proper records for the sludge removal and disposal are maintained by the CETP. The diffused aeration system was not found adequate in terms of physical condition and performance. The sludge dewatering, handling and storage system practiced by CETP found to be unsatisfactory as the SDBs of phase-II is not provided with leachate collection and transfer system. SDBs of Phase-I having leachate collection tank and flexible pipes are reportedly used for transfer of leachate to aeration tank. However, proper and fixed transfer system of leachate to equalization tank needs to be provided for both the phase. The decanter installed at the phase-II was not working. Civil structure, railing of collection tank, aeration tank was found damaged and needs improvement. The OCEMS and flow meter installed by the CETP at the inlet and outlet was not operational during visit as sensors were observed submerged in the sludge and proper working of sensor in such condition is technically not possible. Leakages from sludge transfer pump, glad leackage, accumulation of acidic wastewater near sludge drying beds of phase-II, storage of sludge on open land adjacent to sludge drying bed near collection tank and overall housekeeping shows negligent approach. The final outlet sample collected from CETP significantly exceeds MPCB discharge standards for the concentration of TSS, FDS, COD, BOD, NH3-N, TKN, phenols, PO4-P, Cl, S2, CN, Fe and Pb. MIDC has to provide the final disposal point in the deep sea as suggested by NIO. MIDC also need to repair and maintain the leakage in the discharge pipeline. It is therefore concluded that the CETP has not taken sincere efforts for execution of recommendations given in the earlier reports submitted to Hon'ble NGT. MPCB is in the opinion that change of the management committee of CETP, administration of Registrar of Societies to newly elected committee are the reason for the same. Thus, CETP continue to violate the MPCB discharge norms. It is recommended that CETP should devise systematic time bound approach to address the issues starting from the very first step of treatment scheme to the end. The CETP management is required to revisit the recommendations made in earlier as well as in present reports and also to integrate efforts as stakeholders to implement them without further delay.

The NGT noted that severe pollution was being caused, which was required to be remedied and penal action be taken against the polluters. The NGT directed the MPCB to restore further the damage caused and prevent further pollution. The amount of compensation required to be deposited was increased to Rs. 10 Crores. Given the magnitude of the problem and repeated failure on the part of the regulatory authorities, the NGT constituted a Monitoring Committee to execute the directions of this Tribunal to be

headed by Justice V.M. Kanade, former Judge of Bombay High Court. The Committee was to take stock of the action so far and propose a time-bound action plan. The NGT also directed that an online mechanism monitoring the performance of individual ETPs and CETP should be connected to the servers of the CPCB and the MPCB. The Committee was to prepare an action plan within one month. The NGT directed a joint Inspection Committee comprising the CPCB and the MPCB to submit its report at the earliest.

The Justice V. M. Kanade Committee submitted its first appraisal report in December 2018 that concludes as follows.

> *It may be concluded that the performance of CETP has further degraded. Neither effective control on member units for effluent quality has been achieved, nor has effective improved operation of CETP been achieved. No serious thought is given towards achievements of commitments made by stakeholders as well as implementation & compliance of action framework submitted by the Committee. Stakeholders have not even given any thought for submission of status reports to the committee. The effluent being discharged by CETP has great potential to cause damage to the environment with continuous gross violation of norms. The Committee has decided to call a meeting of stakeholders in the third week of December, 2018 for review.*

The MPCB also submitted it action plan in December 2018 and stated the NGT that the further work is in progress. The MPCB submitted second appraisal report in March 2019 that summarizes as follows.

> *The committee suggested multipronged approach in action framework with more focus and stress upon cleaning, repair & maintenance of CETP and control on pretreatment by member units. Accordingly, following actions have been initiated by CETP:*
>
> *• CETP has taken-up shut down of Phase-2 (10 MLD) plant from 17.11.2018 for cleaning, repair and maintenance. Phase-1 is kept in operation and to be taken-up subsequently for similar cleaning, repair and maintenance.*
>
> *• Huge amount of sludge has been removed from treatment units of CETP. Total 2235.66 MT of sludge is disposed during period from 21.11.2018 to 28.11.2018. Subsequently, 178.920 MT and 217.050 MT of sludge is disposed in common HWTSDF of Taloja on 31.01.2019 and 01.02.2019- respectively.*
>
> *• CETP has arranged awareness programme for member units in compliance of the action framework.*
>
> *• CETP has started monitoring of discharge of member industrial units. Taloja Manufacturers' Association (TMA) has taken following actions to address the action points given in framework:*

• TMA organized awareness prorgamme for member units on 27th December, 2018.

• TMA is organizing one more awareness programme for member units in association with MPCB and MIDC on 26th February, 2019.

• TMA is working on inventorization of the member units as per format prescribed in the action framework.

MPCB has taken following steps to address action points suggested:

• Increased surveillance activities in the area and actions including closure, show cause directions have been taken against defaulter units besides directions for curtailment in water consumption and installation of online monitoring systems.

• The MPCB has reportedly filed prosecution against CETP before Hon'ble CAD, Panvel on 13.12.2018 for noncompliance. The initiatives of committee has resulted in several steps and drastic reduction in concentration values in effluent at outlet of CETP, specially observed after December, 2018 but values are still much higher than standard limits. The pace of physical works related with cleaning, maintenance and repair of CETP is not satisfactory. Actions and target dates are arbitrarily changed by the stakeholders without any intimation to the committee or Hon'ble NGT for which committee has expressed dissatisfaction during last meeting with stakeholders. Adequate focus is not given by the stakeholders in recording and reporting of results of key parameters in the CETP namely flow, ammonical nitrogen and phenolic compounds. Attention has not been paid by stakeholders for regular submission of progress reports to the committee as reflected in Table given on page 5-8 above.

CETP office has been observed very casual towards regular submission of status reports to the committee as prescribed in the framework. Office bearers of CETP failed to attend the meeting of the committee held on 21.02.2019. CETP has still reportedly not deposited balance amount of Rs Five Crore in compliance of the order passed by Hon'ble NGT in the matter. As the works of cleaning, repair and maintenance of CETP has been taken-up by MIDC, MIDC also shares responsibility of timely sharing of progress and compliance reports.

The counsel of Mr. Arvind Mhatre submitted before the NGT that CETP is not functioning and pollution is continuing despite repeated directions. The only option before the NGT to prevent pollution is to permit only such industries to function, which have stand-alone ETPs that fully comply with the norms or industries that switch over to ZLD. Any industry not connected to CETP and not having its own satisfactory ETP or the industries connected to the CETP but not meeting the norms or till CETP meets the norms, must be closed.

The MIDC took over the CETP and MIDC is to upgrade and expand CETP. The MIDC before the NGT stated that 'it started its first phase from 01.11.2018 and Phase-II is under maintenance which will be completed in May 2019. After that, Phase-I will be in maintenance'. The detailed course of action also was submitted by MIDC to operationalize the CETP was presented before the NGT.

Despite that, it was observed that the pollution has not stopped, the only option was to shut down the industries that were the source of pollution until remedial action is taken. The NGT found that the MIDC and MPCB were unable to provide any other solution. It was made clear that the mere fact that MIDC had assigned the work to a contractor does not absolve MDIC of its responsibility of operating CETP as per norms.

Accordingly, the NGT directed, in July 2019, the MPCB to forthwith suspend the Consent to Operate to the industries in the area not meeting the norms and permit them to operate only after remedial steps are taken. Steps in this direction be taken within two weeks from the date of direction. Whether a particular industry is complying or not complying with the norms is the matter to be decided by the MPCB in accordance with the law. Action taken report be furnished to the Committee and the Committee may take a final call in the matter, in case of any surviving issue. The Taloja CETP Co-operative Society Limited stated before the NGT that a sum of Rs. 6.1 Crores are deposited with the District Magistrate. The remaining amount may be collected and deposited with the District Magistrate by MIDC. The NGT directed that the amount may be spent on restoration of damage to the environment by furnishing an action plan to the Committee.

Mr. Arvind Mhatre stated that we, the residents, will get justice and make the industries stop discharging the effluent in the Kasadi and Taloja river. Further, the NGT hearing is still pending and will soon take a review of the action.

In the 9th Meeting of Taloja Monitoring Committee held on 28th December 2020, the MPCB in its presentation before NGT stated that the performance of the CETP based on the samples collected by the Board from CETP inlet and outlet from January 2020 onwards and remarked that Inlet parameters are almost within the standards and Outlet parameters are also considerably achieving the standards except for some occasions. The average outlet COD parameters for the months September 2020 to November 2020 were 195mg/l, 204mg/l and 299mg/l respectively. The MPCB has invited DPR from IIT & NEERI vide dated 29th September 2020 regarding

restoration of Kasardi river and accordingly, NEERI and IIT submitted their proposals on 17th December 2020.

The MIDC reported that as per the recommendation of NIO, the new disposal of treated effluent is 3.3 KM ahead of the existing disposal location. The administrative approval for this work is accorded by competent authority amounting to Rs. 90.92 Cr. and MIDC has appointed the consultant for obtaining permission from MoEF & CC. The EIA/Rapid EIA and CRZ mapping with IRS studies are completed by Anna University, Chennai. The MIDC has applied to Maharashtra Coastal Zone Management Authority (MCZMA) for the recommendation on 25th November 2020. The proposal is in process of getting CRZ Clearance from MoEF& CC. The MIDC further reported that after getting CRZ Clearance, work will be executed and it will take about one year to complete the work of lay down the pipeline.

The Taloja CEPT reported that Phase-I and Phase-II of CETP are already made operational on 20th July 2019 and 30th December 2019 respectively. It reported that both phases are running smoothly. The CETP was in running condition despite the lockdown situation due to Covid-19. The report further states that the CETP faced various problems regarding CETP equipment services and spares due to lockdown during the period from March 2020 to May 2020. The CEPT furnished that Phase-III of 5 MLD capacity almost all work is completed and it is under stabilization stage. The MIDC has finalized the work order of a new RCC holding tank of capacity 10,000m for emergency holding to prevent shock load on CETP and presently excavation work is under progress. The CEPT has obtained Consent to establish for additional Phase -III of capacity 5MLD from MPCB and approval is requested to operationalize the same. The CEPT has reported that an Online Continuous Monitoring System (OCMS) is installed at the CETP outlet and connected to the CPCB and MPCB server. However, OCMS installation at the CETP inlet is not yet in operation due to its maintenance and servicing issues. The testing of CETP samples through a third-party laboratory has started as per suggestions of the Taloja Monitoring Committee. Further, the CEPT reported that it has undertaken a Bioassay test at CETP and observed the survival of fish during testing.

Shri. Aravind Mhatre being a member of the Taloja Monitoring Committee, in the 9th meeting raised the following issues. He stated that the restoration work of the Kasardi river is yet not started. The MIDC has not extended the existing effluent disposal pipeline further 3.3Km, thus

causing damages to the Mangroves and related aquatic life. The CETP has not provided the results of CETP through OCMS, hence we are unable to see the live performance of CETP.

He further, suggested to the Committee that the cleaning process of River Kasardi is yet to be started. There is still a need for laying down a 3.3 km pipeline in Sea. The CETP must lay a foundation for its Laboratory for Testing of air and water pollution. The pollution reading device's to be installed in Taloja MIDC. A new hospital to be constructed For MIDC from CSR fund. The Phase 3 sludge was deposited in the Kasardi river belt to be disposed of.

The MPCB, in the 9th meeting, further instructed the MIDC to give a time bound program for "Extension of 3.3Km of existing treated Effluent disposal Pipeline in the deep sea as per the recommendation of NIO". The MIDC Sump No.-II located near the Ghot Village is receiving effluent from fish/food processing units, and if it is not pumped within 12 hrs, septic conditions develop in the sump and thus created foul smell nuisance. Hence the MIDC is instructed to provide primary treatment with the Aeration system in the MIDC Sump No.-II. The MIDC is requested to submit a time-bound program for the same. It is noted that about 2000m^3 quantity of sludge has accumulated in the MIDC Sump No.-II, which needs to be removed before March 2021. The MIDC is asked to submit a time-bound action program for the same. The MIDC is instructed to provide foggers and a deodorant spraying system on the periphery of CETP to avoid foul smells. The MIDC is suggested to carry out de-sludging/flushing of underground drainage pipelines by using hydra quarterly.

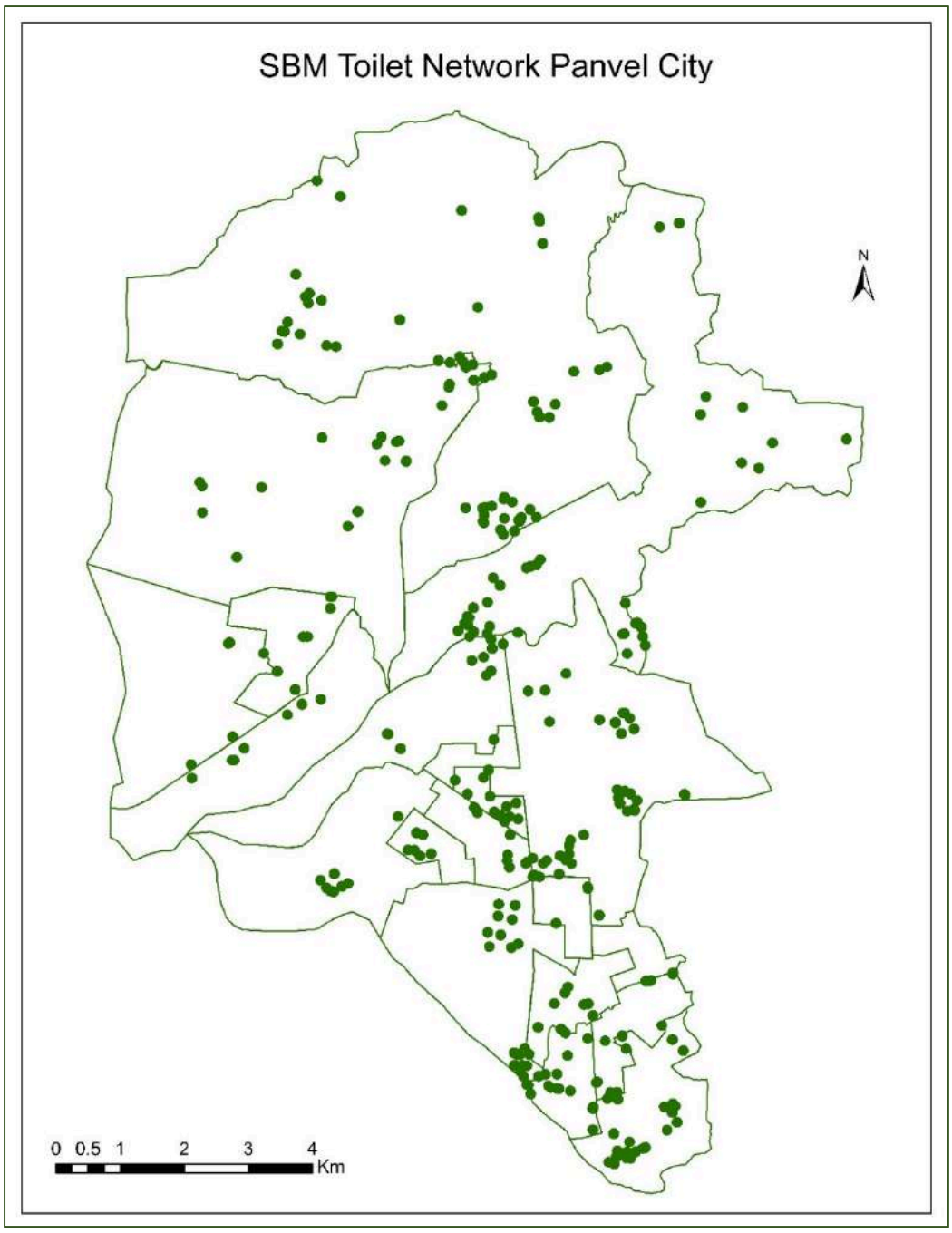
The MPCB observed that the sewage generated from various villages and townships located nearby MIDC Taloja is entered into Kasardi River without any treatment. The Panvel Municipal Corporation is requested to provide adequate treatment facilities such as a sewage treatment plant to prevent river Water Pollution. The MPCB instructed the Panvel Municipal Corporation to take all the necessary steps for the prevention of disposal of Municipal Solid Waste (MSW) into Kasardi River. The MIDC is asked to install CCTV at key points of Kasardi River so that any unauthorized and illegal discharge of effluent from Tankers into the river will be prevented.

The citizens of Panvel City are indebted to Shri. Arvind Mhatre for his restless efforts to make the Kasardi river pollution free.

6.3 Provision of Public and Community Toilets

The Panvel City is certified by ODF++ in August 2020 due to its efforts for public and community toilets. All the public and community toilets are Geotagged as SBM Toilet and any individual can search it in google map service.

Map 18 Geotagged SBM Toilet Network in Panvel City



Source: Panvel Municipal Corporation

According to Panvel Municipal Corporation, 95 per cent of the households have exclusive toilets in most areas such as Kharghar, Kamothe, Khandeshwar, Mansarovar and New Panvel. And the rest of the residents are made available public and community toilets. The Construction Department of PMC has built 4308 individual toilets for the residents in the city. There are 279 public and common toilets with 1725 seats in the city. In market areas, 20 e-toilets are made available. There are 95 littering facilities in the city made available by the PMC. The commercial areas have public toilets at an approximate distance of 100 meters. There are 220 Mobile toilet seats made available where there is no place for building a toilet.

There are separate seats available for handicapped and children in public and common toilets. And ramps and support bars are installed at public and common toilets in the city.

The public and common toilets are equipped with handwash, napkins, citizen feedback system, washbasin, mirror, air freshener and dust bins. All such toilets are cleaned and maintained with the help of private contractors. Each of the public and community toilets has one attendant who takes care of cleaning and maintaining the toilets and looking after the toilets' provisions. All the community toilets are geotagged and google mapping is carried for all public and common toilets.

The toilets at all 29 petrol pumps in Panvel City are declared as public toilets by PMC and the residents are informed accordingly. The cleaning and maintenance are carried out by Petrol Pumps and are asked to maintain the cleaning records that PMC may verify.

Table 54 ODF and GFC Certifications

Sr. No.	Certification	Date of Certification
1	ODF	23rd August 2017
2	ODF Recertification	30th June 2018
3	ODF+	22nd January 2019
4	ODF++	29th August 2019
5	GFC 2 Star Rating	29th December 2019

Source: Panvel Municipal Corporation, Panvel

The PMC secured ODF certification in its second Swachh Survekshan in 2017. The efforts to make the city open defecation free are evidential through the improved certifications. In just two years, the Panvel Municipal Corporation secured ODF++ certification.

6.5 CSR funds for Swachha Panvel City

The PMC administration and local governance have undertaken efforts to motivate the corporates to finance various projects related to solid waste management, toilets and sewage systems. The PMC could successfully raise Rs. 4.84 crores which is a significant fund to support the financial needs.

Table 55 CSR Funds raised by the Panvel Municipal Corporation

Sr.No.	Details	Per unit cost (Rupees)	Total Number of Units	Total (Rupees)
1	E-Toilets with bio digester	8,12,014/-	20	1,62,40,280/-
2	Mounted stainless steel twin litter bin with lid	21,760/-	500	1,08,80,000/-
3	Mobile Toilets	6,72,600/-	20	1,34,52,000/-
4	Sewer Suction Machine	19,94,400/-	2	39,88,800/-
5	Jetting Machine	15,89,600/-	1	15,89,600/-
Total				4,61,50,680/-
5% Contingency Cost				23,07,534/-
Grand Total				4,84,58,214/-
Four Crores Eighty Four Lakhs Fifty Eight Thousand Two Hundred Fourteen Only				

Source: Panvel Municipal Corporation, Panvel.

6.4 Swachha Sarvekshan 2020

Swachh Survekshan is an annual survey of cleanliness, hygiene and sanitation in cities and towns across India. It was launched as part of the Swachh Bharat Abhiyan, which aimed to make India clean and free of open defecation by 2nd October 2019. The Panvel City is among the top 100 cities in India and secured 86th All India Rank among 4237 cities in India in Swachh Survekshan, 2019. The Panvel City secured 59.38 per cent marks out of 5000 marks. The Panvel City is also awarded ODF+ (Open Defecation Free plus) status on 19th January 2019 for 2019 by the Quality Council of India (QCI). The city could earn a two-star rating in the Garbage Free City indicator in December 2019.

To achieve better Open Defecation Free status, PMC continued expanding installations of exclusive toilets for the households. As a result, QCI issued ODF++ status to PMC on 26th August 2019. This certification is received for its commendable job in making the city ODF. Local the administration carried out all the necessary financial and administrative provisions for this purpose. It is the result of hard work and efficiency of the local governance and administration.

The PMC could continually improve its national ranking in Swachh Survekshan from 2016 to 2019. Even in the MMR, it stands out in the improvement in the scores and rankings.

Table 56 Rankings of Cities in Mumbai Region (2016 to 2019)

Sr. No.	City	2016	2017	2018	2019
1	Navi Mumbai	12	8	9	7
2	Mira-Bhayander	-	130	47	27
3	Ambarnath	-	89	67	30
4	Vasai-Virar City	35	139	61	36
5	Greater Mumbai	10	29	18	49
6	Kulgoan-Badlapur	-	158	113	51
7	Thane	17	116	40	57
8	Kalyan-Dombivali	64	234	97	77
9	Bhiwandi-Nizampur	-	392	98	84
10	Panvel	-	**170**	**87**	**86**
11	Ulhasnagar	-	207	107	129

Source: Swachh Survekshan, 2016 to 2019

The Swachh Survekshan ranking was 170th in 2017, which improved to 86 in 2019. The break of marks secured by Panvel City in 2019 may give areas of concern concerning Swachh Survekshan.

Table 57 Marks Secure by Panvel City in Swachh Survekshan, 2019

Part No.	Part Name	Marks Secured	Percentage Marks Secured
I	Service Level Progress	557	44.56
II	Certification	400	32.00
III	Direct Observation	1039	83.12
IV	Citizen Feedback	973	77.84
	Total	2969	59.38

Source: Swachh Survekshan, 2019

Panvel City needed to improve in Part I and Part II of Swachh Survekshan to improve its ranking. In Part I, seven thematic areas cover 32 indicators, Panvel City secured only 44.56 per cent marks. The Environmental Status Report, 2018-19 suggested that the City has to strengthen its 2-star rating in the Garbage Free City indicator to a 7-star rating and ODF to ODF++ rating in Open Defecation Free City indicator of Part II, in which Panvel City secured only 32 per cent marks. Hence Part I and Part II are a matter of concern and the Municipal Corporation has to put in efforts to improve marks in these parts. And Panvel City has to achieve higher marks in all seven thematic areas in Part I in the coming years.

The overall methodology in Swachh Survekshan 2020 is changed and hence it is not comparable with previous performance of its own and with the neighbouring cities in MMR. Perhaps one can observe a substantial improvement in performance and national and state ranking of the city in 2020.

The urban body took it very seriously to work strategically to improve its rankings in Swachh Survekshan. As a result, according to SS2020, Panvel Municipal Corporation secured 20th position in one lakh to 10 lakh population group and 5th position among 33 ULBs in Maharashtra. The achievement in improvement in rankings is due to focused efforts to provide a clean and safe city environment.

Table 58 Rankings of Cities with Population between 1 to 10 Lakhs in Mumbai Region (2020)

Sr. No.	All India Ranking	City	Service Level Progress	Certification	Direct Observation	Citizen Feedback	Total
1	18	Ambarnath	1082.12	1100	1127	1304.92	4614.04
2	19	Mira-Bhayander	1088.12	1100	1140	1280.03	4608.14
3	20	Panvel	1142.91	700	1492.34	1264.49	4599.74
4	26	Bhiwandi-Nizampur	1026.28	1100	1066.3	1203.54	4396.12
5	47	Kulgoan-Badlapur	958.49	700	952.34	1281.15	3891.98
6	94	Ulhasnagar	718.36	500	1042.18	1149.36	3409.91

Source: Swachh Survekshan, 2020

*Navi Mumbai, Thane, Kalyan Dombivali, Greater Mumbai, Vasai-Virar are the ULBs with greater than 10 Lakh population and are ranked in this category.

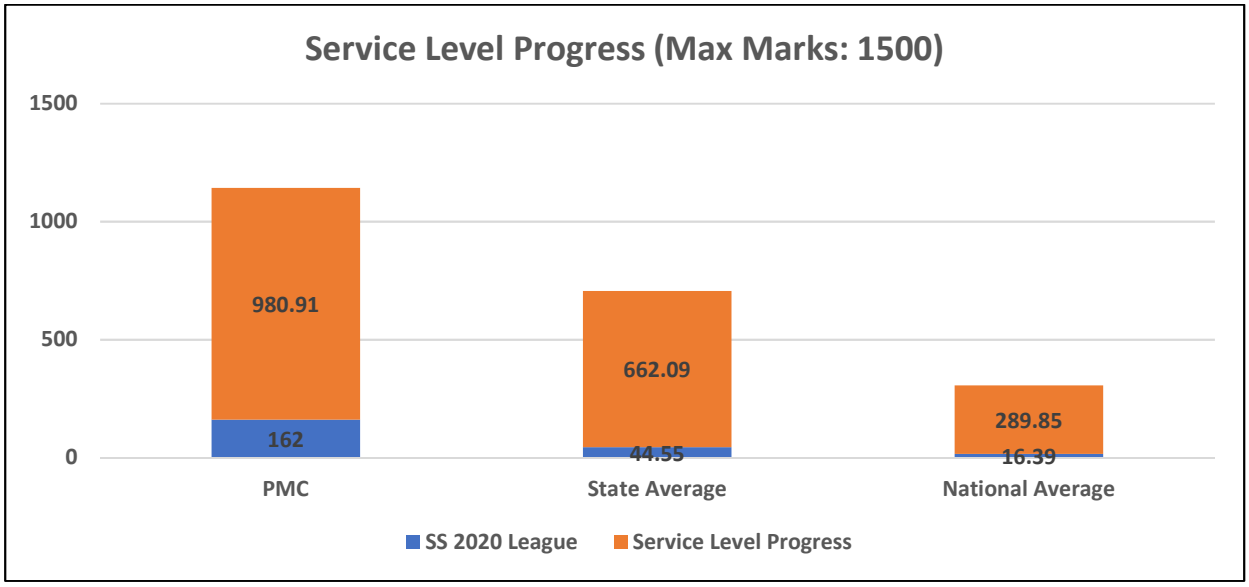
Table 59 Marks Secured by Panvel City in Swachh Survekshan, 2020

Part No.	Part Name	Marks Secured	Percentage Marks Secured
I	Service Level Progress (1500)	1142.91	76.2
II	Certification (1500)	700	46.7
III	Direct Observation (1500)	1492.34	99.5
IV	Citizen Feedback (1500)	1264.49	84.3
	Total (6000)	4599.74	76.7

Source: Swachh Survekshan, 2020

Though the marks secured are not comparable to its earlier scores, due to changes in the methodology of Swachh Survekshan, 2020, the scores secured indicate improvement in all the areas that include Service Level Progress, Certification, Direct Observation and Citizen Feedback.

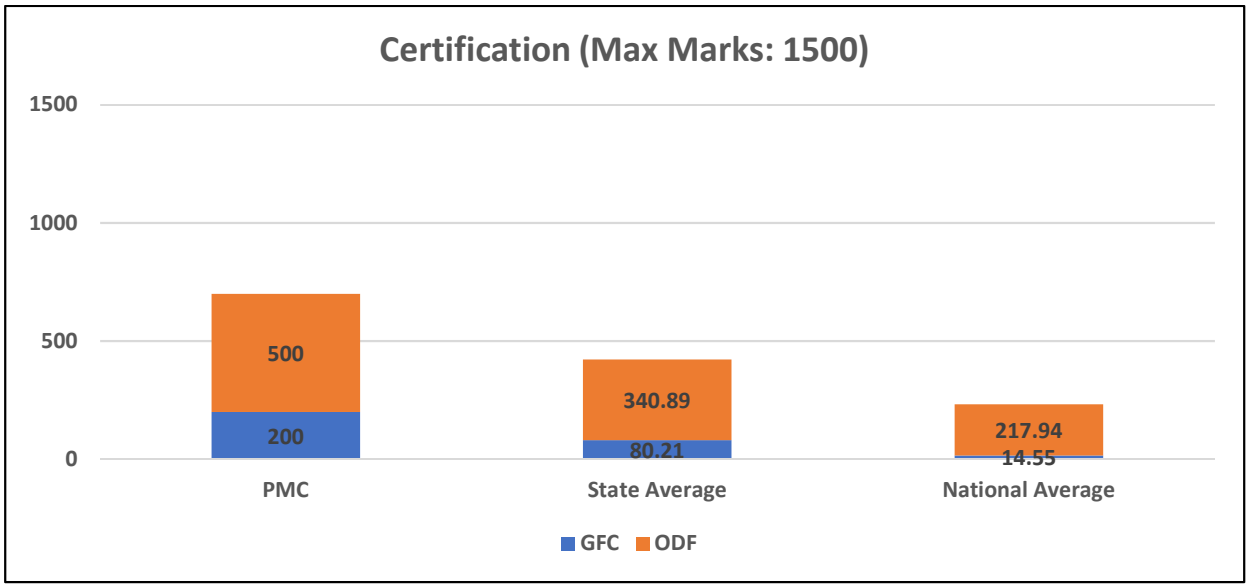
Figure 36 Comparison of PMC with State and National Average in Part I



Source: Swachh Survekshan, 2020

The PMC secured 162 marks (81 per cent) in SS 2020 League out of 200 and 980.91 marks (75.45) in Service Level Progress out of 1300. The ULBs in Maharashtra secured an average of 22.28 per cent marks in SS 2020 League and 50.93 per cent in Service Level Progress; overall, PMC has been far better in Service Level Progress as a whole in Maharashtra. Compared with the ULBs in India, the performance of PMC is significantly better and outperforming in Part I: Service Level Progress.

Figure 37 Comparison of PMC with State and National Average in Part II

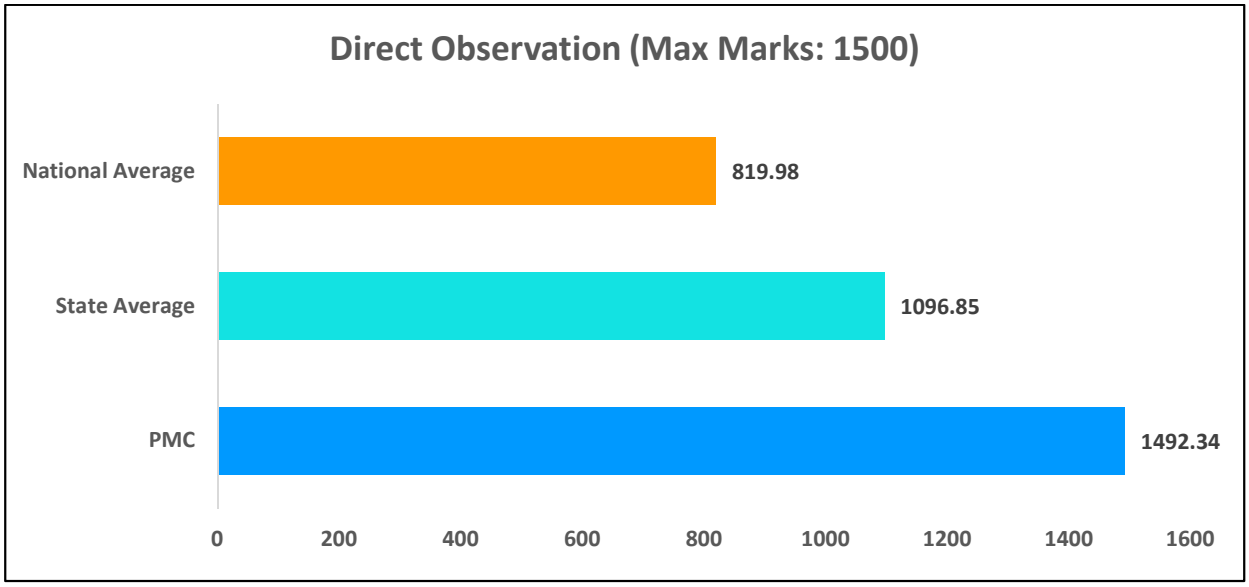


Source: Swachh Survekshan, 2020

There are two certifications in Part II Certifications- Garbage Free City Certification (Maximum 1000 marks) and Open Defecation Free City Certification (Maximum 500 marks). The PMC secured 100 per cent marks in ODF certification by securing ODF++ status in August 2019. And it secured 20 per cent in Garbage Free City Certification. Relatively PMC performs significantly better than State and National average in Part II.

The Part III Direct Observation has nine indicators that include Residential & Commercial areas, Public/Community Toilets, Public Transport Hub, Vegetable & Fruit Market, Art Works from Waste, Beautification of slum/old city area, Measures to control dust in the air, Encroachment free stormwater drains and SBM Messages in CT/PTs.

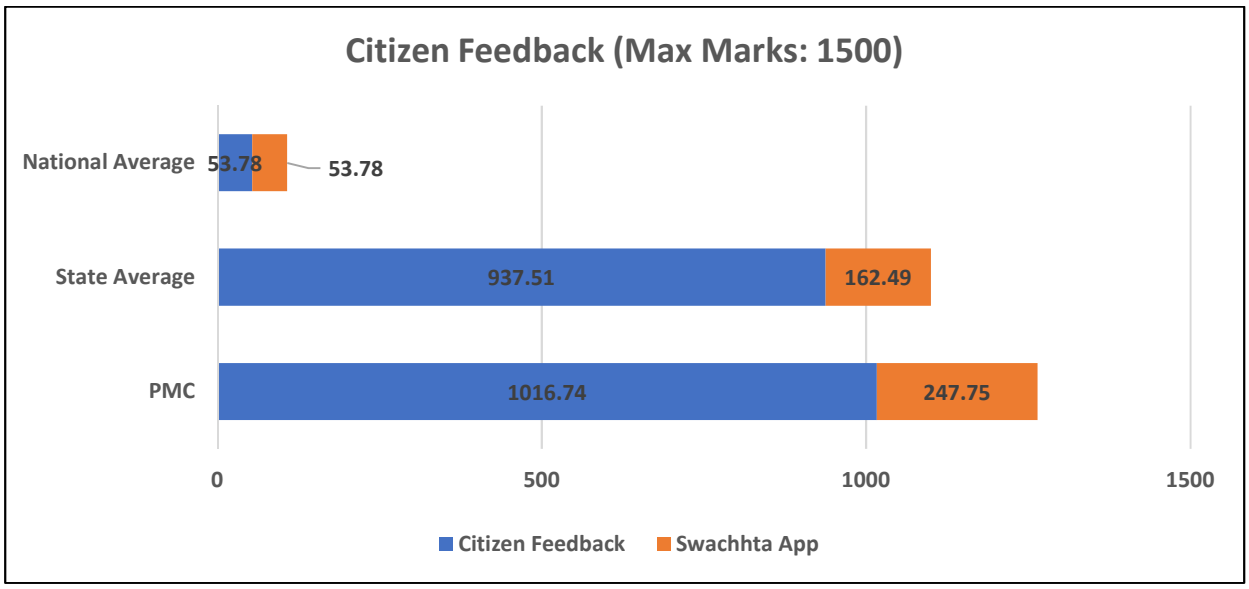
Figure 38 Comparison of PMC with State and National Average in Part III



Source: Swachh Survekshan, 2020

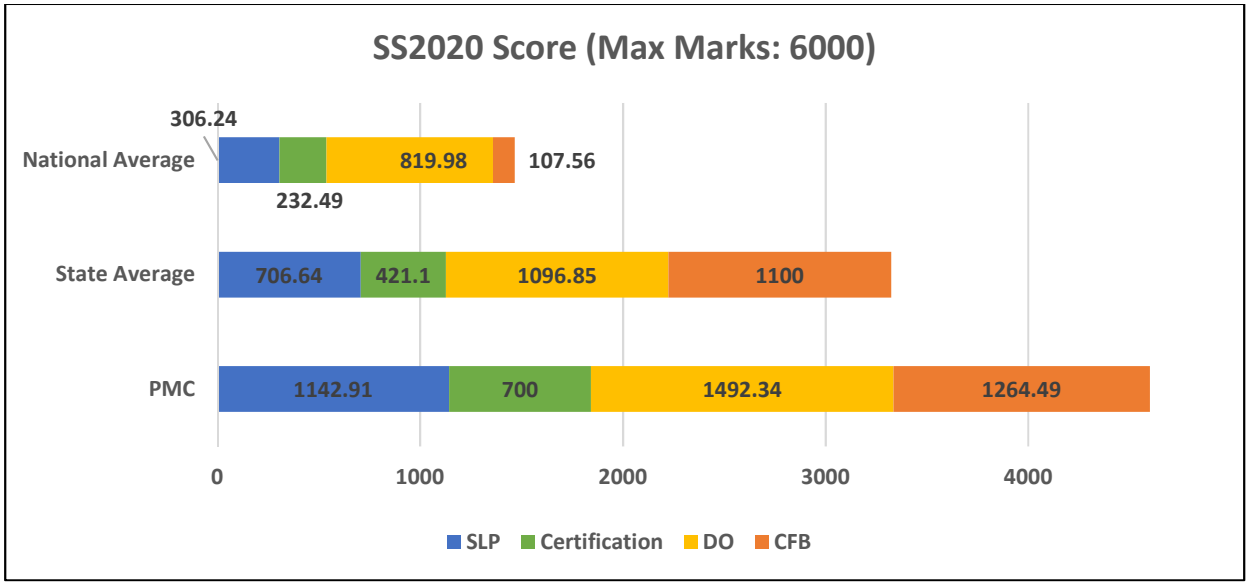
The PMC scored 1492.34 marks (99.48 per cent) marks in Part III of the SS 2020. The scores secured by PMC are significantly high and indicate that it has made substantially high progress in all the indicators. It has scored exceptionally high scores compared to the State and National average in Part III.

Figure 39 Comparison of PMC with State and National Average in Part IV



Source: Swachh Survekshan, 2020

Figure 40 Comparison of PMC with State and National Average in Overall Marks of SS2020



Source: Swachh Survekshan, 2020

Seven questions are asked to the citizens through 5 channels, and four indicators are evaluated from Swachhata App/Local App in Part IV Citizen Feedback (1500 Marks) to assess the ULBs. The PMC secured 1264.49 marks in Part IV, of which it secured almost 92 per cent marks in Citizen Feedback from 7 questions and around 62 per cent through evaluation of the Swachhata App. Its scores are close to the State average but are significantly greater than the National average.

The PMC secured a total of 4,599.74 marks out of 6000 marks. It has performed substantially better in Part I, Part III and Part IV and needs to perform better in Part II of SS2020. The PMC secured exceptionally more scores than the State and National averages in all Parts. The local governance and administration have been continually improving in all Parts of SS2020 by monitoring quarterly performance. Being a relatively new ULB in Maharashtra and having financial constraints, the performance of PMC is commendable.

The results of Swachh Survekshan 2021 are awaited, the PMC due to its commendable efforts is expected to receive improved ranking in all the dimensions.

6.5 Disaster Management

Disasters are not random and do not occur by accident. They are the convergence of hazards and vulnerable conditions. Disasters reveal underlying social, economic, political and environmental problems, but unfortunately, they worsen them (UNEP, 2008). The impacts of disasters on the environment and development are manifold. Disasters create substantial environmental degradation and ecological imbalance, hinder socio-economic development and retard the process of improving the quality of life of the people. The interaction of disasters and the environment has both short-term and long-term effects (Pramanik, 1993).

And hence Panvel Municipal Corporation had prepared Disaster Management Plan for Panvel City in 2018. It has classified Risk and Vulnerability due to probable disasters in the city. The slums are vulnerable due to the location at which these are located. The slums in the city are located on hills, slopes, near drains, steep slopes, tidal areas, areas below high voltage electricity lines, industrial areas, both sides of main water supply pipelines and both sides of open gutters. All such slums are at high risk and vulnerable in terms of disasters. The floods are common in nature in India, though Panvel City has not experienced frequent floods. Perhaps every year, some areas are waterlogged in rainy seasons in Panvel City. To avoid waterlogging in these areas, PMC cleans drainage systems in the city before the rainy season and all the nullahs are cleaned. But still, heavy rainfall and high tide simultaneously create an unavoidable flood-like situation in the city.

There are many reasons for incidents of fire in the city. There are 29 villages in which all houses are built using wood and timber and the houses are built-in with no planning. There are also old housing societies that do not have firefighting equipment installed. The small, medium and large-scale, high-risk industries and oil refineries in Taloja MIDC increase fire risk. Hence firefighting

preparedness is required for which PMC is well equipped. Five Firefighting Stations include Panvel Firefighting Station, CIDCO's New Panvel Firefighting Station, Kalamboli Firefighting Station, Kharghar Firefighting Station, and Taloja MIDC Firefighting Station. All the firefighting stations are equipped with Fire Tenders (Specialized Water Tanker). There are two rescue tenders available with firefighting stations in Panvel City.

The houses in slums and houses that have used kuchha material are at risk from an earthquake. There are a number of the risky old structure of houses that bear the risk of collapse. The residents are to be evacuated from these buildings and these buildings are to be demolished. There are many such buildings in the city.

There is pressure on land in the city, increasing demand for housing due to increasing population necessitates developing residential areas even on sloped land and at the bottom of hills. Possibilities of land sliding cannot be ignored for such buildings and houses.

There are a number of industries that produce and process hazardous products or storage of such products. Such warehouses are very close to residential areas, and hence there is a high possibility of fire and huge chemical blast in these industries and residential areas nearby. HPCL and BPCL have their units near Panvel City, where dangerous and inflammable products are transported many a time via roads in Panvel City. JNPT has declared 32 hazardous chemicals which are handled at JNPT and stored near JNPT, of which transport is carried via roads in Panvel City. HPCL, BPCL, Reyon, Herdillia, ICC, Savita Chemicals, Unique Chemicals, Star Chemicals, etc., are a few industries that have their own limited firefighting systems, which is not sufficient to fight any possible accident. Hence residential areas near these industrial units are at risk.

Besides the above risky and vulnerable aspects, a few residential areas like Kharghar and New Panvel have piped LPG connections. HPCL, BPCL and Reliance provide these LPG connections. There are some incidents of leakages of LPG under land surface and fire.

Panvel City is very close to the sea coast and there are hills to the west of the city. The region has a possible threat of cyclone like Tsunami. A few villages near sea coast and a few slums are situated in these areas that are most vulnerable for such possible event.

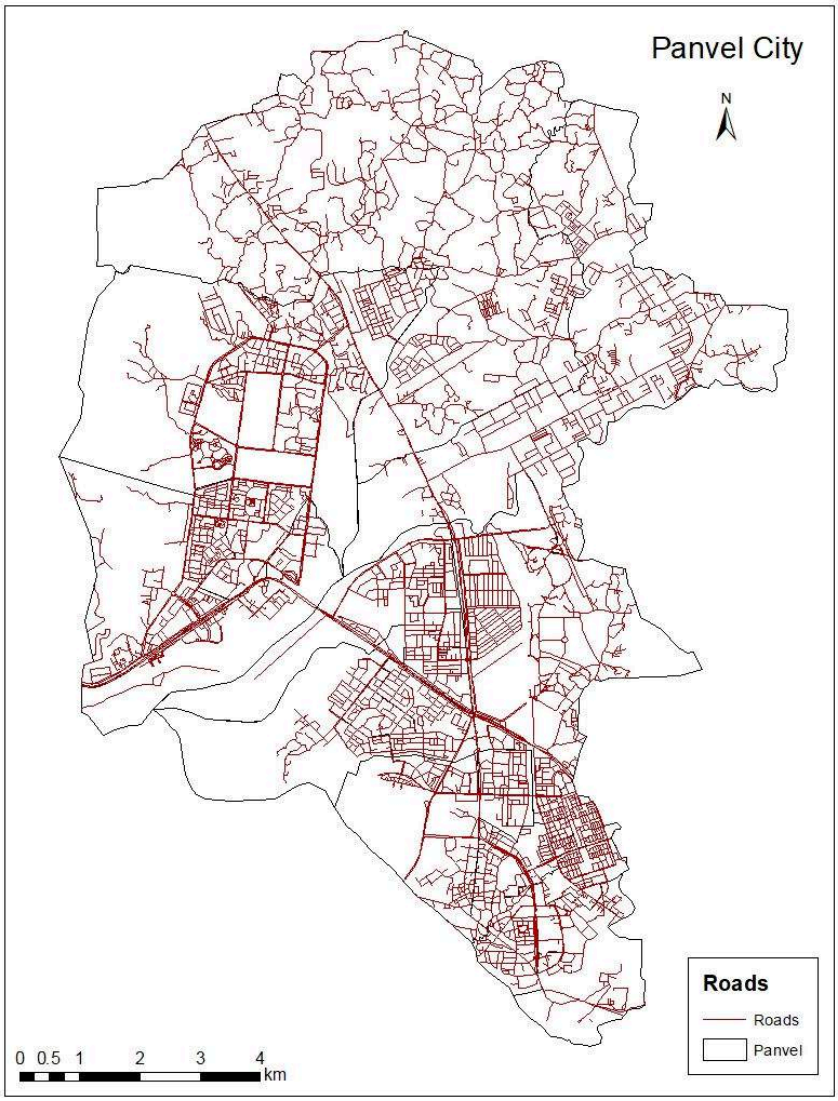
Having known possible disastrous situations, any such event will cause socio-economic loss and environmental imbalance. Hence Panvel Municipal Corporation has prepared Disaster Management Plan to tackle any such situation.

6.6 Provision of Roads

The people travel for various needs and purposes within the city due to spatial distribution and land uses such as workplaces, schools, hospitals, banks, retail stores, hotels and restaurants and grocery market. And the roads offer a range of motorized and non-motorized options for short-distance movements that a user may opt for depending on affordability, convenience, availability and comfort. The automobile has emerged as a preferred form of passenger transportation as it offers flexibility and convenience and contributes to congestion, particularly in urban areas (Rodrigue, Comtois and Slack, 2016).

The mobility of people and the movement of freight necessitate efficient transportation in urban areas. For smooth road transportation, surfaced roads are required. Panvel Municipal Corporation has a total surface road length of 365.39 km. The road density is the ratio of the length of the region's total road network to the region’s land area, in Panvel city is around 332.17 km per 100 square km. The efficiency of road transport implies maintenance cost to the vehicle as well as the road infrastructure. Hence ULBs have an important role in making efficient road transport within the city.

Map 19 Road Network in Panvel City.



Source: Estimated by Authors, Base Map from OpenStreetMap.org

The PMC received a negligible amount as road tax in the year 2018-19, 2019-20 and 2020-21, which is not enough to maintain roads in the city. But under the budget head of Construction, there is provision for maintenance of roads in the town.

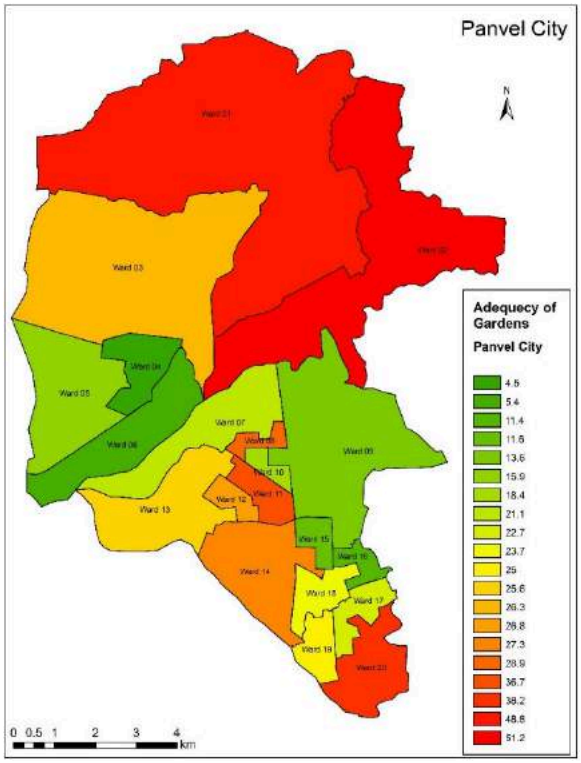
6.7 Gardens and Tree Plantation

The CIDCO, being an Urban Planning Authority, accommodated a sufficient number of parks in Kharghar, Kalamboli, Kamothe and New Panvel. 29 villages, generally villages are unplanned habitate, do not have gardens as these were parts of various Gram Panchayat before 2016. There

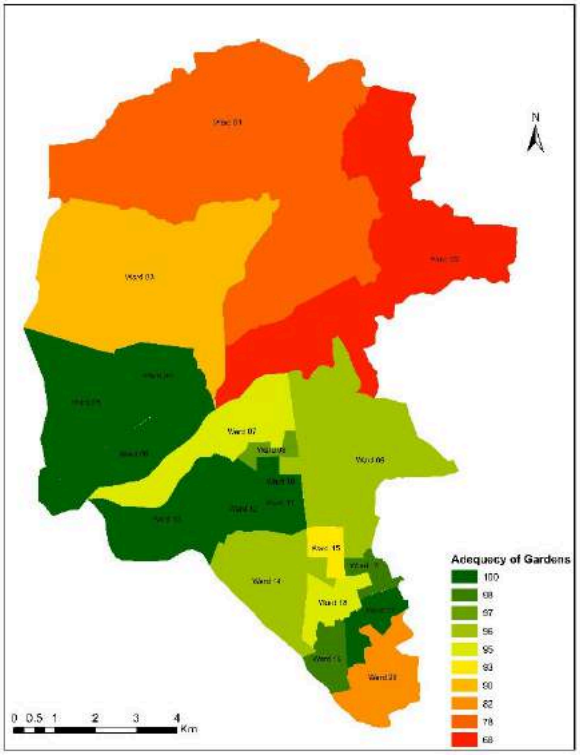
are a few gardens in Old Panvel City that is part of the Old Panvel Municipal Council. We explored the adequacy of gardens in the city by asking households through the environmental survey.

Map 20 Adequacy of Gardens in Panvel City

2018-19



2020-21



Source: Environmental Survey, 2018-19 and 2020-21

We observed that Ward No. 1, 2, 3 and 20 do not have garden facilities. The areas like Kharghar, Kalamboli and New Panvel developed by CIDCO have enough gardens in residential areas. The residents in Old Panvel and Kamothe areas have stated that there not enough gardens in their areas.

The tree plantation is carried by Panvel Municipal Corporation every year. The PMC planted 9250 saplings behind Panvel Court on Survey No.508 (P) and 520 (P). In 2017-18 also PMC planted saplings under AMRUT Programme. The people in the city are also motivated for tree plantation through awareness programmes conducted by PMC.

6.8 Staff to perform functions of the Panvel Municipal Corporation

The workforce in providing public goods in urban areas is an important input to attain sustainable development of that region. The Municipal Corporation has staff as classified by the Government of Maharashtra to manage the needs of urban areas like municipal corporations in the state.

Table 60 Total Staff of Municipal Corporation

Sr. No.	Class	Total Staff	Female Staff	Percentage of Female Staff
1	**Officers**	13	1	7.7
2	**Municipal Corporation**	100	9	9.0
3	**Municipal Cleaning Workers**	220	75	34.1
4	**Rural**	174	19	10.9
5	**Rural Cleaning Workers**	141	23	16.3
	Total (2019-20)	648	127	19.6
	Total (2020-21)	633	121	19.1

Source: Panvel Municipal Corporation, 2019-20 and 2020-21

The whole staff is not enough to manage the urban services in the city. And also, gender equity is not achieved in staffing in Municipal Corporation. 79.6 and 19.4 per cent of the staff is Hindu and Buddhist respectively by religion. The Focused Group Discussion with the officials of PMC revealed that managing day to day functioning of various departments at PMC is difficult with the help of existing staff. It requires having more workforce to handle the functions under various departments in the PMC.

6.9 Information and Communication Technology

All the offices at PMC are digitized and are connected by communication technology. The PMC has developed E-Governance platforms through which the residents can pay Water Tax, Property Tax and Local Body Tax. The residents can book Theater online. E-Tendering is adopted for bidding and giving contracts for various purposes. The Ganesh Festival permission has to be obtained online only. The Birth-Death Registration, application for Marriage Certificates, Trade License and new water connection are to be done online only. And Citizen Charter is displayed at the PMC office and made available on the official website of PMC. All major chowks are installed Traffic Signals to manage traffic and congestion in the city that have eased mobility.

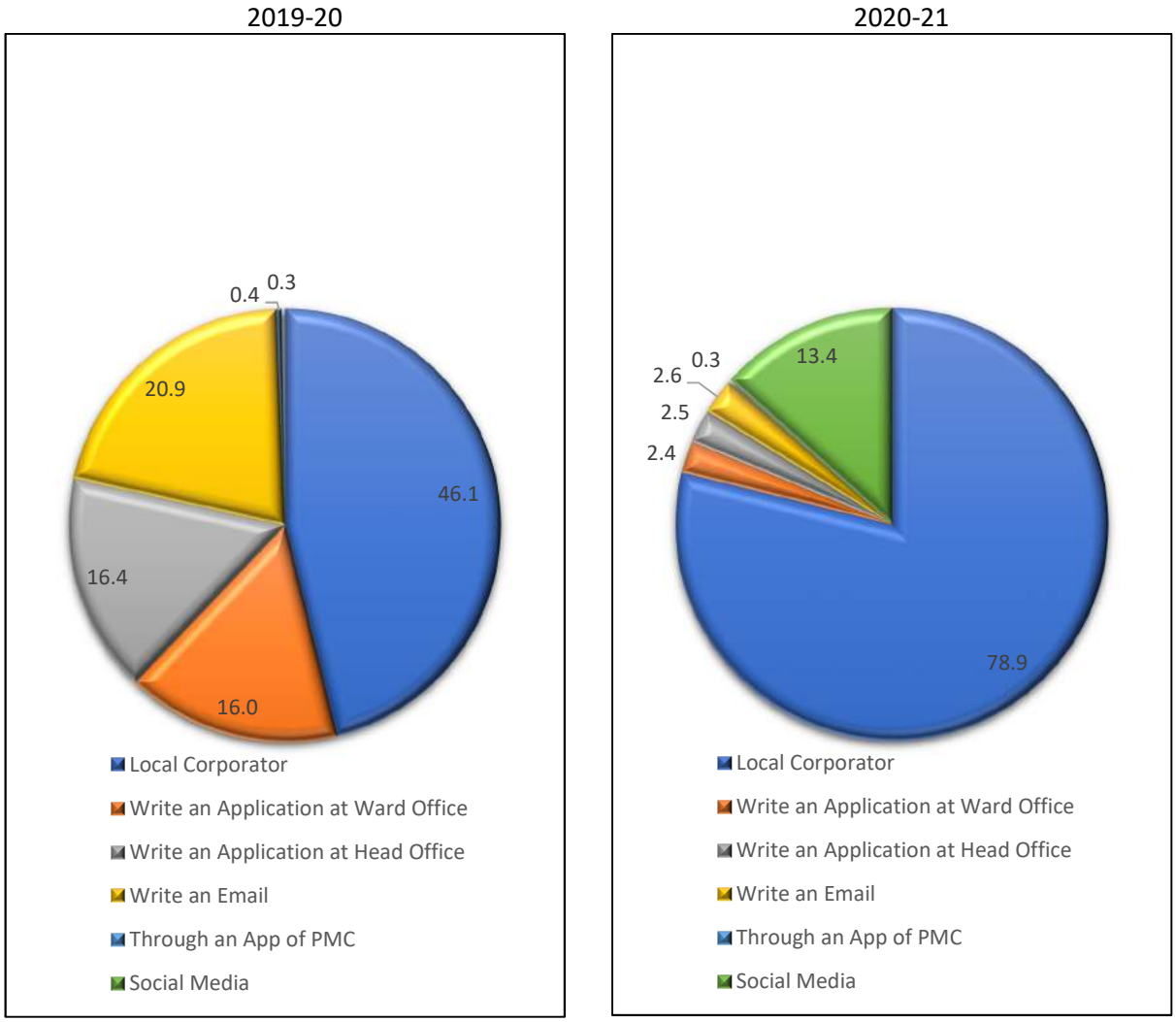
The PMC has been very active on Twitter and Facebook for the last three years; during Covid-19, the PMC has twitted the status of Covid-19 data related to patients, availability of beds in hospitals and the Covid centers every day; the PMC so far twitted 1583 messages through its official handle. The Facebook is used very effectively in dissemination of information related to

various campaigns and activities carried out by the PMC, there are 6809 followers on Facebook and 20201 people follow the PMC on Twitter.

6.10 Redressal of Complaints

The PMC provides a number of public goods and services to the residents in the city. Often, the failure may be observed about civic amenities and urban management, such as solid waste, sewerage and cleaning, that has to be brought into notice of the administration so that PMC can take necessary action to make things in the right order. Awareness about digital payment has been created in the municipal area by hearing and resolving the objections of the citizens regarding property tax.

Chart 10 Mode of Registering Complaints about Civic Amenities by Residents in Panvel City



Source: Environmental Survey, 2019-20 and 2020-21

It is observed that 46.1 per cent (2019-20) of households register their complaints with local corporators as they are approachable to the residents. Due Covid-19, large per centage of people

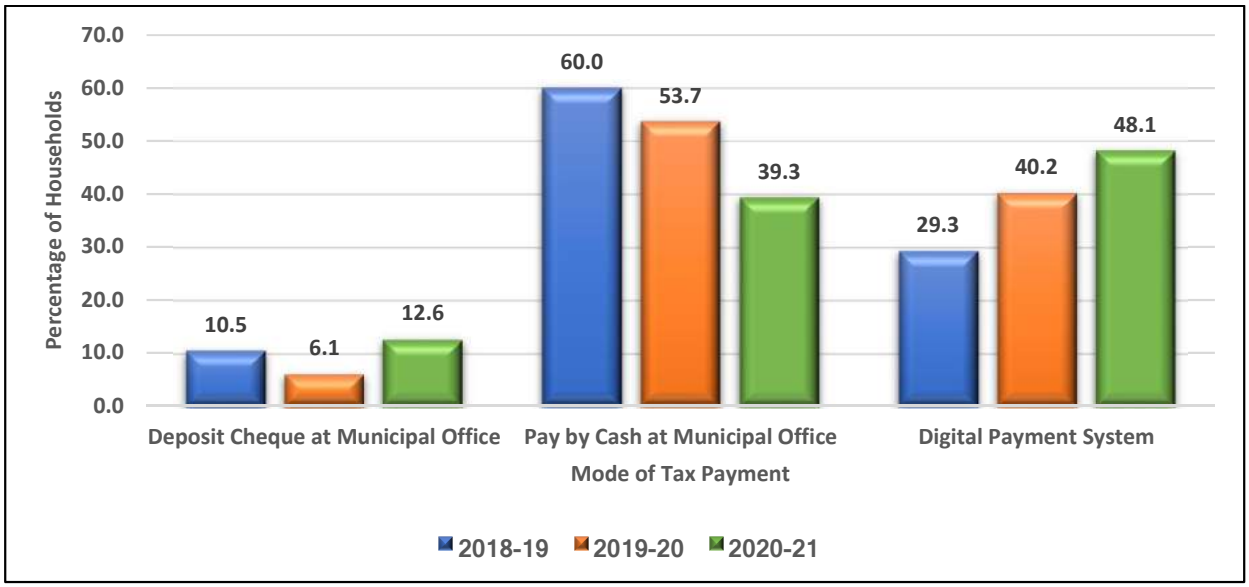
chose to register their complaints with local corporators in 2020-21. Very few households made use of the mobile app and social media for registering complaints about civic amenities (2019-20) that shows a significant change in 2020-21.

6.11 Payment Platforms for Taxes, Fees and Charges

The Municipal Corporation has made various modes of payments of taxes, fees and charges that are to be paid by residents to PMC, such as cash, cheque, demand draft and online payment on the official web portal, online transfers and payment through a mobile app. To promote the digital payment of taxes the PMC has started giving the 2 per cent discount in property tax to the households in the city and public awareness is creating by advertising the digital payment system though the announcements and online advertisements on the official website of the PMC. Also, the net banking/debit card and UPI payments are made processing charges free. The Digital Payment System and the payment of various bills systems have been provided at the Nagari Suvidha Kendra at Ward Offices A, B, C and D in the Municipal area.

If people use digital payment platforms for the payments that are to be made to PMC, they need not travel to PMC office or ward offices, which reduces congestion of vehicles and contributes negatively to vehicular air pollution. Hence it is necessary to know what mode of payment is preferred by the residents to pay taxes, fees and charges to PMC. It is observed that there is a positive impact of digitalization in the payment system on modes of payments to PMC.

Figure 41 Modes of Payments used by Households to Pay taxes, fees and charges to PMC



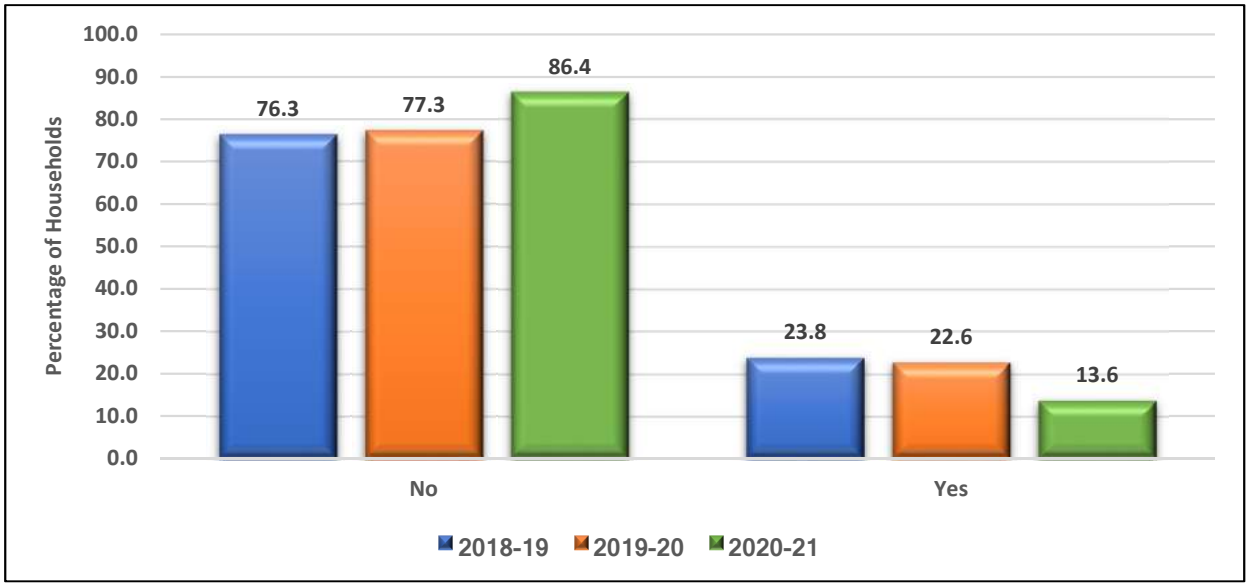
Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

In 2018-19, 29.3 per cent of households made payments to PMC through Digital Payment System using online banking, debit cards and UPI that increased significantly to 48.1 per cent in 2020-21. There is a positive change in making online payments through bank transfer and UPI through PMC website in 2020-21. There is a fall in the percentage of households making tax payments using cash mode of payments.

6.12 Participatory Actions

Public participation in meetings, ward meetings is necessary for improvement in the provision of public goods, services and amenities provided by Urban Local Bodies. As stated above, SHGs are involved in Solid Waste Management and Swachh Bharat Mission by PMC.

Figure 42 Percentage Households Participate in Meetings related to PMC



Source: Environmental Survey, 2018-19, 2019-20 and 2020-21

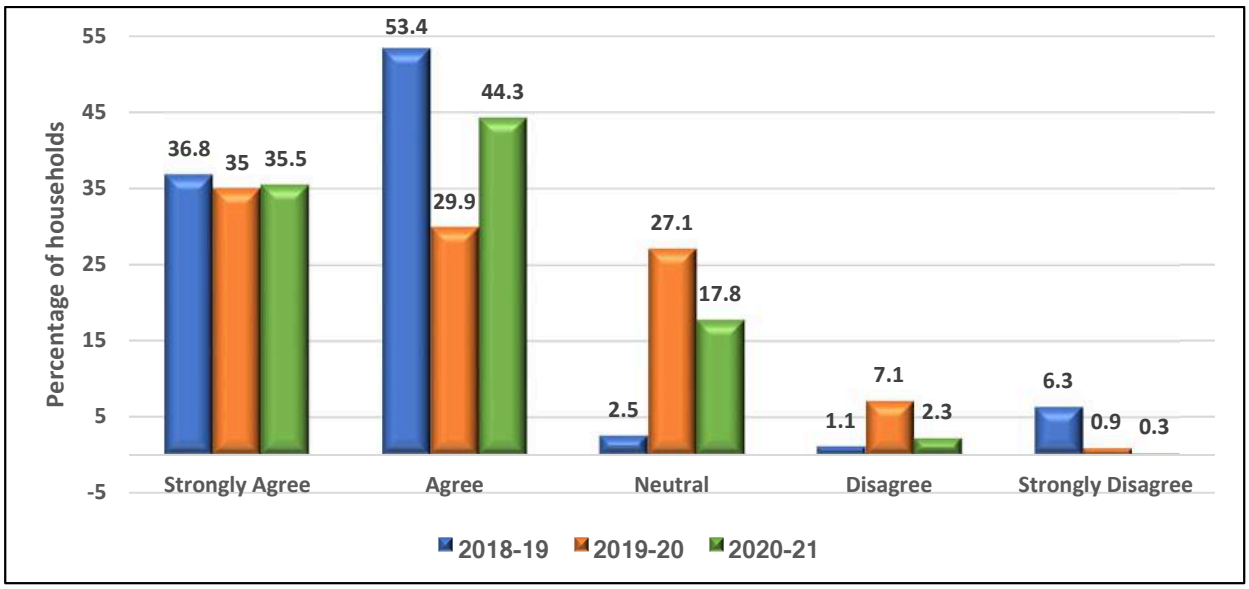
We have assessed public participation in meetings and reviews, comments and suggestions. We asked the households; do they participate in meeting at PMC or ward office or local corporator or visit the municipal office to make suggestions? We received unfavourable responses from the households. Only 23.8 per cent in 2018-19, 22.6 per cent in 2019-20 and 13.6 per cent in 2020-21 households participated actively in meetings or made suggestions to PMC. The fall in the year 2020-21 may be due to Covid-19 guidelines imposed by the government.

The above interventions by PMC have made the lives of residents comfortable, and various attempts and efforts have improved the quality of life of residents. The PMC carries out the

required interventions to achieve sustainable development of Panvel City and make it environment rich city.

When we carried out an environmental survey of 800 households, along with various questions on environment, sustainability and quality of life, we asked a question to opine on a scale from strongly agree to strongly disagree. The question was as follows- Due to its environment, Panvel is the best city to reside in among MMR cities like Badlapur, Ulhasnagar, Kalyan, Dombivali, Navi Mumbai, Thane and Mumbai.

Figure 43 Is Panvel better city in terms of environment than any of the cities in MMR?



Source: Environmental Survey for PMC, 2018-19, 2029-20 and 2020-21

The scales Agree and Strongly Agree denote that households agree largely with the statement. Hence taking these two scales together, we found that 90.1 percent (2018-19) and 88.8 per cent (2020-21) of households stated that Panvel is the best city as a residential place among all other cities in MMR.

7 INTERVENTIONS ON RECOMMENDATIONS MADE IN EARLIER ESRs

The Panvel City has emerged as one of the most favoured cities for residential purpose among all neighbouring cities in MMR. The population in the City is increasing rapidly due to industrialization, urbanization and the upcoming airport near Panvel City. Having seen the potential, many well-known builders started new and big housing projects in and around Panvel City, which will further raise the pressure on natural resources like land, water and air and civic amenities. Since the Municipal Corporation is new and has to improve residents' quality of life in the City. The local governance and administration are efficient enough to address the key issues related to the environment and have initiated steps to make the City sustainable. The response to each of the suggestion and policy recommendation is discussed as follows.

1. A proper Urban Development Plan be made to tackle the increasing demand for housing and increasing population and ward-wise population density. While doing so, the standards and norms for LCLU for roads, tree cover, open space and other facilities be followed.

   The PMC has initiated the work to prepare the Urban Development Plan following UDCPR and it is found that the PMC made substantial progress in this direction in 2019-20.

2. Safe and Adequate Drinking Water is a necessity of residents in Panvel City. The water supply in Panvel is heavily dependent upon water availability in Deharang Dam on Gadhi (Kalundre River). The increasing population in Panvel City has impacted the water supply in the City. People in the City shown their concern about the regular water supply. The water gets over in Dehrang Dam in Summer, which causes a reduction in water supply from MJP and MIDC. There is an alternate day water supply in Municipal Council Area and villages get a shortage of water. Hence Municipal Corporation provides water with the help of tankers in Panvel City. An average of 50 to 60 tankers per day water is supplied in addition to tapped water in Panvel City in Summer. Supplying water making use of tankers neither good for the health of residents nor sustainable. And hence PMC must plan for alternative provision of safe and quality drinking water, keeping the growth of urban sprawl.

   The PMC, with the help of the MJP, initiated the expansion plan to improve the water supply at a sufficient level considering the future growth of the City. In the coming three years, it is expected to get the extended water supply from Nhava Sheva Project through

MJP. The PMC has prepared a plan to meet the demand for water considering future demand for the same.

Future Water Demand:

The Navi Mumbai Airport and NAYANA projects by CIDCO are developing near the PMC area. It leads to a burden on the population in general and water management in particular. It is observed that the current population growth in PMC is are is more than estimated. The estimation shows that the water demand by Panvel city will crease to 541 ML by the year 2041.

Table 61 The estimation of the future water demand in Panvel City

Sr. No.	Year	Estimated Population	Estimated Water Demand (ML)	Estimated Water Supply (ML)	Estimated Deficit
1	2025	20.95 ML	377	335	42
2	2032	24.99 ML	450	335	115
3	2041	30.18 ML	543	335	208

Source: Water Supply Department, Panvel Municipal Corporation, Panvel, 2020-21

Future Planning:

At present 216 ML water is available per day reaming 327 ML water PMC needs to make available from other water sources. There are three main sources such as Navha-Sheva Project (by MJP), Hetavane and Kondhane (by the Patbandhare department) through which PMC can manage the water supply in future. Among which 100 ML supply of water from the Nhava-Sheva project and 19 ML from Rohinjaan will be available till 2022. Therefore, the remaining demand of 208 ML water should be a reserve from Hetavane, Balganga and Kondhane dams. If the excess water from Hetvane and Balganga projects is provided to Navi Mumbai Airport, Ulave Node and SEZ then PMC will face a water deficit of 208ML. In such a case, PMC will require 271 ML water from the Kondhane dam.

Considering the water demand in near future the PMC need to make certain provision to meet the future water demand. Kondhane dam is one such option available for PMC. The dam has the capacity to provide 271ML water per day which would be sufficient to meet the excess water demand which will arise after the year 2032. The Kondhane project is the nearest (45 Kilometre) to PMC and it is owned by CIDCO. Since the majority part of CICDO is covered under PMC, it will be beneficial to use the water supply provided by the

Kondhana dam. The provision regarding the same is allowed under the general meeting of MPC on September 5, 2019.

The Nhava Sheva Project phase 3 has been sanctioned on February 12, 2019, through which Rs. 244.53 crore will be available to PMC under Central Government's Amrut Abhiyaan project. Phase 3 of the projects is expected to complete in June 2023. Along with Kondhane Project, if the efforts have been made to increase the capacity of the Usaran and Ove dam then PMC can achieve self-sufficiency in water management.

3. The most important concern is the pollution of water bodies Kasadi and Taloja rivers in PMC areas. MPCB does not monitor the water quality of any of the rivers because water from these water bodies is not used for drinking purpose except the Gadhi River. But pollution in water bodies has multiple effects on ecosystem and biodiversity in the areas and hence we recommend that PMC insist MPCB to carry out water quality monitoring in all rivers in the PMC area.

   The PMC has requested MPCB to monitor the water quality of the rivers in the area. As an impact of the efforts taken by Shri. Arvind Mhatre, NGT imposed a fine of 15 crores to a few industries in Taloja MIDC, of which NGT advised to clean the Kasadi river.

   The immersion of Ganesha Idols must be banned in any of the rivers, lakes and ponds in the City. The PMC must make arrangements for temporary artificial ponds during Ganesh Festival to immerse Ganesha Idols at various locations in the City. The water must be treated before discharge in the water bodies and sludge must be disposed of using scientific technology. For which industries may be asked to provide CSR funds.

   The local political leaders have made a few attempts to enable the devotees to immerse the Ganesh Idol in artificial ponds. No company came forward to help PMC in this regard.

4. The MPCB monitors Ambient Air Quality at three locations in the PMC area such as Taloja MIDC Common Facility Building, Taloja MIDC, Nimisha Hospital, Sector 12, Kharghar and Panvel Water Supply behind Central Bus Stand, Panvel under National Air Monitoring Programme (NAMP) for four variables such as SO2, NOx, RSPM and SPM. There is a need for Continuous Ambient Air Quality Monitoring Stations (CAAQM). Only three Municipal Corporations have CAAQM in MMR that is BMC at six locations, Navi Mumbai has it at three locations and Kalyan-Dombivali has it at one location and MPCB monitors all. And it enables the administration to monitor air quality for 24x365 and covers all variables like

PM2.5, PM10, NO, NO2, NOx, NH3, SO2, CO, Ozone, Benzene, Eth-Benzene, MP-Xylene, AT, WS, WD, SR and BP. Hence, we strongly recommend to apply for CAAQM and must be installed at all these three locations, which is a necessity for making PMC sustainable.

The policy recommendation is taken very seriously by the local governance and administration. The CPCB was requested to install the CAAQM station in the Panvel City nearby the Taloja MIDC area. The team of CPCB visited the City to select the site for the CAAQM station. And further, CPCB has selected a location in Kalamboli for the very purpose, soon the work is expected to commence.

5. Air Pollution is also contributed by Urban Transport significantly. It is observed that a significant proportion of households make use of individual vehicles for local transportation. To reduce vehicular pollution, subsidized low cost local public transport system, as BEST reduced tariffs significantly recently to attract more people towards the mode of public transport, be made available to the residents in the City. The local public is much needed to curb CO2 emission and earn carbon credit and make Panvel City much more sustainable. It should start its own subsidized low-cost Municipal Transport System which should largely have Electric Buses to boost the reduction in vehicular pollution and also install sources of renewable energy to reduce CO2 emission at electricity generation.

   It is observed that there are number of new purchases of Electric Vehicle in the MMR region including Panvel City. With the increasing number of electric vehicles, the demand for charging stations also will rise. Hence, it is suggested to promote the private vendors for initiating charging stations, if required the land on lease may be given to the operators. Also, while purchasing new vehicles for the PMC officials and other vehicles, electric vehicles be preferred in future.

   Though the policy suggestion is accepted by the local governance and administration positively, some positive steps are taken in this direction. And it is decided to strengthen the efforts to achieve the success to implement Municipal Transport System.

   The Municipal Corporation should make paid parking lots available in commercial areas and charge a hefty penalty for parking vehicles in no-parking zones as BMC started charging Rs. 10000 for illegal parking of the vehicles. Penalty for parking vehicles in No Parking zones will demotivate residents to take personal vehicles in the areas where parking facilities are not available. The paid parking facilities be made available in

Commercial areas and near Bus Stand and Railway Station, but the parking charges be increased at a high level so that people get demotivated to take their vehicles for local transport and rely on public transport. But for that Public Transport must be efficient and optimally provided.

The parking space related aspects are positively taken into consideration in the Urban Development Plan. As per the norms, the reservations for parking are being accommodated.

As Thane Municipal Corporation initiated Bicycle facilities for local transportation, Panvel Municipal Corporation may float such a project for which feasibility study could be conducted before taking initiatives.

The Bicycle facility is initiated in the Kharghar area and has been very successful; it will be expanded soon in other areas in the City.

6. PMC carries out Solid Waste Management with the help of Mumbai Waste Management Ltd., located at Taloja, MIDC. The permission for new housing construction or housing projects must not be issued in notified MIDC area and also nearby villages of the SWM site in Taloja.

   The MIDC is the planning authority of the Taloja MIDC; the PMC does not have any role in sanctioning residential projects in Taloja MIDC. But around the Taloja MIDC, the PMC follows the UDCPR norms for sanctioning permissions for residential construction.

7. Though the waste residual from industries is treated by CEPT, it is observed that many industries in Taloja discharge residual water in Kasadi River. It is also observed that severe pollutants are discharged at Waghivali Creek by CEPT that are hazardous for the health of residents and also biodiversity in the region. The sludge is also a matter of serious concern. The lead and many chemical components in sludge may generate harmful effects on the ecosystem in the vicinity. And hence the PMC should write to the State, and Central Ministry of Environment for closure of all such industries that pollute water bodies significantly and CEPT be equipped with modern techniques that reduce pollutants significantly and make the region sustainable.

   The PMC, in cooperation with MPCB and Collector Raigad, have been positively taking steps and have requested the MPCB and GoM to look into the aspects.

8. All the water bodies such as rivers, lakes and ponds must be cleaned regularly with the help of required equipment. The PMC may take voluntary help of NGOs working on Environmental Issues in the City. There is a need to beautify ponds and lakes in the City as Thane and Navi Mumbai recently, which enlarged City's capacity for recreation and local tourism activities.

   The cleaning drives are undertaken to clean the water bodies in the City from time to time. The beatification of the ponds and lakes is initiated and soon, we will expect the results.

   The cleaning of the water bodies have been taken very seriously by the PMC since last two years. Dewale Talav is rejuvenated on which the PMC spent Rs. 2.25 Crores. The work of beatification and rejuvenation work is started and estimated cost is sanctioned by the PMC on Vadale Talav (Rs. 10.74 Crores), Juinagar Talav (Rs. 1.79 Crores), Lendale Talav (Rs. 2.51 Crores), Taloja Panchnand Talav (Rs. 7.5 Crores) and Kopra Talav (Rs. 3.51 Crores). After finishing the all works of beautification and rejuvenation of these lakes, it is expected to increase the water capacity of 27 Crore liters.

9. The Municipal Corporation must ensure that all 6 Sewage Treatment Plants (STPs) operate efficiently and optimally across the year without fail. Biogas Plants must be installed to generate energy from the sludge residual in STPs. Sewage sludge is produced in STPs as a part of the water cleaning process. The sludge contains the particles removed from the wastewater, rich in nutrients and organic matter, leaving the water clean for its release into nature. STPs serve the growing population in Panvel City, result in the rapid growth of sewage sludge production.

   All the STPs work efficiently and deliver output optimally. The treated water is discharged in the river, but the water quality is monitored from time to time with the help of MPCB. The samples of treated water are tested with the help of MPCB and found that the treated water does not damage the water body negatively.

   The MPCB in the 9th Meeting of Taloja Monitoring Committee put its observation that the sewage generated from various villages and townships located nearby MIDC Taloja is entered into Kasardi River without any treatment. The Panvel Municipal Corporation is requested to provide adequate treatment facilities such as a sewage treatment plant to prevent river Water Pollution. The MPCB instructed the Panvel Municipal Corporation to take all the necessary steps for the prevention of disposal of Municipal Solid Waste (MSW)

into Kasardi River. The PMC has to take it positively and seriously to install a STP in Taloja Node.

Bachmann (2015) stated that Anaerobic Digestion (AD) is a proven technology for sewage sludge treatment, allowing the generation of renewable energy from the same process. During AD, microorganisms break down the organic matter in the sludge and convert it into biogas, a mixture of main methane and carbon dioxide, which can be used for electricity, heat and biofuel production. At the same time, the sludge is stabilized, and its dry matter content is reduced. The benefits of AD of sewage sludge are widely recognized and the technology is well established in many countries.

The PMC can use the PPP model to initiate Biogas plants to generate energy that can fuel the electricity needs of Municipal Administrative Buildings and street lights.

The local government at PMC desires to initiate the Biogas plants to generate energy and a few positive steps are taken.

10. It is observed that there is noise pollution in residential and commercial areas in the City. The residents are to be made aware of noise pollution and its long-term effects on human health and biodiversity at large. The PMC must take a stock check of silence zones officially declared and ensure that silence zone sign boards inform these on the roadsides near such areas. The Silence Zones must be monitored for noise levels regularly with the help of Panvel Traffic Police. Random noise monitoring and penalizing vehicles for noise pollution in silence zones will substantially reduce noise pollution in these areas.

    Panvel Traffic Police monitor the noise pollution and hence the PMC has decided to extend any help that is required from the Traffic Police Department. The Silence Zones are marked as per the norms.

11. All the gardens in the City are cleaned and maintained from time to time. The tree cover in gardens be increased and plants that include flowers and aesthetics in gardens are very important aspects that relax the stress of residents. There are plenty of aesthetic plants that may be used for hedges that include Euphorbia Antiquorum (Tridhara), Pedilanthus Tithymaloides (Devils backbone), Clerodendrum Inermis (Vilayati Mehendi), Bougainvillea Spectabilis (Kagadi Flowers), Jatropha curcas (Mogli Erand), Duranta erecta, Lawsonia inermis (Mehendi), Murraya paniculata (Kamini, Kunti), Hamelia patens (Firebush), Palms, Acalypha, Caesalpinia, Aralia, Eranthemum, Lantana Tecoma etc. The ornamental

plantation can be done to cover the unused, empty open areas of public gardens in the City. The plants like Weddelia, Ipomoea batatas, Ribbon grass, blue star creepers and Irish moss can cover unused and empty areas in these gardens. The gardens must be planted with all season flower plans such as Amaranthus, Ipomoea Morning Glory, Orange Cosmos and Tithonia.

The facilities like water, toilets and electricity in gardens or near gardens be made available. The safety of assets and amenities and the visitors in the gardens is also a matter of concern. Hence security guards are employed to sustain assets and amenities in the gardens.

The gardens maintained by the CIDCO has all the required amenities. The process of handing over the gardens is not completed by CIDCO; once it is done, the PMC will initiate the necessary amenities. The tree cover is a significant concern in the City is well accepted, and the PMC has decided to improve the tree cover in the coming years.

12. Solar based LED street lights are a necessity of urban areas for sustainable cities. Hence, the Municipal Corporation must prepare a plan for Solar LED Street Lights that will not only save the electricity expenditure for years but also make Municipal Corporation self-sufficient in terms of energy.

    The suggestion is well taken by the PMC and initiated the steps in the direction.

    All administrative buildings must be equipped with Solar Energy and LED lights which will cause a one-time investment and saving energy expenditure significantly. No Occupation Certificate be issued unless operative solar energy generation is verified for new housing projects in the City. All the old housing societies must be motivated to generate solar energy for daily needs of power.

    The finance constrains the PMC; it has decided to take the help of the private players to achieve the target.

13. The new housing projects must not be issued Occupation Certificates unless they adhere to the rules and regulations prescribed by the Government of Maharashtra and Municipal Corporation. The Fire Fighting systems must be installed in all housing projects including new one and old. The PMC must ensure that all housing and commercial buildings carry out Yearly Third-Party Audit of Fire Fighting Systems installed in the housing and commercial buildings.

The PMC follows UDCPR norms for issuing Occupation Certificates for residential and commercial buildings.

14. Swachh Bharat Mission is one of the pioneering policies for making cities clean, beautiful and sustainable and attain a higher quality of life for residents in India. Panvel secured all India 86th rank securing 59.38 per cent marks in Swachh Survekshan this year. In Part I there are seven thematic areas covering 32 indicators. Panvel City secured only 44.56 per cent marks. The City has to improve its 2-star rating in the Garbage Free City indicator to a 7-star rating and ODF+ to ODF++ rating in Open Defecation Free City indicator of Part II in which Panvel City secured only 32 per cent marks. Hence Part I and Part II are a matter of concern and the Municipal Corporation must put in efforts to improve marks in these parts. And Panvel City must achieve higher marks in all seven thematic areas in Part I in the coming years.

    The PMC has made a substantial contribution in achieving better scores in Swachh Survekshan 2020 and has secured significantly high ranking the State and the country. The PMC is expected to improve its ranking in Swachh Survekshan 2021 due to its continuous efforts to make the city clean and environmentally sustainable.

15. Cleanliness and Beautification of Roads are equally important in making City sustainable. Roadside gardening on open and unused areas will enhance the look of the roads. That reduces the stress of the commuters and residents passing by the roads.

    The Urban Development Plan is being developed considering the suggestion and the work is in progress.

16. The Slums, generally are unplanned in nature, have to be rehabilitated as the residents in slums are the most vulnerable residents facing low quality of life, which hampers their productivity.

    Considerable success is achieved in this regard with the help of Prime Minister Awas Yojana.

17. Ward No 1, 2, 3 and 20 are more vulnerable and face various issues, as discussed in this report, in the provision of civic amenities due to unplanned developments in the villages in these wards. These wards must be given due weightage in urban planning and distributing resources for equal regional development.

The Urban Development Plan is being developed considering the suggestion following the UDCPR norms.

18. The official website of PMC is not up to the mark and very slow. It needs revamping and all digital payment platforms must be made available through the website and mobile app. Linking digital wallets such as Paytm, Google Pay, UPI with digital payment systems of PMC is required. There is a need to increase awareness about the Swachhata App made available by MoHUA, which helps to take corrective measures for any disproportion in urban civic facilities.

    The PMC initiated considerable changes in Digital Payment System, it installed the same at all ward offices and provide training to its staff for the same and promoted the use of the Swachhata App; thus, it could score more marks in Citizen Feedback of SS2020.

19. The PMC must look forward to applying for the Smart City Mission of Govt. of India in the coming years. The PMC must make efforts to adopt smart solutions in provisioning public goods and services and maintaining the environment while attaining sustainable development of the City.

    The City has sufficient scope of improvement, and the PMC has decided to improve the civic amenities first.

20. There is a need for a separate **Environment Department** at PMC to coordinate with all other departments and organize various environment-related activities. This department may look for PPPs for achieving goals for making City sustainable. It also must tap the potential CSR funds in improving the environment and quality of life in the City.

    The PMC decided to consult the GoM for such a provision.

21. There are many higher educational institutions in and around Panvel City, particularly engineering, medical, technical, science, commerce and humanities, that should be motivated by PMC by providing financial aid to take up scientific and innovative projects for studying environmental impacts useful for PMC from the environmental viewpoint for promoting its sustainable development.

    It is decided to take the help of all educational institutions to achieve the environmental goals. Many campaigns and competitions were conducted with the help of the educational institutions to promote the environment.

22. We proposed to appoint ward-wise 20 '**Environment Mitra**' on a voluntary basis to monitor environmental issues faced by residents in Panvel City. These Voluntary Environment Mitra will monitor environmental aspects in respective wards and coordinate with the Environment Department of PMC and other concerned departments.

    The policy recommendation is well taken and the modalities are worked out to initiate the policy recommendation.

23. The discussion with NGOs working in Environmental Issues in the City and specially with retired Professor Shri. S.V. Ranade a recommendation has come out to establish the **'Environment Rich Panvel'** Club (ERPC). The ERPC must be established under Environment Department. Through ERPC, it is expected to create public awareness about environmental conservation and protection, promotion, and dissemination of best practices in the City's sustaining environment. The EPRC will help in producing environmentally responsible citizens in the City. With the help and coordination of all other departments in PMC, EPRC can conduct various activities related to environmental protection and conservation with the participation of students in schools and colleges in the City. Many studies prove that with the help of active citizen participation, the ULBs have achieved goals for environmental improvements and sustainable development. All the 'Environment Mitra' will also help in achieving objectives set by ERPC. The quality of the environment is the right of the citizen and it also their duty to conserve and protect the environment. And hence for environmental protection and conservation through public participation, we propose to establish ERPC by PMC.

    It is decided to promote **'Environment Rich Panvel'** with the help of people participation. The Panvel Municipal Corporation initiated implementation of suggestions and policy recommendations to improve residents' quality of life through environmental improvement and sustainable development of Panvel City.

    The year 2020-21 have given many lessons to the various government bodies including the ULBs like the PMC, we suggest that a detailed feedback survey may be conducted by the PMC on Covid-19 pandemic to prepare any such disaster across the country. 2 per cent death rate among the detected patients is commendable in the city, the restless efforts made by the PMC saved thousands of lives during the pandemic. Our survey observed that the PMC have received compliments for successfully handling the Covid-19 pandemic.

सारांश

भारतीय राज्यघटनेतील ७४ व्या दुरुस्तीनुसार महाराष्ट्र शासनाने सर्व महानगरपालिकांना दरवर्षी पर्यावरण सद्यस्थिती अहवाल (ईएसआर) तयार करणे बंधनकारक केले. ईएसआर शहरातील पर्यावरणाची स्थिती आणि त्याचे व्यवस्थापन याचे विवेचन करते आणि एकूणच पर्यावरण सुधारण्यासाठी आणखी कोणत्या बाबीबाबत हस्तक्षेप करणे आवश्यक आहे असे क्षेत्र ओळखण्यास मदत करतो. म्हणूनच शाश्वत शहरी विकासासाठी धोरणात्मक निर्णय घेताना ईएसआर एक महत्त्वपूर्ण दस्तऐवज आहे. महाराष्ट्र शासनाने ४ जून २०१० रोजीच्या शासकीय ठराव क्रमांक ईएसआर-२०१०/प्र.क्र.४०/२०१०/ता.क.१ अंतर्गत पर्यावरणास अनुकूल टिकाऊ शहरासाठी मुद्द्यांची ओळख पटविण्यासाठी व धोरणे ठरविण्यासाठी दिलेल्या मार्गदर्शक सूचनांनुसार पर्यावरणावर परिणाम करणारे घटक (Drivers)- पर्यावरणावरील दबाव (Pressures)- पर्यावरणाची स्थिती (Status)- पर्यावरणावरील परिणाम (Impact)- पर्यावरण सुधारण्यासाठी महानगरपालिकेचा हस्तक्षेप (Response) (DPSIR) रचनेवर आधारित ईएसआर तयार करण्यासाठी विस्तृत पध्दत पुरविली आहे. DPSIR रचना हा एक चांगला विश्लेषणात्मक आधार आहे.

सदरिल पर्यावरण सद्यस्थिती अहवाल (ईएसआर), २०२०-२१ हा पर्यावरण सद्यस्थिती अहवाल (ईएसआर), २०१८-१९ आणि २०१९-२० प्रमाणेच शासनाने दिलेल्या २०१० च्या मार्गदर्शक सूचनांमध्ये अभिप्रेत उद्दीष्टे पूर्ण करण्याचा सफल प्रयत्न आहे. पर्यावरणाच्या समस्या ओळखण्यासाठी व पनवेल शहराला पर्यावरणास अनुकूल शाश्वत शहर बनविण्यासाठी DPSIR चौकटीचा वापर करून हा अहवाल तयार केला आहे.

प्रारंभी, पर्यावरणाच्या विविध घटकांच्या सद्यस्थितीचे विश्लेषण करण्यासाठी पनवेल महानगरपालिका (PMC), एमपीसीबी, एमजेपी, एमआयडीसी, महाडिसकॉम, भारतीय रेल्वे, एमएसआरटीसी आणि पनवेल पोलिसांकडून आवश्यक दुय्यम महिती गोळा करण्यात आली. उपलब्ध द्वितीयक माहितीतील त्रुटी भरून काढण्यासाठी व शहरातील पर्यावरणाचे प्रश्न समजून घेण्यासाठी शहराचे पर्यावरण सर्वेक्षण करण्यात आले आहे. शहरातील २० प्रभागांमधील ८०० कुटुंबांचे यादृच्छिकपणे निवडलेल्या नमुन्यांसाठी ज्याप्रमाणे २०१८-१९ व २०१९-२० मध्ये पर्यावरण सर्वेक्षण करण्यात आले होते त्याप्रमाणेच २०२०-२१ या वर्षासाठीसुद्धा पर्यावरण सर्वेक्षण करण्यात आले. पर्यावरणाच्या समस्या आणि समस्यांचे निराकरण करण्यासाठीच्या पीएमसीच्या प्रयत्नांविषयी जाणून घेणे आणि पर्यावरणास अनुकूल असे शाश्वत शहर विकसित करण्यात कुटुंबांच्या पर्यावरण विषयक वाजवी अपेक्षा समजून घेणे ही या सर्वेक्षणाची उद्दीष्टे होती. काही घटकांबाबतची माहिती ही २०१८-१९ च्या पर्यावरण सर्वेक्षणातुन घेण्यात आली आहे कारण संबंधित माहिती ही स्थैतिक घटक प्रकारातील आहे. त्याच बरोबर काही चलांचे विश्लेषण व तुलना करण्यासाठी २०१८-१९, २०१९-२० आणि २०२०-२१ या तीनही पर्यावरण सर्वेक्षणांचा वापर करण्यात आला आहे.

लोकसंख्या, राहणीमान, कुटुंबांची व्यावसायिक रचना, नागरीकरण आणि औद्योगिकीकरण, आरोग्य आणि शिक्षणाची पातळी यासारखे सामाजिक घटक शहरी भागातील पर्यावरणाचे मुख्य प्रेरक आहेत. त्याचबरोबर शहरीकरण आणि शहरातील आणि आसपासच्या उद्योगांचे स्थानिकीकरणामुळे यांचाही पर्यावरणीय ऱ्हास

होण्यात तेवढाच वाटा मानला जातो. शहरातील वॉर्डांमधील लोकसंख्येच्या घनतेत प्रचंड फरक असल्याचे निरीक्षणास आले आहे. शाश्वत शहरी विकासाच्या भूमिकेतून त्याकडे लक्ष देणे आवश्यक आहे. शहरातील कुटुंबांच्या उत्पन्नात विषमता खूपच जास्त असल्याचे दिसून आले आहे आणि त्यामुळे मालमत्ता व सुविधांचे असमान वितरण होते. परिणामी शहरातील अल्प जन मोठ्या प्रमाणात शहरातील पर्यावरणाचा ऱ्हास करण्यास हातभार लावतात.

शहरी भागातील भूमीचा उपयोग, नैसर्गिक संसाधनांचे खनन, बहिर्गत उत्पादक घटक (खते, रसायने, सिंचन), उत्सर्जन (प्रदूषक आणि कचरा) आणि सजीव घटकांमधील बदल आणि त्यांच्या हालचाली यासारख्या महत्त्वपूर्ण दबाव चलांचा पर्यावरणावर परिणाम होतो. पर्यावरण एक सार्वजनिक वस्तू मानली जाते, त्यामुळे पनवेल शहरातील वाढत्या स्थलांतरामुळे वाढणारी लोकसंख्या, स्वस्त घरे, कार्यक्षम रेल्वे वाहतुकीची सोय आणि मोठ्या औद्योगिक उपक्रम हे पर्यावरणाचे संचालन करतात. अलिकडच्या काही वर्षांत पनवेल शहराच्या भूप्रदेशाचे चित्र बदलत असल्याचे दिसून आले आहे, भूमीचा वापर आणि भूआच्छादनामध्ये (Land Use and Land Cover) लक्षणीय बदल झाला आहे. पनवेलमधील घरांच्या मागणीत लक्षणीय वाढ झाल्यामुळे शहरातील उपलब्ध जमिनीवरील ताण वाढला आहे. भूमीचा वापर आणि भूआच्छादनावरून हे स्पष्ट होते कि पनवेल शहरात जलद शहरीकरण झाले आहे. प्रभाग क्रमांक १, २, ३ आणि २० मधील भूमीचा वापर अनियोजित आहे ज्यासाठी तातडीने या भागासंबंधित नगररचनेच्या आराखड्याकडे विशेष लक्ष द्यावे लागेल. झोपडपट्ट्या प्रामुख्याने अनियोजित असतात आणि म्हणूनच अशा भागात झाडाची संख्या कमी असणे, लोकसंख्येची घनता खूप अधिक असणे, अरुंद रस्ते आणि पाणीपुरवठा करणाऱ्या अत्यंत असुरक्षित वाहिन्या (स्वतंत्र पाण्याची पाइपलाइन टाकण्यासाठी पुरेशी जागा नसल्यामुळे ड्रेनेज आणि पाण्याच्या वाहिन्या एकत्र असणे) यासारखे प्रश्न झोपडपट्ट्यामध्ये राहणाऱ्या लोकांच्या जीवनावर वाईट रीतीने परिणाम करतात.

जुलै आणि ऑगस्ट महिन्यात पिण्याच्या पाण्याची गुणवत्ता चांगली नसल्याचे दिसून आले आहे. औद्योगिक क्षेत्रात व औद्योगिक क्षेत्राच्या आजूबाजूला हवेचे प्रदूषण आहे. पनवेल शहरातील नागरिकांच्या मते उद्योगांनी सोडलेल्या प्रदूषित जल प्रवाहातून आजूबाजूचे जल स्रोत प्रदूषित होतात.

या अहवालात वातावरण, जमीन, पाणी आणि जैवविविधता यासारख्या नैसर्गिक भांडवलाबरोबरच आणि स्ट्रॅटोस्फेरिक ओझोन थर कमी होणे, जैवविविधता बदल आणि प्रदूषण, हवा, पाणी, खनिज आणि जमीन ऱ्हास होणे यासारखे पर्यावरणीय परिणाम आणि हवामानातील बदल यावर चर्चा झाली आहे. या पर्यावरणीय सद्यस्थिती अहवालात वाढती लोकसंख्या, शहरीकरण आणि विविध औद्योगिक उपक्रमांमुळे पाणी आणि जैवविविधते सारख्या संसाधनांचा ऱ्हास झाल्याचे दिसून येते.

कार्यक्षम घनकचरा व्यवस्थापन, पुरेशा प्रमाणात सार्वजनिक व सामुदायिक शौचालये आणि उत्तम गटार व्यवस्थापन या संदर्भात पीएमसीने केलेलया प्रामाणिक प्रयत्न आणि एमजेपीने स्वच्छ व सुरक्षित पाणीपुरवठा करण्याच्या केलेल्या प्रयत्नांमुळे शहरात आजारपणाचे प्रमाण कमी असल्याचे दिसून आले आहे.

त्याचबरोबर एमपीसीबीने दिलेल्या माहितीच्या मदतीने शहरातील तीन ठिकाणचे वर्षभराचे वायु प्रदूषण आणि गणेशोत्सव आणि दिवाळी उत्सव काळातील ध्वनी प्रदूषणाचे विश्लेषण या अहवालात केले आहे. उपलब्ध माहितीनुसार वायू गुणवत्ता निर्देशांकाचे निर्धारण करण्यात आले, त्यानुसार वर्षभर खारघर आणि पनवेल बस स्टँड भागात विशेष वायू प्रदूषण नसल्याचे दिसून आले आहे. तर तळोजा औद्योगिक क्षेत्रातही वायू प्रदूषण नगण्य असल्याचे निदर्शनास आले आहे. अहवालात वायू प्रदूषणाची कारणेदेखील उलगडली गेली आहेत, सन २०१९-२० मधील बहुतेक दिवस वायु प्रदूषणाची मध्यम पातळी (सीपीसीबीने ठरविलेल्या कार्यपद्धतीच्या सहाय्याने एअर क्वालिटी इंडेक्सद्वारे मोजली) गाठल्याचे दिसून आले आहे त्याचे प्रमुख कारण शहरातील उद्योग आणि वाहनांमुळे होणारे हवेचे प्रदूषण असल्याचे दिसून आले आहे. परंतु हि तिन्ही वायू गुणवत्ता निरीक्षण केंद्र हवेचे सातत्यपूर्ण नमुने घेत नाहीत. त्यामुळे अद्ययावत तंत्रज्ञानावर आधारित CAAQM यंत्रणा पनवेल शहरातील वायू प्रदूषणावर देखरेख ठेवण्यासाठी असणे अत्यंत आवश्यक आहे आणि त्यासाठी CBCB आणि MPCB कडे त्यासाठी पाठपुरावा करावा अशी शिफारस २०१८-१९ च्या पर्यावरण सद्यस्थिती अहवालात करण्यात आली होती. त्यानुसार पनवेल महानगरपालिकेने CPCB आणि MPCB कडे त्यासाठी पाठपुरावा केला असून लवकरच CAAQM हि यंत्रणा CPCB द्वारे महापालिका क्षेत्रात उभी केली जाणार आहे.

ध्वनी प्रदूषणासाठी, नवरात्रौत्सव काळातील शहरातील तीन ठिकाणी दोन दिवस आणि उत्सव नसलेले आठवड्यातील कामकाजाचे दिवस व आठवड्याच्या शेवटचे दिवस शहरातील निवडलेल्या तीन ठिकाणी ध्वनीची तीव्रता शोधण्यासाठी प्रत्यक्ष ध्वनी तीव्रता मापक यंत्रांच्या सहाय्याने ध्वनी तीव्रतेविषयीची माहिती गोळा करून त्यांचे विश्लेषण केले आहे. त्यात असे निदर्शनास आले आहे कि नवरात्र उत्सवात तिन्ही ठिकाणी ध्वनी तीव्रतेचे राष्ट्रीय मापदंड ओलांडले गेलेले आहेत. त्याचबरोबर उत्सव कालावधी सोडून इतर कालावधीत ज्या तीन ठिकाणच्या ध्वनी तीव्रतेचे मापन करण्यात आले त्यातही असे निदर्शनास आले आहे कि तिन्ही ठिकाणी ध्वनीचे राष्ट्रीय मापदंड ओलांडले गेले आहेत.

औद्योगिक मल प्रवाहामुळे कासाडी आणि तळोजा नदीतील पाणी प्रदूषित झाले आहे त्यामुळे जवळपास रहिवाश्यांच्या आरोग्यावर परिणाम होत असल्याचे निदर्शनास आले आहे. नासाच्या सॅटेलाइट प्रतिमांवर आधारित शास्त्रीय विश्लेषणामुळे शहरातील भूमीच्या वापराचा आणि भूआच्छादनाचा आढावा घेण्यात आला आहे आणि भूआच्छादनाचे वर्गीकरण आणि जमिनीच्या वापराच्या वितरणाची टक्केवारी काढून २०१६, २०१८, २०१९ आणि २०२० चे विश्लेषण करण्यात आले आहे. त्याचा उपयोग नगर विकास आराखडा तयार करण्यासाठी केला जावा अशी शिफारस करण्यात आली आहे. त्याबरोबरच आपणास जैवविविधतेची स्थिती व जैवविविधतेतील बदल शहरीकरणाचा पर्यावरणावर होणारा परिणाम समजण्यास मदत करतात. शहरातील ऑक्सिजनच्या पुरेशा प्रमाणासाठी अधिकाधिक वृक्षारोपणाची गरज असल्याचे यावरून निदर्शनास येते. वृक्षारोपण कार्यक्रमांच्या माध्यमातून वृक्षाच्छादन वाढविण्यासाठी पीएमसीने मागील काही वर्षांपासून केलेले प्रयत्नही या अहवालात नमूद केले आहेत.

शहर स्वच्छ, सुंदर आणि पर्यावरणास अनुकूल बनविण्यासाठी पीएमसीने प्रामाणिकपणे केलेल्या प्रयत्नांमुळे २०१९ मध्ये स्वच्छ सर्वेक्षण मध्ये भारतातील एकूण ४२३७ शहरांमध्ये पनवेल शहराची श्रेणी सुधारून ८६ झाली होती ती २०२० मध्ये सुधारून २० वर आली आहे, त्यात पीएमसीने ६००० पैकी ४५९९.७४ गुण प्राप्त केले. स्वच्छ सर्वेक्षण २०२० मध्ये पीएमसी ने महाराष्ट्रात १ ते १० लाख लोकसंख्या असणाऱ्या शहरांमध्ये ५ वा क्रमांक मिळवला आहे. स्वच्छ सर्वेक्षण २०२० मध्ये पीएमसीने उल्लेखनीय यश मिळवले आहे. त्याचबरोबर महापालिकेला ODF++ दर्जा ऑगस्ट २०१९ मध्ये प्राप्त झाला आहे. घनकचरा व्यवस्थापन, मलनिःसारण व्यवस्था, नियमितपणे शहर स्वच्छता आणि शहरातील काही भाग वगळता रस्त्यांची गुणवत्ता सुधारण्याबाबतच्या महापालिकेच्या प्रयत्नांसाठी पनवेलमधील रहिवाशांनी महापालिकेचे कौतुक केले आहे.

अहवालात शेवटी पनवेल शहर एमएमआरमधील शेजारच्या सर्व शहरांमध्ये राहण्यासाठी पनवेल शहर सर्वात अनुकूल शहरांपैकी एक असल्याचे म्हटले आहे. औद्योगिकीकरण, शहरीकरण आणि पनवेल शहराजवळील आगामी विमानतळ यामुळे शहरातील लोकसंख्या झपाट्याने वाढत आहे. पनवेलमधील भविष्यातील शहरीकरणाची संभाव्यता लक्षात घेऊन अनेक नामांकित बांधकाम व्यावसायिकांनी पनवेल शहराच्या आसपास आणि पनवेल शहरात नवीन गृहनिर्माण प्रकल्प सुरू केले आहेत ज्यामुळे जमीन, पाणी, हवा आणि नागरी सुविधांसारख्या नैसर्गिक संसाधनांवर दबाव वाढण्याची मोठी शक्यता आहे. महानगरपालिका नवीन असल्याने शहरातील रहिवाशांच्या जीवनमानाची गुणवत्ता सुधारणे एक मोठे आव्हान आहे. पर्यावरण सद्यस्थिती अहवाल २०१८-१९ मध्ये काही मूलभूत शिफारशी करण्यात आल्या होत्या त्या सर्व शिफारशी पीएमसी ने अत्यंत गांभीर्याने घेतल्या आहेत. या अहवालात या सर्व शिफारशींवर पीएमसीने काय कार्यवाही केली याचे विश्लेषण सुद्धा केले आहे.

पीएमसीने स्वतःच्या मालकीच्या एसटीपी मध्ये बायोगॅस वर आधारित वीज निर्मिती प्रकल्प सुरु करण्याचे निर्धारित केले आहे, त्याचबरोबर शहरात सार्वजनिक ठिकाणी एलइडी दिवे लावण्याचे निश्चित केले आहे. पीएमसी ने जैविक व अजैविक घरगुती कचऱ्याचे वर्गीकरण १०० टक्के पर्यंत करण्याचे ठरविले होते त्यात महापालिकेला मोठ्या प्रमाणात यश मिळाले आहे. एमजेपीच्या सहकार्याने शहरातील पाणी पुरवठ्याची क्षमता वाढविण्यात येणार आहे. ज्या ज्या ठिकाणी रस्त्यांची रुंदी वाढविणे शक्य आहे असे सर्व प्रयत्न करण्याचे निश्चित केले आहे. सोलार वीज निर्मितीसाठी प्रोत्साहन देण्याचे ठरविले होते त्यात बऱ्याच अंशी पहापालिकेला यश मिळाले आहे. महाराष्ट्र शासनाने प्लास्टिक बंदीविषयीचे २०१८ मध्ये अधिसूचना काढल्यानंतर महापालिकेने निर्बंधित प्लास्टिक उत्पादक, विक्रेते आणि ग्राहक यांच्यावर कारवाई करीत मोठ्या प्रमाणात प्लास्टिक हस्तगत केले आणि यातून फेब्रुवारी २०२० पर्यंत ३९.७१ लाख एवढा दंड जमा केला. त्याचबरोबर इतर सर्व शिफारशी सुद्धा लवकरच राबविण्याचे निर्धारित करण्यात आले आहे.

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Investigator taking interview

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बीकानेर